A

SYSTEM

OF

ANATOMY

AND

PHYSIOLOGY;

FROM THE

LATEST and BEST AUTHORS.

ARRANGED,

AS NEARLY AS THE NATURE OF THE WORK WOULD ADMIT,

IN THE

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THE COMPARATIVE ANATOMY.

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A SYSTEM OF ANATOMY, WITH THE PHYSIOLOGY.

PART VI.

Containing a DESCRIPTION of the

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CHAP I.

Of the HEAD.

BESIDES the brain, which is contained within the cranium, the head preſents to us the organs of ſight, of ſound, of ſmell, of taſte, and the greater part of thoſe which ſerve for deglutition.

THE PERICRANIUM.

BESIDES the external integuments of the head, viz. the hair, ſkin, and cellular ſubſtance, there are two o-

ther expanſions on the head; the firſt is the tendon of the occipito-frontalis muſcle; the ſecond is the pericranium, which covers the external ſurface of all the bones of the cranium.

The external part of this membrane may be ſaid to ſeparate from the other at the ſemicircular plane upon the ſide of the cranium, mentioned in the deſcription of the bones; and becomes a very ſtrong aponeuroſis, which covers the temporal muſcle, and is afterwards fixed to the external proceſs of the os frontis, and to the upper edge of all the zygoma. The reſt of the pericranium is connected to the other parts of the head.

The head, being conſidered in general as one of the three principal cavities of the human body, has this peculiar to it, that its outſide is the ſeat and baſis of ſeveral very complex particular organs; whereas on the inſide it contains only one, which is indeed the primum mobile of the whole animal œconomy; namely, the brain; the mechaniſm of which is very little known; and the ſtructure of its different parts, even of thoſe which we are ſuppoſed to be moſt acquainted with, is very difficult to be demonſtrated.

Sect. I. *Of the* Brain *and its* Appendages.

The name of *brain* is given to all that maſs which fills the cavity of the cranium, and which is immediately ſurrounded by two membranes, called *meninges* by the Greeks, and *matres* by other ancients, becauſe they were commonly of opinion that theſe membranes were the origin, and, as it were, the mother, of all the other membranes of the body.

This general maſs is divided into three particular portions; the cerebrum or *brain* properly ſo called, the cerebellum, and medulla oblongata. To theſe three parts contained within the cranium, a fourth is added, which

which fills the great canal of the ſpina dorſi, by the name of *medulla ſpinalis*, being a continuation of the medulla oblongata.

The meninges, or membranes, are two in number; one of which is very ſtrong, and lies contiguous to the cranium; the other is very thin, and immediately touches the brain. The firſt is named *dura mater;* the ſecond *pia mater.* This laſt is again divided into two; the external lamina being termed *arachnoides*, the internal retaining the common name of *pia mater.* We begin with theſe meninges.

§ 1. *Dura Mater.*

Situation in general. The dura mater incloſes the brain and all its appendages. It lines the inſide of the cranium, and ſupplies the place of an internal perioſteum, being ſpread in holes and depreſſions, and covering all the eminences in ſuch a manner as to prevent their being hurtful to the brain.

Diviſion. In deſcribing the dura mater, we muſt take notice, 1. Of its compoſition. 2. Its adheſions to the cranium. 3. Its folds or ſepta. 4. Its productions, veſſels, and nerves.

Compoſition. The dura mater is compoſed of one lamina; although it may, by maceration, be divided into two or more. Its texture is very cloſe and ſtrong, appearing to be partly ligamentous and partly tendinous.

Adheſion. The dura mater ſticks cloſely to the cranium by a great number of filaments of the external ſurface, which enter the pores of the bones, almoſt every where, but more particularly at the ſutures both above and below; and by penetrating theſe joints, they communicate with the external perioſteum. Theſe filaments are, for the moſt part, ſmall veſſels; which being broken in ſeparating the dura mater from the ſkull,

a great number of red points appear on the external surface of that membrane.

It adheres much more to the whole inner surface of the cranium in children and young persons than in those of an advanced age; the filaments become then very small, being compressed by the contraction of the bony pores; and consequently they are more easily ruptured by any force applied to them.

These adhesions are formed entirely by the outer surface of this membrane, the inner part of it being very smooth and polished, and is also continually moistened by a fine fluid discharged thro' its pores, much in the same manner as the peritonæum and pleura.

Folds and septa. The dura mater sends off several processes; three of which form particular septa that divide the brain into certain parts. One of them is superior, representing a kind of mediastinum between the two great lobes of the brain: The second is in a middle situation like a diaphragm, between the cerebrum and cerebellum: the third is inferior, between the lobes of the cerebellum. The superior septum is longitudinal in form of a scythe, from whence it is termed the *falx of the dura mater;* and it may likewise be called *septum sagittale, verticale*, or *mediastinum cerebri.* The middle septum is transverse; and might be called *the floor of the cerebrum, the diaphragm of the brain, tentorium cerebelli.* The inferior septum is very small, and runs down between the lobes of the cerebellum; on which account it may be termed either simply *septum cerebulli*, or *septum occipitale minus*, the middle partition being looked upon as the septum occipitale majus.

The superior or vertical septum, called the *falx of the dura mater*, is a long and broad fold or duplicature of the internal part, reaching from the edge of the crista Ossis Cribrosi, along the sagittal suture, to the middle of the transverse septum; which it joins in such a manner, as that the lateral laminæ of the falx are continuous

tinuous on each ſide with the neighbouring portions of the ſuperior lamina of the middle ſeptum.

It is broader where it joins the middle ſeptum than at the os ethmoides; and it is thicker at that edge which adheres to the cranium than at the other, which lies looſe and is very ſharp; and from this reſemblance to a ſcythe, it had the name of *falx*.

The tranſverſe or middle ſeptum, called *tentorium cerebelli*, is fixed to the os occipitisa long the grooves of the lateral ſinuſes, and thoſe of the great angles of the apophyſes petroſæ all the way to the poſterior clinoide apophyſes of the os ſphenoidale. By this ſituation it forms a ſort of floor, tent, or ſhallow vault, on the fore-part of which is a large notch almoſt of an oval figure.

This ſeptum divides the cranium into two cavities, one larger or ſuperior, and the other ſmall or inferior, which communicate together by the great oval notch. It is formed by a particular fold, and a very broad membrane of the internal part of the dura mater; and in the natural ſtate it is very tenſe, becauſe of its union or rather continuity with the falx.

This union or continuity of theſe two ſepta keeps them both very tenſe, ſo that the middle ſeptum is capable of ſuſtaining a conſiderable weight without ſinking downward; and the falx is able to reſiſt lateral preſſures, without giving way to the right or left ſide.

We may be convinced of this reciprocal tenſion, by firſt touching theſe two ſepta in their natural ſtate; and again, after they have been cut one after the other according to their breadth; or rather after having cut in this manner the falx in one ſubject, and the tranſverſe ſeptum in another: for as ſoon as the falx is cut, the other will be perceived immediately to loſe its tenſion and firmneſs; and the ſame thing will be obſerved in the falx as we cut the tentorium.

The ſmall occipital ſeptum is both very ſhort and narrow. It runs down from the middle of the tranſverſe

ſeptum to the edge of the great occipital hole, being fixed to the internal ſpine of the os occipitis. It is formed by a fold and duplicature of the internal part of the dura mater, in the ſame manner as the other two, and diſtinguiſhes the lower part of the occipital cavity of the cranium into two lateral parts. In ſome ſubjects this ſeptum is double, anſwering to the double ſpine of the os occipitis.

Sphenoidal folds. Beſides theſe large folds, there are two ſmall lateral ones on each ſide of the ſella turcica, each running from the poſterior to the anterior clinoide apophyſis on the ſame ſide. Theſe two folds, together with the anterior or poſterior parts of the ſella tucirca, form a ſmall foſſula, in which the pituitary gland is lodged. There are likewiſe two anterior folds at the edges of the ſphenoidal or ſuperior orbitary fiſſures, which augment the depth of the middle foſſulæ of the baſis cranii. Thus we have ſeven folds of this membrane, three large and four ſmall, which may be termed *internal productions* or *proceſſes of the dura mater.*

Elongations. The elongations of the dura mater go beyond the general circumference, and paſs out of the cranium, through the openings deſcribed in the treatiſe of the ſkeleton, and may be named *external productions of the dura mater.*

The moſt conſiderable of theſe elongations paſſes through the great occipital foramen, and runs down the common canal of the vertebræ in form of a tube, lining the inſide of that canal, and incloſing the medulla ſpinalis, by the name of the *dura mater* of that medulla. The other elongations accompany the nerves out of the cranium in form of vaginæ, which are more numerous than the nervous trunks reckoned in pairs. For the olfactory nerves, there is the ſame number of diſtinct vaginæ as there are holes in the lamina ethmoidalis; and ſome nerves are accompanied by ſeveral vaginæ through one hole, as thoſe of the ninth pair.

There

There are two particular elongations which form the perioſteum of the orbits, together with the vaginæ of the optic nerves. Theſe orbitary elongations go out by the ſuperior orbitary fiſſures, or foramina lacera of the ſphenoid bone; and, increaſing in breadth in their paſſage, line the whole cavity of the orbits, at the edges of which they communicate with the pericranium and perioſteum of the face. They communicate likewiſe, through the ſpheno-maxillary or inferior orbitary fiſſures, with the pericranium of the temporal and zygomatic foſſæ; and by theſe communications we may explain the accidents which happen to theſe parts in wounds of the head.

The elongations of the dura mater which accompany the blood-veſſels through the foramina of the cranium, unite with the pericranium immediately afterwards. Such, for inſtance, are the elongations which line the foſſulæ of the foramina lacera or jugularia, and the bony or carotid canals of the apophyſis petroſa, &c.

Arteries. The veſſels of the dura mater are arteries, veins, and ſinuſes. The arteries in general are diſtinguiſhed into anterior, middle, and poſterior; and come from the carotids and vertebrales on each ſide. The external carotid ſends a branch through the ſpinal hole of the os ſphenoidale, which is the middle artery of the dura mater; and is called, by way of eminence, *arteria duræ matris.* It is divided into a great number of branches, which are plentifully diſperſed through the ſubſtance of the external lamina as high as the falx, where theſe ramifications communicate with their fellows from the other ſide. The impreſſions of this artery are ſeen on the inſide of the parietal bones; the anterior and lower angle of which, inſtead of a ſimple impreſſion, contains a canal for the paſſage of a trunk or branch of this artery; on which account ſeveral accidents happen in fractures of the ſkull.

The external carotid ſends another ſmall ramus

through the corner or ſmall end of the ſphenoidal or ſuperior orbitary fiſſure; where there is ſometimes a little notch on purpoſe, mentioned in the Deſcription of the Skeleton. This branch is the anterior artery of the dura mater; and it gives off ramifications in the ſame manner as the former with which it communicates, but its ramifications are not ſo numerous. The internal carotid, as it enters the cranium, gives off a ſmall branch to the ſubſtance of the dura mater.

The two vertebral arteries enter by the great occipital foramen, and unite in one trunk on the anterior or ſphenoidal apophyſis of the os occipitis. Immediately after they paſs through the dura mater on both ſides, each of them ſends one or two branches to that membrane. Theſe are the poſterior arteries of the dura mater; and they communicate by ſome ramifications with the middle or ſpinal artery above mentioned.

Veins and ſinuſes. The dura mater contains in its duplicature ſeveral particular canals; into which the venous blood, not only of that membrane, but of the whole brain, is carried. Theſe canals are termed *ſinuſes;* and ſome of them are diſpoſed in pairs, others in uneven numbers: that is, ſome of them are placed alone in a middle ſituation; others are diſpoſed laterally on each ſide of the brain. The moſt ancient anatomiſts reckoned only four; to which we can now add ſeveral others.

Theſe ſinuſes are in the duplicature of the dura mater; and their cavities are lined on the inſide by particular very fine membranes. They may be enumerated in this manner: The great ſinus of the falx, or ſuperior longitudinal ſinus, which was reckoned the firſt by the ancients. Two great lateral ſinuſes, the ſecond and third of the ancients. The ſinus, called *torcular Herophili*, the fourth of the ancients. The ſmall ſinus of the falx, or inferior longitudinal ſinus. The poſterior occipital ſinus, which is ſometimes double. Four ſinus petroſi; two on each ſide, one ſuperior, and

and one inferior. Two tranſverſe occipital ſinuſes, The circular ſinus of the ſella ſphenoidalis. Two ſinus cavernoſi, one on each ſide. Two orbitary ſinuſes, one on each ſide.

All theſe ſinuſes communicate with each other, and with the great lateral ſinuſes, by which they diſcharge themſelves into the internal jugular veins, which are only continuations of theſe lateral ſinuſes. They likewiſe unload themſelves, partly into the vertebral veins, which communicate with the ſmall lateral or inferior occipital ſinuſes; and partly into the external jugular veins, by the orbitary ſinuſes, which communicate with the venæ angulares, frontales, naſales, maxillares, &c. as the lateral ſinuſes likewiſe communicate with the venæ occipitales, &c.

Thus the blood, which is carried to the dura mater, &c. by the external and internal carotid, and by the vertebral arteries, is returned to the heart by the external and internal jugular and vertebral veins; ſo that, when the paſſage of the blood is obſtructed in any particular place, it finds another way by virtue of theſe communications, though not with the ſame eaſe. This obſervation is of conſequence, in relation not only to obſtructions, but to the different ſituations of the head.

The great ſinus of the falx reaches from the connection of the ethmoidal criſta with the os frontis, along the upper edge of the falx, all the way to the poſterior edge of the tranſverſe ſeptum, where it ends by a bifurcation in the great lateral ſinuſes. It is very narrow at its anterior extremity, and from thence becomes gradually wider all the way to its poſterior extremity.

The cavity of this ſinus is not cylindrical, but triangular, having in a manner three ſides; one ſuperior, parallel to the cranium; and two lateral, inclined to the plane of the falx. The upper ſide is formed by the external ſurface of the dura mater; and through

the

the middle of its breadth a kind of fine raphe or future runs from one end to the other.

The two lower or lateral ſides are productions of the inner ſurface of the dura mater; which having parted from the external, are inclined toward each other, and then unite; forming firſt the ſinus, and afterwards the duplicature of the falx. This ſinus is lined interiorly by a fine proper membrane, which forms likewiſe a kind of raphe or future along the bottom of the ſinus, that is, along the union of the two lateral ſides.

In this ſinus we obſerve ſeveral openings and ſeveral ligamentary frænа. The openings are orifices of veins; the ſmalleſt of which belong to the dura mater, the largeſt to the brain. The veins of the brain enter the ſinus for the moſt part, obliquely from behind forward, after they have run about a finger's breadth in the duplicature of the dura mater.

It has been thought that the arteries of the dura mater diſcharged themſelves immediately into the ſinuſes; becauſe injections made by the arteries, or a hog's briſtle thruſt into them, have been found to paſs into theſe ſinuſes: but, on a more cloſe examination, it has been diſcovered, that the injections paſſed from the arteries into the veins, and from thence into the ſinuſes, through the ſmall orifices already mentioned; and that the hog's briſtle pierced the ſides of the artery, which near the ſinuſes are very thin.

This miſtake gave riſe to another, that the dura mater had no veins; and what confirmed it was, that the arteries of the dura mater cover the veins ſo entirely, that the edges of the veins are hardly perceivable on either ſide of the arteries. There are, however, ſome places where the veins being broader than the arteries, their two edges are ſeen on each ſide of the arteries like capillary veſſels. Theſe veins are, for the moſt part, branches of the ſinuſes; and the ſmall trunks of

ſome

ſome of them open into the head of the vena jugularis interna. We may eaſily be ſatisfied that the arteries on both ſides of the dura mater communicate with each other above the falx, either by injecting or blowing into them.

The internal frænа of this great ſinus appear to be tendinous, and to be deſigned to prevent the too great dilatation of the ſinus by the blood. They vary, however, in different ſubjects, and do not always reach from one ſide to the other. It has been pretended, that glands have been found there; but we ought to take care not to miſtake for ſuch certain ſmall corpuſcles, which ſeem to have about them very little of the nature of glands.

The inferior ſinus of the falx is ſituated in the lower edge of its duplicature, being very narrow, and, as it were, flatted on both ſides. It communicates immediately with the fourth ſinus of the ancients; and in ſome ſubjects ſeems even to be a continuation thereof. It likewiſe communicates with the great or ſuperior ſinus by ſmall veins which go from one to the other, and with the veins of the cerebrum by the ſame means.

The lateral ſinuſes repreſent two large branches of the ſuperior longitudinal ſinus, one going to the right hand, the other to the left, along the great circumference of the tranſverſe ſeptum, all the way to the baſis of the apophyſis petroſa of the oſſa temporum. From thence they run down, having firſt taken a large turn, and then a ſmall one; and being ſtrongly fixed in the lateral grooves of the baſis cranii, they follow the courſe thereof all the way to the foramina lacera and foſſulæ of the jugular veins.

They do not always ariſe by an equal bifurcation of the ſuperior longitudinal ſinus; for, in ſome ſubjects, one of the lateral ſinuſes appears to be a continuation of the longitudinal, and the other to be a branch from it. This variety may happen on either ſide; and, in

a word, we ſometimes find one of theſe ſinuſes higher or lower, larger or ſmaller, than the other.

The cavity of theſe lateral ſinuſes is likewiſe triangular, and furniſhed with a proper membrane and with fræna: and it has alſo the ſmall venal openings; which indeed are common to it, not only with the longitudinal ſinus, but with moſt part of the others. The poſterior or outer ſide of this cavity, is formed by the external part of the dura mater, and the other two by the internal part.

As theſe two ſinuſes go out by the poſterior portions of the openings of the baſis cranii, called *foramina lacera*, they are dilated into a kind of bag, proportioned to the foſſulæ of the venæ jugulares, where they terminate in theſe veins.

Near the concourſe of the ſuperior longitudinal and lateral ſinuſes, we obſerve an opening (ſometimes double), which is the orifice of a ſinus ſituated along the union of the falx and tranſverſe ſeptum. It does not always end directly at the lower part of the ſuperior ſinus, but ſometimes opens at the beginning of one of the lateral ſinuſes, eſpecially when the bifurcation is not equal; and in this caſe it often terminates in that lateral ſinus, which appears like a branch from the common trunk of the ſuperior and other lateral ſinus.

This ſinus has been named *torcular Herophili*, from an ancient author, who imagined that the blood was in a manner in a preſs, at the union of theſe four ſinuſes. Its diameter is but ſmall; and it forms a kind of bifurcation with the inferior longitudinal ſinus, and with a vein of the cerebrum, which is ſometimes double, called *vena magna Galeni*.

The cavernous or lateral ſinuſes of the os ſphenoides, are reſervatories of a very particular kind; containing not only blood, but conſiderable veſſels and nerves, as we ſhall ſee hereafter; and likewiſe a ſpongy or caver-

nous ſubſtance full of blood, much like that of the corpus cavernoſum of the urethra.

Nerves and glands. We obſerve ſome nervous filaments which appear to go to the dura mater from the trunk of the fifth pair, at the entry of the cavernous ſinus; and from the common trunk of the eighth pair and nervus acceſſorius or ſpinalis, as they paſs through the foramen lacerum; and inflammation, as well as ſurgical phenomena, ſhow that it is not void of ſenſibility, though, in the ſound ſtate, this is not very obvious. The ſmall tubercles found on the lateral ſides of the longitudinal ſinus of the falx and contiguous parts of the brain, deſerve ſtill to be examined before we can determine any thing about them: They have been called *glands* by Pacchioni, and ſeem to belong rather to the conglomerate than to the conglobate kind. The whole inſide of the dura mater is moiſtened in the ſame manner as the peritonæum and pleura.

The prominent fibres interſecting each other in different manners which appear on the inſide of the dura mater, eſpecially near the falx and tranſverſe ſeptum, and which have been taken for a kind of fleſhy fibres, ſeem to be only ligamentary and elaſtic. The univerſal adheſion of this membrane to the cranium, proves that it can have no particular motion, and conſequently that ſuch fleſhy or muſcular fibres would be altogether uſeleſs. This adheſion was plainly demonſtrated by Veſalius, Riolan, &c. long before Roonhuyſen.

§ 2. *Pia Mater.*

Situation in general. This membrane is a much ſofter and finer ſubſtance than the former; being exceedingly delicate, tranſparent, and vaſcular; and is connected to the dura mater only by the veins which open into the ſinuſes as has been already ſaid.

Structure. It is compoſed of two laminæ, of which

which the external one is named *tunica arachnoidea*, from its reſemblance to a cobweb. They adhere cloſely to each other at the upper part of the brain; but are eaſily ſeparable at the baſis, and through the whole length of the ſpinal marrow.

The tunica arachnoidea is a remarkably thin and tranſparent membrane, having no veſſels that can be injected entering into its compoſition. It is ſpread uniformly over the ſurface of the brain, incloſing all the circumvolutions, but without entering in between any of them; while the pia mater, or internal lamina, forms a great number of plicæ, duplicatures, and ſepta; which not only cover the brain in general, but inſinuate themſelves into all the folds and circumvolutions, and between the different ſtrata of the cerebrum and cerebellum, and are likewiſe continued into the different cavities.

The two laminæ of the pia mater are connected by a cellular ſubſtance, which accompanies them through their whole extent, except at ſome places of the baſis of the cerebrum, &c. where, the internal lamina continuing its inſertions, the external remains uniformly ſtretched over the prominent parts, the interſtices of which are entirely ſeparated from the other lamina without any cellular ſubſtance between them. Theſe ſeparate portions of the external lamina have made it be looked upon as a third membrane of the brain, diſtinct from the pia mater.

§ 3. *Cerebrum.*

Situation and figure. The cerebrum, properly ſo called, is a kind of medullary maſs, of a moderate conſiſtence, and of a greyiſh colour on the outer ſurface, filling all the ſuperior portion of the cavity of the cranium, or that portion which lies above the tranſverſe ſeptum. The upper part of the cerebrum is of an oval figure, like half an egg cut lengthwiſe, or rather like

two quarters of an egg cut lengthwiſe, and parted a little from each other. It is flatter on the lower part, each lateral half of which is divided into three eminences, which correſpond with the cavities at the baſe of the cranium.

Diviſion and lobes. The cerebrum is divided into two lateral portions, ſeparated by the falx, or great longitudinal ſeptum of the dura mater. They are generally termed *hemiſpheres*, but they are more like quarters of an oblong ſpheroide. Each of theſe portions is divided into two extremities, one anterior, and one poſterior, which are termed the *lobes of the cerebrum*, between which there is a large inferior protuberance which goes by the ſame name; ſo that in each hemiſphere there are three lobes, one anterior, one middle, and one poſterior.

The anterior lobes lie upon thoſe parts of the os frontis which contribute to the formation of the orbits and of the frontal ſinuſes, commonly called the *anterior foſſæ of the baſis cranii.* The middle lobes lie in the middle or lateral foſſæ of the baſis cranii, and the poſterior lobes on the tranſverſe ſeptum of the dura mater. The anterior and middle lobes of the cerebrum on each ſide are parted by a deep narrow ſulcus, which aſcends obliquely backward, from the temporal ala of the os ſphenoides to near the middle of the os parietale; and the two ſides of this diviſion have each their particular ridges and convolutions, which gives a very great extent to the cortical ſubſtance. This ſulcus is termed *fiſſura magna ſylvii*, or ſimply *fiſſura cerebri.*

Sides and inequalities. Each lateral portion of the cerebrum has three ſides; one ſuperior, which is convex; one inferior, which is uneven; and one lateral, which is flat, and turned to the falx. Through the whole ſurface of theſe three ſides we ſee inequalities or windings like the circumvolutions of inteſtines, formed by weaving ſtreaks or furrows very deep and narrow, into which the ſepta or duplicatures of the pia mater

inſi-

insinuate themselves, and thereby separate these circumvolutions from each other.

Near the surface of the cerebrum, these circumvolutions are at some distance from each other, representing serpentine ridges; and in the interstices between them, the superficial veins of the cerebrum are lodged, between the two laminæ of the pia mater, from whence they pass into the duplicature of the dura mater, and so open into the sinuses.

These circumvolutions are fixed through their whole depth to the septa or duplicatures of the pia mater, by an infinite number of very fine vascular filaments, as may be seen by pulling the circumvolutions a little asunder with the fingers.

When we cut transversely, we observe that the substantia alba lies not only in the inner part of the brain in general, but also within each circumvolution, so that there is the same number of internal medullary circumvolutions as of external cortical ones; the first representing white laminæ invested by others of an ash-colour; but the cortical substance is in many places thicker than the medullary.

Substance. The substance of the cerebrum is of two kinds, distinguished by two different colours; one part of it being of a greyish or ash-colour; the other, which is somewhat firmer than the former, is remarkably white, but redder in the fœtus. The ash-coloured substance lies chiefly on the outer part of the cerebrum like a kind of cortex, from whence it has been named *substantia corticalis* or *cinerea.* The white substance occupies the inner part, and is named *substantia medullaris*, or simply *substantia alba.* This abounds in greater quantity than the other, and in many places is perforated with red arteries.

Corpus callosum. Having cut off the falx from the crista galli, and turned it backward; if we separate gently the two lateral parts or hemispheres of the cerebrum, we see a longitudinal portion of a white convex body

body which is named *corpus callosum*. It is a middle portion of the medullary substance, which under the inferior sinus of the falx, and also a little toward each side, is parted from the mass of the cerebrum, to which it is simply contiguous from one end of that sinus to the other; so that, at this place, the edge of the inside of each hemisphere only lies on the corpus callosum, much in the same manner as the anterior and posterior lobes lie on the dura mater. Both extremities of this medullary body terminate by a small edge bent transversely downward.

The surface of the corpus callosum is covered by the pia mater, which runs in between the lateral portions of this body and the lower edge of each hemisphere. Along the middle of its surface from one end to the other, there is a kind of raphe formed by a particular intertexture of fibres which cross each other. This raphe is made more perceivable by two small medullary cords which accompany it on each side, and adhere closely to the transverse fibres. The same striated appearance is to be observed in the inner parts of this substance.

Medullary arch and centrum ovale. The corpus callosum becomes afterwards continuous on each side with the medullary substance; which, through all the remaining parts of its extent, is entirely united with the cortical substance, and together with the corpus callosum forms a medullary arch or vault of an oblong or oval figure. To perceive this, the whole cortical substance, together with the medullary laminæ mixed with it, must be cautiously and dexterously cut in the same direction with the convexity of the cerebrum. After which we will observe a medullary convexity much smaller than that which is common to the whole cerebrum, but of the same form; so that it appears like a medullary nucleus of the cerebrum, especially when we consider it together with the medullary substance of the inferior part or basis of the cerebrum; for the deeper we go the medullary part becomes the broader. And from

thence M. Vieuſſens took occaſion to name this nucleus the *centrum ovale.*

Ventriculi laterales. Under this arch are two lateral cavities, much longer than they are broad, and very ſhallow, ſeparated by a tranſparent medullary ſeptum; of which hereafter. Theſe cavities are generally named *the anterior ſuperior ventricles of the cerebrum*, to diſtinguiſh them from two other ſmaller cavities which are ſituated more backward, as we ſhall ſee preſently; but the name of *lateral* or *great ventricles* given them by Steno, is more proper than either of the other two.

The lateral ventricles are broad, and rounded at thoſe extremities which lie next the tranſparent ſeptum. They go from before backward, contracting in breadth, and ſeparating from each other gradually in their progreſs. Afterwards they bend downward, and return obliquely from behind forward, in a courſe like the turning of a ram's horn, and terminate almoſt under their ſuperior extremities, only a little more backward and outward.

At the poſterior part where they begin to bend downward, there is on each ſide a particular elongation, which runs backward, and terminates in a triangular pointed cavity turned a little inward, the two points reſembling horns. Theſe ventricles are every where lined with a continuation of the pia mater.

Septum lucidum. The tranſparent partition, or *ſeptum lucidum*, as it is commonly called, lies directly under the raphe or ſuture of the corpus calloſum, of which it is a continuation and a kind of duplicature. It is made up of two medullary laminæ, more or leſs ſeparated from each other by a narrow medullary cavity, ſometimes filled with a ſerous ſubſtance. This cavity, in ſome ſubjects, reaches a great way backward, and ſeems to communicate with the third ventricle; and in caſes of internal hydrocephalus, has been found full of water as well as the other cavities of the brain.

Fornix. The ſeptum lucidum is united, by its lower part,

part, to the anterior portion of that particular medullary body, called improperly *the fornix* with three pillars, becauſe of ſome reſemblance it is thought to bear to the arches of ancient vaults. It is in reality nothing but the corpus calloſum; the lower ſide of which is like a hollow ceiling with three angles, one anterior and two poſterior; and three edges, two lateral and one poſterior. The lateral edges are terminated each by a large ſemicylindrical border, like two arches; which uniting at the anterior angle, form by their union what is called *the anterior pillar of the fornix;* and as they run backward ſeparately toward the two poſterior angles, they have then the name of *the poſterior pillars.*

The anterior pillar being double, is larger than either of the poſterior; and the marks of this duplicity always remain. Immediately below the baſis of this pillar we obſerve a large, white, ſhort, medullary rope ſtretched tranſverſely between the two hemiſpheres, and commonly called *the anterior commiſſure of the cerebrum.* It is to this pillar that the ſeptum lucidum adheres. The poſterior pillars are bent downward, and continued through the lower portions of the ventricles all the way to their extremities, reſembling a ram's horn, which is a name that has been given to them. They diminiſh gradually in thickneſs during this courſe; and at their outſides they have each a ſmall, thin, flat, collateral border, to which the name of *corpora fimbriata* is applied.

The poſterior pillars of the crura of the fornix unite with two medullary protuberances called *pedes hippocampi.*——The inferior ſurface of the triangular ceiling, which lies between theſe arches, is full of tranſverſe, prominent medullary lines; for which reaſon the ancients called it *pſalloides* and *lyra*, comparing it to a ſtringed inſtrument, ſomething like what is now called a *dulcimer.*

Under the fornix, and immediately behind its an-

terior crura, there is a hole of a conſiderable ſize, by which the two lateral ventricles communicate (*See* Monro on the Nervous Syſtem, Tab. IV.); and another paſſage leads down from this, under the different apellations of *foramen commune anterius*, *vulva*, *iter ad infundibulum*, but more properly *iter ad tertium ventriculum*.

Eminences. The fornix being cut off and inverted, or quite removed, we ſee firſt of all a vaſcular web, called *plexus choroides*, and ſeveral eminences more or leſs covered by the expanſion of that plexus. There are four pairs of eminences which follow each other very regularly, two large and two ſmall. The firſt two great eminences are named *corpora ſtriata;* and the ſecond, *thalami nervorum opticorum.* The four ſmall eminences are cloſely united together; the anterior being called *nates*, and the poſterior *teſtes;* but it would be better to call them ſimply *anterior* and *poſterior tubercles.* Immediately before theſe tubercles there is a ſingle eminence, called *glandula pinealis.*

Corpora ſtriata. The corpora ſtriata got that name, becauſe in cutting them with the knife we meet with a great number of white and aſh-coloured lines alternately diſpoſed, which are only the tranſverſe ſection of the medullary and cortical laminæ mixed together in a vertical poſition in the baſis of the cerebrum, as appears evidently by inciſions made from above downward. Theſe two eminences are of a greyiſh colour on the ſurface, oblong, roundiſh, pyriform, and larger on the fore than on the back part, where they are narrow and bent.

They lie in the bottom of the ſuperior cavity of the lateral ventricles, which they reſemble in ſome meaſure in ſhape, their anterior parts being near the ſeptum lucidum, from which they ſeparate gradually as they run backward, and diminiſh in ſize. They are in reality the convex bottoms of the ventricles; and it is at the lower part of the interſtice between the largeſt portions

tions of them, that we obſerve the greateſt tranſverſe cord, named *the anterior commiſſure of the cerebrum*, which we mentioned already in deſcribing the anterior pillar of the fornix calloſus. This cord communicates more particularly with the bottom of the corpora ſtriata, by a turn toward each ſide.

Thalami nervorum opticorum. The thalami nervorum opticorum, are ſo named, becauſe theſe nerves ariſe chiefly from them. They are two large eminences placed by the ſide of each other, between the poſterior portions or extremities of the corpora ſtriata. Their figure is ſemiſpheroidal and a little oval; and they are of a whitiſh colour on the ſurface; but their inner ſubſtance is partly greyiſh and partly white, ſo that, in cutting them, we ſee ſtreaks of different colours like thoſe of the corpora ſtriata.

Theſe two eminences are cloſely joined together; and at their convex part they are ſo far united, as really to become one body, the whitiſh outer ſubſtance being continued uniformly over them both.

At the bottom theſe two eminences are elongated downward toward both ſides, into two thick, round, whitiſh cords, which ſeparate from each other like horns by a large curvature; and afterwards, by a ſmall curvature turned forward in an oppoſite direction to the former, and repreſenting the tip of an horn, they approach each other again. The ſize of theſe nerves diminiſhes gradually from their origin to their anterior reunion. We ſhall have occaſion to mention them in another place in ſpeaking of the optic nerves.

Third Ventricle. Immediately under the union or beginning of the thalami nervorum opticorum, lies a particular cavity, called the *third ventricle* of the cerebrum. This cavity communicates at its upper and fore-part with the paſſage between the two lateral ventricles, and ſends down from its under and fore part a paſſage through the infundibulum. It opens backwards into the paſſage called *iter ad quartum ventriculum.*

Infundibulum. Between the baſis of the anterior pillar of the fornix and the anterior part of the union of the optic thalami, lies a ſmall medullary canal, named *infundibulum.* It runs down towards the baſis of the cerebrum, contracting gradually, and terminates in a ſtraight courſe by a ſmall membranous canal, in a ſoftiſh body ſituated in the ſella turcica, named *glandula pituitaria.*

Plexus choroides. The plexus choroides is a very fine vaſcular texture, conſiſting of a great number of arterial and venal ramifications, partly collected in two looſe faſciculi, which lie on each lateral ventricle, and partly expanded over the neighbouring parts, and covering in a particular manner the thalami nervorum opticorum, glandula pinealis, tubercula quadrigemina, and the other adjacent parts both of the cerebrum and cerebellum, to all which it adheres.

In each lateral portion of this plexus we obſerve a venal trunk; the ramifications of which are ſpread through the whole extent of the two portions. Near the glandula pinealis theſe two trunks approach each other; and uniting behind that gland, they open into the torcular or fourth ſinus of the dura mater. When we blow into one of theſe trunks toward the plexus, the air paſſes into all its ramifications; and in ſome ſubjects, theſe two veins form one trunk which opens into the ſinus.

The ventricular or looſe portions of the plexus often appear to contain a great number of tubercles like glands; which in the natural ſtate are extremely ſmall, but grow bigger in diſeaſes. To be able to examine them as we ought, the looſe portions muſt be made to ſwim in clear water, and be there carefully expanded. Then, by the help of a microſcope, we will ſee theſe tubercles in the natural ſtate, like ſmall folliculi or little bags more or leſs flatted.

Beſides this vaſcular web or plexus of the ſeptum lucidum, the ſides of the fornix, of the eminences, ventricles, canals, and infundibulum, are all covered by a very

very fine membrane, in which, by injections or inflammations, we discover a great number of very fine vessels. This membrane is in a manner a continuation of the plexus, and that seems to be a detachment from the pia mater. By the same means we likewise discover an extremely thin membrane on the insides of the duplicature of the septum, though, in some subjects, these sides touch each other.

Glandula pituitaria. The pituitary gland is a small spungy body lodged in the sella turcica, between the sphenoidal folds of the dura mater. It is of a singular kind of substance, which seems to be neither medullary nor glandular. On the outside it is partly greyish and partly reddish, and white within. It is transversely oval or oblong; and on the lower part, in some subjects, it is divided by a small notch into two lobes, like a kidney bean. It is covered by the pia mater as by a bag, the opening of which is the extremity of the infundibulum; and it is surrounded by the small circular sinuses which communicate with the sinus cavernosi.

Tubercula. The tubercles are four in number, two anterior and two posterior; adhering together as if they made but one body situated behind the union of the thalami nervorum opticorum. They are transversely oblong; the anterior being a little more rounded, and broader or larger from before backward, than the posterior. Their surface is white, and their inner substance greyish. The names of *nates* and *testes*, given by the ancients to these tubercles, are not very proper, there being no great resemblance between them and the things from which the names are taken. Some of the moderns, with perhaps still less propriety, have called them *tubercula quadrigemina.* We shall use the names, however, as we find them.

Directly under the place where the tubercles of one side are united to those of the other side, lies the *iter ad quartum ventriculum*, which communicates by its anterior opening with the third ventricle, under the

thalami nervorum opticorum, and, by its poſterior opening, with the fourth ventricle, which belongs to the cerebellum.

Foramen commune poſterius. Where the convex parts of the two anterior tubercles join theſe poſterior convex parts of the thalami nervorum opticorum, an interſtice or opening is left between theſe four convexities; but it does not communicate with the third ventricle: for the bottom of it is ſhut up by the pia mater. It has got the name of *anus* applied to it.

Glandula pinealis. The glandula pinealis is a ſmall ſoft greyiſh body, about the ſize of an ordinary pea, irregularly round, and ſometimes of the figure of a pine-apple, ſituated behind the thalami nervorum opticorum above the tubercula quadrigemina. It is fixed like a ſmall button to the lower part of the thalami by two very white medullary pedunculi, which at the gland are very near each other, but ſeparate almoſt tranſverſely toward the thalami.

It ſeems to be moſtly of a cortical ſubſtance, except near the footſtalks, where it is ſomewhat medullary. The footſtalks are ſometimes double, as if they belonged to the two anterior tubercles. This body adheres very cloſe to the plexus choroides, by which it is covered, as we ſhall ſee hereafter; and it therefore requires ſome dexterity to ſeparate it from the glandula, without altering its ſituation or breaking the pedunculi. This gland has been often found to contain gravel. Below the glandula pinealis there is a medullary tranſverſe cord, called the *poſterior commiſſure of the hemiſpheres of the cerebrum.*

§ 4. *Cerebellum.*

Situation and figure. The cerebellum is contained under the tranſverſe ſeptum of the dura mater, in the under and back part of the cranium. It is broader laterally than on the fore or back ſides, flatted on the upper

upper ſide, and gently inclined both ways, anſwerable to the ſeptum, which ſerves it as a kind of tent or ceiling. On the lower ſide it is rounder; and on the back-ſide it is divided into two lobes, ſeparated by the occipital ſeptum of the dura mater.

Structure. It is made up, like the cerebrum, of two ſubſtances, but it has no circumvolutions on its ſurface. In place of theſe it has numerous ſulci, which are pretty deep, and diſpoſed in ſuch a manner as to form thin flat ſtrata, more or leſs horizontal, between which the internal lamina of the pia mater inſinuates itſelf by a number of ſepta equal to that of the ſtrata.

Under the tranſverſe ſeptum, it is covered by a vaſcular texture, which communicates with the plexus choroides. It has two middle eminences called *appendices vermiformes;* one anterior and ſuperior, which is turned forward; the other poſterior and inferior, which goes backward. There are likewiſe two lateral appendices, both turned outward. They are termed *vermiformes*, from their reſemblance to a large portion of an earth-worm.

Beſides the diviſion of the cerebellum into lateral portions, or into two lobes, each of theſe lobes ſeems to be likewiſe ſubdivided into three protuberances, one anterior, one middle or lateral, and one poſterior: but they are not in all ſubjects equally diſtinguiſhed either by their convexity or limits; but they may always be diſtinguiſhed by the direction of their ſtrata, thoſe of the middle and anterior protuberance being leſs tranſverſe than the poſterior.

Fourth Ventricle. When we ſeparate the two lateral portions or lobes, having firſt made a pretty deep inciſion, we diſcover, firſt of all, the poſterior portion of the medulla oblongata, of which hereafter; and in the poſterior ſurface of this portion, from the tubercula quadrigemina, all the way to the poſterior notch in the body of the cerebellum, and a little below that notch, we obſerve an oblong cavity, which is called the *fourth ven-*

ventricle; this terminates backward like the point of a writing pen. Hence the under end of it is called *calamus ſcriptorius.*

At the beginning of this cavity we meet with a thin medullary lamina, which is looked upon as a valve between that canal and the fourth ventricle. A little behind this lamina, the cavity grows wider towards both ſides, and then contracts again to its firſt ſize. It is lined interiorly by a thin membrane, and ſeems often to be diſtinguiſhed into two lateral parts, by a kind of ſmall groove, from the valvular lamina to the point of the calamus ſcriptorius.

This membrane is a continuation of that part of the pia mater which lines the ſmall canal, the third ventricle, infundibulum, and the two great ventricles. To be able to ſee the fourth ventricle in its natural ſtate, in which it is narroweſt, it muſt be laid open while the cerebellum remains in the cranium; and in order to that, the os occipitis muſt be ſawed very low down.

On each ſide of this ventricle, the medullary ſubſtance forms a trunk which expands itſelf in form of laminæ through the cortical ſtrata. But here we find the medullary bearing a leſs proportion to the cortical than it does in the cerebrum. We diſcover theſe medullary laminæ according to their breadth, by cutting the cerebellum in ſlices almoſt parallel to the baſis of the cerebrum; but if we cut one lobe of the cerebellum vertically from above downward, the medullary ſubſtance will appear to be diſperſed in ramifications through the cortical ſubſtance. Theſe ramifications have been named *arbor vitæ*, and the two trunks from whence theſe different laminæ ariſe are called *pedunculi cerebelli.*

We cannot go on with the deſcription of the other middle parts of the baſis of the cerebellum, before that of the middle parts of the baſis of the cerebrum; becauſe theſe two kinds of parts are united, and jointly

form the medulla oblongata. We ſhall only add here, that the ſtrata of both ſubſtances of the cerebellum are not always of the ſame extent in the ſame portions or protuberances of each lobe. This appears merely by viewing the convex or outer ſurface of the cerebellum; for there we ſee, at different diſtances, ſome cortical ſtrata ſhorter than others, and likewiſe that the extremities of the ſhort ſtrata diminiſh gradually in thickneſs till they are quite loſt between two long ones.

If we make a ſmall hole in the external lamina of the pia mater over one of the lobes of the cerebellum, without touching the inner lamina, and then blow into the cellular ſubſtance, by which theſe two laminæ are connected, through a ſmall pipe introduced into the hole; the air will gradually ſwell that ſubſtance, and ſeparate the ſtrata more or leſs equally from each other through their whole extent; and we will ſee at the ſame time the diſpoſition of all the membranous ſepta or duplicatures of the internal lamina of the pia mater, with the numerous diſtribution of the fine blood-veſſels which run upon it, eſpecially after a lucky injection, or in an inflammatory ſtate of theſe membranes.

§ 5. *Medulla oblongata.*

The medulla oblongata is a medullary ſubſtance, ſituated from before backward in the middle part of the baſes of the cerebrum and cerebellum, without any diſcontinuation, between the lateral parts of both theſe baſes: and therefore it may be looked upon as one middle medullary baſis common to both cerebrum and cerebellum, by the reciprocal continuity of their medullary ſubſtances, through the great notch in the tranſverſe ſeptum of the dura mater; which common baſis lies immediately on that portion of the dura mater which lines the baſis of the cranium. The medulla oblongata is therefore juſtly eſteemed to be a third

third general part of the whole mafs of the brain, or as the common production or united elongation of the whole medullary fubftance of the cerebrum and cerebellum.

It is extremely difficult, if not altogether impoffible, to examine or demonftrate it as we ought, in its natural fituation; but we are obliged to do both on a brain inverted.

The lower fide of the medulla oblongata, in an inverted fituation, prefents to our view feveral parts, which are in general either medullary productions, trunks of nerves, or trunks of blood-veffels.

The chief medullary productions are thefe; the large or anterior branches of the medulla oblongata, which have likewife been named *crura anteriora*, *femora* and *brachia medullæ oblongatæ*, and *pedunculi cerebri:* the tranfverfe protuberance, called likewife *proceffus annularis* or *pons Varolii:* the fmall or poferior branches, called *pendunculi cerebelli*, or *crura poferiora medullæ oblongata:* the extremity or cauda of the medulla oblongata, with two pairs of tubercles; one of which is named *corpora olivaria*, the other *corpora pyramidalia;* and to all thefe productions we muft add a production of the infundibulum and two medullary papillæ.

The great branches of the medulla oblongata are two very conficerable medullary fafciculi; the anterior extremities of which are feparated, and the poferior united, fo that, taken together, they fomewhat repref ent a Roman V. Thefe fafciculi are flat, much broader before than behind; their furfaces being compofed of feveral longitudinal and diftinctly prominent medullary fibres. Their anterior extremities feem to be loft at the lower part of the corpora ftriata; and it is for that reafon that they are looked upon as the pedunculi of the cerebrum.

The tranfverfe annular, or rather femi-annular, protuberance, is a medullary production, which feems at firft fight to furround the poferior extremities of the great

great branches; but the medullary ſubſtance of this protuberance is in reality intimately mixed with that of the two former. Varolius, an ancient Italian author, viewing thoſe parts in an inverted ſituation, compared the two branches to two rivers, and the protuberance to a bridge over them both; and from thence it has the name of *pons Varolii*. Its ſurface is tranſverſely ſtreaked; and it is divided into two lateral parts by a very narrow longitudinal depreſſion, which does not penetrate into its ſubſtance. When we cut into the ſubſtance of the pons, we find much cortical ſubſtance within it, and this formed into ſtriæ, which run in various directions. And the ſame thing will be found with reſpect to the medullary part of the brain; for there is ſcarcely any part of it but what has cortical ſtriæ running through it. *See* Monro's Obſervations on the Nervous Syſtem, Tab. VII.

The ſmall branches of the medulla oblongata are lateral productions of the tranſverſe protuberance, which by their roots ſeem to encompaſs that medullary portion in which the fourth ventricle or calamus ſcriptorius is formed. They form in the lobes of the cerebellum, on each ſide, theſe medullary expanſions, a vertical ſection of which ſhows the white ramifications commonly called *arbor vitæ;* and they may be juſtly enough ſtyled *pedunculi cerebelli.*

The extremity is no more than the medulla oblongata contracted in its paſſage backward to the anterior edge of the foramen magnum of the os occipitis, where it terminates in the medulla ſpinalis; and in this part of it ſeveral things are to be taken notice of. We ſee firſt of all, four eminences, two named *corpora olivaria*, and the other two *corpora pyramidalia*. Immediately afterwards, it is divided into two lateral portions by two narrow grooves, one on the upper ſide, the other on the lower. They both run into the ſubſtance of the medulla, as between two cylinders, flatted on that ſide by which they are joined together.

When

When we ſeparate theſe ridges with the fingers, we obſerve a crucial intertexture of ſeveral ſmall medullary cords, which go obliquely from the ſubſtance of one lateral portion into the ſubſtance of the other. M. Petit, member of the Royal Academy of Sciences and doctor of phyſic, is the author of this diſcovery, by which we are enabled to explain ſeveral phænomena both in phyſiology and pathology; of which in another place.

The corpora olivaria and pyramidalia are whitiſh eminences ſituated longitudinally near each other on the lower ſide of the extremity or cauda, immediately behind the tranſverſe or annular protuberances. The corpora pyramidalia are in the middle; ſo that the interſtice between them, which is only a kind of ſuperficial groove, anſwers to the inferior groove of the following portion.

The corpora olivaria are two lateral eminences ſituated at the outſide of the former, and are thus termed by Willis, Duverney, Haller, &c. but Winſlow reverſes the names. Theſe four eminences are ſituated on the lower half of the medulla; which obſervation we here repeat, to make it be remembered, that, in all the figures and demonſtrations, theſe parts are repreſented as ſuperior, which in their natural ſituation are inferior. Thus theſe eminences are under the fourth ventricle, and under the pedunculi cerebelli.

The tubercula mammillaria, which are ſituated very near the production of the infundibulum, have been taken for glands; probably becauſe of their greyiſh inner ſubſtance, which, however, does not ſeem to be different from that of ſeveral other eminences of the medulla oblongata. And for that reaſon we chooſe rather to call them, from their figure, *tubercula mammillaria*, than *papillæ medullares*.

Theſe tubercles ſeem to have ſome immediate relation to the roots or baſes of the anterior pillar of the fornix; ſo that they might be named, as M. Santorini has

has done, *the bulbs of theſe roots*, though they appear to be likewiſe partly a continuation of other portions of the cortical and medullary ſubſtance, of a particular texture.

The beak or tube of the infundibulum is a very thin production from the ſides of that cavity; and it is ſtrengthened by a particular coat given to it by the pia mater. It is bent a little from behind forward, toward the glandula petuitaria, and afterwards expands again round this gland.

The membrana arachnoides, or external lamina of the pia mater, appears to be very diſtinctly ſeparated from the internal lamina, in the interſtices between all theſe eminences on the lower ſide of the medulla oblongata, without any viſible cellular ſubſtance between them. The internal lamina adheres much more to the ſurface of theſe interſtices than to that of the eminences. The external lamina is as it were buoyed up by the eminences, and equally ſtretched between their moſt prominent parts, to which it ſticks very cloſe; and in this reſpect the roots or great cornua of the optic nerves may be joined to theſe eminences.

We muſt obſerve in general concerning the eminences of the medulla oblongata, that thoſe which are medullary on their outſides or ſurfaces, are interiorly either entirely cortical, or partly cortical and partly medullary, or formed by a ſingular mixture of theſe two ſubſtances, which ſtill remains to be unfolded, as well as many other particularities obſervable in examining the internal ſtructure of the brain.

From this common portion of the cerebrum and cebellum, ariſe almoſt all the nerves which go out of the cranium, through the different foramina by which its baſis is perforated. It likewiſe produces the medulla ſpinalis, which is no more than a common elongation of the cerebrum and cerebellum, and of their diferant ſubſtances; and therefore the medulla oblongata may juſtly be ſaid to be the firſt origin or primitive

tive ſource of all the nerves which go out through the ſpina dorſi, and conſequently of all the nerves of the human body.

§ 6. *Medulla ſpinalis.*

The medulla ſpinalis is only an elongation of the extremity of the medulla oblongata; and it has its name from its being contained in the bony canal of the ſpina dorſi. It is conſequently a continuation or common appendix of the cerebrum and cerebellum, as well becauſe of the two ſubſtances of which it is compoſed, as becauſe of the membranes by which it is inveſted.

In the deſcription of the freſh bones, mention was made of a ligamentary ſubſtance which lines the inner ſurface of this bony canal from the great occipital foramen to the os ſacrum. Beſides this, the dura mater, after it has lined the whole internal ſurface of the cranium, goes out by the foramen magnum occipitis; and forms a kind of funnel, in its progreſs downward, through the bony canal of the vertebræ. As it goes out at the occipital hole, it joins the beginning of the ligamentary funnel already mentioned, and adheres very ſtrongly to it. That portion of the pericranium which terminates exteriorly at the edge of the great foramen, joins the funnel likewiſe; which by all theſe ſucceſſions becomes very ſtrong, and capable of reſiſting the greateſt violences.

This adheſion of the dura mater to the ligamentary funnel is gradually diſcontinued below the firſt vertebra; and from thence the dura mater forms a ſeparate tube, which runs down in the bony canal all the way to the os ſacrum, the capacity of it anſwering to that of the canal; but it does not adhere cloſely to the ſides, as it does to that of the cranium. It is ſurrounded by a ſlimy ſubſtance, which, near the lower end of the canal, reſembles fat.

The ſpinal marrow is made up of a cortical and medullary ſubſtance, as the cerebrum and cerebellum; but with this difference, that the aſh-coloured ſubſtance lies within the other; and in a tranſverſe ſection of this medulla the inner ſubſtance is ſomewhat of an oblong form, but has its ſides bent inwards.

The body of the medulla ſpinalis runs down all the way to the bottom of the firſt vertebra of the loins, where it terminates in a point. The ſize of it is proportionable to that of the bony canal; ſo that it is larger in the vertebræ of the neck than thoſe of the back. It is a little flatted on the fore and back parts; ſo that we may diſtinguiſh in it two ſides, one anterior, the other poſterior, and two edges It is likewiſe in a manner divided into two lateral halves or cords by a groove, which runs along the middle of its anterior and poſterior ſurfaces, being a continuation of thoſe in the extremity of the medulla oblongata. The cords are applied cloſely together, but may be readily ſeparated before as well as behind till we come to their middle or deepeſt part, where they are joined together by a thin layer of cineritious ſubſtance paſſing from the one cord into the other.

Each lateral portion ſends off from both the fore and back ſides, between the grooves and the edges, at different diſtances, flat faſciculi of nervous filaments turned toward the neareſt edge. The anterior and poſterior faſciculi are ſeparated from each other by the ligamentum denticulatum; then paſſing outwards, they go through the dura mater by two diſtinct openings though very near each other. Having penetrated the dura mater, the poſterior bundle forms a ganglion; from the oppoſite end of which the trunk comes out again, and is there joined by the anterior bundle.

The dura mater which inveſts the medulla, ſends out on each ſide the ſame number of vaginæ, as there are ganglious and nervous trunks. Theſe vaginæ are productions of the external part of this membrane; the

internal part, which is very ſmooth and poliſhed on the inſide, being perforated by two ſmall holes very near each other, where each vagina goes off, through which holes the anterior and poſterior faſciculi are tranſmitted; and immediately after their paſſage through the internal part, they unite.

The triangular ſpaces left between the anterior and poſterior faſciculi and edge of the medulla, are filled from one extremity to the other by an indented ligament, very thin and ſhining, having the ſame number of indentations as there are pairs of faſciculi. It is cloſely connected by numerous threads to the pia mater at each ſide of the medulla, while the oppoſite ſide ſends out indentations, the greater number of which run tranſverſely, though others go obliquely upwards or downwards; and all of them, after being ſplit into threads, are fixed to the inner ſide of the dura mater. The under end of the ligamentum denticulatum, runs as far as the os coccygis, and is what authors have conſidered as the fortieth pair of nerves*; from whence it ſends filaments to the internal part of the dura mater, by which the anterior faſciculi are diſtinguiſhed from the poſterior.

The membrana arachnoides is here very diſtinct from the internal lamina of the pia mater: ſo that, by blowing through a hole made in the arachnoides, it will ſwell from one end to the other, like a tranſparent gut. The internal lamina, called in this place ſimply the *pia mater*, adheres very cloſely to the medulla ſpinalis, and ſends many productions and ſepta through its ſubſtance. When we blow through a hole made in the pia mater, through the ſubſtance of one lateral portion of the medulla, the air penetrates through the whole, and the pia mater, which covers the other lateral portion, is ſeparated from it.

The membrana arachnoides adheres here more cloſely to the pia mater at the lower than at the upper part, being

* For this and the three preceding paragraphs, ſee Monro on the Nervous Syſtem, Tab. IX. X. XVII. &c.

being in a manner ſuſpended by the indented ligament which runs along both edges of the medulla, and is fixed by a filament to the internal lamina of the dura mater in each interſtice between the nervous faſciculi, as has been already ſaid. It alſo gives off elongations in the ſame manner as the dura mater to each nervous trunk or rope, as we ſhall ſee hereafter.

§ 7. *The Nerves of the Brain and Spinal Marrow, from their origin to their going out of the Cranium and Spine.*

We ſhall afterward find, that the nerves ariſe either from the brain, medulla oblongata, or ſpinalis; that they go out in faſciculi diſpoſed in pairs; but they may be divided into three claſſes, viz. nerves, which paſs through the cranium; nerves immediately from the ſpinal marrow; and nerves from the brain and ſpinal marrow; to which laſt claſs belongs the great ſympathetic nerve. Ten pairs are reckoned to belong to the brain and medulla oblongata, of which nine go out through the foramina of the cranium, and the tenth ariſes from the extremity of this medulla as it paſſes through the great occipital hole; and laſtly, that 29 pairs are reckoned to belong to the medulla ſpinalis, of which ſeven paſs through the lateral notches of the vertebræ cervicis, twelve through thoſe of the back, five through thoſe of the loins, and five through the anterior holes of the os ſacrum.

Our deſign is here principally to mention ſome particular obſervations about the nerves, while they remain within the bones; the reſt of the courſe through the whole body ſhall be afterward ſufficiently deſcribed.

Nerves of the brain. The firſt pair of nerves that ariſe from the brain are the olfactory, anciently called *proceſſus mammillares*. Theſe are two very flat and ſoft medullary ropes, each ariſing firſt by medullary fibres from the outſide of the lower part of the corpora ſtria-

ta, between the anterior and middle lobe, on each side of the cerebrum, and afterwards by another filament more internally, and by a third, which is more posterior and very long. They run under the anterior lobes of the cerebrum, being lodged in two superficial grooves in the basis of these lobes, and lying immediately on the dura mater, from the clinoide apophyses to the os ethmoides.

They are first of all considerably incurvated from without inwards or toward each other, and having reached near the back-side of the os ethmoides, they run for a small space parallel to and at some distance from each other. Backward they are very thin; but they gradually increase in bulk in their course, forward, toward each side of the crista of the ethmoidal bone, where they terminate in elongated papillæ, the substance of which appears to be softer than that of the nerves, and possessing more of the cinericeous substance, as Dr Sœmmering hath best described in his book, *De Bas. Enceph. Orig. et Nervor.* To which the reader is referred for a full account of the parts the author treats of.

These papillæ lie on the two sides of the lamina cribosa, and send down a nervous filament into each hole of that lamina. At the same place, the dura mater sends off the same number of vaginæ which invest and accompany the nervous filaments and their ramifications on the internal parts of the nose.

We have already related the origin of the second pair, or optic nerves, from the eminences called *thalami nervorum opticorum;* and we have described their great curvature, and traced them all the way to their re-union, which happens immediately before the superior part of the glandula pituitaria, and consequently before the beak or production of the infundibulum. The internal carotids run upon the outsides of these nerves, immediately after their union, and before they pass through the foramina optica.

Besides their origin from the optic thalami, these nerves

nerves have likewiſe a kind of communication with the tubercula quadrigemina anteriora by very fine filaments; one extremity of which is loſt in the tubercles, the other in the roots of the great arches or bodies of the optic nerves. They are alſo connected with the crura cerebri. The internal ſtructure of theſe nerves ſeems to change at their entrance into the optic holes, as we ſhall ſee in another place.

The union of theſe nerves, by the ſmall curvatures of their cornua, is very difficult to be unfolded in human bodies. This union is commonly found to be very cloſe: but, in ſome ſubjects, it ſeems to be no more than a ſtrong adheſion; in others, to be partly made by an interſection or croſſing of fibres. They have been found quite ſeparate; and in other ſubjects one of them has been obſerved to be very much altered both in ſize and colour through its whole paſſage, the other remaining in its natural ſtate.

The third pair, called *nervi motores*, *oculi communes*, *oculares communes*, and *oculo-muſculares*, ariſe from the crura cerebri, between the corpora albicantia and a ſulcus that ſeparates the crura from the tuber annulare, by numerous threads collected into two bundles, the one a little longer than the other. Theſe ſoon unite into their reſpective trunks, which pierce the dura mater behind the lateral parts of the poſterior apophyſis of the ſella turcica, and paſs afterwards along the ſinus cavernoſi, by the ſide of the carotid artery, and all the way to the broad portion of the ſuperior orbitary fiſſure, where they are divided in the manner to be afterward deſcribed.

The fourth pair, called *nervi trochleares*, *muſculares obliqui ſuperiores*, and moſt commonly *pathetici*, are very ſmall and tender, and, in proportion, very long. They ariſe each behind the teſtes by one, and ſometimes by two ſmall threads. From thence they take their courſe forward all the way to the edge of the anterior extre-

mities of the tentorium, a little to the outer ſide of the poſterior clinoid proceſs, where on each ſide they enter the duplicature of the dura mater, and advancing by the ſide of the ſinus cavernoſi, they accompany the third pair to the ſuperior orbitary fiſſure.

The fifth pair, called *nervi innominati*, or *trigemini*, are at firſt large trunks ariſing by two faſciculi from the outer and fore part of the crura cerebelli, where they join the tuber annulare a little before the ſeventh pair. They run down obliquely forward on the extremity of the upper or anterior ſide of the apophyſis petroſa, very near the ſide of the ſella ſphenoidalis, where they enter the duplicature of the dura mater and ſinus cavernous.

At their entry into the ſinus, they form a kind of flat irregular ganglion, from which ſome filaments are ſent off to the dura mater; and immediately afterward, each of them is divided into three great branches, one ſuperior or anterior, one middle, and one inferior or poſterior. The firſt branch, which may be termed *ocularis* or *ophthalmicus*, accompanies the nerves of the third and fourth pairs through the foramen lacerum of the ſphenoid bone. The ſecond, called *maxillaris ſuperior*, goes out by the foramen rotundum; and the third, named *maxillaris inferior*, by the foramen ovale of the ſame bone. As the great trunk of this nerve runs down, it perforates the membrana arachnoides, which at this place forms a kind of ceiling.

The ſixth pair, named *motores oculorum externi*, *oculares* or *opthalmici externi*, and *oculo muſculares externi*, are ſmall nerves, but ſtill not ſo ſmall as the fourth pair; and they have ſometimes been found double. They ariſe from a ſulcus between the back-part of the tuber annulare and beginning of the medulla oblongata, and paſſing immediately under the tuber, they pierce the dura mater behind the occipital ſymphyſis of the ſphenoidal bone.

They

They run on each ſide in the duplicature of the dura mater to the cavernous ſinus; and having entered that ſinus, each of them croſſes the out-ſide of the internal carotid artery in their way to the foramen laceram. In this courſe they communicate with the firſt branch of the fifth pair, and by a filament or two, with the great ſympathetic nerve at the ſide of the artery.

The ſeventh pair, named *auditorii*, are each divided into two portions; one from its hardneſs, when compared with the other parts, is called *portio dura*, or *ſympatheticus minor*. This ariſes from the ſpace where the crus cerebelli joins the tuber annulare. The other part is larger and ſofter than the former, and is called *portio mollis*, or the true *auditory nerve*. It ariſes from the inner ſurface of the fourth ventricle, and is afterwards joined by an intermediate portion deſcribed by Dr Wriſberg. The *portio mollis* is hollowed out to receive the portic dura, which accompanies it to the foramen auditorium internum.

The eighth pair, ariſe from the poſterior extremities of the large branches or crura of the medulla oblongata, a little to the outer ſide of the corpora olivaria, by numerous filaments, which are collected into two bundles, one called *gloſſopharyngeus*, the other *par vagum*, or *ſympatheticus medius*. This runs toward the foramen lacerum, which gives paſſage to the lateral ſinus, where it pierces the dura mater, and goes out through the anterior part of that hole, having been firſt joined by a nervous portion that runs up from the medulla ſpinalis through the great occipital foramen by the name of *nervus acceſſorius octavi paris*, or *nervus ſpinalis*. This additional nerve goes out with that of the eighth pair through the foramen lacerum, lying behind it, but diſtinguiſhed from it by a membranous ſeptum.

The ninth pair, called *nervi hypogloſſi externi*, *hypogloſſi majores*, and commonly *guſtatorii*, ariſe each from

the furrow which ſeparates the corpora olivaria and pyramidalia. Theſe branches ſoon unite into a trunk which paſſes through the anterior condyloide hole, and ſometimes the branches form two trunks, which, after piercing the dura mater, unite and go through the hole above mentioned.

The tenth pair, called *nervi ſub-occipitales*, ariſe from the medulla oblangata, under the ninth pair, chiefly from the anterior and a little from the lateral part of the extremity of the medulla oblongata, oppoſite to the poſterior part of the condyloide apophyſis of the occipital bone, by a ſingle plane or faſciculus of ſmall filaments which pierce the dura mater directly from within outward, at the ſame place where the vertebral arteries perforate it from without inwards. Frequently one or two threads come from the back part of the medulla, and are at firſt ſeparated from the anterior bundle by the nervus acceſſorius and ligamentum denticulatum; but afterwards unite with it into one trunk.

Nerves of the medulla ſpinalis. The nerves formed by the lateral union of the anterior and poſterior filaments of the medulla ſpinalis, go out of the bony canal of the ſpina dorſi, toward each ſide, through the intervertebral holes, through the anterior holes of the os ſacrum, and the lateral notches of the os coccygis; and from thence they have the general name of *nervi vertebrales*. They are divided in the ſame manner as the vertebræ, into ſeven pair of cervical nerves, twelve pair of dorſal, five pair of lumbar, and five pair of nervi ſacri.

As the ſpinal marrow which furniſhes all theſe nerves ſeldom goes lower than the firſt or ſecond vertebra of the loins, the ſituation of the faſciculi of nervous filaments muſt be different from that of the holes through which they paſs; and ſeveral of theſe faſciculi, both anterior and poſterior, muſt be longer than the reſt.

This

This we find from experience to be the caſe in the following manner.

The faſciculi of nervous filaments of the medulla ſpinalis, which produce the cervical nerves, run more or leſs tranſverſely toward each ſide from their origin to their paſſage through the intervertebral holes. The faſciculi which form the dorſal nerves run a little obliquely downward from their origin to the intervertebral holes; and thoſe which form the lumbar nerves run down more and more longitudinally from the medulla to the holes by which they go out.

Therefore the cervical faſciculi are very ſhort in the ſpinal canal; the dorſal faſciculi are longer, and the faſciculi from the loins and os ſacrum very long. It muſt likewiſe be obſerved, that the faſciculi of the four loweſt pairs of the cervical nerves, and firſt pair of the dorſal nerves, are broader and more compounded than the following, becauſe the brachial nerves are a continuation of theſe. The filaments belonging to the lumbar nerves, and thoſe of the os ſacrum, are likewiſe very broad, and made up of numerous filaments, as being the roots of the large nerves which go to the lower extremities. The dorſal filaments are very ſmall.

The cervical and lumbar faſciculi are not only broader and made up of more filaments than the dorſal, but alſo ſituated much cloſer to each other, the lumbar faſciculi being ſtill more ſo than the cervical; whereas in the dorſal, a conſiderable interſtice is left between the faſciculi.

Theſe lumbar faſciculi, from their origin to the extremity of the os ſacrum, form, through the whole canal of the lumbar vertebræ and of the os ſacrum, a large bundle of nervous ropes, called by anatomiſts *cauda equina*, becauſe of ſome reſemblance which it bears to a horſe's tail, eſpecially when taken out of the canal, and extended in clear water.

Though the medulla ſpinalis ends at the firſt vertebra of the loins, the vagina of the dura mater by which it

is

is inveſted, is continued through the reſt of the bony canal all the way to the extremity of the os ſacrum, and involves the great bundle or cauda equina, the cords of which pierce it on each ſide nearly oppoſite to the places where they paſs through the intervertebral holes, and the anterior holes of the os ſacrum, almoſt in the ſame manner as was ſaid above in deſcribing the general formation of the vertebral nerves.

This vagina of the dura mater being ſeparated from the canal of the vertebræ, and the lateral elongations which ſerve for particular vaginæ to the cords being cut off, it preſently ſhrinks up and contracts in the ſame manner as all the other elaſtic parts of the human body; for inſtance, as an artery does when cut tranſverſely ſoon after death. Therefore its true length muſt be taken while it is *in ſitu*, and likewiſe the true ſituation of the lateral elongations.

From all this a concluſion may be drawn of great importance, not only in anatomical and philoſophical inquiries, but alſo for underſtanding local diſeaſes, wounds, &c. which is, that when we have occaſion to conſider any particular nerves near the vertebræ of the back or loins, or near the os ſacrum, we muſt remember, that in the ſpina dorſi, the origin of theſe nerves is not even with their paſſage out of the ſpine, but proportionably higher. If, for inſtance, we inquire about any of the loweſt nervi ſacri near the os coccygis, we muſt not ſtop at the extremity of the os ſacrum, but trace its origin as high as the laſt vertebra of the back, or firſt of the loins.

The membrana arachnoides accompanies the original faſciculi ſeparately, to their paſſage through the lateral elongations of the dura mater, forming a kind of duplicature, breaks, or diſcontinuations, between the cords which run in the vagina of the dura mater. The pia mater adheres very cloſely both to the faſciculi and filaments of which they are compoſed.

Among the original productions of the nerves of the medulla

medulla ſpinalis, we ought ſtill to reckon the formation of the nervi acceſſorii of the eighth pair. They ariſe from the lateral parts of this medulla by ſeveral filaments, about the third or fourth vertebræ of the neck, and ſometimes lower. They run up on each ſide between the anterior and poſterior ranks of the nervous faſciculi, increaſing gradually in ſize by the acceſſion of new filaments from the poſterior faſciculi.

Having reached above the firſt vertebra of the neck, they have a kind of adheſion or communication with the neighbouring ganglions of the nervi ſub-occipitales, or thoſe of the tenth pair. Above this adheſion they receive two filaments each, from the back-ſide of the medulla, and afterwards continue their courſe towards the great occipital foramen. As they enter the cranium, they communicate with the nerves of the ninth and tenth pairs; and afterwards they join thoſe of the eighth pair, with which they return out of the cranium.

§ 8. *Blood-veſſels of the brain and medulla ſpinalis.*

Arteries. THE arteries which ſupply the cerebrum, cerebellum, and medulla oblongata, come partly from the carotids which enter the cranium through the canals in the apophyſes petroſæ of the oſſa temporum, and partly from the vertebrales which enter by the great occipital foramen, and ſend off the arteriæ ſpinales into the canal of the ſpine for the medulla lodged there.

All theſe arteries are divided into ſeveral branches, which ſend out a great number of ramifications diſtributed through both ſubſtances of the brain, and thro' the whole extent of the pia mater. The dura mater, both of the cerebrum and cerebellum, has arteries peculiar to it, which have been already deſcribed.

The internal carotid on each ſide enters the cranium by the great canalis petroſus, in an angular or winding courſe, as was obſerved in the deſcription of the ſkeleton. The inner ſurface of this canal is lined by a production

duction common to the dura mater and inferior pericranium; to which the artery adheres only by a loose filamentary substance, in which the plexiform filaments run that belong to the great sympathetic nerve.

Having passed through the bony canal, it immediately bends upward toward a notch in the sphenoidal bone, and through that notch it enters the cranium. Immediately after this, it penetrates the cavernous sinus on the side of the sella turcica; where having formed a third curvature, it goes out from it, from below, upwards; and is bent a fourth time round the anterior clinoide apophysis, from before backward. By this course it is in a manner bathed in the blood of the cavernous sinus, together with the sixth pair of nerves.

After this fourth curvature, the internal carotid having now reached the side of the infundibulum, and consequently being very near its fellow, these two arteries communicate sometimes by a very short transverse arterial production. At this place each of them, after sending a branch through the foramen opticum to the eye, divides into two principal branches, one anterior, the other posterior; and sometimes into three, in which case there is a middle branch between the two former.

The anterior branch runs, first of all, forward under the basis of the cerebrum, separating a little from the same branch of the other carotid. They approach each other again under the interstice between the two olfactory nerves, communicating by a very short anastomosis, and sending small twigs to that pair of nerves. They afterwards separate, being each divided into two or three rami.

The first ramus of the anterior branch goes to the anterior lobe of the cerebrum. The second, which is sometimes double, is inverted on the corpus callosum, to which it gives ramifications, as also to the falx of the dura mater and middle lobe of the cerebrum. The third, which is sometimes a distinct branch, sometimes only

only an additional ramus to the ſecond, goes to the poſterior lobe of the cerebrum. This third ramus is ſometimes ſo conſiderable as to deſerve to be reckoned the middle branch of the three principal ones.

The poſterior branch communicates firſt of all with the vertebral artery of the ſame ſide, and then is divided into ſeveral rami on the ſuperficial circumvolutions of the cerebrum, and between theſe circumvolutions all the way to their bottom. The anterior and middle branches, when there are three, diſtribute the ſame kind of ramifications to the circumvolutions, and to their interſtices.

All theſe different ramifications run on the duplicature of the pia mater, from which they receive a kind of additional coats; and the capillaries being diſtributed upon it in a reticular manner, do afterwards penetrate the cortical and medullary ſubſtance; in which laſt they terminate inſenſibly.

The vertebral arteries enter through the great occipital foramen, having firſt pierced on each ſide the elongations of the dura mater at the ſame place where the ſub-occipital nerves, or thoſe of the tenth pair, pierce it as they go out; the arteries in this place lying above the nerves.

At their entry into the cranium they ſend each ſeveral ramifications to the cauda of the medulla oblongata, and to the corpora olivaria and pyramidalia: which ramifications are diſtributed on the ſides of the fourth ventricle; produce the plexus choroides; are ſpread on the whole ſurface of the cerebellum; inſinuate themſelves between the ſtrata, always inveſted by the duplicature of the pia mater; and are at length loſt in both ſubſtances of the cerebellum.

Afterwards the two vertebral arteries turn toward each other, for the moſt part immediately under the poſterior edge of the great tranſverſe or ſemi-annular protuberance of the medulla oblongata, where they unite and form one common trunk. This trunk paſſes directly

directly from behind forward, under the middle of the great protuberance, and partly in the middle groove of the convex surface of that protuberance, at the anterior edge of which it terminates.

In its passage through the groove, this trunk sends off several small branches on each side, which surround transversely the lateral portions of the protuberance, being partly lodged in the small lateral grooves of these portions. These lateral branches are afterwards distributed to the neighbouring parts of the cerebrum, cerebellum, and medulla oblongata.

This common or middle trunk of the vertebral arteries having reached the edge of the great protuberance, is divided again into small branches; each of which soon communicates with the trunk of the internal carotid on the same side. Instead of this bifurcation, the two last or most anterior lateral branches send each sometimes a small branch forward, which form the anastomoses with the internal carotids.

The principal arteries of the medulla spinalis, called commonly *arteriæ spinales*, are two in number, one anterior and one posterior, lodged in the grooves by which the medulla is divided into lateral portions on both sides. They arise from the vertebral arteries, a little above the great occipital foramen, where these arteries send each a small ramus downward, as soon as they enter the cranium; and having got under the extremity of the medulla oblongata, they send off two other branches backward.

The first two branches uniting soon after their origin, form the arteria spinalis anterior, which runs down within the canal of the vertebræ along the anterior groove of the medulla. The other two small branches are inverted on the sides of the medulla oblongata, and from thence running backward, they unite much in the same manner with the first two, and form the arteria spinalis posterior, which runs down along the posterior groove of the medulla spinalis.

The two ſpinal arteries, in their courſe downward along the medulla, ſend off on each ſide lateral ramifications, by which they frequently communicate with each other, and with the vertebral, intercoſtal, lumbar, and ſacral arteries; and ſometimes they are in a manner ſplit for a little way, and then unite again.

The veins of the cerebrum and cerebellum, &c. may in general be looked upon as not only forming the longitudinal ſinus of the dura mater, and the two great lateral ſinuſes, but alſo all the inferior ſinuſes of that membrane; in all which ſinuſes the veins terminate by different trunks, in the manner already ſaid in the deſcription of the great ſuperior ſinus. Their principal ramifications accompany all the cortical circumvolutions of the cerebrum, and directions of the ſtrata of the cerebellum, running always in the duplicature of the pia mater. The veins of the plexus choroides, in general, are of the number of thoſe already mentioned.

The veins of the medulla ſpinalis terminate partly in the ſuperior extremities of the two vertebral veins, partly in the two venal ropes termed *ſinus venoſi*, which run down laterally on the convex ſide of the production of the dura mater, and form at different diſtances reciprocal communications, by ſemiannular arches, as by ſo many ſubordinate ſinuſes. The two longitudinal ſinuſes communicate likewiſe in their paſſage with the vertebral veins, in the ſame manner as the neighbouring arteries.

From the foregoing hiſtory of the arteries belonging to the brain, it appears, that a very great quantity of blood is in every pulſation ſent to this organ, inſomuch that, according to Dr Haller, it makes above a ſixth part; or rather, from Dr Monro's calculation, a tenth part of the whole blood that goes throughout the body, and derived from trunks that are very near the heart, ſpringing from the convexity of the aorta. From hence it is probable, that the ſtrongeſt parts of the blood

blood go to the head, and such as are most retentive of motion. Is not this evident from the effects of mercurials exerting themselves almost in the head only; from the sudden force and action of inebriating spirits upon the head; from the short stupor which camphor excites; from the heat, redness, and sweat, which happen oftener in the face than other parts of the body; to which add, the more easy eruption of volatile and contagious pustules in the face? Dr Wrisberg, however, observes, that all these arguments are not of the same force: for mercury, applied in different ways to the body, produces its effect not in the head alone; since it occasions in some a diaphoresis, in others a diarrhœa, and in others it acts as a diuretic. The well guarded passage of these great and important vessels in their ascent to the head, defends them from any great injury. The frequent inosculations of one trunk, with the other going to the head, as well as the frequent communications of their branches among themselves, lessen any danger that might ensue from obstruction. Hence, when the carotids are tied, the animal neither dies nor seems to be very uneasy. The considerable flexures of the vertebral and carotid artery serve to moderate the impulse of the blood coming to the brain, since a great part of the velocity, which the blood receives from the heart, is spent by the various inflections. To which add, that some authors do not improperly observe that the arteries here grow larger or somewhat wider.

With respect to the brain, we observe it providently surrounded on all sides, first by a sphere of bones, consisting of many distinct portions; by which means it is rendered extensible, at the same time that it is effectually guarded against external pressure. To the internal surface of this bony sphere, on all sides, grows the dura mater, which is firmly attached by an infinite number of small vessels, as by so many foot-stalks to the whole surface of the said bones,

ſo as to be nowhere eaſily ſeparable in a healthy perſon; this being very thin and ſmooth, adheres leſs firmly to the bones, but more ſtrongly to the *ſutures*. In younger ſubjects, the adheſion of the dura mater to the ſkull is ſuch, that the ſeparation of it pulls off the fibres of the bones to which it is connected. In adults, many of the veſſels being effaced, renders it more eaſily ſeparable: yet it is not without ſome force, even in thoſe, that the dura mater can be ſeparated from the ſkull. From the rupture of theſe veſſels, which enter the bones of the ſkull, appear thoſe bloody drops which are obſervable after removing the cranium. Hence appears the vanity of all that has been advanced concerning the motion of the dura mater. As to the motion which is remarked by the writers of obſervations upon wounds in this part; that, being preternatural, was the conſequence of the beating of the arteries (in a part where the reſiſtance of the bone was now removed, while the reſt of the dura mater next to the ſkull ſuſtained the force of the heart without motion); or of the brain ſwelling during exſpiration. Alſo that part, ſays Dr Haller, which is properly the dura mater, viz. the inner portion, has neither nerves nor ſenſation, nor irritability, while the outer part is ſupplied with ſmall nerves and blood-veſſels coming through all the holes of the ſkull. (Later phyſiologiſts obſerve in general, that the dura mater has but few nerves, and but little ſenſibility in the ſound ſtate; but that ſurgical phenomena ſhow it is not totally deſtitute of ſenſibility.)

The internal part of the dura mater having left the external part adhering firmly to the bones of the ſkull, runs inwards to form the proceſſes which ſerve to prevent the parts from preſſing one another in all ſituations and poſtures of the body; and they likewiſe hinder one part of the brain from bruiſing the other by any ſhock or concuſſion. Hence it is, that in the more active quadrupeds, where a concuſſion is more likely to happen, the brain and cerebellum is divided by a bony partition.

With reſpect to the glands of Pacchioni placed near the falx, their uſe is not yet ſufficiently known. But the vapour, which exhales from the ſurface of the pia mater, is not ſeparated by theſe glands, for it is every where exhaled, even into the ventricles, where there are none of them; and it plentifully tranſpires every where from the mouths of the leaſt arteries, as we ſee by experience, when water or fiſh-glue are injected, which ſweat out through every point in the ſurface of the dura mater.

The next covering of the brain, which is more cloſe to it, and preſſes the whole ſurface of the brain, as that does the cavity of the ſkull, is the arachnoides. This very thin or tender membrane, being pellucid like water, every way ſurrounds the brain, whoſe inequalities it climbs over, and according to its extreme thinneſs is pretty ſtrong, and ſurrounds the larger veſſels in ſuch a manner, that the ſaid veſſels ſeem to run between the pia mater and arachnoides.

The third or innermoſt covering of the brain, which is ſoft and cellular, is properly the *pia mater*. This immediately inveſts the whole ſurface of the brain and ſpinal marrow on all ſides, is tender, and made up of a vaſt number of ſmall veſſels which it conveys into the ſubſtance of the brain.

The *veins* of the brain are not diſpoſed in the ſame manner with thoſe in other parts of the body. For neither have they any valves, nor do they run together in company with the arteries, nor have their trunks the ſtructure which is commonly obſerved in the other veins. The veins from the different parts of the brain run into the ſinuſes which have been already deſcribed.

The great quantity of blood which goes to the brain, the greater impulſe with which it is ſent into the carotid arteries, and the ſecurity of this part from every kind of preſſure by a ſtrong bony fence, joined with the ſlower motion of the blood through the abdominal viſcera and lower extremities, alſo the perpetual exer-

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cife of the brain and fenfes, do all determine a copious flux of blood to thefe parts, and fome other caufes ferve to fill the head furprifingly with blood. Hence it is that a rednefs of the face, a turgefcence and fparkling of the eyes, with a pain and pulfation or throbing of the arteries in the head, are fo frequently followed with a bleeding at the nofe, by violent exercifes or motions of the body. From hence, therefore, it is evident, that if the veins were of a thin and round ftructure in the brain, they would be unavoidably in greater danger of rupturing, and conſequently apopoplexies (to which, in their preſent ſtate, they are often liable) would be much more frequent. To avoid this, therefore, nature has given a different figure to the veins which carry out the blood from the brain, by which they are more eaſily and largely dilatable, becauſe they make an unequal reſiſtance: their texture is likewiſe very firm, and more difficultly ruptured, eſpecially in the larger ſinuſes, which perform the office of trunks; for as to the ſinuſes of the leſſer ſort, they are either round, half cylindrical, or of an irregular figure. Beſides this, nature has guarded the ſinuſes by croſs-beams internally, made of ſtrong membranes, and detached from the right to the left ſide at the bottom of the ſinus, which in greater diſtenſions they draw towards a more acute angle, which is capable of a larger dilatation, ſtrengthening and guarding it from a rupture at the ſame time. She has likewiſe, in theſe veins, provided numberleſs inoſculations, by which they open mutually one into another, and openly communicate with the external veſſels of the head and with thoſe of the ſpinal medulla, by which means they are capable of freeing themſelves more eaſily whenever they are overcharged with blood.

It is by ſome queried, Whether a part of the arterial blood is not poured into the ſinuſes of the brain; and whether they have not a pulſation excited from that blood? That they have no pulſation, ſays Dr Haller,

is paſt doubt; becauſe the dura mater every way adheres firmly to the ſkull, but much more firmly in thoſe parts which are the ſeats of the ſinuſes. But Dr Monro obſerves, that whilſt the heart is performing its ſyſtole, the arteries here, as elſewhere, may be dilating; and in the mean time, a quantity of blood equal to that which is dilating them, is paſſing out of the head by the veins. *See* Obſ. on the Nervous Syſtem. Indeed the ſinuſes receive liquors injected by the arteries; but whether thoſe tranſude through the ſmall exhaling arterial veſſels, or whether they firſt make a complete circle through the veins, as indeed is much more probable, we are not yet furniſhed with experiments enough to determine.

Thus all the blood of the brain is finally conveyed into the jugular veins, which are very dilatable, and for that reaſon guarded with valves to prevent a return of the venous blood from the right auricle, being at the ſame time ſurrounded with a good deal of cellular ſubſtance. As to the blood which goes from the head to the vertebral veins, it is a very inconſiderable quantity; but the jugulars anſwer in ſuch a manner to the great upper vena cava in a direct courſe, that they afford the highway for the blood to return back to the heart. The branches of theſe are commonly the ſame with thoſe of the brain; namely, the veins of the brain, and thoſe of the face.

The veins form innumerable anaſtomoſes with one another, that the blood may return with the greateſt eaſe from the head, of which the repletion is very dangerous. The brain is alſo more eaſily evacuated in the time of inſpiration, and ſubſides as we ſee when the ſkull is opened, but ſwells during the time of exſpiration. Hence, blowing the noſe, ſneezing, and coughing, are dangerous to thoſe whoſe brain is ſwelled by retained blood.

Whether or not there are lymphatic veſſels to be ſeen in the brain, is by ſome queſtioned. Dr Haller thought it probable that there are no lymphatic veſ-

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fels in the brain; becauſe no conglobate glands are found there, and that the ſuperfluous moiſture is abſorbed by the red veins. But according to moſt of the preſent phyſiologiſts, lymphatic veſſels take up the ſuperfluous fluids of the brain, as well as of the other parts of the body, although they cannot be diſtinctly ſhown.

"In almoſt no viſcus," ſays Dr Wriſberg, "has the exiſtence of lymphatic veſſels been oftener aſſerted and again denied, than in the brain. Although, indeed, I am fully certain, that a group of lymphatic glands is nowhere found without lymphatic veſſels, by no means, however, could I aſſert, that there are nowhere lymphatic veſſels where glands do not appear. By analogy drawn from the whole body and all the viſcera, I am led to think, that the brain is not deſtitute of its aqueous veſſels, and that they run in particular upon the ſurface, not in the heart of its ſubſtance, although I myſelf have never ſeen any, but thoſe moving on the choroid plexus towards the tentorium, and on the inner ſurface of the dura mater, in the courſe of the ſuperior longitudinal ſinus. But I cannot diſcredit the induſtry of the celebrated Sommering, who confirms the obſervations of King, Collins, and Pacchioni, who ſaw them going upon the pia mater. I would aſk, May they be joined with the glands of Pacchioni? May theſe corpuſcles ſupply the place of lymphatic glands?"

It now remains for us to ſpeak of the encephalon itſelf. Upon the ſurface of the brain lies the cortex, the fabric of which has been a long time controverted; but it is now ſufficiently evident, from anatomical injections, that much the greater part of it conſiſts of mere veſſels, which are every way inſerted from the ſmall branches of the pia mater, detached like little roots into the cortical ſubſtance, and conveying a juice much thinner than blood in their natural ſtate, although in ſome diſeaſes, and by ſtrangling, they often receive even the red parts of the blood, more eſpecially in brutes and birds. The remaining part of the cortex, which is not filled by any injection, is probably either

an aſſemblage of veins, or of yet more tender veſſels; for no other diſſimilar parts are apparent in the cortex, whilſt it is in an entire or natural ſtate; from whence one may conjecture ſome part of it to be tubular, and the other part ſolid. As to glandules making the fabric of the brain, that notion has been diſcarded by univerſal conſent; nor indeed has there been any other opinion received with leſs probability than this.

In order to gain a knowledge of the nature of medulla, which lies under the cortex, we are to conſider the anatomical ſtructure of this part of the human brain, compared with the brains of brute animals and fiſh. Therefore this part of the brain, which follows immediately under the outer gyri or convolutions of the cortex, is of a white colour, and becomes gradually broader and more abundant; ſo that, at length, it makes up the whole oval ſection of the brain, except only the gyri in the ſurface, which makes the cortex, as was mentioned in the former part of this ſection.

The nerves of the brain, as well as of the ſpinal marrow, divide into branches like the blood-veſſels, but in acute angles, and often in a courſe manifeſtly retrograde, growing gradually ſofter and leſs in bulk, though ſometimes they become thicker as they recede from the brain, till at length their ultimate extremities, which are ſeldom viſible, ſeem to terminate in a pulp, by depoſiting the firm integuments with which they were covered, after the manner which we obſerve in the optic nerve. But the rectilineal courſe of the fibres, continued from the brain itſelf, is ſuch, that it is never broken off by the diviſion or ſplitting of a nerve into ſmaller threads, which only recede from each other by an opening of the cellular ſubſtance that tied them together. This appears from the diſorders, which are determined not to all, but only to ſome ſingle parts by injuries of the brain; as a loſs of the voice, deafneſs, dumbneſs, and palſies of particular muſcles. They are connected in their courſe by the cellular ſubſtance to the

adjacent parts, but have hardly any elaſticity; whence they do not fly back after being divided, but only expel, by the contraction of their integuments, the ſoft medulla which they include. But though they are irritated ever ſo much, they are neither contracted, nor are they rendered ſhorter during the motion of the muſcles which they produce. A great many nerves, ſays Haller, are ſent into the muſcles; many of them go to the ſkin; but fewer to the viſcera, and feweſt of all to the lungs. Wriſberg, however, obſerves, that more nerves manifeſtly enter the organs of ſenſe than the muſcles; and that the lungs are ſupplied with more nerves than the ſpleen, uterus, and other viſcera. Haller alſo aſſerts, that none at all go to the dura and pia mater, arachnoides, tendons, capſules, and ligaments, and laſtly the whole ſecondary membranes. That theſe parts have few nerves is certain; but that nerves can be traced into ſome of them, as the ligaments, cannot now be denied. *See* Monro and Walter's Tables. They make frequent inoſculations with each other, or one trunk gives off many branches: and principally from the conjunction of theſe branches the nervous ganglia are formed; i. e. hard nervous tumours, for the moſt part repleniſhed with blood-veſſels, and included in a firm membrane. Theſe Dr Monro conſiders as ſources of nervous matter and energy; for they are full of nervous fibrillæ, intermixed with a yellowiſh or reddiſh brown ſubſtance, ſomething ſimilar to the cortical ſubſtance of the brain. *See* Obſ. on the Nervous Syſtem.

Thus far we are taught by anatomy concerning the brain and nerves; it now remains only that we explain the phyſiological uſes of theſe parts. Every nerve, therefore, that is irritated by any cauſe, produces a ſharp ſenſe of pain. But we muſt reckon the mind to be changed, when any change happens to the body. It is the medullary part of the nerve which feels the pain. If the nerve was endued with any peculiar ſenſe, that ſenſe periſhes when the nerve is compreſſed or diſ-

fected: the ſenſes of the whole body are loſt by a compreſſion of the brain; and of thoſe parts whoſe nerves originate below the ſeat of preſſure, if you compreſs the ſpinal marrow. If certain parts of the brain are compreſſed from which particular nerves ariſe, then thoſe ſenſes only are loſt which depend on the nerves, as the ſight or hearing. Thoſe parts of the body which receive many nerves, as the eyes and penis, have the moſt acute ſenſation; thoſe have leſs ſenſibility which receive few nerves, as the viſcera; and thoſe which have feweſt nerves, as the dura mater, tendons, ligaments, ſecundines, bones, and cartilages, have little or no ſenſation in the ſound ſtate.

It is therefore evident, that all ſenſation ariſes from the impreſſion of an active ſubſtance on ſome nerve of the human body; and that the ſame is then repreſented to the mind by means of that nerve's connection with the brain. But this ſeems to be falſe, that the mind perceives immediately by means of the ſenſoria and branches of the nerves. For this opinion is refuted, by the pains felt after amputation, the ceſſation of all pain when the nerve is compreſſed, and the deſtruction of the ſenſes by diſeaſes of the brain. And that the effect of the ſenſes is preſerved in the brain, is evident from the loſs of memory which follows when the brain is injured or compreſſed; alſo from the delirium which happens in ſome diſeaſes, and the ſtupor and ſleepineſs which happen in others.

Another office of the nerves is to excite motions, even the moſt violent ones in the muſcles. When a nerve is irritated, the muſcle to which it goes is immediately convulſed; or if it ſends branches to ſeveral muſcles, they are all convulſed at the ſame time. This happens during the life of the animal, and a little after its death, while all the parts are moiſt. By a great irritation other muſcles are thrown into convulſions, and afterwards the whole body. Nor is it neceſſary that the nerve ſhould be whole; for even when it is cut,

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an irritation of it will excite ſimilar motions in the muſcles. On the other hand, when a nerve is compreſſed or tied, a palſy follows; for the muſcles which have their nerves from that one lie unmoved, when they are commanded by the will to act. They alſo recover their motion when the compreſſion is removed, provided the nerve has received no hurt.

But the medulla of the brain being vellicated or irritated deeply in its crura, dreadful convulſions enſue throughout the whole; and this without any exception, whatever be the part of the brain ſo affected; nor is there any difference in the brain, cerebellum, or corpus calloſum. The ſame conſequences alſo follow, if the ſpinal medulla be irritated. But if the encephalon itſelf be compreſſed in any part whatever, there follows thence a loſs of ſenſe and motion in ſome part of the body, which muſt be the part whoſe nerves are detached from the affected or compreſſed quarter of the brain. This is clearly evidenced from experiments which have been made on particular parts of the brain diſordered: as from thoſe, for inſtance, in which the origin of the nerves is compreſſed, the voice is loſt; or the motion of one arm or leg, or one ſide of the pharynx, is aboliſhed. But in the injuries of the ſpinal medulla, it is ſtill more evident, that thoſe parts which receive their nerves ariſing from the place injured in the medulla, are either convulſed, if that be irritated, or rendered paralytic, if it be compreſſed. But when any more conſiderable or large portion of the brain ſuffers a compreſſure, either from blood, water, ſcirrhus, an impacted bone, or other mechanical cauſes, the greateſt part, and then the whole, of the body loſes its power of motion; of thoſe organs which obey the will when the malady is in a leſſer degree, and of them all when it is greater; all which diſorders ceaſe upon removing the compreſſing cauſe. Laſtly, if the ſpinal medulla, entering the neck, be injured, death immediately follows, probably from the intimate connection between

between the nerves of this place and thoſe that ſupply the vital parts.

Theſe things being conſidered, there ſeems to be no doubt, but the cauſe of all motion in the human body ariſes from the brain with its annexed cerebellum and ſpinal marrow; and that it thence proceeds through the nerves to all the muſcular parts of the body. The cauſe, therefore, of this motion cannot reſide in the parts themſelves, becauſe otherwiſe the moving cauſe would continue to act after being ſeparated from the brain; nor would it be increaſed by irritating the brain, or weakened by a compreſſure of it.

Whether or not is there in the brain any principal part, in which reſides the origin of all motion, the end of all the ſenſations, and where the ſoul has its ſeat? Whether is this proved by the frequent obſervation, that the ſenſes are ſometimes entire, and that motion likewiſe remains, though the brain is grievouſly hurt? Is it in the corpus calloſum? Or is this ſhown by the greater fatality of wounds or diſeaſes in the corpus calloſum? Is this body ſufficiently connected with the nerves? Are there any experiments which deduce from thence the fifth, ſeventh, and other nerves? Doth not the ſame or even greater mortality of wounds in the medulla ſpinalis prove the ſame thing? Yet this is not the ſeat of the ſoul, ſeeing, though it is compreſſed or even deſtroyed, the perſon will ſurvive a long time with the perfect uſe of all his ſenſes. Nay, this opinion is oppoſed by very many facts: birds have no corpus calloſum; and wounds in that body are not in the leaſt more mortal than thoſe in other parts of the brain, as appears from undoubted experiments.

But the power of the cerebellum is not greater in exciting the vital motions, nor are the vital and animal functions diſtinct; nor does the cerebellum produce the nerves of the heart and of other vital organs, and the brain thoſe which go to the organs of ſenſe and voluntary motion. From the cerebellum the fifth nerve

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is moſt evidently produced; but that goes to the tongue, pterygoide, buccinator, temporal, and frontal muſcles, the lap of the ear, the eye, the noſtrils; all which are parts either moved by the will, or deſtined for ſenſe. Again, the ſame nerve, like the eighth, ſends vital branches to the heart and lungs, animal and voluntary ones to the larynx, and ſenſitive ones to the ſtomach. Again, it is not even true, that diſorders of the cerebellum bring on ſo certain and ſpeedy death. For certain experiments, even of our own making, ſhow that it has borne wounds and ſcirrhi, without taking away life; nor is it much different from the brain, only that it is ſofter and more tender; and laſtly, we have known, and that not very rarely, wounds of the cerebellum cured. The power, however, of this part, in exciting convulſions, is ſomewhat greater.

Concerning the ſeat of the ſoul, we muſt inquire experimentally. In the firſt place, it muſt be in the head, and not in the ſpinal marrow. For though this is obſtructed, the conſtancy of the mind remains the ſame. Again, it appears, from the experiment of convulſions ariſing, when the inmoſt parts of the brain are irritated, that it lies not in the cortex, but in the medulla; and, by a probable conjecture, in the crura of the medulla, the corpora ſtriata, thalami, pons, medulla oblongata, and cerebellum. And again, by another not abſurd conjecture, where the origin of every nerve lies, as the firſt origins of all the nerves taken together make up the ſenſorium commune. Are the ſenſations of the mind repreſented there, or do the voluntary and neceſſary motions ariſe in that place? This ſeems very probable. For it does not ſeem poſſible, that the origin of motion can lie below that of the nerve; for although it ſhould be aſſumed gratis, that ſome part of the nerve is immoveable, or inſenſible, yet that is altogether ſimilar to the remainder of the nerve. Nor can the origin of motion depend upon the arteries, which have neither the faculty of ſenſation nor that of voluntary motion.

motion. It therefore follows, that the ſeat of the mind muſt be where the nerve firſt begins its formation or origin.

We come now to explain the manner in which the nerves become the organs of ſenſe or motion; which, as it lies hid in the ultimate elementary fabric of the medullary fibres, ſeems to be placed above the reach both of ſenſe and reaſon; but we ſhall, notwithſtanding, endeavour to make this as plain as experiments will enable us. And firſt, it is demonſtrated, that the ſenſation does not come through the membranes from the ſentient organ to the brain, nor that motion is ſent through the coverings from the brain into the muſcle. For the brain itſelf lies deeper than theſe membranes, and receives the impreſſions of ſenſe, and when hurt throws the muſcles into convulſions. Moreover, it is certain, that the nerves ariſe from the medulla of the brain; the truth of which is manifeſt to the eye in all the nerves of the brain, more eſpecially in the olfactory, optic, fourth and ſeventh pair of nerves, which continue their medullary fabric a long way before they put on the covering of the pia mater.

We muſt therefore next inquire into this medulla, what it is. It is a very ſoft ſubſtance; but its compoſition is fibrous, as appears from innumerable arguments; more eſpecially to the eye in the corpus callo-ſum, in the ſtriatum, and thalami of the optic nerves; but ſtill more evidently in the brains of fiſh, and eſpecially in their thalami optici; but in no part of the human brain does the fibrous nature of the medulla more evidently appear than in the fornix, eſpecially when immerſed in ſome of the acids. Again, that the fibres of the brain are continuous with thoſe of the nerves, ſo as to form one extended and open continuation, appears by obſervation very evidently in the ſeventh, fourth, and fifth pair of nerves. There is a great deal of oil in the medulla, upwards of a tenth part of its whole weight.

But

But here a controverſy begins concerning the nature of this fibril, which with others of the like kind compoſes the ſubſtance of the medulla and of the nerves. That this is a mere ſolid thread, and only watered by a vapour exhaling into the cellular fabric which ſurrounds the nervous fibres, has been aſſerted by many of the moderns; but that, when it is ſtruck by a ſenſible body, a vibration is excited, which is then conveyed to the brain.

But the phænomena of wounded nerves will not allow us to imagine the nervous fibres to be ſolid. For if an irritated nerve is ſhaken (and that happens after the manner of an elaſtic cord, which trembles when it is taken hold of), the nerve ought to be made of hard fibres, and tied by their extremities to hard bodies: they ought alſo to be tenſe; for neither ſoft cords, nor ſuch as are not tenſe, or ſuch as are not well faſtened, are ever obſerved to tremulate. But all the nerves at their origin are medullary and very ſoft, and exceedingly far from any kind of tenſion: where they paſs through channels, where they are well guarded, they retain the ſame ſoft texture, and are not covered with membranes, as in the intercoſtal nerves and the ſecond nerves of the fifth pair: ſome alſo are ſoft throughout their whole length, whatever ſize they may be of; for example, the ſoft olfactory and acouſtic nerves, from which we would moſt readily expect a tremor, as in the caſe of ſound. Again, though the nerves are hard, they are ſoftened in the viſcera, muſcles, and ſenſoria, before they exert their operations. Therefore, the nervous fibres cannot poſſibly tremulate in an elaſtic manner, neither at their origin, nor where they are tenſe. But the ſame, even in the proper and moſt favourable caſes, cannot tremulate; becauſe, through their whole length, they are firmly tied to the ſolid parts by means of the cellular fabric; for example, the nerves of the heart are tied to the great arteries, and to the pericardium. Finally, that the nerves are

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deſtitute of all elaſticity, is demonſtrated by experiments, in which the nerves cut in two neither ſhorten nor draw back their divided ends to the ſolid parts; but are rather more elongated by their laxity, and expel their contained medulla in form of a protuberance. Again, the extreme ſoftneſs of the medulla in the brain, with all the phænomena of pain and convulſion, leave no room to ſuſpect any ſort of tenſion concerned in the effects or operations produced by the nerves.

Add to this, that the force of an irritated nerve is never propagated upward, ſo as to convulſe the muſcles that are ſeated above the place of irritation. This is a conſequence altogether diſagreeing with elaſtacity; for an elaſtic cord propagates its tremors every way, from the point of percuſſion to both extremities. But if neither phænomena of ſenſe nor motion can be explained from the nature of elaſticity, the only probable ſuppoſition that remains is, that there is a liquor ſent through the brain, which, deſcending from thence through the nerves, flows out to all the extreme parts of the body; the motion of which liquor, quickened by irritation, operates only according to the direction in which it flows through the nerve; ſo that convulſions cannot thereby aſcend upwards, becauſe of the reſiſtance made by the freſh afflux of the fluid from the brain. But the ſame liquid being put in motion in an organ of ſenſe, can carry that ſenſation upwards to the brain; ſeeing it is reſiſted by no ſenſitive torrent coming from the brain in a contrary direction.

It is therefore probable, that the nervous fibres, and the medullary ones of the brain, which have the ſame nature, are hollow. Nor is the objection which ariſes from the ſmallneſs of theſe tubes, not viſible by any microſcope, of any force againſt the propoſed arguments; to which add the abſence of a ſwelling in a tied nerve, which, in reality, is not ſufficiently true; with other arguments of the like kind, which indeed ſhow

the weakneſs of the ſenſes, but have not any validity againſt the real exiſtence of a juice or ſpirit in the nerves. If they are tubes, it is very probable that they have their humours from the arteries of the brain.

But concerning the nature of this nervous liquid, there are many doubts. Many of the moderns will have it to be extremely elaſtic, of an etherial or of an electrical matter; but the more reaſonable part make it to be incompreſſible and watery, but of a lymphatic or albuminous nature. Indeed it is not to be denied, that we have many arguments againſt admitting either of theſe opinions. An electrical matter is, indeed, very powerful, and fit for motion; but then it is not confineable within the nerves, ſince it penetrates throughout the whole animal to which it is communicated, exerting its force upon the fleſh and fat, as well as upon the nerves. But, in a living animal, the nerves only, or ſuch parts as have nerves running through them, are affected by irritation; and therefore, this liquid muſt be of a nature that will make it flow through, and be contained within the ſmall pipes of the nerves. And a ligature on the nerve takes away ſenſe and motion, but cannot ſtop the motion of a torrent of electrical matter.

A watery and albuminous nature is common to moſt of the juices in the human body, and may be therefore readily granted to the juice of the nerves; like the water which exhales into the ventricles of the brain from the ſame veſſels; alſo, from the example of a gelatinous or lymphatic juice, which flows out in cutting through the brain in fiſh, and the nerves of larger animals; to which add the tumour which ariſes in tied nerves. But are theſe properties ſufficient to explain the wonderful force of convulſed nerves, obſervable in the diſſections of living animals, and even in the leſſer inſects, with the great ſtrength of mad and hyſterical people? Is not this difficulty ſomewhat leſſened from the hydroſtatical experiments of attraction in ſmall tubes;

tubes; which although it may explain the ſtrength and motion, is nevertheleſs inconſiſtent with the celerity?

The nervous liquor then, which is the inſtrument of ſenſe and motion, muſt be exceedingly moveable, ſo as to carry the impreſſions of ſenſe, or commands of the will, to the places of their deſtination, without any remarkable delay: nor can it receive its motions only from the heart. Moreover, it is very thin and inviſible, and deſtitute of all taſte and ſmell; yet reparable from the aliments. It is carefully to be diſtinguiſhed from that viſible, viſcid liquor, exhaling from the veſſels in the intervals between the nervous cords.

That this liquor moves through tubes rather than through a ſpongy ſolid, we are perſuaded from its celerity, and the analogy of the whole body; of which all the liquids, the fat excepted, run through their proper veſſels.

Therefore, upon the whole, it ſeems to be certain, that from the veſſels of the cortex a liquor is ſeparated into the hollow tubes of the medulla, which are continued with the ſmall tubes of the nerves, even to their ſoft pulpy extremities, ſo as to be the cauſe both of ſenſe and motion. But there will be a twofold motion in that humour; the one ſlow and conſtant, from the heart; the other not continual, but exceedingly ſwift, which is excited either by ſenſe or any other cauſe of motion ariſing in the brain.

The ſame nerves moſt evidently preſide over both ſenſe and motion; as we cannot admit a diſtinction between the two ſyſtems of motory and ſenſitive nerves. If ſenſe ſometimes remain after motion is deſtroyed, this ſeems to be becauſe much more ſtrength is required for the latter. Dying people hear and ſee, when they are incapable of motion.

If it be aſked, What becomes of this nervous juice, which cannot but be ſeparated and diſtributed in great abundance, from ſo large a quantity of blood paſſing the brain very ſwiftly, in compariſon of the ſlower moving

ving blood, from whence the milk is ſeparated in the breaſt, and the urine in the leſſer renal artery, or by a compariſon with the meſenteric artery? it may be anſwered, It exhales probably through the cutaneous nerves; the laſſitude, both with reſpect to ſenſe and motion, which may be overcome by ſpirituous medicines, ſhows that this liquid may be both loſt and repaired. Many have judged, that it alſo exhales into the various cavities of the body; as that of the ſtomach and inteſtines. We may expect ſome part of it to be reſorbed, that the nobleſt humour of the body may not be too quickly diſſipated. That it nouriſhes the body, is incredible: It is too moveable to expect adheſion from it: that is the office of a ſlow and viſcid humour.

But then, what is the deſign of ſo many protuberances in the brain? what are the particular uſes of the ventricles, nates, and teſtes; with the diſtinction of the brain from the cerebellum; and the communication betwixt one ſide of the brain, cerebellum, and ſpinal medulla, with their oppoſite ſides, by ſo many tranſverſe bundles of fibres? Future experience alone can determine theſe circumſtances, when the brains of ſeveral animals ſhall have been compared with their functions.

The ventricles ſeem to be made of neceſſary conſequence, and towards the greater uſe and diſtinction of the parts. And that the corpora ſtriata or thalami might keep their medullary parts from cohering one to another, it was neceſſary for a vapour to be poured betwixt them; and the ſame is true with regard to the brain and cerebellum. Beſides the conjectures propoſed by authors, Dr Monro adds, That the ventricles ſerve to increaſe the ſurface of the pia mater; and, that whatever purpoſes are ſerved by that membrane and its veſſels on the ſurface of the brain, we muſt ſuppoſe the ſame performed by it within the ventricles. Perhaps, likewiſe, the neceſſity of adminiſtring a degree of warmth to the cloſe medulla of the brain may be

one reaſon for theſe cavities, by which the arteries enter, and are diſtributed in great numbers. Perhaps alſo it was proper, that, in the inmoſt part of the brain, ſmall veſſels only, without any large ones, ſhould enter. We may alſo ſuſpect, that the ſoftneſs of the fibres of the brain requires ſhortneſs in order to ſuſtain their own weight.

The uſes of moſt of the protuberances we are not acquainted with, but have them yet to learn from diſeaſes, and from anatomical experiments made on animals having a brain like that of mankind. But, in theſe reſpects, we have little hopes of ſucceſs in parts that are ſo ſmall, ſo deeply, and ſo difficultly ſituated, and hardly ever to be approached but by a wound ſoon fatal. Whether theſe parts are ſo many diſtinct provinces in which our ideas are ſtored up, and whether this be confirmed by the protuberant thalami of the optic nerve, are indeed queſtions. But then moſt of theſe protuberances ſend out no nerves at all.

As to the internal communication of one part with the other by ſtriæ or ducts; that ſeems to conduce to the advantage of motion, and probably of ſenſe likewiſe. Some of theſe communications join the brain with the cerebellum; others join the ſpinal medulla with the nerves of the brain itſelf, as in the acceſſory nerve; and moſt of them join the right and left parts together, as in the anterior commiſſure, and in the two poſterior, in that of the corpus calloſum, in the ſtriæ betwixt a proceſs of the cerebellum and teſtes; to which add the medullary croſs-bars in the medulla oblongata and ſpinalis. For from this ſtructure, it ſeems manifeſtly to follow, as well as from numberleſs experiments and obſervations, that when the right ſide of the brain is injured, all the nerves which, on the contrary, belong to the left ſide of the body, become diſeaſed or paralytic, and the reverſe. Moreover, by this contrivance, nature ſeems to have provided, that, in whatever part of

of the brain any injury may happen, the nerve that ariſes from thence is, by this means, not always deprived of its uſe. For if the ſaid nerve receives its fibres by communicating bundles, as well from the oppoſite as from its own hemiſphere of the brain, its office may in ſome meaſure be continued entire by the fibres which it receives from the oppoſite ſide, even after thoſe of its own ſide are deſtroyed. Accordingly, we have numberleſs inſtances of wounds, and with a conſiderable loſs of ſubſtance from the brain, which yet have not been followed with injury to any nerve, or to any of the mental faculties. Many other leſs inequalities, ſtripes, protuberances, and nerve like impreſſions, appear in the brain from mechanical neceſſity, with the pulſation of the veſſels, and the preſſure or figure of the continuous incumbent parts.

Sect. II. *The* Eye.

§ 1. *The Eye in general.*

Situation and compoſition. The eyes are commonly two in number, ſituated at the lower part of the forehead, one at each ſide of the root of the noſe; and they are made up of hard and ſoft parts. The hard parts are the bones of the cranium and face; which form two pyramidal or conical cavities, like funnels, to which we give the name of *orbits*. The ſoft parts are of ſeveral kinds.

The principal and moſt eſſential ſoft part in each organ is the globe or ball of the eye; the others are partly external and partly internal. The external parts are the ſupercilia or eye-brows, the palpebræ or eye-lids, the caruncula lachrymalis, and the puncta lachrymalia; and the internal parts are the muſcles, fat, lachrymal gland, nerves, and blood-veſſels.

The orbits. Seven bones are concerned in the compoſition

position of each orbit, viz. the os frontis, os sphenoidale, os ethmoides, os maxillare, os malæ, os unguis, and os palati. In each orbit we are to consider the edge, sides, and bottom. The edge is formed by the os frontis, os maxillare, and os malæ; the bottom by the os sphenoides and os palati; and all these bones, except the os palati, contribute to form the sides. The bottom is perforated by the foramen opticum of the os sphenoides; and the external side near this foramen by two orbitary fissures, one superior, called *sphenoidalis*, the other inferior, called *spheno-maxillaris*, as has been already said in the description of the skeleton.

All the cavity of the orbit is lined by a membrane, which is an elongation or production of the dura mater; and it comes partly through the foramen opticum of the os sphenoides, and partly through the sphenoidal or superior orbitary fissure. This membrane, which may be looked upon as the periosteum of the orbit, communicates with the periosteum of the basis cranii, by the inferior orbitary fissure, and with the periosteum of the face at the edge of the orbit. At the upper part of the edge of the orbits, the two periostea form a kind of broad ligament, and a narrow one at the lower part of this edge, which may be called *ligaments of the palpebræ*.

The particular situation of the orbits represents nearly two funnels, placed laterally at a small distance from each other, in such a manner as that their apices are almost joined, their neareſt sides almost parallel, and the other sides turned obliquely backward; and for this reason the middle of the great circumference or edge of each orbit, is at a much greater distance from the septum narium, than the bottom or apex; and the edge or great circumference is very oblique, the temporal or external angle of the orbit lying more backward than the nasal or internal angle.

§ 2.

§ 2. *The Globe or Ball of the Eye.*

Compoſition. THE globe of the eye being the moſt eſſential of all the ſoft parts belonging to the organ of ſight, and being likewiſe a part which we are obliged to mention as often as we ſpeak of the other ſoft parts, muſt be firſt deſcribed. It is made up of ſeveral proper parts; ſome of which being more or leſs ſolid, repreſent a kind of ſhell formed by the union of ſeveral membranous ſtrata called the *coats of the globe of the eye;* and the other parts being more or leſs fluid, and contained in particular membranous capſulæ, or in the interſtices between the coats, are termed *the humours of the globe of the eye.* Theſe capſules are likewiſe termed *coats.*

The coats of the globe of the eye are of three kinds. Some form chiefly the ſhell of the globe; ſome are additional, being fixed only to a part of the globe; and ſome are capſular, which contain the humours. The coats which form the globe of the eye are, The ſclerotic, to which the convexity of the globe is owing; the cornea, which forms the anterior part of the globe; the iris, choroides, and retina. The additional coats are two; one called *tendinoſa* or *albuginea*, which forms the white of the eye; and the other, *conjunctiva.* The capſular tunicæ are likewiſe two, the vitrea and cryſtallina.

The globe of the eye thus formed, receives from behind a pretty large pedicle, which is the continuation of the optic nerve. It is ſituated about the middle of the orbit in the manner which we ſhall afterwards ſee; and it is tied to it by the optic nerve, by ſix muſcles, by the tunica conjunctiva, and by the palpebræ. The back-part of the globe, the optic nerve, and muſcles, are ſurrounded by a ſoft fatty ſubſtance, which fills the reſt of the bottom of the orbit.

The humours are three in number; the aqueous, vi-

treous, and cryſtalline. The firſt may properly enough be called an *humour*, and is contained in a ſpace formed in the interſtices of the anterior portion of the coats. The ſecond or vitreous humour is contained in a particular membranous capſula, and fills above three-fourths of the ſhell or cavity of the globe of the eye. It has been named *vitreous*, from its ſuppoſed reſemblance to melted glaſs; but it is really more like the white of a new-laid egg.

The cryſtalline humour is ſo called from its reſemblance to cryſtal, and is often named ſimply the *cryſtalline*. It is rather a gummy maſs than an humour, of a lenticular form, more convex on the back than on the fore ſide, and contained in a fine membrane called *membrana* or *capſula cryſtallina*. What has been here ſaid is ſufficient to give a general idea of the three humours of the globe of the eye.

§ 3. *The Coats of the Eye in particular.*

The moſt external, the thickeſt, and ſtrongeſt coats of the eye, are the ſclerotica and cornea. They inveſt all the other parts of which the globe is compoſed.—The ſclerotic is of a white colour, and made up of many fibres cloſely connected; and is of a firm texture, reſembling parchment. About the middle of its poſterior convex portion, where it ſuſtains the optic nerve, it is in a manner perforated, and thicker than any where elſe, its thickneſs diminiſhing gradually toward the oppoſite ſide, and its ſubſtance is penetrated obliquely in ſeveral places by ſmall blood-veſſels and nerves. The courſe of the nervous filaments thro' this coat is very ſingular: they enter the convex ſide at ſome diſtance from the optic nerve; and running from thence obliquely through its ſubſtance, they pierce the concave ſide ſome way farther forward.

The cornea is made up of ſeveral ſtrata or laminæ cloſely united by cellular ſubſtance, and of a different

rent texture from the former; beſides, it receives no blood-veſſels in the natural ſtate. When macerated in cold water, it ſwells; and then its ſtrata may be ſeparated from each other. If it be macerated till it begin to become putrid, and is then plunged into boiling water, it ſeparates readily, from the ſclerotic being joined only by cellular ſubſtance. (*See* Traité complet d'Anatomie.) It is likewiſe thicker than the ſclerotic, eſpecially in new-born children, where its poſterior ſurface almoſt touches the iris.

This portion is ſomething more convex than the ſclerotica, ſo that it repreſents the ſegment of a ſmall ſphere added to the ſegment of a greater; but this difference is not equally great in all perſons. The circumference of the convex ſide is not circular as that of the concave ſide, but tranſverſely oval: for the ſuperior and inferior portions of the circumference terminate obliquely; but this obliquity is more apparent in oxen and ſheep than in man.

The cornea is perforated by a great number of imperceptible pores, through which a very fine fluid is continually diſcharged, which ſoon afterwards evaporates; but we diſcover it evidently by preſſing the eye ſoon after death, having firſt wiped it very clean; for we then ſee a gradual collection of a very ſubtle liquor, which forms itſelf into little drops; and this experiment may be ſeveral times repeated on the ſame ſubject. It is this dew that forms a kind of pellicle on the eyes of dying perſons, which ſometimes cracks ſoon after, as is obſerved in the Memoirs of the Academy for 1721.

Tunica choroides. The next coat of the globe of the eye is the choroides, which is of a blackiſh colour, more or leſs inclined to red; and adheres, by means of a great number of ſmall veſſels, to the ſclerotica, from the inſertion of the optic nerve all the way to the cornea, where it leaves the circumference of the globe; and turns inward, to form a number of little pro-

ceſſes termed *ciliary*, which are ſituated at the edge of the cryſtalline lens.

The external lamina of the choroides is ſtronger than the internal, and is of a browniſh colour. At a very ſmall diſtance from the cornea this lamina is moſt cloſely united to the ſclerotica, by means of a whitiſh ring called *ciliary ligament*, or *ciliary circle;* and near the edge of the ſclerotica this ring is ſtronger and of a different texture from what it is any where elſe. The choroides adheres ſo cloſely to the ſclerotica, that if we blow through a ſmall hole made therein without touching the choroides, the air will penetrate every where between the two coats, but cannot deſtroy this adheſion, or paſs to the cornea. On the inner ſurface of this lamina we diſcover a great number of flat lines in a vortical diſpoſition, which are the veſſels named by Steno *vaſa vorticoſa*, or *vortices vaſculoſi;* of which hereafter.

The internal lamina of the choroides is thinner and of a darker colour than the external; it is formed of a black varniſh, which is thicker before than behind, and is wanting at the entrance of the optic nerve. At the fore-part of the eye it lies only between the ciliary proceſſes, leaving them white, and adheres to the vitreous humour, forming there a radiated ring. The origin of this ſubſtance has not as yet been obſerved; but, after a nice anatomical injection, Winſlow has obſerved a great number of vaſcular ſtars on its inner ſurface. In Ruyſch's works, it is termed *Membrana Ruyſchiana.*

At the anterior edge of the choroides we find the iris compoſed of two laminæ; the poſterior of which, being of the colour of a grape, was called *uvea* by the ancients. In the middle of the iris there is a hole termed *pupil:* this in a fœtus is covered with a membrane called *pupillaris*, which generally diſappears about the ſeventh month; or between the ſeventh and ninth month, according to Wriſberg. Between the two laminæ of the iris we find two very thin planes of fibres, which

which have been ſuppoſed to be muſcular; but this matter is not yet fully aſcertained. The fibres of one plane is orbicular, and lies round the circumference of the pupil; and thoſe of the other is radiated, one extremity of which is fixed to the orbicular plane, the other to the great edge of the iris. The iris has motions of ſuch a nature, that the pupil is contracted at the approach of a ſtrong light, and is dilated upon being expoſed to a weak one. The different colours which appear in the iris ſeem to be owing to an intermixture of veſſels and nerves; and that the iris poſſeſſes red veſſels is evident from injection (contrary to the opinion of ſome phyſiologiſts), and from obſervations on the eye during life. (*See* Monro on the Structure and Phyſiology of Fiſhes.)

The plicæ or proceſſus ciliares are ſmall radiated and prominent duplicatures of the anterior edge of the choroid coat; and their circumference anſwers partly to that of the ciliary circle. They are oblong thin plates; their external extremities, or thoſe next the choroides, being very fine and pointed; the internal are broad, prominent, bifurcated, and alternately long and ſhort, making ſlight depreſſions on the fore part of the vitreous humour. In the duplicature of each ciliary fold we find a fine reticular texture of veſſels; and ſome pretend to have ſeen fleſhy fibres in the ſame place, lying in ſmall grooves of the membrana vitrea, as we ſhall ſee hereafter.

The ſpace between the cornea and iris contains the greateſt part of the aqueous humour, and communicates by the pupilla with a very narrow ſpace behind the iris, or between that and the cryſtalline. Theſe two ſpaces have been termed *the two chambers of the aqueous humour*, one anterior, the other poſterior, as we ſhall obſerve in deſcribing this humour in particular.

Retina. The laſt coat proper to the eye is of a very different texture from that of the other two coats. It is white, ſoft, and tender, and, in a manner, medullary,

or

or like a kind of paſte ſpread upon a fine reticular web, and lining the bottom of the eye, being a continuation of the optic nerve. Some authors, as Zinn, affirm, that it terminates at the ciliary circle; others, as Dr Haller, repreſent the whole or a part of it as extended to the lens, and even as giving a covering to that humour; but Dr Monro obſerves, that it ends ſome way behind the ciliary circle. (*See* Obſervations on the nervous ſyſtem.) At the place which anſwers to the inſertion of the optic nerve, we obſerve a ſmall depreſſion, in which lies a ſort of medullary button, terminating in a point; and from this depreſſion blood-veſſels go out, which are ramified on all ſides through the ſubſtance of the retina.

It is commonly ſaid, that the retina is a production or expanſion of the medullary ſubſtance of the optic nerve; the ſclerotica, of the dura mater; and the choroides, of the pia mater, which accompanies this nerve. But this opinion is not altogether agreeable to what we obſerve in examining the optic nerve, and its inſertion in the globe of the eye. If we take a very ſharp inſtrument, and divide this nerve through its whole length, between where it enters the orbit and where it enters the globe, into two equal lateral parts, and then continue this ſection through the middle or centre of its inſertion, the following phenomena will appear.

That the nerve contracts a little at its inſertion into the globe; that its outer covering is a true continuation of the dura mater; that this vagina is very different from the ſclerotica both in thickneſs and texture, the ſclerotica being thicker than the vagina, and of another ſtructure; that the vagina from the pia mater forms, through the whole medullary ſubſtance of the nerve, ſeveral very fine cellular ſepta; and that where it enters the globe of the eye, the pia mater does not directly anſwer to the choroides, and is divided into many ſmall threads, which go through the bottom of the eye to form the retina.

The

The inſertion of the optic nerve in the globe of the eye is not directly oppoſite to the pupilla; ſo that the diſtance between theſe two parts is not the ſame when meaſured on all parts of the globe. The greateſt diſtance is on the ſide next the temples; and the ſmalleſt, next the noſe. Winſlow obſerves an inequality of the ſame kind in the breadth of the uvea, which in many ſubjects is leſs near the noſe than near the temples; ſo that the centre of the pupilla is not the ſame with that of the great circumference of the iris; and he has ſeen the ſame difference in the breadth of the corona ciliaris.

§ 4. *The Humours of the Eye and their Capſulæ.*

The vitreous humour. The vitreous humour is a clear and very liquid gelatinous fluid contained in a fine tranſparent capſula, called *tunica vitrea*, together with which it forms a maſs nearly of the conſiſtence of the white of an egg. It fills the greateſt part of the globe of the eye, that is, almoſt all that ſpace which anſwers to the extent of the retina, except a ſmall portion behind the uvea, where it forms a foſſula, in which the cryſtalline lens is lodged. This humour being dexterouſly taken out of the globe, preſerves its conſiſtence for ſome time in the capſula, and then runs off by little and little, till it quite diſappears.

The tunica vitrea is deſcribed by Winſlow as being compoſed of two laminæ very cloſely united, which quite ſurround the maſs of humour; but later authors, as Sabatier, *&c.* find only one; which, after covering the vitreous humour, runs to the edge of the lens; and whether it goes farther, is uncertain. The anterior part of this membrane, which extends between the vitreous humour and edge of the lens, is covered with black ſtreaks from the pigmentum nigrum, and by different authors has been called *membranula coronæ ciliaris;* by Zinn, *zonula ciliaris.* When a puncture is made

through this, and air is blown in, it forms a paſſage which runs round the lens, and has been termed *Canalis Pititianus*, after the diſcoverer, who deſcribes it in the Memoirs of the Royal Academy 1728.

The internal ſurface of the tunica vitrea gives off, through the whole ſubſtance of this humour, a great number of cellular elongations or ſepta diſcovered by Riolin, ſo extremely fine, as not at all to be viſible in the natural ſtate, the whole maſs appearing then to be uniform and equally tranſparent through its whole ſubſtance; but they are diſcovered by putting the whole, ſoon after it is taken out of the body, into ſome aceſcent and gently coagulating liquor. Theſe cells muſt communicate with each other; for, by puncturing the membrane, and hanging up the eye for a ſhort time, a conſiderable part of the humour runs out, ſo that the eye becomes lighter.

The radiated ſulſci of the tunica vitrea, which may be termed *ſulci ciliares*, are perfectly black when the coat is taken out of the body. This proceeds from the black ſubſtance with which the laminæ or proceſſus ciliares are naturally covered, as well as all the reſt of the choroides, and which remains in the bottom of the ſulci after the laminæ have been taken out. We obſerve very fine veſſels in this humour, which ſhall be deſcribed afterwards.

The cryſtalline humour. The cryſtalline lens is a ſmall lenticular body of a pretty firm conſiſtence, and tranſparent like cryſtal. It is contained in a tranſparent membranous capſula, and lodged in the anterior foſſula of the vitreous humour, as has been already ſaid. It is very improperly called *an humour*, becauſe it may be handled and moulded into different ſhapes by the fingers, and ſometimes almoſt diſſolved by different reiterated compreſſions, eſpecially when taken out of the capſula; but the centre is of a harder conſiſtence than the reſt.

The

The figure of the cryſtalline is lenticular; but its poſterior ſide is more convex than the anterior, the convexity of both ſides being very rarely equal. Steno obſerved, that the lens was compoſed of concentric lamellæ; and this has been confirmed by later authors: and Zinn has diſcovered radiated ſtreaks of a pearl colour, dividing the lens into little triangles. *See* Zinn de Oculi, tab. vii. fig. vii.

The colour and conſiſtence of the cryſtalline varies in different ages, as was diſcovered by M. Petit the phyſician. (*See* Memoirs for 1726.) Till the age of 30 it is very tranſparent, and almoſt without any colour. It afterwards becomes yellowiſh, and that yellowneſs gradually increaſes. The conſiſtence varies almoſt in the ſame manner, being of an uniform ſoftneſs till the age of 20, and afterwards growing gradually more ſolid in the middle of the maſs; but in this there are varieties, explained in the Memoirs for 1727. Haller takes notice of a watery liquor ſituated betwixt the cryſtalline lamellæ, which in old age turns of its own accord to a yellow colour; and Steno and Morgagni deſcribe a little water effuſed betwixt the lens and its capſul.

The cryſtalline capſula or coat is formed by a duplicature of the tunica vitrea, or of a proper capſul to which the tunica vitrea is connected. The anterior portion of the cryſtalline capſula is thicker than the poſterior, and, in a manner, elaſtic; and both its thickneſs and elaſticity may be diſcovered in diſſection, without any other artifice.

The anterior portion ſwells when macerated in water, and then appears to be made up of two pelliculæ, united by a fine ſpongy ſubſtance. "I demonſtrated this duplicature (ſays Winſlow) very plainly in the eye of an horſe by the knife alone; and I even carried the ſeparation of the two laminæ as far as the vitreous coat. Having made a ſmall hole in the middle of the capſula of

of an ox's eye, and blown into it through a pipe, ſome part of the air remained between the edge of the cryſtalline maſs and that of the capſula in form of a tranſparent circle."

The aqueous humour is a very limpid fluid, reſembling a kind of lympha or ſerum, with a very ſmall degree of viſcidity; but in the fœtus, for a ſhort time after birth, it is of a reddiſh colour. (*See* Petit, Memoirs for 1727.) It appears to come from the arteries of the iris. Winſlow and others were of opinion, that it has no particular capſula like the cryſtalline and vitreous humour; but from obſervations lately made in a memoir preſented to the Royal Academy of Sciences in 1760, it appears that the inner ſide of the cornea and anterior ſurface of the iris are covered with an exceedingly fine membrane, ſuppoſed to come from the choroid: whether it goes into the poſterior chamber, is doubtful. The aqueous humour fills the ſpace between the cornea and iris, that between the iris and the cryſtalline, and the hole of the pupilla. Theſe two ſpaces are called the *chambers of the aqueous humour*, and they are diſtinguiſhed into the anterior and poſterior.

The two chambers are not of the ſame extent. The anterior, which is viſible to every body between the cornea and iris, is the largeſt; the other between the iris and cryſtalline is very narrow, eſpecially near the pupilla, where the iris almoſt touches the cryſtalline. This proportion between the two chambers has been ſufficiently proved, contrary to the opinion of many ancient writers, by M. Heiſter, Morgagni, and ſeveral members of the Royal Academy; but none has treated theſe matters at ſo great a length as M. Petit the phyſician, as appears by the printed memoirs of that Society.

§ 5. *The Tunica Albuginea, and Muſcles of the Globe of the Eye.*

THE tunica albuginea, called commonly the *white of the eye*, and which appears on all the anterior convex ſide

ſide of the globe, from the cornea to the beginning of the poſterior ſide, is formed chiefly by the tendinous expanſion of the four recti-muſcles. This expanſion adheres very cloſe to the ſclerotica, and makes it appear very white and ſhining, whereas the reſt of it is of a dull whitiſh colour. It is very thin near the edge of the cornea; in which it ſeems to be loſt, terminating very uniformly.

There are commonly ſix muſcles inſerted in the globe of the human eye; and they are divided, on account of their direction, into four recti and two obliqui. The recti are again divided, from their ſituation, into ſuperior, inferior, internal, and external; and, from their functions, into a levator, depreſſor, adductor, and abductor. The two oblique muſcles are denominated from their ſituation and ſize, one being named *obliquus ſuperior* or *major*, the other *obliquus inferior* or *minor*. The obliquus major is likewiſe called *trochlearis*, becauſe it paſſes through a ſmall cartilaginous ring, as over a trochlea or pulley.

The muſculi recti do not altogether anſwer to that name; for in their natural ſituation they do not at all lie in a ſtraight direction, as they are commonly repreſented in an eye taken out of the body. To underſtand this, we ought to have a juſt idea of the ſituation of the globe in the orbit, and at the ſame time to remember the obliquity of the orbits, as already explained. The globe is naturally placed in ſuch a manner, as that, during the inaction or equilibrium of all the muſcles, the pupilla is turned directly forward; the inner edge of the orbit is oppoſite to the middle of the inſide of the globe; the outer edge of the orbit, becauſe of its obliquity, is behind the middle of the outſide of the globe; and laſtly, the great circumference of the convexity of the globe between the pupilla and the optic nerve, runs directly inwards and outwards, upwards and downwards.

In this ſituation, the adductor alone is in a ſtraight direction,

direction, the other three being oblique; and the abductor is the longeſt, the adductor the ſhorteſt, and the levator and depreſſor of the ſame middle length between the two former. The abductor is likewiſe bent round the outer convex ſide of the globe; the levator and depreſſor are alſo incurvated, but in a leſs degree; whereas the whole adductor is almoſt ſtraight. The ſuperior oblique are ſituated ſo as to ſerve as antagoniſts to the former. (*See* Deſcription of the Muſcles, vol. I.)

Uſes of theſe muſcles. The levator moves the anterior portion of the globe upward when we lift up the eyes; the depreſſor carries this portion downwards; the adductor toward the noſe, and the abductor towards the temples.

When two neighbouring recti act at the ſame time, they carry the anterior portion of the globe obliquely toward that ſide which anſwers to the diſtance between theſe two muſcles: and when all the four muſcles act ſucceſſively, they turn the globe of the eye round, which is what is called *rolling the eyes*.

It is to be obſerved, that all theſe motions of the globe of the eye are made round its centre; ſo that in moving the anterior portion, all the other parts are likewiſe in motion. Thus, when the pupilla is turned toward the noſe or upward, the inſertion of the optic nerve is at the ſame time turned toward the temple, or downward.

The uſe of the oblique muſcles is chiefly to counterbalance the action of the recti, and to ſupport the globe in all the motions already mentioned. This is evident from their inſertions, which are in a contrary direction to thoſe of the recti, their fixed points with relation to the motions of the globe being placed forward, and thoſe of the recti backward, at the bottom of the orbit. The ſoft fat which lies behind the globe is altogether inſufficient to ſupport it: neither is the optic nerve more fit for this purpoſe; for I have ſhown that this nerve

follows all the motions of the globe, which would be impoſſible, were not the fat very pliable and without reſiſtance. And to this we muſt add, that the optic nerve at its inſertion in the globe has a particular curvature, which allows it to be elongated, and conſequently prevents it from ſuffering any violence in the different motions of the eyes.

The obliquity of theſe two muſcles does not hinder them from doing the office of a fulcrum; becauſe this is not a fulcrum diſtinct from the part moved, or on which the globe of the eye ſlides like the head of one bone in the articular cavity of another; but being fixed to the part, it eaſily accommodates itſelf to all the degrees of motion thereof. Had theſe muſcles lain in a ſtraight direction, they would have incommoded the recti; but their obliquity may be ſaid to be in ſome meaſure rectified by the inner ſurface of the orbit, and the rectus externus.

The inner ſurface of the orbit ſerves for a kind of collateral fulcrum, which hinders the globe from falling too far inward; as the joint action of the two obliqui prevents it in part from falling too far outward. The rectus externus, by being bent on the globe, not only hinders it from being carried outward, but alſo prevents the indirect motions of the obliqui from thruſting it out of the orbit toward the temples. The other uſes attributed to theſe muſcles ſeem to be without foundation, from the conſideration of their inſertions, and of the ſtructure of the parts with which they are concerned; both which reaſons are explained in the Memoirs of the Academy for 1721.

§ 6. *The Supercilia, and Muſculi frontales, occipitales, and ſuperciliares.*

Supercilia. THE ſupercilia or eye-brows are the two hairy arches ſituated at the lower part of the forehead,

between the top of the nose and temples, in the same direction with the bony arches which form the superior edges of the orbits, and are peculiar to the human species. The skin in which they are fixed does not seem to be much thicker than that of the rest of the forehead; but the membrana adiposa is thicker than on the neighbouring parts. The colour of the eye-brows is different in different persons; and often, in the same person, different from that of the hair on the head; neither is the size of them always alike. The hairs of which they consist are strong and pretty stiff; and they lie obliquely, their roots being turned to the nose, and their points to the temples.

The supercilia have motions common to them with those of the skin of the forehead, and of the hairy scalp. By these motions the eye-brows are lifted up; the skin of the forehead is wrinkled more or less regularly and transversely; and the hair and almost the whole scalp is moved, but not in the same degree in all persons; for some by this motion alone can move their hat, and even throw it off from their head. The eye-brows have likewise particular motions which contract the skin above the nose; and all these different motions are performed by the occipital and fontal muscles. (*See* Vol. I.)

The occipital and frontal muscles appear to be true digastrici, both in regard to their insertions and action. The fixed insertions of the occipitales at the lower part of the occiput, and the moveable insertions of the frontales in the skin of the forehead and of the supercilia, being well considered, together with their reciprocal insertions in the same aponeurosis, seem to be a very convincing proof that they are digastric muscles.

These four muscles seem always to act in concert, the occipitales being only auxiliaries or assistants to the frontales, the office of which is to raise the supercilia by wrinkling the skin of the forehead; these wrinkles

kles following the direction of the eye-brows pretty regularly in ſome ſubjects, and very irregularly in others.

To be convinced of the co-operation of theſe four muſcles, we need only hold the hand on the occipitales, while we raiſe the eye-brows and wrinkle the forehead ſeveral times; and we will perceive the occipitales to move each time, though not in the ſame degree in all ſubjects. In ſome perſons the occipitales ſeem to be relaxed, while the frontales being in contraction move the whole ſcalp and pericranium forward, and then contract to bring them back to their natural ſituation.

The action of the muſculi ſuperciliares is to depreſs the eye-brows, to bring them cloſe together, and to contract the ſkin of the forehead immediately above the noſe into longitudinal and oblique wrinkles, and the ſkin which covers the root of the noſe into irregular tranſverſe wrinkles. This action, as well as that of the frontales, and of the muſcles of the noſe and lips, is not always arbitrary, but ſometimes mechanical and involuntary. Theſe muſcles may perhaps likewiſe ſerve to keep the muſculi frontales in equilibrio during their inaction, they being moveable by both extremities.

§ 7. *The Palpebræ and Membrana conjunctiva.*

Palpebræ. The palpebræ are a kind of veils or curtains placed tranſverſely above and below the anterior portion of the globe of the eye; and accordingly there are two eye-lids to each eye, one ſuperior the other inferior. The ſuperior is the largeſt and moſt moveable in man. They both unite at each ſide of the globe; and the places of their union are termed *angles*, one large and internal which is next the noſe, the other ſmall or external which is next the temples.

Structure of the palpebræ. The palpebræ are made up of common and proper parts. The common parts are the ſkin, epidermis, and membrana adipoſa. The proper parts are the muſcles, the tarſi, the puncta or foramina lacrymalis, the membrana conjunctiva, the glandula lacrymalis, and the particular ligaments which ſuſtain the tarſi. The tarſi and their ligaments are in ſome meaſure the baſis of all theſe parts.

Tarſi. The tarſi are thin cartilages, forming the principal part of the edge of each palpebra; and they are broader at the middle than at the extremities. Thoſe of the ſuperior palpebræ are ſomething more than a quarter of an inch in breadth; but in the lower palpebræ they are not above the ſixth part of an inch; and their extremities next the temples are more ſlender than thoſe next the noſe.

Theſe cartilages are ſuited to the borders and curvature of the eye-lids. The lower edge of the ſuperior cartilage, and the upper edge of the inferior, terminate equally, and both may be termed the *ciliary edges*. The oppoſite edge of the upper tarſus is ſomething ſemicircular between its two extremities; but that of the inferior tarſus is more uniform, and both are thinner than the ciliary edges. Their inner ſides, or thoſe next the globe, are grooved by ſeveral ſmall tranſverſe channels, of which hereafter; and the extremities of both cartilages are connected by a kind of ſmall ligaments.

Ligamenta tarſorum lata. The broad ligaments of the tarſi are membranous elongations formed by the union of the perioſteum of the orbits and pericranium along both edges of each orbit. The ſuperior ligament is broader than the inferior, and fixed to the ſuperior edge of the upper cartilage, as the inferior is to the lower edge of the lower cartilage; ſo that theſe ligaments and the tarſi, taken alone or without the other parts, repreſent palpebræ.

Mem.

Membrana conjunctiva. The membrana conjunctiva is a thin membrane, one portion of which lines the inner ſurface of the palpebræ, that is, of the tarſi and their broad ligaments. At the edge of the orbit it has a fold, and is continued from hence on the anterior half of the globe of the eye, adhering to the tunica albuginea; ſo that the palpebræ and the fore-part of the globe of the eye are covered by one and the ſame membrane, which does not appear to be a continuation of the pericranium, but has ſome connection with the broad ligaments of the tarſi.

The name of *conjunctiva* is commonly given only to that part which covers the globe, the other being called ſimply *the internal membrane of the palpebræ*; but we may very well name the one *membra oculi conjunctiva*, and the other *membrana palpebrarum conjunctiva*. That of the palpebræ is a very fine membrane adhering very cloſe, and full of ſmall capillary blood-veſſels. It is perforated by numerous imperceptible pores, thro' which a kind of ſerum is continually diſcharged; and it has ſeveral very evident folds which ſhall be ſpoken to hereafter.

The conjunctiva of the eye adheres by the intervention of a cellular ſubſtance; and is conſequently looſe, and as it were moveable; and it may be taken hold of, and ſeparated in ſeveral places from the tendinous coat. It is of a whitiſh colour; and being tranſparent, the albuginea makes it appear perfectly white: theſe two coats together forming what is called *the white of the eye.* The greateſt part of the numerous veſſels which run upon it contain naturally only the ſerous part of the blood, and conſequently are not diſcoverable, except by anatomical injections, inflammations, obſtructions, &c. With the point of a good knife we continue the ſeparation of this membrana over the cornea.

Glandula lacrymalis. The lacrymal gland, the uſe of

which till of late years was not known, is yellowiſh, and of the number of thoſe called *conglomerate glands*. It lies under that depreſſion obſervable in the arch of the orbit near the temples mentioned in the deſcription of the ſkeleton, and laterally above the globe of the eye. It is a little flatted, and divided as it were into two lobes; one of which lies toward the inſertion of the muſculus rectus ſuperior, the other toward the rectus externus. It adheres very cloſely to the fat which ſurrounds the muſcles and poſterior convexity of the eye, and it was formerly named *glandula innominata*.

From this gland ſeveral ſmall ducts go out, which run down almoſt parallel to each other, through the ſubſtance of the tunica interna or conjunctiva of the ſuperior palpebra, and afterwards pierce it inwardly near the ſuperior edge of the tarſus. Steno diſcovered the excretory ducts of this gland upon the eye of an ox; and they are painted by Bidloo 1661. In man, however, they are ſeen with more difficulty; for although deſcribed by Winſlow and Lieutaud, they were unknown to later authors, as Morgagni, Zinn, and Haller, till Dr Monro, the preſent profeſſor, diſcovered and injected them before the year 1753. They are ſix or ſeven in number, have no communication with each other, and open upon the inner ſide of the upper eye-lid near the outer angle.

The borders of each palpebra taken together are formed by the edge of the tarſus, and by the union of the internal membrane with the ſkin and epidermis. This border is flat, and of ſome ſenſible breadth from within about a quarter of an inch of the internal angle, all the way to the external angle, near which the breadth diminiſhes. This breadth is owing only to the thickneſs of the palpebræ, which at this place have their edges oblique or ſlanting, in ſuch a manner as when the two palpebræ touch each other ſlightly, a tri-

triangular ſpace or canal is formed between them and the globe of the eye.

Cilia. The flat edge of each palpebra is adorned with a row of hairs called *cilia*, or the *eye-laſhes*. Thoſe belonging to the ſuperior palpebra are bent upward, and longer than thoſe of the lower palpebra which are bent downward. Theſe rows are placed next the ſkin; and are not ſingle, but irregularly double or triple. The hairs are longer near the middle of the palpebræ than toward the extremities; and for about a quarter of an inch from the inner angle they are quite wanting.

Glandulæ ciliares. Along the ſame border of the palpebræ near the internal membrane, or toward the eye, we ſee a row of ſmall holes, which may be named *foramina* or *puncta ciliaria*. They are the orifices of the ſame number of ſmall oblong glands which lie in the ſulci, channels, or grooves on the inner ſurface of the tarſus. Theſe little glands are of a whitiſh colour; and, when examined through a ſingle microſcope, they appear like bunches of grapes, thoſe of each bunch communicating together; and when they are ſqueezed between two nails, a ſebaceous matter like ſoft wax is diſcharged through the puncta ciliaria. They are more numerous in the upper than in the under eyelid, and were firſt painted by Caſſerius, but afterwards deſcribed by Meibomius, whoſe name they frequently go under.

Puncta lacrymalia. Near the great or internal angle of the palpebræ, the flat portions of their edges terminate in another which is rounder and thinner. By the union of theſe two edges an angle is formed; which is not perfectly pointed like a true angle, but rounded; and may be called *the internal* or *naſal angle*.

At this place, the extremity of the flat portion is diſtinguiſhed from the round portion by a ſmall protuberance or papilla, which is obliquely perforated by a

ſmall hole in the edge of each palpebra. Theſe two ſmall holes are very viſible, and often more ſo in living than in dead bodies; and they are commonly named *puncta lacrymalia*, being the orifices of two ſmall ducts, called *lacrymal*, which unite beyond the angle of the eye, and open a little below the upper end of a particular reſervoir, termed *facculus lacrymalis*, which ſhall be deſcribed in the article of the *Noſe*.

The puncta lacrymalia are oppoſite to each other, ſo that they meet when the eye is ſhut. Round the orifice of each of theſe points, we obſerve a whitiſh circle, which ſeems to be a cartilaginous appendix of the tarſus, and which keeps the orifice always open. Theſe two oblique circles are ſo diſpoſed, that when the eye is but ſlightly ſhut, they touch each other only toward the ſkin, and not toward the globe of the eye. The fine membrane which covers theſe circles, and paſſes through the puncta into the ducts, ſeem ſometimes to run into gathers when it is touched with a ſtilet. This obſervation was firſt made by M. Saint Yves a Pariſian oculiſt.

Caruncula lacrymalis. The caruncula lacrymalis is a ſmall reddiſh, granulated, oblong body, ſituated preciſely between the internal angle of the palpebræ and globe of the eye, but it is not fleſhy as its name would inſinuate. The ſubſtace of it ſeems to be wholly glandular; and it appears through a ſingle microſcope, in the ſame manner as the other conglomerate glands. We diſcover upon it a great number of fine hairs covered by an oily, yellowiſh matter, furniſhed by this gland; and on the globe of the eye, near this glandular body, we ſee a ſemilunar fold formed by the conjunctiva, the concave ſide of which is turned to the uvea, and the convex ſide to the noſe.

This fold, which has the name of *membrana ſemilunaris*, appears moſt when the eye is turned toward the noſe; it is ſhaped like a creſcent, the two points of which

which anſwer to the puncta lacrymalia, and conduct the tears into the puncta.

§8. *The Muſcles of the Palpebræ.*

The muſcles of the palpepræ are commonly reckoned to be two; one peculiar to the upper eye-lid, named *levator palpebræ ſuperioris;* the other common to both, called *muſculus orbicularis palpebrarum*, which has been ſubdivided by different authors in different manners. *See* Deſcription of Muſcles, Vol. I.

The ſkin of the ſuperior palpebra is folded archwiſe, almoſt in a parallel direction to that of the ſemioval fibres; the plicæ interſecting the levator, whereas the other folds only interſect the orbicularis. The radiated and oblique plicæ ſeldom appear in young perſons, except when the firſt and ſecond portions of the orbicularis are in action; but in aged perſons the marks thereof are viſible at all times.

In man, the ſuperior palpebra has much more motion than the inferior. The ſmall ſimple motions, called *twinkling*, which frequently happen, though not equally often in all ſubjects, are performed by the alternate contraction of the levator palpebræ and orbicularis.

Theſe ſlight motions, eſpecially thoſe of the upper palpebra, are not very eaſy to be explained according to the true ſtructure of the part. The motions which wrinkle the palpebræ, and which are commonly performed to keep one eye very cloſe ſhut, while we look ſtedfaſtly with the other, are explicable by the ſimple contraction of all the portions of the orbicularis. Theſe motions likewiſe depreſs the ſupercilia, which conſequently may be moved in three different manners, upwards by the muſculi frontales, downward by the orbiculares, and forward by the ſuperciliares.

§ 9. *The*

§ 9. *The Veſſels of the Eye and its Appendages.*

The external carotid artery, by means of the arteria maxillaris externa, and the temporal and frontal arteries, give ſeveral ramifications to the integuments which ſurround the eye, and to all the portions of the muſculus orbicularis; and theſe ramifications communicate with thoſe which are diſtributed to the membrana conjunctiva palpebrarum, and to the caruncula. Some ſmall branches alſo come in through the ſphenamaxillary future, to be diſtributed chiefly on the perioſteum and fat of the eye. The internal carotid artery having entered the cranium, ſends off a conſiderable branch called *ocular*, which accompanies the optic nerve, to be diſtributed to the muſcles and globe of the eye, to the levator palpebræ, to the fat, glandula lacrymalis, membrana conjunctiva, caruncula lacrymalis, &c. It likewiſe communicates with the external carotid, and ſends one or two very ſmall branches to the noſe. The branches which ſupply the globe of the eye have the name of *ciliares;* they perforate the back part of the tunica ſclerotica in five or ſix places, after which they run a little way through its ſubſtance, where each branch forms a plexus, which ſends numerous branches to the choroid.

Dr Wriſberg obſerves, they next perforate the external lamina of the choroides, and form between that and the internal lamina the vaſcular ſtellæ mentioned in the deſcription of this internal lamina. Some ſmall vaſcular filaments from theſe ramifications are likewiſe obſerved to adhere very cloſely to the tunica vitrea; and they ſend ſmall arteries in a direct courſe to the circumference of the iris, where they form a vaſcular circle, which ſends out capillaries as far as the membrana cryſtallina, which are very eaſily injected in new-born children. But the poſterior part of the capſul

ful of the lens is supplied from another source; Albinus, and after him many others, have injected in a fœtus a branch from the arteria centralis retina, which passes thro' the middle of the vitreous humour, and is dispersed in a radiated manner on the back part of the capsula crystallina. Zinn is of opinion, that these vessels pass also into the body of the lens; but there is no certain proof of this.

The veins of all these parts answer nearly to the arteries; but those of the globe of the eye are called *vasa vorticosa*. The internal veins unload themselves, partly into the internal jugular vein, by the sinus cavernosi; and partly into the external jugular vein, by the vena angularis, or maxillaris externa, the maxillaris interna, temporalis, &c.

Besides the capillary vessels, easily distinguishable by the red colour of the blood, there are great numbers of those which admit nothing but the serous and lymphatic parts of the blood, and consequently do not appear in the natural state. They become visible in some places by inflammations and injections, as on the membrana conjunctiva of the eye; but these contrivances do not discover them every where in aged persons. In a fœtus, and in new-born children, says Winslow, a fine injection has succeeded so well as to discover the vessels of the membrana crystallina and vitrea; and in a fœtus of about six months, the injected liquor seemed to me to have penetrated a part of the crystalline and vitreous humour.

§ 10. *The Nerves of the Eye and of its Appendages.*

Besides the optic nerve already described, the globe of the eye receives several small ones, which run on each side along and about the optic nerve, from its entry into the orbit to its insertion in the globe. These filaments come chiefly from a small lenticular ganglion, formed

formed by a very ſhort rami of the orbitary or ophthalmic branch of the fifth pair, and by a branch of the third pair, or motores oculi.

The nerves of the lenticular ganglion having reached the globe of the eye, are divided into five or ſix faſciculi; which having ſurrounded the optic nerve, and penetrated and perforated the ſclerotica, run at diſtances more or leſs equal between the ſclerotica and choroides towards the iris. There each of them is divided into ſeveral ſhort filaments, which terminate in the ſubſtance of the iris. Theſe ſmall nerves, which run from behind forward between the ſclerotica and the choroides, have formerly been taken for particular ligaments by anatomiſts of conſiderable eminence; but are now known under the name of *ciliary nerves*.

The nerves which go to the other parts belonging to the eye, come from the third, fourth, ſixth, and firſt two branches of the fifth pair of nerves, and likewiſe from the portia dura of the ſeventh pair. The third, fourth, and ſixth pairs give nerves to the muſcles of the globe of the eye. The two branches of the fifth pair, and the portio dura of the ſeventh, give nerves not only to the other parts which ſurround the globe, but alſo to the muſculi frontales and internal parts of the noſe.

The trunk of the third pair, or motor oculi, having entered the orbit through the ſuperior orbitary fiſſure, or foramen lacerum of the ſphenoid bone, produces four branches. The firſt runs upward, and divides into two; one for the muſculus levatur oculi, and the other for the levator palpebræ ſuperioris. The trunk continuing its courſe, gives off the ſecond ſhort branch to the depreſſor oculi. The third branch is long, and goes to the obliquus inferior, contributing likewiſe to the formation of the lenticular ganglion already mentioned. The fourth branch is large, and ſupplies the adductor oculi.

The

The firſt branch of the fifth pair, commonly termed *nervus ophthalmicus*, divides into three rami, as it enters the orbit; and ſometimes only in two, one of which is afterwards ſubdivided. Of theſe three branches one is ſuperior, and termed *nervus ſuperciliaris;* one internal, termed *naſalis;* and one external, to which the name of *temporalis* or *lacrymalis* is applied.

The ſuperior or ſuperciliary ramus runs along the whole perioſteum of the orbit; and having paſſed thro' the ſuperciliary notch or foramen of the os frontis, is diſtributed to the muſculus frontalis, ſuperciliaris, and ſuperior portion of the orbicularis palpebrarum; and it communicates with a ſmall branch of the portio dura of the ſeventh pair.

The internal or naſal branch paſſes under the ramification of the nerve of the third pair; and running toward the noſe, is diſtributed thereto, and to the neighbouring parts of the orbicularis, the caruncula, &c. This branch ſends off a filament, which, paſſing thro' the internal anterior orbitary hole, enters the cranium, and preſently returns again through one of the ethmoidal holes to the internal parts of the noſe. Sometimes this naſal ramus communicates with the ramus ſuperciliaris by a particular arch, before it enters the orbitary hole.

The external or temporal ramus, which is ſometimes a ſubdiviſion of the ſuperciliaris, is diſtributed to the glandula lacrymalis, and ſends off a filament which pierces the orbitary apophyſis of the os malæ.

The ſecond branch of the fifth pair, called *nervus maxillaris ſuperior*, ſends off a ramus through the bony canal of the lower part of the orbit; which going out at the anterior inferior orbitary hole, is diſtributed to the neighbouring portion of the muſculis orbicularis, and communicates with a ramus of the portio dura. The reſt of the ſuperior maxillary nerve ſhall be deſcribed afterwards.

The

The portio dura of the seventh pair, or auditory nerve, gives branches to the superior, inferior, and external lateral parts of the orbicularis palpebrarum; one of which communicates with the nervus superciliaris, and another with the sub-orbitarius, to be afterwards described.

§ 11. *Sight.*

Every one knows that the eye is the organ of vision. The greater part of it is composed of pellucid humours capable of refracting the more subtle medium of light. The complexity of this organ is necessary for the defence of its tender parts, and from the diversity of the several humours to be contained each in their proper integuments.

Outwardly, a defence is afforded to this organ by the eye-brow or *supercilium;* and the thick hairs placed there, which are capable of being pulled down by the action of the frontal, corrugator, and orbicular muscles, so as to afford a shade to the eye in too strong a light. After this office is finished, the eye-brow is raised again by the insertion of the frontal muscle, which, being of a long quadrangular figure, is drawn backward by the occipital muscle. A depression of the eye-brow serves also to express concern of the mind; as an elevation of it denotes the mind to be in a serene quiet state. This guard also conduces to throw off the sweat and retained dust, or the insects which might fall into the eye.

The palpebræ are placed still nearer guards to the eye; and that they might shut together more exactly, they have each of them a cartilaginous arch, called *tarsus*, upon their margins, which meet together. It hinders the eye-lid from falling into wrinkles while it is elevated or depressed. The elevation of the upper eye-lid is performed by a muscle arising from the involuerum

lucrum of the optic nerve gradually ſpreading, and extended by its expanſion to the tarſus. This elevator is conſiderably aſſiſted in its action by the frontalis, and by various connections with the orbicularis drawn up or dilated by the former. The upper eye-lid is depreſſed by the *orbicularis* muſcle; which alſo ſerves to elevate the lower eye-lid, and covers the eye in ſuch a manner that no duſt or light can enter it in ſleep. The lower eye-lid is depreſſed by a double portion of fibres, inſerted into the upper-lip.

Finally, that the protuberant margins of the eye-lids might not injuriouſly beat againſt each other, the *cilia* are placed ſo as to make a blind or ſhade. Theſe are of uſe in more diſtinct viſion, by excluding the extraneous rays, when we require a diſtinct repreſentation of any object.

That the eye-lids rubbing againſt each other might not grow together, they are ſupplied with a row of *ſebaceous glandules*. Theſe diſcharge a ſoft liniment, which mixes and waſhes off with the tears.

But the perpetual attrition of the eye-lids aſcending and deſcending againſt the globe of the eye, is prevented by the *tears;* which preſerve alſo the tenderneſs of the membranes and of the cornea, and ſerve to waſh out any inſects or other ſharp corpuſcles. Theſe form a ſaline pellucid liquor that may be evaporated, and never ceaſes to be poured over the anterior ſurface of the eye; but never runs over the cheeks, unleſs collected together in a larger quantity from ſome cauſe. This liquor is exhaled partly from the arteries of the conjunctiva, as we ſee from an imitation of nature by injecting water: and it in part proceeds from the lacrymal gland.

The ſeparation of the tears is increaſed by the more frequent contraction of the orbicular muſcle, either from irritation, or ſome ſorrowful paſſion; by which means the tears are urged over the whole ſurface of the eye and conjunctiva, which they waſh.

After

After the tears have performed their office, ſome part of them flying off into the air, the reſt, that they might not offend by their quantity, are propelled by the orbicular muſcle towards its origination next the noſe, to a part which is the loweſt of the palpebral margins; which not being ſurrounded by the tarſus, does therefore not meet exactly together. Here the caruncula lacrymalis interpoſes and ſeparates the meeting of the eye-lids, at the ſame time furniſhing a liniment to thoſe parts which have none of the Meibomian ducts. Before this part is extended a ſmall portion, like a little eye-lid; which, deſcending perpendicularly, joins the true eye-lids, and is larger in beaſts than in men: but at the beginning of this ſpace, betwixt the eye-lids, appears the *punctum lacrymale*, which drinks up the tears from the ſinus in which they are collected; and this partly by tubular attraction, and partly by impulſe from the orbicular muſcle. If theſe points or openings are obſtructed, the tears run over and excoriate the cheek.

From both points proceeds a ſmall duct: theſe join together, and are inſerted by two mouths near the uppermoſt part of the *lacrymal ſac*, which deſcends a little backward into the nares, opening there by an oblique oblong aperture at the bottom of the meatus, covered by the lower os ſpongioſum. Through this paſſage the ſuperfluous tears deſcend into the noſe, which they in part moiſten. A muſcle is by ſome aſcribed to this ſac; but it is not yet ſufficiently confirmed. Some late authors have compared the lacrymal ſac to the bladder of urine, which retains its contents for a conſiderable time, till it is thrown out, the ſphincter being relaxed. A ſimilar ſphincter has been aſcribed to the naſal duct, which is ſometimes ſhut and again relaxed, that the tears collected in the ſac may run out through the noſtrils.

The globe of the *eye*, compreſſed before, but longer than

than it is broad, is ſeated in the cavity of a bony orbit. But as this is larger than the eye itſelf, the exceſs is on all ſides occupied by a very ſoft fat, ſurrounding the globe of the eye, that it may both fill and have a free motion within the orbit.

Among the coats of the eye, the iris is the only one poſſeſſing motion. Though it has little ſenſation, and is not endowed with any mechanical irritability; yet in a living man, quadruped, or bird, it is conſtricted on every greater degree of light, and is dilated on every ſmaller one; hence it is rendered broader for viewing diſtant objects, and narrower for viewing ſuch as are near. The cauſe of this dilatation ſeems to be a remiſſion of the powers reſiſting the aqueous humour; an argument of which, is the dilatation of the pupil, occaſioned by debility, and which ſucceeds ſyncope and death. The contraction is more obſcure, and perhaps only depends on the ſtronger afflux of humours into the colourleſs veſſels of the iris, into which theſe veſſels are extended; and, along with theſe, the iris is rendered longer, and ſhuts the greater part of the pupil: ſo that this motion has ſomething in common with a beginning inflammation. The pupil is more evidently moved and contracted; as the eye gradually grows callous in old people, it is rendered almoſt immoveable. In an animal twenty or thirty hours dead, Dr Haller has ſeen the iris extend by heat, and ſhut the pupil.

With reſpect to the origin of the black pigment, we are as yet unacquainted with it; nor can any glandules befound, which ſome have aſſigned for its ſeparation. Among its other uſes, one ſeems to be to keep firm the cryſtalline lens. In infants, this ſame mucus has the image of a radiated flower behind the ciliary proceſs.

But the *retina*, which is truly a continuation of the medulla from the optic nerve, immediately embraces

the vitreous humour. Here Dr Haller deſcribes the retina as running as far as the ſurface of the cryſtalline lens; while Dr Monro obſerves, that it ends ſome way behind the ciliary circle.

That the action of the eye lies wholly in the reception of light, excepting only a few doubts, appears very plainly from phyſical and mechanical experiments. Light is a matter either the ſame with, or very nearly approaching to, that of fire, extremely fluid and ſubtile, penetrating through all even the hardeſt bodies, without receiving alteration from any length or diſtance in its courſe; moving with ſuch a very great velocity, as to run through the diſtance between the ſun and earth in the ſpace of about eight minutes and thirteen ſeconds. The light we have in our atmoſphere proceeds either from that of the ſun, whoſe body ſeems to have the power of impelling to us, in right lines, the matter of light, which is confuſedly ſpread around; or elſe it proceeds from ſome other ignited point or lucid body; from whence the rays ſpread every way, as from a centre to all points of a large ſphere, ſo as to fall upon the ſurfaces of bodies; from whence again it is reflected into the eye, from the enlightened ſurfaces, in angles equal to that of their incidence, ſo as to render the bodies from whence it thus flows to the eye both viſible and of ſome colour.

It is now ſufficiently evidenced from experiments, that light is compoſed of rays in right lines, almoſt without any phyſical breadth or thickneſs; and yet, that each of theſe rays is again ſeparable into ſeven other permanent and immutable rays of a leſſer kind. The known properties of theſe rays are, that all of them, conjoined together, conſtitute a white beam; which, being refracted by the minute ſurfaces of bodies, are ſubdivided into rays of a red colour, which are more conſtant or permanent, hard, and leſs refrangible; next to which follow thoſe of an orange, of

a

a yellow, green, blue, and indigo or violet colour; of which thoſe are always weaker and more refrangible, which are farther diſtant in order from the red rays. A ſhadow ariſes from a deficiency in the reflected rays. Thoſe primitive rays, variouſly compounded together with ſhade, make up all the variety of colours.

The colours, then, which ſeem proper to bodies, ariſe hence; that the minute ſurfaces of their conſtituent ſolid particles, by which their pores or vacuities are limited, do, according to the difference of their thickneſs, denſity, &c. reflect or ſeparate the rays of light, ſo as to ſend more of one kind or colour to the eye than another; whilſt moſt part of the remaining rays are loſt by repeated reflections within the pores of the ſubſtance: ſo that the ſtrongeſt and thickeſt particles reflect a white colour; thoſe next in denſity and ſize, a red colour; till at laſt the minuteſt ſurfaces reflect a violet colour. Thoſe bodies are opake, which retain the rays within their ſubſtance, without permitting any to paſs through them: which ſeems to follow from the largeneſs and the number of the pores, to the ſides of which the light is attracted; which pores are filled with ſome matter that has a power of refraction, different from that which the light ſuffers from the parts of the body itſelf. Theſe principles we embrace, till a new theory that places the diverſity of colours in vibrations of different celerities ſhall be better eſtabliſhed; neither is it our buſineſs to concern ourſelves with this matter.

Theſe rays, falling obliquely upon the ſurface of liquors of various denſities, paſs through them with a change in their direction, by variouſly receding from or approaching nearer to a perpendicular: and this is called their *refraction*. In general, the denſer the medium, the more are the rays bent towards the perpendicular; excepting only inflammable liquors, which,

by a peculiar property, draw the rays more to a perpendicular than in proportion to the denſity of the liquor. The proportions of the angles of incidence to thoſe of refraction are obſerved to be conſtant enough; ſo that the ſine of the radius of refraction from air into water is to the ſine of the angle of incidence as 3 to 4: and in the radius, paſſing from air into glaſs, the ſine of the incidence is to that of refraction as 17 to 11; and from water into glaſs, as 51 to 44.

Rays, which come through the air with but little divergency, (as thoſe of the ſun do on account of their immenſe diſtance, or as in general do any rays that come from the diſtance of above 100 feet), falling out of the air upon denſer bodies, ſpherically convex, are reflected to greater angles, as of 48½ degrees; nor are they under that meaſure. If the angles are ſmaller, and they penetrate the refracting medium, they are there ſo refracted, as to meet together in one point, which is called their *focus*. This point always falls within the axis or radius that is perpendicular to the ſurface; whence it becomes permanent and unchangeable. So that the focus of rays, paſſing from air into a ſphere of water, will be diſtant from the axis one ſemidiameter of the ſphere; and in a globular glaſs, it will be diſtant a fourth part of the diameter: but in a convex lens of glaſs, that is, part of a ſphere not leſs than thirty degrees, and equally convex, the focus will be likewiſe diſtant one ſemidiameter; yet ſo that the rays will meet, not in a ſingle point, but in a little circle.

Therefore the rays of light, whether direct or inflected, fall in ſuch a manner upon the tunica cornea of the eye, as to form a moſt ſharp cone betwixt the lucid point and the membrane upon which they are ſpread: the baſis of which cone will be the ſurface of the cornea, and the apex in the radiant point; yet ſo that all rays in this cone may, without any ſenſible er-

ror,

ror, be reckoned parallel with each other. Among theſe, there are ſome rays reflected back from the cornea, without ever penetrating the ſurface; namely, all ſuch as fall upon that membrane in a greater angle than that of forty degrees. Others, which enter the cornea at very large angles, but leſs than the former, and fall in betwixt the iris and ſides of the cryſtalline lens, are ſuffocated or loſt in the black paint that lines the iris and the ciliary proceſſes; but thoſe rays only fall upon the ſurface of the lens, which enter the cornea at ſmall angles, not much diſtant from the perpendicular, or at moſt not exceeding twenty-eight degrees. By this means, all thoſe rays are excluded which the refracting power of the humours in the eye could not be able to concentrate or bring together upon the retina; without which they would paint the object too large and confuſedly.

Thoſe ſlender rays, therefore, coming thus to the thick cornea, which is denſer than water, and forms the ſegment of a ſphere, ſuffer thus a greater power of refraction, and paſs through it in a more conſiderable degree towards the perpendicular; namely, about a fourth part: but theſe rays falling with but little convergency upon the aqueous humour, which is ſmall in quantity and almoſt like water, making there no focus, becauſe of the nearneſs of the humour to the cornea, go on nearly parallel, or little converging, to the next adjacent ſurface of the very pellucid or cryſtalline lens; becauſe their divergency was conſiderably corrected by the refracting power of the cornea. Moreover, the cornea being convex, and part of a leſs ſphere than that of the ſclerotica, receives and collects a greater number of rays than if it was flatter with a leſs ſurface.

The refracting power of the cryſtalline lens, which exceeds that of water, may be underſtood from its greater hardneſs and weight; although we have no certain meaſure. In this lens, therefore, and more

eſpecially in its poſterior very convex ſide, the rays will converge greatly, and paſs thence into the vitreous body.

This vitreous body is denſer than water, in which it ſinks to the bottom; but rarer than the cryſtalline lens; and continues to bend the rays a little more gently towards the perpendicular, till at length the rays coming from the point of diſtinct viſion, are concentrated into a very ſmall part of the retina, where they paint an image of that object from whence they come; but in a poſition inverted, from the neceſſary decuſſation or croſſing of the rays. The manner in which the images of objects are thus painted, may be ſeen experimentally in an artificial eye, or by a natural eye when the back part of the ſclerotica is cut off, and a piece of paper placed to receive the object. But the image we ſee is painted on the outer ſide from the optic nerve within the bounds of the viſual axis; yet ſo that it is not a mere point, but has ſome degrees of breadth; ſince we ſee many objects at once, whoſe images muſt be in diſtinct points of the painted field. And there an object is ſeen moſt diſtinctly, becauſe the rays arrive thither nearly perpendicular. But frequently this point of viſion does not fall on the ſame place on both of the eyes. When the lens has been couched or diſplaced, the vitreous body, with a weaker refracting power, uſually ſuffices to bring the viſual rays together to a focus.

Is it altogether falſe that the object is painted on the retina? Or is this pictnre made on the choroides? Is this new opinion confirmed by an experiment, by which it is found that the place where the optic nerve enters is blind? and which is thus explained, that there is in that place no choroides but the bare retina, and that thence there is no viſion. But this is repugnant to a very well known obſervation, namely, that the retina is a moſt ſenſible nervous medulla; and that the choroides conſiſts almoſt entirely of a few ſmall nerves, and

and of veſſels moſt certainly blind. This is likewiſe contradicted by the very great variety of the choroides in animals; the equally great conſtancy of the retina; and the black ſpots, which, even in man, obſcure the exterior ſurface of the retina. But by this experiment we know the reaſon why the optic nerve is not inſerted into the axis of the eye, but into its ſide. For thus, except only in one ſingle caſe, where there is an impediment in the concourſe of lines drawn through the centre of the optic nerves, the one eye ſees and aſſiſts that whoſe blind ſide is turned towards the object.

But ſince the neceſſary offices of human life require a diſtinct object to be painted upon the retina, not only by the rays which come from one certain diſtance, but likewiſe by rays which come from very different parts more or leſs diſtant; therefore, it is to be believed, that the neceſſary change is produced in the eye by its own proper cauſes. Other famous anatomiſts have ſuppoſed the lens moveable by the powers before mentioned. This art of ſeeing diſtinctly is ſaid to be learned by experience, it being unknown to an eye lately couched of a cataract. Alſo, in an artificial eye, the uſe and neceſſity of this motion, it is ſaid, may be plainly perceived. Therefore too great a divergency of the rays, as in thoſe which come from objects very cloſe to the eye, is corrected by a removal of the lens farther from the retina, ſo as to bring the focus of the diverging rays upon the retina itſelf, which would otherwiſe have fallen behind the eye; for the refracting power of the eye being determined, that which will unite the focus of rays coming from the diſtance of three feet, ſo as to make them fall perfectly upon the retina, will not be able to collect together into the ſame point thoſe rays which come from the diſtance of three inches; and rays ſtill more diverging will meet together yet farther behind the

eye, if they are not collected together by a greater refracting power.

But those rays, which come from parts very remote, and which may be therefore counted parallel, will meet together before the retina, in the vitreous body; and again separate according to the nature of rays from the point of concourse, as if it was a lucid point: to remedy which, therefore, it is probable that those powers remove the crystalline lens back from the cornea nearer to the retina; that the rays, which come together from a certain distance to the lens, may be also united together at a certain proportionable distance on the retina. For an eye, that will collect the rays coming from seven inches, so as to unite them on the retina, will collect those together before the retina which come from a distance of three feet. It was therefore perfectly necessary for the eye to be made thus changeable, that we might be able to see distinctly at various distances. But the point of distinct vision is in that part of the retina where the given object is painted in the least compass possible. The powers causing the visual rays to unite or converge on the retina, are often very different in the two eyes of one and the same person, so as to render one eye nearly presbyoptical or long-sighted, and the other myoptical or short-sighted.

These and other things similar are commonly received and taught, more especially by the mathematicians, who more readily perceive the necessity of these changes. But yet there is no power in the human eye which can either move the crystalline humour out of its place, or compress it. But we do not perceive this faculty in ourselves: for we move a book nearer to our eyes when it is too far off, so as to appear confused; which we would have no occasion to do, if by changing the internal figure of the eye we could correct the fault of the distance: and through a small hole, we perceive an object only single in the point of

of diſtinct viſion, but double in every other. Perhaps the contraction of the pupil may do ſomething, by which we can perceive more diſtinctly ſuch objects as are near.

But this artifice of the eye is not ſufficient in all perſons. For there are now a greater number of people than formerly employed in a ſtudious or ſedentary life, and taken up with the obſervation of more minute objects; by which the cornea is rendered more convex and denſe, and the cryſtalline lens more ſolid and of leſs ſegments; while the eye itſelf, by the weight of the humours, is more elongated, and the reſt of the humours themſelves are probably more denſified: many or all of which circumſtances attend the eyes of one perſon. In ſuch, the iris is ſenſible in a ſmall light; whence, by winking, or ſtraining the eye-lid, they are denominated *myopes*, ſhort or near ſighted. In theſe, the point of diſtinct viſion is very near to the eye, from one to ſeven inches from before the cornea; but they ſee remoter objects more obſcurely, without being able to diſtinguiſh their parts. The reaſon of this is evident; ſince, from the forementioned cauſes, there is a greater refracting power of the humours, by which the diſtant and conſequently parallel rays are obliged to meet in their focus before the retina; from whence ſpreading again, they fall upon the retina in many points. Thus alſo to a good eye, the ſenſe of objects which are too near the cornea is confuſed; becauſe the rays coming from thence are ſpread all over the retina, without being collected towards the centre.

The remedy for this fault in the ſight is to correct it in its beginning, by viewing diſtant places, by keeping the eyes from minute or near objects, and by the uſe of concave glaſſes; or by viewing things through a ſmall hole, by which the light is weakened. When the diſorder is confirmed, the remedy is a concave lens, which takes off a degree of the refracting power in the humours, cornea, and cryſtalline lens, in proportion

tion as it is more concave; by which means the focus of rays from remote objects is removed farther behind the cornea, so as to fall upon the retina. This glass ought to be a portion of a sphere, whose diameter is equal to the distance of distinct vision from the naked eye, squared by the distance of distinct vision in the armed eye, and divided by the difference betwixt them. Age itself advancing, gives some relief to the short-sighted; for children are in a manner naturally myoptical: but, as the eye grows older, it becomes flatter, in proportion as the solids grows stronger; and, contracting to a shorter axis, the converging powers of the lens and cornea are diminished.

Another disorder of the sight, contrary to the former, troubles people who are often looking upon very distant objects, and is more especially familiar and incurable in old people. In such, the cornea and crystalline lens are flatter, and the humours of the eye have a less refracting power. Hence near objects, whose rays fall very diverging upon the cornea, appear confused; because the converging or refracting powers of the eye are not sufficient to bring the rays together in a focus upon the retina, but the rays go on scattered through the retina, and through the point of their pencil behind the eye; from whence vision is confused. The point of distinct vision among presbyopi, or old or long-sighted people, is from the distance of fifteen inches to three feet.

Such persons are, in some measure, relieved by looking through a black tube held before the eye; by the use of which the retina grows tenderer, and the rays come to the eye in a parallel direction. The remedy here is a convex lens of glass, which may cause the rays to converge and unite together sooner in a focus, that it may not fall behind the eye, but upon the retina. The diameter of the sphere, of which such a lens ought to be a portion, is determined as before.

There

There is no hope from age, which increaſes the malady.

The medium betwixt ſhort and long ſighted is the beſt, by which a perſon can ſee diſtinctly enough objects that are both near and remote; and of this kind we reckon an eye that is able to read diſtinctly at the diſtance of one foot. But to this are to be added other neceſſary conditions; ſuch as a perfect clearneſs of the humours; a due mobility of the eye itſelf, and its parts; a ſenſibility of the pupil and retina, neither too tender nor too tough.

But the mind not only receives a repreſentation of the image of the object by the eye, impreſſed on the retina, and transferred to the common ſenſory or ſeat of the ſoul; but ſhe learns or adds many things from mere experience, which the eye itſelf does not really ſee, and other things the mind conſiders or interprets to be different from what they appear to her by the eye. And firſt, the *magnitude* of an object is judged of by an optical angle intercepted; as the baſis of a triangle betwixt the cornea, and as the point of a cone betwixt the radiant object. From hence, things very near ſeem large, and remote objects ſeem ſmall. Hither may be referred the power of microſcopes, by which objects are made to appear to us ſo much larger, as the diſtance of the focus of the lens or magnifier is leſs than the diſtance of diſtinct viſion; when, in reality, they do not appear larger, only more diſtinct and lucid; whence the mind judges them to be nearer.

The ſtrength of viſual light likewiſe is proportionable to the ſame angle, in the external day-light; and the multitude or number of the rays, joined with the ſmallneſs of the ſeat which they affect in the retina, occaſions near objects to appear brighter, and diſtant objects more obſcure; or if remote objects appear bright by their own light, the mind repreſents them as large, near at hand, or both.

The *place* of a diſtant object appearing to one eye, is reckoned

reckoned to be in a line comprehended by two other ſtraight lines drawn to the extremities of the body. If the ſame body is looked upon with both eyes, it will then ſeem to be in the concourſe of two lines drawn through the axis of both eyes to that object.

Diſtance we cannot perceive; and if a blind man, who never ſaw, ſhould by any means be reſtored to ſight, he would imagine every thing he ſaw to touch his eyes. Even we who are accuſtomed to judge by ſight, make many fallacious conjectures concerning the diſtance of objects: but concerning this we judge as well from the known diminution of the bulk of the body, as from the leſſer ſtrength of the light, and faint image of the object whoſe parts we are leſs capable of diſtinguiſhing, and from the number of bodies interpoſed, whoſe diſtance is known.

The *convexity* or *protuberance* of a body is not ſeen; but is afterwards judged of by experience, after we have learned, that a body, which is convex to the feeling, cauſes light and ſhadow to be diſpoſed in a certain manner. Hence it is, that microſcopes frequently pervert the judgment, by tranſpoſing or changing the ſhadows. The ſame alſo happens in that phenomenon which is not yet ſufficiently underſtood, by which the concave parts of a ſeal are made to ſeem convex, and the contrary.

The viſible *ſituation* of the parts of an object, are judged by the mind to be the ſame with that which they naturally have in the object, and not the inverted poſition in which they are painted upon the retina. But it is certainly a faculty innate or born with the eye, to repreſent objects upright to the mind, whenever they are painted inverted upon the retina; for new-born animals always ſee things upright. And men who have been born with cataracts, without ever being able to ſee, are obſerved, upon couching the cataracts, to ſee every thing in its natural ſituation, without the uſe of any feeling, or previous experiences.

One

One thing which impoſes upon the mind, is the continuance which external ſenſations make, during almoſt the ſpace of a ſecond of a minute, after they have been conveyed to the ſenſorium by the eyes; whence they are repreſented to the mind as objects really preſent. From hence proceeds the idea of a fiery circle from the circumrotation of a lucid body; and from hence proceeds the continuance of the ſhining image of the ſun, and ſometimes of other bodies, after they have been viewed by the eye.

Do we perceive only that object diſtinctly which is directly before that part of the retina which ſees moſt diſtinctly? And does the eye perſuade itſelf, that it ſees many objects at a time, partly from the duration of the ideas, and partly from the quickneſs of the motions of the eye? Concerning the moſt diſtinct viſion, this is moſt certain; but we cannot affirm it of that which is leſs diſtinct. Why do we ſee only one object with two eyes? Becauſe the ſenſation becomes one, and without difference, when we have ſimilar impreſſions of two objects. For, even without the concourſe of optic nerves, inſects who have numerous eyes perceive objects ſingle. Hence the images of two objects excite only one ſenſation, when they fall upon the ſame point of the retina; but two ſenſations ariſe from one object, when the images fall upon different parts of the retina. Whence proceed diurnal and nocturnal blindneſs? The former is common to many nations living in the warmeſt climates, under the brighteſt rays of the ſun, and to old men. The other happens in inflamed eyes, and young men of a hot temperament, and hence endowed with eyes vaſtly ſenſible. Whence do animals ſee in the dark? From a large dilatible pupil, and tender retina; a ſhining choroides, and one which reflects the light very ſtrongly. Why are we blind when brought out of a ſtrong light into a weak one? Becauſe the optic nerve, having ſuffered the action of ſtronger cauſes, is incapable of being moved by weaker ones.

Whence

Whence have we a pain, by paſſing ſuddenly from a dark place into the light? Becauſe the pupil, being widely dilated in the dark, ſuddenly admits too great a quantity of light before it can contract; whence the tender retina, which is eaſily affected by a ſmall light, feels, for a time, an impreſſion too ſharp and ſtrong. Whether ſee we with one eye, or with both? Moſt frequently with one, and more eſpecially the right eye: but when both are employed together, we ſee more objects, and more plainly; and we alſo diſtinguiſh more points of the ſame object, and judge better of their diſtances.

Sect. III. *The* Nose.

The parts of which the noſe is compoſed, may be divided in two different ways, viz. from their ſituation, into external and internal parts; and, from their ſtructure, into hard and ſoft parts.

The external parts are the root of the noſe, the arch, the back or ſpine of the noſe, the ſides of the noſe or of the arch, the tip of the noſe, the alæ, the external nares, and the part under the ſeptum.

The internal parts are the internal nares, the ſeptum narium, the circumvolutions, the conchæ ſuperiores, or oſſa ſpongioſa ſuperiora, chonchæ inferiores, the poſterior openings of the internal nares, the ſinus frontales, ſinus maxillares, ſinus ſphenoidales, the ductus lacrymales, and ductus palatini.

The firm or hard parts are moſtly bony, and the reſt cartilaginous, viz. the os frontis, os ethmoides, os ſphenoides, oſſa maxillaria, oſſa naſi, oſſa unguis, oſſa palati, vomer, conchæ inferiores, and the cartilages. To theſe we may add the perioſteum and perichondrium, as parts belonging to the bones and cartilages.

The ſoft parts are the integuments, muſcles, ſaccu-

lus lacrymalis, membrana pituitaria, veſſels, nerves, and hairs of the nares. The bony parts have been all explained in the deſcription of the ſkeleton; and therefore we need only in this place ſet down the diſtribution and diſpoſition thereof, for the formation of ſome of the principal parts. The ſeptum is formed by the deſcending lamina of the os ethmoides, and by the vomer; and it is placed in the groove framed by the criſtæ of the offa maxillaria, and riſing edges of the offa palati. The fore part of the noſe is formed by the offa naſi; and the ſides, by the ſuperior apophyſes of the offa maxillaria.

The internal nares, or the two cavities of the noſe, comprehend the whole ſpace between the external nares and poſterior openings, immediately above the arch of the palate, from whence theſe cavities reach upwards as far as the lamina cribroſa of the os ethmoides, where they communicate forward with the ſinus frontales, and backward with the ſinus ſphenoidales. Laterally, theſe cavities are bounded on the inſide by the ſeptum narium; and on the outſide, or that next the cheek, by the conchæ or offa ſpongioſa between which they communicate with the ſinus maxillaris.

The particular ſituation of theſe cavities deſerves our attention. The bottom of them runs directly backward, ſo that a ſtraight and pretty large ſtilet may eaſily be paſſed from the external nares, under the great apophyſis of the occiptial bone. The openings of the maxillary ſinuſes are nearly oppoſite to the upper edge of the offa malarum. The openings of the frontal ſinuſes are more or leſs oppoſite to and between the pulleys or rings of the muſculi trochleares; and by theſe marks the ſituation of all the other parts may be determined.

The inferior portion of the external noſe is compoſed of ſeveral cartilages, which are commonly five in number, and of a pretty regular figure. The reſt are only additional, ſmaller, more irregular, and the number of

of them more uncertain. Of the five ordinary cartilages, one is ſituated in the middle, the other four laterally. The middle cartilage is the moſt conſiderable, and ſupports the reſt, being connected immediately to the bony parts; but the other four are connected to the middle cartilage, and to each other, by means of ligaments.

The principal cartilage of the noſe conſiſts of three parts, one middle and two lateral. The middle portion is a broad cartilaginous lamina, joined, by a kind of ſymphyſis, to the anterior edge of the middle lamina of the os ethmoides, to the anterior edge of the vomer, and to the anterior part of the groove formed by the oſſa maxillaria, as far as the naſal ſpines of theſe bones. This lamina completes the ſeptum narium, and indeed forms the principal part thereof.

The lateral portions are oblique and narrow, ſuited to the correſponding parts of the bony arch. Where they join the middle lamina, a ſuperficial groove is obſervable; which makes them ſometimes appear like two diſtinct pieces, ſeparated from the lamina, though they are really continuous. This ſhallow groove terminates below by a ſmall criſta.

The lateral cartilages are two, on each ſide of the inferior part of the lamina; one anterior, the other poſterior. The two anterior cartilages are very much bent forward, and form what is called the *tip of the noſe;* the ſpace between their incurvated extremities being commonly filled with a kind of fatty ſubſtance. The two poſterior cartilages form the alæ of the nares, being pretty broad, and of an irregular figure.

The ſpaces left between ſome portions of the anterior and poſterior cartilages, thoſe between the poſterior cartilages and the neighbouring parts of the oſſa maxillaria, and laſtly thoſe between theſe four lateral cartilages and the principal lamina, vary in different ſubjects; and are filled by ſmall additional cartilages,

the number, ſize, and figure of which are as various as the interſtices in which they lie.

The ſub-ſeptum, or portion under the ſeptum narium, is a pillar of fat applied to the inferior edge of the cartilaginous partition, in form of a ſoft moveable appendix. The thickneſs of the alæ narium, and eſpecially that of their lower edges, is not owing to the cartilages, which are very thin, but to the ſame kind of ſolid fat with which theſe cartilages are covered. The great cartilage is immoveable by reaſon of its firm connection to the bony parts of the noſe; but the lateral cartilages are moveable, becauſe of their ligamentous connections, and they are moved in different manners by the muſcles belonging to them.

The external noſe is covered by the common integuments, the ſkin, epidermis, and fat. The parts which cover the tip of the noſe and alæ narium, are pierced with the ducts of a great number of glandulæ ſebaceæ, the contents of which may eaſily be ſqueezed out by the fingers. All theſe bony and cartilaginous parts have likewiſe the common perioſteum or perichondrium.

Muſcles of the noſe. Six muſcles are commonly reckoned to belong to the noſe; two levatores, two depreſſores, and two compreſſores. In very muſcular bodies, there are likewiſe ſome ſupernumerary muſcles, or ſmall acceſſorii. The noſe may alſo be moved in ſome meaſure by the neighbouring muſcles, which in many caſes become aſſiſtants to the proper muſcles of this organ.

The firſt pair of theſe muſcles raiſes and dilates the ala of the nares when they act. They likewiſe wrinkle the ſkin on the ſides of the noſe. The ſecond pair have the contrary effect; and the third pair compreſs the ſides of the noſe to the ſeptum, as in ſmelling.

Membrana pituitaria. The membrana pituitaria is that which lines the whole internal nares, the oſſa

ſpongioſa, the ſides of the ſeptum narium, and by an uninterrupted continuation, the inner ſurface of the ſinus frontales and maxillares, and of the ductus lacrymales, palatini, and ſphenoidales. It is likewiſe continued down from the nares to the pharynx, ſeptum palati, Euſtachian tubes, &c. as we ſhall ſhow hereafter. It is likewiſe known by the name of *Schneideriana*, from the anatomiſt who has given a deſcription of it.

It is termed *pituitaria*, becauſe, through the greateſt part of its large extent, it ſerves to ſeparate from the arterial blood a mucilaginous lympha, called *pituita* by the ancients, which in the natural ſtate is pretty liquid; but it is ſubject to very great changes, becoming ſometimes glutinous or ſnotty, ſometimes limpid, &c. neither is it ſeparated in equal quantities through the whole membrane.

When we carefully examine this membrane, it appears to be of a different ſtructure in different parts. Near the edge of the external nares it is very thin, appearing to be the ſkin and epidermis in a degenerated ſtate. All the other parts of it in general are ſpongy, and of different thickneſſes. The thickeſt parts are thoſe on the ſeptum narium, on the whole lower portion of the interal nares, and on the conchæ; and if we make a ſmall hole in it at any of theſe places, and then blow through a pipe, we diſcover a very large cellular ſubſtance. In the ſinuſes it appears to be of a more ſlender texture.

Winſlow obſerves, that on the ſide next the perioſteum and perichondrium, it is plentifully ſtored with ſmall glands, the excretory ducts of which are very long near the ſeptum narium, and their orifices very viſible; and that by applying a pipe to any of theſe orifices, the ducts may be blown up almoſt through their whole extent; but that in order to this, the parts muſt firſt be very well cleaned and waſhed in lukewarm water. Sabatier gives ſomewhat of a different deſcription: He admits of mucous follicles; but ſays they are very

very different from thoſe which are properly called glands.

Sinus. The frontal, maxillary, and ſphenoidal ſinuſes open into the internal nares, but in different manners. The frontal ſinuſes open from above downward, anſwering to the infundibula of the os ethmoides deſcribed in the hiſtory of the ſkeleton. The ſphenoidales open forwards, oppoſite to the poſterior orifices of the nares; and the maxillares open a little higher, between the two conchæ or oſſa ſpongioſa. Therefore the ſinus frontales diſcharge themſelves moſt readily when we ſtand or ſit; and the ſphenoidales, when the head is inclined forward.

The ſinus maxillares cannot be emptied wholly or both at the ſame time in any one ſituation. Their opening, which in ſome ſubjects is ſingle, in others double, &c. lies exactly between the two oſſa ſpongioſa of the ſame ſide, about the middle of their depth: ſo that when the head is held ſtraight, or inclined forward or backward, they can only be half emptied; but when we lie on one ſide, the ſinus of the oppoſite ſide may be wholly emptied, the other remaining full.

It is proper here to obſerve the whole extent of the maxillary ſinus. Below, there is but a very thin partition between it and the dentes molares, the roots of which, in ſome ſubjects, perforate that ſeptum. Above, there is only a very thin tranſparent lamina between the orbit and the ſinus. Backward, above the tuberoſity of the os maxillare, the ſides of the ſinus are very thin, eſpecially at the place which lies before the root of the apophyſes pterygoides. Inward, or toward the conchæ narium, the bony part of the ſinus is likewiſe very thin.

Sacculus lacrymalis. The lacrymal ſacculus is an oblong membranous bag, into which the ſerous fluid is diſcharged from the eye through the puncta lacrymalia, already deſcribed, and from which the ſame fluid paſſes to the lower part of the internal nares. It is ſi-

tuated in a bony groove and canal, formed partly by the apophyſis naſalis of the os maxillare and os unguis, partly by the ſame os maxillare and lower part of the os unguis, and partly by this lower portion of the os unguis, and a ſmall ſuperior portion of the concha narium inferior. This groove and canal are the bony lacrymal duct, about which beginners ſhould conſult what was ſaid in the deſcription of the ſkeleton.

With reſpect to the ſituation of this bony duct. It runs down for a little way obliquely backward, toward the lower and lateral part of the internal nares on each ſide, where its lower extremity opens on one ſide of the ſinus maxillaris under the os ſpongioſum inferius, nearly at the place from which a perpendicular line would fall in the interſtice between the ſecond and third dentes molares. The upper part of this duct is only an half-canal or groove; the lower is a complete canal, narrower than the former.

The ſacculus lacrymalis may be divided into a ſuperior or orbitary portion, and an inferior or naſal portion. The orbitary portion fills the whole bony groove, being ſituated immediately behind the middle tendon of the muſculus orbicularis. About one-fourth of its length is above this tendon, and the reſt below; the upper part is the lacrymal ſac properly ſo called; while the naſal portion, which lies in the bony canal of the noſe, being narrower and ſhorter than the former, is termed *lacrymal duct:* the one is merely a continuation of the other, without any valve, &c. between them.

The orbitary portion is diſpoſed at its upper extremity much in the manner of an inteſtinum cæcum, and at the lower extremity is ſomewhat narrower than the portio naſalis. Towards the internal angle of the eye, behind the tendon of the orbicular muſcle, it is perforated by a ſmall ſhort canal formed by the union of the lacrymal ducts.

The naſal portion becomes gradually larger towards its

its under end, and having reached the lower part of the bony duct under the inferior concha, is perforated by a round opening; but which at firſt ſight appears oblong, and is conſiderably ſmaller than the cavity of the duct.

If a tranſverſe line be drawn between the lower part of the noſe and os malæ, and another line be drawn directly upward, oppoſite to the third dens molaris, or oppoſite to the ſecond and third, theſe two lines will interſect each other nearly at the lower extremity of this ſacculus.

Sometimes the upper extremity of this bag has been found divided into an anterior and poſterior part, by a kind of valvula connivens lying in the anterior portion, a little lower than the tendon of the muſculus orbicularis. The ſmall common canal of the two lacrymal ducts opens in the poſterior part of this ſacculus.

The ſubſtance of this ſacculus is ſomething ſpongy or cellulous, and pretty thick, being ſtrongly united by its convex ſide to the perioſteum of the bony canal, which may be very diſtinctly ſhown. Sabatier obſerves, that its ſubſtance is ſimilar to that of the membrana pituitaria, and that it is lined with the ſame kind of mucous within. Its uſe has been compared by ſome late writers to that of the bladder of urine, as was mentioned in the deſcription of the eye.

Ductus inciſorii. The ductus inciſorii, or naſo-palatini of Steno, are two canals which go from the bottom of the internal nares croſs the arch of the palate, and open behind the firſt or largeſt dentes inciſorii. Their two orifices may be diſtinctly ſeen in the ſkeleton at the lower part of the naſal foſſæ, on the anterior and lateral ſides of the criſtæ maxillares; and we may likewiſe perceive their oblique paſſage through the maxillary bones, and laſtly their inferior orifices in a ſmall cavity or foſſula called *foramen palatinum anterius.* In freſh ſubjects they are not ſo apparent, eſpecially in human

ſubjects; but in ſheep and oxen they are eaſily diſcoverable.

Arteries and veins. The arteries of all theſe parts come chiefly from the external carotid. Thoſe of the external parts of the noſe are chiefly branches and rami of the arteria maxillaris externa or angularis, and of the temporalis; and the arteries of the internal parts are branches and ramifications of the maxillaris interna, and likewiſe ſmall branches from the ocular artery. The veins are, almoſt in the ſame manner, branches and ramifications of the external jugular; and they communicate with the orbitary ſinus, and, by that means, with the ſinuſes of the dura mater, and with the internal jugulars.

Nerves. The principal nerves belonging to the noſe are filaments of the nervi olfactorii, which run down through the holes of the tranſverſe lamina of the os ethmoides, and are diſtributed to the common membrane of the internal nares, eſpecially to the villous portions thereof. The inner ramus of the orbitary or opthalmic ſends a filament through the internal anterior orbitary hole into the cranium, which comes out again in company with one of the filaments of the olfactory nerve through the ethmoidal lamina.

This internal ramus advances afterwards toward the os unguis; and is diſtributed partly to the ſacculus lacrymalis, partly to the upper portion of the muſculus levator alæ naſi, and of the integuments of the noſe. The ſuborbitary nerve, which is a branch of the maxillaris ſuperior, having paſſed through the inferior orbitary hole, ſends filaments to the lateral external parts of the noſe. Another ramus of the ſuperior maxillary nerve goes to the poſterior opening of the nares, being ſpent on the conchæ and other internal parts of the noſe.

The outer part of the noſe is ſupplied by branches from the ſuperior maxillary nerve, or ſecond branch of

of the fifth pair, and by others from the portio dura of the ſeventh pair.

In animals which ſmell acutely, the parts of the noſe are remarkably large; but the formation of the human head into that of a roundiſh figure, has in us given to the organ of ſmelling but a ſmall extent of ſurface; but to enlarge this the more, nature has made the internal parts of the noſe variouſly hollow and complicated in a ſurpriſing manner.

§ 1. *Of Smelling.*

The ſenſe of ſmelling conduces to the diſtinguiſhing prejudicial from ſalutary food. By it we both diſcover and are admoniſhed to avoid, before it comes to our taſte, what might be otherwiſe dangerous: and we are eſpecially enabled to avoid any thing of a putrid tendency in our victuals, which to us is of a moſt peſtilent nature, and likewiſe to diſcern what are grateful and wholeſome aliments; although cuſtom has rendered it more remarkable among brute animals than among men. For men who have been brought up wild by themſelves, without debauching the ſcent by a variety of ſmells, have been obſerved to poſſeſs that diſtinguiſhing faculty in a very infallible degree. Finally, the powers and virtues of medicinal plants are hardly to be better known than by the ſimple teſtimony of taſting and ſmelling. From hence it is, that in all animals theſe organs are placed together; and from hence the ſmelling is ſtronger, and the organs larger, in thoſe animals which are to ſeek their prey at a conſiderable diſtance, or to reject malignant plants from among thoſe that are fit for food.

The ſenſe of ſmelling is performed by means of a ſoft pulpy membrane, full of pores and ſmall veſſels, which lines the whole internal cavity of the noſtrils, being thicker upon the ſeptum and principal convolutions, but thinner in the ſinuſes. Within this mem-

brane are diſtributed the veſſels and nerves already deſcribed.

The nerves of the noſe, being almoſt naked, require a defence from the air, which is continually drawn through the noſtrils, and blown out again by the uſe of reſpiration. Nature has therefore ſupplied this part, which is the organ of ſmelling, with a thick inſipid mucus, very fluid in its firſt ſeparation, and not at all ſalline, but, by the air condenſing into a thick dry cruſt, more conſiſtent here than in other parts of the body. By this mucus the nerves are defended from drying and from pain. It is poured out from many ſmall arteries of the noſtrils; and depoſited partly into numerous cylindrical ducts, and partly into round viſible cryptæ or cells ſcattered all over the noſtrils. The ſame flows out all over the ſurface of the olfactory membrane, which is therewith anointed on all ſides. This mucus is accumulated in the night-time; but in the day expelled by blowing the noſe, or ſometimes more powerfully by ſneezing; and may offend by its exceſs or tenuity, or irritate by too great thickneſs the very ſenſible nerves, from whence a ſneezing is excited for its removal. But the ſinuſes of this part, which abound with mucus, are this way variouſly evacuated, agreeable to the different poſtures of the body; by which always ſome of them are at liberty to free themſelves, whether the head be erect, or inclined forward, or laterally; yet ſo, that generally the maxillary and ſphenoidal ſinuſes are more difficultly emptied than the reſt. Moreover, the tears deſcend, by a channel proper to themſelves, into the cavity of the noſe, by which they moiſten and dilute the mucus.

The cartilages render the noſe moveable by its proper muſcles, ſo as to be raiſed and dilated by a muſcle common to the upper lip, and to be contracted together into a narrow compaſs by the proper depreſſor and compreſſor muſcle pulling down the ſeptum. The noſe projects

projects like an engine in the air, for the reception of ſmells, and may be dilated in proportion to the quantity of inhaled air, and again contracted, when it is expelled in the ſame abundance.

The air, therefore, filled with the ſubtle and inviſible effluvia of bodies, conſiſting of their volatile, oily, and ſaline particles, is, by the powers of reſpiration, urged through the noſe, ſo as to apply the ſaid particles to the almoſt naked and conſtantly ſoft olfactory nerves, in which a kind of feeling is excited, which we call *ſmelling:* and by this ſenſe we diſtinguiſh the ſeveral kinds of oils, ſalts, and other matters, difficultly reducible to claſſes, which hereby we perceive indiſtinctly; whence they are difficultly recalled to memory, though the odours already eſtabliſhed are ſufficient enough for our purpoſes. This ſenſe ſerves to admoniſh us of any pernicious putrefaction; of any violent acrimony; or of a mild, ſoapy, and uſeful diſpoſition in bodies. And as ſalt, joined with an oil, is the object of taſte; ſo a volatile oil, aided with ſalts, ſerves to excite ſmells: whence the affinity of the two ſenſes, which conjunctly aſſiſt and move each other, may be eaſily underſtood. But volatile particles chiefly are diſtinguiſhed by ſmell, and fixed ones by the taſte; perhaps becauſe the thick mucous cuticle, ſpread over the tongue, intercepts the action of the more ſubtle ſaline effluvia from acting upon the taſte, which yet eaſily affect the ſofter and leſs covered nerves of the internal noſe. We are ignorant of the reaſon why ſome ſmells pleaſe, and others diſpleaſe; perhaps cuſtom may have ſome effect in this caſe.

Smells have a very ſtrong action, but of ſhort continuance; becauſe they are applied immediately, by the moſt minute particles, to nerves which are very near to the brain itſelf, and almoſt naked; from thence too proceeds the force of poiſonous vapours, and the refreſhment from agreeable odours, by which ſome perſons

ſons are effectually recalled to themſelves out of a dead ſwoon, or even after drowning. From hence comes that violent ſneezing, which often ariſes from acrid particles; and a looſeneſs or purging of the bowels, from the ſmell of ſome medicines, with the power of particular antipathies. From hence is derived the pernicious effects of exceſſive ſneezing, more eſpecially blindneſs, from the near conſent or ſociety of the nerves. But amongſt the various parts of the noſe, the ſeptum, and more eſpecially the os turbinatum, have a conſiderable ſhare in the organ of ſmelling: ſince theſe are parts multiplied in quick ſcented animals, ſo as to form beautiful ſpires in hounds and other quadrupeds; and in fiſh, who ſmell by water, they are formed like the teeth of a comb, in an elegant manner.

Sect. IV. *The* Ear.

The ear in general. Every one knows that the ears are two in number, that they are ſituated in the lateral parts of the head, and that they are the organs of hearing. Anatomiſts commonly divide or diſtinguiſh the ear into external and internal. By the external ear they mean all that lies without the external orifice of the meatus auditorius in the os temporis; by the internal ear, all that lies within the cavities of that bone, and alſo the parts that bear any relation thereto.

The greateſt part of the external ear conſiſts of a large cartilage very artificially framed, which is the baſis of all the other parts of which this portion of the ear is made up. The internal ear conſiſts chiefly of ſeveral bony pieces, partly formed in the ſubſtance of the os temporis, and eſpecially in that portion of it called *apophyſis petroſa;* and partly ſeparated from, but contained in a particular cavity of, that bone.

The

The external ear. Two portions are diſtinguiſhed in the external ear; one large and ſolid, called *pinna*, which is the ſuperior, and by much the greater part; the other ſmall and ſoft, called the *lobe*, which makes the lower part. We may likewiſe conſider two ſides in the outward ear; one turned obliquely forward, and irregularly concave; the other turned obliquely backward, and unequally convex; for all ears which have not been diſordered by binding the head too tight in childhood, are naturally bent forward.

The foreſide is divided into eminences and cavities. The eminences are four in number, called *helix*, *antihelix*, *tragus*, and *antitragus*. The helix is the large folded border or circumference of the great portion of the ear. The antihelix is the large oblong eminence or riſing ſurrounded by the helix. The tragus is the ſmall anterior protuberance below the anterior extremity of the helix, which in an advanced age is covered with hairs. The antitragus is the poſterior tubercle, below the inferior extremity of the antihelix.

The cavities on the foreſide are four in number: the hollow of the helix; the depreſſion at the ſuperior extremity of the antihelix, called *foſſa navicularis;* the concha, or great double cavity that lies under the riſing termed *antihelix*, the upper bottom of which is diſtinguiſhed from the lower by a continuation of the helix in form of a tranſverſe criſta; and laſtly, the meatus of the external ear, ſituated at the lower part of the bottom of the concha.

The backſide of the external ear ſhows only one conſiderable eminence, which is a portion of the convex ſide of the concha, the other portion being hid by the adheſion of the ear to the os temporis. This adheſion hinders us likewiſe from ſeeing the hollow anſwering to the criſta, by which the cavity of the concha is divided.

The

The other parts of the external ear are ligaments, muſcles, integuments, ſebaceous and ceruminous glands, veſſels, and nerves.

The cartilage of the outward ear is nearly of the ſame extent and figure with the large ſolid portion thereof already mentioned; but it is not of the ſame thickneſs, being covered by integuments on both ſides. In the lobe or ſoft lower portion of the ear, this cartilage is wanting. On the back ſide, it ſhows all the eminences and cavities on the foreſide in an oppoſite ſituation with reſpect to each other, except the fold of the great circumference; and it conſiſts only of one piece from that circumference all the way to the meatus externus, except at the two extremities of the folded part of the helix, where there are two ſmall ſeparate portions connected to the great cartilage only by the integuments.

The cartilaginous portion of the external meatus auditorius does not make a complete circle; but rather a ſhort tube, in one ſide of which there is a break, and which terminates in an oblique border fixed to the edge of the bony canal by ſeveral ſmall inequalities; and from this obliquity it is, that the cartilaginous border terminates downward in a kind of apex or point. The lateral break in this cartilage is between the upper and back part of its circumference; and on each ſide thereof the cartilaginous edges are rounded. There are likewiſe two or three other ſmall inciſures in this circumference, which, in regard to the meatus, repreſent obliquely tranſverſe fiſſures. The anterior fiſſure is in a manner quadrangular; neither are the intermediate parts always oppoſite to each other, for the uppermoſt is a little further from the os temporis than the poſterior.

The external ear is fixed to the cranium, not only by the cartilaginous portion of the meatus already mentioned, but alſo by ligaments which are two in number,

ber, one anterior, the other poſterior. The anterior ligament is fixed by one extremity to the root of the apophyſis zygomatica of the os temporis, at the anterior and a little toward the ſuperior part of the meatus oſſeus, cloſe to the corner of the glenoide cavity; and by the other extremity, to the anterior and ſuperior part of the cartilaginous meatus.

The poſterior ligament is fixed by one end to the root of the maſtoide apophyſis, and by the other to the poſterior part of the convexity of the concha; ſo that it is oppoſite to the anterior ligament. There is likewiſe a kind of ſuperior ligament, which ſeems to be only a continuation of the aponeuroſis of the frontal and occipital muſcles.

Of the muſcles of the external ear, ſome go between the cartilages and the os temporis, others are confined to the cartilages alone. Both kinds vary in different ſubjects, and are ſometimes ſo very thin as to look more like ligaments than muſcles. The muſcles of the firſt kind are generally three in number, one ſuperior, one poſterior, and one anterior; and they are all very thin.

The ſmall muſcles which are confined to the cartilages, are only ſmall ſtrata of fibres found on both ſides of the cartilages. In many ſubjects they are of ſo pale a colour as not to look at all like muſcular fibres. Of this number are thoſe which Valſalva diſcovered in the different cavities on the backſide of the cartilage; and thoſe found by Santorini on the tragus, and along the convex part of the anterior portion of the helix. (*See* the Treatiſe on the Muſcles.)

The ſkin of the external ear is in general a continuation of that which covers the neighbouring parts of the temporal region. The ſkin on the foreſide of the ear is accompanied by a very ſmall quantity of cellular ſubſtance; and therefore we find all the eminences and cavities of that ſide diſtinctly marked upon it, as far

as

as the bottom of the external meatus auditorius. In what has been ſaid of the ſkin, the epidermis is likewiſe comprehended.

The backſide is covered by the ſkin continued from the foreſide; but as the folds are there very cloſe, it only paſſes over them, except that portion of the concha which ſurrounds the entry of the meatus auditorius, and which is joined to the os temporis by means of the cellular ſubſtance. The hollow of that common fold which lies between the antihelix and concha does not appear on the backſide; for as it is filled with cellular ſubſtance, the ſkin paſſes over it.

The lobe of the ear, or that ſoft portion which lies under the tragus, antitragus, and meatus auditorius, is made up of nothing but ſkin and cellular ſubſtance. The meatus auditorius is partly bony and partly cartilaginous. The bony portion is the longeſt, and forms the bottom of the canal, as may be ſeen in the deſcription of the ſkeleton. The cartilaginous portion is the ſhorteſt; and, in adults, forms the external opening or orifice of the canal, as has been already ſaid.

Theſe two portions joined endwiſe to each other, form a canal of a conſiderable length, of different wideneſs in its different parts, and a little contorted. It is lined on the inſide by the ſkin and cellular membrane, through its whole length; and thus theſe integuments make up for the breaks in the cartilaginous portions, and form a kind of cutaneous tube in the other portion. The cellular membrane is confounded with the perichondrium and perioſteum of the meatus.

The ſkin which covers both ſides of the cartilage contains a great number of ſmall glands, which continually diſcharge an oily, whitiſh humour, collected chiefly near the adheſions of the ear to the head, and under the fold of the helix; and theſe glands are of the ſebaceous kind. The ſkin, which lines the meatus auditorius, contains another kind of glands, of a yellowiſh colour, and which may be plainly ſeen on

the convex ſide of the cutaneous tube already mentioned.

Theſe glands are diſpoſed in ſuch a manner as to leave reticular ſpaces between them, and they penetrate a little way into the ſubſtance of the ſkin. They are called *glandulæ ceruminoſæ*, becauſe they diſcharge that matter which is named *cerumen* or the *wax* of the ear. They were firſt deſcribed by Steno, though ſome have named them after Duveney.

The inner ſurface of the cutaneous tube is full of fine hairs, between which lie the orifices of the ceruminous glands. The firſt place in which we meet witth theſe glands is on that part of the convex ſide of the cutaneous tube, which ſupplies the breaks of the cartilaginous meatus.

The arteries of the external ear come anteriorly from the arteria temporalis, and poſteriorly from the occipitalis, all of which are branches of the external carotid. It is proper to obſerve here, that the occipital artery communicates with the vertebralis, and thereby with the internal carotid. The veins are rami of the jugularis externa; and the occipital vein, one of theſe rami, communicates, not only with the vena vertebralis, but with the neighbouring lateral ſinus of the dura mater.

The portio dura of the auditory nerve having paſſed out of the cranium through the foramen ſtylo-maſtodeum, in the manner that ſhall be afterwards deſcribed, gives off a ramus, which runs up behind the ear, to the backſide of which it ſends ſeveral filaments; and the trunk of this ramus ſends likewiſe filaments to the meatus and foreſide of the ear. The ſecond vertebral pair ſends alſo a ramus to the ear, the ramifications of which communicate with thoſe of the other ramus from the portio dura.

After having deſcribed the external parts of the ear, we next proceed to examine its internal bony parts; and here we ſhall conſider them at ſome length, as they

they are purpoſely omitted in the oſteological part of this work.

The bony part of the organ of hearing may be divided into four general parts: 1. The meatus auditorius externus; 2. The tympanum; 3. The labyrinth; 4. The meatus auditorius internus. It may likewiſe be divided into immoveable or containing parts, which take in all the four already mentioned; and moveable or contained parts, which are four little bones lodged in the tympanum, called *incus*, *malleus*, *ſtapes*, and *os orbiculare* or *lenticulare*.

The meatus externus at its outer end has its edges rough and prominent; but its back part is conſiderably depreſſed. The paſſage itſelf is ſomewhat more than half an inch in length, running obliquely from behind foreward in a curved direction. Its cavity is almoſt oval, but wider at each end than in the middle. It terminates inwardly by an even circular edge, lying in a plane very much inclined, the upper part of it being turned outward, and the inner part inward; ſo that the canal is longer on the lower than upper ſide. The circular edge is grooved quite round for the attachment of the membrana tympani.

In children, this bony canal is wanting, as well as the maſtoid proceſs; and the inner circular edge is a diſtinct ring, which, in an advanced age, unites entirely, and becomes one piece with the reſt. It is termed the *bony circle* in infants; and indeed it is very eaſily ſeparated from all the other parts.

It would ſeem, therefore, that the whole bony canal in adults is only a prolongation of the bony circle in children; becauſe, even in a more advanced age, the whole canal may without much difficulty be taken out. The circular groove lies between the maſtoid proceſs and the articular fiſſure mentioned in the deſcription of the other parts of the temporal bone.

Tympanum. The tympanum, or drum of the ear, is a cavity ſomewhat ſpherical, or rather hemiſpherical,

cal, the bottom of which is turned inward, and the mouth joined to the circular groove already mentioned.

The remarkable eminences are three in number: A large tuberosity, lying in the very bottom of the tympanum, a little toward the back part; and a small irregular pyramid, situated above the tuberosity, and a little more backward, the apex of which is perforated by a small hole: on one side of the basis two small bony filaments are often found in a parallel situation; and indeed it appears that they are seldom wanting, though their tender structure exposes them to be often broken. In the third eminence is a cavity situated at the upper and a little toward the anterior part of the bottom of the tympanum. This cavity is part of a half canal, which in a natural state has one of the muscles of the malleus lodged in it.

The principal cavities in the tympanum, are, The opening of the mastoid cells; the opening of the Eustachian tube; the bony half canal; the fenestra ovalis and rotunda; and to these may be added the small hole in the pyramid.

The opening of the mastoid cells is at the posterior and upper part of the edge of the tympanum. The cells themselves which end there are hollowed out in the substance of the mastoid process, being very irregular and full of windings and turnings.

The openings of the Eustachian tube is at the anterior and upper part of the edge of the tympanum. It runs from the tympanum toward the posterior openings of the nostrils and arch of the palate. The bony portion thereof, of which alone we here speak, is hollowed out in the pars petrosa, and is afterwards lengthened out by the spinal process of the os sphenoides.

The mastoid cells, and the Eustachian tube, from their situation, may be looked upon in some measure as prolongations of the tympanum.

The bony half canal lies immediately above the Euſtachian tube, toward the upper ſide of the pars petroſo. In the recent ſubject, one of the muſcles of the malleus is lodged in it,

The feneſtra ovalis is a hole of communication between the tympanum and labyrinth. It lies immediately above the tuberoſity; the upper ſide of it being a little rounded, the lower a little flattened, and has its longeſt diameter from before backwards. Toward the labyrinth, this opening has a little boarder round it, which renders it narrower at that place than any where elſe.

The feneſtra rotunda is ſomething leſs than the ovalis, and ſituated above it toward the lower and poſterior part of a large tuberoſity; the opening of it, which is the orifice of a particular duct in the labyrinth, lying obliquely backward and outward.

The hole in the apex of the pyramid is the orifice of a cavity, which may be named the *ſinus* of this pyramid.

Officula auditus. The tympanum contains ſeveral little bones, called the *bones of the ear.* They are generally four in number, demonſtrated from ſomething to which they are ſaid to bear a reſemblance, viz. incus, malleus, ſtapes, and os orbiculare or lenticulare.

Incus. The incus, or anvil, reſembles, in ſome meaſure, one of the anterior dentes molares, with its roots at a great diſtance from each other. It may be divided into a body, and two branches or legs; one of the legs is long, the other ſhort. The body is turned forward, the ſhort leg backward, and the long leg downward.

The body of the incus is broader than it is thick. It has two eminences, and two cavities between them, much in the ſame manner as we ſee in the crown of the firſt dentes molares.

The ſhort leg is thick at its origin; and from thence de-

decreasing gradually, it ends in a point. It is situated horizontally, its point being turned backward, and joined to the edge of the mastoid opening of the tympanum.

The long leg viewed through the external auditory passage appears to be situated vertically; but if we look upon it either on the fore or back side, we see it is inclined, the extremity of it being turned much more inward than the root or origin. The point of the extremity is a little flatted, bent inward like a hook, and sometimes a little hollowed like a kind of ear-picker. By this we may distinguish the incus of one ear from that of the other, when out of their places: for turning the short leg backward, and the long leg downward, if the curvature of this long leg be toward the left hand, the bone belongs to the right ear; if toward the right, it belongs to the left ear.

Malleus. The malleus, or hammer, is a long bone with a large head, a small neck, an handle, and two processes; one in the neck, the other in the handle.

The top of the head is considerably rounded; and from thence it contracts all the way to the neck. Both head and neck are in an inclined situation; and the eminences and cavities of it answer to those in the body of the incus. The handle is looked upon by some as one of the processes of the malleus; and in that case it is the greatest of the three. It forms an angle with the neck and head: near which it is something broad and flat, and decreases gradually toward its extremity.

The process of the handle, termed by others the *small* or *short process* of the malleus, terminates in the angle already mentioned, being extended toward the neck, and lying in a straight line with that side or border of the handle which is next it. The process of the neck, called also *processus gracilis*, is, in a natural state, very long; but so slender, that it is very easily broken,

eſpecially when dry; which is the reaſon why the true length of it was for a long time time unknown. It ariſes from the neck, and ſometimes appears much longer than it really is, by the addition of a ſmall dried tendon ſticking to it.

When the malleus is in its true ſituation, the head and neck are turned upward and inward; the handle downward, parallel to the long leg of the incus, but more forward; the proceſs of the handle upward and outward, near the ſuperior portion of the edge of the tympanum, near the centre of which is the extremity of the handle; and the proceſſus gracilis forward, reaching all the way to the articular fiſſure in the os temporis. It is eaſy, after what has been ſaid, to diſtinguiſh the malleus of the right ſide from that of the left.

Stapes. The ſtapes is a ſmall bone, very well denominated from the reſemblance it bears to a ſtirrup. It is divided into the head, legs, and baſis. The head is placed upon a ſhort flatted neck; the top of which is alſo ſometimes flat, ſometimes a little hollow.

The two legs, taken together, form an arch like that of a ſtirrup; in the concave ſide of which is a groove which runs through their whole length. One leg is longer, more bent, and a little broader than the other. The baſis reſembles that of a ſtirrup both in its oval ſhape and union with the legs, but it is not perforated. Round its circumference next the legs, is a little border, which makes that ſide of the baſis appear a little hollow. The other ſide is pretty ſmooth; and one half of the circumference is more curved than the other.

The ſubject being in an erect poſture, the ſtapes is to be conſidered as lying on its ſide, with the head turned outward near the extremity of the leg of the incus; the baſis being fixed in the feneſtra ovalis; the longeſt leg backward, and both legs in the ſame plane.

By

By this ſituation, it is eaſy to know the ſtapes belonging to each ear.

Os orbiculare. The os orbiculare, or lenticular *bone*, is the ſmalleſt bone in the body. It lies between the head of the ſtapes and extremity of the long leg of the incus, being articulated with each of theſe.

In dry bones it is found very cloſely connected, ſometimes to the ſtapes, ſometimes to the incus; and might, in that ſtate, be eaſily miſtaken for an epiphyſis of either of theſe bones.

Theſe four little bones appear to have been unknown to the Greek anatomiſts. It is difficult to ſay with certainty who has diſcovered them; but Veſalius is the firſt who has named the malleus and incus; Arantius or Sylvius, the os orbiculare; Ingratias is ſaid to have diſcovered the ſtapes.

Labyrinth. The labyrinth is divided into three parts; the anterior, middle and poſterior. The middle portion is termed *veſtibulum*, the anterior *cochlea*, and the poſterior *labyrinth in particular;* which comprehends the three ſemicircular canals.

The cochlea lies forward and inward toward the extremity of the pars petroſa; the ſemicircular canals backward and outward toward the baſis of the proceſs; and the veſtibulum between the other two.

Veſtibulum. The veſtibulum is an irregular round cavity, leſs than the tympanum, and ſituated more inward, and a little more forward. Theſe two cavities are in a manner ſet back to back, with a common partition between them, perforated in the middle by the feneſtra ovalis, by which the cavities communicate with each other. The cavity of the veſtibulum is likewiſe perforated by ſeveral other holes; on the back ſide by the five orifices of the ſemicircular canals; on the lower part of the fore ſide by a hole, which is one of the paſſages of the cochlea; and on the fore ſide, toward the meatus auditorius, oppoſite to the feneſtra ovalis, by a number of very ſmall holes, for the paſ-

ſage of the nerves; on the upper ſide there are only ſmall pores.

Semicircular canals. The ſemicircular canals are only three in number; one vertical, one oblique, and one horizontal; or by ſome they are called *vertical ſuperior*, *vertical poſterior*, and *horizontal* or *external*. The vertical canal is ſituated tranſverſely with reſpect to the pars petroſa, the convex ſide of it being turned upward. The oblique canal lies farther back than the former, and runs parallel to the length of the proceſs, the convex ſide being turned backward, with one extremity upward, the other downward: the ſuperior extremity of this canal meets and loſes itſelf in the internal extremity of the former.

The curvature and extremities of the horizontal canal are almoſt on a level; the curvature lying obliquely backward; and the extremities forward, and under thoſe of the vertical canal, but a little nearer each other, the inner being almoſt in the middle ſpace between the extremities of the oblique canal.

The horizontal canal is generally the leaſt of the three; the oblique is often, and the vertical ſometimes, the greateſt; and ſometimes theſe two are equal. All the three canals are larger than a ſemicircle, forming nearly three-fourths of one; they are broader at the orifices than in the middle. Theſe orifices open into the back-ſide of the veſtibulum, and are but five in number, becauſe two of them open into each other; ſo that in the poſterior part of the veſtibulum, two appear toward the inſide, and three toward the outſide.

In children, the ſubſtance of theſe canals is compact, while that which ſurrounds them is ſpongy. Hence they may be eaſily ſeparated from the reſt of the pars petroſa. In adults, all the parts of the bone are ſo ſolid, that theſe canals appear only like paſſages formed in a piece of ivory. From this deſcription, it is eaſy to diſtinguiſh the right labyrinth from the left.

Cochlea.

Cochlea. The cochlea is a ſort of ſpiral body with two ducts, formed in the anterior part of the pars petroſa, ſomewhat reſembling the ſhell of a ſnail. The parts to be diſtinguiſhed in it, in its true ſituation, are, The baſis; the apex; the ſpiral lamina, or half ſeptum, by which its cavity is divided into two half canals; the modiolus, round which the cochlea turns; and, laſtly, the orifices and union of the two ducts. The baſis is turned directly inward toward the internal foramen auditorium, the apex outward; and the axis of the modiolus is nearly horizontal; but in all of them allowance muſt be made for the obliquity of the pars petroſa in which they lie.

The baſis of the cochlea is gently hollowed; and, toward the middle, perforated by ſeveral ſmall holes. The modiolus is a kind of ſhort cone with a very large baſis, which is the middle of the baſis of the cochlea: through its whole length runs a double ſpiral groove, which, through a microſcope, ſhows a great number of pores. The cochlea makes about two turns and a half from the baſis to the apex; and the two half canals being firmly united together through their whole courſe, form a half ſeptum, called *lamina ſpiralis;* which muſt not be confounded with the complete ſeptum in the recent ſubject, as is often done. One edge of the lamina ſpiralis is ſtrongly joined to the modiolus, being thicker there than in any other place; whereas the other edge is terminated all round by a very thin border, lying in the middle cavity of the cochlea. In the natural ſtate, the other half of the ſeptum is membranous, and completes the partition between the two canals. The two half canals turn jointly about the modiolus; one being ſituated toward the baſis of the cochlea, the other toward the apex; for which reaſon we have always called one of them *internal*, the other *external.*

The ſpiral or volute of the cochlea begins at the lower part of the veſtibule; runs from thence forward

to the top, then backward down to the bottom, afterward upward and forward; and ſo on from the baſis, which is turned inward to the apex, which is turned outward. From this deſcription, it is eaſy to know to what ear any cochlea belongs when we ſee it prepared: it likewiſe teaches us, that, in the right cochlea, the direction of the turnings is the ſame as in garden-ſnails, and almoſt all the other common ſhells; but in the left cochlea, the turnings are in a contrary direction, as in one kind of ſhell, which is rarely met with. The two half canals communicate fully at the apex of the cochlea. Their ſeparate openings are toward the baſis; one of them being immediately into the lower part of the fore-ſide of the veſtibulum, the other into the feneſtra rotunda. Theſe two openings are ſeparated by a particular turning, which ſhall be deſcribed afterwards.

The *meatus auditorius internus*, is on the back-ſide of the pars petroſa, in ſome meaſure behind the veſtibule and baſis of the cochlea. It is a kind of blind hole, divided into two foſſulæ; one large, the other ſmall. The large one lies loweſt, and ſerves for the portio mollis of the auditory nerve or ſeventh pair. The ſmall one is uppermoſt, and is the opening of a ſmall duct, through which the portio dura of the ſame nerve paſſes. The inferior foſſula is full of little holes, which, in the natural ſtate, are filled with nervous filaments of the portio mollis, which go to the veſtibule, to the ſemicircular canals, and to thoſe of the cochlea. It is this foſſula which forms the ſhallow cavity at the baſis of the ſpindle of the cochlea. The paſſage for the portio dura of the auditory nerve runs behind the tympanum, and its external orifice is termed *foramen ſtylomaſtoideum*. It begins by the ſmall foſſula, and pierces from within outward the upper part of the pars petroſa, making there an angle or curvature; from thence it is inclined backward behind the ſmall pyramid of the tympanum, and runs down to the foramen ſtylomaſtoi-

maſtoideum; through which it goes out, and is diſtributed in the manner to be deſcribed hereafter. It communicates likewiſe by a hole with the ſinus of the pyramid, and lower down by another hole with the tympanum. At the upper part of the pars petroſa it is covered with a bony lamina, although ſometimes it has been found open above.

The ſoft parts of the internal ear are chiefly the membrana tympani, the perioſteum of the tympanum, and of the officula auditus, labyrinth, and of all its cavities, the membrana maſtoidæa interna, the muſcles of the officula, the parts which complete the formation of the Euſtachian tube, the arteries, veins, and nerves. We are, however, under a neceſſity of beginning by the tuba Euſtachiana, for two reaſons: firſt, becauſe the bony parts of that tube are but of very ſmall uſe for the knowledge of its whole ſtructure and compoſition; and, ſecondly, becauſe we are obliged to mention it in deſcribing the muſcles.

The *ductus auris palatinus*, or Euſtachian tube, as was obſerved in the deſcription of the ſkeleton, is a canal or duct which goes from the tympanum to the poſterior openings of the nares, or naſal foſſæ, and toward the arch of the palate; it is dug in the apophyſis petroſa along the carotid canal, and it is lengthened out by the ſpinal apophyſis of the os ſphenoidale.

In its natural ſtate, this duct reaches from the cavity of the tympanum to the root or ſuperior part of the internal ala of the apophyſis pterygoides; and through this whole courſe it is made up of two portions, one entirely bony, and the other partly bony, partly cartilaginous, and partly membranous.

The bony portion lies through its whole length immediately above the fiſſure of the glenoide or articular cavity of the os temporis, and terminates at the meeting of the ſpinal apophyſis of the os ſphenoides with the pars petroſa of the os temporis.

The

The other or mixed portion reaches in the ſame direction from this place to the internal ala of the apophyſis pterygoides, or to the poſterior and outer edge of the nares. But to form a more exact idea of it, it will be proper to conſider it as divided into four parts, two ſuperior and two inferior.

The two upper parts or quarters are bony; and of theſe the innermoſt is formed by the ſide of the apophyſis petroſa, the outermoſt by the ſide of the apophyſis ſpinalis of the os ſphenoides. Of the two inferior parts, the internal, or that next the os ſphenoides, is cartilaginous; and the external, or that next the pars petroſa, membranous.

The Euſtachian tube thus formed, is very narrow next the ear, but grows gradually wider, eſpecially near the poſterior nares, where the inner cartilaginous ſide terminates by a prominent edge, and the outer ſide joins that of the neighbouring noſtril. The cavity of the tube is lined by a membrane like that of the internal nares, of which it appears to be a continuation; and on the prominent edge, this membrane is conſiderably increaſed in thickneſs, repreſenting a kind of half pad.

The ſituation of the two tubes is oblique, their poſterior extremities at the ears being at a greater diſtance than the anterior at the nares; and the convex ſides of the prominent edges are turned toward each other. The openings of the tubes are oval at this place; as is likewiſe their whole cavity, eſpecially that of the mixed portion.

The membrana tympani is a thin, tranſparent, flattiſh pellicle; the edge of which is round, and ſtrongly fixed in the orbicular groove which divides the bony meatus of the external ear from the tympanum or barrel. This membrane is very much ſtretched or very tenſe, and yet not perfectly flat: for on the ſide next the meatus externus it has a ſmall hollowneſs, which is pointed on the

the middle; and on the ſide next the tympanum, it is gently convex, and alſo pointed in the middle.

This membrane is ſituated obliquely, the upper part of its circumference being turned outward, and the lower part inward, ſuitably to the direction of the bony groove already mentioned. It is made up of ſeveral very fine laminæ, cloſely united together. The external lamina is in ſome meaſure a production of the ſkin and cuticula of the external meatus; for they may be pulled at the ſame time like the finger of a glove. The internal lamina is a continuation of the perioſteum of the tympanum; and when the membrane has been firſt macerated in water, each of theſe lamina may be ſubdivided into ſeveral others. In very young children, this membrane is covered on the outſide by a thick mucilaginous web.

The depreſſion in the middle of the membrana tympani, is cauſed by the adheſion of the malleus; the handle of which is cloſely joined to the inſide of the membrane, from the upper part of the circumference all the way to the centre, to which the end of the handle is fixed. This handle ſeems to lie in a very fine membranous duplicature; by means of which it is tied to the membrana tympani, and which ſerves it for a perioſteum. The malleus is accompanied with blood-veſſels, which run in a radiated manner from the centre to the circumference of the membrane; but theſe are beſt ſeen in the fœtus.

The perioſteum of the tympanum, or barrel of the ear, produces that of the ſmall bones; and it may be made viſible by means of anatomical injections, which diſcover capillary veſſels very diſtinctly ramified on the ſurface of the oſſicula. It is likewiſe continued over the two feneſtræ, and enters the Euſtachian tube, where it is loſt in the inner membrane of that duct.

The cellulæ maſtoidæi are very irregular cavities in the ſubſtance of the maſtoide apophyſis, which communicate

municate with each other, and have a common opening towards the inside, and a little above the posterior edge of the orbicular groove. These cells are lined by a fine membrane; which is partly a continuation of the periosteum of the tympanum, and partly seems to be of a follicular structure like a kind of membrana pituitaria. The mastoide opening is opposite to the small opening of the Eustachian tube, but a little higher.

The ligaments of the officula may be looked upon as continuations of the periosteum. The incus is tied by a strong short ligament fixed in the point of the short leg to the edge of the mastoide opening. Between the incus and malleus we find a small thin cartilage. The malleus is connected through the whole length of its handle to the inside of the membrana tympani, in the manner already said.

The malleus has two little muscles, one anterior, and one internal; and the stapes has one muscle. *See* Innes on the muscles.

The internal muscle of the malleus, called *tensor tympani*, is very fleshy and distinct. It lies along the inside of the Eustachian tube, and is inserted in the neck of the malleus above the small apophysis, advancing likewise as far as the handle. Vesalus first observed, and afterwards Eustachius more particularly described, this muscle.

The anterior muscle of the malleus, called, from its use, *laxator tympani*, is said by some to be fleshy, long, and thin. It runs along the outside of the Eustachian tube, to which it adheres very closely through its whole length, and is inserted in the long thin apophysis of the malleus. It is partly accompanied by a nerve, which forms what is called the *chorda tympani*, as we shall see hereafter. Haller denies the existence of muscular fibres in this substance. Sabatier describes it; but doubts if it be really muscular. Cæcilius Folius is said to have been the discoverer.

A third muscle has by some been described under the

the name of *external* or *ſuperior muſcle of the malleus*; but this is much leſs diſtinct than thoſe already mentioned. It is ſaid to ariſe from the internal ſuperior and poſterior part of the meatus externus, and to be fixed by a ſmall tendon to the neck of the malleus. Neither Haller nor Sebatier have been able to diſcover muſcular fibres in it. Caſſerius firſt deſcribed it.

The muſcle of the ſtapes is ſhort and thick, and lies concealed within the ſmall bony pyramid at the bottom of the tympanum. It runs forward to be inſerted in the neck of the ſtapes on the ſide of the longeſt and moſt crooked leg of that bone.

The three parts of the labyrinth, that is, the veſtibulum, ſemicircular canals, and cochlea, are lined by a fine perioſteum, which is continued over all the ſides of their cavities, and ſhuts the two feneſtræ of the tympanum. Upon this the veſſels and nerves are diſperſed.

The ſemicircular canals are ſimply lined by a perioſteum adhering to their inner ſurfaces without any particular membranous bands. The two half-canals of the cochlea are lined in this manner; the perioſteum of the two ſides of the bony ſpiral lamina advances beyond the edge of that lamina, and forms a membranous duplicature, which extending to the oppoſite ſide completes the ſpiral ſeptum.

The ſeptum ſeparates the two half canals from the baſis to the apex; but there it leaves a ſmall opening, by which the ſmall extremities of the half canals communicate with each other. The large extremity of the external half-canal ends by an oblique turn in the feneſtra rotunda, which is ſhut by a continuation of the perioſteum of that canal. The large extremity of the other half-canal opens into the veſtibulum; and theſe two extremities are entirely ſeparated by a continuation of the perioſteum.

The whole internal cavity of the labyrinth is filled with a watery fluid ſecreted from the veſſels, which are diſperſed

diſperſed upon the perioſteum. This fluid tranſmits to the nerves the vibrations it receives from the membrane ſituated between the tympanum and labyrinth.

The ſuperfluous part of this fluid is ſuppoſed to paſs off through two ſmall canals called the *aquæducts of Cotunnius*, from the diſcoverer, an ingenious phyſician at Naples. One of theſe ducts is ſent off from the cochlea, at the under part of the ſcala tympani, near the feneſtra rotunda; it terminates by a pretty wide triangular opening within the cranium, under the meatus internus. The beginning of this duct was known to Duverney, Caſſebohm, and Morgagni; but they conſidered it as a paſſage for an artery and a vein. It is lined internally with the dura mater, which is connected with the perioſteum of the cochlea. The other duct goes off under the termination of the common canal in the veſtible. The orifice of this was firſt diſcovered by Caſſebohm, and afterwards by Morgagni, who has deſcribed it; but is unacquainted with its uſe. From this place the duct aſcends, and terminates by a triangular opening between the layers of the dura mater, at the back part of the pars petroſa, under the middle of its upper edge. It is alſo lined by a production of the dura mater, which may be traced to the veſtible. For a full account of the above, ſee an excellent Diſſertation by Dr Meckel of Berlin.

All the perioſteum of the internal ear, eſpecially that of the óſſicula and tympanum, is in children no more than a mucilage; and in them likewiſe the membrana tympani is thick, opaque, and covered with a whitiſh, ſlimy mater.

Through the whole extent of the perioſteum of the internal ear, eſpecially on that of the oſſicula, ſemicircular canals, and half-canals of the cochlea, we diſcover a vaſt number of blood-veſſels, not only by anatomical injections, but in inflammations, and even without the help of a microſcope. The arteries come partly from the internal and external carotids, and partly from the arteria baſilaris, which is a continuation of the verte-

bralis,

bralis, the ſmall capillary ramifications of which may be obſerved to accompany the auditory nerve through the internal foramen auditorium, from whence the fluid is ſuppoſed to be abſorbed. Two veins carry the principal part of the blood from the labyrinth; one goes off from the cochlea, near its aqueduct, and ends in the lateral ſinus; the other lies near the aqueduct of the veſtibule, and carries the blood from that cavity, and from the ſemicircular canals, into the beginning of the internal jugular vein, by a triangular opening.

The portio mollis of the auditory nerve ends, by its trunk, at the great foſſula of the internal auditory hole, from whence the filaments paſs through ſeveral ſmall holes in the baſis of the cochlea, to be diſtributed thro' the cochlea, the veſtibule, and the ſemicircular canals. *See* Monro on the Nervous Syſtem, Tab. XXIX. XXX. XXXI.

The portio dura runs firſt of all into the ſmall foſſula of the foramen auditorium internum, then paſſes through the whole bony duct called *aquæductus Fallopii*, and comes out again through the ſtylo-maſtoide hole of the os temporis. In this courſe it communicates with the dura mater on the upper or anterior ſide of the apophyſis petroſa, at the place where the bony duct is interrupted.

Having reached behind the ſmall pyramid in the bottom of the tympanum, this nerve ſends a ſmall filament to the muſcle of the ſtapes; and a little before it goes out by the ſtylo-maſtoide hole, it gives off another more conſiderable filament, which enters the tympanum from behind forward, paſſes between the long leg of the incus and handle of the malleus, and afterwards runs croſs the whole breadth of the tympanum a little obliquely, and goes out at the ſame place at which the tendon of the anterior muſcle of the malleus enters.

This ſmall nerve is generally called *chorda tympani*, becauſe in its paſſage through the tympanum it has been compared to the cord of a drum. Having left the cavity of the internal ear, it advances toward one ſide of the

the baſis of the tongue, where having joined the nervus lingualis of the fifth pair, it is conſidered as a kind of recurrent; but the remaining part of its courſe muſt be referred to the deſcription of the tongue.

The portio dura of the auditory nerve having paſſed through the foramen ſtylo-maſtoideum, is diſtributed in the manner to be afterwards mentioned in the deſcription of the nerves; and we ought very carefully to obſerve its different communications with the branches and rami of the nerves of the fifth pair, with the ſympatheticus medius or eighth pair, with the ſecond pair of cervical nerves, and with the nervi ſub-occipitales or tenth pair of the medulla oblongata, &c.

Hearing. As the ſenſe of hearing perceives the elaſtic tremors or impulſions of the air, ſo we obſerve the ſenſitive organ of the ear to be compoſed in a different manner from that of any of the other ſenſes; as it is made up for the moſt part either of hard bones or elaſtic cartilages and membranes, which are the moſt exquiſitely enabled to receive and communicate the neceſſary tremors.

The external parts of this organ, called the *auricle* or *outer ear*, is a cartilaginous funnel connected; but with a ſort of mobility before and behind, to the bones of the temple, by means of a ſtrong cellular plate, and likewiſe by its own proper ligaments and muſcles; but the mobility of this part is diminiſhed by cuſtom. This cartilage is of a very compound figure; in general of a kind of oval figure, yet marked with ſpirals ſtanding up, and hollows interpoſed, to which other hollows and ridges correſpond in the oppoſite ſurface.

This whole cartilaginous body of the outer ear is only ſurrounded by a thin ſkin, and an empty cellular ſubſtance; it is repleniſhed with many ſebaceous glandules, which ſupply an ointment. This part is governed or directed by certain muſcles, which generally loſe their uſe and action, from the cuſtom of binding the head in children, which we are otherwiſe to ſuppoſe

they were designed by nature to perform. And they act likewise upon the concha; the cavity of which they doubtless are designed to open or enlarge.

To the concha is connected the *meatus auditorius*, and through the auditory passage are continued the cuticle and true skin, gradually extenuated and exactly stretched over the surface of the bone, by which it is rendered extremely sensible of any itching pleasure or pain; and, being replenished with irritable hairs, is by them admonished of any sordes or wax abounding, and guarding from the entrance of small insects. But under the skin are seated the glandulæ ceruminosæ, which pour out their contents by short ducts into the cavity of the auditory passage; at first of an oily consistence, but afterwards it becomes more thick, bitter, and inflammable like wax. This liniment defends the sensible skin and membrane of the tympanum from injuries of the air, and keeps out or catches any small insects; but, when accumulated in too great abundance in those who are slothful or uncleanly, it may be the cause of deafness, or a difficulty of hearing.

Into this funnel of the ear the sonorous waves of the air flow, which, from principles of mechanics, it must of course collect together. The elastic air only receives sonorous tremors or impulsions; and transfers them, either alone or principally, much after the same manner as we see water, without air, transfer any impulse that is given to it; for that water conveys sound, and seemingly nearly in the same time as the atmosphere, is proved by different experiments. (*See* Monro on the structure and physiology of fishes.) The sound is increased in air that is condensed, and is lost in a vessel emptied of its air. But the medium receives these tremors, either from some body striking against it, or from the air itself colliding against another body, or lastly from the collision of two bodies against each other in the air. But the body which produces sound ought to tremble or vibrate in all, even the least of its particles,

ſo as to form alternate arches riſing up from the former ſtraight ſurface, and returning beyond the ſame; the curve line of the ſame exceeding that of the ſounding body. From ſuch a tremor, the contiguous air is beat into waves, whereby the parts of the air that lie outermoſt are compreſſed and fly back again as ſoon as their elaſticity gets over the impulſe; whence the air flies again towards the ſonorous body, where it is now more looſe and rarefied, to be there again compreſſed by impulſion; and in the ſame manner the anterior and outer portion of air, ſurrounding that which is impelled, is, by the action of the latter, compreſſed and removed farther from the trembling body, yet ſo as to return again in its proper time by the force of elaſticity, driving its contents to the tremulous body for the exciting of a new wave. Theſe oſcillations or impulſions of the air are required to ſucceed each other with a certain velocity; and, in order to render them audible, they muſt not be fewer than 30 in a ſecond of time.

Acute ſounds are, in general, yielded from bodies that are hard, brittle, and violently ſhook or ſtruck; but grave ſounds are from the contrary. Thoſe ſounds in general are called *acute*, which are produced from more numerous tremors in an equal time; and thoſe *obtuſe*, which are produced from few tremors. As to any medium betwixt acute and grave ſounds, there is none but what is arbitrary. Cords, or other bodies, that yield the ſame number of vibrations in a given time, are ſaid to be *uniſon;* as thoſe which make double the number of oſcillations in that time, are ſaid to yield a tone that is an octave or eight notes higher; and other proportions betwixt the numbers of the vibrations have different names aſſigned to them. The ſhorter cords produce ſharper tones, and the reverſe, in a proportion directly as their lengths; as thoſe which are more ſtretched afford ſharper ſounds in a ſubduplicate proportion to their tenuity, or to the weights or powers by which they are ſtretched. Experiments to this purpoſe

poſe are very eaſily made with a monochord, or a ſeries of cords ſtretched with weights.

The ſound, thus produced, whether acute or grave, ſtrong or weak, is carried through the air with a celerity equal to about 1142 feet in a ſecond, or near 13 miles in a minute; and that with an uniform velocity, without abating in the larger diſtances. But a contrary wind, cauſing the vibrations to extend more ſlowly, retards the progreſſion of ſound about 1-12th of its velocity. So likewiſe denſity and dryneſs of the air increaſe the ſound, as a rarefaction and moiſture of the air leſſen it. Hence, in ſummer time, ſounds move ſwifter; and in Guinea, it has been obſerved to paſs at the rate of 1098 Pariſian feet in one ſecond of time.

The ſound, thus every way extended, meets with certain particles in all adjacent bodies, even in water and mercury, to which it communicates ſimilar tremors or vibrations, not only ſuch as are in uniſon with the original tone, and which yield a ſound in a more particular manner ſenſible; but alſo it excites tremors leſs ſenſibly, even in the other parts of bodies, which vibrate in the various proportions of the ſcale. From hence it is, that every ſound which we hear, is a mixture of the original tone, produced by the trembling body, in conjunction with ſecondary tones generated from the elaſtic tremors of the ſurrounding bodies. The ſtrength of ſound is increaſed, if one audible or primary tone follows the other ſo cloſely, that their ſucceſſion cannot be diſtinguiſhed by the ear; but if they follow each other ſo ſlowly as to be diſtinguiſhable by the ear, they produce an echo; but to produce this requires an interval of ſix thirds of a ſecond of time, or the diſtance of 55 feet betwixt the reflecting or echoing body and the ear.

Sounds, being elaſtic, are reflected from hard bodies in angles equal to thoſe of their incidence. But the ſame ſound, uſhered into the open air, and dilating through an immenſe ſphere, grows proportionably

weaker: but if it be uſhered through a tube, in a cylindrical ſhape, the ſtrength of it is more confined together; or elſe, by being collected into the focus of a parabola or ellipſis, it becomes increaſed, as we obſerve in ſpeaking-trumpets, from which the voice goes out parallel to the focus of the parabola, without ſcattering the ſonorous rays.

Therefore the ſonorous waves of the elaſtic air, being driven into the cartilaginous funnel of our ear, which is naturally inclined forward and outward in an high ſituation, are repelled and collected together, by alternate reflections from its elaſtic ſides, into the cavity of the concha, from whence it proceeds through the auditory, with a force ſo much ſtronger as the ſurface of the outer ear is larger than the light or ſection of the auditory paſſage. Through this paſſage, however cylindrical, the ſame force is continued entire forward, and increaſed by new reſonances, excited from the percuſſion of the laſtic cartilages and hard bones, ſo as to mix imperceptibly with the primitive ſound.

Moreover, the bottom or end of the ſaid auditory paſſage is terminated internally by the *membrana tympani*; which Dr Haller ſays is not naturally perforated with any opening, as far as he has been able to diſcover; and that the tranſmiſſion of ſmoke is fabulous. Authors in general agree with him now in the former of theſe opinions; but that an accidental opening has ſometimes happened, and that the ſmoke of tobacco has been blown through it during life, is certain. Upon the ſurface of this membrane, and more eſpecially upon its conical cavity pointing inward, the ſonorous waves ſtrike, after they have received their laſt reflections from the auditory paſſage, by which the elaſtic fabric of this membrane is forced into oſcillation.

The membrane is ſtretched over the *tympanum*; which contains the little bones to which the ſmall muſcles of the internal ear are fixed. By means of the tenſor of the malleus, the membrane of the tympanum is diſpoſed for the hearing of weak ſounds; as the

the other muſcle ſerves to moderate in too violent ſounds, by drawing the malleus from the incus; by which therefore the propagation of the ſonorous tremors is interrupted. If the membrane of the tympanum be broke, or the bones of hearing diſlocated, the perſon becomes at firſt hard of hearing, and afterwards, ſays Dr Haller, perfectly deaf. There have been inſtances, however, where the membrana tympani has been partly deſtroyed, and yet the perſon has retained the ſenſe of hearing, though leſs diſtinctly than before.

The malleus returns the tremors impreſſed upon the membrane of the tympanum to the incus, which ſends it inwards to the next bones.

The *ſtapes*, aptly enough ſo called from its figure, lies inclined, and is covered by its own muſcle, which ſeems to draw the ſtapes, that it may lie higher up, under the back part of the feneſtra ovalis, and paſs out of it before. Thus the nervous pulp of the veſtibulum is preſſed by the baſis of the ſtapes, and by the air of the tympanum, and the *Euſtachian tube*, by the action of the circumjacent muſcles, may be compreſſed and cloſed, and probably a little relaxed and opened again, by the circumflex muſcle of the moveable palate. By this canal the inſpired air enters into the tympanum to be changed or renewed, and the ſurrounding mucus of the little bones and other parts are this way depoſited: nor is it at all improbable, that the air enters by this tube, to ſupport the tympanum when it is preſſed inward by the more violent ſounds; for ſounds themſelves, received into the mouth, are this way conveyed to the organ of hearing. In inſpiration, the air preſſes the membrane of the tympanum outward: and from thence proceeds that claſhing or whiſpering noiſe, by which the hearing is obſcured, when the mouth is held wide open in yawning; for then the air entering more abundantly through the cavity of the tube, to the tympanum, reſiſts the tremors of the external air.

With reſpect to the nerve which is diſtributed thro'

the veſtibulum and ſemicircular canals, there is no doubt but it is ſtruck by the tremors of the external air, propagated to the ſtapes; from whence the tremors immediately paſs through the oval feneſtra, to preſs upon the naked pulp of the nerve; and it is probable, that the ſpiral plate of the cochlea, ſpread full of nerves, is agitated with tremors from the oſcillations of the membrane of the tympanum, by which the air in the cavity of the tympanum is agitated, ſo as to preſs the membrane of the round feneſtra, which again agitates the air contained in the cochlea.

The preceding conjecture is plauſible; ſince the ſpiral plates make up a triangle, ending in a ſhort point towards the tip, by which it may be conceived to contain an infinite number of nervous cords, continually ſhortening in their length; and by that means adapted to an harmonical uniſon or conſonance, according to the variety of acute and grave ſounds, ſo as to tremble together at the ſame time with moſt of them; namely, the longeſt cords in the baſis of the cochlea with grave ſounds; and the ſhorteſt cords nearer the tip or apex, with the ſharper ſounds. Whether are ſounds perceived in the middle ſemicircular canals, when theſe alone are found in all claſſes of animals? Are they detained in theſe canals, in the cochlea, and by the membrane ſuſpended through the veſtibulum? This ſeems probably the caſe.

From what has been ſaid, it appears, that the elaſtic waves or tremors of the air arrive through the outer ear and auditory paſſage, to the membrane of the tympanum; which being injured, and not repaired, the hearing is in a great meaſure deſtroyed. This ſeems to be ſtretched, for hearing weak ſounds, by the muſcles of the malleus. From this membrane the ſound is conveyed through the ſmall bones to the veſtibulum; for theſe bones being deſtroyed, the hearing is again aboliſhed. The bony ſides of the veſtibulum, by their tremulation, agitate the ſmall quantity of aqueous fluid ſurrounding

ſurrounding the nervous pulp. It ſeems to be ſtruck by the nervous pulp ſuſpended in the veſtibulum, and that tremor to be continued through the continuous pulp of the cochlea and ſemicircular canals. Of more than this we are not certain: but, by undoubted experiments, tremors, and even elaſtic ſounds, communicate themſelves by the internal Euſtachian tube, and through all the bones of the ſkull, ſo as to impreſs their force upon the auditory nerve.

The diſtinction of ſounds, doubtleſs, proceeds from the celerity of the tremors excited in the hearing nerve, according as they ſucceed each other more ſwiftly or ſlowly, in a ſhort time; in order to which it is not neceſſary the mind ſhould number them; it is ſufficient that ſhe perceive their numbers to be different, and that this difference excites a variation in her thoughts and ideas thence ariſing. Whether the harmony or agreeableneſs of ſounds ariſes from the number of parts ſounding together in uniſon? and whether the mind, ignorant of herſelf, numbers the degrees of conſonance, ſo as to pleaſe herſelf in a majority of them? theſe are queſtions denied by the moſt expert muſicians, who make it appear, that there is an agreeableneſs, and that very conſiderable, in ſounds approaching the leaſt to a conſonance, and which lies in a proportion very difficult to determine. Why do ſounds often become too ſharp for the the ear? Our auditory nerves ſeem to be ſtrained upon the ſpiral plates, in ſuch degrees as to be in danger of breaking, after the manner drinking-glaſſes may be broke by ſharp ſounds, and as the hearing is ſometimes almoſt loſt for a while by the violently ſhrill whiſtlings of the inhabitants of the Canary iſlands.

Sect. V. *The* Mouth, &c.

Introduction. The word *mouth* may have two ſignifications: for, firſt, it means the tranſverſe ſlit between

the noſe and chin, formed by the lips; and, ſecondly, it expreſſes the internal cavity, of which this tranſverſe ſlit is the external opening. For this reaſon the mouth may be diſtinguiſhed into external and internal; and the parts of which it conſiſts may likewiſe come under the ſame two general heads. The bony parts are the oſſa maxillaria, oſſa palati, maxilla inferior, and the teeth: to theſe we may add the os hyoides, and the upper vertebræ of the neck.

The external parts of the mouth are, The two lips, one upper, the other under; the borders or red parts of the lips; the corners or commiſſures of the lips; the foſſula of the upper lip, the baſis of the under lip; the chin; the baſis of the chin; the ſkin; the beard; and even the cheeks, as being the lateral parts of the mouth in general, and of the lips in particular.

The internal parts of the mouth are, The gums palate, ſeptum palati, uvula, amygdalæ, the tongue, the membrane which lines the whole cavity of the mouth, the ſalival ducts and glands, and the bottom of the mouth. We might likewiſe reckon among the internal parts of the mouth, all the muſcles that have any relation to it, as thoſe of the lips, of the tongue, of the uvula, of the ſeptum palati, &c. and to theſe might be added the muſcles of the lower jaw, and of the os hyoides.

§ 1. *The Cheeks, Lips, and Gums.*

The cheeks and lips form the ſides and entry of the cavity of the mouth. They are formed in general by the connection of ſeveral fleſhy portions of different breadths, fixed round the convex ſides of the two jaws, covered on the outſide with the ſkin and fat, and lined on the inſide by a glandulous membrane. Beſides all this, the lips ſeem likewiſe to have a ſoft ſpongy ſubſtance in their compoſition, which ſwells and ſubſides on certain occaſions, independently of the action of the

the muſcles belonging to them, and is mixed with fat.

The ſubſtance which forms the red border of the lips is very different from the reſt of the ſkin, being a collection of very fine, long, villous papillæ, cloſely connected together, and covered by a fine membrane, which ſeems to be both a continuation of the epidermis, and of that pellicle which covers the glandulous membrane of the cavity of the mouth. This ſubſtance is extremely ſenſible, and very painful when the outer membrane is by any accident deſtroyed, The internal membrane of the upper lip forms a ſmall middle frænum above the firſt dentes inciſorii.

The gums are that reddiſh ſubſtance which covers the two ſides of the whole alveolary border of both jaws, inſinuates itſelf between all the teeth, ſurrounds the collar of each tooth in particular, and adheres very ſtrongly to them. Therefore the outer and inner gums are continuous, and both together form juſt as many openings as there are teeth.

The ſubſtance of the gums is of a very ſingular ſtructure, reſembling, in ſome meaſure, the texture of a hat, ſuppoſed to be very compact and elaſtic. It is not immediately fixed to the bones of the jaws, but by the intervention of the perioſteum, with which it is perfectly united; and it is covered by a fine ſtrong even membrane, which ſticks very cloſe to the ſubſtance of the gums; and ſeems to be a continuation of that thin membrane which goes to the lips and cheeks, and of that which goes to the tongue.

The arteries which go to the lips, cheeks, and gums, are ramifications of the external carotid, and chiefly of thoſe branches called *maxillares externæ et internæ*. The veins are ramifications of the external jugular.

The nerves of theſe parts come from the maxillaris ſuperior and inferior, which are branches of the fifth pair; and alſo from the portio dura of the auditory nerve,

nerve, or ſympatheticus minimus; the ramifications of which are ſpread in great numbers on all theſe parts, and communicate in a pretty ſingular manner with the nerves of the fifth pair in ſeveral places, as may be ſeen in the Deſcription of the Nerves.

The muſcles of the lips are commonly divided into common and proper. The common muſcles are thoſe which end at the angles or commiſſures of the two lips; and thoſe are proper which are fixed in one lip only; which are again ſubdivided into the proper muſcles of the upper lip, and proper muſcles of the under lip. All theſe muſcles have particular names; ſome of which are taken from ſomething in the conformation of the muſcles, ſome from the inſertions or ſituation, and ſome from the uſes attributed to them, as has been already deſcribed.

The muſcles may be enumerated in the following order: Levator anguli oris; levator labii ſuperioris, alæque naſi; depreſſor labii ſuperioris, alæque naſi; depreſſor anguli oris; depreſſor labii inferioris; levator labii inferioris; buccinator; zygomaticus major; zygomaticus minor, orbicularis oris. *See* Vol. I.

The common muſcles of the lips either draw both corners of the mouth at once, or only one at a time, according to the different direction of their fibres. The proper muſcles pull the different parts of the lips in which they are inſerted. The buccinators in particular may ſerve to move the food in maſtication. An entire treatiſe might be written on the almoſt innumerable combinations of the different motions of all theſe muſcles, according to the different paſſions, and according to the different poſtures in which a man may put his face. None are more affecting than thoſe produced by the cutanei alone, eſpecially in weeping, which they do by their adheſions to the depreſſors of the corners of the mouth, &c. But by their inſertions in the bone of the lower jaw, they draw up the lower part of the integuments of the neck, and thoſe of the breaſt

breaſt next to theſe; for they cannot move the jaw. In old people, and in thoſe who are very much emaciated, theſe muſcles may be perceived by the eye, under the chin, and on the neck.

§ 2. *The Palate, Uvula, &c.*

THE palate is that arch or cavity of the mouth, ſurrounded anteriorly by the aleveolary edge and teeth of the upper jaw, and reaching from thence to the great opening of the pharynx. The arch is partly ſolid and immoveable, and partly ſoft and moveable. The ſolid portion is that which is bounded by the teeth, being formed by the two oſſa maxillaria and two oſſa palati. The ſoft portion lies behind the other, and runs backward like a veil fixed to the edge of the oſſa palati, being formed partly by the common membrane of the whole arch, and partly by ſeveral muſcular faſciculi, &c.

The membrane that covers all this cavity is continued with the membrane of the nares upon the inner ſurface of the pharynx. It is very thick ſet with ſmall glands, known under the name of *palatine*, the orifices of which are not ſo ſenſible as in the pharynx, and eſpecially in the rugæ of the ſuperior portion thereof, where M. Heiſter obſerved a conſiderable orifice, and a canal proportioned to that orifice, which he could eaſily inflate with air. Small ducts of the ſame kind with what has now been mentioned, may be ſuppoſed to lie along the middle line or raphe of the arch of the palate, and along the alveolary edge, becauſe of ſome ſmall tubercles or points which appear there.

This membrane, together with that of the poſterior nares, forms, by an uninterrupted continuation, the anterior and poſterior ſurface of the ſoft portion of the palate or velum palati, ſo that the muſcular faſciculi of this

this portion lie in the duplicature of a glandulous membrane.

The velum or valvula palati, terminates below by a loose floating edge, representing an arch situated transversely above the basis or root of the tongue. The highest portion or top of this arch sustains a small, soft, and irregularly conical glandular body, fixed by its basis to the arch, and its apex hanging down without adhering to any thing, which is called *uvula*.

On each side of the uvula there are two muscular half arches, called *columnæ septi palati*. They are all joined to the uvula by their upper extremities, and disposed in such a manner as that the lower extremities of the two which lie on the same side, are at a little distance from each other, and so as that one half arch is anterior, the other posterior, an oblong triangular space being left between them, the apex of which is turned toward the basis of the uvula.

The two half arches on one side, by joining the like half arches on the other side, form the entire arch of the edge of the septum. The posterior half-arches run by their upper extremities, more directly toward the uvula than the anterior. The anterior half-arches have a continuation with the sides of the basis of the tongue, and the posterior with the sides of the pharynx. At the lower part of the space left between the lateral half-arches on the same side, two glands are situated, termed *amygdalæ*, which shall be described hereafter, together with the glandular structure of the uvula, among the other glands of the mouth.

The half-arches are chiefly made up of several flat fleshy portions, almost in the same manner with the body of the septum. The membrane which covers them is thinner than the other parts of it towards the palate, pharynx, and tongue. Each portion is a distinct muscle, the greatest part of which terminates by one extremity in the substance of the septum and of the

the half-arches, and by the other extremity in parts different from theſe.

As anatomiſts uſed formerly to aſcribe all theſe muſcles, as far as they knew them, to the uvula, without any regard to the ſeptum, they termed them in general either *ptery-ſtaphylini*, or *peri-ſtaphylini*. The laſt part of theſe two compound words expreſſes the uvula: the firſt part of the firſt word is an abridgement of ptery-goides, and expreſſes the inſertion of theſe muſcles; but the firſt part of the ſecond word ſignifies no more than round, or about, &c.

We might make uſe of the term *peri-ſtaphylinus* as a general denomination for the muſcles belonging to the ſeptum, and then add the other terms, of which theſe names have been made up by modern writers. But the reader will find it more agreeable to uſe the names expreſſed in the treatiſe on the muſcles already deſcribed.

Of the muſcles of the palati we have found the conſtrictores iſthmi, faucium, palato phyryngei, tenſores palati, levatores palati, and azygos uvuvæ.

The ſeptum palati ſerves to conduct the lacrymal lymph, and that which is continually collected on the arch of the palate, into the pharynx. It ſerves for a valve to hinder what we ſwallow, and eſpecially what we drink, from returning from the nares.

§ 3. *The Tongue.*

Every one knows, that the tongue is a ſoft fleſhy body, which fills all that part of the cavity of the mouth that is ſurrounded by the alveolary border and teeth of the lower jaw, and extends ſtill farther back. All this ſpace is therefore in a manner the mould and meaſure of the length and breadth of the tongue, as well as of its thickneſs and figure.

The tongue is divided into the baſis and point; the upper and under ſides; and the lateral portions, or edges

edges. The baſis is the poſterior and thickeſt part; the point, the anterior and thinneſt part. The upper ſide is not quite flat, but a little convex; and divided into two lateral halves, by a ſhallow depreſſed line, called *linea linguæ mediana*. The edges are thinner than the other parts, and a little rounded as well as the point. The lower ſide reaches only from the middle of the length of the tongue to the point.

The tongue is principally compoſed of very ſoft fleſhy fibres, intermixed with a particular medullary ſubſtance, and diſpoſed in various manners. Many of theſe fibres are confined to the tongue without going any farther; the reſt form ſeparate muſcles which go out from it in different ways, and are inſerted in other parts. All the upper ſide of the tongue is covered by a thick membrane of a papillary texture, upon which lies another very fine membrane like a kind of epidermis, which is likewiſe continued over the lower ſide, but without papillæ. Under the epidermis, on the ſurface of the tongue, we find the corpus mucoſum thicker but more moiſt than in other parts of the body. This diſpoſition ſeems neceſſary to protect the tender papillæ, which are the organs of taſte. In brute animals a perforated mucous net-work receive the papillæ, which are in a manner wrapped up in capſules of this mucous body covered with the cuticle.

Three ſorts of papillæ may be diſtinguiſhed in the upper ſide of the tongue; capitatæ, ſemi-lenticulares, and villoſæ. Thoſe of the firſt kind are the largeſt, and are of a lenticular form, having round heads with ſhort ſtems. They lie on the baſis of the tongue in ſmall ſuperficial foſſulæ.

They have a ſmall depreſſion in the middle of their upper or convex ſide, which opens into a mucous follicle. They occupy the whole ſurface of the baſis of the tongue, and they are ſituated near each other in ſuch a manner as that the moſt anterior form an angle. They are glandular papillæ, or ſmall ſalival or

mucilaginous glands, of the ſame kind with thoſe that are to be deſcribed hereafter.

We commonly obſerve about the middle of this part of the tongue a particular hole of different depths, the inner ſurface of which is entirely glandular, and filled with ſmall papillæ, like thoſe of the firſt kind. It is called *foramen cæcum Morgagnii*, as being firſt deſcribed by that author. It is nothing elſe than the meeting of excretory ducts of glands ſituated in the tongue, and which throw out a thick ſaliva.

The papillæ of the ſecond kind, or ſemilenticulares, are ſmall orbicular eminences, only a little convex, their circular edge not being ſeparate from the ſurface of the tongue. When we examine them in a ſound tongue, with a good microſcope, we find their convex ſides full of ſmall holes or pores, like the end of a thimble.

They lie chiefly in the middle and anterior portions of the tongue; and are ſometimes moſt viſible on the edges, where they appear to be very ſmooth and poliſhed even to the naked eye, and ſometimes in living ſubjects. They ſoon loſe their conſiſtence after death; ſo that, by rubbing them ſeveral times, they may be drawn out in form of ſmall ſoft pyramids inclined to one ſide.

The papillæ of the third kind, or villoſæ, are the ſmalleſt and moſt numerous. They fill the whole ſurface of the upper ſide of the tongue, and even the interſtices between the other papillæ. They would be more properly named *papillæ conicæ* than *villoſæ*, from the figure which they appear to have when examined through a microſcope in clear water. They are naturally ſoftiſh, but they become extremely flaccid after death; ſo that by handling them they may be made ſhort and thick, whereas they are naturally long and ſmall. Anatomiſts conſider theſe as the extremities of the veſſels and nerves of the tongue.

The fleſhy fibres of which the tongue is compoſed, and

and which go no further than the tongue, may be termed *muſculi linguæ interiores*. The fibres theſe muſcles conſiſt of, are of three general kinds; longitudinal, tranſverſe, and vertical; and each of theſe ſituations admits of different degrees of obliquity. The longitudinal fibres point to the baſis and apex of the tongue; and ſeem partly to be expanſions of the muſculi ſtylogloſſi, hyo-gloſſi, genio-gloſſi, and lingualis. The vertical fibres ſeem likewiſe to be in part produced by theſe muſcles.

Beſides theſe mixed productions, there is a diſtinct plane of longitudinal fibres, which run near the ſurface of the upper ſide of the tongue, and a diſtinct tranſverſe plane under them. All theſe fibres are partly interwoven, one portion of them terminating at the two edges of the tongue, and the other at the baſis and point, without going to any other part; and they lie immediately above thoſe that belong to the genio-gloſſi. To diſcover all theſe different fibres, and their different degrees of direction, we need only cut the tongue longitudinally, after it has been boiled, or long macerated in ſtrong vinegar.

The muſculi exteriores, are thoſe which by one extremity make a part of the body of the tongue, and are fixed by the other in ſome part without the tongue. Of theſe we commonly reckon three pairs; ſtylo-gloſſi, hyo-gloſſi, genio-gloſſi.

The muſcles which move the os hyoides belong likewiſe to the tongue. The names of theſe are, *Mylo-hyoidæi*, *genio-hyoidæi*, *ſtylo-hyoidæi*, *omo-hyoidæi*, *ſterno-hyoidæi*.

When either of the ſtylo-gloſſi acts, it turns the tongue toward the cheek, and forces the aliment between the upper and lower molares. When they act jointly with the lateral portions of the ſuperior fleſhy plane of the tongue, they turn the tongue obliquely upward to the teeth of the upper jaw, and near the cheeks, as when we bring down any part of the food that may

have ſtuck there after maſtication. When they act jointly with the lateral portions of the hyo-gloſſi, they turn the tongue downward between the lower teeth and the cheek.

When all the parts of the hyo-gloſſi act together, they ſhorten the tongue. They likewiſe turn the point of the tongue between the teeth and the under lip, and make it paſs over that lip. The ſuperior fleſhy plane of the body of the tongue bends it upward toward the palate, and makes it paſs along and lick the upper lip.

The tongue is fixed in the mouth, not only by muſcles, but alſo by ligaments, which are for the moſt part membranous. The principal ligament is that called the *frænum*, which is the prominent fold that appears firſt under the tongue when we raiſe it, with the mouth opened; and is no more than a continuation or looſe duplicature of that membrane which covers the inferior cavity of the mouth. It covers the curvature of the anterior portion of the genio-gloſſi from the point of the tongue, almoſt as high as the middle interſtice between the lower dentes inciſorii.

The other ligaments of the tongue are the ſmall membranous fold which runs along the middle of the convex ſide of the epiglottis to the baſis of the tongue, and the membranous folds which cover the inferior half arches of the ſeptum palati. Theſe three folds are continuations of the membrane which covers the neighbouring parts. The aponeurotic ligaments of the ſtylo-gloſſus may be looked upon as true lateral ligaments of the tongue; and they adhere a little to the lower part of the muſculus pterygoidæus internus or anterior.

The principal blood-veſſels of the tongue are thoſe that appear ſo plainly on its lower ſurface on each ſide of the frænum; and they conſiſt of one artery and one vein, which accompany each other, and are called *arteriæ et venæ ſublinguales* or *raninæ*. The veins lie next the frænum, and the arteries on the other ſide of the

veins. The arteries are rami of the ſecond internal or anterior branch of the external carotid on each ſide, and communicate with the firſt external or poſterior branch of the ſame carotid, &c. The veins are commonly rami of a branch of the external jugular vein, deſcribed among the other veins.

We obſerve ſix nervous ropes to go very diſtinctly to the baſis of the tongue, and to continue their courſe through its whole ſubſtance all the way to the point. Two of theſe ropes are rami of the inferior maxillary nerves, or of the third branch of the fifth pair; other two are the nerves of the ninth pair; and the remaining two are ſmall portions, or the firſt branches of the eighth pair.

The great lingual nerve on each ſide runs forward between the muſculus mylo-hyoidæus and hyo-gloſſus, under the genio gloſſus, and is diſtributed to the fleſhy fibres all the way to the point of the tongue, communicating by ſeveral ſmall filaments with the lingualis minor, and with the nerve from the eighth pair. For the other diſtributions of it, we refer to the deſcription of the nerves.

The ſmall lingual nerve on each ſide goes off from the maxillaris inferior, ſometimes at, and ſometimes before, its paſſage between the pterygoide muſcles. Afterwards, ſeparating more and more from the trunk, it paſſes under the lateral part of the tongue, over the ſublingual gland; of which hereafter. It ſupplies the neareſt parts of the tongue as it paſſes; and then entering its ſubſtance, terminates at the point, having ſent a great number of filaments to the papillary membrane. It communicates, as has been ſaid, with the lingualis major, and with the nerve from the eighth pair.

This lingual nerve, a little after it leaves the maxillaris inferior, receives the chorda tympani, which was formerly mentioned in deſcribing the ear.

This ſmall nervous rope has been looked upon by anato-

anatomiſts as a kind of ſmall recurrent of the nervus lingualis; but as in ſome ſubjects it appears to make ſimply an acute angle with the lingual nerve, and as this lingual nerve is ſomething larger after this angle, it ought rather to be believed to come from the tympanum, and to unite with the lingual nerve, than to ariſe from this nerve, and run up to the tympanum. In ſome ſubjects, the union of this nerve with the lingualis is in a manner plexiform, and very difficult to be unfolded.

The lingual nerve of the eighth pair, which is its firſt branch, runs firſt of all on the inſide of the digaſtric muſcle of the lower jaw, and ſupplies the geniohyoidæi, the neighbouring muſcles of the baſis of the tongue, and thoſe of the pharynx. Afterwards it ſends out the ramifications, and forms the communications deſcribed in the hiſtory of the nerves; and laſtly goes to the lower part of the tongue, where it communicates with the lingual ramus of the fifth pair, and with the lingual ramus of the ninth.

The tongue is the organ of the ſenſe called the *taſte*; and by certain experiments it appears, that the power of taſte is exerciſed by the tongue chiefly, although it is not confined to the tongue alone. For on whatever part of the mouth, palate, or cheeks, we apply a ſapid body, we do not perceive the ſenſe of pain, but of taſte; and of ſome bodies, as arum, pepper, &c. it will be ſtronger and more diſtinct in theſe parts than any where elſe. That ſenſation which is ſometimes excited in the ſtomach, œſophagus, and fauces, by the regurgitation of the aliments, ſeems alſo to belong to the tongue, to which the ſapid vapours are ſent back, uncommonly acrid and penetrating; and even that ſenſe which is ſometimes occaſioned in the ſtomach, œſophagus, and fauces, from a riſing of the aliments, ſeems alſo to be owing to the tongue, to which the taſtable vapours are conveyed.

Only the upper and lateral edges of the tongue are fitted to exercise the sense of taste.

The *papillæ* of the tongue, which are larger and softer than those of the skin, perpetually moist, perform the office of touch more exquisitely than those of the small and dry cutaneous papillæ; and from hence the tongue is liable to a sharper degree of pain: moreover, naked salts are not otherwise perceived than under a sense of moisture, or of pain. But the papillæ of the tongue being raised a little protuberant, to perform the office of taste, from salts dissolved in water, or saliva, and applied against their tips or summits, are affected in a particular manner; which being distinguished by the mind, and referred to certain classes, are called *tastes*, either sour, sweet, rough, bitter, saline, urinous, spirituous, aromatic, or pungent and acrid, of various kinds, insipid, putrid, and others resulting partly from pure salts, and in part from an intermixture of the subtile, animal, or vegetable oils, variously compounding and changing each other. If it be inquired, Whether the diversity of tastes arises from the different figures which are natural to salts? and whether this does not appear from the cubical figure in which sea-salt shoots, the prismatical figure of nitre, or the particular configuration of vitriol, sugar, &c.? we answer, That this does not seem probable, for even tasteless crystals have their particular configurations; and the taste arising from very different salts, and differently qualified objects of this sense, are too much alike each other, and at the same time too inconstant or changeable, to allow such a theory; as for example, in nitre. The mechanical reason, therefore, of the diversity of tastes, seems to reside in the intrinsic fabric or opposition of their elements, which do not fall under the scrutiny of our senses.

But the nature or disposition of the covering with which the papillæ are clothed, together with that of the juices, and of the aliments lodged in the stomach, have

have a conſiderable ſhare in determining the ſenſe of taſte; inſomuch, that the ſame flavour does not equally pleaſe or affect the organ in all ages alike, nor in perſons of all temperatures; nor even in one and the ſame perſon at different times, who ſhall be differently accuſtomed in health or variouſly diſeaſed. In general, whatever contains leſs ſalt than the ſaliva itſelf ſeems inſipid.

The ſpirituous parts, more eſpecially of vegetables, either penetrate into the papillæ themſelves, or elſe are abſorbed by the adjacent villi of the tongue; as may appear from the ſpeedy reſtitution of the ſtrength by vinous or aromatic liquors of this kind, even before they are received into the ſtomach.

Nature deſigned the difference of taſtes to be felt by the tongue, that we might know and diſtinguiſh ſuch foods as are moſt ſalutary: for in general, there is not any one kind of aliment healthy that is of a diſagreeable taſte; nor are there any ill taſted matters that are fit for our nouriſhment. For it muſt be obſerved, that we here take no notice of exceſs, by which the moſt healthy food may be prejudicial. In this manner, nature has invited us to take neceſſary food, as well by the pain called hunger as by the pleaſure ariſing from the ſenſe of taſte. But brute animals, who have not, like ourſelves, the advantage of learning from each other by inſtruction, have the faculty of diſtinguiſhing flavours more accurately, by which they are admoniſhed to abſtain cautiouſly from poiſonous or unhealthy food; and therefore it is that herbivorous cattle, to which a great diverſity of noxious plants is offered amongſt their food, are furniſhed with ſuch large and long papillæ, of ſo elegant a ſtructure, in the tongue, which are not ſo neceſſary to man.

The tongue is likewiſe one of the principal inſtruments of ſpeech, and of the articulation of the voice. Riolan, in his Anthropographia, mentions a child of

five years of age, who, though he had loſt his tongue by the ſmall-pox, but not the uvula, continued ſtill to ſpeak almoſt as diſtinctly as before. Probably the baſis of the tongue ſtill remained. M. de Juſſieu has publiſhed an obſervation in the Memoirs of the Royal Academy concerning a little girl who could ſpeak, though ſhe was born without a tongue; in room of which there was only a kind of ſmall tubercle.

The tongue ſerves alſo to collect all the morſels which we chew; to turn them in different manners, and to different parts of the mouth; and to rub off whatever ſticks to the palate: and it is uſeful in ſpitting, ſucking, &c. It bears a great part in deglutition, being aſſiſted by the digaſtric muſcles; which, by contracting at the ſame time that the other muſcles preſs the lower jaw againſt the upper, raiſe the os hyoides, and fix it at a convenient height; that the ſtylo-gloſſi and hyo-gloſſi may make the baſis of the tongue bear back upon the morſel which is to be ſwallowed, and ſo force it into the pharynx; the portions of which, that are at that time immediately above the morſel, do inſtantly contract, and puſh it into the œſophagus.

§ 4. *The larynx.*

The larynx forms the protuberance in the upper and anterior part of the neck, called commonly *pomum Adami*. This is larger and more prominent in men than in women.

It is chiefly made up of five cartilages; the names of which are theſe: Cartilago-thyroides, which is the anterior and largeſt; cricoides, the inferior, and baſis of the reſt; two arytenoides, the poſterior and ſmalleſt; and the epiglottis, which is above all the reſt. Theſe cartilages are connected together by ligaments, and they have likewiſe muſcles, glands, membranes, &c. belonging to them.

Cartilago thyroidæa. The cartilago thyroidæa is large and

and broad, and folded in such a manner as to have a longitudinal convexity on the foreside, and two lateral portions which may be termed *alæ*. The upper part of its anterior middle portion is formed into an angular notch; the upper edge of each ala makes an arch; and, together with the middle notch, these two edges resemble the upper part of an ace of hearts in playing cards.

The lower edge of each ala is more even, and the posterior edges of both are very smooth, being lengthened out both above and below by apophyses, which we name the *cornua of the thyroide cartilage*. The superior apophyses are longer than the inferior, and the extremities of all the four are rounded like small heads, which in the inferior apophyses have a shining surface on the inside, resembling an articular eminence.

On the outside of each ala near the edge, is a prominent oblique line which runs from behind forward. The upper extremity of this line is near the superior apophysis or cornu; and both that and the lower extremity end in a small tuberosity, the lowest being often the most considerable. These tuberosities serve for the insertion of muscles and ligaments. The inside of the alæ and the convex side of the anterior portion are very uniform; and this cartilage ossifies gradually in old age.

Cartilago cricoides. The cricoide cartilage resembles a kind of thick, irregular ring, very broad on one side and narrow on the other; or it may be compared to a small portion of a thick tube, cut horizontally at one end, and very obliquely at the other, and distinguished into a basis and top, into an anterior, posterior, and two lateral sides. The basis is almost horizontal when we stand, and to this the aspera arteria is connected; so that the cricoides may be looked upon as the upper extremity of the trachea.

The posterior portion of the cricoides is larger than the rest, and its posterior or convex side is divided by

a longitudinal eminence, or prominent line, into two diſtinct ſurfaces, for the inſertion of muſcles. The top is gently ſloped above this prominent line; and terminates on each ſide by a kind of obtuſe angle, formed between it and the oblique edge of each lateral portion of this cartilage. At the upper part of each of theſe angles, there is a very ſmooth articular ſurface, gently convex.

The whole poſterior ſide is diſtinguiſhed into two lateral portions by two prominent lines, each of which runs down almoſt in a ſtraight direction from the articular ſurface at the top, a little below the middle of this ſide, where it terminates in another articular line a little concave; and near theſe four articular ſurfaces there are ſmall tubercles. The two ſuperior ſurfaces are for the articulation of the cartilagines arytenoidææ, and the two inferior, for the articulation of the inferior cornua or appendices of the cartilago thyroides.

Cartilagines arytenoidææ. The cartilagines arytenoidææ are two ſmall, equal, ſimilar cartilages, which joined together reſemble the ſpout of an ewer; and they are ſituated on the top of the cricoides. In each, we may conſider the baſis; cornua; two ſides, one poſterior and concave, the other anterior and convex; and two edges, one internal, the other external, which is very oblique. The baſes are broad and thick; and have each a concave articular ſurface, by which they are joined to the cricoides.

The cornua are bent backward, and a little toward each other. In ſome ſubjects they are very looſe, appearing like true appendices, and eaſily ſeparable from the reſt. Between their inner edges they form a kind of fiſſure, and their outer oblique edges terminate each by a thick prominent angle.

Epiglottis. The epiglottis is an elaſtic cartilage, ſomewhat of the figure of the tongue, narrow and thick at the lower part, thin and ſlightly rounded at the upper part, gently convex on the fore-ſide, and concave

concave on the back-ſide. It is ſituated above the anterior or convex portion of the cartilago thyroides; and its lower extremity is tied by a ſhort, pretty broad, and very ſtrong ligament, to the middle notch in the upper edge of that cartilage. It is perforated by a great number of ſmall holes, which are hid by the membranes that cover its two ſides.

Ligaments of the larynx. The cartilago thyroides is connected to the cricoides by ſeveral ſhort ſtrong ligaments, round the articulations of the two inferior cornua with the lateral articular ſurfaces of the cricoides. The apices of the ſuperior cornua are fixed to the poſterior extremities of the great cornua of the os hyoides, by ſlender round ligaments, about a quarter of an inch in length.

In the middle of each of theſe ligaments, we often meet with a ſmall cartilage of an oval figure, and much thicker than the ligaments. The thyroides is likewiſe connected to the os hyoides by a ſhort, broad, ſtrong ligament; one end of which is inſerted in the ſuperior notch of the cartilage, and the other in the lower edge of the baſis of the bone. It has alſo two ligaments at the middle of the concave ſide which belong to the arytenoidææ.

The cricoides is tied to the lower part of the thyroides by a ſtrong ligament; and by the ligaments already mentioned, to the inferior cornua of that cartilage. Its baſis is fixed to the firſt cartilaginous ring of the trachea arteria, by a ligament exactly like thoſe by which the other rings are connected together; and the membranous or poſterior portion of the trachea is likewiſe fixed to the poſterior part of the baſis of the cricoides.

Glottis. The cartilagines arytenoidææ are connected to the cricoides by ligaments, which ſurround their articulations with the top of that cartilage. Anteriorly the baſis of each arytenoides is fixed to one end of a ligamentary cord, which by its other end is inſerted about the middle of the concave ſide of the anterior portion

portion of the thyroides. At their inſertions in the thyroides, theſe two ligaments touch each other; but a ſmall ſpace is left between them, where they are fixed in the two arytenoides; and they ſeem likewiſe to have a ſmall adheſion to the top of the cricoides. This is what is called *the glottis*.

Under theſe two ligamentary cords there are two others which run likewiſe from behind forward. The interſtice between the ſuperior and inferior cords on each ſide form a tranſverſe fiſſure, which is the opening of a ſmall membranous bag, the bottom of which is turned outward, that is, toward the ala of the thyroides. Theſe two ſacculi are the ventricles mentioned by the ancients, and reſtored by M. Morgagni, who has given an excellent deſcription of them. They are chiefly formed by a continuation of the internal membrane of the larynx, and the inner ſurface of their bottom appears ſometimes to be glandular.

On the anterior ſurface of the arytenoide cartilages, there is a ſmall depreſſion between the baſis and the convex upper part. This depreſſion is filled by a glandular body, which not only covers the anterior ſurface of each arytenoides, but is likewiſe extended forward from the baſis over the poſterior extremity of the neighbouring ligamentary cord. They are larger and more ſenſible in ſome ſubjects than in others; and they are covered by the membrane which lines the neighbouring parts. Theſe glands were diſcovered by M. Morgagni.

The two ligaments which connect the epiglottis to the notch of the thyroid cartilage, and to the baſis of the os hyoides, and a third which ties the baſis of the os hyoides to the notch of the thyroides, form a triangular ſpace filled with a cellular or fatty ſubſtance, and with ſmall glands.

The epiglottis has likewiſe two lateral ligaments, by which it is connected to the arytenoides all the way to their points or cornua. It has alſo a membranous li-

gament, which, running along the middle of its anterior or concave ſide, ties it to the root or baſis of the tongue. This ligament is only a duplicature of the membrane which covers the epiglottis, continued to the neighbouring parts. Laſtly, there are two lateral membranous ligaments belonging to it, fixed near the glandulous bodies called *amygdalæ*.

The epiglottis is not only perforated by the regular holes already mentioned, but has likewiſe a great number of ſmall irregular fiſſures and breaks, which are ſo many different lacunæ ſituated between its two membranes, and filled with ſmall glands, the excretory orifices of which are chiefly on the back-ſide of this cartilage.

Muſcles of the larynx. The larynx gives inſertion to a great number of muſcles, which may be divided into common, proper, and collateral. The common muſcles, according to the general acceptation of that term, are all thoſe that move the whole body of the larynx, one extremity of them being inſerted in other parts; and theſe are reckoned to be four in number, two for each ſide, viz. ſterno-thyroidæi, thyro-hyoidæi or hyo-thyroidæi.

The proper muſcles are thoſe inſerted wholly in the larynx, and which move the cartilages ſeparately. Theſe have been divided in various manners, but may be all reduced to the following pairs: Crico-thyroidæi; crico-arytenoidæi laterales; crico-arytenoidæi poſteriores; thyro-arytenoidæi; arytenoidæi; thyro-epiglottici; aryteno-epiglottici.

By the collateral muſcles, is underſtood thoſe which are inſerted by one portion in the larynx, without appearing to contribute any thing to the motions of it. Of this kind are the thyro-pharyngæi, crico-pharyngæi, &c.

The larynx may likewiſe be moved by muſcles, which are not immediately inſerted in it, but altogether in other parts. Such are the mylo-hyoidæi, genio-hyoidæi,

dæi, ſtylo-hyoidæi, omo-hyoidæi, ſterno-hyoidæi, and eſpecially the digaſtrici of the lower jaw, by reaſon of their particular adheſion to the os hyoides. It is likewiſe probable that thoſe muſcles of the pharynx which are inſerted in the baſis cranii, may, in certain circumſtances, move the larynx in ſome ſmall degree. The blood veſſels of the larynx, &c. are the arteriæ and venæ, thyroideæ, ſuperiores, and inferiores. The nerves are the ſuperior and inferior laryngeals, which are branches of the eighth pair.

Uſes. The larynx ſerves particularly to admit and let out the matter of reſpiration; and the ſolidity of the pieces of which it is compoſed, hinders not only external objects, but alſo any hard thing which we ſwallow, from diſordering this paſſage. The glottis being a narrow ſlit, modifies the air which we breathe; and as it is very eaſily dilated and contracted, it forms the different tones of the voice, chiefly by means of the different muſcles inſerted in the cartilagines arytenoidææ, to which the other muſcles of the larynx, both proper and common, are aſſiſtants.

The whole larynx is likewiſe of uſe in deglutition, as has been already obſerved, by means of its connection with the os hyoides, to which the digaſtric muſcles of the lower jaw adhere; which muſcles raiſe the larynx together with the os hyoides every time we ſwallow.

The facility of varying and changing the tone of the voice depends on the flexibility of the cartilages of the larynx, and decreaſes in proportion as we advance in age; becauſe theſe cartilages gradually harden and oſſify, though not equally ſoon in all perſons: and this change happens not only in the cartilago thyroides, but alſo to the cricoides and arytenoides.

The muſculi ſterno-thyroidæi ſerve in general to pull down the thyroide cartilage, and the whole larynx along with it. They may likewiſe aſſiſt the ſterno-hyoidæi in its action, and compreſs the thyroide gland; of which hereafter. The thyro-hyoidæi may, as occaſion

caſion requires, either draw up the larynx toward the os-hyoides, or draw that bone downward toward the cartilago-thyroides.

It is difficult to determine the uſe of the crico-thyroidæi from their ſituation. They may either pull the cricoides obliquely backward, or the thyroides obliquely forward; and by this action the inferior cornua of the thyroides, and ſmall articular ſurfaces of the cricoides, muſt ſlide upon each other.

Both the lateral and poſterior crico-arytenoidæi may ſeparate the arytenoide cartilages, and thereby open or dilate the glottis; but they do not both perform this action in the ſame manner. The lateral muſcles ſeparate theſe cartilages obliquely forward, and at the ſame time looſen or relax the ſides of the glottis; but the poſterior muſcles ſeparate them obliquely backward, and at the ſame time ſtretch or extend the ſides of the glottis; and when both muſcles act equally, they ſeparate the cartilages directly.

The thyro-arytenoidæi acting together, draw both the arytenoide cartilages forward, and conſequently looſen the glottis, and render it capable of the ſmalleſt quaverings of the voice. They may likewiſe probably compreſs the lateral ſinuſes or ventricles of the larynx, and alſo the arytenoide glands.

The arytenoidæi bring the arytenoide cartilages cloſe together, and preſs them againſt each other; and when the cartilages are in this ſituation, they may at the ſame time be inclined either forward by the thyro-arytenoidæi, or backward by the crico-arytenoidæi poſteriores. By this means the glottis, when ſhut, may be either relaxed or tenſe; and in this laſt caſe it is entirely ſhut, as when we hold in our breath in ſtraining: but of this more in another place.

The general uſe of the epiglottis is to cover the glottis like a pent-houſe, and thereby hinder any thing from falling into it when we eat or drink; and for this purpoſe it is depreſſed in the manner that ſhall be ſhown hereafter.

hereafter. It ſerves likewiſe to hinder the air which we inſpire from ruſhing directly upon the glottis; but by ſplitting it, as it were, obliges it to enter by the ſides, or in an oblique courſe. The muſcles of the epiglottis do not appear to be abſolutely neceſſary for that cartilage; for in deglutition it may be ſufficiently depreſſed by the baſis of the tongue, and it may raiſe itſelf again by its own elaſticity. The thyro-epiglottici and aryteno-epiglottici may ſerve to ſhut any lateral openings that might remain when the epiglottis is depreſſed by the baſis of the tongue; and the hyo-epiglottici may pull it a little forward in ſtrong reſpirations, as in ſighing, yawning, &c.

Voice and Speech. The *larynx* is the principal organ of the voice; for that being injured, the air paſſes through the windpipe without yielding any ſound. By the larynx we underſtand an aſſemblage of cartilages, joined into a hollow machine, which receives the air from the fauces, and tranſmits it into the windpipe.

All the cartilages of the larynx are connected by various muſcles and ligaments, with a certain degree of firmneſs, to the adjacent parts; and yet ſo that the whole is eaſily moveable together, as are alſo its ſeveral parts upon each other.

The whole larynx is ſuſpended from the os hyoides by the ligaments proceeding towards the ſuperior horns of the thyroide cartilage, and perfecting that cartilage from the middle of its baſis to the conjunction of its plates. The ſame, together with the conjoined os hyoides, is capable of being raiſed conſiderably, at leaſt half an inch above its mean altitude. This is performed by the biventer muſcles, together with the geniohyoidei, geniogloſſi, ſtylogloſſi, ſtylohyoidei, ſtylopharyngei, thyreopalatini, hyothyroidei; all or ſome of which conſpire together in that action. In this elevation the glottis is preſſed together or made narrower, and the ligaments before mentioned approach nearer together. But thus, by the aſſiſtance of the action of the arytæ-

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noide muſcles, together with the oblique and tranſverſe ones, the glottis may be accurately cloſed, ſo as to reſiſt with an incredible force the preſſure of the whole atmoſphere.

The ſame larynx may be, in like manner, depreſſed to about half an inch beneath its ordinary ſituation, by the ſternohyoidei, ſternothyroidei, and coracohyoidei, as they are called; and, when theſe are in action, alſo by the joint force of the anterior and poſterior cricothyroidei. In this motion the arytænoide cartilages depart from each other, and render the glottis wider, which is alſo drawn open laterally by the muſcles inſerted into the ſides of the arytænoide cartilages, together with the crico-arytænoidei poſtici and laterales, and thyreo-arytænoidei: theſe may alſo compreſs the ventricles of the larynx on which they are incumbent; the particular cartilages which make up the larynx can ſcarce be moved ſeparately.

We ſhall now conſider what action the air produces, when it is driven from the lungs in exſpiration through the windpipe into the larynx, and from them urged out through the glottis into the mouth, variouſly configured. The conſequences or effects of this are, voice, ſpeech, and ſinging. The voice, indeed, is only formed, when the air is expelled with ſo great a velocity through the contracted glottis, that it ſplits or makes a colliſion upon the ligaments of the glottis, ſo as to put the larynx into a tremor, which tremor is returned and continued or increaſed by the elaſticity of theſe parts. Sound, therefore, ariſes from the conjunct trembling of the ligaments, together with the cartilages of the larynx at one and the ſame time, which we then call the voice, and is of a peculiar kind or modulation in every ſingle claſs of animals, depending entirely upon the difference of the larynx and glottis. But when a trembling is not excited, the exſpired air cauſes a whiſper.

The ſtrength of the voice is proportionable to the quantity

quantity of air blown out, together with the narrowneſs of the glottis; and, therefore, a large pair of lungs eaſily dilatable, with an ample cartilaginous and elaſtic larynx and windpipe, and the free echo of the noſtrils, joined with a powerful exſpiration, all conduce to this effect. But acute and grave tones of the voice, we obſerve to ariſe from various cauſes. The former proceeds from a tenſion and narrowneſs of the glottis, and the latter from a relaxation and expanſion of it. For thus, in the former, a greater number of aërial undulations are ſplit in the ſame time upon the ligaments of the glottis, whence the tremors excited at the ſame time are more numerous; but when the glottis is dilated, the contrary of all this follows. And from the greater tenſion of the ligaments, the tremors in like manner become more numerous from the ſame ſtroke. Therefore, to produce an acute and ſhrill voice, the whole larynx is drawn upwards and forwards; and ſo much the more as the voice is required to be ſharper, inſomuch that the head itſelf is inclined backwards, by which the powers of the muſcles elevating the larynx are rendered more full and effectual. The truth of this is confirmed by experience, by applying the fingers to the larynx when it forms an acute ſound; for then, to raiſe the voice an octave, you will eaſily perceive it to aſcend near half an inch. Alſo the ſame is evident from comparative anatomy, which demonſtrate the narroweſt glottis and the cloſeſt approximation of cartilages in ſinging birds, but an ample or broad glottis in hoarſe animals and ſuch as bellow or bleat. An inſtance of this we have in whiſtling, where the voice manifeſtly becomes more acute by a contraction or narrowneſs at the mouth: alſo in muſical inſtruments, in which a narrowneſs of the mouth or opening that expels the air, with a celerity of the wind blown out, are the cauſes of an acute or ſhrill tone.

Gravity of the voice, on the contrary, follows from a depreſſion of the larynx by the cauſes already deſcribed;

bed; to which add a broad glottis and a very ample larynx. This is evident to the touch of the finger applied to the larynx when a perſon ſings, by which the deſcent of it is manifeſtly perceived to be about an inch for every octave: hence the voice of males is more grave; and hence the loweſt degrees of the voice degenerate into a muteneſs or whiſpering.

Is the whole difference of tone owing to the length of the ligaments of the glottis, which is augmented when the ſcutiform cartilage is drawn forward, and the arytænoide ones backward? Is it according to this rule, that the moſt acute tones are produced, which ariſe from the ligaments being exceedingly ſtretched, and thus vibrating with great celerity? This has been confirmed by repeated experiments made by eminent men; and ſome late anatomiſts have obſerved, that when the cords or ligaments of the glottis are tenſe, the peculiar voice of every kind of animal is produced by blowing air into its larynx: that this voice was more acute as the ligaments were more tenſe, and more grave as they were ſlackened; that by ſhutting the whole ligament, the voice was ſuppreſſed; by ſhutting the half, the voice was rendered an octave higher; by ſhutting a third part, a fifth higher, &c. There are not wanting, however, doubts concerning this new theory, ariſing from the cartilaginous and bony ſtructure of the glottis of birds, which of conſequence muſt be immoveable, and not extenſible; from the voice moſt certainly becoming more acute, in whiſtling, from the mere contraction of the lips; from the example of women, in which the larynx is ſofter, but the voice more acute, than in men; from experiments which ſhow, that more acute ſounds are produced by bringing the ligaments of the glottis nearer into contact with each other; from the perfect want of machines, by which the ligaments can be ſtretched, and which may bring the ſcutiform cartilage forward from the annular one. But ſeeing it appears from experiments, that a tenſion of the liga-

ments ſuffices for producing acute ſounds, without the contraction of the glottis, we may believe that the different tenſion of the glottis contributes more to the diverſity of voice than the different diameter of it.

Singing is when the voice, modulated through various degrees of acuteneſs and gravity, is expelled through the larynx, while it is trembling and ſuſpended betwixt two contrary powers; and herein lies the principal difference betwixt the chanting of ſimple notes and the expreſſion of words. Hence it appears to be a laborious action, by reaſon of the continual contractions of the muſcles, which keep the larynx at an equilibrium: and hence it is, that ſinging makes a perſon hot; becauſe in acute tones the narrower glottis much retards the exſpiration, while at the ſame time a great deal of air is required to give ſtrength to the voice; to which, again, deep inſpirations are neceſſary. Hence likewiſe the windpipe is rendered very dry, from the quicker paſſage or current of air: to prevent which, a great deal of mucus is required; and therefore it is that there are ſuch numbers of mucous receptacles in the larynx; amongſt which I am firmly of opinion the ventricles before deſcribed ought to be numbered.

Speech is performed by the larynx at reſt, or held in the ſame place, in tones of voice differing but little in acuteneſs and gravity: but then the voice is variouſly changed or modulated by the organs of the mouth. Singing has a variation in the tone or cadence of the voice, together with a modulation of it by the organs of the mouth at the ſame time.

All ſpeech is reducible to the pronunciation of letters, which differ in various nations; but moſt of them are alike all the world over. Of theſe, ſome are called *vowels*, which are made only by an expreſſion of the voice through the mouth, without any application of the tongue to certain parts of the mouth. But conſonants are formed by a colliſion of the tongue againſt certain parts of the mouth, lips, and teeth. But to be more

more particular in these matters is beyond our purpose, which does not permit us to expatiate upon the beautiful art of pronunciation. That art, as an extraordinary instance of mechanical knowledge, has so accurately determined all the corporeal causes concurring to each letter, that, by inspection only, with the assistance of touch, letters pronounced are understood without hearing them; and the attentive person is thereby taught to imitate the same speech by a like use of the organs.

§. 5. *The Pharynx.*

The pharynx is a muscular and glandular bag; the outer surface of which is closely joined to the inner surface of all that space which is at the bottom of the mouth, behind the posterior nares, uvula, and larynx, and which reaches from the cuneiform process of the os occipitis all the way to the œsophagus, which is the continuation of the pharynx. This space is bounded posteriorly by the muscles which cover the bodies of the first vertebræ of the neck, and laterally by the superior portions of both the internal jugular veins, and of both the internal carotid arteries, by the spinal apophyses of the os sphenoides, by the extremities of the apophyses petrosæ, by the os sphenoides, immediately above the internal alæ of the apophyses pterygoides, and by the neighbouring portion of both pterygoide muscles.

From these limits and adhesions of the pharynx we may pretty nearly determine its figure. It may be compared to the wide part of a covered funnel, of which the œsophagus is the narrow part or tube; or it may be called the *broad end of the œsophagus*, that and the pharynx taken together being compared to a trumpet. The pharynx may be divided into three parts; one superior, which is the arch of the pharynx; one middle, which is the body or great cavity; and one

inferior, which is the bottom, narrow portion, or ſphincter. We are likewiſe to obſerve in it three openings; that of the arch, toward the nares; that of the body, toward the mouth; and that of the bottom, toward the œſophagus.

The arch is the broadeſt part of the pharynx; and ends on each ſide in an angle or point, toward the jugular foſſulæ of the baſis cranii. Afterwards the great cavity contracts a little toward the ſides, all its other dimenſions continuing the ſame; and behind the larynx it is again enlarged on each ſide, a very ſmall ſpace being left between it and the cricoid cartilage. The extremity of the lower portion is very narrow, and joins the baſis of the cartilage juſt named.

The pharynx is made up partly of ſeveral diſtinct fleſhy portions, which are looked upon as ſo many different muſcles ſo diſpoſed as to form a large cavity; and partly of a membrane which lines the inner ſurface of this whole cavity, and is a continuation of that of the nares and palate.

This membrane is wholly glandular; and it is thicker on the ſuperior and middle portions of the pharynx than on the bottom or lower portion. Immediately above the firſt vertebra it forms ſeveral longitudinal rugæ very thick, deep, and ſhort; and we generally find therein a collection of mucus in dead bodies. In the great cavity there are no rugæ, the membrane adhering, both there and in the upper part, very cloſely to the muſcles. At the lower part where it is thinneſt it covers likewiſe the poſterior part of the larynx; and is very looſe, and formed into irregular folds. It runs in a little on each ſide between the edges of the pharynx.

Muſcles of the pharynx. Though almoſt all the muſcular or fleſhy portions of which the pharynx is compoſed, concur in the formation of one continued bag or receptacle, they are nevertheleſs very diſtinguiſhable from each other, not only by their different inſertions,

from

from which they have been denominated, but alſo by the different directions of their fibres. They may be looked upon as three digaſtric muſcles; the middle tendons of which lie backward in one longitudinal line, which in ſome ſubjects appears plainly like a linea alba.

The loweſt of the muſcular fibres make a complete circle backward between the two ſides of the baſis of the cartilago cricoides. This circle is the beginning of the œſophagus, and has been thought by ſome to form a diſtinct muſcle called *œſophagus*. Beſides the muſcles which form the body of the pharynx, there are ſeveral other ſmall ones connected with it; but of theſe ſufficient deſcriptions have been already given in a former part of the work.

The particular uſes of theſe muſcles are very difficult to be determined. It is certain that thoſe of the middle and lower portions of the pharynx ſerve chiefly for deglutition. Thoſe of the upper portion, and ſome of thoſe of the middle portion, may, among other functions, be uſeful in modifying the voice, according to the opinion of M. Santorini.

§ 6. *The Salival Glands, &c.*

By ſaliva we mean in general, that fluid by which the mouth and tongue are continually moiſtened in their natural ſtate. This fluid is chiefly ſupplied by glands, called for that reaſon *glandulæ ſalivales*, of which they commonly reckon three pairs, two parotides, two maxillares, and two ſublinguales. Theſe are indeed the largeſt, and they furniſh the greateſt quantities of ſaliva; but there are a great number of other leſſer glands of the ſame kind, which may be reckoned aſſiſtants or ſubſtitutes to the former. All theſe may be termed *ſalival glands*, and they may be enumerated in the following manner: Glandulæ parotides, glandulæ maxillares, glandulæ ſublinguales, glandulæ molares, glandulæ buccales, glandulæ labiales, glan-

dulæ linguales, amygdalæ, glandulæ palatinæ, glandulæ uvulares, glandulæ arytenoidææ, glandula thyroidæa.

The parotides are two large, whitiſh glands, irregularly oblong and protuberant, ſituated on each ſide, between the external ear and the poſterior or aſcending ramus of the lower jaw, and lying on ſome part of the neighbouring maſſeter muſcle. The ſuperior portion of this gland lies before the cartilaginous meatus of the ear, and touches the apophyſis zygomatica of the os temporis; and it is extended forward and backward under the lobe of the ear, as far as the maſtoide apophyſis.

From the anterior and ſuperior portion of this gland, a white membranous duct or canal is produced by the union of a great number of ſmall tubes repreſenting ſo many roots. This duct runs obliquely forward on the outſide of the maſſeter; and then perforates the buccinator from without inward, oppoſite to the interſtice between the ſecond and third dentes molares, where the hole or orifice repreſents the ſpout of an ewer.

This canal is named *ductus ſalivalis Stenonis*, or *ductus ſuperior*. It is about the twelfth part of an inch in diameter, and on the outer ſide of the maſſeter muſcle it receives ſometimes one and ſometimes two ſmall ducts from a like number of little glands; which Haller calls *glandulæ acceſſoriæ*. The external carotid artery and vein, and the portio dura of the ſeventh pair of nerves, paſs through the ſubſtance of the parotid gland, to which they give branches; and the facial artery and vein paſs over its duct.

The maxillary glands are ſmaller and rounder than the parotides; and are ſituated each on the inſide of the angle of the lower jaw, near the muſculus pterygoidæus inferior. From the inſide, or that which is turned to the muſculus hyo-gloſſus, each of them ſends out a duct in the ſame manner as the parotides; but it is ſmaller and longer, and goes by the name of *ductus ſalivalis Whartoni*, or *ductus inferior*.

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This duct advances on the side of the musculus genio-glossus, along the inner part and superior edge of the glandula sublingualis, to the frænum of the tongue, where it terminates by a small orifice in form of a papilla.

The glandulæ sublinguales are likewise two in number, of the same kind with the former, only smaller, something oblong, and flatted like a blanched almond. They are situated under the anterior portion of the tongue, one on each side, near the lower jaw, on the lateral portions of the musculi mylo-hyoidæi which sustain them. The two extremities of each gland are turned backward and forward, and the edges obliquely inward and outward.

They are covered on the upperside by a very thin membrane, which is a continuation of the membrane that covers the underside of the tongue. They send out laterally several small short ducts which open near the gums by the same number of orifices, all ranked in the same line, at a small distance from the frænum, and a little more backward. In many animals we find particular ducts belonging to these glands, like those of the glandulæ maxillares, but they are not to be found so distinctly in men. The musculi genio-glossi lie between the two sublingual glands, and also between the two maxillary ducts. The arteries and veins of these and of the former glands belong to the lingual vessels, and the nerves are from the lingual branch of the fifth pair.

The molares are two glands nearly of the same kind with the former, each of them being situated between the masseter and buccinator; and in some subjects they may easily be mistaken for two small lumps of fat. They send out small ducts which perforate the buccinator, and open into the cavity of the mouth, almost overagainst the last dentes molares; and from thence M. Heister, who first described them, called them *glandulæ molares*.

All the inside of the cheeks, near the mouth, is full of small glandulous bodies, called *glandulæ buccales*, which open by small holes or orifices through the inner membrane of the mouth. The membrane which covers the inside of the lips, a continuation of that on the cheeks, is likewise perforated by a great number of small holes, which answer to the same number of small glands, called *glandulæ labiales*. The glandulæ linguales are those of the foramen cæcum of the basis of the tongue, which have been already described.

We have also explained the glandulæ palatinæ, or those that belong to the arch and septum of the palate; and the glandulæ arytenoidææ were described with the larynx. The uvular glands are only a continuation of the membrane of the palate in form of a small bunch of grapes. We might likewise reckon among the salival glands those of the superior portion of the pharynx mentioned in the description of that part, and also the follicles of the membrana pituitaria of the nares, and of the sinuses which communicate with these.

The amygdalæ are two glandular bodies of a reddish colour, lying in the interstices between the two lateral half-arches of the septum palati, one on the right, the other on the left side of the basis of the tongue. Their appearance is not unlike that of the outside of an almond-shell, both because their surface is uneven, and because it is full of holes big enough to admit the head of a large pin.

These holes, which represent a sieve, or a piece of net-work, are continued to an irregular sinus or cavity within the gland, filled commonly with a viscid fluid, which comes from the bottom of the sinus, and is from thence gradually discharged through these holes into the throat.

The thyroide gland is a large reddish mass which covers the anterior convex side of the larynx. It seems at first sight to be made up of two oblong glandular portions united by their inferior extremities, below the cri-

cricoide cartilage, in ſuch a manner as to have ſome reſemblance to a creſcent, with the cornua turned upward. It is of a moderate thickneſs, and bent laterally like the thyroide cartilage, from which its name is taken. The two lateral portions lie on the muſculi thyrohyoidæi, and the middle or inferior portion on the crico-thyroidæi. The thyro-pharyngæi inferiores ſend fibres over this gland; and they communicate on each ſide, by ſome ſuch fibres, with the ſterno-thyroidæi and hyo-thyroidæi.

This gland ſeems to be of the ſame kind with the other ſalival glands, but it is more ſolid. Some anatomiſts thought they had diſcovered the excretory duct, but they miſtook a blood-veſſel for it. Sabatier obſerves, that the internal ſtructure of this gland is flaccid and reddiſh, and formed of glandulous grains, leſs eaſily diſtinguiſhed than in the other glands, and of veſicles of different ſizes full of a yellowiſh oily liquor, which may ſerve the purpoſe of lubricating the parts in its neighbourhood. We ſometimes meet with a kind of glandular rope which runs before the cartilago-thyroides, and diſappears before the baſis of the os hyoides.

This glandular rope goes out from the common baſis of the lateral portions of the thyroide gland; and is loſt between the muſculi ſterno-hyoidæi, behind the baſis of the os hyoides, or between that baſis and the epiglottis.

The glandulæ lymphaticæ will come in more properly in a latter part of this work, with the deſcription of the abſorbent ſyſtem.

§ 7. *Of Maſtication, Saliva, and Deglutition.*

Such hard and tough foods as conſiſt of long parallel fibres, or are covered with a bony ſhell or cartilaginous ſkin, generally require maſtication, to divide them into leſs cohering parts, that they may more eaſily yield their nouriſhment to the diſſolving powers of the

the ſtomach. The more diligently they are ſubdivided in the mouth, the more reliſhing and agreeable they become to the ſtomach; and the nearer they approach to the nature of a fluid, the more eaſily are they digeſted or aſſimilated.

Therefore moſt animals are provided with teeth extremely hard; and as the materials of our food are various in their texture and firmneſs, nature has accordingly made our teeth variouſly figured. The office of the inciſores is only, in the ſofter foods, to cut thoſe which are tougher than the reſt into ſmaller portions; ſuch as the fibres and membranes of animals and vegetables, with the brittle ſeeds and kernels of fruits.

The canine teeth lacerate tough aliments, and hold faſt ſuch as require a long triture by the grinders.

Betwixt the molares the moſt compact or bony foods are interpoſed and broke, as the more tough and hard are ground ſmaller, while the lower teeth are urged obliquely and laterally againſt the moveable upper ones; and theſe are the teeth which perform principally what we are to expect from maſtication of food. But that the teeth might break or grind the food with due ſtrength and firmneſs, the uppermoſt are fixed into the ſockets of the immoveable upper jaw, as the lower ones are into the lower moveable jaw, which is a ſingle bone, and ſo joined with the temporals, that it may be drawn down from the upper jaws, and pulled up againſt them with a great force; and may be moved laterally to the right or left, forward and backward. Thoſe various motions of the lower jaw depend upon the articulation of its oval heads, in which the lateral parts of the jaw terminate. This joint has the freer liberty in moving, and its incruſtated cartilages have a longer duration, by the interpoſition of a ſmall cartilaginous plate, betwixt the condyle of the jaw and tubercle of the temporal bone.

The muſcles moving the lower jaw, which are weak in man, but very ſtrong in brute animals, are the temporalis

poralis and maſſeter which act in concert; but the temporal muſcle brings the jaw more backwards, and the maſſeter forwards. The *pterygoideus internus* elevates or draws it to one ſide or the other alternately. The *pterygoideus externus* proceeds backward and downward into the outer part of the condyle of the lower jaw, which it moves laterally, and draws forward before the upper jaw.

The lower jaw is depreſſed, ſo as to open the mouth by the digaſtric or *biventer* muſcle. Moreover, the mouth may be partly opened by all the other lower muſcles of the jaw, os hyoides, and the larynx, as the genio-hyoideus, genio-gloſſus, ſterno-hyoideus, ſterno-thyroideus, coraco-hyoideus, and latiſſimus colli; although the latter rather draws the ſkin of the neck and face downward than the jaw itſelf. The genio-hyoideus and digaſtric muſcles have a power of drawing the jaw backwards.

The lower jaw is elevated with a great force, ſo as to divide the food by the preſſure of the upper and lower teeth againſt each other, by the action of the temporal maſſeter, and internal pterygoide muſcles; the contraction of which appears by experiments to be very powerful, and ſufficient to raiſe ſeveral hundred weight. The lateral and circular motions of the jaw upon one of its immoveable condyles are performed by the external and internal pterygoidei, acting either alone or together with the former. Thus the food is cut, lacerated, and ground to pieces; and if the maſtication be continued diligently, it is, together with the liquors of the mouth, reduced into a kind of pulp.

During the trituration of the food in the mouth, there is continually poured into it a large quantity of a watery clear liquor, evaporable or inſipid, or at leaſt but very little ſaline, and containing but little earth; neither acid nor alkaline, although from thence may be obtained a very ſmall portion of lixivial ſalt; of which there are numerous ſprings in the neighbourhood.

hood. A large quantity of this *ſaliva* is ſeparated by numberleſs ſmall glands of the lips and cheeks; and the juice poured out from the exhaling veſſels of the tongue, mouth, and cheeks, is of the like kind, or rather more watery. As for the ductus inciſivus, we are now ſufficiently certain, that in the generality of perſons it is blind, or diſcharges nothing into the mouth, and only gives paſſage to veſſels and nerves running between the palate and noſtrils.

The ſaliva is a watery liquor, with a moderate quantity of ſalt, partly lixivial, and partly culinary; with ſome oil and earth, diſſipable by the fire; with ſcarce any taſte, unleſs given to it by diſeaſe or famine. The quantity produced is very conſiderable, as twelve ounces have been known to flow out from wounds in thoſe parts in the ſpace of an hour. By good-mannered people it is for the moſt part ſwallowed; and uſefully, as it cannot be thrown away without hurting the digeſtion.

The ſalival glands eſpecially, ſupply the watery humour called after their own name. Of theſe the principal are, the parotid, maxillary, and ſublingual.

By the motion of the jaw in maſtication, the ſalival glands are compreſſed, ſo as to diſcharge their juices into the mouth in great plenty. When the mouth is opened, the maxillary gland, being preſſed by the digaſtric and mylo-hyoideus, throws forth abundance of ſaliva; the maſſeter when ſwelled preſſes the parotid gland, as does alſo the cutaneous muſcle of the neck which lies over it: and it is this muſcular preſſure that excites the appetite, and pours the ſaliva into the mouth.

The food, therefore, being in this manner ground betwixt the teeth, and intermixed with the watery ſaliva and air, is broken down into a ſoft juicy pulp, pliable into any figure, and replete with elaſtic air, which, by the action of the latter, undergoes a farther diſſolution, by the warmth of the parts exciting the elaſticity

elaſticity of the air to expand and burſt aſunder the confining particles of the food, betwixt which it is included. In this act of maſtication, the oily, aqueous, and ſaline parts of the food are intermixed the one with the other; the ſmell and taſte of different ingredients are loſt in one, which by the dilution of the ſaline parts with ſaliva renders the food flavourable: but ſuch particles as are more volatile and penetrating, being directly abſorbed by the bibulous veſſels of the tongue and cheeks, enter ſtraight into the blood-veſſels and nerves, ſo as to cauſe an immediate recruit of the faculties.

But the motions which are neceſſary for turning round the food, applying it to the teeth, and conveying it through the different parts of the mouth in maſtication, are adminiſtered by the tongue, cheeks, and lips. And firſt, the tongue being expanded ſo as to form a ſmall concavity in its back or ſurface, takes up the food thus prepared, and conveys the charge by its moving powers to the parts for which it is deſigned. At one time the tongue, rendered narrow by lateral contraction, ſearches every part of the mouth with its tip, and turns out the latent food into a heap on its common concavity. At another time, applying its extremity to the fore-teeth, and raiſing itſelf up ſucceſſively, it draws from the cavity of the mouth the fluids or chewed aliments, and conveys them to the fauces or back part of the mouth behind the teeth.

But theſe motions of the tongue are likewiſe governed by the muſcles and membranes, largely inſerted into the os hyoides; and this bone being drawn down by its reſpective muſcles, depreſſes the tongue at the ſame time, and the lower jaw likewiſe, if the muſcles of that be relaxed. Theſe powers are the ſterno-hyoides, ſterno-thyroideus, hyo-thyroideus, thyreo-pharyngeus, and coraco-hyoideus.

The other powers which elevate the os hyoides, together with the tongue, are its *ſtylogloſſus* muſcle, ſuſtained by a peculiar ligament of the upper jaw. The

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ſtylohyoideus, and ſecond *ſtylohyoideus*, which, when it is preſent, reſembles the former. All theſe muſcles draw the tongue back, but laterally they elevate it. The *mylohyoideus* elevates the tongue, and fixes it in making various motions, or in like manner depreſſes the jaw. The *geniohyoideus*, being a companion of the geniogloſſus, pulls the tongue forward out of the mouth.

But the muſcles of the cheeks variouſly move and preſs the food in the mouth. Others move it from the cavity of the cheeks into the inner cavity of the mouth behind the teeth, as we ſee in the buccinator when the mouth is ſhut. Others open the mouth for receiving the food; ſuch as the double-headed proper elevator of the upper lip, and the elevator anguli oris; to which add, the zygomaticus, upper and lower; the buccinator, depreſſor anguli oris, and depreſſor labii inferioris. Others, again, cloſe the lips, that the food received may not return out of the mouth; ſuch as the orbicularis of each lip, the proper depreſſor of the upper lip, and the proper elevator of the lower lip, and that which ſerves in common for the elevation of both.

By theſe means the food, ground and mixed with the ſaliva into a ſoft pulp, collected from all parts of the mouth by the tongue into the arched ſpace betwixt the teeth, is afterward, by the expanſion and ſucceſſive preſſure of the tongue, conveyed backward behind the teeth; and, in this action, the tongue is expanded by the hyogloſſi and geniogloſſi, and rendered a little concave by the ſtylogloſſus. And from thence it is next conveyed into the fauces.

For the tongue being raiſed by the ſtylogloſſi, and broadly applied to the palate, firſt by its apex, then alſo inſenſibly by its poſterior extremity, preſſes the food ſucceſſively towards the fauces, which at that time only afford an open paſſage. After this, the thick root and back part of the tongue itſelf, by the forementioned

ed muſcles, and by the ſtylohyoidei and biventers carried backward, preſſes down the epiglottis, which ſtands up behind the tongue, connected therewith by numerous membranes, and perhaps by ſome muſcular fibres. At the ſame time, the muſcles elevating the pharynx all act together; ſuch as the biventer, geniohyoides, geniogloſſus, ſtylohyoideus, ſtylogloſſus, ſtylopharyngeus, and the other elevators, which now draw the larynx upward and forward, that the epiglottis, being brought nearer to the convex root of the tongue, may be better cloſed or depreſſed. Hence it is neceſſary towards deglutition for the jaws to be cloſed, that by this means the biventer may have a firm ſupport; and, together with the muſcles already deſcribed, elevate the os hyoides. Thus the epiglottis, being inverted, ſhuts up and covers the paſſage very exactly, into the larynx, over which it is extended like a bridge for the aliment to paſs over into the fauces.

The pharynx is dilated in its action by the powers ſerving to its elevation; ſuch as the *ſtylopharyngeus*, the *thyreopalatinus*, &c. and it cloſely ſurrounds and follows the drink, on each ſide the epiglottis, above the larynx, that it may from thence fall into the œſophagus.

That the aliments might not regurgitate into the noſtrils at the time when they are preſſed into the dilated pharynx, a moveable velum or palate is interpoſed. The elevator of this velum, with its companion, forms an arch, which is moveable with the palate itſelf, between the two plates of the thyreopalatinus muſcle, ſo as to be brought into a cloſe contact with the ſides of the nares and with the tubes, that none of the aliment may enter into either of them. But this elevator does not ſeem to have any conſiderable action in ſwallowing. At this time regurgitation into the noſtrils is prevented by a conſtriction of the muſcles of the pharynx, together with a depreſſure of

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the thyreopalatinus, which then manifeſtly draws the moveable velum downward and towards the tongue and pharynx. Add to theſe, the *circumflexus palati mollis*, which is able both to open the tube, and to preſs down the moveable velum of the palate. Thus the pharynx being contracted like a ſphincter, drives down the food, without permitting any part to return back into the cavity of the nares. Hence, when the velum of the palate is vitiated, the aliments regurgitate into the noſtrils, and a deafneſs enſues.

During this endeavour to depreſs the food by the pharynx, the velum, drawn back and expanded, is pulled down towards the tongue, by the action of the palatopharyngei, and by the circumflex muſcles of the ſoft palate. Theſe muſcles, together with the gloſſopalatinus, preſs the velum againſt the protuberant root of the tongue, and intercept any return to the mouth and noſtrils. After there is no further danger of any part falling into the windpipe, the epiglottis is raiſed up again, as well by its own elaſticity, as by the elevation of the tongue itſelf, by which it is drawn forward. Laſtly, the depreſſed uvula is raiſed by the azygos, which ariſes from the tendons of the circumflexi muſcles and levator of the ſoft palate.

A little after this follows an attempt to urge the food downward, which is exerted by the conſtrictor muſcles of the pharynx which draw the fore parts towards the back, and the muſcles which are partly tranſverſe and partly aſcend into the poſterior ſurface of the pharynx. Theſe muſcles acting ſucceſſively from above downward, according to their ſituation, drive the aliment into the œſophagus. At the ſame time the depreſſing muſcles of the larynx, coracohyoideus, ſternohyoideus, and ſternothyreoideus, draw down the larynx forward, and leſſening the capacity of the pharynx urge the food downward. But in this action, as the aliment paſſes by the poſterior rima of the glottis, the arytænoidei contract the larynx perpendicularly.

As various dry and rough bodies are frequently ſwallowed, it was neceſſary for the pharynx to be dilatable and not very ſenſible of pain; to which end the great quantity of mucus, which is collected in all parts of the fauces, greatly conduces. Therefore, in general, betwixt the nervous and innermoſt coat of the pharynx, are placed a great number of ſimple mucous follicles or cells, pouring out their mucus through ſhort mouths; of a ſoft, viſcid, and ſomewhat watery nature; but ropy, or drawing out into threads, not without oil, and abounding more with volatile ſalt and earth than the ſaliva itſelf.

The aliments are moved through the œſophagus as through an inteſtine. The longitudinal fibres, aſcending to the cartilages of the larynx, dilate the gullet, oppoſite to the deſcending morſel. But when it is received, the longitudinal fibres equally dilate and elevate the gullet at that place which receives it. Then that part of the œſophagus where the morſel is ſeated, being irritated, contracts, and moves the food downwards. The muſcle is ſtrong, and very irritable.

This upper opening of the ſtomach is contracted or compreſſed in ſuch a manner, by the lower muſcle of the diaphragm, in every inſpiration, as to confine the food within the ſtomach, and direct it in every exſpiration, by preſſure, naturally towards the pylorus. By this means, the ſtomach is ſo cloſely ſhut, that in the moſt healthy man even wind or vapours are confined within the ſtomach; nor do they ever aſcend but by a morbid affection.

CHAP. II.

Of the THORAX.

BY the thorax, we commonly underſtand all that part of the body which anſwers to the extent of the ſternum, ribs, and vertebræ of the back, both outwardly and inwardly.

The thorax is divided into the anterior part, called commonly the *breaſt;* the poſterior part, called the *back;* and the lateral parts, called the *right* and *left ſides.*

The external parts of the thorax, beſides the ſkin and membrana adipoſa, are principally the mammæ; and the muſcles which cover the ribs, and fill the ſpaces between them.

The muſcles are the pectorales, majores, and minores, ſubclavii, ſerrati majores, ſerrati ſuperiores poſtici, latiſſimi dorſi, and vertebrales; and to theſe we may add the muſcles which cover the ſcapula.

The internal parts of the thorax are contained in the large cavity of that portion of the trunk which the ancients called the *middle venter*, but the moderns name it ſimply the *cavity of the breaſt.* This cavity is lined by a membrane named *pleura*, which forms the mediaſtinum; and contains the heart and lungs, with the veſſels, &c. which go into or out from them: through it likewiſe the œſophagus paſſes to the ſtomach, and part of the nerves are contained in it which go to the contents of the abdomen.

External conformation of the thorax. The whole extent of the thorax in a living ſubject, is commonly determined not only by the ſternum, vertebræ of the back and ribs, but alſo by all that ſpace contained between the articulations of the two arms with the ſcapulæ and claviculæ; and in this ſenſe, the outſide of the thorax

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is broader above than below in a healthy ſubject who has a moderate ſhare of fleſh on his bones.

The breadth of the upper part of the breaſt is owing to the pectorales majores and latiſſimi dorſi viewed directly forward or backward. But when we take a direct lateral view of the breaſt, it appears narrower above than below, not only in an entire ſubject, but even after every thing has been removed that covers the ſides of the thorax, and in the ſkeleton itſelf.

The common integuments of the thorax are the ſame with thoſe of the abdomen; and the convex ſide of this part of the body is likewiſe covered by ſeveral muſcles. Anteriorly, we find the pectorales majores and minores, a large portion of the ſerrati majores, the ſubclavii, a portion of the ſcaleni and of the obliqui abdominis externi. Poſteriorly, we have all the muſcles which cover both ſides of the ſcapula, the ſerrati poſtici, and a part of the ſacro-lumbares, longiſſimi dorſi, vertebrales, &c. as in the hiſtory of the muſcles. Among all the external parts of the thorax, only two are peculiar to it in the human body; namely, the two eminences called *mammæ*, which muſt therefore be deſcribed in this chapter.

Cavity of the thorax. The hard parts which form the ſides of the cavity of the thorax, are, The twelve vertebræ of the back, all the ribs, and the ſternum. The ſoft parts which complete the ſides, are, The membrane called *pleura*, which lines the cavity; and the muſculi intercoſtales, ſterno-coſtales, and diaphragma, already deſcribed among the muſcles.

All theſe hard and ſoft parts taken together, repreſent a kind of cage, in ſome meaſure of a conical figure, flatted on the foreſide, depreſſed on the backſide, and in a manner divided into two nooks by the figure of the vertebræ of the back, and terminated below by a broad arched baſis inclined backward. The intercoſtal muſcles fill up the interſtices betwixt the ribs, and ſo complete the ſides of the cavity: the baſis

is the diaphragm; and the pleura not only covers the whole inner ſurface of the cavity, but, by forming the mediaſtinum, divides it into two, one on the right, the other on the left.

§ 1. *Mammæ.*

THE name of *mammæ*, or *breaſts*, is given to two eminences more or leſs round, ſituated in the anterior, and a little toward the lateral parts of the thorax, their centre or middle part lying almoſt oppoſite to the bony extremity of the ſixth true rib on each ſide. Their ſize and figure vary in the different ſexes and different ages.

In children of both ſexes, and in males of all ages, they are commonly no more than cutaneous tubercles, or ſoft verrucæ of a reddiſh colour, called *papillæ* or *nipples;* each of them being ſurrounded by a ſmall, thin, and pretty broad circle or diſk, more or leſs of a browniſh colour and an uneven ſurface, termed *areola.*

In females come to the age of puberty, which is ſometimes ſooner, ſometimes later, a third part is joined to the two former, which is a convex protuberance, more or leſs round, of about five or ſix fingers in breadth; the papilla and areola being ſituated near the middle of its convex ſurface. This is what is properly termed *mamma;* and it may be termed the *body of the breaſt*, when compared with the other two parts. It increaſes with age, and is very large in women with child, and in thoſe that give ſuck. In old age it decreaſes and becomes flabby, loſing its natural conſiſtence and ſolidity.

Body of the Mamma. The body of the mamma is partly glandular, and partly made up of fat; or it is a gland of the conglomerate kind, ſurrounded on all ſides with cellular ſubſtance and fat. The glandular part is divided into little maſſes, ſeparated alſo by fat, and which are divided into ſmall granulæ, from which the

the lactiferous ducts arise: the cellulous pelliculæ support a great many blood-vessels, lymphatics, and serous or lactiferous ducts, together with the small glandular moleculæ already mentioned; all of them being closely surrounded by two membranes continued from the pelliculæ.

The innermost of these two membranes, which is in a manner the basis of the body of the mamma, is thick and almost flat, adhering to the musculus pectoralis major. The second or external membrane is thinner, forming a particular integument for the body of the mamma, more or less convex, and adhering closely to the skin.

The corpus adiposum of the mamma in particular, is a spongy cluster, more or less interlarded with fat, or a collection of membranous pelliculæ, which, by the particular disposition of their outer sides, form a kind of membrane in shape of a bag, in which all the rest of the corpus adiposum is contained. The anterior or outer portion of this bag, or that which touches the skin, is very thin; but that side next the pectoralis major is thick.

Ductus lactiferi. The glandular body contains a white mass, which is merely a collection of membranous ducts, narrow at their origin, broad in the middle, and which contract again as they approach the papilla, near which they were supposed by some to form a circle of communication; but from the observations of the latest anatomists, the ducts have little or no communication with each other at this place. They are named *ductus lactiferi;* and, in their course, are accompanied by a ligamentous elastic substance, which terminates with them in the nipple: both this substance, and the ducts it contains, are capable of considerable extension and contraction; but in their natural state are moderately corrugated, so as to prevent an involuntary flow of milk, unless the distending force be very great from the accumulation of too great a quantity."

Areola. The coloured circle or disk already mentioned, is formed by the skin; the inner surface of which sustains a great number of small glandular moleculæ, of that kind which Morgagni calls *glandulæ sebaceæ.* They appear very plainly all over the areola, even on the outside, where they form little flat heights or eminences at different distances quite round the circle.

These tubercles are perforated by small holes, through which a kind of sebaceous matter, more or less liquid, is poured out to defend the areola and nipple. Sometimes one or more of the lactiferous ducts have been found to terminate upon the surface of the areola; from which it would appear Morgagni was led to think that the glands there are of the lactiferous kind.

Papilla. The tubercle which lies in the centre of the areola, is termed *papilla*, or the *nipple.* It is of different sizes in different ages and constitutions, and in the different conditions of females in particular. In women with child, or who give suck, it is pretty large, and generally longer or higher than it is thick or broad; and when it happens to be short, it causes great uneasiness to the child.

The texture of the nipple is spongy, elastic, and liable to divers changes of consistence, being sometimes harder, sometimes more flaccid. It seems to be made up chiefly of ligamentary fasciculi; the extremities of which form the basis and apex of the nipple. These fasciculi appear to be gently folded, or curled, during their whole length; and if, by drawing the fibres out, these folds be destroyed, they return again as soon as that action ceases.

Between these spongy and elastic fasciculi lie from twelve to fifteen or twenty particular tubes at small distances from each other, and all in the same direction. These tubes go to the basis of the papilla, and run through the apex in the same number of almost imperceptible holes or orifices; and as they are closely

ly united to the elaſtic faſciculi, they are folded in the ſame manner with them.

The body of the papilla is covered by a thin cutaneous production, and by the epidermis. Its outer ſurface is uneven, being full of ſmall tubercles and wrinkles; among which thoſe near the circumference of the nipple ſeem to have a tranſverſe or annular diſpoſition, which, however, is not uniform.

This diſpoſition or direction ſeems to be owing to the elaſtic folds already mentioned: and from this ſimple ſtructure it is eaſy to explain how infants in ſucking the nipple, and women in drawing the teats of cows, bring out the milk. For the excretory tubes being wrinkled in the ſame manner as the faſciculi, do, by theſe wrinkles or folds, as by ſo many valves, hinder the milk contained in the ducts from flowing out; but when the nipple is drawn and elongated, the tubes loſe their folds, and the paſſage becomes ſtraight. Beſides this, when they are drawn with a conſiderable force, the whole body of the mamma is increaſed in length and contracted in breadth, and thereby the milk is preſſed into the open tubes; and thus by barely preſſing the body of the breaſt, the milk may be forced toward the nipple, and even through the tubes: but thoſe who underſtand the principles of the air-pump will more readily conceive the manner in which the child draws out the milk.

Arteries, *veins*, *nerves*, &c. The arteries and veins diſtributed through the mammæ, are ramifications of the arteriæ and venæ mammariæ; of which one kind comes from the ſubclaviæ, and are named *mammariæ internæ;* the others from the axillares, called *mammariæ externæ.*

Theſe veſſels communicate with each other, with thoſe near them, and with the vaſa epigaſtrica. The nerves come chiefly from the coſtales, and, by means of theſe, communicate with the great nervi ſympathetici. The mamma has numerous lymphatic veſſels,

which Wriſberg obſerves run in two ſets; and that moſt of theſe veſſels gradually collect into a great plexus, which go to the axillary glands; but others enter the thorax through the interſtices of the ribs, near the ſternum, and communicate with the glands behind the mammary veſſels.

Uſes. The uſe of the mammæ in the nouriſhment of children is known to all the world; but it is not certainly known what the papillæ and areolæ in males can be deſigned for. Milk has been obſerved in them in children of both ſexes; and this happened to one of Winſlow's brothers when he was about two years of age. *See* Art. Conception.

§ 3. *Pleuræ and Mediaſtinum.*

THE pleura is a membrane which adheres very cloſely to the inner ſurface of the ribs, ſternum, and muſculi intercoſtales, ſub-coſtales, and ſterno-coaſtales, and to the convex ſide of the diaphragm. It is of a very firm texture, and is ſupplied with blood-veſſels and nerves, in all which it reſembles the peritonæum; and likewiſe in that it is made up of an inner true membranous lamina, and a cellular ſubſtance on the outſide.

Each ſide of the thorax has its particular pleura, entirely diſtinct from the other, and making, as it were, two great bladders, ſituated laterally with reſpect to each other in the great cavity of the breaſt, in ſuch a manner as to form a double ſeptum or partition running between the vertebræ and the ſternum, their other ſides adhering to the ribs and diaphragm.

This particular duplicature of the two pleuræ is termed *mediaſtinum.* The two laminæ of which it is made up are cloſely united together near the ſternum and vertebræ; but in the middle, and toward the lower part of the foreſide, they are ſeparated by the pericardium and heart, as we ſhall ſee hereafter. A little more backward they are parted in a tubular form by the

the œsophagus, to which they serve as a covering; and in the most posterior part, a triangular space is left between the vertebræ and the two pleuræ from above downward, which is filled chiefly by the aorta.

Before the heart, from the pericardium to the sternum, the two laminæ adhere very closely; and there the mediastinum is transparent, except for a small space near the upper part, where the thymus is situated: so that in this place there is naturally no interstice or particular cavity. The apparent separation is owing entirely to the common method of raising the sternum, as was plainly demonstrated by Bartholinus, in his Treatise of the Diaphragm, published at Paris in 1676.

The mediastinum does not commonly terminate along the middle of the inside of the sternum, as the common opinion has been. Winslow demonstrated in the year 1715, to the Royal Academy of Sciences, that from above downward it inclines toward the left side; and that if, before the thorax is opened, a sharp instrument be run through the middle of the sternum, there will be almost the breadth of a finger between the instrument and the mediastinum, provided that the sternum remain in its natural situation, and the cartilages of the ribs be cut at the distance of an inch from it on each side.

From all this we see, not only that the thorax is divided into two cavities entirely separated from each other by a middle septum without any communication; but also that, by the obliquity of this partition, the right cavity is greater than the left; but there are exceptions to the above descriptions. Lieutaud says he has met with several subjects in which the mediastinum descended along the middle of the sternum; and others, where it was inclined to the left side. Sabatier observes this is rare; but he has likewise met with several examples, where an instrument thrust through the middle of the sternum got into the left cavity of the thorax: and he has sometimes seen the right lamina of the

the mediaſtinum fixed to the middle of the ſternum, while the left one was fixed oppoſite to the articulation with the cartilages of the ribs; a ſpace being left between the two, which was filled with cellular ſubſtance, intermixed with fat. From hence we may judge of the uncertainty of trepanning the ſternum, which the ancients have recommended in ſome caſes of abſceſſes, &c. between the layers of the mediaſtinum.

The pleura is connected to the membranous portion of the ſternum, ribs, and muſcles; to the diaphragm, pericardium, thymus, and veſſels; and, in a word, to whatever lies near its convex ſide.

The ſurface of the pleura turned to the cavities of the breaſt, is continually moiſtened by a lymphatic ſeroſity which tranſudes through the pores of the membranous portion. This fluid is ſaid to be ſecreted by imperceptible glands; but the exiſtence of theſe glands has not been hitherto demonſtrated.

Arteries and veins. The arteries and veins of the pleura are chiefly ramifications of the intercoſtals; and theſe ramifications are exceedingly numerous, and for the moſt part very ſmall. The mammariæ internæ and diaphragmaticæ likewiſe ſend branches hither, which communicate very frequently with thoſe that come from the intercoſtals.

The mediaſtinum has particular veſſels, called *arteriæ* and *venæ mediaſtinæ*, which are commonly branches of the ſubclaviæ. The mammariæ internæ ſend likewiſe ramifications to the fore-part of it, the diaphragmaticæ to the lower part, and the intercoſtales and œſophageæ to the back-part.

Nerves. The nerves, which are few, are ramifications of the true intercoſtales. Near the vertebræ they communicate with the great ſympathetic nerves, and but very little with the eighth pair.

Uſe. The pleura ſerves in general for an inner integument to the cavity of the thorax. The mediaſtinum cuts off all communication between the two cavities,

ties, and hinders one lung from preſſing on the other when we lie on one ſide. It likewiſe forms receptacles for the heart, pericardium, œſophagus, &c.; and it is continued over the lungs in the manner which ſhall be explained hereafter.

Before we leave the pleura, it muſt be obſerved that it adheres firmly to the ribs. This adheſion keeps the pleura ſtretched, and hinders it from ſlipping or giving way. It likewiſe renders this membrane extremely ſenſible of the leaſt ſeparation cauſed by a coagulated lympha or accumulated blood; the nervous filaments being likewiſe in this caſe very much compreſſed in inſpiration by the ſwelling of the intercoſtal muſcles.

§ 4. *Thymus.*

The thymus is an oblong very ſoft glandular body, round on the upper part, and divided below into two or three great lobes; of which that toward the left hand is the longeſt. In the fœtus it is of a pretty large ſize; leſs in children, and very little in aged perſons. In children it is of a white colour, ſometimes mixed with red; but in an advanced age its colour is generally dark.

The greateſt part of the thymus lies between the duplicature of the ſuperior and anterior portion of the mediaſtinum, and the great veſſels of the heart; from whence it reaches a little higher than the tops of the two pleuræ, ſo that ſome part of it is out of the cavity of the thorax; and in the fœtus and in children, it lies as much without the thorax as within it, and is then compoſed of numerous lobules, each incloſed in a thin covering, and united together by cellular ſubſtance: theſe are hollow within, and communicate together ſomewhat like the cells of the lungs, but they contain a milky fluid, which readily appears after an opening is made, but this fluid vaniſhes ſoon after birth. Among the various opinions about the uſe of this ſubſtance, ſome

ſome have thought it ſerved only to fill a part of the thorax of the fœtus in the collapſed ſtate of the lungs, becauſe its ſize decreaſes after the lungs are dilated.

Its particular inward ſtructure and ſecretions are not as yet ſufficiently known to determine its uſes; which, however, ſeem to be deſigned more for the fœtus than for adults. It has veſſels belonging to it, called *arteriæ* and *venæ thymicæ;* which are branches from the laryngæ inferior and mammaria interna.

§ 5. *Pericardium.*

The heart, with all the parts belonging to it, is contained in a membranous capſula, called *pericardium;* which is in ſome meaſure of a conical figure, and ſomewhat bigger than the heart; but the difference muſt be leſs during life when the heart is full of blood. It is not fixed to the baſis of the heart, but round the large veins above the auricles before they ſend off the ramifications, and round the large arteries before their diviſions.

The pericardium is made up of three laminæ; the middle and chief of which is compoſed of very fine tendinous filaments, which are beſt ſeen in old perſons; they are cloſely interwoven, and croſs each other in different directions. The internal lamina ſeems to be a continuation of the outer coat of the heart, auricles, and great veſſels. The trunks of the aorta and pulmonary artery have one common coat, which contains them both as in a ſheath, and is lined on the inſide by a cellular ſubſtance, chiefly in that ſpace which lies between where the trunks are turned to each other, and the ſides of the ſheath. There is but a very ſmall portion of the inferior vena cava contained in the pericardium.

It is the middle lamina which chiefly forms the pericardium; and the figure of this bag is not ſimply conical, its apex or point being very round, and the baſis

ſis having a particular elongation which ſurrounds the great veſſels, as has been already ſaid, as amply as the other portion ſurrounds the heart.

The pericardium is cloſely connected to the diaphragm, not the apex, but exactly at that place which anſwers to the flat or lower ſide of the heart; and it is a very difficult matter to ſeparate it from the diaphragm in diſſection, the tendinous fibres of the one ſubſtance intermixing with thoſe of the other. This adhering portion is in ſome meaſure of a triangular ſhape, anſwering to that of the lower ſide of the heart; and the reſt of the bag lies upon the diaphragm, without any adheſion.

The external lamina, or common covering, as it may be called more properly, is formed by the duplicature of the mediaſtinum. It adheres to the proper bag of the pericardium by the intervention of the cellular ſubſtance in that duplicature, but leaves it where the pericardium adheres to the diaphragm, on the upper ſurface of which it is ſpread, as being a continuation of the pleura.

The internal lamina is perforated by an infinite number of very ſmall holes, through which a ſerous fluid continually tranſudes, in the ſame manner as in the peritonæum, there being no glands for this purpoſe, as ſome have ſuppoſed. The pericardium, at its forepart, receives arteries from the mammaria interna and diaphragmatica: the lower part is ſupplied by the diaphragmatica; while the poſterior ſurface has branches from the ſubclavia, from the mammaria, and from the aorta, &c. The veins correſpond with the arteries, excepting ſome which go to the vena azygos. The nerves are chiefly from the eighth pair and great ſymphathetics. This fluid being gradually collected after death, makes what is called *aqua pericardii*, which is found in conſiderable quantities in opening dead bodies while they remain freſh. Sometimes it is of a reddiſh colour,

lour, which may be owing to a tranſudation of blood through the fine membrane of the auricles.

§ 6. *Of the Heart.*

Situation in general and conformation. THE heart is a muſcular body ſituated in the cavity of the thorax, on the anterior part of the diaphragm, between the two laminæ of the mediaſtinum. It is in ſome meaſure of a conical figure, flatted on the ſides, round at the top, and oval at the baſis. Accordingly we conſider in the heart, the baſis; apex; two edges, the one right and the other left; and two ſides, one of which is generally flat and inferior, the other more convex and ſuperior.

Beſides the muſcular body, which chiefly forms what we call the *heart*, its baſis is accompanied by two appendices, called *auriculæ*, and by large blood-veſſels; of which hereafter: and all theſe are included in the pericardium.

The heart is hollow within, and divided by a ſeptum which runs between the edges into two cavities, called *ventriculi;* one of which is thick and ſolid, the other thin and ſoft. This latter is generally termed the *right ventricle*, the other the *left ventricle;* though, in their natural ſituation, the right ventricle is placed more anteriorly than the left, as we ſhall ſee hereafter.

Each ventricle opens at the baſis by two orifices; one of which anſwers to the auricles, the other to the mouth of a large artery; and accordingly one of them may be termed the *auricular orifice*, the other the *arterial orifice.* The right ventricle opens into the right auricle, and into the trunk of the pulmonary artery; the left into the left auricle, and into the great trunk of the aorta. At the edges of theſe orifices are found ſeveral moveable pelliculæ, called *valves* by anatomiſts; of which ſome are turned inward toward the cavity of the ventricles, called *triglochines*, or *tricuſpides;* others are turned toward the great veſſels, called *ſemilunares*,

or *ſigmoidales*. The valvulæ tricuſpides of the left ventricle are likewiſe termed *mitrales*.

Ventriculi. The inner ſurface of the ventricles is very uneven, many eminences and cavities being obſervable therein. The moſt conſiderable eminences are thick fleſhy productions, called *columnæ*. To the extremities of theſe pillars are faſtened ſeveral tendinous cords, the other ends of which are joined to the valvulæ tricuſpides. There are likewiſe other ſmall ſhort tendinous ropes along both edges of the ſeptum between the ventricles. Theſe ſmall cords lie in an obliquely tranſverſe ſituation, and form a kind of net-work at different diſtances.

The cavities of the inner ſurface of the ventricles are ſmall deep foſſulæ or lacunæ placed very near each other, with ſmall prominent interſtices between them. The greateſt part of theſe lacunæ are orifices of the venal ducts, to be deſcribed hereafter.

Structure of the ventricles. The fleſhy or muſcular fibres of which the heart is made up, are diſpoſed in a very ſingular manner, eſpecially thoſe of the right or anterior ventricle; being either bent into arches or folded into angles.

The fibres which are folded into angles are longer than thoſe which are only bent into arches. The middle of theſe arches, and the angles of the folds, are turned toward the apex of the heart, and the extremities of the fibres toward the baſis. Theſe fibres differ not only in length, but in their directions, which are very oblique in all, but much more ſo in the long or folded fibres than in the ſhort ones, which are ſimply bent.

It is commonly ſaid that this obliquity repreſents the figure 8; but the compariſon is very falſe, and can only agree to ſome bad figures drawn by perſons ignorant of the laws of perſpective.

All theſe fibres, regard being had to their different obliquity and length, are diſpoſed in ſuch a manner, as

as that the longeſt form partly the moſt external ſtrata on the convex ſide of the heart, and partly the moſt internal on the concave ſide; the middle of the arches and the angles meeting obliquely and ſucceſſively to form the apex.

The fibres ſituated within theſe long ones grow gradually ſhorter and ſtraighter all the way to the baſis of the heart, where they are very ſhort and very little incurvated. By this diſpoſition, the ſides of the ventricles are very thin near the apex of the heart, and very thick toward the baſis.

Each ventricle is compoſed of its proper diſtinct fibres; but the left ventricle has many more than the right, its ſubſtance being conſiderably thicker. Where the two ventricles are joined, they form an impervious ſeptum which belongs equally to both. Oppoſite to this ſeptum a groove is ſeen on the outſide of the heart; one running longitudinally on its upper, the other on its under ſurface: in theſe grooves the great branches of the coronary arteries and veins are lodged.

There is this likewiſe peculiar to the left ventricle, that the fibres which form the innermoſt ſtratum of its concave ſide, form the outermoſt ſtratum of the whole convex ſide of the heart, which conſequently is common to both ventricles; ſo that, by carefully unravelling all the fibres of the heart, we find it to be made up of two bags contained in a third.

The anterior or right ventricle is ſomewhat larger than the poſterior or left, as was well obſerved by the ancients, and clearly demonſtrated by M. Helvetius. The left is a little longer than the right, and in ſome ſubjects they end exteriorly in a kind of double apex. But it appears from experiments, that the inequality between the parts of the right and thoſe of the left ſide of the heart, are not ſo great during life as after death; for, in the hearts of animals killed by cutting acroſs the veſſels of the neck, and in thoſe of perſons who have died in battle from a wound in

the vena cava or pulmonary artery, the inequality is leſs than we commonly perceive. This was firſt obſerved by M. Vieuſſens Profeſſor of Anatomy at Altorf.

Sabatier has made numerous experiments on animals; the reſult of which is nearly the ſame with that mentioned above.

All the fibres are not directed the ſame way, though they are all more or leſs oblique: for ſome end toward the right hand, others toward the left, ſome forward, ſome backward, and others in the intermediate places; ſo that, in unravelling them, we find that they croſs each other gradually, ſometimes according to the length of the heart, and ſometimes according to its breadth.

The tubes which croſs each other tranſverſely are much more numerous than thoſe which croſs longitudinally; which ought to be taken notice of, that we may rectify the falſe notions that have been entertained concerning the motion of the heart; namely, that it is performed by a contortion or twiſting like that of a ſcrew, or that the heart is ſhortened in the time of contraction, and lengthened in dilatation.

The fibres which compoſe the inner or concave ſurface of the ventricles do not all reach to the baſis; ſome of them running into the cavity, and there forming the fleſhy columnæ, to which the looſe floating portion of the tricuſpidal valves is faſtened by tendinous ropes.

Beſides theſe fleſhy pillars, the internal fibres form a great many eminences and depreſſions, which not only render the inner ſurface of the ventricles uneven, but give it a great extent within a ſmall compaſs. Some of theſe depreſſions are the orifices of the venal ducts found in the ſubſtance of the ventricles, which have been already mentioned. The circumferences of the great openings at the baſis of the heart are tendinous, and may be looked upon as the common tendon of all the fleſhy fibres of which the ventricles are compoſed.

Valvulæ. The valves at the orifices of the ventricles

are of two kinds: one kind allows the blood to enter the heart, and hinders it from going out the ſame way; the other kind allows the blood to go out of the heart, but hinders it from returning. The valves of the firſt kind terminate the auriculæ; and thoſe of the ſecond lie in the openings of the great arteries. The firſt are termed *ſemilunar* or *ſigmoidal valves*; the others, *triglochines*, *tricuſpidal*, or *mitral*.

The tricuſpidal valve of the right ventricle is of a circular form, and is fixed to the opening of the auricle, while the other end is attached to the internal ſurface of the ventricle. The circular membrane of the valve ſoon divides into many parts, three of which are more conſiderable than the reſt; and theſe have got the name of *tricuſpid valves*, though they are now generally conſidered as forming one. That which is next the mouth of the pulmonary artery is the largeſt, and is ſaid by ſome to prevent the blood from getting into the artery while the ventricle is filling. It has three triangular productions, very ſmooth and poliſhed on that ſide which is turned towards the auricle; and on the ſide next the cavity of the ventricle, they have ſeveral membranous and tendinous expanſions, and their edges are notched or indented. The valve of the auricular orifice of the left ventricle is of the ſame ſhape and ſtructure, but it is only divided into two parts; and, from ſome ſmall reſemblance to a mitre, has been named *mitralis*. That which is next the mouth of the aorta is the largeſt.

The ſemilunar valves are ſix in number, three belonging to each ventricle, ſituated at the mouths of the great arteries; and they may be properly enough named *valvulæ arteriales*. Their concave ſides are turned toward the cavity of the arteries, and their convex ſides approach each other. In examining them with a microſcope, we find fleſhy fibres lying in the duplicature of the membranes of which they are compoſed.

They

They are truly ſemilunar, or in form of a creſcent, on that ſide by which they adhere: but their looſe edges are of a different figure, each of them repreſenting two ſmall creſcents; the two extremities of which meet at the middle of this edge, and there form a kind of ſmall papilla, firſt deſcribed by Arantius, and afterwards by Morgagni, and therefore named from them.

The aorta in general. The great artery that goes out from the left ventricle, is termed *aorta*. As it goes out, it turns a little toward the right hand, and then bends obliquely backward, to form what is called *aorta deſcendens*; which we ſhall have occaſion to mention again hereafter. At the beginning of the aorta, and behind the ſemilunar valves, three elevations are obſerved on the outſide: theſe correſpond to an equal number of pits on the inſide, which, from the diſcoverer, have been called *ſinuſes of Valſalva*. Their uſe is not well known. From about the middle of the convex ſide of this curvature three great branches ariſe, which furniſh an infinite number of ramifications to the head and upper extremities of the body; as the deſcending aorta does in the ſame manner to the thorax, abdomen, and lower extremities.

The arteria pulmonaris in general. The trunk of the artery which goes out from the right ventricle, is called *arteria pulmonaris*. This trunk, as it is naturally ſituated in the thorax, runs firſt of all directly upward for a ſmall ſpace; then divides laterally into two principal branches, one for each lung; that which goes to the right lung being the longeſt, for a reaſon that ſhall be given hereafter.

Auriculæ. The auricles are muſcular bags ſituated at the baſis of the heart, and their capacities are in proportion to thoſe of their reſpective ventricles; one towards the right ventricle, the other towards the left, and joined together by an inner ſeptum and external communicating fibres, much in the ſame manner with

the ventricles; one of them being named the *right auricle*, the other the *left*. They are very uneven on the inside, but smoother on the outside; and terminate in a narrow, flat, indented edge, representing a cock's comb, or in some measure the ear of a dog; this properly gets the name of *auricle*, the larger and smooth part of the cavity being called *sinus venosus*, but as the two parts make one general cavity, the name of *auricle* is commonly applied to the whole. They open into these orifices of each ventricle, which I name *auricular orifices*; and they are tendinous at their opening, in the same manner as the ventricles.

The right auricle is larger than the left; and it joins the right ventricle by a common tendinous opening, as has been already observed. It has two other openings united into one, and formed by two large veins which meet and terminate there, almost in a direct line, called *vena cava superior* and *inferior*. Highmore has described an eminence in form of a valve, placed between the mouths of the two venæ cavæ: this he supposed directs the blood from the veins into the auricle; afterwards Lower described and delineated it; and other anatomists have called it *tuberculum Loweri*, till Morgagni denied its existence in the human subject. At the mouth of the inferior cava we find a membrane in form of a crescent, described by Eustachius, and named from him. Its convex edge is fixed to the union of the vein and the right auricle, while its concave edge is turned upwards over the mouth of the vein. It is most complete in the fœtus; but it is found likewise in a person of advanced age, though it sometimes, from use, has a reticular appearance. It is said to prevent the blood in the auricle from returning into the cava; but it has a different use in the fœtus. The notched edge of this auricle terminates obliquely in a kind of obtuse point, which is a small particular production of the great bag, and is turned toward the middle of the basis of the heart.

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The whole inner ſurface of the right auricle is uneven, by reaſon of a great number of prominent lines which run acroſs the ſides of it, and communicate with each other by ſmaller lines, which lie obliquely in the interſtices between the former. The lines of the firſt kind repreſent trunks, and the other ſmall branches in an oppoſite direction to each other. In the interſtices between theſe lines, the ſides of the auricle are very thin and almoſt tranſparent, ſeeming to be formed merely by the external and internal coats of the auricle joined together, eſpecially near the point.

The left auricle is in the human body a kind of muſcular bag or reſervoir, of a pretty conſiderable thickneſs and unequally ſquare, into which the four veins open called *venæ pulmonares*, and which has a diſtinct appendix belonging to it, like a third ſmall auricle. This bag is very even on both ſurfaces, and is therefore called *ſinus venoſus;* but to diſtinguiſh it from the one on the right ſide, it is called *ſinus venoſus ſiniſter.* However, the bag and appendix have but one common cavity; and therefore may ſtill be both comprehended under the common name of the *left auricle.* In men, the ſmall portion may likewiſe be named *the appendix of the left auricle;* but in other animals, the caſe is different.

This ſmall portion or appendix of the left auricle is of a different ſtructure from that of the bag or large portion. Exteriorly, it reſembles a ſmall oblong bag, bent different ways, and indented quite round the edges. Interiorly, it is like the inſide of the right auricle. The whole common cavity of the left auricle is ſmaller in an adult ſubject than that of the right; and the fleſhy fibres of this left auricle croſs each other obliquely, in ſtrata differently diſpoſed.

Arteriæ & venæ coronariæ. Beſides the great common veſſels, the heart has veſſels peculiar to itſelf, called *the coronary arteries* and *veins*, becauſe they in ſome

meaſure crown the baſis of the heart. The coronary arteries, which are two in number, go out from the beginning of the aorta, and afterwards ſpread themſelves round the baſis of the heart, to the ſubſtance of which they ſend numerous ramifications.

Vieuſſens believed that ſome of the branches of the coronary artery opened into the cavities of the ventricles and auricles; for, by throwing a fine injection into theſe arteries, he found it run out on all ſides of the right ventricle and auricle. Thebeſius of Allemand, being nearly of the ſame opinion, endeavoured to prove, that there were veins which carried part of the blood from the coronary arteries immediately into the cavities of the heart; and theſe have therefore got the name of *veins of Thebeſius*, though he is not the firſt diſcoverer. Winſlow, Haller, and ſeveral others, deſcribe ſuch veins; but Duverney, after injecting the heart of an elephant, doubts of their exiſtence. Senac, who has paid much attention to this ſubject, denies it altogether; and Sabatier coincides with him in opinion.

The nerves of the heart are from the par vagum and great ſympathetics: theſe form the cardiac plexus, which ſends off branches to the pericardium, to the roots of the great veſſels, and are ſpent at laſt on the different parts of the heart.

There are ſeldom more than two arteries; of which one lies toward the right hand, the other toward the left of the anterior third part of the circumference of the aorta. The right coronary artery runs in between the baſis and right auricle, all the way to the flat ſide of the heart, and ſo goes half way round. The left artery has a like courſe between the baſis and left auricle; and before it turns on the baſis, it ſends off a capital branch, which runs in between the two ventricles. Another principal branch goes off from the union of the two arteries on the flat ſide of the heart; which running to the apex, there joins the other branch.

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The coronary veins are diſtributed exteriorly, much in the ſame manner. The largeſt opens into the poſterior inferior part of the right auricle, by an orifice which is furniſhed with a valve, firſt deſcribed by Euſtachius. Beſides the coronary veins, the heart has other anterior veins, which have been called by Vieuſſens *venæ innominatæ*. Some of them go into the right auricle, others end in the right ventricle; and there are other veins ſtill ſmaller, which are found in the ſubſtance of the heart, and which terminate in the right ſinus and auricle.

Particular ſituation of the heart. The heart lies almoſt tranſverſely on the diaphragm, the greateſt part of it being in the left cavity of the thorax, and the apex being turned toward the bony extremity of the ſixth true rib. The baſis is toward the right cavity; and both auricles, eſpecially the right, reſt on the diaphragm; but the ſituation of the heart during life changes a little, according to the ſtate of reſpiration, and to the poſition of the body.

The origin or baſis of the pulmonary artery is, in this natural ſituation, the higheſt part of the heart on the foreſide; and the trunk of this artery lies in a perpendicular plane, which may be conceived to paſs between the ſternum and ſpina dorſi. Therefore ſome part of the baſis of the heart is in the right cavity of the thorax; and the reſt, all the way to the apex, is in the left cavity; and it is for this reaſon that the mediaſtinum is turned toward that ſide.

According to this true and natural ſituation of the heart, the parts commonly ſaid to be on the right ſide are rather anterior, and thoſe on the left ſide poſterior; and that ſide of the heart which is thought to be the foreſide is naturally the upper ſide, and the backſide conſequently the lower ſide.

The lower ſide is very flat, lying wholly on the diaphragm; but the upper ſide is a little convex through its whole length, in the direction of the ſeptum be-

tween the ventricles. And it may be proper here to remark, that though commonly received terms of art may ſtill be retained, yet it is neceſſary to prevent their communicating falſe ideas to thoſe who have not had an opportunity of making obſervations themſelves, or of being inſtructed by others.

Uſes in general. The heart and parts belonging to it are the principal inſtruments of the circulation of the blood. The two ventricles ought to be conſidered as two ſyringes ſo cloſely joined together as to make but one body, and furniſhed with ſuckers placed in contrary directions to each other, ſo that by drawing one of them, a fluid is let in, and forced out again by the other.

The heart is made up of a ſubſtance capable of contraction and dilatation. When the fleſhy fibres of the ventricles are contracted, the two cavities are leſſened in an equal and direct manner, not by any contortion or twiſting, as the falſe reſemblance of the fibres to a figure of 8 has made anatomiſts imagine. For if we conſider attentively in how many different directions and in how many places theſe fibres croſs each other, as has been already obſerved, we muſt ſee clearly, that the whole ſtructure tends to make an even, direct, and uniform contraction, more according to the breadth or thickneſs than according to the length of the heart; becauſe the number of fibres ſituated tranſverſely, or almoſt tranſverſely, is much greater than the number of longitudinal fibres.

The fleſhy fibres thus contracted do the office of ſuckers, by preſſing upon the blood contained in the ventricles; which blood being thus forced toward the baſis of the heart, preſs the tricuſpidal valves againſt each other, opens the ſemilunares, and ruſhes with impetuoſity through the arteries and their ramifications, as through ſo many elaſtic tubes.

Syſtole. The blood thus puſhed on by the contraction of the ventricles, and afterwards preſſed by the elaſtic

ſtic arteries, enters the capillary veſſels, and is from thence forced to return by the veins to the auricles, which, like retirements, porches, or antichambers, receive and lodge the blood returned by the veins during the time of a new contraction. This contraction of the heart is by anatomiſts termed *ſyſtole*.

Diaſtole. The contraction or ſyſtole of the ventricles, ceaſes immediately, by the relaxation of their fleſhy fibres; and in that time the auricles which contain the venal blood, being contracted, force the blood through the tricuſpidal valves into the ventricles, the ſides of which are thereby dilated, and their cavities enlarged. This dilatation is termed *diaſtole*.

Circulation. In this manner does the heart, by the alternate ſyſtole and diaſtole of its ventricles and auricles, puſh the blood through the arteries to all the parts of the body, and receive it again by the veins. This is called the *circulation of the blood*, which is carried on in three different manners.

The firſt and moſt univerſal kind of circulation is that by which almoſt all the arteries of the body are filled by the ſyſtole of the heart, and the greateſt part of the veins evacuated by the diaſtole.

The ſecond kind of circulation oppoſite to the firſt, is through the coronary veſſels of the heart, the arteries of which are filled with blood during the diaſtole of the ventricles, and the veins emptied during the ſyſtole.

The third kind of circulation is that of the left ventricle of the heart; through the venal ducts of which a ſmall quantity of blood paſſes, without going through the lungs, which is the courſe of all the remaining maſs of blood.

Beſides theſe three different kinds of circulation, there are ſome peculiarities in the courſe of the blood, which may be looked upon as particular circulations. Such is the paſſage of the blood through the liver, cor-

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pora cavernoſa of the parts of generation, and through the cavernous ſinuſes of the dura mater.

NATURE hath given a heart to moſt animals, even to many inſects and worms: to others ſhe hath denied it; and theſe are the moſt ſimple of all animals, even very large ones, though they are irritable throughout their whole body; as, for inſtance, the prickly hydra. Thoſe animals which have no hearts, have alſo no veſſels.

The veins which carry back the blood from the whole body to the heart, if we except thoſe of the lungs, are reducible to two, which are the venæ cavæ.

The blood of the two venæ cavæ is propelled by a muſcular force, in either vein, into the right auricle. Theſe veins, as far as they lie within the breaſt, are endowed with ſtrong and irritable muſcular fibres, by whoſe contraction the blood is driven into the neighbouring auricle.

In like manner, the auricle, being irritated, is contracted on all ſides. And, firſt, by a conſtriction of its muſcular fibres, the anterior ſemicylinder of the auricle is reduced to a plane; while the ſame fibres, by their contraction, bring back the middle arch towards the anterior extremity or beginning of the heart, and likewiſe towards its poſterior extremity or ſinus. Then the appendix to the auricle deſcends, and is contracted tranſverſely by itſelf, while the lower part aſcends; and thus the auricle becomes ſhorter. Again, the left edge turns evidently to the right, and the right edge a little to the left; and thus the auricle is rendered narrower. Thus the blood of both cavæ, being mixed together in the beginning of the heart now diſencumbered, is driven through the edges of the open valve, in ſuch a manner as to urge the valves of the right ventricle cloſe to the ſides of the heart. But the blood is now hindered from returning again into the lower cava, both by the contraction of the auricle, the reſiſtance of the ſucceeding blood from the

the abdomen, and of the *Euſtachian valve;* and upwards it is hindered from aſcending, both by the motion and weight of the conſequent blood. It is driven back, however, on both ſides, if there happens to be any obſtacle in the lungs.

The uſefulneſs of the valvulæ tricuſpides is evident enough; for the right auricle being contracted, the blood contained in the right porch of the heart, at the looſe extremity of the auricle, being impelled from the circumference towards the axis, like a wedge, ſeparates the pendulous portions of the valves, and preſſes them to the ſides of the heart. Thus is filled the right ventricle of the heart, while the uppermoſt valve ſhuts the pulmonary artery, leſt the blood, by the weak impulſe of the auricle, ſhould flow into that artery: the blood thus received, and confined within the right ventricle of the heart, is, by the ſtrong contraction thereof, more powerfully expelled into the artery.

The ſenſible fleſh of the heart, being irritated by the quantity and weight of this warm blood, is thereby ſolicited to a contraction: for that the heart, being irritated, will contract itſelf in a perſon dying, or even lately dead, is proved by injections of water, and inflations of air, whereby the heart, then quieſcent, is recalled to its motion.

The heart's motion is performed by *muſcular fibres;* the originations of which, in general, are from rings formed of the cellular ſubſtance, compacted into a callous ligament, agreeable to the deſcription already given, and with which all the larger blood-veſſels at their opening into the heart are ſurrounded. From thence the fibres, which ariſe, deſcend gradually in an oblique winding courſe towards the left ſide, and forward to the apex, in many diſtinct plates, and ſometimes a little traverſing each other, the middle ones being the moſt tranſverſe, while the outermoſt and innermoſt deſcend in a ſtraighter line. In the flat ſide of the heart there are few fibres; and ſo thin, that when you have removed

ved the fat, the cavity appears almoſt uncovered. That which is called the left ventricle, is, however, very firmly inveſted by the fibres; which, after ſurrounding the ſame ventricle, form a ſlight decuſſation in the ſeptum cordis with the fibres of the right ventricle, and are interwoven with them. Some of theſe fibres deſcend into the cavities of the ventricles, and form there the fleſhy columns. Others at the tip of the heart, are wound in a vortical or whirling poſition, the two horns ending by a ſtrong faſciculus or bunch in each ventricle. A very thin and ſmooth membrane covers the external and internal ſurface of theſe fibres; but the external membrane, eſpecially where it is ſpread over the coronary veſſels, contains much fat beneath it. It is difficult to diſtinguiſh any thing more particular in the muſcular fabric of the heart, with any tolerable degree of evidence; becauſe it is the peculiar property of the fibres in the heart to join together in branchy appendices or heaps, in ſo ſtrict union, that they cannot be ſeparated without laceration.

But there are ſeveral eminent anatomiſts, whoſe ingenuity and communicative freedom deſerve reſpect, who have repreſented and deſcribed thoſe fibres diſplayed and ſeparated: namely, the external fibres of the heart, common to both ventricles, deſcending to the tip, and then, taking another courſe, to inſert themſelves into the ſeptum; others again, at the tip, to perforate the left ventricle, and return, in a contrary courſe, to the baſis along the inner ſurface of the ſaid ventricle. But the middle fibres, betwixt the aforeſaid inner and outermoſt ones, being variouſly inclined towards the baſis, form the ſeptum. And others have given us figures and deſcriptions of ſtill different orders of fibres, of which the outermoſt run counter to the innermoſt, while the intermediate are tranſverſe. To the above deſcription, ſays Dr Haller, as they are not much different from my own obſervations, I ſhall make no oppoſition, although I have never been able to ſee this

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diſpoſition of them ſufficiently manifeſt, and am acquainted with great anatomiſts who have not been more ſucceſsful than myſelf.

Theſe fibres of the heart, like other muſcles, are furniſhed with *nerves* of their own, very numerous and of various origin.

That theſe nerves conduce powerfully to move the heart, is the opinion of eminent anatomiſts, from a conſideration of the common nature of muſcles; and from the increaſe which follows in the heart's motion, by irritating the eighth pair of nerves, either at the brain or the ſpinal medulla; and from the languor that enſues upon tying thoſe nerves, which proves fatal, either ſuddenly or within a few days, even though you happen to make the ligature on but a few of the nerves that come to the heart; for the intercoſtal, and eſpecially thoſe from the ganglion of the upper thoracic, cannot be tied.

But that there are ſtill other cauſes, beſides that of the nerves, conducing to the motion of the heart, we are perſuaded from obſerving its motion undiſturbed by the irritation of all the nerves in the living animal; from its remaining after the greateſt wounds of the head, and even of the cerebellum and medulla ſpinalis; likewiſe from its motion when torn out of the breaſt; chiefly in thoſe animals whoſe lungs, being impermeable, make no reſiſtance to the heart's motion; for the motion of the heart is obſerved to be very vigorous in the fœtus before the brain is well formed, and likewiſe in animals wanting the head. And all our experiments agree in this, that the quieſcent heart in dead or dying animals, when irritated by heat, vapours, poiſons, and eſpecially impelled flatus, watery liquors, wax, or blood, or on receiving an electric ſpark, immediately contracts itſelf, putting all its fibres into a rapid motion, by a force ſometimes common throughout the whole heart, and ſometimes affecting only a particular part of it.

Thus then we ſee, that there reſides in the heart a kind of impatience of ſtimulus; ſo that even in the viſcus, when almoſt dead, wrinkles, and motions of different kinds, appear to be propagated along its ſurface, from places as it were irradiating from points: again, the heart, when torn out and cold, on being pricked, inflated, or irritated, contracts itſelf; and its fibres, when diſſected, corrugate themſelves orbicularly, when there is neither nerve nor artery to bring it ſupplies of any kind. This irritability is greater, and remains longer in the heart, than in any other part of the body; ſeeing, by ſtimulating it, the motion of the heart may be renewed at a time, when that of no other muſcle can. The heart of the fœtus is moſt irritable, as well as larger, in proportion, than in adults; and moſt tenacious of its motion, even in the cold. That motion is *peculiar to the heart itſelf;* coming neither from the brain, nor the ſoul; ſeeing it remains in a dead animal even when the heart is torn out of the breaſt; neither can it, by any act of the will, be made either quicker or ſlower.

It is, therefore, evident, that the ſtimulus, occaſioned by the impulſe of the venous blood, cauſes the heart contract itſelf; and that this contraction is convulſive, made with great celerity, and a manifeſt corrugation of the fibres; whereby the whole heart becomes ſhorter, thicker, and harder; ſo that the left ventricle is drawn ſomewhat towards the ſeptum of the heart, and the right one much more. The baſe alſo advances towards the apex; but the apex more evidently towards the baſis. (This Dr Haller has often obſerved with the greateſt certainty in diſſecting brute animals; ſo that thoſe learned gentlemen muſt have ſome way or other been deceived, who have aſſerted, that the heart is elongated during its contraction.) But the heart does not ſeem to turn pale in ſuch animals as have warm blood. Even the ſeptum of the heart is rendered ſhorter, and draws itſelf towards the baſis. By this action, the

fleſhy parts of the heart ſwell inwardly, and compreſs the blood as they do the finger, when introduced into its cavities. But that the heart is accurately enough emptied in this action, appears from the event; the evident paleneſs of animals whoſe heart is white, as frogs and chickens; and from the internal ſurface being full of eminences, which exactly anſwer to oppoſite cavities, and to the thick reticular arms or columns interrupted by ſinuſes. And beſides, the apex of the heart, being contracted a little like a hook, ſtrikes againſt that part of the pericardium next the thorax. Forwards, there is alſo a pulſation from the left venal ſinus; which is at that time particularly filled. In exſpiration, the heart ſtrikes violently upwards and forwards. The truth of both theſe we know by experiment.

The blood, which is preſſed by the contracted heart, endeavours to eſcape in all directions; but being driven from the muſcular ſides, towards the axis of the ventricle, by the reaction of what is lodged betwixt the venal ring and ſides of the heart, the looſer ends of the ſaid ring are driven forwards and extended inward at the ſame time. By this action upon the whole circumference of the ring, it not only becomes extended itſelf, but, at the ſame time, rejects a part of that blood into the right auricle, which had before deſcended into the cone of the open valve, whoſe ſides, now approaching, ſhut up the venous orifice more cloſely as the heart contracts more ſtrongly; by whoſe force the tricuſpid valves, as they are called, would be preſſed reduplicated into the auricle, if the muſcular nipples or columns did not keep down their edges, and hold them firmly by their contraction (which is the ſame with that of the heart) in ſuch a ſhape as will extend the annexed cords of the valve, without injuring them.

But the niſus of the remaining blood, now reſiſted by the tricuſpids, ſeeks another courſe; and whilſt the larger of thoſe valves that is ſeated to the right, advances from the ſide towards the axis of the heart, this

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leaves open the mouth of the pulmonary artery, which it before covered; whereupon the blood preſſing the valves in the mouth of the ſaid artery cloſe to its ſides thus ruſhes into it.

Each of theſe valves, in conjunction with the ſides of the artery here diverging, intercepts a ſpace, which is blind or impervious downward, but open upward in a parabolical ſhape, as we ſhall find in the valves of the veins. When, therefore, the blood is impelled from the ſides towards the axis of the contracting heart, it endeavours to eſcape in the direction of the ſaid axis; and, by ruſhing forth like a wedge, betwixt the valves, preſſes their looſe ſail-like edges againſt the ſides of the pulmonary artery, ſo as to run freely out of the heart. The truth of this appears from the fabric, from injections, and from ligatures, which, by obſtructing the lungs, will not ſuffer the large cavities in the right ſide of the heart to be emptied.

The blood now received into the pulmonary artery, goes on then to make its circulation through the lungs. That artery is firſt divided into two branches; of which the left, being leſs and ſhorter, enters directly into the ſubſtance of the lungs: but the right branch, being larger and longer, paſſes tranſverſely through the arch of the aorta; and, after going a little way behind the ſaid aorta, enters the correſponding lungs of the ſame ſide. From each of theſe branches, by a multiplied ſubdiviſion, ariſe the very leaſt arteries; ſome of which tranſmit the blood directly into the continued ſmall veins, and others exhale part of its aqueous juices into the pulmonary cells. That the blood goes thus directly from the arteries into the pulmonary veins, appears evidently from their ſtructure; alſo from a ligature, which intercepting the blood's courſe, while the heart and lungs ſtill urge it, cauſes an aneuriſmatic dilatation of the artery; and from polypuſes, by which, the mouth of the pulmonary artery being obſtructed, the right cavities of the heart become monſtrouſly enlarged, and

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at length burſt, while the left remain empty. Laſtly, from injections; for water, fiſh-glue, and milk, are very eaſily forced from the pulmonary artery into the vein, and from thence into the left cavity of the heart. But the direct anaſtomoſes or final openings of the arteries into the veins in the lungs, is proved even to the ſight by the microſcope, in frogs, &c.

Nor can the blood which has once entered the pulmonary artery return back again upon the heart; becauſe the valves therein are of ſuch dimenſions, that when diſtended, they perfectly ſhut up the opening at the heart; and are ſo ſtrong that they reſiſt a much greater force than the contraction of the pulmonary artery, without being conſtrained to yield. However, ſometimes, from a greater contractile force of the artery, they grow ſomewhat callous; or, from a laceration of their outer membrane, a bony matter is poured in betwixt the duplicature of the valves. For, when the blood, by the contraction of the artery, returns towards the heart, it meets and enters the open ſail-like concavities of the valves, which are by that means expanded, and driven together towards an axis in the middle: whence the valves, once expanded, quite ſhut up the mouth of the artery, ſo as to leave not the leaſt ſlit open; for any opening that might be left, is precluded by the ſmall callous bodies remarked in the middle of the valves.

The *pulmonary veins*, of which we ſhall ſay more hereafter, gather into larger branches, which at laſt terminate in four (ſeldom two, and ſtill more rarely into five) trunks; to which it has been cuſtomary to affix a name in the ſingular, by calling them the *pulmonary vein*. Theſe enter the cavity of the pericardium, from whence they receive an external covering; and are then inſerted at angles into the ſquare left or poſterior ſinus, which is ſometimes likewiſe called the *pulmonary ſinus*. In this courſe the upper veins deſcend as the lower ones aſcend. But that theſe veins bring their

blood towards the heart, in the ſame direction with the ſinus into which they open, is proved by a ligature, which cauſes a turgeſcence or ſwelling, from the blood retained, betwixt the ligature and the lungs.

In this left ſinus, the blood waits for the heart's relaxation; at which time the niſus of the blood impelled againſt the venous valves, and the contracting ſtronger force of the ſinus, grow leſs. Then the left ſinus ſtretches itſelf forward acroſs the heart, is contracted tranſverſely along with it, and the appendix becomes evidently ſhorter and narrower. Thus the blood is driven into the left ventricle, in like manner as the right auricle impelled its blood into the right ventricle. For here, as before, a like membranous oval ring forms productions called *mitral valves*, of which there are uſually two only counted. Theſe valves are longer and ſtronger than thoſe of the right ventricle. They have each its own and ſeparate muſcular ſtructure; but it is much firmer than that of the tricuſpids. And here, more often than in the valves on the right ſide, we find cartilaginous tumors in the tendinous ſtrings, produced by the friction occaſioned by the great motion of the heart.

From what has been ſaid then, it appears that the ſame blood is now arrived into the left ventricle of the heart, which was a little before ſent from the venæ cavæ into the right auricle, which drove it into the correſponding or right ventricle; by which again it was urged into the pulmonary artery; and from thence paſſing into the pulmonary veins, was conveyed into the left ſinus; and out of this we here find it driven into the left ventricle. This courſe of the blood, from one ſide of the heart to the other through the lungs, is called the *pulmonary* or *leſſer circulation*, and was known to many of the ancients. It is proved by the increaſed bulk of the pulmonary veins on the left ſide; and likewiſe of the right cavities of the heart, from

from an obſtruction of the entrance into the left ventricle.

The *left*, or poſterior and upper *ventricle* of the heart, which is always firſt formed, and in a great number of animals the only one, makes up that part of its half cone-like body, which we before called *obtuſe*. It is ſomewhat narrower than the right ventricle, a little longer, rounder, and generally of a leſs capacity within, ſays Dr Haller: for the contents of this ventricle are about two ounces, while thoſe of the right approach to three. Its fabric internally is reticular, but more nicely wrought than in the right ventricle; and within the mouth of the artery it is ſmooth: but its force is conſiderably greater, as the muſcular fleſh that ſurrounds it is much thicker and almoſt three times ſtronger. The ſeptum of the heart belongs moſtly to the left, but ſome part of it alſo to the right ventricle: the whole of it is reticulated in like manner; but ſolid, and incapable of ſuffering any injected liquid to paſs from one ventricle to another.

Again, this left ventricle being inſtigated to motion by the impelled blood, does, from the ſame irritable nature already mentioned, contract, and drive its contained blood with a violent motion in the direction of its axis, and determine it towards the baſis, at the time when the tip or cone of the heart is drawn nearer to its baſis. And ſince the apparatus of the mitral valves is here the ſame as in the tricuſpids, the venous blood now expanding the ring from whence they ariſe, removes that valve which lay againſt the mouth of the aorta, ſo as to open a way for itſelf to the artery; in dilating the mouth of which, the ſaid blood preſſes the ſemilunar valves, there placed, againſt the ſides of the aorta, into which it ruſhes with a violent impetus. This is proved by ocular demonſtration in living animals, where the left ventricle ſwells upon ſhutting the paſſage into the aorta.

The *ſemilunar valves of the aorta* differ little from

thoſe in the pulmonary artery: only as the opening is here greater, ſo the valves are proportionably larger and ſtronger, and are not ſo often found to want thoſe callous round bodies in the middle. The fibres too of the valves, both tranſverſe and aſcending, are here ſomewhat more conſpicuous.

After the contraction of the heart, follows its relaxation or diaſtole, in which it becomes empty, lax, and ſoft, recovers its former length, the ventricles recede from the ſeptum, and the baſis from the apex. But, while it is in this ſtate, the blood in the auricles, having been as it were in a ſtate of expectation, ruſhes through the openings of the valves of the veins, dilates the oppoſite ſides of the heart, and makes it at once longer and larger. After the auricles have freed themſelves of the blood they contained, they are in like manner relaxed, and their oppoſite ſides remove from each other. Then the blood collected in the venæ cavæ and pulmonary veins, fills the auricles by the contraction of the veins; renders them long, broad, and thick, like the ventricles; and even diſtends and fills the tooth-like proceſſes of the creſted margin. That the fibres of the heart are not dilated, is proved from the junction of thoſe fibres; which, being tied together by their middle branches, cannot be ſeparated: alſo, by the diſſections of live animals, in which the whole heart is ſhown to be contracted.

But we muſt now conſider, that theſe motions of the right and left auricle, with the right and left ventricle, are not performed in that ſucceſſion in which, for the ſake of method, we have here deſcribed them; for both the auricles are contracted, while the ventricles are relaxed: ſo that the contraction of the auricles precedes the contraction of the ventricles; as we are aſſured from manifeſt experiments on dying animals, and on thoſe whoſe living blood is cold. But both auricles are filled together in the firſt inſtant, as both of them are emptied together in the ſecond inſtant; and

and both the ventricles are contracted together in the third inſtant, which is the ſame with the firſt; and both ventricles being evacuated, are relaxed in the fourth inſtant, which is the ſame with the ſecond. Thoſe who have inadvertently taught otherwiſe, have not taken the advantage of making a ſufficient number of experiments on living animals. That the auricle, near death, makes frequent palpitations before the ventricle of the heart performs one contraction, is true enough. The auricle with its ſinus forms one cavity, and both are filled and both emptied in the ſame inſtant.

But it may be aſked, Why the heart never ceaſes from its perpetual motion through ſuch a number of years as there is in one's life, through ſo many days as there are in a year, and through ſo many hours as there are in a day; when in each hour the heart of a healthy perſon contracts not much leſs than 5000 times; ſo often are there ſucceſſive repletions followed with new contractions, perpetually in the ſame conſtant order; nor is there any muſcle, beſides the heart and diaphragm, but what becomes tired and painful, by acting inceſſantly, even for a few hours? Different anſwers have been given to this queſtion by different profeſſors, founded either upon a compreſſure of the cardiac nerves betwixt the large arteries, or upon an alternate repletion of the coronary arteries and cavities of the heart, &c.

But to Dr Haller the ſimplicity of nature ſeems very great in this matter. When the auricle is relaxed, it is directly filled by the muſcular force of the continuous great vein; and ſo the heart alſo contracts itſelf, when it is irritated by the blood driven into it from the auricle. Therefore the heart having once received the blood, is contracted by that ſtimulus, or irritable force, whereby muſcular fibres are excited into contraction; whereupon it empties itſelf of the blood; and being freed from the ſtimulus thereof, im-

mediately reſts or relaxes itſelf. But the heart being now relaxed, the auricle is in like manner irritated by its contained blood, and by contracting fills it again; while the inceſſant actions of the heart and arteries continually urge new blood into the right ſinus and auricle. That this is the true ſtate of the heart's motions, is proved from actual experiment or obſervation; whereby we plainly diſcern the ſucceſſive repletions and contractions made in the great vein, auricle, ventricle, and artery, eaſily ſeen in a weak or expiring animal; but more eſpecially, and more evidently, in thoſe animals which have but one ventricle in the heart; as the tortoiſe, frog, ſnake, fiſhes; and in the chick hatching in the egg, which, inſtead of a heart, has only one crooked canal. Beſides, it is confirmed from the inertia of the heart, produced by tying the veins; and from the return of its motion, when the ligatures are unlooſed; provided theſe phenomena are ſufficiently valid: but this is more unequivocally corroborated by injection, and by the perpetual contraction of a frog's heart, from the inflation of a bubble of air, which many hours it alternately ejects and receives into the auricle. The left ventricle firſt ceaſes its motion; then the auricle of that ſide; then the right ventricle; after that the right auricle; and, laſt of all, the pulmonary veins and venæ cavæ. Whatever motion is in the venæ cavæ, ought to be attributed to the auricle repelling the blood into both theſe veins, and which the heart, when dead, is not capable of receiving.

Nor does Dr Haller believe there is any thing more required to the heart's motion than a continual ſtimulus applied to a very irritable part. For, juſt upon the approach of death, the very coldneſs of the limbs, which the warmth of life has left, contracts the veins, and drives the blood to the heart; when the lungs, being impermeable for want of reſpiration, tranſmit no blood to the cavities of the left ſide. And, on the other

ther hand, the heart, after it is thoroughly emptied, remains at reſt. It may thus happen, that, inſtead of the vena cava and right auricle, the laſt appearance of life may be transferred to the left auricle and ventricle; if we ſuppoſe the right cavities to be emptied, the left may be irritated by the blood contained in them. But if you derive the reſting of the heart from the compreſſion of its nerves, the motion of the auricles will be an objection, becauſe their nerves are not compreſſed. An example alſo we have in fiſh, and little chicken in the egg, where there can be no room for a compreſſure of the nerves. If, again, you deduce the heart's reſt from a compreſſure of the coronary arteries, this is contrary to experience; ſince they are not covered by the valves of the aorta, and from a wound of the ſaid arteries, during the ſyſtole of the heart, the blood ſtarts out to a great height.

Nor with the ſtrength of the heart does Dr Haller join the oſcillations of the very ſmall veſſels, which is refuted by experiments: nor the force of external heat; ſeeing animals are found to live and thrive in the coldeſt regions of the north: and though the contractile force of the artery, and the weight of the parts and of the atmoſphere, aſſiſt the motion of the blood during the diaſtole of the heart, the ſame powers reſiſt it during the ſyſtole; ſo that, indeed, by theſe means the blood is moved no farther through the contractile arteries, than through the rigid arteries of ſmaller animals.

But with what celerity, and with what force the heart drives forward the blood, is controverted and variouſly computed. The more modern writers have raiſed their calculations upon a ſuppoſition, that, for the celerity to be determined, we are to admit two ounces of blood to iſſue out of the heart with ſuch a celerity, that the part of the pulſe called its *ſyſtole*, makes one third of the whole pulſation, and is finiſhed within a $\frac{1}{222}$ part of a minute; but the area of the mouth of the aorta,

they have eſtimated 0.4187 parts of an inch: ſo, by dividing the ſpace filled by two ounces of blood, (3.318 inches) by the area or ſection of the aorta at its mouth [and length of its cylinder filled by two ounce. viz. $=7\frac{29}{31}\frac{309}{180}$], the number thence produced divided by $\frac{1}{227}$, the time in which the heart contracts, they find 149 feet and two-tenths of an inch for the ſpace through which the blood runs in a minute, if it goes on in a cylinder with the ſame velocity it firſt had from the heart. But the incumbent weight of blood moved by the heart, they have computed by the jerk wherein the blood ſtarts forth from the larger arteries in a living animal, being ſeven feet five tenths; and from the ſurface of the ventricle, whoſe area makes 15 inches. Thus 1350 cubical inches of blood, or 51 pounds five ounces, circulate, which preſs againſt the ventricle of the contracting heart. The heart, therefore, thus drives forward a weight of 51 pounds with a velocity by which it may run through 149 feet in a minute; which force it exerts four thouſand eight hundred times in an hour.

Although there are many particulars here unthought of which may render the eſtimate incomplete, and ſuch perhaps as we may never aſcertain; and although the mouth of the diſtended aorta may be wider in a living animal, though the area of the ventricle is of uncertain dimenſions, and the jerk of blood computed from an inſufficient height; yet if we conſider the violence with which the blood ſtarts from ſome of the leaſt ſanguine arteries in the living animal, although we cannot eaſily determine how much of the heart's ſyſtole is thus ſpent, variations in which will greatly alter the computation; yet, in the mean time, it will plainly appear that the machine we call the *heart*, is a very powerful one. The truth of this is evident from experiments; in which it appears to be very difficult to fill all the red blood-veſſels by anatomical injections, and quite impoſſible to fill all the ſmaller ones; yet the

the heart, we ſee, not only gradually diſtends all the larger, the ſmaller, and even the leaſt veſſels, with blood, but alſo drives it forward through them with a conſiderable celerity. Even in the leaſt arteries, the blood is urged forward by the heart with ſuch a force as to make the alternate motions of that muſcle perceptible. Likewiſe, in the veins and ſmaller veſſels of cold animals, even while contained in the inſect's egg, there is no other force beſides that of the heart, by which the blood is driven through their ſmall veſſels. And, from ſome of the leaſt arteries, I have ſeen the blood ſtart forth ſeveral feet, the jerk deſcribing a parabola, whoſe height was four feet, and amplitude of projection ſeven feet; and ſome aſſert, they have ſeen the blood aſcend from the aorta to the height of twelve feet.

Moreover, that we may make a juſt eſtimate of the heart's force in living animals, we muſt conſider what great reſiſtances that complex muſcle overcomes: we muſt compute the enormous weight there is of the whole blood; a maſs perhaps of fifty pounds and upwards: for all that quantity of fluids, once ſtagnant in a perſon lately drowned or fainted away, are eaſily put into their former motion by the heart only. We muſt again conſider the great decreaſe of the blood's velocity, ariſing from the greater light or capacity of the dividing branches (from whence the ratio of its celerity, even in the inteſtines, may be computed to only a 24th or a 30th part of its original impulſe), abates two-thirds from the heart's force. And yet we ſee there are humours ſwiftly moved through the moſt minute veſſels; as, for example, the Sanctorian perſpiration, which in a ſubterraneous cavern I have obſerved to aſcend ſwiftly in form of ſmoke or vapour; and the ſame celerity of the blood in the leaſt veſſels of little fiſhes, &c. is apparent to the eye by a microſcope. Now, ſince the frictions in every machine always conſume the greateſt part of the moving forces; much more do they

they in the human body, whoſe blood and juices are ſo much more viſcid or clammy than water, and driven through veſſels ſo ſmall, that they permit a globule only at a time to paſs through, and even hardly allow that without changing their figure: but from ſo ſtrong and extended a friction there muſt neceſſarily follow a very great hindrance to the motion; whence we may eaſily underſtand, that the force muſt be very great, which drives ſo ſwiftly ſuch a prodigious maſs of fluids in ſpite of ſo many reſiſtances and decrements of the moving forces. But, more than that, aneuriſms and arteries are burſt, and very great weights, as well as the body itſelf, raiſed, by the force of the heart's ſyſtole.

The blood, being driven into the aorta, immediately finds the two openings of the coronary arteries, which lie next the arterial valves, but above them, or within the aorta; and in conſequence of this, it ruſhes firſt of all into the ſaid coronary arteries, by which the heart ſupplies itſelf with blood. Theſe arteries are for the moſt part two; the right goes off between the aorta and pulmonary artery, and the upper and left one between the left auricle and the aorta. All the external arteries are ſurrounded with much fat; but their cavity is more intercepted with valves than that of other arteries. Theſe arteries communicate, by inoſculations of the ſmall branches, every where about the ſeptum and tip of the heart; but they no where make a complete ring round the heart. They terminate in a twofold manner.

The firſt termination of them is into the coronary veins, whoſe branches running in company with thoſe of the arteries, have their trunks of neceſſity diſpoſed in a different courſe.

There are ſome who will have the coronary arteries filled with blood, not by the contracting of the heart, but of the aorta in its ſyſtole; which they think muſt be a conſequence of the retrograde angle of the blood's courſe here, and the paleneſs of the contracted heart, with

with a ſuppoſition that the valves of the aorta cover or cloſe the mouths of the coronary arteries. But the two laſt of theſe are diſproved by experience; and the firſt, or retrograde courſe, can only impede or leſſen, and not intercept, the flux into the heart: for the injections of wind or mercury into all the ſeminal and biliary veſſels, demonſtrate that the large retrograde angles, which the veſſels often make there, do not hinder the fluids from taking, though they retard, their natural courſe. But a proof, ſtill more evident, is, that the coronary artery has a pulſe at the ſame time with all the other arteries in the body, and the blood ſtarting from it makes a higher ſaltus at the time when the heart is contracting.

The circulation through the coronary veſſels ſeems to be completed in the ſhorteſt ſpace of time that can be neceſſary in any part, from the great velocity the blood receives from the heart itſelf, urging the ſame through its own ſubſtance. But that the whole contents of the veſſels are cleared in each contraction, does not ſeem probable; for the blood-veſſels of the heart do not look pale enough in that action to produce ſuch an effect as an entire evacuation. There is a very free or open paſſage from the arteries of the heart into the cellular ſubſtance, or fat which ſurrounds it. If you aſk, What are the uſes of thoſe leaſt or ſhorteſt veins which open obliquely through the ſurface of both the ventricles? they ſerve to return the blood of thoſe deeply ſeated ſmall arteries, which have no correſponding veins.

The humours of the heart, which are thinner than blood, return by the valvular *lymphatic veins*, which accompany the coronary blood-veſſels, and aſcend towards the thoracic duct and ſubclavian vein; but they are to be very rarely ſeen, although they can be diſtinctly obſerved in brute animals.

§ 7. *Of*

§ 7. *Of the Nature of the Blood and Juices of the Human Body.*

THE liquor which is contained in the beating arteries and their correſponding veins, is called by one general name, the *blood:* which, to a looſe examination, appears homogeneous, or of ſimilar parts, red and coagulating throughout; and is obſerved to be redder in proportion to the ſtrength of the animal: in a weak and famiſhed one, the blood inclines to a yellow: it hath a whiteneſs mixed with it, which comes almoſt totally from the chyle. But from various experiments it is certain, that this animal liquor contains very different ingredients.

That fire is contained in the blood may be proved from its heat, which, in human blood, and that of ſome other animals, is from 92 to 100 degrees of Fahrenheit's thermometer, which is more than the mean degree of atmoſpherical heat, but leſs than the greateſt. "The heat (ſays Dr Wriſberg), which all perfect animals peculiarly poſſeſs in by a far a greater degree than vegetables, from the more ſimple claſs of animals, through the various orders of fiſhes, amphibia, man, quadrupeds, and birds, at length gradually increaſes, till for the moſt part, in a natural ſtate, even at its greateſt heat, it does not exceed the 110th degree of Fahrenheit. Daily experience ſhows, that it differs in man, according to age, temperament, ſtate of mind, motion, or reſt of body, climate, weather, kind of life, meat and drink, health, and the various ſpecies and violence of diſeaſe. It is alſo certain that the degrees of heat in the body increaſes a little from an augmentation of heat in the atmoſphere: but it does not riſe to the greateſt pitch of ſummer-heat, although we can live in a much greater heat; as is proved by perſons employed in ſugar-houſes, melting furnaces, by mowers, and the uſe of baths and ſtoves in Finland and Ruſſia; and alſo by the late experiments of Fordyce, Blagden,

Blagden, Hunter, and Dobſon. It is ſometimes ſo diminiſhed in an intenſe cold, that in a perſon froſt-bitten, but not dead, a thermometer applied to the mouth, arm-pits, groins, and even the vagina, would not riſe above 76° of Fahrenheit. But is the matter of heat in the blood alone? It is ſufficiently probable from phenomena; ſince the heat of the body is diminiſhed by hemorrhagy, or when the blood is intercepted by ligature and compreſſion from reaching the joints, it being reſtored when the blood returns. I muſt obſerve, however, that my experiments on living animals, particularly upon ſwine, did not diſcover ſo great a difference as might be expected, between the heat of the heart, the arteries, veins, brain, ſtomach, inteſtines, tunica vaginalis, and even the interſtices of the cellular texture in the muſcles." Again, a kind of volatile vapour or exhalation continually flies off from the warm blood, with a ſort of fetid odour intermediate betwixt that of the ſweat and urine. This vapour, after collection and condenſation in convenient veſſels, partakes of an aqueous nature, with ſomewhat of an alkaline quality.

After this vapour has diſſipated, the blood of a healthy perſon ſpontaneouſly congeals into a ſciſſile trembling maſs; and with a leſs degree of heat than that of boiling water, (viz. 150 deg.) This toughneſs is greater in feveriſh perſons than in ſuch as are in health. It ſometimes coagulates in the veins of a living perſon, and is found clotted in wounds of the arteries. But even within the veſſels of a living perſon, and in one dying of a fever, the blood has been ſeen, by the violence of that diſtemper, changed into a concreted tremulous jelly throughout all the veins. The principal part of this coagulated maſs is the *craſſamentum* or *cruor*, which has the red colour peculiar to itſelf, and gives it to the other parts of the blood. This, if it be not kept fluid by the attrition of a vital circulation, or ſome ſimilar concuſſion, runs confuſedly into a compact, but

ſoft

ſoft maſs, like liver, merely by reſt and a moderate degree of cold; as it alſo does by the addition of alcohol, by mineral acids, or by a heat of 150 degrees, of which 98 is the blood's heat in robuſt people. It is, either as a fluid or a ſolid, ſpecifically heavier than water by near an eleventh part; and, when freed from its water, it is wholly inflammable. In a maſs of healthy blood, one half or upwards is red cruor: and, in ſtrong laborious people, the ſerum makes only a third part; and is ſtill more diminiſhed in fevers, often to a fourth or fifth part of the maſs.

Another white, ſomewhat yellowiſh part of the blood, ſeparates from this coagulum, tranſuding, as it were, through its pores, and at laſt becomes a quantity, in which the coagulum ſinks: this again ſeems, though not really ſo, a homogeneous liquor. This part of the blood is, in general, one thirty-eighth part heavier than water, and almoſt a twelfth part lighter than the red globular maſs of craſſamentum: this too, by a heat of 150 deg. or by mixture of mineral acids or alcohol, and by a concuſſive motion, is coagulable into a much harder maſs than the red cruor; and forms an indiſſoluble glue, a fleſh like membrane, which at length ſhrinks up to a horn-like ſubſtance, or friable gum. From thence are formed the pleuritic cruſts or ſkins, polypuſes, and artificial membranes. Beſides this coagulable albumen, ſimple water, of which there is the greateſt portion, is latent in this ſerum; and likewiſe a quantity of mucus, leſs capable of being drawn into threads than the red cruor; nor at the ſame time coagulable, like the albumen, by heat and acids. Hewſon has diſcovered a ſecond kind of lymph, which Krauſius has alſo allowed; but this does not hurt the received opinion of the elements of the blood.

But by putrefaction only, or the diſſolving power of the air hot to 96 deg. equal to the blood's natural heat, the whole maſs, but eſpecially the ſerum, diſſolves or melts into a fetid liquor; firſt the ſerum, and then the cruor

cruor more ſlowly; till at length the whole maſs, both of ſerum and cruor, is turned into a volatile and fetid exhalation, leaving very few feces behind. The blood being a little diſſolved by putrefaction, and even before that, becomes fetid; with the fetor it aſſumes an alkaline nature; and effervesces with acids. This property it afterwards loſes, the alkaline ſalt being deſtroyed by putrefaction. The putrid blood cannot by any art be inſpiſſated, as it is alſo very difficult to be reſolved after it has been coagulated by ſpirit of wine. By too ſevere exerciſe, heat, and malignant diſorders, the coheſion of the blood is diſſolved, and it aſſumes an alkaline nature almoſt as if from putrefaction.

Beſides theſe parts of which the blood appears to conſiſt, without ſubjecting it to any violence, it contains in its ſubſtance a quantity of *ſea-ſalt*, which is diſcernible to the taſte, and ſometimes viſible by the microſcope. That there is *earth* in the blood is demonſtrated from nutrition; and from a chemical analyſis, whereby the earth appears to lodge in the moſt fluid, and eſpecially in the oily parts of the blood. By ſome very late experiments, it appears, that a conſiderable quantity of ferruginous earth, eaſily reducible into metal by the addition of phlogiſton, is contained in the blood when calcined. Laſtly, another part in the blood is *air* in an unelaſtic ſtate, and that in a very conſiderable quantity; the exiſtence of which air in the blood and ſerum is proved by the putrefaction and diſtillation, or by removing the ambient air from them by the pump. But we are not to think, from hence, that the blood-globules are bubbles full of air, for they are ſpecifically heavier than the ſerum.

By the admixture of neutral ſalts the colour of the blood becomes deeper and brighter, without being either diſſolved or thickened. It is ſcarcely altered by a weak acid. By fermented liquors it is coagulated. Fixed alkaline ſalts have almoſt the ſame effects as the neutrals. The volatile alkalis rather turn it brown,

and coagulate it. Alcohol and diſtilled oils, and likewiſe vinegar, coagulate it. It does not effervesce with any ſalt.

Chemiſtry has, in various ways, ſhowed us the nature of the blood. (1.) When freſh drawn, before it has time to putrefy, the blood, diſtilled with a ſlow heat, yields a *water* to the quantity of five parts in ſix of the whole maſs; which water has little or no taſte or ſmell till you come towards the end of the operation, when it is proportionably more charged with a fetid oil. (2.) The reſiduum expoſed to a ſtronger fire, yields various alkaline liquors; of which the firſt, being acrid, fetid, and of a reddiſh colour, is uſually called the *ſpirit* of blood; conſiſting of a volatile ſalt, with ſome little oil, diſſolved in water to the amount of one twentieth part of the original maſs of blood. There is an acid obſervable in the fat, and likewiſe in putrid fleſh and blood. (3.) A little before, and together with the oil, that next aſcends in the diſtillation, dry *volatile ſalt* ariſes, and adheres in branchy fleeces to the neck and ſides of the glaſs; and this in but a ſmall proportion, leſs than an eightieth part of the firſt maſs. (4.) The next liquor is that called *oil* of human blood, which aſcends gradually thicker and heavier, and is at firſt yellow, afterwards black, till at laſt it reſembles pitch, being very acrid and inflammable, but in a ſmall quantity, about a fiftieth of the whole maſs. (5.) There now remains, in the bottom of the retort, a ſpongy inflammable coal or cinder of the blood; which, being kindled, burns away, and leaves aſhes behind. From theſe, by lixiviation with water, is obtained a *mixed ſalt*, partly ſea-ſalt, and partly fixed alkali, together with a ſmall quantity of fixed earth. This fixed ſalt is ſcarce the five hundredth part of the firſt maſs, and of this only one fourth part is alkaline: but being urged with the moſt intenſe degrees of fire, the whole ſalt affords ſome portion of *an acid ſpirit*; which we judge to ariſe

partly from the ſea-ſalt in the blood, ſome of which is demonſtrable even in the ſpirit of blood; and partly from the vegetable kind of the aliments, not yet digeſted into an animal nature. For which laſt reaſon, an acid is procurable from the blood of graminivorous animals as well as from that of man. But the *earth*, ſeparated from the lixivium by filtration, will, perhaps, make about an hundred and fiftieth part of the original maſs; and contains ſome particles which are attracted by the loadſtone.

From the preceding analyſis of the blood, it evidently contains a variety of particles, differing in bulk, weight, figure, and tenacity; ſome watery, others inflammable, and moſt of them inclined greatly to putrefaction or to an alkaline nature. For the blood, in a ſound healthy ſtate, not injured by putrefaction, or too violent a degree of heat, is neither alkaline nor acid; but mild or gelatinous, and a little ſaltiſh to the taſte: yet, in ſome diſeaſes, it is ſharp enough, and comes near to a ſtate of putrefaction; as for inſtance, in the ſcurvy, where it corrodes its containing veſſels; and in dropſies, the waters of which are often next to alkaline. But an alkaleſcent calx is found in the blood of inſects, which effervesces with acids.

By viewing freſh blood in a ſmall glaſs tube by a microſcope, or by applying the ſame inſtrument, while it is yet moving in the veins of a warm living animal as a hen-chicken, or a cold one as a frog, we perceive in it red globules; which, doubtleſs, make that part called *cruor* or *craſſamentum*. If it be queſtioned, whether theſe are not rather lenticular particles of the ſame kind with thoſe obſerved by Leuwenhoek in fiſh, and lately diſcovered in our own ſpecies, we confeſs it is a point difficult to determine: Hewſon, however, obſerves, that the particles are flat like a guinea. (*See* his Treatiſe on the Blood.)

The colour of theſe globules is red; and ſo much the deeper and more inclined to ſcarlet the ſtronger

the animal is: and in the ſame proportion their number increaſes, when compared with the quantity of yellow ſerum. Their diameter is very ſmall, being between $\frac{1}{2000}$ and $\frac{1}{3000}$ of an inch. They are ſaid to change their figure into an oblong egg-like ſhape, which Dr Haller could never obſerve with ſufficient certainty. They are alſo ſaid to diſſolve into other leſſer globules of a yellow colour, which he had neither obſerved himſelf nor can eaſily admit.

From the red part of the blood, fibres are generated in abundance; from the ſerum, in ſmaller quantities. They are procured by pouring the blood into a linen cloth, and waſhing it gradually with a great deal of water, or by beating it with a rod. In quantity, they equal the 28th part of the whole maſs. Theſe are formed of the gluten, and are not generated in a living animal; ſeeing they are neither to be perceived by the microſcope, which ſo eaſily renders viſible the red globules, nor yet does their long thread-like figure ſeem adapted for receiving motion.

From the preceding experiments compared together, ariſes that knowledge which we at preſent have of the blood; namely, that the craſſamentum or cruor is compoſed of globules. The inflammable or combuſtible nature of theſe globules is proved from dried blood, which takes flame and burns; as alſo from the pyrophorus, which is generated from the human blood: and from theſe moſt probably ariſes the greater part of the pitchy oil that is obtained from blood by the violence of fire.

The ſerum of the blood diſtilled with a ſtrong fire, gives over almoſt the ſame principles with the cruor, viz. ſalt, oil, and earth. It yields, however, much more water, but no iron at all. Similar principles, but with a leſs proportion of oil and ſalt, are obtained from the aqueous humours prepared from the blood; as the ſaliva and mucus.

The exact maſs or quantity of blood contained in the

the whole body cannot be certainly computed. The weight of the maſs of humours, however, is much greater than that of the ſolids; but many of them do not flow currently in the circulation, as the glue or jelly that lodges in moſt parts, and the fat. But if we may be allowed to form a judgment from thoſe profuſe hemorrhagies that have been ſuſtained without deſtroying the life of the patient, with experiments made on living animals by drawing out all their blood, joined with the bulk of the arteries and veins themſelves: from theſe principles, the maſs of circulating humours will be at leaſt fifty pounds; of which about 28 will be true red blood, current in the arteries and veins: of which the arteries contain only four parts, and the veins nine.

Nor does the blood always contain the ſame, or a like proportion, of thoſe elements or principles above mentioned: for an increaſed celerity, whether by laborious and ſtrong exerciſes, a full age, fever, or otherwiſe, augments the craſſamentum, with the redneſs, congealing force, and coheſion of the particles; and the hardneſs and weight of the concreted ſerum with the alkaline principles, are by the ſame means increaſed. On the other hand, the younger and leſs active the animal, and the more watery or vegetable the diet on which it is fed, the craſſamentum of the blood is proportionably leſſened, and its ſerum and mucus increaſed. Old age, again, leſſens the craſſamentum and the gelatinous part likewiſe.

From theſe principles, but with a conjunct conſideration of the ſolid fibres and veſſels, the different temperaments of people are derived. For a *plethoric* or *ſanguine* habit ariſes from an abundance of the red globules; a *phlegmatic* temperature from a redundancy of the watery parts of the blood: a *choleric* diſpoſition of the humours ſeems to ariſe from a more acrid, acid, and alkaleſcent property of the blood; as appears from thoſe who live on fleſh and on the human

ſpecies, being ſo much fiercer and more paſſionate than thoſe who live on plants or on vegetable food. In the ſolid parts, a great firmneſs joined with an exquiſite ſenſibility, or nervous irritability, diſpoſes to a choleric habit; a leſs irritability, with a moderate denſity, to a ſanguine habit; and a leſſer degree both of denſity and irritability are to be referred to a phlegmatic temperament. There is alſo a kind of dull heavy temperament, in which there is the greateſt ſtrength of body, joined with no great degree of irritability. In the melancholic, again, a weakneſs of the ſolids is joined with the higheſt degree of nervous irritation or ſenſibility. But you muſt be careful not to take theſe temperaments as the ſole and limited ſyſtems or claſſes of conſtitutions; which, in the courſe of nature, are found to be not only four, or eight, but are really diſtinct in numberleſs degrees.

The red part of the blood ſeems chiefly of uſe to generate heat, ſince its quantity is always in proportion to the heat of the blood. This being confined, by the largeneſs of the globules, within the red and firſt order of veſſels, hinders them from collapſing: and, in receiving the common motion of the heart by the greater denſity of its parts, it has a greater impetus, and ſets in motion the leſſer orders of humours. Nor is it improbable, that the heart is more ſtrongly irritated by the ponderous cruor of the blood. The globular figure of its parts, together with their denſity, makes it eaſily pervade the veſſels; and the quantity of iron it contains, as well as of oil, perhaps increaſes its power of generating heat. And hence it is, that the red part of the blood being too much diminiſhed by profuſe bleedings, there follows a ſtagnation or leſſened motion of the humours in the ſmaller veſſels; whence fatneſs, and dropſy. By the ſame rule alſo a due proportion of cruor is neceſſary within the habit, to generate and repair new blood. For, by large hemorrhagies, we ſee the blood loſes its red or

denſe

denſe nature, and degenerates into a pale, ſerous, or watery ſtate.

The coagulable ſerum is more eſpecially deſigned for the nutrition of the parts, as will be hereafter more apparent. The thinner juices ſerve various purpoſes; as the diſſolution of the aliments, the moiſtening of the external ſurface of the body and ſurfaces of the internal cavities, to preſerve the flexibility of the ſolids, and conduce to the motion of the nerves, the ſight, &c. The ſaline particles ſeem proper for diſſolving the aliment, and ſtimulating the veſſels. The properties of the aërial part are not yet well known. The heat occaſions the fluidity, and is not eaſily raiſed to ſuch a degree as to coagulute the humours.

Therefore health cannot ſubſiſt without a denſe and red blood, whoſe quantity too much diminiſhed cauſes a ſtagnation of the juices within the ſmaller veſſels; whence all parts of the body become cold and weak. Nor can life or health ſubſiſt without a ſufficiency of thinner juices intermixed with the red blood; ſeeing the cruor, deprived of its watery part, congeals, and obſtructs the ſmalleſt paſſages of the veſſels, and kindles too great a heat.

If it is aſked, Whether there be any difference betwixt the arterial and venous blood? we anſwer, That ſome difference ſeems to happen; the former having lately ſuffered the action of the lungs. But, in experiments, I ſcarce find any obſervable difference either in colour, denſity, or any other known diverſity. Sometimes, however, I have found a moſt evident difference; for the bright colour of the arterial blood ſeems to diſtinguiſh it from the duſky dark-coloured blood in the veins; but this, in the plain example of the hatching of a chicken, ariſes only from the deeper ſeries of globules in the thicker vein. But we have not ſufficient certainty of a difference in the blood of different arteries. However, the arterial blood is apparently of a more bright or ſplendid red, and having a great-

er degree of fluidity and proportion of watery parts, may ſo far differ from the venous darker coloured blood. But to clear up this, farther experiments are requiſite.

From one and the ſame maſs of blood, driven into the aorta, are generated all the fluids of the human body; which, from their affinity one to another, are reducible to certain claſſes. The manner in which they are ſeparated ought to be accounted for by the fabric or mechaniſm of the glands themſelves. But we muſt firſt conſider what the blood ſuffers from its containing veſſels.

"The theory of the temperaments of the human body (ſays Dr Wriſberg), in the ſenſe commonly received by phyſicians, and taught in the ſchools, the received diviſion of them into four ſpecies, and their repeated production from the different nature and mixture of the blood, ſavours too much of the ancient and particularly of the Galenical doctrine. I think there can be no doubt, that there are temperaments; and that the manner and rule which nature follows in man, and likewiſe perfect animals, may be obſerved in the performance of the corporeal and mental functions, in either preſerving or endangering the health and life, and in the exerciſe of moſt of the duties and affairs of life, and in the actions of the internal and external parts, which are more or leſs connected with the ſafety of the animal. If, therefore, one would wiſh to give any ſpecific name to this different relation and determination of the parts of our body, when once communicated with the ſyſtem in general, as you would do to any plant, or other particular natural body, and to keep the ancient denominations ſanguineous, choleric, phlegmatic, and melancholic, in preference to all others, he muſt be aware, that neither the various habits nor temperaments of mankind can originate ſolely from the different nature of the blood,

nor

nor all be comprehended under theſe four modifications.

" With reſpect to the cauſes of diverſity of temperament, there are many which co-operate. (1.) The various quantity, firmneſs, and ſentient faculty of the nervous ſyſtem, from the brain communicated to each nerve. I have always obſerved a choleric, and cholerico-ſanguineous diſpoſition, in all perſons having a large brain and thick ſtrong nerves, along with a great ſenſibility as well of the whole body as of the organs of ſenſe. Hence ariſes a ready apprehenſion of objects, and an increaſe of underſtanding and knowledge, and, owing to the compariſon of many ideas, an acute and entire judgment, which choleric perſons poſſeſs in ſo eminent a degree: but along with this condition of the nerves, they are exceſſively liable to grief and anger, when the body or mind is but ſlightly affected; and on this account medicines ſhould be cautiouſly given, and leſs doſes preſcribed to them. With a ſmall brain and ſlender nerves, I have obſerved the ſenſes more dull, and a phlegmatic or phlegmatico-melancholic torpor conjoined. Therefore they require from external objects ſtronger impreſſions upon the organs of ſenſe, and longer applied, if they are meant to leave laſting effects: hence their judgment is frequently weak on account of the defect of ideas; and they ſeldom acquire any extenſive knowledge: but nature has compenſated theſe diſadvantages, by making them more able to undergo hardſhips from change of climate, life, or labour; they demand more powerful medicines and larger doſes. What a great difference in man and the cetaceous animals! (2.) The various degrees of irritability in the muſcular parts. For wherever you find a very delicate irritability, affected by almoſt every ſtimulus, and retaining laſting impreſſions, and at the ſame time acting with a certain celerity; in that caſe you cannot doubt of a choleric diſpoſition: hence that remarkable ſtrength in the

muſcles of ſome perſons, which acts with ſo incredible quickneſs, diſpatch, and conſtancy. On the contrary, if you examine a phlegmatic perſon, you obſerve the contractile power of the muſcles languid, difficultly yielding to ſtimuli, unleſs powerful; ſince the muſcles of phlegmatico-melancholic men are long of being determined to motion, although ſtrongly excited, and finiſh it with an appearance of languor. (3.) Even a certain ſoftneſs is obſervable in all fibres and membranes, if you touch the body of a phlegmatic perſon; or a ſeeming hardneſs and dryneſs in melancholic habits: along with which particularities the phlegmatic join leſs elaſticity, whilſt in the melancholic there is a greater tone and contractile power. (4.) There is in the air, undoubtedly, a certain electrical principle, which being by reſpiration communicated in different ways with the body, imparts a natural tone to the fibres, occaſions a quicker motion in the veſſels, and increaſes and diminiſhes by turns the alacrity of the mind. But as this principle of atmoſpheric air does not prevail in equal quantity every hour of the day, all times of the year, and in every climate; ſo ſometimes we feel an univerſal laſſitude, which ſuddenly ceaſes, the ſtrength of the body and mind being reſtored with a ſerene and elaſtic air; ſo in like manner all men do not equally abſorb this electric matter, which thus forms a remarkable diverſity of temperament. (5.) We ought too to combine with theſe the various nature of the blood from the proportion of the elements: and in fact, as greater ſtimuli in the blood excite the heart to briſker contractions; ſo a more acrid and copious bile may effectually promote the periſtaltic motion, and the abundance of mucus occaſion a tendency to lentor and frequent catarrhs.

" Now, we ſee we have ſufficient cauſes, which from our birth may bring on, in the firſt growth of the parts of the body, an irrevocable determination to this

this or that habit or temperament. I therefore can ſcarcely admit a complete tranſmutation of temperament, which, during the exerciſe of theſe natural laws, could render a purely choleric perſon phlegmatic: But that ſome change may take place in temperaments, that violent attacks may be mitigated, that lentor, torpor, and liſtleſſneſs may be increaſed, I readily agree; and from the remedies by which ſuch a change may be produced, I form a ſecond claſs of the cauſes of temperaments. The chief are, (1.) A different kind of meat and drink. An animal diet adds a great ſtimulus to our ſtrength, invigorates our ſenſes, and ſometimes induces ferocity; as is evident from the Anthropophagi, carnivorous animals, wild beaſts and their whelps, and hunters, particularly if the abuſe of aromatics, wines, and medicines, has ſupervened. Vegetables, on the contrary, increaſe the lentor of the fibres, weaken the ſtrength, diminiſh ſenſibility and irritability; in a word, induce a phlegmatic diſpoſition; in which potatoes have a wonderful effect. It would be of great conſequence to pay regard to this in the bringing up of children, viz. to invigorate the inertia of the mental and corporeal faculties by the uſe of animal food, but to temper the vehement paſſions, peculiar to choleric perſons, by uſing amongſt food a good deal of vegetables. (2.) The particular mode of education, examples. It need ſcarce be inſiſted on of what influence theſe are poſſeſſed, particularly in infancy: hence it happens, that whole nations are of one temperament. (3.) Climate, weather, native country. Rarely in an unſettled climate or country, in hot climates, or in moiſt countries, will you find in choleric perſons that alacrity of temper, agility of body, and quickneſs of underſtanding, which is ſo common in a ſerene and temperate heaven, and high hilly countries. (4.) The increaſe of knowledge. I have often admired that change which a ſtrenuous induſtry produces in ſome of the moſt dull men; ſo that

that with the increaſe of knowledge, they became of a more cheerful temperament. (5.) Abundance and want of neceſſaries, both in life and for the purpoſe of forwarding improvement. For this reaſon it may happen, that according to the diverſity of the form of government, whether under mild or more ſevere and tyrannical laws, the temperament of the ſubject may be either lively or languid. (6.) The ſort of life itſelf, intercourſe with men, and public employment, may have a great ſhare in changing temperaments; ſince rarely after the 36th year of a man's life do you find the blood ſtill pure; and rarely a choleric perſon, who, after 50 years, has preſerved his former alacrity. It is difficult to ſay into how many ſpecies temperaments ſhould be divided, and what kind of character ſhould be aſſigned to each, according to nature and not conjecture. I doubt, I may not be more ſucceſsful than the celebrated Kaempfius and Gerreſhemius, as I exhibit the firſt lines only. The ſanguineous and phlegmatic temperaments, ſeem with various intermedia to comprehend all modifications. (1.) Then, the ſanguineous, which is inconſtant and not well ſpecified, is diſtinguiſhed by a vivid colour of the face; the veſſels are full; and hence, for the moſt part, they take ill with external heat; they are prediſpoſed greatly to inflammatory diſeaſes; they have a great ſhare of ſenſibility and irritability, which all therefore indicate a deſire of pleaſure in this temperament, and the greateſt inquietude, both of body and mind, prevails: they are talkative; abide not long with any occupation; they are eaſily ſeduced, and contract an intimacy with every body; but they ſoon forget their friends, ſhowing a certain diffidence to all of them; they ſeldom meddle with affairs of any conſequence, and rarely acquire proficiency in the ſciences, unleſs in an advanced age. (2.) The ſanguineous-choleric enjoys a better mixture of cauſes; it has the ſupports of health and cheerfulneſs along with the former, but has perſeverance

ſeverance in common with the choleric. (3.) The choleric: Here you will always obſerve the body tender, though not emaciated and dry as is the caſe with the melancholic; the ſkin is of a whitiſh yellow, with red hairs; the balls of the eyes are of a moderate magnitude, the pupil being frequently dim; a penetrating lively countenance, ſometimes joined with a degree of ferocity; a quick pulſe; actions of the muſcles in walking, ſpeaking, and other reſpects very rapid; copious and acrid bile; hence an effectual periſtaltic motion, more frequent ſtools, a ready inclination to undertake any thing of conſequence, formed as if to command, and particularly fond of animal food. (5.) The hypochondriac: An unhappy temperament, troubleſome to itſelf and others. Men of this ſort, for the moſt part, are ſubject to diſeaſes in the liver, have a yellowiſh appearance, always diſcontented, wonderfully tortured with envy and diffidence, and are called by ſome *cholerico-melancholic*. (6.) The melancholic have a dejected aſpect: The eyes, for the moſt part, ſmall, retracted, and winking; the hair black, and ſkin rigid, remarkable for its dryneſs and leanneſs; a ſmall and ſlow pulſe, ſparing and black bile, a ſlow periſtaltic motion. They indeed have quick perceptions, and ponder long; they ſubmit to toilſome labour with the greateſt patience, but finiſh it with incredible ſlowneſs: for the moſt part they pay no regard to time. They eaſily bear the diſadvantages of life; but when once their anger is excited, they love revenge. (7.) The bœotic or ruſtic joins a great ſhare of the ſanguineous temperament with the melancholic and phlegmatic. The body is luſty, full of juices, a ſmall irritability in its ſtrong muſcles, and ſome ſtupor in its ſmall nerves. Perſons of this ſort are capable of no education; and whatever they undertake favours of a low turn of mind. (8.) The gentle and mild temperament: this is compoſed of the ſanguineous, choleric, and phlegmatic.

They

They are a good race of men, wiſhing well to all: in them we always perceive a calmneſs and ſweetneſs of manners; they ſtrongly hate a prating, noiſy loquacity: if devoted to ſtudy, they calmly undertake the taſk, anxiouſly ponder what they learn, and are capable of great proficiency. (9.) The ſlow phlegmatic is diſtinguiſhed by a ſoft and moſtly whitiſh ſkin, a very lax body, very prominent eyes, drowſy aſpect, a ſlow pulſe and walk: for the moſt part they ſpeak ſlow, are patient of the weather's inclemency and other peoples affronts; born to obey; and, on account of their ſlight irritability, difficultly enraged, and eaſily pacified again.

§ 8. *Of the Circulation or Motion of the Blood through the Arteries and Veins.*

The arteries and veins contain either blood or lymph. The red blood fills the arteries and veins commonly known, which we call *red*, or thoſe of the firſt order, and which have their origin in the heart. Theſe it ſo fills in a living perſon, that at ſome times they are very looſely and imperfectly diſtended by it, and at other times they are rendered very full and turgid. After death, the veins are found fuller of blood than the arteries; but ſometimes, when the perſon has been dead a conſiderable time, the ſmall veins have been found diſtended with air. But the arteries of a dead body commonly contain only a ſmall quantity of blood.

This diſtending blood, then, is rapidly moved thro' all the veſſels of a living body. The truth of which is demonſtrated to us from wounds, by which the patient ſoon expires from the loſs of ſo much blood as was neceſſary for the maintenance of life; which loſs of blood happens almoſt inſtantly from the larger arteries, and ſometimes very ſuddenly from the ſmaller ones: but from the veins, unleſs they are ſome of the largeſt, this loſs of blood is more ſlow and difficult; yet

yet are there not wanting inſtances of fatal hemorrhagies from wounds of the veins, in the inner corners of the eyes, and thoſe under the tongue. Experiments made upon living animals ſufficiently evidence the impulſe and rapidity with which the blood is moved, particularly through the arteries. The height to which blood from cut carotids aſcended, according to Hales's calculation, Dr Wriſberg ſaw confirmed in robuſt men who had been ſentenced to die, to wit, about ſeven feet; with this difference, however, that in two examples the blood ſprung higher from the vertebrals than from the carotids. In the larger trunks, it runs moſt ſwiftly; but in the leaſt of them, ſomewhat ſlower. And, in the larger veins, the blood's celerity is leſs than in the arterial trunks, in the ſame proportion as the lights or ſections of the arteries are leſs than thoſe of the veins, i. e. twice or almoſt thrice ſlower. Another argument of the circulation, is the compreſſure and relaxation of a vein, whereby the motion of the blood is promoted from one valve to another. This motion of the blood is, in the veins, uniform or equable enough; but in the arteries it is alternately greater when the veſſel is more dilated, and leſs when it is contracted. This is proved by ocular inſpection in living animals.

That the motion which the blood deſcribes, is a courſe through the ſanguineous arteries into the veins, is diſcovered from experience. For, firſt, it is certain, that all the arteries and veins communicate or open one into the other; becauſe often, from one, and that a ſmall artery, all the blood ſhall run even until death, and make all the fleſh exceedingly pale; and this not only out of the wounded limb, but from the whole body. Of ſuch fatal examples we have a number, from an inner artery of the noſe, from the gums, a finger, tooth, cutaneous pore enlarged, from the lachrymal point, from the wound of cupping on the ſkin, and even the bite of a leech. There are, there-

therefore, of courſe, open ways, by which the blood ſpeedily flows from the venous into the arterial ſyſtem.

That the blood, again, in the arteries, flows from the heart toward the extreme parts of the body, is proved by the microſcope, and by a ligature on the artery of a living animal, and likewiſe by the fabric, mechaniſm, and proportion of the ſemilunar valves between the arteries and their correſponding ventricles. Whatever artery is ſtopped by a ligature, the ſwelling enſues in that part betwixt the heart and the ligature, whilſt the other part is emptied beyond the ligature, which is the part of the artery more remote from the heart: neither has it there any pulſation; nor if it be there wounded, will it yield any blood. The ſame effects, which we ſee follow from a ligature, are likewiſe often produced by diſeaſe; as when ſome tumor, by compreſſure, or an aneuriſm, intercepts the blood's motion from the heart. Experiments of this kind have been made on moſt of the arteries; anaſtomoſes, however, or the blood flowing through a neighbouring branch, or the retroceſſion of the blood in a dying animal, form exceptions to this rule.

But of the courſe or motion of the venous blood, it has been always more doubted; almoſt all the ancients have been perſuaded, that the blood in the veins flowed through them, either from the heart or from the liver, to all parts of the body. Very few of them have known that this was an error. Several of them have, indeed, acknowledged it to be falſe in the pulmonary vein. But that the blood did not move from the heart in the vena cava was known to ſtill fewer anatomiſts of the ancients: only to Andreas Cæſalpinus by chance, and (from an extraordinary accident) to Veſalius.

Dr William Harvey was the firſt who experimentally aſſerted the motion of the blood returning in the veins to the heart, in ſuch a manner as to render the whole intelligible, and leave no room to doubt of it. And, firſt, the valves of the veins lead us to this truth: for

the common uſe or office of theſe valves is, to determine the preſſure that is given from any quarter upon the veins, towards the heart, by allowing no opportunity to the venous blood that has once entered the trunk, which they intercept, to flow back to the branches. For, ſince the covering ſpaces of the valves open upwards towards the heart, the blood enters and expands them. Thus thoſe parts of the valves which project freely into the cavity of the vein, approach towards the axis, until the oppoſite ſides by meeting together ſhut up the tube. This we know from inflations, ligatures, and injections of the veins; for you never can force a liquor eaſily into the veins by propelling it againſt their valves. They do not, indeed, every where ſhut up the whole cavity of the veins; but where they ſhut not cloſe, they always intercept the greateſt part of the light.

Another office of the valves in the veins ſeems to be for ſuſtaining the weight of the blood, that its upper columns may not gravitate upon the lower; nor the blood, flowing through the trunks, make too great a reſiſtance againſt that which follows it through the branches. For if, from the ſlower motion of the blood, its weight or preſſure ſhall, in any part, much exceed the impulſe that drives it on, ſo as to cauſe ſome part of the column to deſcend by its weight; it is, in that caſe, immediately catched, and ſuſtained in its relapſe by the next adjacent valve, which hinders it from urging againſt the next ſucceeding column, and affords time and opportunity for ſome contiguous muſcle by its preſſure or concuſſion to propel the ſaid column. And this is the reaſon why valves are placed in the veins of the limbs and neck; in which parts they are both more numerous and more robuſt than elſewhere. And this is the cauſe of varices, when the blood, entering the hollow valves, urges their ſolid convexity downwards, and makes the vein dilate in that part. Likewiſe, in muſcular action, the valves are the cauſe

of

of the whole effect of the preſſure which the veins ſuſtain, forwarding the blood in its due courſe towards the heart.

Moreover, the valves, placed in the right ventricle of the heart, have ſuch a fabric that they freely permit blood, air, or wax to paſs from the venous trunks of the cava into the heart, but deny any reflux from the heart into the veins.

Again, ligatures, in a living perſon, may make the thing more evident. When the veins of the limbs are tied, either by deſign or accident, with the limb itſelf about the hams, arms, ancles, or wriſts, the limb below the ligature ſwells, the veins fill and diſtend themſelves, and when opened make a free diſcharge of blood: but at the ſame time nothing of this kind happens above the ligature, nor are any of the veins to be ſeen there. The ſame phenomenon happens when the veins are compreſſed by ſwelled ſcirrhous glandules in the viſcera; and from polypuſes the veins are often greatly ſwelled or enlarged into tumors. Theſe ligatures will ſerve to keep the blood in any limb round which they are tied, that it may not return to the heart, and be loſt through a wound in another part.

The experiments to prove this courſe of the blood, which have been made in living animals, are ſtill more accurate. From them, even from our own, it appears, that by tying any vein, in a living animal, near the cava, or belonging to the pulmonary veins, that part always ſwells which is moſt remote from the heart, all below the ligature appearing diſtended with the retained blood, while above and next the heart they are pale and flaccid. Laſtly, if the arteries are tied at the ſame time with the veins, theſe laſt remain flaccid and empty; but, upon removing the ligature from the arteries, the veins are immediately filled.

In like manner, the infuſion of poiſons or medicinal liquors ſhow, that, into whatever vein you inject chemical acid ſpirits, the blood is driven along with the

force of the poiſon to the heart itſelf. But when, from this cauſe, the brain is affected with the narcotic virtue of opium, and the inteſtines and ſtomach with the virtue of purgatives and emetics, this is a demonſtration that the blood, with which theſe ſubſtances were mixed, had paſſed through the ramifications of the veins to the heart, and from thence through the whole body.

Another proof we have in the *transfuſions* of blood; in which all the blood from the arteries of one animal is urged into the veins of another exhauſted of blood; whereby the heart, arteries, and empty veins of the latter become ſo turgid and well repleniſhed, that they work the whole machine of the animal with a remarkable degree of vivacity, or even cauſe it to labour under a plethora.

But that the blood paſſes from the leaſt arteries into the leaſt veins, we are clearly taught by *anatomical injection;* where, by one arterial trunk, we eaſily fill all the arteries and veins, almoſt throughout the whole body; provided the liquor be watery or very fluid, ſo as to paſs eaſily in the veſſels of the head, meſentery, heart, and lungs.

Laſtly, *the microſcope* has put the matter beyond all doubt in the pellucid tails, feet, and meſenteries, of animals; where we ſee that the blood, brought to the extreme parts by the arteries, is poured either into ſmall veins continuous with the reflexed artery, or elſe goes through branches of the arterial trunk into the parallel communicating vein, by which it goes on to the parts neareſt the heart. This is the way in which the blood paſſes as well into the leaſt veins which are capable of receiving only one globule, as into thoſe that are ſomewhat larger, being able to admit two or more globules to advance forward in a breaſt. But that there is no ſpongy or parenchymous interpoſition betwixt the arteries and veins, in the general courſe of the circulation, is proved both from microſcopes and injections. For if there were any ſuch parenchyma or

ſpongy maſs betwixt the arteries and veins, the hardening injections would ſhow it, by appearing extravaſated in a like unſhapen maſs.

The circulation of the blood is, therefore, now received by every one as a medical truth; namely, that all the blood of the human body is carried through the aorta, from the left cavity of the heart, to the extreme parts or converging ends of the arterial branches; from whence the whole maſs is again tranſmitted into the leaſt veins, which convey it to the larger, and from them into the cava and heart itſelf; in which courſe it perpetually goes and returns during life.

Yet there are ſome inſtances where, by paſſions of the mind, a ſudden revulſion by copious blood-letting, or convulſions, the blood has been forced to recede back from the ſmaller into the larger arteries; and, on the other ſide, where an obſtruction being formed above the valves, the blood has been known to ſlide back from the venous trunks into their ſmaller branches. But then theſe accidents are very momentaneous or ſudden, and the blood ſoon returns into its natural courſe. Theſe things happen moſt frequently in the abdomen and vena portarum.

The courſe of the humours *in the lymphatic veins* which have valves, appears both from the nature of thoſe veins and from ligatures: for every lymphatic vein tied ſwells betwixt the ſmaller extremities of it and the thoracic duct; but grows flaccid betwixt the ſaid duct and the ligature. All the valves in theſe, like thoſe of the blood-veins, give a free paſſage for flatus and mercury to flow to the thoracic duct: but they make a reſiſtance, and often an obſtinate one, to any return the other way; although ſometimes they have been known to yield.

The vapours that moiſten the whole cellular ſubſtance, the ſteams of the abdomen and other venters, are all thus drunk up by the leaſt pellucid veins, and ſo conveyed to the blood-veins, that their contained juices may

may pafs on to the heart: and from thence it is, that œdema enfues, when a vein is compreffed by a ligature; becaufe by intercepting the courfe of the abforbing veins by the ligature, the vapours ftagnate unabforbed. In the other fmaller veffels, we can make no experiments: but they appear conformable to what we have faid, both from reafon and analogy; and are likewife fupported by the experiments of water or other liquors, abforbed out of the cavity of the inteftines, thorax, and pulmonary veficles.

All juices, therefore, in the human body, are drove out of the heart into the aorta; from whence they are all returned again to the heart by the leaft veins; thofe humours only excepted, which are exhaled or difcharged withoutfide the cavities of the body. To complete this circle, it only remains for us to find out a courfe for the blood, from the right to the left cavities of the heart: but then this fuppofes us to be firft acquainted with the hiftory of the heart and the pulmonary veffels.

§ 9. *Lungs.*

Situation in general and figure. The lungs are two large fpongy bodies, of a reddifh colour in children, greyifh in adult fubjects, and bluifh in old age; filling the whole cavity of the thorax, one being feated in the right fide, the other in the left, parted by the mediaftinum and heart; and of a figure anfwering to that of the cavity which contains them, that is, convex next the ribs, concave next the diaphragm, and irregularly flatted and depreffed next the mediaftinum and heart.

When the lungs are viewed out of the thorax, they repreſent in fome meafure an ox's foot, with the forepart turned to the back, the back-part to the fternum, and the lower part to the diaphragm.

Diviſion and figure in particular. They are diſtinguiſhed

guiſhed into the right and left lung; and each of theſe into two or three portions called *lobi*, of which the right lung has commonly three, or two and a half, and the left lung two. The right lung is generally larger than the left, anſwerably to that cavity of the breaſt, and to the obliquity of the mediaſtinum.

At the lower edge of the left lung, there is an indented notch or ſinus oppoſite to the apex of the heart, which is therefore never covered by that lung even in the ſtrongeſt inſpirations, and conſequently the apex of the heart and pericardium may always ſtrike againſt the ribs; the lungs not ſurrounding the heart in the manner commonly taught. This ſinus is expreſſed in Euſtachius's tables.

Structure. The ſubſtance of the lungs is almoſt all ſpongy, being made up of an infinite number of membranous cells, and of different ſorts of veſſels ſpread among the cells, in innumerable ramifications.

Coats. This whole maſs is covered by a membrane continued from each pleura, which is commonly ſaid to be double; but what is looked upon as the inner membrane, is only an expanſion and continuation of a cellular ſubſtance, which ſhall be ſpoken to after I have deſcribed the veſſels of this viſcus.

Bronchia. The veſſels which compoſe part of the ſubſtance of the lungs are of three or four kinds; the air-veſſels, blood-veſſels, and lymphatics, to which we may add the nerves. The air-veſſels make the chief part, and are termed *bronchia.*

Theſe bronchia are conical tubes, compoſed of an infinite number of cartilaginous fragments, like ſo many irregular arches of circles, connected together by a ligamentary elaſtic membrane, and diſpoſed in ſuch a manner as that the lower eaſily inſinuate themſelves within thoſe above them.

They are lined on the inſide by a very fine membrane, which continually diſcharges a mucilaginous fluid; and in the ſubſtance of the membrane are a great

great number of ſmall blood-veſſels, and on its convex ſide many longitudinal lines, which appear to be partly fleſhy, and partly made up of an elaſtic ſubſtance of another kind.

The bronchia are divided in all directions into an infinite number of ramifications, which diminiſh gradually in ſize; and as they become capillary, change their cartilaginous ſtructure into that of a membrane. Beſides theſe very ſmall extremities of this numerous ſeries of ramifications, we find that all the ſubordinate trunks, from the greateſt to the ſmalleſt, ſend out from all ſides a vaſt number of ſhort capillary tubes of the ſame kind.

Veſiculæ bronchiales. Each of theſe numerous bronchial tubes is widened at the extremity, and thereby formed into a ſmall membranous cell commonly called *a veſicle.* Theſe cells or folliculi are cloſely connected together in bundles; each ſmall branch producing a bundle proportionable to its extent and the number of its ramifications.

Lobuli. Theſe ſmall veſicular or cellulous bundles are termed *lobules;* and as the great branches are divided into ſmall rami, ſo the great lobules are divided into ſeveral ſmall ones. The cells or veſicles of each lobule have a free communication with each other, but the ſeveral lobules do not communicate ſo readily.

Interlobular ſubſtance. The lobules appear diſtinctly to be parted by another cellulous ſubſtance, which ſurrounds each of them in proportion to their extent, and fills up the interſtices between them. This ſubſtance forms likewiſe a kind of irregular membranous cells, which are thinner, looſer, and broader, than the bronchial veſicles.

This ſubſtance is diſperſed through every part of the lungs, forms cellulous or ſpongy vaginæ, which ſurround the ramifications of the bronchia and blood-veſſels, and is afterwards ſpread over the outer ſurface of each lung, where it forms a kind of fine

cellular coat, joined to the general covering of that viſcus.

When we blow into this interlobular ſubſtance, the air compreſſes and flattens the lobuli; and when we blow into the bronchial veſicles, they preſently ſwell; and if we continue to blow with force, the air paſſes inſenſibly into the interlobular ſubſtance. We owe this obſervation to M. Helvetius.

Vaſcular texture. All the bronchial cells are ſurrounded by a very fine reticular texture of the ſmall extremities of arteries and veins which communicate every way with each other. The greateſt part of this admirable ſtructure is the diſcovery of the illuſtrious Malpighi.

Blood-veſſels. The blood-veſſels of the lungs are of two kinds; one common, called *the pulmonary artery and veins;* the other proper, called *the bronchial arteries and veins.*

The pulmonary artery goes out from the right ventricle of the heart: and its trunk having run directly upward as high as the curvature of the aorta, is divided into two lateral branches; one going to the right hand, called *the right pulmonary artery;* the other to the left, termed *the left pulmonary artery.* The right artery paſſes under the curvature of the aorta, and is conſequently longer than the left. They both run to the lungs, and are diſperſed through their whole ſubſtance by ramifications nearly like thoſe of the bronchia, and lying in the ſame directions.

The pulmonary veins having been diſtributed thro' the lungs in the ſame manner, go out on each ſide, by two great branches which open laterally into the reſervoir or muſcular bag of the right auricle.

The ramifications of theſe two kinds of veſſels in the lungs, are ſurrounded every where by the cellular ſubſtance already mentioned, which likewiſe gives them a kind of vagina; and the rete mirabile of Malpighi, deſcribed above, is formed by the capillary extremities

ties of these vessels. It must be observed, that the ramifications of the arteries are more numerous and larger than those of the veins, which in all other parts of the body exceed the arteries both in number and size.

Bronchial arteries and veins. Besides these capital blood-vessels, there are others called the *bronchial arteries and veins*, which are very small, but they follow the bronchia through all their ramifications. They communicate with the pulmonary arteries and veins in many places; likewise with the arteries and veins of the œsophagus, and with branches of the coronary artery and vein.

The varieties in the origins of the bronchial arteries and veins, especially of the arteries, their communications or anastomoses with each other and with the neighbouring vessels, and above all, the immediate anastomosis of the bronchial artery with the common pulmonary vein, are of so great consequence in the practice of physic, that it will be proper to repeat here what we have said about them elsewhere, that the attention of the readers may not be diverted by being obliged to turn to another place of this work.

The bronchial arteries come sometimes from the anterior part of the aorta descendens superior, sometimes from the first intercostal artery, and sometimes from one of the œsophagææ. They go out sometimes separately, toward each lung; sometimes by a small common trunk, which afterwards divides to the right and left, near the bifurcation of the aspera arteria hereafter to be described, and follow ramifications of the bronchia.

The left bronchial artery comes pretty frequently from the aorta; and the right, from the superior intercostal on the same side, because of the situation of the aorta. There is likewise another which arises from the aorta posteriorly near the superior intercostal, and above the anterior bronchialis.

The bronchial artery gives off a small branch to the

auricle of the heart on the ſame ſide, which communicates immediately with the coronary artery.

Sometimes one bronchial artery gives origin to ſeveral ſuperior intercoſtals; and ſometimes ſeveral bronchial arteries ſend off ſeparately the ſame number of intercoſtals.

The bronchial veins, as well as arteries, were known to Galen. The vein on the left ſide goes into the left ſuperior intercoſtal vein, while the trunk on the right ſide paſſes into the vena azygos; and ſometimes both veins are branches of the gutturalis.

Nerves. The lungs have a great many nerves diſtributed through them by filaments which accompany the ramifications of the bronchia and blood-veſſels, and are ſpread on the cells, coats, and all the membranous parts of the lungs. The eight pair and great ſympathetic nerves, form behind each lung a particular intertexture, called *plexus pulmonaris;* from whence nervous filaments go out, which communicate with the plexus cardiacus and ſtomachicus.

Lymphatic veſſels. On the ſurface of the human lungs, between the external and cellular coat, we obſerve lymphatic veſſels: but we ought to take care not to miſtake for ſuch veſſels a tranſparent reticular ſubſtance obſervable on the ſurface of the lungs after blowing ſtrongly into the lobuli; this appearance being entirely owing to the air which paſſes through the bronchial veſicles into the interlobular cells, and which, by ſeparating a certain number of lobuli, finds room to lodge between them.

Ligaments. Under the root of each lung, that is, under that part formed by the ſubordinate trunk of the pulmonary artery, by the trunks of the pulmonary veins, and by the trunk of the bronchia, there is a pretty broad membranous ligament which ties the poſterior edge of each lung to the lateral parts of the vertebræ of the back, from that root all the way to the diaphragm.

Tra-

Trachea arteria. The bronchia already deſcribed, are branches or ramifications of a large canal, partly cartilaginous, and partly membranous, called *trachea* or *aſpera arteria.* It is ſituated anteriorly in the lower part of the neck, from whence it runs down into the thorax between the two pleuræ, through the upper ſpace left between the duplicature of the mediaſtinum, behind the thymus.

Having reached as low as the curvature of the aorta, it divides into two lateral parts, one toward the right hand, the other toward the left, which enter the lungs, and are diſtributed through them in the manner already ſaid. Theſe two branches are called *bronchia;* and that on the right ſide is ſhorter than that of the left, whereas the right pulmonary artery is the longeſt.

The trachea is made up of ſegments of circles of cartilaginous hoops, diſpoſed in ſuch a manner as to form a canal open on the back-part, the cartilages not going quite round; but this opening is filled by a ſoft glandular membrane, which completes the circumference of the canal; but this cannot be to give way to the œſophagus; for, inſtead of deſcending immediately upon the middle of that canal, the trachea inclines a little to the right ſide, and the ſame ſtructure is found in the back-part of the great bronchial veſſels, which are at ſome diſtance from the œſophagus.

Each circle is about the twelfth part of an inch in breadth, and about a quarter of that ſpace in thickneſs. Their extremities are round; and they are ſituated horizontally above each other, ſmall interſtices being left between them, and the lower edge of the ſuperior ſegments being turned toward the upper edge of thoſe next below them.

They are all connected by a very ſtrong elaſtic membranous ligament fixed to their edges. I have obſerved the firſt three ſegments united into one bent alternately in two different places according to its breadth. Sometimes two are continuous in the ſame manner.

The

The trachea is covered externally with a quantity of cellular ſubſtance, which unites it to the neighbouring parts, and it is lined on the inſide by a particular membrane; which appears to be partly fleſhy or muſcular, and partly ligamentary, performed by an infinite number of ſmall holes more or leſs imperceptible, through which a mucilaginous fluid continually paſſes, to defend the inner ſurface of the trachea againſt the acrimony of the air which we breathe.

This fluid comes from ſmall glandular bodies diſperſed through the ſubſtance of the membrane, but eſpecially from glands ſomething larger than the former, which lie on the outer or poſterior ſurface of that ſtrong membrane by which the circumference of the canal is completed. The ſame ſtructure is obſervable in the ramifications of the trachea from the greateſt to the ſmalleſt.

All the veſſels of which the lungs are chiefly compoſed, that is, the air-veſſels or bronchia, and the blood-veſſels, or the pulmonary and bronchial arteries and veins, accompany each other through this whole viſcus.

They are diſpoſed commonly in ſuch a manner, even to the laſt ramifications, as that a ſubordinate trunk or branch of the bronchia lies between the like trunks or branches of the pulmonary artery and vein; the bronchial veſſels being immediately joined to the bronchia. In ſome places theſe three kinds of veſſels touch each other in ſuch a manner as to leave a triangular ſpace in the middle.

The bronchia are divided into a very great number of ramifications; and the laſt rami are the pedicles or footſtalks of the ſmall lobuli. All the lobuli are angular, oblong, broad, thin, &c. The footſtalks ſend out other ſmaller membranous pedicles, which are very ſhort, and terminate in the bronchial veſicles or cells, of which they are continuations. The ſubordinate

trunks and rami detach a great number of theſe pedicles from their convex ſurface.

When we blow into the lungs, the bronchial cells neareſt their outer ſurface appear like ſmall portions of round veſicles; and from this appearance all the bronchial cells have got the name of *veſicles*, though they are all angular except thoſe which I have now mentioned.

When we examine a lung without blowing it up, we find that the cartilaginous ſegments of the bronchia lie ſo near as to be engaged in each other; and in drawing out any portion of the bronchia by the two ends, theſe ſegments are parted; and the whole canal is increaſed in length; but it contracts again, by means of its elaſtic membrane, as ſoon as that force is taken off.

When we open lengthwiſe any portion of the pulmonary artery and vein in the ſame lung, we meet with a great number of tranſverſe rugæ, which are deſtroyed when theſe veſſels are elongated. This is an obſervation made by M. Helvetius.

By virtue of this ſtructure, all the ramifications both of the bronchia and pulmonary arteries and veins, have conſtantly the ſame direction, whether the lung be inflated or collapſed; and they contract in length, without being either contorted or folded. In exſpiration theſe veſſels are elongated, and ſhortened in inſpiration.

Theſe three veſſels lie in a ſort of cellular vagina, which accompanies all their ramifications; and is a continuation of their interlobular cells, or cellular ſubſtance, in the interſtices of the lobuli. The pelliculæ which compoſe it, are, however, there diſpoſed in a more regular manner, and more longitudinally, than in other places, and thereby appear to form a true vagina.

When we blow through a pipe introduced ſo far as to touch immediately a trunk of the blood-veſſels or bron-

bronchia, the air runs at firſt through all the cells that lie neareſt that trunk or its branches; but if we continue to blow, it inſinuates itſelf through the whole interlobular ſubſtance.

Bronchial glands. At the angle of the firſt ramification of the trachea arteria, we find on both the fore and back ſides certain ſoft, roundiſh, glandular bodies, of a bluiſh or blackiſh colour, but reddiſh in a child; in ſize they vary from that of a field-bean to that of a millet-ſeed. Through theſe the lymphatic veſſels of the lungs paſs in their way to the thoracic duct.

The trachea has ſeveral coats, as has been already obſerved. The outermoſt or common covering ſurrounds that part of the trachea which lies in the thorax; but out of the thorax, this firſt coat is derived from the aponeurotic expanſions of the muſcles of the neck; and it is between this and the following covering that the glands already mentioned are ſituated.

The ſecond is a proper coat, being a continuation of the cellular covering of the lungs; the pelliculæ of which, neareſt the cartilaginous ſegments, ſerve them for an external perichondrium. The third membrane lies on the inſide, adhering cloſely to the ſame cartilages, and ſupplying to theſe the place of an internal perichondrium.

The fourth membrane is that which completes the circumference of the cartilaginous circles of the trachea. It conſiſts chiefly of two laminæ or ſtrata, partly muſcular and partly tendinous; the external or poſterior lamina being made up of longitudinal fibres; and the internal, or anterior, of tranſverſe fibres. This membrane is perforated by the ſmall ducts of the above-mentioned glands, which diſcharge a fluid when preſſed; and being examined through a microſcope, they appear veſicular or folliculous, much like that of the ſtomach.

The ligaments between the cartilaginous circles are very ſtrong and elaſtic; and each of them is confined

to

to two cartilages, without communicating with any of the reſt; being fixed to the edges of theſe cartilages, much in the ſame manner as the intercoſtal muſcles are inſerted in the ribs.

As the bronchia penetrate into the ſubſtance of the lungs, they gradually loſe their cartilages, till at laſt they become purely membranous; but the muſcular lines of M. Morgagni appear as much, and ſometimes more than before. The two planes above-mentioned continue likewiſe to be viſible; and we obſerve very diſtinctly, ſometimes even without a microſcope, a great many ſmall holes in the pellicles of the lobuli, and bronchial veſicles or cells which open from within outwards.

Uſes. Reſpiration is performed by organs of two kinds; one of which may be looked upon as active, the other as paſſive. The lungs are of the ſecond kind, and the firſt comprehends chiefly the diaphragm and intercoſtal muſcles.

As ſoon as the intercoſtal muſcles begin to contract, the arches of the ribs are raiſed together with the ſternum, and placed at a greater diſtance from each other; by which means the cavity of the thorax is enlarged on the two lateral and anterior ſides.

At the ſame inſtant the diaphragm is flatted or brought toward a plane by two motions, which are apparently contrary; that is, by the contraction of the diaphragm, and the dilatation of the ribs in which it is inſerted. The external ſurface of the thorax being thus in a manner increaſed, and the cavity of the bronchia being at the ſame time, and by the ſame means, leſs reſiſted or preſſed upon, the ambient air yields to the external preſſure, and inſinuates itſelf into all the places where the preſſure is diminiſhed; that is, into the aſpera arteria, and into all the ramifications of the bronchia, all the way to the veſicles. This is what is called *inſpiration.*

This motion of inſpiration is inſtantaneous, and ceaſes

ſes in a moment by the relaxation of the intercoſtal muſcles; the elaſtic ligaments and cartilages of the ribs bringing them back at the ſame time to their former ſituation. This motion by which the ribs are depreſſed and brought nearer to each other, is termed *exſpiration.*

The pulmonary arteries and veins which accompany the bronchia through all their ramifications, and ſurround the veſicles, tranſmit the blood through their narrow capillary extremities, and thereby change or modify it, at leaſt in three different manners.

The firſt change or modification which the blood undergoes in the lungs, is to have the coheſions of its parts broken, to be attenuated, pounded, and, as it were, reduced to powder. The ſecond is, to be deprived of a certain quantity of ſerum, which tranſpires through the lungs, and is what we commonly call the *breath.* The third is, to be in a manner reanimated by the impreſſion of the air, whether the whole body of the air enters the blood, whether the common air is only the vehicle of ſome finer parts which are conveyed to it, or whether the air only compreſſes and ſhakes the blood as it paſſes round the bronchial veſicles in the reticular capillary extremities of the veſſels.

The cartilages of the aſpera arteria and bronchia ſerve in general to compoſe a canal, the ſides of which will not ſink in or ſubſide by compreſſion, but will nevertheleſs yield to certain preſſures and impulſes without breaking. As theſe cartilages are not complete circles or rings, and as their circumferences are completed by elaſtic membranes, they allow of thoſe dilatations and contractions which modulate the voice; and as they are connected by elaſtic ligaments of a conſiderable breadth, the alternate elongation and contraction of the bronchia is facilitated in the motions of reſpiration.

The larynx is commonly looked upon as the upper part of the aſpera arteria: but we have already deſcribed

ſcribed it in the preceding chapter *of the Head*, with which it has a particular connection in relation to the tongue.

§ 10. *Reſpiration.*

THE lungs completely fill the ſacs formed by the pleura. They are freely ſuſpended by the great blood-veſſels; unleſs you call that a ligament, which is made by the external membrane of the pleura going to the lungs and to the baſis of the diaphragm. Betwixt the lungs and pleura is found a watery or rather ſerous vapour, of a coagulable nature, like that of the pericardium; which vapour tranſudes from the ſurface of the lungs continually in the fœtus, and not unfrequently in the adult. This is ſometimes increaſed, ſo as to form a dropſy; or thickens into a kind of ſebaceous matter; or, laſtly, concreting into fibres, joins the lungs to the pleura.

The veſicles of the lungs do not receive the air by a ſingle orifice from the windpipe, as a vial; but the air, exhaling from the leaſt branches of the ſaid wind-artery, is admitted in ſuch a manner into their irregular ſpaces, that it freely ſpreads through them from any one part of the lungs into all the reſt, and returns again in like manner. This is demonſtrated by inflation, which drives the air even through the leaſt branches of the windpipe into the ſmalleſt lobes; from whence it readily paſſes into all the reſt. Nor, in man and ſmaller animals, ſays Haller, is the cellular fabric of the intervals ſhut up from the veſicles of the lungs; but, according to Sabatier and other late writers, there is no communication between the common cellular ſubſtance and the cells of the lungs.

The air is driven into theſe veſicles through the windpipe, which ariſes from the larynx; and, in the upper part of the thorax is received between the laminæ of the poſterior part of the mediaſtinum.

Its

Its laſt branches are inviſible, which exhale the air into the cellular ſpaces of adult lungs, and likewiſe receive the watery vapours exhaling from the arteries into the ſaid ſpaces; from whence they are thrown by exſpiration.

The blood-veſſels of the bronchia are the arteriæ and venæ bronchiales; but there are other larger veſſels belonging to the lungs, called the *pulmonary artery* and *vein*. The great artery, in the fœtus larger than the aorta, and in the adult but little leſs, has two branches; the right larger but ſhort, the left narrower and longer. In the fœtus, the trunk itſelf is continued into the deſcending aorta, and is known by the name of *ductus arterioſus*. In an adult, that trunk degenerates into a ſolid ligament. The four pulmonary veins accompany the arterial branches and the aſpera arteria of the windpipe in their courſe through the lungs, ſurrounded with a good deal of cellular ſubſtance; which ſubſtance, being increaſed, at laſt compoſes the lungs themſelves. Within this cellular fabric, and likewiſe upon the ultimate ſpaces or cells, the air-veſſels and blood-veſſels are ſubdivided, ſpread, and interwoven like a net; and here the ſmall arteries exhale a plentiful vapour into their cells, and the lymphatics abſorb a watery vapour from the ſame cells. Hence water tinctured, the whey of milk, or a thin waxen injection, being urged into the pulmonary artery, flows with a froth into the windpipe; or, on the contrary, being urged from the windpipe into the lungs, they penetrate into the pulmonary artery; or from thence, laſtly, a liquor injected by the arteries, readily enters the pulmonary veins; and the reverſe.

The lymphatic veſſels, as in other parts, form a network upon the ſurface of the lungs, from whence there are branches conveying the lymph to the cavity at the back part of the mediaſtinum, and to the ſmall glands which lie behind the œſophagus, opening at laſt into the thoracic duct. The anterior pulmonary nerves

are ſmall, but the poſterior ones ſomewhat larger; they come from a nerve of the eighth pair; and there are alſo ſome ſmall nerves to the lungs from the recurrent, and likewiſe from the cardiac plexus, which enter together with the large blood-veſſels. Hence, ſays Haller, the lungs have but little ſenſation; nor are they of an irritable nature. But Wriſberg remarks, contrary to this, that if he were to conſider the number and magnitude of the bronchial nerves, he would be inclined to ſuppoſe, that the lungs of all the human viſcera, the organs of ſenſe excepted, receive, upon compariſon, many nerves, and therefore poſſeſs ſenſibility.

The quantity of blood which enters into the lungs is exceedingly great, equal to (or even perhaps greater than) that which is ſent in the ſame time throughout the reſt of the body; which, therefore, demonſtrates ſome very conſiderable uſe proper to this viſcus. And that this uſe depends manifeſtly upon the air, appears from the univerſal conſent of nature, in which we ſcarce find any animal without breathing; alſo from the ſtructure of the lungs in the fœtus, in which, for want of air, they are uſeleſs, receiving only a ſmall portion of the blood, which the pulmonary artery conducts from the heart. We come next, therefore, to ſpeak of reſpiration, by which the air is drawn into and expelled from the lungs.

The element of air appears, from the principles of philoſophy, to be an elaſtic and ſonorous fluid, with a ſpring which cannot be deſtroyed. But the atmoſpherical air, which we commonly receive into the lungs, is impure, filled with a great quantity of watery and other vapours, alſo with ſalts and the univerſal acid, with the ſeeds of plants and animals, and other foreign matters; but in very minute particles, having a ſpecific gravity 859 times leſs than water, a cubic foot of air weighing between 610 and 694 grains. This air, which ſurrounds the earth on all ſides, being preſſed

by the incumbent columns of its own maſs, perpendicularly, laterally, and in all directions, enters wherever it meets a leſs reſiſtance, and with a conſiderable force, as appears from experiments made with empty or exhauſted veſſels, and by the air-pump; ſo that its preſſure on the human body is not leſs than 3000 pounds weight. It is repelled chiefly by the pores of the membranes, which yet are permeable by water: it likewiſe penetrates oil or mucus with difficulty.

This air is excluded from all parts of the human body by the ſurrounding cloſe ſkin, which, even when dried or tanned, is impervious to the air; but more ſo, as under the ſkin is placed the fat, making an equal reſiſtance to the narrow openings of the abſorbing veſſels. It, therefore, now remains for us to inquire, why the air enters the lungs of an adult perſon; for with this they are in a manner conſtantly full, and of courſe are equally preſſed, and reſiſting againſt the weight of the whole atmoſphere: but that the lungs always contain air is evident; becauſe, however cloſe you compreſs them, they will be ſtill lighter than water; and even in the fœtus, after they have been inflated but a few times, they always ſwim; whereas they ſink to the bottom of water, if they have not given admittance to the air.

The equilibrium of the air's preſſure being removed in any place, it conſtantly deſcends or flows that way where it is leaſt reſiſted. But air that is denſe and heavy will deſcend more eaſily than ſuch as is light, whoſe force ſcarce overcomes that of the air which is already in the lungs, nor is able by the ſame force to overcome the reſiſtance of the bronchia, and force by which the lungs compreſs the air contained in them. Hence an animal lives better in a denſe than in a light air: although that kind of air is always moſt tolerable, which is pure at the ſame time that it is light; ſuch as that of the higheſt mountains of the Alps. Therefore, for the air to enter the lungs, they muſt make a leſs

leſs reſiſtance to it than before; namely, the air, which is already in the cellular fabric of the lungs, muſt be rarefied: but this effect will follow, if the cavity of the thorax, in which the lungs are contained, and which they exactly fill, be dilated. Thus the air, which is always in the lungs, expands into a larger ſpace; by which, being weakened in its ſpring, it makes a leſs reſiſtance to the external air; and conſequently a portion of the ſaid external air deſcends into the lungs, ſufficient to reſtore the confined and rarefied air, filling the lungs to the ſame denſity with that of the external air.

In order to dilate the ſeat of the lungs, and thus to put the body in ſuch a ſtate that the external air may ruſh into the lungs, it is neceſſary for the thorax to be elevated. By this means all the ſections of the thorax form right angles, and its capacity is increaſed. This motion is performed by various muſcles, which either operate conſtantly or only at certain times. The intercoſtal muſcles, therefore, all of them act perpetually in elevating the ribs: but ſome doubt has ariſen about the action of the internal intercoſtals; becauſe their lower part is inſerted into that portion of the rib which is neareſt its articulation with the vertebræ, and which therefore ſeems to be the leaſt moveable: however, they elevate the ribs notwithſtanding this; for the great firmneſs or immobility of the upper rib, exceeding that of the lower, is evident from the articulation, weight, and ligaments there formed, which ſurpaſſes that mobility, ariſing from the greater diſtance of the centre of motion. This appears from the diſſection of living animals; in which we ſee the inner intercoſtal muſcles operate in the elevation of the ribs, and reſt in the depreſſion of them alſo from a flexible thread fixed to the rib of ſome human ſkeleton, and drawn in the ſame direction with that of the fibres of the inner intercoſtal muſcles; by which means the lower rib will be always approximated towards the upper.

The greater firmneſs alſo of the upper ribs proves this, as they ſerve for a fixed point to the lower ones: for the firſt or uppermoſt ribs are from eight to twelve times firmer and leſs moveable than the lower true ribs; but the difference of diſtance in them from the centre of motion, is ſcarcely the twentieth part of the length of their whole lever. Laſtly, the elevating power of the internal intercoſtal muſcles appears plainly by experiment in a dead ſubject; when, by the thorax being raiſed, the muſcles inſtantly ſwell.

By the action, therefore, of theſe muſcles, the thorax is elevated, not altogether as one machine, nor would reſpiration be aſſiſted by ſuch a motion; but the ribs turning upon their articulations, though behind they are but little moved, yet the fore-part of their extremities deſcends, and forms larger angles both with the ſternum and vertebræ; but from thence in the middle of their arches, by aſcending, their lower edges are drawn upward. At the ſame time, the ſternum is thruſt out forward more from the vertebræ and from the ribs. Thus the ribs are both removed farther from the vertebræ, and the right ribs depart from the left; and the diameter on both ſides, betwixt the right and left ribs, betwixt the ſternum and the vertebræ, is increaſed almoſt to two lines: and therefore this enlargement, following in every imaginable ſection of the thorax, will ſufficiently dilate the cavity of the breaſt. This action of the ribs is more particularly complete in women, and in men who have no ſhortneſs of breath. Theſe effects are produced leaſt of all by the firſt ribs, but more by the following ones. In very ſtrong inſpiration, the ribs deſcend both behind and before; and, along with theſe, the ſternum and the ſpaces between the cartilage are leſſened. But this dilatation alone is not ſufficient for healthy breathing: nor is it ſo conſpicuous or evident in men; although, in them, the intercoſtal muſcles, by retaining and elevating the ribs, very much aſſiſt the inſpiration in a tacit manner, while

while they afford a fixed point to the diaphragm, that the whole force of that muſcle may be ſpent, not ſo much in depreſſing the ribs, as in urging down the abdomen. The greater part, therefore, of the ſpace which the thorax gains in inſpiration, ariſes from the action of the diaphragm; the centre of which is more moveable and at liberty than the reſt; except in the middle of its tendinous part near the fleſhy margin, where the incumbent heart makes a reſiſtance; but the lateral parts and the fleſhy portions belonging to them are the moſt moveable.

There are two holes in the diaphragm; of which that on the right ſide of its tendinous part is ſomewhat ſquare, and circumſcribed by four ſtrong tendinous portions; the left, which is elliptical, lies betwixt the right and left fleſhy portions, which ariſe from the middle of the bodies of the vertebræ of the loins: under this opening they decuſſate and croſs each other once or twice, but above they end in the tendon. This left opening is therefore drawn cloſe together in the contraction of the diaphragm, while it is probable that the other opening remains immoveable. The tendons are but little changed in the motion of the muſcles.

The ſtructure of the parts, and the diſſection of living animals, demonſtrate, that the fleſhy portions of the diaphragm, which on all ſides aſcend from the firm parts to the middle and more moveable, do, by their contraction, depreſs the ſame, and by that means draw downward the lateral bags of the thorax, which contain the lungs; and, by this means, the perpendicular diameter of the thorax is conſiderably increaſed. The fleſhy parts are more depreſſed; the tendon leſs; both becauſe it is fixed to the pericardium, and becauſe its own ſubſtance does not contract. Even the œſophagus and vena cava are contracted, while the diaphragm exerts its action. So that the diaphragm almoſt alone performs the office of reſpiration in a healthy man who is at reſt; as alſo in that thorax whoſe ribs are fractu-

red, or the ſternum burſt, or where the perſon will not make uſe of his ribs by reaſon of pain. The force of the diaphragm alſo, in dilating the breaſt, is greater, according to the calculations that have been made, than all the reſt of the powers which contribute to reſpiration. A ſtrong inſpiration is as yet confined; becauſe, during the greateſt exertion of the diaphragm, the lowermoſt ribs are brought inwards, and thus far the thorax is ſtraitened. Leſt this ſhould always happen, the intercoſtal muſcles interefere in ordinary inſpirations; in very great ones they are inferior to the diaphragm. The phrenic nerve, which is more eaſily irritated than in moſt other muſcles, forces the diaphragm to perform its office. The lungs themſelves are altogether paſſive or obedient to the action of the air, ribs, and diaphragm; to which they are preſſed into cloſe contact on all ſides, as through a large wound; and when the thorax is denudated by the knife, leaving its capacity entire, the lungs appear through the pellucid pleura and diaphragm.

But in larger inſpirations, which receive a greater quantity of blood driven into the lungs, and when there is any obſtacle or difficulty oppoſed to the action of the lungs themſelves; in thoſe caſes, ſeveral other powers conſpire to elevate the thorax: which powers are inſerted either into the thorax, clavicles, or ſcapulæ; ſuch as the ſcaleni muſcles, trapezii, cervicales deſcendentes, ſerrati ſuperiores, and pectorales; together with the ſmall elevators; of which a more ample deſcription may be had from profeſſed ſyſtems of anatomy.

We have now ſurveyed the powers which are able to increaſe the capacity of the thorax in all its three dimenſions. By theſe the cavity of the breaſt is dilated, ſo that it compreſſes the lungs leſs than before: the lungs then ſtrive to diffuſe themſelves over that ſpace, ſeeing they are never deſtitute of air, which expands itſelf by its elaſticity as ſoon as the preſſure is taken off. Without that muſcular force the lungs have no proper

power

power of their own by which they are capable of attracting air: and even when they are moſt full of air, by having the aſpera arteria cloſed, the animal vehemently attempts to inſpire, by the efforts of its intercoſtal muſcles and diaphragm. It therefore remains, that the air, which is a heavy fluid, and preſſed on all ſides by the incumbent columns of the atmoſphere, muſt now enter the thorax with the greater force the leſs air the lungs contain; or yet more powerfully, if they contain no air: but with no force at all, if the air admitted through a wound in the breaſt preſſes upon the ſurface of the lungs. In this action, therefore, which is called inſpiration, the bronchia are every way increaſed, both in length and diameter; becauſe all the diameters of the thorax are increaſed: but in this act, the inflated lungs always follow cloſely contiguous to the pleura without leaving any intermediate ſpace. At the ſame time, the pulmonary blood-veſſels, which are wrapped up, together with the bronchia, in a covering of the cellular ſubſtance, are likewiſe with them extended in length, and ſpread out from ſmaller into larger angles; by which means, the circulation through them is rendered eaſier. While this is performing, the veſicular ſubſtance, or fleſh of the lungs themſelves, filled with air, increaſes thoſe ſpaces through which the capillary blood-veſſels of the lungs advance; whereby the veſicular preſſure, upon each other, and upon thoſe veſſels adjacent, is leſſened: thus, therefore, the blood will flow with greater eaſe and celerity into and through the larger and ſmaller veſſels of the lungs. Hence a dying animal is revived by inflating its lungs, and facilitating the paſſage of the blood to the left ventricle of the heart; and thus people, ſeemingly dead by being kept a long time under water, are again recovered. But as for the preſſure of the air upon the blood in the lungs in this action, it is ſo inconſiderable as not to deſerve our notice, as being 300 times leſs than the force of the heart; nor can it ever urge the air into the blood, as it may be eaſily forced by art with a ſyringe.

It is by ſome queſtioned, Whether there be not air betwixt the lungs and the thorax? and whether this air, being rarefied in inſpiration, is not afterwards condenſed, ſo as to compreſs the lungs, and cauſe exſpiration? And they again aſk, Whether this opinion be not confirmed by the inſtances of birds, in which we find this matter to be truly ſo? For by Camper's very elegant diſcovery, it is certain, that air paſſes into almoſt all the long bones of birds flying much in the higher regions, into the cavity of the ſternum, the vertebræ, cranium, inferior maxilla, both from the lungs and through the Euſtachian tube, and goes from one cavity into another: ſo it does not ſeem improbable, that the ſame may paſs out by the ſurface of the body. But in birds, who ſoar not ſo high, the air gains admiſſion through fewer bones. It is a pretty and ſufficiently agreeable experiment, to perforate the humerus or femur; and the air inflated into the aſpera arteria comes out at that foramen with the blood, which it has changed into froth; and *vice verſa*, the air inflated through the hole diſtends the lungs. In like manner Wriſberg has ſeen mercury injected into a foramen of this kind make its appearance in the lungs. But we ſee every thing concurs to confute theſe opinions with reſpect to man and quadrupeds, &c.; for, immediately behind the pleura, in living quadrupeds, as well as in dead human bodies, the lungs are viſible, without any intermediate ſpace betwixt them; but the pleura being perforated, the lungs are immediately, by the contiguous air that enters, preſſed together towards the vertebræ. In birds, indeed, the lungs, being pervious to the air, admit it into the cavity of the thorax through large holes in their ſubſtance. But in theſe there is a manifeſt ſpace betwixt the lungs and the pleura. Large wounds, admitting the air only into one cavity of the thorax, diminiſh the reſpiration; but ſuch wounds as let the air into both cavities, quite ſuffocate or ſuppreſs the reſpiration. The thorax being opened under water,

water, ſends out no bubbles of air through the ſaid water; but in birds it does, becauſe they have air in their thorax. The imaginable ſpace betwixt the lungs and the thorax is always filled up by a watery or ſerous vapour, or elſe by the ſame vapour condenſed into a watery lymph. If the lungs adhere, they injure the reſpiration but in a ſmall degree; which ought entirely to ceaſe, if it required an intermediate air betwixt the lungs and thorax. Finally, the external being admitted to any of the internal membranes of the human body, deſtroys their texture, if they are not defended by a plentiful mucus; of which we can find none upon the ſurface of the pleura.

But reſpiration, whether by the admixture of a ſubputrid vapour, or by ſome other method, certainly vitiates the air, and renders it unfit either for inflating the lungs or ſupporting flame; and laſtly, it deprives that element of its elaſticity. We may ſuppoſe that this happens from putrefaction, ſeeing the air is rendered peſtilential by a crowd, and fevers of the moſt malignant kind are thus generated in a few hours. But in whatever manner this is produced, we are certain that the air is vitiated in the lungs; loſes its elaſticity; and thus cannot keep the lungs diſtended, ſo as to tranſmit an increaſed quantity of blood through the dilated pulmonary arteries into the veins. Nor can the will dilate the breaſt beyond certain bounds, or aſſiſt that paſſage of the blood in an unlimited manner. A ſtate of body therefore will take place, in which the blood cannot paſs through the lungs.

Thus is generated a new reſiſtance to the blood continually coming from the heart: and in long retentions of the breath, as in making violent efforts, the venous blood, eſpecially of the head, ſtagnates before the right ventricle of the heart being ſhut, becauſe it cannot evacuate itſelf into the lungs; and thus ſwells up the face with redneſs, ſometimes burſts the veins of the brain, neck, inteſtines, kidneys, and laſtly of the lungs and

and right auricle of the heart. This occaſions prodigious anxiety and uneaſineſs to the ſpirits; this alſo is the cauſe of death in compreſſed air, in drowned people, and ſuch as are ſtrangled, which is much more ſudden than is commonly imagined. A living perſon therefore, that he may remove thoſe inconveniences which flow from an obſtruction of the paſſage of the blood, ſlackens the powers of inſpiration, and excites thoſe of exſpiration, which free the breaſt from an air too greatly rarefied.

Theſe powers are, firſt, the elaſticity of the ribs; which being drawn upwards out of their natural ſituation, as ſoon as the powers which elevated them ceaſe to act, ſpontaneouſly place themſelves, ſo as to make more acute angles with the ſternum and vertebræ. To this end conduces likewiſe the elaſtic force of the bronchia and veſicles diſtended with air, which ſtrive to contract themſelves. Hence exſpiration is performed more eaſily and quickly than inſpiration; and hence it is the laſt action of dying people.

To this alſo contribute the oblique muſcles of the abdomen, together with the ſtraight and tranſverſe ones. The former of theſe are, in one part of them, faſtened to the lower ribs; and, in another part, they are attached to the os pubis and ilium, as a fixed point with reſpect to the breaſt. Therefore the ſtraight muſcles, being contracted, depreſs the arch or convexity, into which the abdominal viſcera are thruſt by the diaphragm, and bring the ſame nearer to a ſtraight line: at the ſame time the abdominal viſcera are preſſed by thoſe muſcles upward and backward againſt the diaphragm, which alone is able to give way; and yield up into the thorax, which at that time is rendered ſhorter. The oblique muſcles, for the ſame reaſons, compreſs the lateral parts of the abdomen, and urge the liver and ſtomach backwards, and preſs them towards that place where there is the leaſt reſiſtance. Laſtly, they draw down the ribs which were before elevated by the intercoſtals. The tranſverſe muſcles, indeed, do not

draw the ribs; but they pull the cartilages of the falſe ribs a little inward, and render the whole capacity of the abdomen leſs, while at the ſame time they preſs the viſcera againſt the diaphragm. Along with theſe we may reckon the powers of the ſternocoſtal and long intercoſtal muſcles, which are called *depreſſors*. By this joint force the ſuperior ribs deſcend; but the middle ones more, the uppermoſt leſs, the loweſt moſt of all; and the ſame are brought inwards by their margin: the cartilages aſcend, and return into acute angles with the ſternum; and the ſternum itſelf returns backwards with the ribs. By theſe means the thorax, contrary to its former ſtate, is every where rendered narrower and ſhorter, ſo as to expel as much air out of the lungs as is ſufficient to relieve the uneaſineſs cauſed by its retention.

In more powerful reſpirations, when the inſpirations are made greater, the exſpirations are likewiſe increaſed by the aſſiſtance of ſome other powers, as of the ſacrolumbalis, longiſſimus and quadratus muſcles of the back and loins. This force, by which the air is blown out of the lungs, is ſufficient to carry a leaden bullet, weighing about a dram, to the diſtance of 363 feet; which force is equal to a third part of the preſſure of the atmoſphere. But, in a healthy perſon, the muſcles of the abdomen alone ſuffice to an eaſy exſpiration, in which the lungs are not ſo much emptied of air as they are by a violent efflation.

The effects of exſpiration are, a compreſſure of the blood-veſſels in the lungs, a reduction of the bronchia into more acute angles, a preſſure of the reticular ſmall veſſels by the weight and contact of the adjacent larger veſſels, and an expulſion of the corrupted blood from the lungs; by which means part of the blood heſitating in the capillary arteries, is urged forward through the veins to the left ſide of the heart, while at the ſame time that part of the blood is reſiſted which flows in by the artery from the right ventricle. Exſpiration, there-

therefore, will ſtop the eaſy paſſage of the blood thro' the lungs; and when the whole thorax is compreſſed together, repels the venous blood into the veins of the head, and fills the brain and its ſinuſes.

In this manner a freſh neceſſity follows for repeating the reſpiration; becauſe the collapſed veſſels of the lungs reſiſt the blood repeatedly expelled from the right ventricle of the heart. And this makes another cauſe of death in thoſe animals which expire in veſſels exhauſted of air: for, in ſuch, the lungs having the air drawn out from them, appear denſe, ſolid, and heavier than water; whence they are rendered impervious to the blood. Of the ſame kind is the death of thoſe who are killed by lightning, and perhaps by the noxious vapours of caverns. Thus, therefore, by the power of a moſt wiſe fabricature, the organs of exſpiration are relaxed ſo ſoon as that uneaſineſs is perceived, which ariſes from the hindrance of the blood's courſe through the lungs; and hence the powers of inſpiration are excited into action, whereby the motion of the blood through the lungs is rendered free and quicker.

It is by ſome queſtioned, Whether or no there are not other cauſes of alternate reſpiration? Whether or no we may hope for any diſcovery in this matter, by compreſſing the vena ſine pari, the phrenic nerve, or intercepting the blood ſent to the brain? But thoſe are repugnant to comparative anatomy; by which we always find the ſame alternation in the breathing of the animal, independent of any ſuch nerve or vein. Whether or no reſpiration is from the alternate contraction of the antagoniſt muſcles, among which thoſe of exſpiration relax the others of inſpiration, and the reverſe? But in this manner, all the muſcles of the human body are perpetually in an alternate motion.

From what has been hitherto ſaid, it appears, that reſpiration is unavoidably and abſolutely neceſſary to life in a healthy adult perſon; becauſe, whether the lungs remain long in a ſtate either of exſpiration or inſpi-

inſpiration, we ſee death will be the conſequence. Therefore no animal that has lungs like ourſelves, after it has once breathed and received the air into the inmoſt parts of the lungs, and by that means brought a new and large quantity of blood to that viſcus, can ſubſiſt longer than a few minutes without the uſe and benefit of a free air; but it will either periſh, or at leaſt fall into ſuch a ſtate as differs from death only in its being recoverable again by certain powers or actions. In an animal lately born, this neceſſity for air does not take place ſo ſuddenly.

But the uſe of reſpiration is different from this neceſſity; which nature might have avoided, either by uſing no lungs at all, or elſe by diſpoſing them in a manner reſembling thoſe of the fœtus. This uſe, therefore, of reſpiration muſt be very conſiderable, ſince all animals are either made with lungs, or with gills, as in fiſh, or elſe with a windpipe diſperſed thro' all parts of the body.

In order to diſcover this uſefulneſs of reſpiration, let us compare the blood of an adult perſon to that of a fœtus, and alſo with the ſame vital fluid in fiſh. It appears then in a fœtus, that the blood is deſtitute of its florid redneſs and ſolid denſity; and in the blood of fiſh, we obſerve there is no heat, the denſity inconſiderable, and but little craſſamentum contained in it; and, therefore, all theſe properties, we are, by the nature of things, perſuaded, the blood acquires in the lungs.

It may be aſked, therefore, Whether the blood does not acquire its heat principally in the lungs? But this does not ariſe from the alternate extenſion and contraction, relaxation and compreſſion, of the pulmonary veſſels, by which the ſolid parts of the blood are perpetually rubbed and cloſely compreſſed? The lungs therefore will add to the office of the reſt of the arteries, becauſe in them the blood is alternately relaxed and compreſſed more than in any other part of the body. But even when

when the lungs are obſtructed, ulcerated, and almoſt deſtroyed, a morbid heat ſeizes upon the body: but in the lungs the cold air very nearly touches the blood.

The denſity of the blood is, indeed, again promoted in the lungs, partly by the copious diſcharge of the watery vapour which is there ſeparated, by which the reſt of the maſs becomes ſpecifically heavier. But the ſame effect ſeems to follow here, as in other arteries, namely, from the attrition and preſſure which the blood here ſuffers in being alternately retarded, accelerated, and figured in its courſe through the modulating tubes of the leaſt veſſels, which give a ſphericity and denſity to the particles; hence it becomes denſer, as having more of the weighty globules, and leſs of the lighter fluid. And, in this reſpect, the pulmonary vein, being ſmaller than its correſponding artery, is of no ſmall uſe towards increaſing the attraction of coheſion betwixt the parts of the globules, ſo as to compreſs and bring them cloſer to each other. Nevertheleſs, cold animals, which have very ſmall lungs, have denſe and coagulable blood; as alſo a chicken before it is hatched. The blood alſo has a ſhort paſſage through the lungs: the paſſage through the whole body is longer, and the artery weaker; the heart, by which the blood is driven forward, is alſo weaker.

It is therefore queried by ſome, Whether the air itſelf is not received by the blood in the lungs, ſo as to excite neceſſary vibrations therein? Whether this does not appear from the reſiſtance of bodies to the heavy external air; and from the air found in the blood-veſſels, in the cellular ſubſtance, and in certain cavities of the human body; alſo from the cracking obſerved by an extenſion of the joints; to which add the air manifeſtly extravaſated from the windpipes into the hearts of certain animals, as in the locuſt; from air coming out of the blood and humours of animals in Mr Boyle's vacuum; together with a neceſſity of a vital of-

oſcillation in the blood itſelf; and, laſtly, the increaſed redneſs of the pulmonary blood?

But that no elaſtic air is here received into the blood, is demonſtrated from the impoſſibility of forcing air into blood, if it retains its elaſticity; from the inutility of its reception, if the ſpring of it ſhould be loſt in the blood; from the perfect immutability of the blood, by cold; from the minuteneſs of the inhaling veſſels, with the mucus that perpetually lines the ſides of the veſicles in the lungs: to which add the nature of the elaſtic air itſelf, which is very unapt to paſs through capillary veſſels; with a repulſion of it by water, that hinders it from paſſing through paper, linen cloth, or ſkins that are wetted by water. Again, the air being driven into the wind-pipe, never paſſes to the heart; or whenever it does, it is forced thither by ſome great or unnatural violence: but the permanent air in the veſſels and humours of the human body, from a ſtate of inelaſticity, may become elaſtic by putrefaction, froſt, or an external vacuum. But ſuch permanent unelaſtic air is incorporated with all liquors; and taken into our bodies with the aliments and with abſorbed vapours, mixing ſlowly and with ſome difficulty. But there never were any elaſtic bubbles of air obſerved in the blood of a living animal; and ſuch air being inflated into the blood-veſſels of any living animal, kills it certainly and ſpeedily. Laſtly, though air indeed is abſorbed by moſt of our humours, yet that abſorption is performed ſlowly, and takes up the ſpace of ſeveral days after the former air has been exhauſted by the pump. It then likewiſe lays aſide its elaſtic nature; nor is there any reaſon produced, why the air ſhould either be more ſpeedily abſorbed by the blood, or why it ſhould retain its elaſticity after it is ſo abſorbed.

" In theſe our times (ſays Wriſberg), it is now too much a matter of diſpute, as if it were a ſubject entirely new, I mean the different kinds of air; to wit, fixed, inflammable, narcotic, nitrous, &c. which were partly known

known to Helmont, Newton, Boyle, Camerarius, Hales, and several others; but the pneumatic theories in general have been remarkably elucidated, increased, and limited, as occasion required, by the laudable industry of Drs Brownrigg, Black, Cavendish, Priestley, Spielman, Erxleben, &c. If, in a few words, I might offer my opinion about the air found in our bodies, which has been the basis of so many disputes, I am persuaded, that the atmospheric air is a very compound fluid, consisting of parts of a very different nature and quality; which parts when mixed with any primigeneous fluid as a vehicle, make the common air we inhale in inspiration. This primigeneous fluid is, perhaps, that air which we observe in animals, vegetables, and likewise in the earth itself, differing only according to the various substances with which it is united. If there is mixed, in a due proportion with this universal fluid, any elastic, ethereal, electric principle, or any particles not yet fully understood, perhaps there will result salubrious atmospheric air. But it will become infected and noxious in various degrees, from an admixture of putrefactive substances, narcotic or inflammable suffocating elements. For that reason it seems to me very proper, that our judgment about the salutary or noxious quality of the air should be directed by these principles; and hence it will be in our power to correct unwholesome air, provided we know what qualities the air should possess which is most properly suited to the function of respiration."

Whether or not is the blood cooled in the lungs? and whether or not does this seem to be true from the death of animals, in air which is hot to such a degree as equals the heat of the hottest breezees in the most sultry dog-days? Whether the pulmonary veins are not, therefore, less than the arteries; and whether the desire of cold in people that are working hard does not arise from thence? That the blood is cooled in the lungs is thus far true, as it warms the contiguous air,

and therefore loſes ſomething of its own heat. But that this was not the principal deſign of nature, is evident; ſince no one will ſay that the venous blood is hotter than the arterial, although ſome pronounce the former to be ſomewhat cooler; but nobody ever obſerved the left ventricle of the heart cooler than the right. But the venous blood enters the lungs; if it be there cold, it will follow, that the arteries muſt receive it in ſtill a colder ſtate. But then here the degrees of heat which the blood communicated to the air are again recovered by it. And, indeed, a perſon may live in an air much hotter than the blood itſelf; of which we have a familiar example in baths and the warm countries. The pulmonary artery in a fœtus, which does not reſpire, is greater; and the larger area of the right auricle and ventricle of the heart, is likewiſe much greater in a fœtus; which ſeems neceſſary to reſerve and retard the blood, as the pulmonary vein being narrower accelerates it.

Whether or not is the redneſs of the blood produced from the air? This is contradicted by what we ſee in cold animals, which, though they are almoſt entirely deprived of the uſe of air, have blood equally red with that of warm animals; from the certain connection of redneſs in the blood of frogs with their having plenty of food, and a paleneſs of it with a want of food; and from the air, as we have juſt now ſaid, being denied acceſs to the blood. Nevertheleſs, redneſs is produced when the air has acceſs to the blood, by which means it is alſo reſtored after it has been loſt; and, on the other hand, it is deſtroyed by the denial of the acceſs of air. Whether or not may not a more ſubtle element from the air penetrate the blood, and be the cauſe of its colour, as light is required for the colours of plants?

Whether the uſe of the lungs is to abſorb a nitre from the air to the blood? or whether the florid colour, obſervable in the ſurface of a cake of blood, be

owing to the ſame cauſe, while the bottom part looks of a dark and blackiſh colour? and whether or not this is a preſervative againſt the putrefaction of the animal? remain as queſtions with ſome. That there is a kind of volatile acid in the air is certain, ſince that meeting with a ſuitable earth forms nitre; for a nitrous earth, being exhauſted of its ſalt, and expoſed again to the air, becomes re-impregnated with more nitre. But the ſame univerſal acid, we know by certain experiments, meeting with a different ſort of earth, forms a vitriolic ſalt, or alum, or elſe ſea-ſalt. For the caput mortuum of ſea-ſalt, which remains after the diſtillation of the ſpirit, recovers ſo much ſtrength from the air, as enables it to yield more ſpirit by diſtillation; even in ſnow there is a cubical ſalt: but marcaſite perſpires a true vitriol; and colcothar recovers again the acid ſpirit which was drawn from it; alſo fixed alkali, expoſed to the air, turns into a vitriolated tartar. This, therefore, cannot be the uſe of reſpiration, becauſe thoſe ſalts abound in too ſmall a quantity in the air for ſuch uſes; and air is fitteſt for breathing when pure in high mountains, where thoſe ſalts are the leaſt to be found; nor is there any nitrous ſalt as yet known to be found in our blood.

If it be aſked, Why tortoiſes, frogs, lizards, ſnails, ear-wigs, and other inſects, live long without air? we anſwer, That in them the lungs are given not ſo much for the preparation of the blood, which they receive but in a very ſmall quantity, as for the uſe of ſwimming in the water: and from hence it is that their lungs are immediately joined with the vena cava and aorta. But inſects, we know, draw the air in, and exhale it again, through points in the ſkin. If it be aſked, Why all animals periſh in air that is confined or not renewed, although the animal be ſmall, ſuch as little birds? we anſwer, Becauſe the air, which has once entered the lungs, and been fouled by watery vapours, is rendered leſs elaſtic, and unfit for reſpiration, by alkaline vapours:

vapours: not becauſe it becomes lighter; for the mercury falls but little in air which has not been renewed, and which has killed an animal. Hence it is that the animal ſurvives longer in air that is more compreſſed than that of the atmoſphere: for in that caſe there is a greater proportion of the elaſtic element, which takes up a longer time to corrupt. But, even in other caſes, confined air is rendered deſtructive only by ſtagnation, and filling it with vapours. But the reaſon why animals ſwell in an exhauſted veſſel, is, from the extrication and expanſion of the unelaſtic air lodged in the blood and other juices.

There is a certain conſent or proportion between the pulſe and reſpiration; ſo that, according to the common courſe of nature, there are three or four pulſes counted to one reſpiration. But if more blood is ſent to the heart in a given time, the numbers both of the pulſe and reſpiration are increaſed. This is the reaſon of the panting or ſhort breathing in a perſon that exerciſes his body with any conſiderable motion; whereby the venous blood is returned faſter to the heart. But if the blood meets with a greater reſiſtance in the lungs, ſo that it cannot paſs freely from the right into the left ventricle of the heart; then reſpiration is increaſed, both in number and magnitude, in order to forward its courſe: and this is the cauſe of ſighing, yawning, and wheezing; of which the firſt is a deep inſpiration; the ſecond ſlow, and very great; and the third, a frequent and imperfect one. The number of reſpirations, however, does not always increaſe with the pulſe; of which we have an example in thoſe fevers where the lungs are not affected.

The mucus, which lines the ſenſible membranes of the air-veſſels in the lungs, may become troubleſome both by its quantity and acrimony; it has been known to cauſe even ſuffocation in a dropſy of the lungs. Therefore its quantity, adheſion, or acrimony, excites a cough; namely, an irritation of the reſpirative ſy-

ſtem, by alternate large inſpirations, ſucceeded by large and quick exſpirations, together with ſudden ſhocks of the abdominal muſcles; by which the mucus, and ſometimes calculous matters, are expelled from the lungs.

Laughter differs from coughing in its cauſe, which reſides commonly in the mind, or at leaſt conſiſts in a certain titillation of ſome of the cutaneous nerves; and, moreover, becauſe it is made up of imperfect quick exſpirations through the contracted glottis, leſt the air ſhould be totally evacuated from the lungs. Hence laughter, in a moderate degree, conduces to health; becauſe, in the time of one full inſpiration, many ſhort inſpirations and exſpirations happen, and thus the concuſſion is greater. Hence its danger of ſtagnating the blood; becauſe the exſpiration is not full or entire, whereby the blood is admitted into the pulmonary artery without being ſuffered to paſs through it. Weeping begins with a great inſpiration, after which follow ſhort alternate inſpirations and exſpirations; and the ſame is finiſhed with a deep exſpiration, that is immediately joined by a large inſpiration: hence it has nearly the ſame good and bad effects; and, when moderate, it conduces to relieve the anguiſh ariſing from grief. An hiccup is a very great, ſonorous, and ſudden inſpiration. Sneezing conſiſts of one large or deep inſpiration, which is followed immediately with a powerful and ſudden exſpiration; and the acrid matter is blown out by it in ſome quantity from the noſtrils.

The ſecondary uſes of reſpiration are very many. It exhales, as an emunctory, parts redundant, or even noxious, from the blood, which would ſuffocate, if they remained in the air; and the breath of many people, ſhut up in a cloſe place, impregnates the air with a ſuffocating quality. On the other hand, it abſorbs from the air a thin vapour, of which the uſe is perhaps not ſufficiently known.

" Among

" Among the uſes of reſpiration (ſays Wriſberg), ſeeing ſeveral of them are accounted of the ſame importance, may be counted the power of reſorption; by which the lungs abſorb by means of their veſſels, from the air inhaled in inſpiration, not only vapours mixed with the air, but mingle with our humours by means of the foramina, ducts, and proper canals, ſome other by far nobler parts, conſtituting, at the ſame time, one of the elements of the air.

" This ſubſtance has got no proper name; nor do we know the nature of the part which is principally referred, in the firſt place, to the elements of the air, and, next, to our humours and blood. The once celebrated *pabulum vitæ* was an ingenious denomination, ſeeing, as has often happened, many perſons confined in narrow ſpaces, unleſs free acceſs of air is procured, have run the riſk of their life, from their wanting a proper renewal or pabulum of air. But the name of *electric principle*, if we conſider the whole conſent of nature, ſeems more fitly adapted to the ſubject. For ſince the publication of the famous obſervations made by Gilbert, Guerick, Boyle, the Florentine academicians, Hawkſbee, Du Fay, Muſchenbroeck, Watſon, Ludolph, Winckler, Nollet, Franklin, Hartman, Prieſtley, and ſeveral others, both about the electricity of bodies in general, as well as of the atmoſphere in particular, the whole doctrine, by means of the new machine, the electrometer, from the experiments of Volta, Wilſon, Wilkenius, his ſerene highneſs Gallitzin, Lightenberg, &c. has received ſo great additions, that it might almoſt be aſſerted, that the electric matter of the air is collected in the moſt ſimple manner by almoſt every body. From all thoſe experiments we collect,

" 1. That there is in the air a fluid which, in different ways, may be increaſed in one place, and diminiſhed in another; which, when collected *ſecundum artem*, exhibits electric ſparks; but, when collected in the clouds, breaks forth in lightning and thunder.

" 2. If from its too great congeſtion in any region of the atmoſphere or in the clouds, the circumambient air wants its due proportion, our reſpiration is leſs refreſhing, our ſtrength grows languid; but they are quickly renewed after a thunder-ſtorm, the equilibrium of the electric matter in the atmoſphere being effected, as it were, by the flaſhes of lightning.

" 3. Perhaps, too, we learn a method, and the remedies, by which we may artificially remove this defect: it is worth while at leaſt to conſider of this.

" 4. This electric matter paſſes into the blood or lymph by innumerable pores and foramina, with which the inſide of the larynx, aſpera arteria, and bronchia, abound. Upon the diverſity of theſe holes, both with reſpect to number, condition, and mucus, with which they may be covered, and to the ſize of the lungs, depends the reaſon why all men cannot inhale and abſorb the ſame quantity of electric matter from one and the ſame air.

" 5. It will not be eaſy for any perſon, in an affair deſtitute of ſufficient obſervation, to unravel what uſe this ſubſtance ſerves in animal bodies, and what functions depend upon it. Whether is the tone and irritability of the fibres of the body principally ſupported by it? Do the increaſe and cauſes of animal heat proceed from it? I think it is clear, we ought hence to ſeek the cauſe of animal electricity; which is very conſpicuous in cats, and likewiſe horſes, and many men, by the numerous ſparks which may be made to appear iſſuing from their bodies. This is perhaps the cauſe of the greater danger to which ſome men are liable of being ſtruck with thunder. The ſpontaneous burning of ſome bodies in nature are undoubtedly to be aſcribed to the ſame cauſe; and the alacrity and vigour of ſome temperaments ſurely is wonderfully increaſed by the preſence of this fluid. May this ſubſtance be joined with the acidum pingue and inflammable principle?"

It is by this force that the abdomen and all its viſcera

cera are continually compreſſed; by virtue of this, the ſtomach, inteſtines, gall-bladder, receptacle of the chyle, bladder of urine, inteſtinum rectum, and the womb itſelf, diſcharge their contents; by this action the aliments are principally ground or diſſolved, and the blood is urged through the ſluggiſh veſſels of the liver, ſpleen, and meſentery. It excites a kind of flux and reflux in the blood, ſo that it is alternately preſſed back towards the extremities of the veins, and a little after is propelled towards the heart by an accelerated velocity, as into an empty ſpace. Moreover, inſpiration ſerves to convey odours along with the air to the organs of ſmelling. By this, the air is mixed with the aliments; which it conduces very much to break and diſſolve towards a perfect digeſtion. But even ſucking, ſo neceſſary to the new-born infant, is made by the uſe of reſpiration, and forming a larger ſpace in the mouth, in which the air is rarefied; ſo that, by the greater preſſure of the outward air, the milk is driven into that part, where it is leſs reſiſted. Laſtly, the voice itſelf is owing to the air which we breathe; as was explained in a former part of the work.

§ 11. *Oeſophagus.*

Situation and figure. The œſophagus is a canal partly muſcular and partly membranous; which commences at the inferior part of the pharynx, and deſcends along the neck and back part of the thorax into the abdomen. While it lies in the neck, it is placed between the middle and left part of the cervical vertebræ behind the left part of the trachea; in the thorax, it is ſituated between the layers of the poſterior mediaſtinum, and deſcends to the fourth or fifth vertebra of the back, in the ſame direction which it had above: there it inclines a little from left to right, till it reaches the ninth rib, to make way for the aorta; afterwards it inclines from right to left, and from behind forward,

to get through the diaphragm into the upper orifice of the ſtomach.

Structure and coats. It is made up of ſeveral coats almoſt in the ſame manner as the ſtomach, of which it is the continuation. The firſt coat, while in the thorax, is formed only by the duplicature of the poſterior part of the mediaſtinum, and is wanting above the thorax and in the neck, where the outer coat of the œſophagus is only a continuation of the cellular ſubſtance belonging to the neighbouring parts.

The ſecond coat is muſcular, being made up of ſeveral ſtrata of fleſhy fibres. The outermoſt are moſtly longitudinal, and their quantity is much greater than that on the reſt of the alimentary canal; but they are not all continued from one end of the œſophagus to the other. The following ſtrata are obliquely tranſverſe, and the innermoſt are turned a little obliquely the contrary way. They croſs each other irregularly in many places, but are neither ſpiral nor annular.

The third is termed the *nervous coat*, and is like that of the ſtomach and inteſtines. It is differently folded or plaited, according to its length, being much wider than the muſcular coat; and it is ſurrounded by a whitiſh, ſoft, fine filamentary ſubſtance, like a kind of cotton, which, when ſteeped in water, ſwells and grows thicker.

The fourth or innermoſt coat reſembles in ſome meaſure that of the inteſtines; except that, inſtead of the villi, it has ſmall and very ſhort papillæ. It is folded lengthwiſe like the third coat; ſo that the œſophagus, when cut acroſs, repreſents one tube within another. Through the pores of this coat, a viſcid lympha is continually diſcharged.

The upper end of the œſophagus is ſupplied with arteries from the laryngeæ inferiores; farther down it has branches from thoſe which ſupply the pericardium; the reſt of it is ſupplied by the arteriæ bronchiales. The veins go into the ſuperior laryngeals, to the top

of

of the ſuperior vena cava, to the vena azygos and bronchial veins.

The nerves are chiefly from the eighth pair: ſome ſmall branches come from the great ſympathetics.

§ 12. *Ductus Thoracicus.*

THE thoracic duct is a thin tranſparent canal, which runs up from the receptaculum chyli along the ſpina dorſi, between the vena azygos and aorta, as high as the fifth vertebra of the back, or higher. From thence it paſſes behind the aorta toward the left hand, and aſcends behind the left ſubclavian vein, where it terminates, in ſome ſubjects, by a kind of veſicula, in others by ſeveral branches united together, and opens into the back-ſide of the ſubclavian vein near the outſide of the internal jugular.

This canal is plentifully furniſhed with ſemilunar valves turned upward. Its opening into the ſubclavian vein is covered by valves, ſo diſpoſed as to permit the entrance of the chyle into the vein, and hinder the blood from running into the duct. It is ſometimes double, one lying on each ſide; and ſometimes it is accompanied by appendices, called *pampiniformes*.

CHAP.

CHAP. III.

Of the ABDOMEN.

THE whole fore-part of the abdomen forms an oblong convexity like an oval vault, more or leſs prominent in the natural ſtate, in proportion to the quantity of fat upon it and of food contained in it, or to the different degrees of pregnancy in women. The hypogaſtric and umbilical regions are more ſubject to theſe varieties than the epigaſtric region.

On the ſides, between the hypochondria and oſſa ilium or haunch, the abdomen is commonly a little contracted; and backward, about the middle of the regio lumbaris, it is gently depreſſed, forming a kind of tranſverſe cavity, anſwering to the natural incurvation of the lumbar portion of the ſpina dorſi.

This anterior convexity, and poſterior cavity, change as we ſit, ſtand, kneel, lie at our full length, or with the thighs bent; and theſe variations depend on the particular ſituation of the oſſa innominata in theſe different poſtures.

In ſtanding, the convexity of the belly, and cavity of the loins, are more conſiderable than in moſt other ſituations; for then the lower extremity of the os ſacrum is turned very far back, and conſequently the os pubis very much down. In this ſituation of the pelvis, the inteſtines fall naturally forward, and thus increaſe the convexity of the abdomen; and as the vertebræ of the loins are very much bent at the ſame time, the cavity in that place muſt likewiſe be very conſiderable.

In kneeling, the oſſa pubis are ſtill lower than when we ſtand: and this not only increaſes the hollow of the loins, and throws the abdomen and its viſcera more outward or forward, but alſo in ſome meaſure ſtrains the

the abdominal muſcles; which is ſo uneaſy to ſome perſons, as to cauſe them to faint away.

This depreſſion of the os pubis in kneeling depends partly on the tenſion of the two muſculi recti anteriores; the lower tendons of which are, in this ſituation, drawn with violence under the condyloide pulley of the os femoris.

When we ſit in the common manner, that is, with the thighs ſtretched out in a plane parallel to that of the ſeat, the convexity of the belly and hollow of the loins diminiſh.

For the pelvis being in this ſituation ſupported on the tubercula iſchii, and theſe tubercles being very near the fore-part of the pelvis, the trunk of the body preſſing on the os ſacrum muſt lower the pelvis behind, and raiſe it before.

When we lie upon the back at full length, and with the thighs extended, the belly is leſs convex, but more ſtretched and hard; whereas, when the thighs are bent, it is ſoft and lax. In this ſituation, the regio lumbaris is almoſt flat and very little depreſſed.

When we lie on the back, and raiſe the head, or endeavour to raiſe it, we feel a tenſion in the fore-part of the abdomen, which increaſes in proportion to the force we uſe in raiſing the head.

Integuments of the abdomen. The anterior portion of it is not only thinner and more compact than the poſterior, as has been already obſerved, but it has this likewiſe peculiar to it, that it may be naturally increaſed very much in breadth, and ſometimes in a very extraordinary manner, without loſing any thing of its thickneſs, in proportion to what it gains in breadth.

The cells of the membrana adipoſa, which covers the convex part of the abdomen, are diſpoſed in a very regular manner, as we diſcover by diſſecting the ſkin from the muſcles; for then there appears on the inner ſurface of the membrana adipoſa a longitudinal line like a kind of raphe, produced by the meeting of the cellular

lular rows, which form angles ſucceſſively, one above another, oppoſite to the linea alba of the abdomen. The cells in theſe rows are more oblong than the reſt, and in a manner oval, or like a grain of wheat.

Cavity of the abdomen. The appendix enſiformis of the ſternum, the cartilaginous portions of the laſt pair of true ribs, thoſe of the firſt four pairs of falſe ribs, all the fifth pair, the five lumbar veriebræ, the oſſa innominata, the os ſacrum, and os coccygis, form the bony ſides of the cavity of the abdomen.

The diaphragm, the muſcles called particularly *muſculi abdominis*, the *quadrati lumborum*, *pſoai*, *iliaci*, the *muſcles of the coccyx*, and of the *inteſtinum rectum*, form the chief part of the circumference of this cavity; and its whole inner ſurface is lined by a membranous expanſion, termed *peritoneum*, all theſe parts being covered by the integuments already ſpoken to. As additional or auxiliary parts, we might likewiſe add ſome portions of the ſacro-lumbares, longiſſimi dorſi, vertebrales, glutæi, &c.

The cavity of the abdomen is of an irregularly oval figure, but ſtill ſymmetrical. On the foreſide it is uniformly arched or oval, and its greateſt capacity is even with the navel and neareſt part of the hypogaſtrium. On the upper ſide it is bounded by a portion of a vault, very much inclined. On the back-ſide it is in a manner divided into two cavities by the jetting out of the vertebræ of the loins. On the lower ſide, it contracts gradually all the way to what I call the *little edge* of the pelvis; and from thence expands again a little as far as the os coccygis, and tubercles of the iſchium, terminating in the void ſpace between theſe three parts.

§ 1. *Peritonæum.*

HAVING carefully removed the muſcles of the abdomen, the firſt thing we diſcover is a very conſiderable membranous covering, which adheres immediately to the

the inner ſurface of the muſculi tranſverſi, and of all the other parts of this cavity; and involves and inveſts all the viſcera contained therein, as in a kind of bag. This membrane is named *peritonæum*, from a Greek word, which ſignifies to be ſpread around.

The peritonæum, in general, is a membrane of a pretty cloſe texture, and yet very limber and capable of a very great extenſion; after which it can recover itſelf, and be contracted to its ordinary ſize; as we ſee in pregnancy, dropſies, corpulency, and repletion.

It may be looked upon as a ſingle membrane, although it has been deſcribed by many anatomiſts as a duplicature of two diſtinct membranous laminæ. But, properly ſpeaking, the internal portion alone deſerves the name of a *membranous lamina*, as being the main body of the peritonæum. The external portion may properly enough be termed the *cellular ſubſtance of the peritonæum.*

The inner ſurface of the peritonæum is very ſmooth, and poliſhed on that ſide which is turned to the cavity and viſcera of the abdomen, and continually moiſtened by a ſerous fluid diſcharged through almoſt imperceptible pores.

Theſe pores may be ſeen by ſpreading a portion of the peritonæum on the end of the finger, and then pulling it very tight on all ſides; for then the pores are dilated, and ſmall drops may be obſerved to run from them, even without a microſcope.

The ſources of this fluid are chiefly from the exhalent veſſels. The whitiſh corpuſcles found in diſeaſed ſubjects are no proof of the glands, which ſome anatomiſts place there in the natural ſtate.

The cellular ſubſtance, or external portion of the peritonæum, adheres very cloſely to the parts which form the inſides of the cavity of the abdomen; and it is not every where of an equal thickneſs. In ſome places it is in a very ſmall quantity, and ſcarcely any appears at the

the tendinous or aponeurotic portions of the muſculi tranſverſi, and on the lower ſide of the diaphragm.

In all other places it is thicker, and forms cells expanded into very fine laminæ, which, in diſeaſed ſubjects, become ſometimes ſo broad and thick, as to reſemble ſo many diſtinct membranes.

In ſome places, this ſubſtance is every way like a membrana adipoſa, being filled with fat, as round the kidneys, and along the fleſhy portions of the tranſverſe muſcles, to which it adheres. It entirely ſurrounds ſome parts, as the bladder, ureters, kidneys, ſpermatic veſſels, &c. and it is in theſe places improperly termed the *duplicature of the peritonæum.*

Beſides theſe differences in thickneſs, the cellular ſubſtance has ſeveral elongations, which have been called *productions of the peritonæum.* Two of theſe productions accompany and inveſt the ſpermatic ropes in males, and the vaſcular ropes, commonly called the *round ligaments*, in women. There are other two, which paſs under the ligamentum Fallopii, with the crural veſſels, which they involve; and they are gradually loſt in their courſe downward.

To theſe four productions of the cellular ſubſtance of the peritonæum we may add a fifth, which is ſpread on the neck of the bladder; and perhaps a ſixth, which accompanies the inteſtinum rectum. All theſe elongations paſs out of the cavity of the abdomen, and may be termed *external*, to diſtinguiſh them from others that remain in the abdomen, and are called *internal;* of which hereafter.

The great blood-veſſels, that is, the aorta and vena cava, are likewiſe involved in this cellular ſubſtance of the peritonæum. In a word, it involves immediately and ſeparately all the parts and organs which are commonly ſaid to lie in the duplicature of the peritonæum.

The true lamina, or membranous portion of the peritonæum, is connected by the intervention of the cellular ſubſtance to the inner ſurface of the cavity of the

abdomen; but it does not naturally accompany the external elongations of that ſubſtance. It only covers the origin or baſis of theſe productions, without any alteration in its own ſurface at theſe places.

It has, nevertheleſs, productions of its own; but they are very different from thoſe of the cellular ſubſtance; for they run from without inward, that is, they advance from the convex ſide of the great bag of the peritonæum into the cavity of that bag, ſome more, ſome leſs, and alſo in different manners, as if the ſides of a large ball or bladder were thruſt inward into the cavity of the ball or bladder.

Of theſe internal elongations of the peritonæum, ſome are ſimply folded like a duplicature; ſome are expanded like inverted bags, or ſacculi, to contain ſome viſcus; ſome begin by a ſimple duplicature, and are afterwards expanded into a cavity which contains ſome organ; ſome are alternately extended in the form of ſimple duplicatures and of cavities; and, laſtly, ſome form only a ſmall eminence on the inner ſurface of the great cavity of the peritonæum.

Under the firſt ſpecies of theſe productions, we may bring the membranous ligaments of the abdomen, ſuch as thoſe of the liver, colon, &c. We ſee the ſecond ſpecies in the external membrane of the liver; the third in the meſentery; the fourth in the meſocolon; and the fifth at the kidneys and ureters.

Beſides the external productions of the cellular ſubſtance of the peritonæum, it has the ſame number of internal elongations with the true lamina; which lie between all the duplicatures, and line the inſides of all the cavities, or that ſide next the viſcera contained in them.

The veſſels and nerves of the peritonæum are from thoſe that ſupply the neighbouring parts. The arteries come from the mammariæ internæ, the intercoſtales inferiores, the lumbares, the arteriæ ſacræ, the iliolumbares, the epigaſtricæ, the ſmall anterior iliacs, the inferior

inferior diaphragmatics, and from the veſſels which ſupply the abdominal viſcera. The veins correſponding with theſe arteries have the ſame courſe and bear the ſame names. The nerves of this membrane are few in number, and ſmall: they come from the great intercoſtals from the lumbars and ſacrals.

The uſes of the peritonæum, in general, ſeem to be very evident from the deſcription which has been given of it: and the chief of theſe uſes are, to line the cavity of the abdomen, to inveſt the viſcera contained in that cavity as in a common bag, to ſupply them with particular coats, to form productions, ligaments, connections, folds, vaginæ, &c. as we ſhall ſee hereafter.

The fine fluid which tranſudes through the whole internal ſurface of the peritonæum prevents the inconveniences which might ariſe from the continual frictions and motions, to which the viſcera of the abdomen are expoſed, either naturally or by external impulſes.

We muſt here obſerve, that it is the common cuſtom to demonſtrate four ligamentary ropes, termed the *umbilical veſſels*, before the peritonæum is opened, becauſe they adhere to the umbilicus; and three of them are really veſſels in the fœtus, viz. two umbilical arteries and one vein. We are in a manner obliged to ſubmit to this cuſtom in public anatomical demonſtrations, where we have but one ſubject for the whole; but as we are here under no ſuch neceſſity, we refer the deſcription of theſe ligaments to other more proper places of this work. The venal ligament ſhall be deſcribed in the hiſtory of the liver; and the two arterial ligaments, together with the urachus, which is the fourth, in the hiſtory of the bladder.

It is ſufficient to obſerve here in general, that three of theſe umbilical ropes or ligaments are involved ſeparately, and ſuſtained by a production or duplicature, which the peritonæum ſends into the cavity of the abdomen in form of a falx.

§ 2. *Ventriculus.*

Situation and figure of the ſtomach. The ſtomach is a great bag or reſervoir, ſituated partly in the left hypochondrium, and partly in the epigaſtrium.

The figure of the ſtomach is like that of a bag-pipe; that is, it is oblong, incurvated, large, and capacious, at one end, and ſmall and contracted at the other. We ſee this figure moſt evidently when the ſtomach is moderately filled with air or with any other fluid.

The curvature of the ſtomach gives us occaſion to diſtinguiſh two arches in it; one large, which runs along the greateſt convexity; and one ſmall, directly oppoſite to the former. Theſe arches are named the *great* and *ſmall* curvatures of the ſtomach; and by the ſides of the ſtomach, we underſtand the two lateral portions which lie between the two arches.

The ſtomach has two extremities; one large and one ſmall. It has two openings, called the *orifices of the ſtomach;* one between the great extremity and the ſmall curvature, the other at the end of the ſmall or contracted extremity. The firſt opening is a continuation of the œſophagus; the other joins the inteſtinal canal, and is called by the name of *pylorus.*

The ſtomach is not ſituated in the left hypochondrium and epigaſtric region, in the manner repreſented in moſt of the figures. It lies tranſverſely, obliquely, and almoſt laterally; in ſuch a manner as that the great extremity, and the orifice next it, are on the left hand; and the ſmall extremity, with its orifice, or the pylorus, on the right hand, and lower and more inclined than the former: Therefore we ought, with the ancient anatomiſts, to call one of theſe orifices *ſuperior*, the other *inferior.*

The great extremity of the ſtomach is in the left hypochondrium, and for the moſt part immediately under the diaphragm: yet the ſuperior orifice is not in the left

hypochondrium, but almoſt oppoſite to, and very near the middle of, the bodies of the loweſt vertebræ of the back.

The ſmall extremity of the ſtomach does not reach to the right hypochondrium. It bends obliquely backward toward the upper orifice: ſo that the pylorus lies about two fingers breadth from the body of the vertebræ immediately under the ſmall portion of the liver; and conſequently lower down, and more forward, than the other orifice by almoſt the ſame diſtance. This extremity of the ſtomach has ſometimes a particular dilatation on the ſide next the great curvature.

According to this natural ſituation, the ſtomach, eſpecially when full, is ſituated with its great curvature forward and a little downward, and its ſmall curvature backward and a little upward.

One of the lateral convex ſides is turned upward, the other downward; and not forward and backward as they appear in dead bodies, where the inteſtines do not ſupport them in their natural ſituation.

If we divide the ſtomach along the two curvatures into two equal parts, we ſhall ſee that the two orifices do not both adhere to the ſame half of this diviſion, as we would be apt to imagine according to the common notion; but that the diaphragmatic orifice is entirely in the upper half, and the inteſtinal orifice in the lower.

Therefore the body of the ſtomach is ſo far from lying in the ſame plane with the œſophagus, as it is commonly repreſented in figures drawn from a ſtomach taken out of the body and laid upon a table, that it forms an angle or fold immediately at the paſſage of the œſophagus through the ſmall muſcle of the diaphragm; and it is on account of this angle that the ſuperior orifice is turned backward.

Structure of the ſtomach. The ſtomach is compoſed of ſeveral parts; the chief of which are the different ſtrata which form its ſubſtance, to which anatomiſts give the name of *tunicæ* or *coats*. Theſe coats are commonly reckoned

reckoned to be four in number; the outer or common, the fleſhy or muſcular, the nervous or aponeurotic, and the villous or inner coat; and they are afterwards ſubdivided ſeveral ways.

The firſt or outermoſt coat is ſimply membranous, being one of the internal productions of the peritonæum. This appears evidently at the connection of the ſuperior orifice with the diaphragm, where the external membrane of the ſtomach is really continuous with the membrane, which lines the inferior ſurface of the diaphragm; and it is from this that it has been named the *common coat*.

The ſecond or muſcular coat is made up of ſeveral planes of fibres, which may all be reduced to two; one external, the other internal. The external coat is longitudinal, though in different reſpects following nearly the direction of the curvatures and convexities of the ſtomach; and the internal plane is tranſverſely circular.

The fibres of the external plane run ſlanting in ſeveral places; and are interſected by ſmall oblique whitiſh lines, which ſeem to be in ſome meaſure tendinous. This plane is ſtrengthened by a particular faſciculus which runs along the ſmall curvature, its fibres appearing to be leſs oblique than thoſe of the great plane.

The fibres of the inner or circular plane of this muſcular coat are ſtronger than thoſe of the outer plane. They are rather ſegments which unite at different diſtances, than entire circles; and they are likewiſe interſected by great numbers of ſmall white lines, in ſome meaſure tendinous and very oblique, which all together repreſent a kind of net-work, the areolæ or meſhes of which are very narrow.

As theſe circles or ſegments advance on the great extremity of the ſtomach, they diminiſh gradually, and form a kind of muſcular vortex; the centre of which is in the middle of that extremity.

Between the outer and inner planes, round the ſuperior orifice, there are two diſtinct planes about the

breadth of a finger, and very oblique, which furround this orifice in oppofite directions, and interfect each other where they meet on the two lateral fides.

Along the middle of each lateral fide of the fmall extremity, there runs a tendinous or ligamentary flat portion, above a quarter of an inch in breadth, which terminates in the pylorus. Thefe two portions lie between the common and mufcular coats, and adhere very ftrongly to the firft.

Between the two fame coats, there is a cellular fubftance which adheres very clofely to the external coat, and infinuates itfelf between the fleſhy fibres of the fecond, all the way to the third, as may be perceived by blowing it up. Some make it a diftinct coat, and call it *tunica cellulofa;* but it is no more than the cellular portion of the membranous coat, like the cellular portion of the peritonæum.

The third coat, called commonly *tunica nervofa*, but properly *tunica cellulofa*, is compofed of capillary veffels and nerves, with a very large proportion of cellular fubftance. On the concave fide it feems to be of a very loofe fpongy or filamentary texture, refembling fine cotton, as may be feen by macerating it a little in clear water, which fwells it confiderably in a very fhort fpace of time. It is fupported by a kind of groundwork of a very fine ligamentary or aponeurotic filaments which interfect each other obliquely, much in the fame manner as the third coat of the inteftines, of which hereafter; and it adheres to the convex fide of the villous coat.

The fourth coat of the ftomach has been termed by Fallopius *tunica villofa*, becaufe, when it fwims in clear water, fomething is feen in it like the pile of velvet. The ancients called it *tunica fungofa;* and perhaps this name agrees beft with its true ftructure.

Thefe two coats are of a larger extent than the two former, and they join in forming large rugæ on the concave

concave ſurface of the ſtomach; the greateſt part of which is tranſverſe, though irregular and waving. There are likewiſe ſome longitudinal ones which interſect the others; but at the pylorus they all become longitudinal, and terminate there.

At the ſuperior orifice of the ſtomach, theſe rugæ are in a manner radiated, and ſeem to be a continuation of the plicæ or folds of the œſophagus; only they are thicker; and where theſe rugæ and plicæ meet, they form a ſort of crown, which diſtinguiſhes the ſuperior orifice of the ſtomach from the inferior extremity of the œſophagus.

In the interſtices of theſe rugæ, there is often found a ſort of ſlimy mucus, with which the whole cavity of the ſtomach ſeems likewiſe to be moiſtened. This mucus, which is termed *ſuccus gaſtricus* or *ſtomachicus*, is much more fluid in living than in dead bodies, and has been ſuppoſed by Winſlow, Leber, &c. to be ſupplied by ſmall glands ſituated in the ſubſtance of the ſtomach. But Morgagni and Haller have ſeldom ſeen ſuch an appearance; and Sabatier obſerves, that when ſuch an appearance is met with, it may be conſidered as the effect of diſeaſe, and that nothing is more doubtful than the exiſtence of glands in this place.

On the inner ſurface of the ſmall extremity of the ſtomach, at the place where it ends in the inteſtinal canal, we obſerve a broad, thin, circular border, with a roundiſh hole in the middle. This hole is the inferior orifice of the ſtomach, called by the Greeks *pylorus*, which ſignifies a porter.

This border is a fold or duplicature of the two inner coats of the ſtomach, the nervoſa and villoſa; and it is formed in part by a faſciculus of fleſhy fibres fixed in the duplicature of the tunica nervoſa, and diſtinguiſhed not only from the other fleſhy fibres of the extremity of the ſtomach, but alſo from thoſe of the inteſtines, by a thin, whitiſh circle, which appears even

through the external or common coat, round the union of the ſtomach and inteſtines.

The figure of the pylorus is that of a ring, tranſverſely flatted; the inner edge of which, or that next the centre, is turned obliquely toward the inteſtines. This inner edge runs naturally more or leſs into little plaits or gathers, like the mouth of a purſe almoſt ſhut; all which particulars are very different from what figures and dried preparations would make us believe. It is therefore a kind of ſphincter, which can contract the inferior orifice of the ſtomach, but ſeems not capable of ſhutting it quite cloſe.

Arteries of the ſtomach. The principal arteries of the ſtomach are the coronaria ſiniſtra, which goes firſt to the cardia, and from this runs along the ſmall curvature; coronaria dextra, which runs from the arteria hepatica to the right end of the ſmall curvature, and joins the coronaria ſiniſtra; gaſtro-epiploeca dextra, which ariſes from the arteria hepatica, and runs along the great curvature; arteria gaſtro-epiploeca ſiniſtra and vaſa brevia, which ariſe from the arteria ſplenica, and run along the left end of the great curvature.

Theſe two arterial arches ſend a great number of branches toward each other on both ſides of the ſtomach; and theſe branches are gradually ramified in different directions, by very different diviſions and ſubdiviſions; the greateſt part of which communicate with thoſe from the other artery.

From theſe frequent ramifications and communications of the arterial arches of the ſtomach, two different reticular textures ariſe; whereof one, which is the largeſt, lies between the common and muſcular coats in the cellular ſubſtance found there: the other, which is very fine, lies on the ſurface of the tunica nervoſa. This latter is a production of the firſt, being formed by means of a great number of very ſhort rami, which go out from the other, and paſs through the ſmall interſtices between the fibres of the muſcular coat.

By

By artificial injections we can ſhow a third extremely fine reticular texture of capillary veſſels, which run between the glandular bodies and papillæ of the tunica villoſa. Theſe do not ſeem in the natural ſtate to be purely blood-veſſels, as inflammations and injections may incline us to think.

The arteries of the ſtomach come originally from cæliaca, by means of the hepatica, ſplenica, and coronaria. The pylorica and meſenterica ſuperior likewiſe contribute to them by communications, more or leſs immediate. They communicate alſo with the mammariæ internæ, and diaphragmaticæ, and, by means of the epigaſtrica ſiniſtra, with the meſenterica inferior.

Veins of the ſtomach. The veins of the ſtomach are ramifications of the vena portæ in general; and in particular of the meſeraica major, ſplenica, and meſenterica inferior; the diſtribution of which may be ſeen in the deſcription of the veins. They accompany the arteries more or leſs, and form nearly the ſame kinds of arches and reticular textures; with this difference, that they are proportionably greater, their reticular areolæ larger, and their external communications more frequent.

Nerves of the ſtomach. Between the common and muſcular coats of the ſtomach, we find a great number of nerves of different ſizes. Many of them accompany each other, in form of a broad flat faſciculus, along the ſmall curvature of the ſtomach, from the ſuperior to the inferior orifice. The reſt are ſpread in different directions, on the ſides, extremities, and great curvature, forming at different diſtances a kind of reticular plexus, from which a great number of filaments are detached to the inner coats.

They ariſe chiefly from the nervi ſympathetici medii, or eighth pair, by means of the plexus coronarius ſtomachicus formed round the ſuperior orifice of the ſtomach, by the expanſion of the extremities of two

large ropes, which run down upon the œsophagus, by the name of *nervi stomachici*. The great sympathetic nerve, commonly called *intercostalis*, contributes likewise to them, by communicating filaments, which the plexus stomachicus receives from the semilunar ganglions of the plexus hepaticus, and particularly from the plexus splenicus. *See* Walter's beautiful and accurate Tables of the Nerves, of the Thorax, and Abdomen.

Uses of the stomach. The stomach receives in general whatever the mouth and tongue send thither thro' the canal of the œsophagus: but its particular use is to receive the aliments; to contain them for a longer or shorter time, in proportion as they are more solid or fluid; and to digest them, that is, to put them in a condition to be turned into that nutritious fluid called *chyle*.

This operation, which goes by the general name of *digestion*, and by which chylification begins, is performed partly by the succus gastricus, which flows continually from the tunica villosa, and partly by the continual contraction and relaxation of the muscular coat. These motions in men are but very weak, and nowise sufficient for digestion, without the assistance of the alternate motions of the diaphragm and muscles of the abdomen.

The pylorus, or fleshy circle of the inferior orifice of the stomach, serves to retain the aliments in it, till they have acquired a sufficient degree of fluidity, to pass easily through that opening. But by a particular irritation of the muscular coat of the stomach, and still more by a violent contraction of the diaphragm and muscles of the abdomen, the contents of the stomach may be very soon forced towards the small extremity, and pushed through the pylorus.

The gentle and alternate motions of the orbicular fibres of the muscular coat may assist in sending thro' the pylorus, in the natural way, the aliment that is sufficiently digested. This was called the *peristaltic* or *vermicular*

vermicular motion, by thoſe who believed that it is ſucceſſively reiterated, like that of earth-worms when they creep.

Trituration might be a proper enough term for this operation, provided it be made to ſignify only a gentle agitation or action of the fleſhy fibres in a ſubſtance continually moiſtened by the gaſtric liquor, and not a violent grinding of a dry ſubſtance.

The ſituation of the ſtomach, which is nearly tranſverſe, is likewiſe of uſe in making the aliment remain long enough in that cavity; and may ſerve to make the length of this ſtay, in ſome meaſure, arbitrary, by means of the different poſtures of the body; for when we lie on the left ſide, the aliment muſt remain longer than when we lie on the right, &c.

The obliquity of the ſtomach may ſerve to clear up a difficulty that very much torments thoſe who believe that both orifices of the ſtomach lie on the ſame level; which is, how any heavy ſubſtance, once got into the ſtomach, can ever riſe again to this level, to paſs into the inteſtines.

§ 3. *The Inteſtines in general.*

Situation, ſize, and diviſion of the inteſtines. Between the pylorus and the very loweſt part of the abdomen lies a long canal, bent in a great many different directions by numerous convolutions or turnings, called the *inteſtines*.

This canal, thus folded and turned, forms a conſiderable bulk, which fills the greateſt part of the cavity of the abdomen; and it is connected through its whole extent to membranous productions or continuations of the peritonæum, principally to thoſe called the *meſentery* and *meſocolon;* of which hereafter.

The incurvations of the inteſtinal canal form two arches; a ſmall one, by which it is connected to the meſentery and meſocolon; and a great one on the oppoſite

oppoſite ſide, which lies looſe. The whole canal is generally about ſix or ſeven times as long as the ſubject.

The inteſtinal canal is neither of an equal ſize nor thickneſs through its whole length; from whence anatomiſts have taken occaſion to conſider its different portions as ſo many particular inteſtines, and to divide them all into ſmall and great.

And as they ſtill found ſome differences in each claſs taken altogether, they divided each into three portions, which they diſtinguiſhed by particular names. In the ſmall inteſtines, the three portions are named *duodenum*, *jejunum*, and *ileum;* and in the great inteſtines, *cæcum*, *colon*, and *rectum*.

Structure of the inteſtines. The inteſtines in general are compoſed of ſeveral coats, much in the ſame manner with the ſtomach. The firſt and outermoſt is a continuation of the meſentery, or of ſome other elongation or duplicature of the peritonæum.

This is commonly termed the *common coat;* and it has a cellular ſubſtance on its inner ſurface, like that of the ſtomach, which M. Ruyſch thought fit to call a diſtinct coat by the name of *tunica celluloſa*.

The ſecond coat of the inteſtines is fleſhy or muſcular, and made up of two planes; one external, the other internal. The external plane is very thin, and its fibres longitudinal; the internal plane is thicker, and its fibres run tranſverſely round the circumference of the inteſtinal cylinder.

It would appear that theſe fibres are neither ſpiral, nor are they formed perfect circles or of rings; but they ſeem rather to be ſegments of circles, diſpoſed much in the ſame manner as in the ſtomach, and thus ſurrounding entirely the inteſtinal canal.

Theſe two planes adhere cloſely together, and are ſeparated with great difficulty. They adhere likewiſe to the common coat by the intervention of the cellular

ſubſtance, which is in greater quantities on the ſide next the meſentery than on the other.

The third coat is called *nervoſa*, and is ſomething like that of the ſtomach. It has a particular plane, which ſerves as a baſis to ſuſtain it, made up of very fine ſtrong, oblique fibres, which ſeem to be of the ligamentary or tendinous kind.

To ſee this plane diſtinctly, a portion of the inteſtines muſt be inflated, the common coat removed, and the fleſhy fibres ſcraped off.

This coat ſuſtains two reticular ſubſtances, which are both vaſcular, one arterial, the other venal, accompanied by a great number of nervous filaments. Theſe veſſels and nerves are productions of the meſenteric veſſels and nerves; and as they ſurround the whole canal of the inteſtines, ſome anatomiſts have formed them into a diſtinct coat by the name of *tunica vaſculoſa*.

The nervous coat ſends off from its inner ſurface a great number of portions of ſepta, more or leſs circular, which contribute to the formation of what are called *valvulæ conniventes;* of which hereafter. It likewiſe ſeems to ſuſtain ſeveral different glandular bodies, which we diſcover in the cavity of the inteſtines.

The fourth or innermoſt coat is very ſoft, and is named *tunica villoſa*. It has the ſame extent with the third coat, which ſupports it; and it lines all the ſepta of that third coat; but it is not uniform through the whole canal, as we ſhall ſhow in the particular deſcription.

It is now generally believed, that the fourth coat is a continuation of that in the ſtomach, and, of conſequence, from the epidermis.

Inteſtina tenuia. The ſmall inteſtines form one continued uniform canal; and although three portions of it have three different names, yet we have no ſufficient marks whereby to diſtinguiſh them, to fix the preciſe extent

extent or length of each portion, or to ſettle its juſt limits.

The firſt and ſmalleſt portion of the whole canal is called *duodenum;* the ſecond, which is much longer, *jejunum;* and the third, which is ſtill longer than the ſecond, *ileum.*

§ 4. *Inteſtinum Duodenum.*

THE firſt portion of the ſmall inteſtines was called *duodenum*, from the length aſcribed to it by the ancients, viz. the breadth of twelve fingers; and the moderns need not cavil much about this length, if it is meaſured with the ends of the fingers of the ſubject.

This inteſtine having ariſen from the pylorus, is immediately bent a little backward and obliquely downward; then it bends a ſecond time toward the right kidney, to which it is a little connected; and from thence paſſes before the renal artery and vein, aſcending inſenſibly from right to left, till it gets before the aorta and laſt vertebræ of the back. It continues its courſe obliquely forward by a gentle turn, which may be reckoned a third incurvation, and alſo the extremity of the duodenum.

Through this whole courſe the duodenum is firmly bound down by folds of the peritonæum, eſpecially by a tranſverſe duplicature which gives origin to the meſocolon. The two laminæ of this duplicature being at firſt ſeparate, and ſoon afterwards uniting, muſt leave a triangular ſpace between them, which is lined with a cellular ſubſtance.

It is in this ſpace that the duodenum adheres by means of the cellular ſubſtance to the parts already named; and the inteſtine is contained therein, as in a caſe; ſo that, without diſſection, we can ſee nothing but its two extremities; and even theſe are hid by the colon, and by the firſt convolutions of the jejunum.

Structure

Structure of the duodenum. The firſt coat of the duodenum is conſequently different from that of the other ſmall inteſtines, having this peculiar to it, that it does not inveſt the whole circumference of the inteſtine; becauſe, through the greateſt part of its length, it lies in the triangular ſpace already mentioned; and, for the ſame reaſon, there is a greater quantity of cellular ſubſtance belongs to the outer coat of the duodenum than to that of the other inteſtines.

The muſcular coat of the duodenum is thicker than in the jejunum and ileum.

The tunica nervoſa and villoſa form conjointly, on the inſides of this inteſtine, a great number of ſmall duplicatures, which advance into the cavity more or leſs directly, like portions of circular planes, with one edge fixed to the inteſtine, and the other looſe. Theſe are what anatomiſts call *valvulæ conniventes.*

The looſe or floating edge of theſe valves is formed into ſmall gathers or waves in the natural ſtate. The whole ſurface of theſe duplicatures or valves is villous, as well as that of the inteſtines between them.

The villi of this inteſtine are thicker than in the ſtomach; but the texture of them in man is not like hairs, as they are commonly repreſented in figures, but rather like that of a fungous, granulated ſubſtance, compoſed of an infinite number of very fine papillæ of different figures; in which we ſee, through a microſcope, a multitude of depreſſed points or pores, by which their whole ſurface ſeems to be pierced.

By the ſame help we obſerve, on different places of the inner ſurface of this inteſtine, ſeveral round villous tubercles, riſing like ſmall verrucæ at different diſtances from each other.

This ſubſtance ſuſtains an infinite number of capillary veſſels of different kinds; for beſides the blood-veſſels, we ſometimes obſerve a great number of white filaments which run through it, and end at its inner ſurface like ſo many capillary roots of the veſſels called

venæ

venæ lacteæ. When the villous ſubſtance is examined in the microſcope, beſides the blood-veſſels, numerous follicles are obſerved lodged in cellular ſubſtance. Theſe have been conſidered as the origin of the lacteal veſſels, and have been called *ampullulæ of Leibercuhn*, becauſe he firſt diſcovered them.

The fungous ſubſtance which binds theſe capillary filaments together, and ſurrounds them, is very tender; and the capillary extremities of the ſmall blood-veſſels diſtributed through it, ſeem to be turned toward the pores of the papillæ. Through theſe pores a mucous fluid, more or leſs tranſparent, is diſcharged, which continually moiſtens the cavity of the inteſtine.

Glands of the duodenum. The internal ſurface of the duodenum is furniſhed with a great number of ſmall flat glandular tubercles, named after Brunner, which are raiſed on the ſides, and depreſſed in the middle by a kind of foſſula; and they are more numerous near the beginning of this inteſtine than any where elſe. About the pylorus they lie in a manner in heaps or cluſters; and from thence the diſtance between them increaſes gradually all the way to the other extremity where they are ſingle.

Theſe glands, when examined carefully, appear like little bladders, with the orifices turned toward the cavity of the inteſtine, and the bodies fixed in the ſpongy ſubſtance next the nervous coat. They furniſh a particular fluid, which is often found to be viſcid.

The biliary orifice of the duodenum. In the inner ſurface of the duodenum, almoſt at the lower part of the firſt incurvation, and on the ſhorteſt ſide, there is a longitudinal eminence; in the point or apex of which lies a particular opening, which is the orifice of the ductus bilarius, within which the ductus pancreaticus likewiſe opens.

This inteſtine is commonly the wideſt, though the ſhorteſt, of the inteſtina tenuia, and has been called by

by ſome *ventriculus ſuccenturiatus;* and is inveſted by more cellular ſubſtances, eſpecially while within its triangular caſe, where it wants the outer coat which the others have; and conſequently it is more eaſily dilatable by the ſubſtances which might otherwiſe ſtick within it.

§ 5. *Inteſtinum Jejunum.*

Situation and ſize of the jejunum. The jejunum, ſo called, becauſe it is oftener found empty than the ileum, begins at the laſt incurvation of the duodenum, and is there connected to the beginning of the meſocolon.

From thence it bends downward from left to right, and obliquely forward, or from the vertebræ, and makes ſeveral convolutions, which lie chiefly in the upper part of the umbilical region. Through all this courſe it is connected to the meſentery, in the manner that ſhall be explained hereafter.

It is a pretty difficult matter to fix the exact bounds between this inteſtine and the ileum. The external marks of a redder colour in the one than in the other, though pretty common, are not conſtant; and the internal marks fixed from the plurality of valvulæ conniventes are indeterminate, and oftentimes appear only from diſſection.

Theſe two inteſtines may be better diſtinguiſhed by their different ſituations, which are pretty regular; but as even this mark is not particular enough, the moſt eaſy way that I have been able to contrive, and which will in moſt caſes be found ſufficiently exact, is to divide both inteſtines into five parts; and to allow nearly two-fifths to the jejunum, and three-fifths and a little more to the ileum.

Structure of the jejunum. The coats of the jejunum are nearly of the ſame ſtructure with thoſe of the duodenum, but thinner. The common coat is a continuation

nuation of the meſentery; and the cellular ſubſtance is in leſs quantity than in the duodenum, and indeed ſeems to be altogether wanting along the great curvature of the convolutions, where the longitudinal fibres of the muſcular coat adhere very cloſely to the external membrane.

This muſcular coat is not ſo ſtrong as that of the duodenum. The longitudinal plane of fibres is very thin, and almoſt imperceptible, except along the great curvature, oppoſite to the connection of the meſentery, where we ſee, through the membranous coat, a kind of whitiſh ligamentary band, about the third part of an inch in breadth, which is continued along the great curvature of all the convolutions of this inteſtine, and of the ileum.

This ligamentary band is like thoſe which we obſerve on the ſides of the ſmall extremity of the ſtomach. It adheres perfectly to the membranous coat, and to the longitudinal fibres of the muſcular, which are here more viſible, and appear to be ſtronger than in any other place.

The tunica nervoſa, which we chooſe rather to call *reticularis*, and its proper cellular or lanuginous ſubſtance, have nothing peculiar to them more than has been already ſaid about the inteſtines in general. By blowing artfully into this ſubſtance, it may be made to ſwell ſo much, round the whole cavity of the inteſtines, as to deſtroy all the duplicatures or valvulæ conniventes.

Theſe valves in this inteſtine are very broad, very numerous, and very near each other. On the ſide of the great curvature, their circumference is continuous and uniform; but next the ſmall curvature, there are ſeveral breaks in them, the extremities of ſome advancing beyond the reſt, and terminating in points. Some of theſe valves go quite round, others only ſome part of the way; and ſome of them are very ſmall, which go

obliquely between two large ones, forming a kind of communication.

The papillæ of the tunica villoſa are here more raiſed, more looſe and floating, than in the duodenum; and each of them ſeems to be divided into ſeveral others, by inciſures of a very ſingular kind. In other reſpects they agree pretty much with what was ſaid in the deſcription of the inteſtines in general. The obſervations and figures publiſhed by M. Helvetius, firſt phyſician to the French queen, in the Memoirs of the Royal Academy, expreſs theſe papillæ, and the whole tunica reticularis, very juſtly.

The glandular lacunæ of the jejunum are of the ſame ſtructure with the glandulæ Brunneri or duodenales; but they are diſpoſed in a different manner. They are partly ſingle, at different diſtances from each other; and partly in ſeveral cluſters, like flat oblong bunches of grapes, called *plexus glanduloſi Peyeri.* Theſe are in the largeſt quantity near the great curvature, and they croſs through ſeveral valvulæ conniventes at once.

The veſſels, nerves, connections, &c. muſt be referred till the meſentery has been deſcribed.

§ 6. *Inteſtinum Ileum.*

Situation of the ileum. The convolutions of this inteſtine ſurround thoſe of the jejunum on the two lateral and lower ſides, and it paſſes in a winding courſe from the left ſide, by the hypogaſtrium, to the right ſide, where it terminates a little below the right kidney, joining the inteſtina craſſa, in the manner that we ſhall relate hereafter. The lateral convolutions are ſupported by the oſſa ilium, ſo called, not from this inteſtine, but from the region of the abdomen, termed *ilia.*

Structure of the ileum. The ſtructure of the ileum is much the ſame with that of the jejunum; only the in-

ternal duplicatures or valvulæ conniventes decreaſe gradually both in number and ſize. Near the extremity of the ileum their direction is changed; and inſtead of being tranſverſe or circular, they become longitudinal, and terminate in a kind of pylorus, which advances into the cavity of the great inteſtines, as we ſhall ſee preſently.

We obſerve likewiſe in this inteſtine, as in the jejunum, ſingle or ſolitary glands or lacunæ, and alſo reticular glands or glands in cluſters; the laſt of which, at the extremity of this inteſtine, is oftentimes of a great extent: but the greateſt part of theſe glands appear to be flatter here than in the jejunum. The cellular ſubſtance of the external coat is in leſs quantities than in the foregoing inteſtines; and the ileum appears commonly more pale, or not ſo red as the jejunum.

Sometimes, though rarely, we meet with proceſſes ſent off from the jejunum or ileum, and of the ſame ſtructure with theſe inteſtines. Their form, being ſimilar to that of the finger of a glove, appears to have given them the name of *appendices digitales*. They are mentioned by different anatomiſts, and have ſometimes been found to form true herniæ.

The veſſels, nerves, connections, &c. muſt be referred to the hiſtory of the meſentery.

§ 7. *The Inteſtina Craſſa in general.*

THE great inteſtines are one continued canal, divided into three portions, like the ſmall ones. This canal begins by a kind of facculus or bag, which is reckoned the firſt of the three portions, and called *cæcum*. The ſecond portion, called *colon*, is the longeſt of the three; and is diſtinguiſhed from them by a great number of particular eminences or convexities, which appear on its outer ſurface through its whole length. The laſt portion is named *rectum*; being more uniform,

form, narrower, thicker, and much ſhorter, than the colon.

The ſtructure of the great inteſtines is nearly the ſame with that of the ſmall ones, in regard both to the number and diſpoſition of their coats. They are ſhorter, and have fewer convolutions, but are much more capacious. The coats in general are ſtronger, but eſpecially the muſcular coat. The villi and mucilaginous glands are different; and there are ſeveral other things relating to them, which will come in better in the particular hiſtory.

Situation and ſtructure of the cæcum. The inteſtinum cæcum is only a round ſhort broad bag, the bottom of which is turned downward, and the mouth or opening upward. It lies under the right kidney, and is hid by the laſt convolution of the ileum. It has nothing to diſtinguiſh it from the colon, excepting that it is a little wider, is ſhut at its under end, and gives origin to the appendicula vermiformis.

Appendicula vermiformis. On one ſide of the bottom of the cæcum lies an appendix, reſembling a ſmall inteſtine, nearly of the ſame length with the cæcum, but very ſlender. It is termed *appendicula vermiformis*, from its ſuppoſed reſemblance to an earth-worm. Its common diameter is not above a quarter of an inch. By one extremity it opens laterally and a little obliquely into the bottom of the cæcum; and the other extremity is cloſed, being ſometimes greater ſometimes ſmaller than the reſt of the appendix.

It has ſome contortions, like thoſe of a worm when it is touched, from whence comes the epithet of *vermicularis* or *vermiformis*. Its ſtructure reſembles nearly that of the other inteſtines.

The internal coat of this appendix is folliculous, like that of the duodenum; and it is likewiſe reticular, the meſhes being the glandular lacunæ, which continually diſcharge a fluid into its cavity.

It has been often diſputed whether this appendix, or

the large portion, which is, as it were, the head of the colon, ought to be called the *cæcum;* but the general diviſion of the inteſtines into great and ſmall, leaves no room to doubt of its being only an appendix in man, whatever reaſon there may be for talking differently with reſpect to brutes and birds.

Through the membranous or common coat of the cæcum, we ſee three white muſcular ligamentous looking bands, which adhere very cloſely both to the outer and muſcular coat. One of them is hid by the adheſion of the meſocolon; and all the three divide the cæcum longitudinally into three parts more or leſs equal.

They all unite on the appendicula vermiformis, and cover its whole outer ſide immediately under the common coat. Though they appear exteriorly on the cæcum to be ligamentary, they are made up interiorly of fleſhy fibres which accompany and ſtrengthen the longitudinal fibres of the muſcular coat.

The villous ſubſtance of the inner coat of the cæcum is very ſhort, and furniſhed in ſeveral places with glandular lacunæ or ſolitary glands, broader than thoſe of the ſmall inteſtines.

Theſe glandular lacunæ or folliculi ars flattened and depreſſed in the middle like ſmall-pox. When we blow through a pipe into theſe lacunæ without touching them, the folliculi are inflated, and repreſent little caps with a hole in the middle of their convex ſide.

§ 8. *Inteſtinum Colon.*

Situation and ſtructure of the colon. The colon is the moſt conſiderable of all the inteſtines. From the cæcum, of which it is a continuation, it reaches, in form of an arch, above the umbilical region, and to the lower part of the left hypochondrium. Its continuity is, however, a little interrupted by the ileum, which advances into the cavity of the colon, and, together with a certain

certain fold of that inteſtine, forms what is called *valvula coli*.

The whole convex ſide of the colon is divided longitudinally into three parts, by three muſcular bands, firſt known to Sylvius and Euſtachius, continued from thoſe of the cæcum, and of the ſame ſtructure with theſe. Two of theſe bands run on each ſide along the great curvature of the colon; and the third along the ſmall curvature.

The uppermoſt band of the two that belong to the great curvature, is the broadeſt of the three; that which belongs to the ſmall curvature is the narroweſt, and lay hid by the connection of the meſocolon, till it was brought to light by M. Morgagni.

Theſe three longitudinal bands do the office of longitudinal frænа, between which this inteſtine is thro' its whole length alternately depreſſed into tranſverſe folds, and raiſed into conſiderable eminences. All the folds are duplicatures, which form portions of valvulæ conniventes in the cavity of the inteſtine; and the eminences form receptacles, called the *cells of the colon*.

All the coats of the colon concur equally to the formation of theſe duplicatures and cells, the depth of which decreaſes gradually toward the extremity of the inteſtine, and neither of them go any further than the ligamentary bands.

Theſe portions of the colon which are immediately covered by the ligamentary bands, are ſmooth and without rugæ; and therefore, if theſe bands alone are cut acroſs, the inteſtine is not elongated ſufficiently to deſtroy all the folds and cells.

The common coat on one ſide is a continuation of the meſocolon, and on the other ſide it contributes, by the ſame continuation, to form the omentum. The longitudinal fibres of the muſcular coat are very ſlender; excepting in the bands already mentioned; and thoſe which anſwer to the annular or circular fibres of the ſmall inteſtines, are only ſegments ſtretched over the eminences and folds. The other coats are nearly as

in the cæcum; only the glandular lacunæ or ſolitary glands are broader and more numerous.

The arch of the colon begins under the right kidney, near the haunch. It runs up on the foreſide of that kidney to which it is connected; paſſes under the veſicula fellis, which tinges it with a yellow colour at that place; and continues its courſe before the firſt incurvation of the duodenum, to which it adheres, and partly hides it. In this part of its courſe, therefore, there is a remarkable connection between the colon, duodenum, right kidney, and veſicula fellis.

From thence the arch of the colon runs before the great convexity of the ſtomach, and ſometimes a little lower; then turns backward under the ſpleen, in the left hypochondrium; runs down on the fore-ſide of the left kidney, to which it is connected; below this kidney, turns toward the vertebræ, and terminates there by a double incurvature, or by two oppoſite convolutions, which repreſent in ſome meaſure an inverted Roman S.

Theſe laſt convolutions of the colon are ſometimes multiplied, and even advance to the right ſide of the pelvis; and along the great arch, and the two laſt incurvations, there are a kind of fringes, called *appendices coli adipoſæ*, which we ſhall afterwards explain, as alſo the connections of the colon with the meſocolon and omentum.

Valvula coli. At the place where the cæcum joins the colon, one portion of the circumference of both is depreſſed, and forms a large fold on the inſide, which advances into the cavity of the inteſtine, and gets the name of *valve* of the *ileum*, of the *cæcum*, or of the *colon*. Some have named it after Bauhin, who was ſaid to diſcover it accidentally at Paris in 1579, by throwing water into the inteſtines, and finding that the paſſage was obſtructed at the end of the ileum; but Vidus Vidius has deſcribed it ſeveral years before this. It is a little open in the middle, and its extremities are very thick,

thick, by reaſon of the mutual duplicature of the coats of the cæcum and colon.

The extremity of the ileum is as it were grafted in the opening of this fold, and ſtrongly united to its ſides by the adheſion of its tranſverſe fibres to the tranſverſe fibres of the cæcum and colon.

This union forms a pretty thick ring, which likewiſe advances into the common cavity of the cæcum and colon, where it is wrinkled or formed into gathers, almoſt like the lower extremity of the œſophagus, the pylorus, or inſide of the anus. Its circumference is more or leſs oval; and, by a kind of continuity with the common fold of the cæcum and colon, it forms two productions, which M. Morgagni calls the *retinacula valvulæ Bauhini*.

The membranous coat of the extremity of the ileum is continued on the cæcum and colon, without ſinking into any fold at the place where the ileum enters the colon. The longitudinal fibres of the muſcular coat ſeem here to be confounded with the neareſt circular fibres of the cæcum and colon.

The inner portion of the muſcular coat of the ileum runs in between the circular fibres of the ileum and colon, as into a common fold of theſe two inteſtines; from all which a pretty thick ſhort portion of a fleſhy tube is formed, which is the circular riſing already mentioned.

The tunica nervoſa and villoſa of the extremity of the ileum likewiſe enter the common cavity of the cæcum and colon, and on the edge of the circular riſing join the like coats of theſe two inteſtines; ſo that the circular riſing or ſhort muſcular tube is covered both on the outer and inner ſides by a nervous and villous coat; that on the inſide being ſupplied by the ileum, and the other by the two great inteſtines.

The ſituation of this extremity of the ileum is moſt commonly tranſverſe, and is inſerted almoſt in the ſame direction in the common cavity of the two inteſtines al-

ready mentioned; but it is often a little more inclined toward the cæcum than to the colon; and whereas in all other places the ileum is wide and eaſily dilatable, it is very narrow at its inſertion, and its ſides are more ſolid and firm.

It is chiefly in this ſtructure that the mechaniſm of the inſertion of the ileum in the cæcum and colon conſiſts; about which inſertion or opening, authors are very much divided, ſome reckoning it a valve, others only a ſphincter.

It is very evident, from what we have ſaid, that it is a double machine contrived to hinder the return of the excrements into the ileum, becauſe it can produce this effect partly as a valve, and partly as a kind of ſphincter. The dried preparations of this part give a very falſe idea of its ſtructure and conformation; and the ſame thing is to be ſaid of the opening of the appendicula vermiformis into the cæcum.

The capacious arch of the colon is connected by both extremities to the regio lumbaris, near the kidneys, by two particular ligaments, one on the right ſide, the other on the left, which are only ſmall duplicatures of the peritoneum, more or leſs tranſverſe.

The remaining portion, which forms the two convolutions in form of the Roman S, contracts below the left kidney, being narrower there than lower down. The coats of this portion become gradually thicker and ſtronger, and likewiſe the ligamentary bands, which approach each other by degrees, and ſeem to increaſe in breadth.

The veſſels, nerves, &c will be found in the deſcription of the meſentery.

§ 9. *Inteſtinum rectum, and Anus.*

Situation, figure, and ſize of the rectum. The laſt of all the inteſtines is named *rectum*, or the *ſtraight gut*, from its ſituation; for, when viewed directly forward, it

it appears to run down in a ſtraight courſe from the laſt vertebra of the loins, on the foreſide of the os ſacrum, all the way to the os coccygis, where it ends in what is called the *anus*.

This inteſtine, properly ſpeaking, is a true continuation of the laſt convolution of the colon; and it is the repoſitory, ſink, and common ſewer of the whole inteſtinal canal. It has likewiſe a ſpecial relation to the bladder, and to the parts of generation in both ſexes.

The rectum having paſſed below the laſt vertebra of the loins, to the inſide of the os ſacrum, is bent backward, on that concave ſide, to which it is connected, in the manner that ſhall be afterwards explained; and having reached the os coccygis, it runs likewiſe in the direction of that bone, and bends a little forward, terminating beyond the extremity of the coccyx.

The figure of this inteſtine varies according as it is full or empty. When empty, it is irregularly cylindrical, and ſinks in by a kind of tranſverſe folds; and in that ſtate, it is about three fingers breadth in diameter more or leſs. When full, it is wider in proportion to the quantity of fæces, wind, or whatever elſe is contained in it; and it may be extended to the ſize of a large bladder, ſo as to repreſent a kind of ſtomach.

Structure of the rectum. The membranous coat often contains a great quantity of fat, ſpread between it and the muſcular coat, and forming round the inteſtine numerous eminences, in the room of the appendices adipoſæ of the colon, which ſhall be explained in the hiſtory of the omentum.

The muſcular or fleſhy coat is very thick; and the longitudinal fibres, which in the other inteſtines are very thin, are in this ſtronger than the circular fibres of the reſt. The ligamentary bands continue to increaſe in breadth, and to approach each other, as has been ſaid; and it is to the fleſhy fibres of theſe bands that the thickneſs of the longitudinal fibres ſeems to be owing.

The

The nervous or filamentous and internal coats, are larger here than in the other inteſtines; and when the rectum is empty, they form a great number of waving rugæ in its cavity, which diſappear in proportion as that cavity is filled.

The innermoſt coat is very improperly termed *villoſa*, and ſcarce deſerves the name of *papillaris*, becauſe of the ſmallneſs of the little corpuſcles ſpread on its ſurface. It contains a great number of ſingle or ſolitary glands; and it is always moiſtened by a mucus of different conſiſtences, diſcharged by theſe glands or folliculi, and perhaps by the corpuſcles alſo.

Near the extremity of this inteſtine the rugæ or folds become in a manner longitudinal; and at laſt, towards the circumference of the inner margin of the anus, they form little bags or ſemilunar lacunæ, the openings of which are turned upward, toward the cavity of the inteſtine. Theſe lacunæ are ſomething like thoſe of the lower extremity of the œſophagus, or upper orifice of the ſtomach.

Muſcles of the anus. At length the extremity of the rectum contracts, and terminates by a narrow orifice called the *anus*, the ſides of which are diſpoſed in cloſe folds or gathers. This extremity of the inteſtine has ſeveral muſcles belonging to it, ſome of which ſurround it like ſphincters; the reſt are broad fleſhy planes inſerted in it, and which, being likewiſe fixed to other parts, ſuſtain it in its natural ſituation, and reſtore it to that ſituation after being diſturbed by the force neceſſary for the excluſion of the fæces. Theſe latter muſcles are termed *levatores ani;* the firſt go by the general name of *ſphincters*. *See* Deſcription of Muſcles in Vol. I.

§ 10. *Meſenterium et Meſocolon.*

Diviſion of the meſentery, &c. This great bundle of inteſtines is not left to move at random in the cavity of the abdomen; but artfully bound down by a membra-

nous web, which prevents the inteſtinal convolutions from being intangled in each other, and from being twiſted or compreſſed in all their different ways of meeting; and yet allows them a gentle floating, but limited motion.

This web goes ſtill by the ancient Greek name of *meſentery*, as being in ſome meaſure in the middle of the inteſtines. It is diſtinguiſhed into two portions; one of which being very broad and very much plaited, connects the ſmall inteſtines; the other, which is long and incurvated, does the ſame office to the great inteſtines.

Theſe two portions are in reality only one and the ſame continuation of the membranous lamina of the peritonæum doubled back upon itſelf, and they are diſtinguiſhed only by their breadth. Taken both together, they form a kind of ſpiral roll, more or leſs plaited in its circumference. The firſt portion has retained the name of *meſentery*, the other is termed *meſocolon*.

Structure of the meſentery, &c. The meſentery begins at the laſt incurvation of the duodenum, and runs obliquely from left to right, along the vertebræ of the loins. In this ſpace, the membranous portion of the peritonæum is detached on both hands, produces a duplicature by two elongations or particular laminæ applied to each other, and thus forms the meſentery.

It is narrower at its upper and lower parts, but chiefly at the upper. The middle portion is very broad, and the edge of it next the inteſtines is every where very much plaited. Theſe plaits or folds are only waving inflexions, ſuch as may be obſerved in the edge of a piece of ſhamoy which has been often drawn thro' the fingers. They make this edge of the meſentery very long, and they run through about one third of its breadth.

The two laminæ are joined together by a cellular ſubſtance, which contains glands, veſſels, and nerves, that

that ſhall be deſcribed hereafter; and in ſome ſubjects it has a great quantity of fat, which keeps the two laminæ at a good diſtance from each other.

Along the whole circumference of the meſentery, the two laminæ are naturally ſeparated, and applied to the two ſides of the ſmall inteſtines, which they inveſt by their union or rather reciprocal continuation on the great curvature of that canal, and carry it as in a ſcarf or ſling. This is what forms the external or membranous coat of the inteſtines.

The meſocolon is the continuation of the meſentery; which having reached the extremity of the ileum, contracts and changes its name. At this place, the particular lamina which is turned to the right ſide, forms a ſmall tranſverſe fold, called *ligamentum coli dextrum.*

Afterwards the meſocolon aſcends toward the right kidney, where it ſeems to be loſt by the immediate adheſion of the colon to that kidney, and to the firſt incurvation of the duodenum. Then it appears again, and increaſing in breadth, it continues its courſe almoſt tranſverſely under the liver, ſtomach, and ſpleen, where it begins to turn downward, under the left hypochondrium, toward the kidney on the ſame ſide.

Through this whole courſe the meſocolon extends in breadth, and forms nearly a tranſverſe ſemicircular plane, very little plaited at its great circumference. By this circumference or edge, it is connected to the colon, and hides that ligamentary band of this inteſtine, which runs along its ſmall curvature. By its ſhort or ſmall edge, it forms the triangular caſe of the duodenum; and, by its great edge, the external coat of the colon, in the ſame manner as the meſentery does that of the ſmall inteſtines. As it paſſes under the large extremity of the ſtomach, it adheres a little to the lower portion of that extremity, as the diaphragm does to the upper.

Having got below the left kidney, it contracts, and forms another tranſverſe fold, called *ligamentum coli ſiniſtrum.* Afterwards it expands again, but not ſo much

much as in the upper part; and runs down on the left pſoas muſcle, toward the laſt vertebra of the loins. This deſcending portion is fixed to the convolutions of the colon, in the ſame manner as the ſuperior portion is to the arch of that inteſtine.

The inteſtinum rectum is likewiſe inveſted by a particular production of the peritonæum, called commonly by the name of *meſo-rectum*. This production is very narrow; and about the middle of the foreſide of the rectum, it forms a tranſverſe ſemicircular fold, which appears when the inteſtine is empty, but is loſt when it is filled.

Between the laminæ of the meſentery, a great number of glands lie ſcattered through the cellular ſubſtance. In the natural ſtate, theſe glands are ſomething of the figure of lentils or little round beans, ſome of them being orbicular, others oval, but all of them a little flatted, and in corpulent ſubjects we find them ſurrounded with fat.

Theſe glands are of the number of thoſe that anatomiſts call *glandulæ conglobatæ*, the ſtructure of which is not as yet ſufficiently known. They ſeem to be of a cellular ſubſtance, ſurrounded by a very fine membrane or coat, on which, by the help of microſcopes, we diſcover an intertexture, of particular filaments, which Malpighi believed to be fleſhy fibres.

The niceſt anatomical injections have not hitherto given us any ſatisfaction about theſe particulars: for though they be made with all poſſible care, they always fill the folliculous texture of theſe glands; and tho' by means of theſe injections we may diſcover a great many veſſels, which were before inviſible, we are not a whit the nearer our purpoſe, becauſe we cannot by this method diſtinguiſh the ſecretory, excretory, and blood-veſſels from each other.

Beſides the blood-veſſels, which are diſtributed in a reticular manner in the meſenteric glands, and beſides many nervous filaments ſpread through them, we diſcover

diſcover an infinite number of ſmall veſſels of another kind, running from gland to gland.

Theſe veſſels are extremely thin and tranſparent, and furniſhed on the inſide with numerous valves, which appear on the outſide like little ſmall knots very near each other. They go out from each gland by ramifications, as by ſo many roots; and having formed a ſmall trunk, they are again divided, and enter ſome neighbouring gland by the ſame kind of ramifications by which they went out from the former.

Lacteal veſſels. Theſe are termed *lymphatic veſſels*, becauſe for the moſt part they contain a very clear, limpid, though mucilaginous ſerum, called *lympha* by anatomiſts. But as they have likewiſe been obſerved to be filled with a white milky fluid, called *chyle*, they have been called *vaſa chylifera*, or *venæ lacteæ*. They have the name of *veins*, becauſe their valves are diſpoſed as thoſe of the ordinary blood-veins, and becauſe the fluid which they contain runs from ſmaller into larger tubes: But the particular deſcription of theſe will come in more properly in a latter part of the work.

§ 12. *The Blood-veſſels and Nerves of the Inteſtines.*

Blood-veſſels of the inteſtines. The duodenum has commonly a particular artery called *duodenalis* or *inteſtinalis*, which comes indifferently from the ſtomachica coronaria, pylorica, gaſtrica major, or hepatica. It has likewiſe ſeveral diſtinct ramifications from theſe trunks, and from the meſenterica ſuperior and ſplenica; which ramifications communicate with each other.

The arteria duodenalis, and the other additional ſmall arteries, form a vaſcular net-work round the muſcular coat of the inteſtine, which ſends out a great number of capillaries toward both the outer and inner ſides, that make the whole inteſtine look of a red colour.

The veins of the duodenum are ramæ of the vena portæ

portæ, and the diſtribution and denomination thereof is pretty much the ſame with that of the arteries; only they communicate more with each other than the arteries, and alſo with the great hæmorrhoidal vein.

The venal ramifications form round the duodenum a net-work like that of the arteries; and the ſame kind of vaſcular texture is more or leſs to be found in all the other inteſtines.

The arteries of the jejunum come chiefly from the meſenterica ſuperior, and ſome from the aſcending branch of the meſenterica inferior. The veins for the moſt part open into the great meſeraica; and the reſt go into the ſplenica and ſmall meſeraica or hæmorrhoidalis interna.

The principal ſubaltern trunks of theſe arteries and veins accompany each other through the cellular ſubſtance between the laminæ of the meſentery; are diſtributed by branches and rami; and form the meſhes, lozenges, and arches, which ſhall be mentioned in the deſcription of the arteries and veins. The laſt of theſe arches and lozenges, or thoſe next to the inteſtine, produce two ſmall vaſcular planes, which ſeparate from each other very diſtinctly, and ſurround the inteſtinal canal in a reticular manner.

The blood-veſſels of the ileum have the ſame ſources with thoſe of the jejunum; and it ought to be obſerved concerning both theſe veſſels, and thoſe of the jejunum, that in their whole courſe through the meſentery, they give ramifications to the glands, laminæ, and cellular ſubſtance of the meſentery; and alſo that there is a kind of communication between ſeveral ſmall meſeraic veins and the capillary rami of the venæ lumbares and ſpermaticæ.

The arteries of the cæcum and appendicula vermiformis, are ramifications of the laſt branch from the convex ſide of the meſenterica ſuperior; and they have likewiſe ſome ſmall ones from the ſecond and third branches, when both are found. The veins of theſe

theſe two parts are ramifications of the great meſeraica; and one of theſe rami is by Riolan termed *vena cæcalis.*

The ſtraight portion of the arch of the colon, or that which is an immediate continuation of the cæcum, is ſupplied with arteries by the ſecond branch that comes from the concave ſide of the meſenterica ſuperior, and likewiſe a little by the third, when there is a third.

The ſuperior or middle portion of the arch of the colon, is furniſhed by the firſt branch from the ſame ſide of the meſenterica ſuperior, which by a bifurcation communicates on both hands with the other portions of the arch of the colon.

The left portion of this arch derives its arteries partly from the firſt branch of the ſame meſenterica, and partly from that of the meſenterica inferior; which two branches form the celebrated communication or common arch of the two meſentericæ.

By means of this communication or continuation, in caſe one artery ſhould be obſtructed or compreſſed, the other would furniſh blood to all the branches below the place of the obſtruction. The ſecond branch of the meſenterica inferior gives likewiſe ſmall arteries to the left extremity of the colon.

The deſcending convolutions of the colon, which repreſent a Roman S, are ſupplied by the other branches of the meſenterica inferior; the laſt of which forms the hæmorrhoidalis interna.

The veins of all theſe portions of the colon form trunks which terminate chiefly in the hæmorrhoidalis interna or meſaraica minor and major, and likewiſe in the vena portæ ventralis. The diſtribution of theſe branches and ramifications is in ſome meaſure the ſame with that of the arteries, as may be ſeen in the deſcription of the veins.

The arteries of the rectum are furniſhed by the hæmorrhoidalis interna, the laſt branch of the meſenterica inferior, which communicates with the hypogaſtrica,

and particularly with the hæmorrhoidalis externa, a production of one of these arteries.

The veins of the rectum go to form the beginning of the meseraica minor or hæmorrhoidalis interna; and they communicate with the hæmorrhoidales externæ, which are rami of one of the hypogastricæ. They communicate likewise with the capillary ramifications of the other hypogastric veins, which come from the internal parts of generation of both sexes.

It is here to be observed in general, that there is a successive continuation, more or less simple or multiplied, between all the arteries of the intestinal canal, and likewise between all the veins; and also that the veins are here thinner and more capacious than the arteries, in a greater proportion than in the other parts of the body.

Nerves of the intestines. The nerves of the duodenum are the middle plexus of the semilunar ganglion, and some filaments of the plexus stomachicus and hepaticus.

The nerves of the jejunum, ileum, and mesenteric glands, are the plexus mesentericus superior, the posterior mesenteric fasciculi, and the plexus mesentericus inferior.

The nerves of the cæcum are the posterior mesenteric fasciculi or plexus, and the plexus mesentericus inferior.

The nerves of the arch of the colon are the same fasciculi, and the two plexus mesenterici.

The nerves of the last convolutions of the colon are the posterior mesenteric fasciculi, and the plexus mesentericus inferior and sub-mesentericus.

The nerves of the rectum are the plexus mesentericus inferior, plexus sub-mesentericus or hypogastricus, and the two ganglions of that plexus.

The nerves of the anus, and of its muscles, are the ganglions of the plexus sub-mesentericus, the inferior

rope of both ſympathetici maximi, and the common arch of the extremities of both ropes.

§ 12. *Digeſtion.*

WITHIN the human ſtomach we firſt meet with a great quantity of mucus, ſpread upon its villous lining; which mucus is not unfrequently tinged by ſome of the bile returning into the ſtomach. Beſides this, in an empty ſtomach after faſting, upon bending the body, a great quantity of a limpid humour will ariſe into the mouth, altogether of the ſame nature with the ſaliva, but more mucous; which liquor is very rarely to be found pure or unmixed in the ſtomach. It is very far from poſſeſſing any acid acrimony, when it can be had pure from the food. Left to itſelf, it changes, both in man and brutes, rather to a lixivial or alkaline nature, when it is ſeparated from the acid illuvies of the aliments, more eſpecially in an hungry animal. This liquor diſtils from the arteries of the ſtomach, through its villous coat, after the manner we ſee by anatomical injections: by which water, fiſh-glue, and oil, may be eaſily urged into the veſſels of the ſtomach, ſo as to ſweat through its numberleſs pores.

The ſtomach then, contained within the abdomen, which is perfectly full, will from thence, as in a preſs, receive a force or compreſſure upon its ſides, which lie betwixt the diaphragm; the concavity of whoſe right wing is filled by the liver, under which, and within the left wing, lies the ſtomach extended almoſt tranſverſely behind the reſiſting muſcles of the abdomen, viz. the recti and obliqui, but chiefly the tranſverſe. The more the ſtomach is filled, the more it is urged by this preſſure of the abdominal muſcles; becauſe, at the ſame time, it riſes upward in a right angle to the contact of the peritonæum.

Now we muſt ſpeak of what is received into the ſtomach, and why it is received. The Creator has given to

man the two faithful guards of pleaſure and pain for his preſervation; the one to avert evil, the other to invite him to uſeful actions. But the taking of aliment is an action very neceſſary and uſeful to our ſupport. For ſince every day there is a great quantity waſted from the body, by a diſſolution of its true ſubſtance thrown off by perſpiration, a repairing of this loſs is every way neceſſary, as the body is manifeſtly waſted by faſting. But this neceſſity of taking food recurs the more quickly from the nature of the blood itſelf, which is ſtrongly inclined to a ſharp, ſaline, lixivial quality, and to a putrid acrimonious ſtate: to which laſt it is continually ſolicited, and approaches from the putreſcent diſpoſition of all the more ſtagnant humours of the animal, promoted by the inceſſant and natural motion of the heart and arteries, and by the heat, which very much promotes the putrefaction of all the animal humours. Moreover, the coagulable diſpoſition of the blood, continually loſing a great part of its diluting water by inſenſible perſpiration, calls ſtrenuouſly for a recruit of the watery element, in the way of drink, by which its coheſive globules are ſeparated from each other, and hindered from running together into a conſiſtent maſs.

Theſe truths are proved not only from their cauſes, but likewiſe by the appearances which they exhibit in men and other animals killed by hunger. For, in ſuch, we commonly obſerve a ſharp ſtinking breath, a looſeneſs of the teeth from the diſſolving acrimony of the juices, violent pains in the ſtomach, ſharp fevers, and even a true madneſs. All theſe diſorders ariſe ſooner and ſtronger, as the perſon is more robuſt and more violently exerciſed with motion of body; but they enſue very ſlowly in phlegmatic people, who are unactive, perſpire little, and put the blood into no great motion. Laſtly, thoſe who have been without food, have alſo lived without bodily exerciſe, and for the moſt part laboured under a diſeaſe of the nerves.

The fresh chyle, composed, for the most part, out of the acescent class of vegetables, and of a consistence always thinner than that of the blood itself, being received into its torrent of circulation, temperates the putrescent acrimony, dilutes the coagulation threatened, and reduces the whole mass to that moderate degree of saline nature which is natural to man: and finally, the chyle, but more especially that derived from the flesh of animals, and likewise what is formed of farinaceous vegetables, being replenished with gelatinous lymph, serves to repair the consumption or waste which is made from the body itself, to the vacuities of whose broken solids it is applied by the causes which promote the growth of the body. The drink dilutes the cohesive or grumous inclination of the blood, hinders its putrefaction, and carries off by the emunctories such particles as are already putrid: and hence it is, that a person may live for a long time without solid food, if he is supplied with drink; but without drink, life subsists but a few days.

We are solicited to take food, as well from the sense of pain we call hunger, as from that of pleasure, which is received by the taste. The first of these proceeds doubtless from the sensible folds or wrinkles of the stomach rubbing against each other by the peristaltic motion, of which there is an acute sensation, joined with a pressure from the diaphragm and abdominal muscles, by which the naked villi of the nerves on one side grate against those of the other, after a manner intolerable. Thus we are effectually admonished of the dangers ensuing from too long abstinence or fasting, and excited to procure food or nourishment by labour and industry.

To this sense perhaps the gastric liquor or juice of the stomach, collected and sharpened after feeding, does in some measure conduce, unless it becomes putrescent.

Thirst is seated in the tongue, fauces, œsophagus, and stomach. For whenever these very sensible parts, which are constantly and naturally moistened by mucous and salival

ſalival juices, grow dry from a deficiency of thoſe or the like humours, or are irritated by a redundancy of muriatic or alkaleſcent ſalts here lodged, there ariſes a ſenſe much more intolerable than the former, as thirſt is more dangerous; whoſe uneaſy ſenſe continues until the proportion of diluting water in the blood, being recruited, reſtores the neceſſary moiſture and free ſecretion required in the parts before mentioned. From hence we learn, why thirſt attends labour, which exhales a greater proportion of the watery perſpiration; and why it is a ſymptom of fevers, where there is an obſtruction of the exhaling veſſels belonging to the tongue and fauces; why ſimple water is leſs efficacious in abating thirſt, which yields nevertheleſs eaſily to ſome acid liquors, that not only moiſten and render fluid, but alſo, by their mild irritation of the tongue and mouth, provoke forward the humours, and at the ſame time correct their putrid tendency.

From theſe cauſes, mortals, being under a neceſſity of ſeeking food for the ſupport of life, have in all ages determined their choice to the ſucculent parts of vegetables and animals, in ſuch a manner, that water and ſalt ſeem to be added only as third aſſiſtants. And firſt, it is probable, that the primitive choice of our foods was made by experiments, according as the variety of ſmells and flavours in vegetables and their ſeveral parts invited, and as the ſtrength or recruit of our faculties thence following confirmed their utility. But by degrees, animals increaſing ſo much as to be incommodious to the huſbandman, and vegetables alone not being ſufficient for ſupporting them under their labours, the fleſh of animals was afterwards added. At preſent, both the number and variety of ſubſtances are almoſt infinite, which we take either as food or ſeaſoning for our nouriſhment.

Although there are many inſtances of particular perſons, and even of whole nations, who have ſupported life only with one kind of food, either vegetable or animal,

or even from a ſmall claſs of either of them; and laſtly, though ſome have lived altogether upon milk or its whey; yet it ſeems to be neceſſary, both from the nature and fabric of the human body itſelf, as well as from certain experiments, that we ought to ſupport life by the two kinds of food, ſo intermixed, that neither of them may exceed their reaſonable bounds; and this mediocrity we are taught from the loathing itſelf, which follows to any one kind of food that has been continued for too long a time together.

The fleſh of animals appears a neceſſary part of our nouriſhment, even from the fabric of the human ſtomach itſelf, reſembling that of carnivorous animals; and from the two rows of teeth, with the canine teeth in each jaw; alſo from the ſmallneſs and ſhortneſs of the inteſtinum cæcum, and from the neceſſary vigour which we require. For the fleſh of animals alone contain the gelatinous lymph ready prepared for the recruit both of our fluids and ſolids; which, being extracted from the broken veſſels and fibres, eaſily paſſes in great abundance into the blood. An abſtinence from animal food generally cauſes great weakneſs both to the body and ſtomach, being perpetually attended with a troubleſome diarrhœa. But in the amplitude and length of the inteſtina craſſa, man agrees with herbivorous animals.

Eſculent vegetables are generally of the aceſcent kind; only ſome few of them are either alkaleſcent, or elſe repleniſhed with a ſpicyneſs. But few of them have that animal glue which is ſpontaneouſly changeable into blood; for it is only the ſmall portion of jelly which is drawn from their farinaceous parts, that, after many repeated circulations, is converted into the nature of our indigenous juices. Yet theſe are neceſſary to avoid over repletion with blood, and of too putreſcent a kind from the uſe of animal food alone, which, from the moſt creditable accounts of the anthropophagi, prevails to ſo great a degree as to breed the hot alkaleſcent

alkalescent scurvy, a fierce or savage temper, a stinking and leprosy of the body, with a lixivial corruption of all the juices; which are only to be cured by change of diet, in which a vegetable acidity abounds. Hence it is, that we are furnished but with few canine teeth; and that our appetite in health, but more especially in disease, is stronger for acidulous vegetables, in proportion to our warmer temperature of body, and greater heat of the country or the season of the year. Hence we see, that in the hottest climates, people live either altogether upon vegetables, or use flesh meats but very rarely, and not without danger of acute diseases; while, in the colder countries, flesh is eaten freely with less danger: and hence bread, or a farinaceous aliment similar to it, is made a standing part of our food throughout the world.

The best *drink* is afforded by pure water, not incorporated with salts, nor with air, which may excite fermentations. Of this kind we justly prefer that from a mountainous spring, which runs through a sandy bed, being very cold, clear, light, and insipid. Whenever we are unprovided with such pure water, as is frequently the case in the lower flat countries, or when any increase of the strength and muscular constriction of the stomach is required from a spicy stimulus, its place may be very well supplied by wine, prepared chiefly from grapes; but, in defect of those, from apples and pears; which, after a due fermentation, becomes clear, and is repleniſhed with an acid salt, and oily or inflammable spirit, well diluted in water. Liquors of the same kind, repleniſhed with a vinous or inflammable spirit, but more flatulent, heavy, and less palatable, are prepared from corns roasted, afterwards extracted with boiling water, and prepared by fermentation, as a substitute for wine in those countries where the grape does not ripen.

But mankind have invented various pickles and sauces, such as salt, vinegar, and acids of various kinds,

to correct the putrescent disposition of flesh-meats; with pepper, mustard, and other hot spices, to strengthen the action of the stomach, which is perpetually weakened by the use of vegetables: and to these add sugar, salt, and the eastern spices, which are generally added either for the sake of flavouring or preserving our food. But all these yield no nourishment, being destitute of all gelatinous lymph, or any farinaceous quality.

The aliments are variously prepared, according to the difference of country, climate, or season; and thus their crudity is removed, their solid fibres softened, their superfluous air expelled, and their disagreeable acrimony changed and rendered agreeable. But, even after this, many vegetable foods, and more especially flesh-meats, require to be divided, in some degree, by a previous triture in the mouth, which is particularly necessary in man, whose stomach is but little fleshy, and likewise that the food may not stay so long upon the stomach as to become putrid.

The measure of our food is determined by hunger, which is different according to the difference of bodies. Animal and farinaceous food nourishes most: other aliments ought to supply by their quantity what they want in their powers of nourishment. In general, we are nourished best by a somewhat spare diet, unless subjected to much labour.

Into this stomach, therefore, the aliments are let down, often almost crude, and but little chewed, of various kinds; some of them being alkalescent, as flesh-meats; rancescent, as oily or fat substances; or acescent, as bread, milk, and most of the vegetable kind. These, we observe, are digested in a heat equal to that of an hatching egg, administered to the stomach by the contiguous spleen, liver, and heart; and this in a cavity altogether close or confined above, as it also is below, by the ascent of the incurvated pylorus, and in a great measure by a shutting valve, and likewise constringed by a muscular force of the fibres; from whence we

we obſerve, that even milk itſelf is often retained in the ſtomach of ſtrong animals ſeveral hours after a meal, without paſſing into the inteſtines. Obſerve, again, that theſe aliments are continually cohobated or moiſtened with watery juices, and at the ſame time are repleniſhed with a good deal of air incorporated with them, either naturally or in the maſtication. This air, therefore, expanding by the force of heat, putrefaction, or fermentation, breaks open the cells by which it was included, divides the viſcid liquors, and ſoftens or opens the ſolid fibres, ſo as to make a way for diſcharging their juices. But the ſame ſubſtance of the air, turning to a ſolid, makes the principal glue or cement by which the animal ſolids and other bodies receive their firmneſs; and this, being extricated by heat, leaves the other elementary parts friable, or without a vinculum, as we ſee from the change which happens in Papin's digeſter, in the ſtomachs of many animals, and even in that of ourſelves. This air, ſet at liberty by the digeſtion, often diſtends the ſtomach more than the food itſelf, under the denomination of flatus. While this air is extricated, the aliments by long ſtay begin to corrupt or change into a nauſeous liquid, often aceſcent; or otherwiſe putreſcent, which however happens leſs in mankind from our uſe of bread and ſalt; or ranceſcent, as appears from the flatus and matters eructated, often of a moſt fetid, cauſtic, and inflammable nature, from ſubſtances of the like diſpoſition. This putreſcency, or imperfect putrefaction, ſays Haller, is almoſt the only cauſe of digeſtion in fiſh, ſerpents, and carnivorous birds. Hence, in mankind, metals themſelves, by long ſtay in the ſtomach, grow ſoft, and are eroded; but from Spallanzani's experiments it appears, that there are no ſigns of putrefaction in the time of digeſtion, except in ſick animals. (*See* Experiments on Digeſtion, &c.) At this time hunger is abſent, the nervous plates of the ſtomach being removed and defended from their contacts with each other by the interpoſed aliment, at the ſame time that the juice of the ſtomach itſelf is leſs ſharp and freer

freer from a mixture with the old remains of the laſt food, which often excite a naufeating uneaſineſs in the nerves of the ſtomach.

But that the aliment might not degenerate into a complete acidity, there is a check from the putreſcent degree of the heat, the power of the juices diſtilling from the ſtomach, and that of the ſaliva itſelf, ſwallowed to the amount of half an ounce in an hour, and rather inclined to an alkaleſcency: alſo theſe juices being ground together with the aliment, macerate, ſoften, and diſſolve the fibres themſelves and their cellular bands, leaving them a ſoft pulp like what we ſee by letting them ſtand for a long time in warm water, extract their juice, and mingle it with themſelves. There is therefore no particular kind of ferment in the ſtomach; from which the deſign of nature, the diſpoſition of the ſtomach, and its uſe, are all very remote. And yet the juice of the ſtomach alone, by its longer ſtay in fiſhes, diſſolves the bones which they had devoured. (*See* Spallanzani's Experiments.)

For the fleſhy fibres in the ſtomach being now irritated by the flatus, weight, and acrimony of the food, begin to contract themſelves more powerfully than when the ſtomach is empty, and with a greater force in proportion as it is more full, the round ſwelling of which ſtretches theſe fibres. And, firſt, the muſcular ſtratum, which paſſes along the leſſer curvature, connects the pylorus with the œſophagus; and, being inſerted only into the left face of the former, draws it to the right. The principal ſtratum of the circular fibres contracts the capacity of the ſtomach, according to its length; grinds or intermixes its contents together with the liquors; and determines them both, like the preſſure of two hands placed oppoſite, to flow towards the pylorus: but this flux through the pylorus is not made continually on account of the valvula pylori, and likewiſe becauſe this motion begins from ſome part that is more irritated; and from thence the aliment

ment is driven here upward, as in other parts downward. Theſe alternate contractions at laſt terminate in a full evacuation. In this action of the ſtomach, there is nothing which reſembles the triture made by the ſtrong gizzards of granivorous fowls, which ſome anatomiſts have aſcribed to the human ſtomach; which yet has a conſiderable degree of ſtrength, ſince the contraction of its fibres is often more than a third part of their length; for we frequently ſee the ſtomach reduced to leſs than a third of its diameter: frequently alſo the ſtomach is obſerved to be diminiſhed to much leſs than a third part, even to the breadth of an inch; which, laſtly, makes it fit for moving forward ſharp-pointed ſubſtances. Yet it neither bruiſes berries nor the ſofteſt worms.

But that motion which it receives from the diaphragm and muſcles of the abdomen, is ſtronger than the periſtaltic force of the ſtomach; for, by this, the ſtomach is more perfectly emptied by a cloſe approximation of its anterior and poſterior ſides. For it is principally by this force that the drinks are urged on continually, but the foods only when they are diſſolved, leſt thoſe parts which are too groſs ſhould be expelled through the pylorus into the duodenum, when the ſtomach is more that way inclined by repletion; for the ſolid aliments do not ſeem to leave the ſtomach, before they have changed their fibrous or other texture for that of a mucous, as it were cineritious, yellowiſh, ſomewhat fetid, mucilaginous, and liquid pulp. That which is firſt prepared and turned fluid, goes before the reſt out of the ſtomach; firſt water; then milk, pot-herbs, bread; and laſt of all, fleſh-meats, the harder, tougher, and longer ſkins or fibres of which paſs unchanged: but ſuch things as are hard, or too large to paſs the pylorus, are retained in the ſtomach for a long time.

But a conſiderable portion of the drink is abſorbed by the pendulous exhaling veſſels of the ſtomach itſelf, gaping like the exhaling arteries of the ſame part: ſo

their contents take a ſhorter way into the blood, as plainly appears from repeated experiments.

The ſtomach being irritated by too great a quantity or acrimony of the food, or elſe by ſickneſs, a repulſion of the bile, or other cauſe, does, by an antiperiſtaltic or reverted motion of its fibres, drive its contents upwards through the open and relaxed œſophagus in the act of vomiting. Any part of the whole inteſtinal canal, from the pharynx to the rectum, may be conſtricted as well ſlowly by an antiperiſtaltic motion. If it happens ſuddenly to the upper parts at the ſtomach, the diaphragm being at the ſame time convulſed, and likewiſe the abdominal muſcles, it is called *vomiting;* if it is ſlowly performed, it may be called *ruminatio;* if the ſmall, and particularly the great inteſtines, return their contents upwards, the diſeaſe is called *ileus.* The effect of vomiting is partly from the preſſure of the abdominal muſcles depreſſing the falſe ribs, and urging the contents of the abdomen againſt the diaphragm; which, at the ſame time, contracting itſelf to a plane downwards, forces the ſtomach, as betwixt the ſides of a preſs, to throw up its contents.

But the aliments driven in their natural courſe to the duodenum, meet there with the influent bile and pancreatic juice, which often flow back into the ſtomach.

From the exhaling arteries of the inteſtines diſtils a thin watery liquor into the cavity of the inteſtines, like the juice of the ſtomach, not acrid, but ſaltiſh. The quantity of this liquor may be computed from the large extent or ſum of all the excretory orifices, and from the ſection or light of the ſecretory artery, larger than which we ſee no where in the body; add to this, the laxity of the parts perpetually kept warm and moiſt, and the copious diarrhœa or watery diſcharge that often follows the uſe of purgative medicines. But the mucus ariſing from the pores or cells before-mentioned ſerves to lubricate and defend the internal ſurface of the villous

membrane, and to guard the ſenſible nerves from ſtrongly acrid or pungent particles. Hence we ſee, it is more abundant at the beginning of the larger inteſtines, becauſe there the maſs of aliment begins to be more feculent, acrid, and tenacious.

The mixture of this liquor with the pulp-like maſs of the aliment, together with the bile and pancreatic juice, is made by the motion of the ſurrounding muſcles of the abdomen; but this force is quite ſmall, and unfit for moving forward the aliments. But for this purpoſe ſerves eſpecially the periſtaltic motion, which is more particularly ſtrong and evident in the ſmall inteſtines. For any part of the inteſtine, irritated by flatus or any ſharp or rough body, contracts itſelf, even after death, moſt violently in that part where the ſtimulus is applied, in order to free itſelf from the offending or diſtending body, which it expels into the next open part of the lax inteſtine; where, being received, it is again propelled forward, by exciting a like ſtimulus and contraction as before. This contracting motion of the inteſtines is made in various parts of the gut, either ſucceſſively or at the ſame time, wherever the flatus or aliment excite a ſtimulus; and this, without obſerving any certain order. So well fitted, however, are the inteſtines for this motion, that they emulate, and even exceed, the irritability of the heart, or at leaſt are ſcarcely exceeded by it. When they are not irritated, they remain at reſt; and we may ſuppoſe this to be the cauſe why the fat remains in the belly. The air acts chiefly as a ſtimulus to the inteſtines, next to it is the aliment, and laſtly the bile. This motion is performed by a wonderful ſort of alternate creeping and revolution of the inteſtines, which diſſection eaſily demonſtrates in living brute animals, and unhappy caſes of wounds in the abdomen and ruptures have manifeſted in the human ſpecies, And ſince here, among ſo many inflexions, the weight of the aliment is but of little force, it eaſily aſcends or deſcends through the irrita-

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ted inteſtine, which thus empties itſelf. From hence the antiperiſtaltic motion is intelligible, by which the pulp of the alimentary maſs is oftener or longer applied with a gentle force to the triture of the inteſtine, to the exhaling diluent liquor, and to the mouths of the abſorbing veins. But all the contents of the inteſtine are determined downward to the large inteſtines, becauſe the ſtimulus begins above, from the left opening of the ſtomach; and ſo, by the ſucceſſion of new chyle, repeating the ſtimulus above the contraction, it deſcends, when there is no reſiſtance made to it, into the lower part of the ileum, at its opening into the colon: here the looſe part of this inteſtine readily receives what is preſſed into it by the contraction from above, and as eaſily unloads itſelf into the large unactive cæcum; from whence it is again repelled upward, and in part urged on by the preſſure of the ſucceeding maſs. Anatomiſts obſerve, that this motion is made ſtronger downward than upward, and that the ſuperior parts of the inteſtines are more irritable than the lower. But as often as an inſuperable obſtacle reſiſts the paſſage of the aliment, there will be the ſeat of the principal contraction, and the aliment likewiſe is driven upward from the valve of the colon through the whole length of the inteſtines, into the ſtomach, and laſtly into the mouth.

This periſtaltic motion of the inteſtines is performed by the conſtriction of their circular fibres, which know how to empty the tube exactly, without injuring the inteſtine againſt pins, needles, or any other ſharp bodies lodged within their contents, which they tenderly promote forward. But the revolutions of the inteſtines, drawn upward and downward, and the ſtraightening of crooked parts of them one before another, which is ſo remarkably conſpicuous in brute animals, are performed by the long fibres, which we ſee contract themſelves at the ſeat of the preſent ſtimulus, and dilate the following portion of them to receive what enſues. By the

the ſame contraction the villous membrane of the inteſtines, within their cavity, is urged and reduced into longer folds; whence the mucus is expreſſed and applied to that part of the alimentary maſs, where it was required by the force of irritation and ſtimulus. Theſe long fibres frequently make intro-ſuſceptions of the inteſtines, and generally without any bad conſequences, by drawing up the contracted portion of the inteſtine into that which is looſe, in ſuch a manner, that the former is ſurrounded by the latter, which is relaxed.

The alimentary pulp, therefore, diluted with the pancreatic juice and that of the inteſtines, intimately mixed with the ſaponaceous bile and circumjacent mucus, is more perfectly diſſolved than by the efficacy of the ſtomach, in proportion as the ſides of the inteſtines come into a larger contact, and approach nearer together; to which add, the longer ſeries of the periſtaltic motions, and the greater quantity of diſſolving juices. In this manner the alimentary pulp, intermixed with air, forms a froth, without any kind of fermentation, which air is the ſame with what we commonly eructate from the ſtomach; but yet, at the ſame time, the acid or aceſcent force is ſubdued, while the oily or fat parts, diſſolved by the bile, intermix with the watery juices, and give the chyle its uſual milky appearance, like an emulſion, of a bright colour in the duodenum, at the firſt entrance of the biliary duct; from whence downward it cloſely adheres to the villous coat of the ſmall inteſtines. But the gelatinous juices of fleſh meats, diluted with a large portion of water, and likewiſe from their own ſubviſcid nature, do more particularly adhere to the villous coat, and enter it in the way of abſorption. So water and watery liquors are all very greedily drank up by the abſorbents; and yet the feculent remains never grow thick in the ſmall inteſtines, as far as Haller has been able to obſerve, becauſe the watery part is repaired by the arterial vapour and mucus; nor do

do they become fetid in any conſiderable degree, as well becauſe of the great quantity of diluting juices, as becauſe the quick progreſſion will not allow them time enough for a putrefaction. Thoſe remains, which are of a more earthy, groſs, and acrid diſpoſition, which were excluded by the mouths of the abſorbing lacteal orifices, do, by their weight, or by the muſcular contractions, deſcend ſlowly into the large inteſtines, ſo as to complete their whole courſe in the ſpace of about twenty-four hours. But within three, four, or a few more hours time, all the chyle of the aliment is commonly extracted.

The conſiderable length of the ſmall inteſtine, which is five or more times longer than that of the body, the great ſurface of the villous membrane increaſed by folds, the incredible number of exhaling or abſorbing veſſels, the ſlow courſe of what remains through the large inteſtines, and the great quantity of the inteſtinal juice poured into the alimentary maſs, do all of them concur in the ſmall inteſtine, abundantly to perform what is required in the emulſions of the food for our healthy juices, and for their abſorption into the lacteals and the meſenteric veins; alſo for abſterſion of viſcidities from the inteſtine; for the avoiding adheſions and coagulations; for the deſtruction of any acid diſpoſition not yet ſubdued; and for the ſubduing any venomous quality in many juices; which, being directly mixed with the blood, inſtantly kill, but are thus ſent in by the mouth without damage. Hence, in general, the inteſtines are long in animals that feed upon any hard diet, but ſhort in carnivorous ones, and ſhorteſt in all thoſe that live upon juices: and, even in man, an uncommon ſhortneſs of the inteſtines has been known to be attended with hunger, and a flux or diſcharge of fetid and fluid fæces.

The heat by which the aliment is fomented, and which is exceedingly proper for the ſolution of the gelatinous matter, and exciting a beginning putrefaction,

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is hence the principal cauſe of the fetor which is gradually produced in the aliment; thence alſo is the cauſe of that thinneſs by which the uſeful part of the aliment is fitted for abſorption. But the air alſo, incloſed in the viſcid aliment, operates here, as in the ſtomach, by breaking the coheſion of the aliments, if any yet remain whole. The inteſtinal water dilutes the little maſſes of aliment; and if any hard part remains, this liquor ſoftens it by maceration. The bile being intimately mixed with oil, diſſolves the ſame, and renders it miſcible with water.

What remains, after the chyle has been abſtracted, conſiſts of ſome portion of the bile, but mucilaginous and degenerate; ſome part of the human mucilages; moſt of the earthy parts that were lodged in the food; and all thoſe parts which by their acrimony were rejected by the abſorbing mouths of the lacteals, yet changed by means of putrefaction; with all the ſolid fibres and membranes, whoſe coheſion was too great to be overcome by the maceration and periſtaltic motion in the inteſtines.

All theſe remains paſs from the extremity of the ileum into the cæcum, in which they are collected and ſtagnate.

The inteſtinal feces, therefore, retained in the blind beginning of the colon or large inteſtine, there grow dry by the abſorption of moiſt vapours, ſo as to be capable of receiving a figure from the round contracted parts of the colon; they aſcend from the bottom of the cæcum elevated by the long ligaments, which end in the worm-like appendix. And here the manner in which the feces are propelled by the contraction of the circular fibres, appears better than in the ſmall ones. The longitudinal fibres of the inteſtine, being attached to the contracted parts as fixed points, draw up and dilate the lower parts of the inteſtine; then the next parts of the inteſtine, to which the feces are brought, being irritated and contracted in like manner, are immediately after drawn together by the round and

long fibres; by a ſucceſſive repetition of which the feces finiſh their courſe entirely, through the whole large inteſtine for the moſt part in twenty-four hours in a healthy perſon. For wounds in mankind, and the comparative anatomy of brute animals, demonſtrate this periſtaltic motion of the inteſtines to the eye; which is alſo confirmed by the antiperiſtaltic motion, and its conſequences, by which the matter of glyſters is returned up through the mouth. The ſame fibres reſiſt the air contained in the inteſtines; and wind is ſaid to be generated as often as theſe fibres being overcome by its impulſe yield, and the inteſtine is dilated.

While the groſs feces aſcend by the folds or valves of the ileum, the weight of them depreſſes the lower fold to the left ſide, which draws back the ligament common to each valve, in ſuch a manner as to compreſs and exactly cloſe the upper fold downward, that nothing may return back into the ileum; which might eaſily happen in a fluid ſtate of the feces, if this port was not ſo accurately ſhut up. The feces, when in danger of falling down from the upper parts, depreſs the upper valve, and thus accurately exclude themſelves. This happens very exactly with the feces, but not ſo accurately with water. From thence they continue to move ſlowly forward, more dry, conſiſtent, and figured by the ſame cauſes through the whole tract and repeated flexures of the colon, which is ſometimes of five or ſeven feet in length, ſo as to retain the feces a ſpace of time ſufficient to give no interruption to the affairs of human life; and this time is proportionably leſs than twenty-four hours, the greater the velocity with which the ſmall inteſtines propel their contents.

At length the figured excrement falls into the *rectum*, which is inflected firſt a little downwards and then forward, of a broad depreſſed figure, at firſt deſcending contiguous to, and afterwards ſpread under, the bladder or vagina, but connected more with the former than the latter. Here, for a great while, and often to

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a great quantity, the feces are collected together, in a part which is loose, or openly surrounded with soft viscera and muscles, with a good deal of fat.

The structure of the rectum differs very much from that of the other intestines. The external membrane or peritonæum is only spread before it; while behind it is supported by a broad stratum of the cellular substance, repleniſhed with fat, and many conglobate glandules, connecting this intestine all the way to the os sacrum. The muscular fibres in this intestine are much stronger and more numerous, more especially the longitudinal ones, than in the other intestines; being composed of the three ligaments of the colon, expanded and separated first over the anterior face, and then over the whole intestine; which they dilate against the advancing feces, and draw back the intestine after it has excluded them. But the transverse fibres are also strong; and the last of them are oval, forming a protuberant ring, which is the internal *sphincter* itself, by which the opening of the anus is closed.

Moreover, the villous tunic, extremely full of pores, and of a rough surface, full of reticulated polygonous and tender wrinkles, has likewise some sinuses peculiar to itself. Namely, that part of the intestine which is next to the skin or outward opening, forms a white firm circle like a valve, into which descend the longitudinal folds, but incurvated and approaching one to another in the circle itself. Betwixt those folds are intercepted sinuses, hollow upwards, and of a greater depth towards the lower extremity of the intestine. Into the cavity of these open the mouths of the large mucous glandules; while the margin of the anus itself is defended by sebaceous glandules, that it might not be excoriated by the harder acrid feces.

There are also proper muscles which govern the anus. Of these the outermost is the *sphincter*, which is broad and fleshy, consisting of two plates of half elliptic fibres, which cross each other towards the coccyx, and to-

wards the genital parts. And there they are inſerted by fleſhy bundles into a callous cellular fabric deſcending from the coccyx. But forward, they are firmly attached, by denſe portions of the ſame kind, to the ſkin of the perinæum; but by three ſtronger portions in the middle, and two in the ſides, they are inſerted into the bulb of the urethra, whoſe lateral parts they ſurround, betwixt the ſphincter and levator. The fibres, therefore, of the ſphincter, placed betwixt the anterior and poſterior face of the rectum, aſcending in a direct courſe, cloſe the opening of the anus, which they ſurround. With the internal ſphincter, the external one is conjoined by fleſhy portions, that they may co-operate together. The conſtriction of them is not perpetual but voluntary; for the anus ſeems to cloſe itſelf naturally, if the ſmallneſs of its opening be compared with the largeneſs of the inteſtine above, and with the correſponding wrinkle, aided by the ſtrength of the tranſverſe fibres of the internal ſphincter and the incumbent bladder.

But there is another office belonging to the *levators*, which are broad complicated muſcles. They deſcend broadly from betwixt the oppoſite protuberances of the oſſa iſchia, placed under the rectum and bladder; and ſerve to ſuſtain the rectum on each ſide, and prevent it from ſubſiding, or from an unſightly everſion. Moreover, the ſame fibres of the levator, declining broadly from each other, in the nature of a ſphincter, to which they join, ſerve to dilate its orbicular fibres, and open the anus; but, at the ſame time, they both elevate and ſuſtain the inteſtine from prolapſing downward by the preſſure of the hard feces. They ariſe, as is well known, from the ſpine of the iſchium, os ileum, and ſynchondroſis of the oſſa pubis, terminated by the margin of the great foramen of the pubes, and that part of the iſchium which is above the tubercle. Finally, they meet together in one above the coccyx, into which they are inſerted by numerous fibres.

Therefore,

Therefore, whenever the feces are collected to ſome quantity within the rectum, ſo as to be troubleſome by their weight, irritation, or acrimony, they excite an uneaſineſs through the adjacent viſcera; and are then urged downward by a voluntary preſſure through the ſtraits of collapſed inteſtine by the force of the incumbent diaphragm exciting an effort; which urging downward with great force, the viſcera of the abdomen, which is always full, are determined downward through the inner rim of the pelvis, ſo as to urge upon the contents of the leſs reſiſting bladder and rectum. When the reſiſtance of the anus is thus overcome, the compreſſing forces of the diaphragm abate, and the feces continue to diſcharge from the body, urged only by the periſtaltic motion itſelf of the inteſtine. After the feces are expelled, the inteſtine is drawn back or up into the body by its longitudinal fibres; after which the opening of the anus itſelf is cloſely contracted by the two proper ſphincters as at firſt. Theſe feces in men and carnivorous animals are very fœtid, almoſt putrid, ſubalkaline, ſoft, and contain much oil intimately mixed with ſalts, which are left both by the aliments, as well as by the the bile and other humours of the human body. An acrid and fœtid water returns from the feces into the blood; hence coſtiveneſs in fevers is hurtful, putrefaction being increaſed by the affuſion of the above-mentioned matter into the body.

§ 13. *Hepar, and Veſicula Fellis.*

Situation, figure, and diviſion, of the liver. The liver is a large and pretty ſolid maſs, of a dark red colour, a little inclined to yellow, ſituated immediately under the arch of the diaphragm, partly in the right hypochondrium, which it fills almoſt entirely, and partly in the epigaſtrium, between the appendix enſiformis and ſpina dorſi, and terminating commonly in the left hypo-

chondrium, into which it ſometimes runs a conſiderable way.

The figure of the liver is irregular, it being arched or convex on the upper part, unequally concave on the lower, and very thick on the right and back ſides. Towards the left and anterior ſides, its thickneſs decreaſes very much, and terminates there by a kind of edge; and it is broader from right to left than from before backwards.

The liver may be divided into two extremities, one great, the other ſmall; two edges, one anterior, and one poſterior; two ſides, one ſuperior and convex, which is ſmooth, poliſhed, and proportioned to the arch of the diaphragm, and one inferior, concave and uneven, with ſeveral eminences and depreſſions; of which hereafter.

It may likewiſe be divided into two lateral parts, called *lobes;* one of which is termed the *great* or *right lobe*, the other the *ſmall* or *left lobe*. Theſe two lobes are diſtinguiſhed above by a membranous ligament, and below, very plainly, by a conſiderable ſciſſure, lying in the ſame direction with the ſuperior ligament.

The eminences on the concave ſide of the liver belong to the great lobe. The principal eminence is a ſort of triangular or pyramidal apophyſis, ſituated backward near the great ſciſſure which diſtinguiſhes the two lobes.

This triangular eminence is termed ſimply the *ſmall lobe of the liver*, or *lobulus Spigelii*, though it was known to ſeveral anatomiſts long before his time. One of its angles advances a conſiderable way toward the middle of the lower ſide of the great lobe, and is loſt there. This angle we call the *root* of the lobulus. Toward the foreſide there is another eminence leſs prominent, but broader; and to this eminence, and the former, the ancients gave the general name of *portæ*.

The depreſſions on the concave or lower ſide of the liver, which deſerve our attention, are four in number.

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The firſt is the ſciſſure that ſeparates the two lobes, which runs acroſs the concave ſide, from the eminences already mentioned, to the anterior edge, where it terminates by a notch of different depths in different ſubjects. This is termed the *great ſciſſure* of the liver; and in ſome ſubjects part of it is an entire tube. The ſecond depreſſion is ſituated tranſverſely between the two eminences of the great lobe, and filled by the ſinus of the *vena portæ*, ſo called by the ancients becauſe it lies between the eminences of the ſame name. The third depreſſion is backward between the great lobe and lobulus Spigelii, and the vena cava paſſes through it. The fourth is a kind of ſulcus between the lobulus and ſmall lobe of the liver, which in the fœtus ſerved to receive a venal canal loſt in adults, in whom it appears only as a kind of ligament. This ſulcus is in ſome meaſure a continuation of the great ſciſſure, and joins the vena cava by an acute angle.

Beſides theſe four depreſſions, there is one on the fore part of the great lobe, in which the veſicula fellis is lodged; and it ſometimes runs as far as the edge, where it forms a ſmall notch. We may likewiſe reckon among theſe depreſſions a ſmall ſuperficial cavity in the poſterior and lateral part of the lower ſide of the great lobe, by which it reſts on the right kidney; and likewiſe a ſuperficial cavity in the left lobe, where it runs over the ſtomach.

Laſtly, on the poſterior edge of the liver, there is a great ſinus common to both lobes, which gives paſſage to the ſpina dorſi and œſophagus, near the place where the vena cava deſcends; and we ſometimes meet with ſciſſures on both ſides of the liver, which are not ordinary.

Ligaments of the liver. The convex ſide of the liver is commonly connected to the diaphragm by three ligaments, which are only continuations of the membranous lamina of the peritonæum. One lies near the edge of the extremity of each lobe, and one in the

middle; and they are accordingly termed the *right*, *middle*, and *left ligaments*. There is a cellular ſubſtance in the duplicature of each, in which the blood-veſſels and lymphatics run, and which ſends off a kind of lamina into the ſubſtance of the liver.

The right ligament ſometimes connects the great lobe to the cartilages of the falſe ribs; and the left ligament, or that of the ſmall lobe, is often double, and advances toward the middle ligament. This middle ligament begins below in the great ſciſſure of the liver, near the eminences called *portæ*; and from thence paſſes through the anterior notch, and over the convex ſide of the liver at the union of the two lobes, and is fixed obliquely in the diaphragm.

It is likewiſe fixed along the upper and inner part of the vagina of the right muſculus rectus of the abdomen, in ſuch an oblique manner as to be nearer the linea alba below than above.

Beſides theſe ligaments, the great lobe of the liver is likewiſe connected to the right ala of the tendinous portion of the diaphragm, not by a ligament, but by a broad and immediate adheſion, without the intervention of the membrane of the peritonæum, which is only folded quite round this adheſion, to form the external membrane of all the reſt of the body of the liver.

This broad adheſion is commonly, though improperly, called *ligamentum coronarium*: but, in the firſt place, it is not a ligament, as has been already obſerved; and, ſecondly, it is not circular, but oval and very oblong.

It is not on the upper part of the convex ſide of the liver, but along the poſterior part of the great lobe; the broad extremity of the adheſion lying nearer the notch, and the pointed extremity towards the right hypochondrium.

The middle ligament, called improperly *ligamentum hepatis ſuſpenſorium*, contains in its duplicature a thick white rope, like a round ligament, which was the umbilical

bilical vein in the fœtus. Thus the lower part repreſents a falx; the convex edge of which is ſharp, and the other rounded.

All theſe ligaments ſerve to keep the liver in its proper ſituation, and to hinder it from inclining too much towards either ſide: but we muſt not imagine that any of them ſerve to ſuſpend it; becauſe it is ſufficiently ſupported by the ſtomach and inteſtines, eſpecially when they are filled.

When the ſtomach is empty, or when we faſt longer than ordinary, it is a common expreſſion to ſay the ſtomach pinches us. As the liver is not then ſuſtained by the ſtomach and inteſtines, it deſcends by its own weight, and, chiefly by means of the middle ligament, pulls the diaphragm along with it. It is in that place, therefore, that we have this uneaſy ſenſation; and not at the ſuperior orifice of the ſtomach, as is commonly believed.

The right or great lobe of the liver, which lies in the right hypochondrium, reſts on the right kidney by a ſmall ſuperficial depreſſion above-mentioned; and it likewiſe covers a portion of the arch of the colon and the pylorus. About two third parts of the ſmall or left lobe lie in the middle of the epigaſtrium, and the remaining third part advances over the ſtomach towards the left hypochondrium.

This ſmall lobe is ſituated almoſt horizontally; the great lobe is very much inclined, and its thick extremity runs down almoſt in a perpendicular direction to the right kidney on which it lies, in the manner already ſaid. This obſervation is of uſe to diſtinguiſh the different parts of the liver in wounds and chirurgical operations.

It may likewiſe ſerve to direct us in examining a liver taken out of the body; the ſituation of which may be otherwiſe very eaſily miſtaken, eſpecially that of the parts of the concave ſide. The paſſage of the vena cava, between the body of the great lobe and the lobulus Spigelii,

Spigelii, may likewiſe ſerve for a rule in placing a detached liver in its true ſituation.

Structure of the liver. The liver is compoſed of ſeveral kinds of veſſels; the ramifications of which are multiplied in an aſtoniſhing manner, and form, by the intertexture of their capillary extremities, an innumerable collection of ſmall pulpy friable corpuſcles, which are looked upon to be ſo many organs deſigned to ſeparate from the maſs of blood a particular fluid, termed the *bile*.

The greateſt part of theſe veſſels, from one end to the other, is included in a membranous vagina, called *capſula venæ portæ*, or *capſula Gliſſoni*, from an Engliſh author who firſt deſcribed it particularly, about the middle of the laſt century. This vagina is commonly conſidered as a continuation of the membrane which covers the liver, and which penetrates this ſubſtance along with the blood-veſſels; but Sabatier is of opinion it is a continuation of the cellular membrane which covers the vena porta ventralis.

The veſſel which carries the blood to the liver is called *vena portæ*, for the reaſon already given. In the deſcription of the veins, we obſerved that the vena portæ might be conſidered as two large veins, the trunks of which are joined endwiſe, and ſend out branches and ramifications in oppoſite directions to each other; that one of theſe veins is ramified in the liver, the other lying without the liver, and ſending its branches and ramifications to the viſcera of the abdomen; and, laſtly, that the firſt of theſe large veins may be termed *vena portæ hepatica*, the other *vena portæ ventralis*.

Vena portæ hepatica. The particular trunk of the vena portæ hepatica is ſituated tranſverſely between the broad anterior eminence of the great lobe of the liver and the root of the lobulus in a particular ſciſſure, and forms what is called the *ſinus of the vena portæ*. From this ſinus five principal branches go out, which are afterwards

wards divided into millions of ramifications through the whole ſubſtance of the liver.

At this place the vena portæ lays down the common office of a vein, and becomes a kind of artery as it enters, and is again ramified in the liver. The extremities of all theſe ramifications of the trunk of the vena portæ hepatica end in the pulpy friable corpuſcles of the liver.

Pori bilarii et ductus hepaticus. It is in theſe corpuſcles that the bile is ſecreted; and it is immediately collected in the ſame number of extremities of another kind of veſſels, which unite, by numerous ramifications, into one common trunk. Theſe ramifications are termed *pori bilarii*, and the trunk *ductus hepaticus;* and the ramifications of theſe two kinds of veſſels are inveſted together by the capſula of the vena portæ.

Hepatic veins. The blood deprived of this bilious fluid is reconveyed to the heart by a great number of venal ramifications, which afterwards unite into two or three principal branches, beſides others that are leſs conſiderable, that terminate in the vena cava, and are all called by the name of *vena hepatica.*

The capillary extremities of the ramifications of the vena hepatica, join thoſe of the vena portæ, and accompany them through the liver; and yet the great branches of both veins interſect each other in ſeveral places.

When we cut the liver in ſlices, it is eaſy to diſtinguiſh in each ſlice the ramifications of the vena hepatica from thoſe of the vena portæ; the firſt being thinneſt and largeſt, and adhering cloſeſt to the ſubſtance of the liver; whereas thoſe of the vena portæ, which are inveſted by the cellular capſula, appear to be a little ruffled when empty; becauſe the cellular capſula ſubſides when it is cut, but the other veins remain uniformly open, their ſides adhering to the ſubſtance of the liver; beſides, they are accompanied by branches of the hepatic

patic artery and biliary ducts, which do not follow those of the venæ hepaticæ: and Sabatier obſerves, that the direction of the branches of the venæ hepaticæ is perpendicular to that of the vena portæ.

Hepatic artery and nerves. The liver receives from the arteria cæliaca a particular branch, termed *arteria hepatica;* which being very ſmall when compared with the bulk of that viſcus, ſeems deſigned only for the nouriſhment thereof, and not for the ſecretion of the bile. The plexus hepaticus, formed by the nervi ſympathetici maximi et medii, furniſhes a great number of nerves to the ſubſtance of the liver. The ramifications of the artery and nervous plexus are included in the cellular capſula, together with thoſe of the vena portæ and pori bilarii.

The pulſation of this artery has been by ſome anatomiſts taken for that of the capſula, which they ſuppoſed to be muſcular; and by this they have endeavoured to explain the arterial function of the vena portæ: but they have not conſidered, that the blood in this vein does not require to be pumped forward; becauſe ſo ſwift a motion would have been prejudicial to the ſecretion of the fine oil of the bile, for which a ſlow and almoſt inſenſible motion is neceſſary. Cowper and Santorinus were the firſt who doubted of the muſcular nature of the capſula, and they have been followed in this by modern anatomiſts.

The liver is covered exteriorly by a particular membrane or coat, which is a continuation of the peritonæum. There is likewiſe a membranous or filamentary ſubſtance that runs through this whole viſcus, and connects the ramifications and extremities of all its veſſels to each other. This ſubſtance ſeems to be a complicated production of the capſula of the vena portæ, and of the external membrane of the liver.

The outer ſurface of this coat is very ſmooth, but its inner ſurface is uneven, being made up of a great number of thin membranous laminæ; between which

we obſerve, very diſtinctly, numerous lymphatic veſſels, on both the convex and concave ſides of the liver; but it is more difficult to trace thoſe which accompany the filamentary ſubſtance through that viſcus. Some of the lymphatic veſſels from the ſubſtance and concave ſurface of the liver run in the capſul of Gliſſon; and after paſſing through conglobate glands ſituated there, they end at laſt in the receptaculum chyli, or into ſome of the large lacteals; others, upon the convex ſurface of the liver, run to the ligamentum ſuſperiorum, from which they pierce the diaphragm in company with the vena cava, to end in the thoracic duct.

We have already obſerved, that the ſubſtance of the liver is chiefly made up of an infinite number of pulpy friable corpuſcles; each of which is bounded, and in a manner ſurrounded, by a particular expanſion of the capſula Gliſſoni; and all theſe expanſions are connected by common ſepta, in ſome meaſure reſembling a bee-hive.

Theſe corpuſcles have ſeveral angles, eſpecially in the inner ſurface of the liver; but near the ſurface they are raiſed in the form of ſmall tubercles. Their pulpy texture appears like radiated villi, a ſmall void ſpace being left in the middle of each.

If we blow through a pipe into the vena portæ, vena cava, arteria hepatica, or trunk of the pori bilarii, but eſpecially through the two veins, we obſerve the liver to ſwell, and the corpuſcles near the ſurface are raiſed, and become more ſenſible. If we blow with much force, we burſt theſe corpuſcles; and the air getting between them and the external membrane, raiſes it from the ſubſtance of the liver in bliſters.

Ductus cholidochus. The ductus hepaticus, or trunk of the pori bilarii, having run a little way, joins another canal, called *ductus cyſticus* or *veſicularis;* becauſe it comes from the veſicula fellis, as we ſhall ſee in the deſcription of that organ. Theſe two united ducts form

form a common trunk, named *ductus cholidochus;* becauſe it conveys the bile. This duct having reached the incurvation of the duodenum, inſinuates itſelf thro' the coats of that inteſtine, and opens into the cavity thereof, not by a round papilla, but by an oblong orifice rounded at the upper part, and contracted at the lower like the ſpout of an ewer, or like a common tooth-picker.

The edges of this orifice are raiſed, broad, and plaited, as we may ſee by making this portion of the duodenum ſwim in clear water. At the entry of this orifice we ſee another ſmall opening diſtinct from it, which is the orifice of the ductus pancreaticus; of which hereafter. Gliſſon was of opinion, that the extremity of the ductus cholidochus was furniſhed with a ſphincter of muſcular fibres, which was capable of ſhutting the orifice and of preventing the contents of the duodenum from entering it; but no ſuch duct has been found by others, and the obliquity of the paſſage anſwers the ſame purpoſe.

Veſicula fellis. The gall-bladder is a kind of ſmall bag, ſhaped like a pear; that is, narrow at one end, and wide at the other. The wide extremity is termed the *fundus* or *bottom*, the narrow extremity the *neck*, and the middle portion the *body*. About one third of the body of the veſicula lies in a depreſſion on the concave ſide of the liver, from the trunk or ſinus of the vena portæ, where the neck is ſituated, to the anterior edge of the great lobe, a little toward the right ſide, where the bottom is placed; and in ſome ſubjects it advances beyond the edge, ſo as to oppoſe itſelf to the muſcles of the abdomen under the edges of the falſe ribs.

Therefore when we ſtand, the veſicula fellis lies in a plane inclined a little from behind forward. When we lie upon the back, it is almoſt inverted. When we lie on the right ſide, the bottom is turned downward, and it is turned upward when we lie on the left ſide; and

theſe ſituations vary according to the different degrees of each poſture.

The gall-bladder is compoſed of ſeveral coats; the outermoſt of which is a continuation of that which inveſts the liver, and conſequently of the peritonæum.

The under ſide of the gall-bladder touches the colon at the beginning of the duodenum, and ſometimes at the pylorus.

The ſecond coat is ſaid by ſome to be fleſhy, and made up of two ſtrata; one longitudinal, the other tranſverſe, like that of the ſtomach or inteſtines; but excepting in ſome very robuſt ſubjects, there are ſcarcely any muſcular fibres to be ſeen.

A whitiſh ſtratum is looked upon as the third coat of the gall-bladder, anſwering to the tunica nervoſa of the inteſtines.

The innermoſt, or fourth coat, has on the inſide a great number of reticular folds, filled with ſmall lacunæ, like perforated papillæ, eſpecially near the neck of the veſicula, where theſe folds are longitudinal, and afterwards form a kind of ſmall pylorus, with plaits of the ſame nature with thoſe in the great one. Theſe lacunæ are looked upon to be glands. Sabatier admits only of the firſt and the laſt of theſe coats; and conſiders the intermediate ſubſtance as being merely cellular and vaſcular.

That ſide of the body of the veſicula which lies next the liver is connected to that viſcus by a vaſt number of filaments, which run a great way into the ſubſtance of the liver. Among theſe fibres, in ſome animals, ducts have been obſerved a long time ago. They are moſt numerous near the neck of the veſicula; and they are named *ductus cyſto-hepatici*, or *hepatico-cyſtici*: but no ſuch ducts can be demonſtrated in the human body.

The neck of the veſicula is formed by the contraction of the ſmall extremity; and this neck bending afterwards in a particular manner, produces a narrow canal,

nal, named *ductus cyſticus*. This incurvation repreſents, in ſome meaſure, the head of a bird, of which the cyſtic duct, by the gradual diminution of its diameter, expreſſes the beak. This cannot be ſeen when the liver is *extra ſitum*; and even *in ſitu* it is but very imperfectly ſeen, when, in order to view the concave ſide, the liver is raiſed and thruſt too much againſt the diaphragm; for by thus inverting the liver, the curvature is diſordered, and we ſee two in the place of one.

To ſee this curvature in its true natural ſituation, the liver is to be raiſed but very little, and the duodenum left untouched; then we muſt ſtoop and look under the liver, without diſordering any thing. This incurvation may be of uſe to hinder too precipitate a diſcharge of the bile contained in the veſicula, which ſome ſituations of the body might occaſion.

The neck of the veſicula is nearly of the ſame ſtructure with the other parts. It has on the inſide ſeveral reticular rugæ and ſome folds, which appear like fragments of valvulæ conniventes, ſituated very near each other, from the neck to the contraction of the cyſtic duct. The firſt of theſe folds is pretty broad and large, and almoſt circular; the next is more oblique and ſmaller in ſize, and the reſt diminiſh in the ſame manner. Taken all together, they form a kind of ſpiral flight, which may be ſeen through the neck on the outſide, where it ſometimes appears like a ſcrew, eſpecially when the neck is filled with any fluid. This obſervation is owing to M. Heiſter.

By ſlitting the neck and duct, we ſee all theſe folds very diſtinctly, eſpecially when we examine them in clear water. When they are viewed in any other manner, they eaſily deceive us, being miſtaken for true valves, becauſe of their tranſverſe ſituation. They may, however, in ſome meaſure, ſupply the place of valves, by hindering the bile from running too faſt into the duodenum, and the contents of the duodenum from entering this duct. The ſtructure of the biliary ducts

ducts appears to be entirely membranous, covered externally with a thick cellular substance, and lined within by a kind of tunica villosa, which is pierced with numerous holes, that make it appear like a sieve. Through these a mucous humour flows to save the ducts from the impression of the bile. And the internal surface of all these biliary ducts, that is, of the ductus hepaticus, cysticus, and cholidochus, being examined through a microscope in clear water, appears to be nearly of the same structure through their whole extent.

The cystic and hepatic ducts do not, in their ordinary and natural situation, represent the capital Y of the Greeks, where they form the ductus cholidochus. After the incurvation of the neck of the vesicula, these two ducts run very near each other, and they appear to be separated only by raising up the liver to view them. The same disorder happens in an inverted liver extra situm; for then the body of the liver subsides, and is flattened, and thereby separates the ducts; whereas, in its true situation, it is very much incurvated, and the ducts very near each other.

The ductus cholidochus appears rather to be a continuation of the ductus cysticus than the common trunk of that and of the ductus hepaticus: for this last duct runs for some space within the sides of the former, before it opens into the cavity; much in the same manner as the ductus cholidochus passes into the duodenum. Winslow has observed, at the opening of the hepatic into the cystic duct, a small loose valvular membrane, which may hinder the bile from returning out of the ductus cholidochus into the hepaticus. But later anatomists describe only a sharp angle at the meeting of the cystic and hepatic ducts similar to the bifurcation of the arteries or veins.

The bile, which passes through the ductus hepaticus into the cholidochus, may be called *hepatic;* and that which is collected in the vesicula fellis, may be termed

cyſtic. The hepatic bile flows continually through the ductus cholidochus into the duodenum; whereas the cyſtic bile flows only by reaſon of plenitude or by compreſſion.

Remarks on the veſſels, &c. of the liver. The trunk of the vena portæ ventralis terminates between the lobulus and the oppoſite part of the great lobe; and there joins the trunk of the vena portæ hepatica in the tranſverſe ſinus of the liver, between the right extremity and the middle of that ſinus.

The umbilical ligament, and conſequently the umbilical vein in the fœtus, joins the trunk of the vena portæ hepatica toward the left extremity of the tranſverſe ſinus of the liver. The canalis venoſus in man is not exactly oppoſite the vena umbilicalis, but a little to the right hand; and therefore theſe three veſſels lie in ſuch a direction as to form two oppoſite angles, reſembling thoſe of the handle of a wheel or of a ſpit.

In the fœtus, therefore, the blood which comes from the umbilical vein does not run directly through that contained in the vena portæ hepatica in the ſinus, and from thence into the canalis venoſus; but is obliged to turn from left to right, and ſo to mix with the blood in the vena portæ, before it enters that canal which opens into the trunk of one of the great hepatic veins of the vena cava near the diaphragm.

The hepatic vena portæ gives off commonly five large branches into the liver, viz. three from its right extremity into the great lobe, and two from its left extremity into the ſmall lobe; and from the interſtice between theſe, a ſmall branch goes directly to the middle of the convex ſide of the liver.

The hepatic veins are commonly two or three large branches, which go into the trunk of the vena cava by one common opening, eſpecially two of them. In the ſubſtance of the liver, they interſect the branches of the hepatic vena portæ, and are ramified in all directions in the manner already explained. The inferi-

or

or portion of the opening of these veins into the vena cava, forms a kind of semilunar valve.

Below these hepatic veins, the vena cava inferior, in its passage by the liver, receives several other small hepatic veins, which seem to have the same relation to the hepatic artery as the great veins to the vena portæ.

The passage of the vena cava is through the right portion of the posterior sinus of the liver, and consequently on the side of the great lobe, which is hollowed at this place sufficiently to give passage to the vein, of which it surrounds about three-fourths, sometimes more, and sometimes the whole.

This passage answers to the interstice between the lobulus and the rest of the great lobe; and its direction is, in the natural state, from below upwards, and a little from left to right: but when the liver is viewed extra situm, and inverted, it appears very oblique; but still it serves as a guide to beginners, who are very apt to be mistaken in examining an inverted liver.

The trunk of the great vena portæ, the hepatic arteries, the ductus hepaticus, or trunk of the pori bilarii, and the nerves of the plexus hepaticus, form all together a large bundle before they enter the liver. The trunk of the hepatic vena portæ is in the middle of this bundle; the hepatic arteries lie on the right and left sides of this trunk, the nerves surround it on all sides, and they communicate with the plexus mesentericus superior.

Afterwards the first branches of the arteries, nerves, and pori bilarii, leave the trunk of the great vein, and join in the same manner the trunk of the small or hepatic vena portæ, and its ramifications in the capsula Glissoni explained above.

All these branches of the vena portæ, and of the arteries, nerves, and pori bilarii, accompany each other by ramifications through the whole substance of the

liver, forming every where ſmall faſciculi, in the ſame manner as the large bundles formed by their trunks. Each ramus of the vena portæ, artery, nerve, and porus bilarius, has a proper vagina, and all the four have a common vagina diſtinguiſhed from the former cellular ſepta, which are only continuations of the vaginæ of both kinds.

The convex ſide of the common cellular vagina is connected quite round to the ſubſtance of the liver by numerous filaments which ariſe from it, and which form the cellular ſubſtance found between the glandular corpuſcles. The concave ſide produces the cellular ſepta above-mentioned.

In this common vagina, the veſſels, ducts, and nerves, are diſpoſed in ſuch a manner, as that the rami of the vena portæ chiefly fill the cavity of it, and lie in a lateral ſituation: the arterial ramus and porus bilarius lie together on the ſide of the vein, and the nerve is divided into ſeveral filaments, which run in between the veſſels and ducts, and chiefly accompany the artery and porus bilarius; the vena portæ having by much the feweſt.

The uſes of the liver ſhall be explained after the deſcription of the pancreas, ſpleen, and omentum, all theſe viſcera having a great relation to the liver.

§ 14. *Pancreas.*

Figure, diviſion, and ſituation, of the pancreas. The pancreas is a long flat gland, of that kind which anatomiſts call *conglomerate*, ſituated under the ſtomach, between the liver and the ſpleen. Its figure reſembles that of a dog's tongue; and it is divided into two ſides, one ſuperior, the other inferior; two edges, one anterior, the other poſterior; and two extremities, one large, which repreſents the baſis of a tongue, and one ſmall and a little rounded like the point of a tongue.

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The pancreas is ſituated tranſverſely under the ſtomach, in the duplicature of the poſterior portion of the meſocolon. The large extremity is connected to the firſt incurvation of the duodenum, and from thence it paſſes before the reſt of that inteſtine all the way to its laſt incurvation; ſo that a great part of the duodenum lies between the pancreas and the vertebræ of the back. The ſmall extremity is fixed to the omentum near the ſpleen.

Structure of the pancreas. The pancreas is compoſed of a great number of ſoft glandular moleculæ, combined in ſuch a manner, as to exhibit the appearance of one uniform maſs on the outſide, the ſurface of which is rendered uneven, only by numerous ſmall convexities, more or leſs flatted. When theſe moleculæ are ſeparated a little from each other, we find, along the middle of the breadth of the pancreas, a particular duct, in which ſeveral ſmaller ducts terminate laterally on each ſide, like ſmall rami in a ſtem.

This canal, named *ductus pancreaticus* or *ductus Virſungi*, from the diſcoverer of it in the human body, is very thin, white, and almoſt tranſparent, and the extremity of the trunk opens commonly into the extremity of the ductus cholidochus. From thence it diminiſhes gradually, and terminates in a point, next the ſpleen. The ſmall lateral branches are likewiſe pretty large near the trunk, and very ſmall toward the edges of the pancreas, all of them lying in the ſame plane like the branches of the common filix or fern.

The pancreatic duct is ſometimes double in man, one lying above the other. It is not always of an equal length, and ſometimes runs in a winding courſe, but always in the ſame plane; and it is nearer the lower than the upper ſide of the pancreas. It pierces the coats of the duodenum, and opens into the ductus cholidochus, commonly a little above the prominent point of the orifice of that canal; and ſometimes it opens immediately into the duodenum.

The ſmall pancreas. In man, Winſlow obſerved, that where the great extremity of the pancreas is connected to the curvature of the duodenum, it ſends down an elongation, which adheres very cloſely to the following portion of the inteſtine; and, upon a careful examination, he found a particular pancreatic duct ramified like the large one, which ran toward and interſected this great duct, into the extremity of which it opened, after having perforated the duodenum. This portion he termed *pancreas minus.* It ſometimes opens ſeparately into the duodenum, in which we likewiſe obſerve ſeveral ſmall holes round the ductus cholidochus, which anſwer to the pancreas.

Blood-veſſels and nerves of the pancreas. The arteries of the pancreas come from the pylorica, duodenalis, and chiefly from the ſplenica, which adheres very cloſely to the whole lower ſide of the pancreas near the poſterior edge, and it ſends off in its paſſage a great many rami named *arteriæ pancreaticæ*, which go off from each ſide, more or leſs tranſverſely. It receives alſo ſome ſmall ramifications from the gaſtrica major and meſenterica ſuperior.

The pancreatic veins are rami of the ſplenica, one of the principal branches of the vena portæ major or ventralis. This vena ſplenica runs likewiſe along the lower ſide of the pancreas near the edge, in a ſhallow depreſſion formed in the ſubſtance of the gland. Theſe veins anſwer to the arteries of the ſame name; and there are likewiſe other ſmall veins correſponding to the ſmall arteries, which are productions of the great meſeraica, &c.

The nerves of the pancreas come partly from the plexus hepaticus, partly from the plexus ſplenicus, and partly from the plexus meſentericus ſuperior, and it likewiſe receives ſome from the flat ganglion or plexiform intertexture, mentioned in the deſcription of the nerves, by the name of the *tranſverſe rope.*

The pancreatic duct is not only double in ſome ſubjects,

jects, as has been said, but the collateral branches have communications in form of islands in several places, within the body of the pancreas.

The pancreatic juice, which is watery, insipid, thin, neither acid nor alkaline, is poured into the same place into which the bile discharges itself. The quantity of juice secreted by the pancreas is uncertain; but it must be very considerable, if we compare the bulk or weight of it with that of the salival glands; than which it is three times larger, and seated in a warmer place. It is expelled by the force of the circulating blood, with an alternate pressure from the incumbent and surrounding viscera; as the liver, stomach, spleen, mesenteric and splenic arteries, with the aorta. The great usefulness of this gland may appear from its being found not only in man, but almost in all animals: nor is its use the less from that experiment which shows a great part of it may be cut out from a robust animal without occasioning death; because, in the experiment, a part of the pancreas must be left with the duodenum. Its effervescence with the bile arises from the effect of a ligature, and air mixed with the intestinal humour.

The pancreatic juice seems principally of use to dilute the viscid cystic juice, to mitigate its acrimony, and mix it with the food. Hence it is poured into a place remote from the cystic duct as often as there is no cystis. Like the rest of the intestinal humours, this juice dilutes the mass of aliments, resolves them, and does every other office of the saliva.

§ 15. *Lien.*

Situation, division, and figure of the spleen. THE spleen is a bluish mass, something inclined to red, and of a long oval figure, being about seven or eight fingers breadth in length, and four or five in breadth. It is of a softish substance, and is situated in the left hypochondrium, between the great extremity of the sto-

mach, and the neighbouring falſe ribs, under the edge of the diaphragm, and above the left kidney.

It may be naturally divided into ſides, edges, and extremities. It has two ſides, one external and gently convex, and one internal which is irregularly concave; two extremities, one poſterior which is pretty large, and one anterior which is ſmaller and more depreſſed; two edges, one ſuperior, and one inferior, on both which there are, in ſome ſubjects, ſeveral inequalities.

The inner or concave ſide is divided by a longitudinal groove or ſciſſure, into two planes or half ſides, one upper, the other lower; and, by this groove, the veſſels and nerves enter in human ſubjects. The ſuperior half ſide is broader and more concave than the inferior, being proportioned to the convexity of the great extremity of the ſtomach. The inferior half ſide lies backward on the left kidney, and forward on the colon; and ſometimes this ſide of the ſpleen appears to have two ſuperficial cavities, one anſwering to the convexity of the ſtomach, the other to that of the colon. The convex ſide of the ſpleen is turned to the left ribs.

It is connected to the ſtomach by the veſſels called *vaſa brevia*; to the extremity of the pancreas, by ramifications of the ſplenic artery and vein; and to the omentum, by ramifications which the ſame artery and vein ſend to the ſpleen, and which run in the longitudinal groove.

It is connected to the edge of the diaphragm by a particular membranous ligament of different breadths in different ſubjects, fixed in its convex ſide, ſometimes near the upper edge, and ſometimes near the lower. This ligament is ſituated tranſverſely with reſpect to the whole body, and longitudinally with reſpect to the ſize of the ſpleen. In ſome ſubjects, it is connected by other ligaments to the ſtomach and colon; but in all this there are conſiderable varieties.

The figure of the ſpleen is not always regular, and is as various as the ſize. Sometimes it has conſider-

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able ſciſſures both in the ſides and edges, and ſometimes it has appendices. I have ſometimes found a kind of ſmall diſtinct ſpleens, more or leſs round, and connected ſeparately to the omentum, at ſome diſtance from the anterior extremity of the ordinary ſpleen.

Structure of the ſpleen. The ſtructure of the ſpleen is not eaſy to be unfolded in man; and it is very different from that of the ſpleens of brutes.

Its coverings adhere to it ſo cloſely in man, that it is difficult to diſtinguiſh the common from the proper coat; whereas in ſome brutes, ſuch as oxen, ſheep, &c. nothing is more eaſy; for in ſuch animals we find two coats ſeparated by a cellular ſubſtance. This covering ſeems to be no otherwiſe a continuation of the peritonæum than by the intervention of the omentum and meſocolon; and even in man the two coats may be diſtinguiſhed, where the veſſels enter by the longitudinal ſciſſure.

In man, the ſubſtance of the ſpleen is almoſt wholly vaſcular, that is, compoſed of the ramifications of all kinds of veſſels. In oxen, the ſubſtance of the ſpleen is chiefly reticular, and in ſheep it is cellular. In oxen and ſheep, there are no venal ramifications; but inſtead thereof, only open ſinuſes diſpoſed like branches, except a ſmall portion of a venal trunk perforated on all ſides, at the extremity of the ſpleen.

Structure and uſe of the ſpleen. The ſpleen is one of thoſe viſcera which ſend their blood to the liver. The ſituation of it varies with that of the ſtomach itſelf, which it follows. When that is empty, the ſpleen is raiſed perpendicularly, ſo as to place its extremities right up and down: but when the ſtomach is full, the middle curve or arch of it ariſes upward and forward; and at the ſame time obliges the ſpleen to change its ſituation, ſo as to lie almoſt tranſverſely with its lower end forward, and its upper end backward. Thus, being of a very ſoft and looſe texture, it grows larger by diſtenſion when the ſtomach is empty, and becomes

leſs

leſs again when its blood is preſſed out by the diſtenſion of the full ſtomach againſt the ribs. From hence the ſpleen is found large in thoſe who die of lingering diſeaſes; but in thoſe who die ſuddenly, and in full health of body, it is ſmall. Another motion of the ſpleen is, that of deſcending with the diaphragm in inſpiration, and aſcending again in exſpiration; and beſides this, the ſpleen frequently varies in its ſituation with that of the colon. Frequently there is a ſecond or leſs ſpleen placed upon the former.

The *blood-veſſels* of the ſpleen are large, in proportion to its weight. The arterial trunk comes from the cœliac; the upper branch of which, proceeding in a ſerpentine courſe above and behind the pancreas, to which it gives branches, as well as to the meſocolon, ſtomach, and omentum, is at length incurvated in the direction of the ſulcus or notch of the ſpleen, which it, after a manner, perforates by ſeveral diſtinct branches, ſuſtained at the right extremity by the omentum gaſtrocolicum. The thickneſs of this artery is greater than that of the aorta. The ſplenic vein, which accompanies the artery, is conſiderably ſofter than any other veins of the body; it forms the principal left branch of the vena portarum. Beſides theſe, the ſpleen receives ſmall arteries from the great coronary deſcending behind the pancreas, and ſometimes from the internal hæmorrhoidal. The vaſa brevia of the ſpleen and ſtomach we have mentioned elſewhere; and its ligaments and membranes receive ſmall arterial twigs from the lumbar arteries, phrenics, intercoſtals, and thoſe of the renal capſules. In like manner alſo the veins in the ſpleen, and thoſe which join it to the ſtomach, communicate with the phrenics, and with the veins of the renal capſules.

The *lymphatic veſſels* of the ſpleen ariſe in the duplicature of the ſplenic coat or membrane, and from thence proceed on to the receptacles of the chyle, very evident in a calf; in mankind they are rendered conſpicuous

ſpicuous by blowing air under the membrane, by maceration, or water injected into the arteries.

The *nerves* of the ſpleen are very ſmall; from whence it is capable of but little pain, and is very rarely inflamed. They ariſe from a particular plexus, compoſed out of the poſterior branches of the eighth pair at the ſtomach, and of certain branches from the large gangliform plexus, which produces the ſplenic trunk of the intercoſtal nerve, from whence the branches ſurround the artery into the ſpleen.

The fabric of the ſpleen appears to be much more ſimple than has been commonly believed. For it is compoſed, both in us and in calves, altogether of arteries and of veins; the former of which, after ſpending themſelves in a great number of ſmall branches, are at length thickly ſubdivided into very ſoft bruſh-like bunches, very difficult to fill with injection, terminating in circles; by which there is a ready paſſage for liquors into the correſponding veins. Theſe circles, with their parallel branches, form a ſort of bunches like a pencil bruſh, but of a ſhorter rounder kind; whence many have miſtaken them for glands. Nor does the injection, rightly managed, ever eſcape from the veſſels into the intervals; nor were any hollow glandules ever diſcovered by certain obſervation. Every little arterial trunk, with the ſmaller twigs that proceed from it, are each of them ſurrounded by a very fine cellular ſubſtance or web work, in the ſame manner with the ſmall veſſels of all the other viſcera, but here rather ſofter. The whole body of the ſpleen is outwardly ſurrounded by a ſingle membrane, which is not very tough, continued from the peritonæum, and joined to the fleſhy part of the ſpleen by a pretty thick cellular texture.

Hence we obſerve, that the ſpleen contains more blood in proportion than the other viſcera; ſince it has no muſcles, fat, air-veſſels, or excretory ducts, interpoſed betwixt its blood-veſſels. We learn alſo from obſervation, that the blood of this part hardly ever congeals,

congeals, from the abundance of its volatile or bilious ſalts: but it looks of a dark-brown colour, and may be eaſily diluted; whence one may compare it almoſt to the blood of a fœtus.

The want of an excretory duct to the ſpleen, has occaſioned the uſe of it to be doubtful, and controverted throughout all ages of anatomy. To us the fabric itſelf ſeems to lead to the following uſes; although, perhaps, they do not comprehend all the uſes of the ſpleen. A great quantity of blood is imported to the ſpleen, and with a ſlower motion, from the ſerpentine courſe and hardneſs of the artery: but, at the time when the ſtomach is empty, this blood comes, and is received in a greater quantity by the ſpleen, not now ſo much compreſſed, therein to ſtagnate, as it would ſeem plainly from the great proportion of branches to the trunks in this part; to which add, the difficult courſe or ſlow circulation which the blood meets with in paſſing from the ſpleen through the liver: from hence the frequent ſcirrhoſities of the ſpleen; and from hence the immenſe quantity of blood with which the ſpleen is in every point diſtended, the like of which we do not ſee in any other part. Here, then, the almoſt ſtagnant blood, fomented with heat, attenuated, and in a manner diſſolved by the putrid feces of the adjacent colon, enters thus upon the firſt ſteps of a begun putrefaction, as we learn by experiments, both from its colour and conſiſtence. But the greater fluidity of the blood herein proceeds not only from this diſſolution, but becauſe all its watery juices that enter by the artery return alſo again by the vein; for there are no ſecretory ducts in the ſpleen.

Moreover, when the ſtomach is full of food or flatus, the ſpleen is thereby compreſſed into a narrower compaſs, againſt the ribs and ſuperincumbent diaphragm; by which means the blood, that before was ſcarce able to creep along through the ſplenic veins, being now preſſed out more plentifully, returns with a greater

greater celerity towards the liver; till mixing with the ſluggiſh blood in the trunk of the porta, repleniſhed with the fat or oil of the omentum and meſentery, it dilutes or thins the ſame, and renders it leſs apt to ſtagnate or congeal; and at the ſame time it conduces to form a larger ſecretion of bile at a time when it is moſt wanted, viz. to flow plentifully to the food now under digeſtion. The ſpleen, therefore, ſeems to prepare the blood, that it may ſupply a ſort of watery juice to the bile; but ſuch as is probably of a ſubalkaline nature, and rendered ſomewhat ſharp by the remora of the blood.

Whether is the ſpleen of a cellular fabric? Is the blood poured out into thoſe cells ſo as to ſtagnate? or is it diluted with ſome juice ſecreted by peculiar glands? We ſee nothing of this is demonſtrable by anatomy; nor does the liquor or wax injected ever extravaſate into the cellular ſubſtance, unleſs urged with much greater violence than nature ever uſes or intended. As to the old queſtion, Whether the ſpleen brews up an acid to whet or ſharpen the ſtomach? that opinion has been long diſcarded, as repugnant to the nature of all the animal juices. If it be aſked, Whether the ſpleen be not an uſeleſs maſs, as it might ſeem to be from the little damage an animal ſuſtains after it has been cut out? we anſwer, That a robuſt animal, ſuffering but little injury from the loſs of a part, does not prove it to be uſeleſs; and yet there are examples, after ſuch an experiment has been made, that the liver becomes ſwelled and diſordered, makes a leſs quantity of bile, and of a darker brown colour; while the animal is perpetually troubled with flatulencies, gripes, or indigeſtion: all which are to be aſcribed to the vitiated nature of the bile, an obſtruction of the liver, and an imperfect or weak digeſtion; at the ſame time they are confirmed by repeated experiments.

§ 16. *Omentum*

§ 16. *Omentum and Appendices Epiploicæ.*

Situation, diviſion, and connection of the omentum. The omentum is a large, thin, and fine membranous bag, ſurrounded on all ſides by numerous portions of fat, which accompany and even inveſt the ſame number of arteries and veins adhering cloſely to each other.

The greateſt part of it reſembles a kind of flat purſe, or a ſportman's empty pouch; and is ſpread more or leſs on all the ſmall inteſtines from the ſtomach to the lower part of the regio umbilicalis. Sometimes it goes down to the lower part of the hypogaſtrium, and ſometimes does not reach beyond the regio-epigaſtrica. It is commonly plaited or folded in ſeveral places, eſpecially between the bands of fat.

It is divided into a ſuperior and inferior, an anterior and poſterior, and a right and left portion. The ſuperior portion is in a manner divided into two borders, one of which is fixed along the great curvature or convex ſide of the arch of the colon, and the other along the great curvature of the ſtomach. The commiſſure or union of theſe two borders on the right ſide, is fixed to the common ligament or adheſion of the duodenum and colon, and to the contiguous parts of theſe two inteſtines. That on the left ſide is fixed to the longitudinal ſciſſure of the ſpleen, to the extremity of the pancreas, and to the convex ſide of the great extremity of the ſtomach. It is likewiſe fixed to the membranous ligament which ſuſtains the ductus cholidochus, and connects it to the vena portæ ventralis.

Below theſe adheſions, the other portions, that is, the anterior, poſterior, two lateral and inferior portions, which laſt is the bottom of the ſacculus epiploicus, have commonly no fixed connections, but lie looſe between the fore-ſide of the cavity of the abdomen and the inteſtines. The anterior and poſterior portions are generally called the *laminæ* of the omentum; but as that term is

ordinarily employed to expreſs the duplicature of ſome compound membrane, it would be more convenient to call them *folia*, *alæ*, or ſome ſuch name.

Structure of the omentum. The membrane of the omentum is, through its whole extent, made up of two extremely thin laminæ joined by a cellular ſubſtance; the quantity of which is very conſiderable along the blood-veſſels, which it every where accompanies in broad bands proportioned to the branches and ramification of theſe veſſels. Theſe cellular bands are more or leſs filled with fat, according to the corpulency of the ſubject; and for that reaſon I have called them *bands* or *portions of fat*.

Little omentum. Beſides this large membranous bag, which I name the *great omentum*, there is another much ſmaller, which differs from the large one, not only in ſize, but alſo in figure, ſituation, and connection; and this I name the *little omentum*. This ſmall bag is fixed by its whole circumference, partly to the ſmall curvature of the ſtomach, and partly to the concave ſide of the liver before the ſinus of the vena portæ, ſo as to ſurround and contain the prominent portion of the lobulus.

The little omentum is thinner and more tranſparent than the other, and its cavity diminiſhes gradually from the circumference to the bottom, which in ſome ſubjects terminates in ſeveral ſmall cavities or foſſulæ more or leſs pointed. Its ſtructure is pretty much the ſame with that of the great omentum, it being compoſed of two laminæ, with a mixture of the ſame portions of fat, which are conſiderably finer than in the other.

We ſee from this ſituation of the two omenta, that in the ſpace left between the lower ſide of the ſtomach and upper ſide of the meſocolon, they have a very broad communication with each other; ſo that if either of them contained in its cavity any fluid, that fluid might readily get between the ſtomach and meſocolon, and ſo paſs into the other bag; eſpecially when the ſtomach

ſtomach is empty, and conſequently its ſituation eaſily changed.

Therefore, by means of this interſtice between the ſtomach and meſocolon, the two omenta form one cavity, which opens into the cavity of the abdomen by one common orifice, ſituated near the commiſſure on the right ſide of the great omentum. This orifice is ſemilunar or ſemicircular, and formed by the union of two membranous ligaments, whereof one connects the beginning of the duodenum and neck of the veſicula felis to the liver; the other connects the contiguous portion of the colon to the ſame viſcus, and extends to the pancreas. From thence ariſes an incurvated border, which ſurrounds the root of the lobulus, leaving an opening wide enough to admit the end of the finger.

To diſcover this orifice of the omentum, we need only raiſe a little the great lobe of the liver, and find out the root of the lobulus, and apply to it a large pipe wrapped round with cotton, wool, or tow, to hinder the regreſs of the air. Then if we blow gradually, the air will inflate the ſides of the great omentum, and give it the appearance of a large bladder irregularly divided into ſeveral lobes or tubercles by the bands of fat, which appear in this ſtate like ſo many fræna between the lobes.

To be ſure of ſucceeding in this experiment, the two omenta muſt be in their natural ſtate, and they muſt be handled very gently with the fingers firſt dipped in oil. It ſucceeds better in young, lean ſubjects, than in old or fat ſubjects,

When we touch theſe membranes with dry fingers, they ſtick to them ſo cloſely as hardly to be ſeparated without being torn, as we ſee by the reticular holes which appear in thoſe portions of membranes that have been thus handled. In that caſe it is to no purpoſe to blow through the natural orifice already mentioned; and it is owing to theſe ſmall holes that the

membranes of the omentum have been ſuppoſed to be naturally reticular.

The membranous laminæ of the little omentum are continuous partly with the external membrane of the liver, partly with that of the ſtomach, and a little with the membrane that lines the neighbouring portion of the diaphragm. Thoſe of the great omentum are continued partly with the ſame coat of the ſtomach, and partly with the external covering of the colon, and conſequently with the meſocolon; and they likewiſe communicate with the covering of the ſpleen.

We may ſatisfy ourſelves concerning theſe continuations, by making a ſmall hole in one of the laminæ of the omentum near the ſtomach, colon, &c. and by blowing into that hole, through a pipe well fitted to it; for the air will gradually inſinuate itſelf under the common coats of theſe viſcera; but if the parts be dry, they muſt be moiſtened a little before the experiment is made.

Appendices epiploicæ. The fatty appendices of the colon and rectum are conſidered by Winſlow as a kind of ſmall omenta or appendices epiploicæ. They are ſituated at different diſtances along theſe inteſtines, being particular elongations of their common or external coat. They are of the ſame ſtructure with the great omenta; and there is a cellular ſubſtance contained in their duplicature, more or leſs filled with fat, according as the ſubject is fat or lean.

Next the inteſtine, each of them forms a broad, thin baſis; and they terminate by irregular papillæ, thicker than their baſes. Theſe baſes are at firſt diſpoſed longitudinally; then obliquely; and laſtly, more or leſs tranſverſely, eſpecially near the rectum, and upon that inteſtine.

Theſe appendices are for the moſt part ſeparated from each other; but ſome of them which have longitudinal baſes communicate together, the veſtiges of theſe communications being very narrow, and not very

prominent. By blowing through a ſmall hole made in one of theſe appendices, it is inflated like a ſmall irregular bladder, and the air paſſes under the external coat of the colon or rectum.

Beſides theſe appendices epiploicæ, we obſerve at different diſtances along the colon, between the ligamentary band, which lies hid, and one of the other two, that is, on both ſides of the adheſion of the meſocolon, ſeveral adipoſe ſtrata, which may likewiſe be looked upon as appendices of the ſame nature with the former; but theſe ſtrata are very ſeldom obſerved between the two apparent ligamentary bands of the colon.

Veſſels of the omentum. The arteries and veins of the great omentum are branches of the gaſtricæ, and for that reaſon go by the name of *gaſtro epiploicæ dextræ* and *ſiniſtræ*. The arteries on the right ſide anſwer to the hepatic artery, and thoſe on the left ſide to the ſplenic; and both communicate with the arteria ventriculi coronaria, and reſpectively with the arteriæ meſentericæ. The gaſtro-epiploic veins anſwer in the ſame manner of diſtribution to the vena portæ.

The veſſels of the little omentum come chiefly from the coronariæ ventriculi, and thoſe of the appendices and ſtrata are ramifications from the reticular texture of the arteriæ and veins of the colon and rectum.

§ 17. *Secretion of the Bile.*

THE *liver*, being the largeſt of all the viſcera, fills up a very large part of the abdomen in its upper chamber, above the meſocolon; and is ſtill larger in proportion in the fœtus. It is ſurrounded on all ſides by the neighbouring viſcera, and fixed by ligaments in ſuch a way that it is ſuſpended in the body, with a conſiderable degree of firmneſs; yet ſo as to be allowed a conſiderable liberty to move and be variouſly agitated, raiſed and depreſſed, by the actions of the diaphragm.

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This large viſcus is proportionably ſupplied with veſſels, and of various kinds. For, beſides the arteries, it has the vena portarum, which receives all the blood of the ſtomach, of the inteſtines and meſentery, of the ſpleen, omentum, and laſtly, of the pancreas, at firſt into two trunks; the tranſverſe ſplenic and aſcending meſenteric; then into one, which is continued with the meſenterics. This is large, compoſed of ſtrong membranes, and ſurrounded with a good deal of cellular ſubſtance, derived to it from the meſentery and ſpleen, denſe, ſhort, and adding ſtrength to the membranes; thoſe with which it is furniſhed being harder than the aorta itſelf. Intermixed with this cellular ſubſtance, are alſo many of the ſmaller veſſels and hepatic nerves, which all come together under the denomination of a *capſula*. By this the vena portarum is conducted to the liver, and firmly ſuſtained; inſomuch, that the branches, being cut, maintain the round lights of their ſections. But each branch of this veſſel is divided into many others, again divided and ſubdivided, after the manner of arteries, till they at length produce the ſmalleſt capillaries. In this courſe every branch of the vena portarum is accompanied with a ſocial branch of the hepatic artery, creeping upon the ſurface of the vein, and the contiguous hepatic ducts, almoſt in the ſame manner as the bronchial arteries uſually creep along the ramifications of the windpipe in the lungs; while, in the mean time, both the artery and the vein are connected to the branches of the biliary ducts by a thin cellular ſubſtance like a ſpider's web. Some go out of the liver, being divided to the ligaments, and inoſculating with the ſurrounding veins. And the ſum of the branches in the vena portarum is always greater than the trunk; whence the lights of all the branches together greatly exceed that of the trunk: from whence follows a great friction or reſiſtance, after the ſame manner as we obſerve in the arteries.

But, since the blood is in this manner conveyed through the liver to the branches of the vena portarum, together with the hepatic artery, it must of course be conveyed back again by some other veins: and, therefore, the extreme branches of the vena portarum and hepatic artery inosculate ultimately into other veins, which are *branches of the cava;* which arising from the whole circumference of the liver, run together towards the posterior gibbous part of the liver into branches and trunks, which at last go off into ten or more large vessels. The lesser of these trunks, and greater number of them, pass out through the posterior lobule of the liver, and go to the cava through the sulcus, that lies on the right side of the lobule, often completed into a circle by a sort of bridge or production of the liver; from whence they ascend together through the diaphragm towards the left side. Two or three trunks, much larger than the former, are inserted into the same cava, close to the diaphragm, whose veins they often take in by the way. The branches of the vena cava are, in the adult, generally fewer and less than those of the vena portarum; which is an argument that the blood moves quicker, because of the less friction, and of the very collection of the blood into a less light or capacity, by which it is always accelerated when there is a sufficient compressing force. As to any valves at the openings of these branches into the cava, there are none which deserve to be regarded. The trunk of the vena cava, passing through a foramen of the diaphragm, obtusely quadrangular, surrounded and terminated by mere tendons, is thereby rendered not easily changeable: and having surmounted this opening of the diaphragm, it then immediately expands into the right auricle. The smaller veins of the liver creeping about its surface, are sent into the phrenics, renals, and azygos; or at least there is certainly a communication betwixt these and the hepatic veins coming from the portæ.

That

That the blood comes from all parts by the vena portarum to the portæ, is proved by a ligature, by which any vein betwixt theſe parts and the ligature ſwells; but the porta itſelf, above the ligature, grows flaccid and empty. But that it afterwards goes thro' the liver to the cava, appears by anatomical injections, which ſhow open and free anaſtomoſes or communications betwixt the vena portarum and the cava, together with the common nature of the veins going to the cava. Again, the difficult diſtribution or paſſage thro' the vena portarum, like to that of an artery, together with its remoteneſs from the heart, and the oily or ſluggiſh nature of the blood itſelf, occaſion it to ſtagnate, accumulate, and form ſcirrhous ſwellings in no part oftener than the liver. But this danger is diminiſhed by the motion of the adjacent muſcles, and by the reſpiration; as it is increaſed by inactivity, with ſour and viſcid aliments. But, hitherto, we have been ſpeaking of the adult liver, in which both the umbilical vein and the ductus venoſus are empty and cloſed up, although they continue to cohere with the left branch of the vena portarum.

The *nerves* of the liver are rather numerous than large; hence, when wounded or inflamed, it is capable of no very great pain.

The *lymphatic veſſels* of the liver are numerous, ariſing from all ſides, and paſſing into the thoracic duct.

The interior fabric of the liver is more obſcure. Through the whole ſubſtance of the liver go bundles of biliary veſſels, of branches of the vena portarum, and of the hepatic artery. Each veſſel has both its proper cellular texture ſurrounding it, and ſimilar ligaments, by which it is tied to its fellow veſſels; and, laſtly, the whole bundle has its cellular texture placed round it. The branches of the vena cava lie on the outſide of the reſt, being leſs accurately received into the ſame bundle. Laſtly, the ultimate ſmall branches of the vena portarum, cava, and hepatic artery, toge-

ther with the bilious ducts, are united together by means of the cellular substance, into a sort of mulberry-like bunches, of an hexagonal shape, surrounded with a lax cellular texture. In these bunches, likewise, there are mutual anastomoses betwixt the portal branches and hepatic artery, with the roots of the vena cava on one side, and the first organs of the pori biliarii of the liver on the other side; which last demonstrate their inosculations by anatomical injections; for liquors injected by the vena portarum return again through the porus cholidochus.

Many eminent anatomists have taught, that the forementioned bunches are hollow, having arteries and veins spread upon their external surface, and deposite the bile into their cavity, after it has been secreted from the branches of the vena portarum. For this they allege arguments taken from the comparative anatomy of brutes, whose liver is made up of more round and definite bunches; and from those diseases which demonstrate cells and round tubercles, filled with lymph, chalk, and various kinds of concreted matter. To this they might have added the thick sluggish nature of the bile itself, by which it is related to mucus, and the analogy of the follicles of the gall-bladder.

But greater accuracy in anatomy will not allow any follicles into which the small secretory vessels open; for such would intercept the course of anatomical injections, and give us the appearance of knots, intermediate betwixt the secretory vessels and the biliary pores, which we have never yet been able to see: for the wax flows immediately, without any interruption or effusion, into a cavity in a continued thread from the vena portarum into the biliary ducts. But, again, a follicular or glandular fabric is not allowable in the liver, from the great length of the biliary ducts. For all follicles deposite their contents into some space immediately adjacent; and are unfit to convey their secerned fluid to

any

any length of courſe, as they deſtroy ſo great a part of the velocity received from the arteries. Laſtly, the very common preſſure which we muſt ſuppoſe to be on theſe bunches of kernels, would ſo cruſh them, that no aſſiſtance could from thence be brought to promote the motion of the excretory ducts. Concretions and hydatids are formed in the cellular ſubſtance; and, laſtly, the bile, when firſt ſecreted, is ſufficiently fluid.

Haller is perſuaded that no bile is ſeparated from the hepatic artery; becauſe the peculiar ſtructure of the vena portarum would be uſeleſs if it ſecreted nothing. Its office in ſecretion appears plainly by the continuations of its branches with the biliary ducts, in a manner more evident than that of the artery: but it appears by experiments, alſo, that the biliary ſecretion continues to be carried on after the hepatic artery is tied; add to this the largeneſs of the biliary ducts, in proportion to ſo ſmall an artery, with the peculiar nature of the blood collected in the vena portarum, ſo extremely well fitted for the formation of the bile. But in the blood of the hepatic artery, ſays Haller, we can find nothing peculiarly fit for the ſecretion of bile, or analogous to its nature.

Since, therefore, the vena portarum conveys the blood ready charged with biliary matter, fit to be ſecreted in the leaſt acini, and from thence there is an open free paſſage, without any intermediate follicles, from the ultimate branches of the vena portarum into the beginning roots of the biliary ducts, and that the humours driven into the vena portarum may eaſily chooſe this paſſage, the bile will be expelled from thence by the force of the blood urging behind, as well as by the auxiliary force of the diaphragm preſſing the liver againſt the reſt of the viſcera in the abdomen when very full; and again, contracted in exſpiration, it will be forced into the larger branches, and laſtly into two trunks of the larger biliary duct of the liver; which trunks meet together in one upon the vena portarum,

in the tranſverſe foſſa of the liver, near the anonymous lobule.

The fabric of this duct is made up like that of the inteſtines. But there is here no muſcular fabric apparent. From experiments it appears to be endowed with a moderate degree of irritability. That it is vaſtly dilatable, is ſhown from diſeaſes. The ſame ſeem alſo to ſhow that this duct is endowed with a very ſharp ſenſation.

The hepatic duct, thus formed, goes on upon the vena portarum, more to the right than the artery, towards the pancreas; and then deſcending obliquely, covered by ſome part of that gland, it goes to the lower part of the ſecond flexure of the duodenum, and is inſerted backward about four or five inches from the pylorus, through an oblique oblong ſinus made by the pancreatic duct, into which it opens by a narrow orifice. The ſaid ſinus runs a great way through the ſecond cellular coat of the duodenum obliquely downward; then it perforates the nervous coat, and goes on again obliquely betwixt it and the villous tunic; and, laſtly, it opens into a protuberant long wrinkle of the duodenum. Thus there is almoſt the length of an inch taken up betwixt the firſt inſertion and the egreſs of this duct through the coats of the duodenum, by a ſinus which ſurrounds and receives the ductus cholidochus, in ſuch a manner, that when the coats of this inteſtine are diſtended by flatus, or cloſely contracted by a more violent periſtaltic motion, the opening of the duct muſt be conſequently compreſſed or ſhut; but when the duodenum is relaxed and moderately empty, the bile then has a free exit. Any regurgitation from the duodenum is hindered by this obliquity and wrinkling of the duct, eaſily preſſed together, or cloſed and joined with a quick ſucceſſion of freſh bile deſcending perpendicularly from the liver. Nor does wind inflated into the inteſtine find any paſſage into the duct.

But, in the portæ themſelves, this common duct receives

ceives another leſs canal of the ſame kind, which lies for a good way parallel with itſelf from the gall-bladder, making its inſertion in a very acute angle; and this, which is called the cyſtic duct, from its origin, is ſometimes firſt increaſed by another ſmall duct from the hepatic before its common inſertion. This duct is formed by the gall-bladder as a peculiar receptacle for the bile given to moſt animals; but is abſent in ſome, eſpecially thoſe of a ſwifter foot, and perhaps only in ſuch of theſe as are herbivorous: it is placed in an excavation of the right lobe of the liver, to the right ſide of the anonymous lobule, in ſuch a manner, that in infants or children it lies wholly within the edge of the liver, but in adults projects conſiderably beyond, lying upon the inteſtinum colon. Its ſituation is almoſt tranſverſe from the fore to the back parts; its neck aſcends a little upwards.

The figure of the gall-bladder is variable, but in general like that of a pear, terminated in its fore-part by an obtuſe hemiſpherical end, which is impervious, gradually diminiſhing backward; the neck or tip of this truncated cone being inflected upwards againſt itſelf once or twice, and tied together by the cellular ſubſtance belonging to it, makes then another ſmall flexure upward, and begins the cyſtic duct; which from thence goes on towards the left ſide of the hepatic duct. Within this duct there are many protuberant wrinkles, formed by the numerous cellular bridles which tie them together: and theſe wrinkles, conjunctly in the dry gall-bladder, repreſent a kind of ſpiral valve; but being altogether ſoft and alternate in a living perſon, they do not ſtop, only leſſen the courſe of the bile, as we are aſſured from experiments, by preſſing the gall-bladder, and by inflations. Beſides, it is reticulated like the gall-bladder itſelf.

The coats of the gall-bladder are like thoſe of the inteſtines, only the ſecond coat has ſometimes ſplendent fibres, chiefly longitudinal; but ſome obliquely interfecting

ſecting each other in various directions; at other times it has none at all: ſo that we may doubt of its muſcular nature, eſpecially as the irritability of the gall-bladder is ſlow and obſcure. The inner coat differs from that in the inteſtine, in being reticulated and full of cells.

The generality of animals, between their gall-bladder and liver, or between the ducts coming from both, have, beſides, ſome peculiar openings in the gall-blader, into which ſome ducts originating from the liver, or the hepatic biliary duct, diſcharge their contents. In mankind theſe ducts have not been ſhown by any certain experiment; and the gall-bladder is eaſily looſed from the liver, without a drop of bile diſtilling either from it or from the liver. There is alſo a thin water in the bladder as often as the cyſtic duct is obſtructed.

The bile flows both out of the bladder and liver, according to its nature, as long as there is no impediment in its way; ſo that both ducts ſwell when that paſſage is obſtructed, and the cyſtic lies in a ſtraight line with the cholidochus. Nor is it credible that all the bile ſhould be diverted into the gall-bladder before it flows into the duodenum. There is not a perpetual obſtacle which hinders the afflux, and peculiarly reſiſts the hepatic bile, and admits the cyſtic; the paſſage into the ductus cholidochus is larger and ſtraighter, the ductus cyſticus much leſs than the hepatic, nor is that duct ſo well formed for receiving all the bile; the cholidochus being much larger than the cyſtic duct, cannot therefore be made only for the reception of its bile. There are many animals in which the hepatic duct diſcharges its contents into the inteſtine without any communication with the cyſtic. In living animals, even when the cyſtic duct is free, the bile appears to deſcend into the duodenum with a perpetual current. That the quantity is very conſiderable, appears from the magnitude of the ſecretory organ, and the excretory duct, ſo many times larger than the ſalival ones; from

from diſeaſes, in which four ounces of the cyſtic bile only have flowed out duly through an ulcer of the ſide. But the hepatic bile goes into the bladder, as often as there is any obſtruction in the duodenal ſinus, from flatus or any other cauſe compreſſing the exit of the ductus cholidochus. Accordingly, we find it extremely full, whenever the common biliary duct is obſtructed or compreſſed by ſome ſcirrhous tumor, whence the gall-bladder is ſometimes enlarged beyond all belief; and if the cyſtic duct be tied, it ſwells betwixt the ligature and hepatic duct; and in living animals, the hepatic bile viſibly diſtils into the wounded gall-bladder, even to the naked eye. The retrograde angle, or direction of this duct, is not repugnant to ſuch a courſe of the bile: for a very ſlight preſſure urges it from the liver into the gall-bladder; and even wind may be eaſily drove the ſame way, more eſpecially if the duodenum be firſt inflated. Nor does there ſeem to be any ſort of bile ſeparated by the gall-bladder itſelf. Whenever the cyſtic duct is obſtructed by a ſmall ſtone, or a ligature made upon it, we find nothing ſeparated into the gall-bladder more than the exhaling moiſture, and a ſmall quantity of inſipid mucus ſecreted from the follicles. In many animals, we meet with no appearance of any gall-bladder, when at the ſame time there is a plentiful flux of ſtrong well prepared and ſalutary bile diſcharged into their inteſtines. Again, it does not ſeem probable, that the cyſtic branch of the vena portarum can ſeparate bile into the gall-bladder; for that vein in itſelf is a mere reconductory veſſel: nor can any be ſeparated from the hepatic artery: for it muſt be vaſtly beyond probability, that ſuch a ſtrong bile as that of the gall-bladder ſhould be ſeparated from a milder blood than the more ſoft hepatic bile prepared from the blood which is moſt fit for that purpoſe.

Laſtly, the bile flows alſo from the gall-bladder to the liver, and at length returns into the blood when its

its paſſage into the inteſtines is totally intercepted, ſometimes alſo from a cauſe latent in the nerves. This paſſage or abſorption of the bile into the ſyſtem is pernicious, and is the occaſion of jaundice; which, when the offending ſtones or concretions are removed, is cured by the bile's free courſe into the duodenum being reſtored.

Therefore a portion of the hepatic bile being received into the gall-bladder, there ſtagnates, only a little ſhaken by reſpiration; and there, by degrees, exhales its thinner parts, which, as we ſee, filtrate thro' and largely penetrate the adjacent membranes. The remainder, as being a fluid of an oily ſubalkaline nature, digeſting in a warm place, grows ſharp, rancid, more thick, bitter, and of a higher colour: for this is all the difference betwixt the cyſtic and hepatic bile; which laſt we find weaker, leſs bitter, lighter coloured, and of a thinner conſiſtence, while it remains within its proper hepatic ducts. That this difference betwixt them proceeds only from ſtagnation, appears from ſuch animals as have only a larger porus hepaticus, inſtead of a gall-bladder; for here we find the bile, which ſtagnates in the larger hepatic pore, is conſiderably more bitter than that in the ſmaller pores of the liver; as for example, in the elephant. But the gall-bladder gives this particular advantage, that it receives the bile when the ſtomach, being empty, has no call for it, that afterwards it may be able to return it in greater plenty, when we principally want it for the digeſtion of the aliments now flowing in great quantity into the duodenum. This flow of the bile is quicker in proportion through the cyſtic duct, as the ſection of that duct is leſs than the ſection of the gall-bladder.

The gall-bladder, indeed, hardly touches the ſtomach, but the beginning of the deſcending duodenum. But when the ſtomach is extremely diſtended, and in a very full abdomen, it makes a conſiderable preſſure both upon the liver and duodenum; by which the gall-

bladder is urged, and its bile expreſſed. Thus the bile flows through a free paſſage from the gall-bladder into the common duct and the duodenum: and this it does more eaſily in perſons lying on their back; in which poſture the gall-bladder is inverted, with its bottom upward. Hence it is that the gall-bladder becomes ſo full and turgid after faſting. The expulſive force of the bile is but little more than that of the preſſure received from the ſtomach and diaphragm; for as to any muſcular force reſiding in the fibres of the proper membrane, which may be thought to contract the gall-bladder, it muſt be very weak and inconſiderable.

The hepatic bile is always bitter, but the cyſtic is more ſo; always viſcid; of a full yellow colour, with a tincture of green; miſcible, by triture, either with water, oil, or vinous ſpirits; coagulable by mineral acid liquors; diſſoluble by alkalies, eſpecially the volatile kinds; and extremely well adapted to diſſolve oily, reſinous, or gummy ſubſtances; quickly putrefying, and by putrefaction ſpontaneouſly degenerating to a muſk-like odour. Its chemical analyſis, and experiments of mixture with various ſubſtances, demonſtrate, that it contains a large portion of water, and a conſiderable quantity of inflammable oil, which, in ſtones of a gall-bladder, appears very evidently. The bile, therefore, is a natural ſoap; but of that ſort which is made from a volatile ſaline lixivium, mixed with oil; and has its water along with it. This, therefore, being intermixed with the aliment, reduced to a pulp, and ſlowly expreſſed from the ſtomach by the periſtaltic force of the duodenum and preſſure of the abdominal muſcles, incorporates them all together; and the acid or aceſcent qualities of the food are in ſome meaſure thus ſubdued, the curd of milk is again diſſolved by it into a liquid, and the whole maſs of aliment inclined more to a putrid alkaleſcent diſpoſition: it diſſolves the oily matters, ſo that they may freely incorporate with the watery parts, and make up an uniform maſs of chyle to enter

enter the lacteals; the ſurrounding mucous in the inteſtines is hereby abſterged and attenuated, and their periſtaltic motion is excited by its acrimony; all which offices are confirmed, by obſerving the contrary effects from a want or defect of the bile. Nor is the hepatic bile ſufficient to excite the neceſſary motion of the inteſtines, if the cyſtic is wanting; both which are of ſo much uſe and importance to the animal, that we find, by experiment, even the ſtrongeſt will periſh in a few days, if the flux of bile to the inteſtines be intercepted, by wounding the gall-bladder.

Thus it ſlowly deſcends along with the alimentary maſs; and having ſpent its force, or changed its bitterneſs by putrefaction, moſt of it is afterwards excluded together with the feces; but probably ſome of the more ſubtle, watery, and leſs bitter parts, are again taken up by the abſorbents. It returns the leſs into the ſtomach, becauſe of the aſcent of the duodenum, which goes under the ſtomach, with the reſiſtance it meets with from the valvula pylori, and the advancement of the new chyle which the ſtomach adds to the former: in man, however, it frequently enters; and always in birds. The bile is of a ſweet ſoft nature in the fœtus; for in them the blood ſeems not ſufficiently charged for its ſecretion to ſupply putrid alkaline vapours to the liver, nor are there any oily or fat ſubſtances abſorbed from the inteſtines. As the bile is a viſcid fluid, and thickens by inactivity of body in fat animals, and in us from the ſame cauſes, eſpecially when the blood moves languid from grief; ſo it eaſily coagulates into an hard, ſomewhat reſinous, and often ſtony ſubſtance, inſomuch that ſtones of the gall are much more frequent than thoſe of the urinary bladder, as we are taught by experiments. Its uſe is manifeſt, as, being triturated with the aliments, it diſſolves oil, reſiſts acidity, and thus ſtimulates the inteſtines to contraction.

The uſe of the liver, beſides ſecreting the bile, is manifeſt in the fœtus. It ſeems to tranſmit the blood

brought back from the placenta, and to break its force. Even in an adult perſon it has the ſame uſe though leſs manifeſt, namely, to retard the return of the blood coming back from the viſcera appointed for preparing the chyle.

§ 18. *Renes et Ureteres.*

Situation, figure, and diviſion of the kidneys. THE kidneys are two pretty ſolid glandular bodies, ſituated in the poſterior part of the cavity of the abdomen, on each ſide of the lumbar vertebræ, between the laſt falſe ribs and os ilium. The right kidney lies under the great lobe of the liver; and is conſequently lower than the left, which lies under the ſpleen.

The figure of the kidneys reſembles that of a large bean, their circumference being convex on one ſide, and concave on the other. The concave ſide is turned to the vertebræ, and the convex ſide the oppoſite way. Their length anſwers to the diſtance between the laſt falſe rib and os ilium; they are about half as broad as long, and half as thick as broad.

In each kidney we obſerve a fore and back ſide, an upper and lower extremity, a great and ſmall curvature, and a convexity and concavity.

The back-ſide is broader than the fore-ſide; and the upper extremity is a little broader and more incurvated than the lower. The depreſſion in the ſmall curvature is oblong and uneven, reſembling a ſinus, ſurrounded by ſeveral tubercles; and as it is turned a little toward the fore-ſide, this ſide is ſomething narrower than the other.

Blood-veſſels of the kidneys. The deſcending aorta and inferior vena cava lie between the kidneys, pretty cloſe to the bodies of the vertebræ and to each other; the artery being on the left hand, the vein on the right. The renal artery comes commonly from the ſide of the aorta under the ſuperior meſenteric artery: that of the left

left ſide has its origin a little higher and further back than that of the right ſide; and both having run over almoſt at right angles, enter the ſinus of the kidney, and divide into many branches, which ſubdivide into many others ſtill ſmaller. The renal veins have leſs variety than the arteries. It is ſeldom we find more than one on each. From each kidney ſeveral branches come out, which ſoon unite to form a trunk, which ends in the vena cava. Theſe veſſels were by the ancients termed the *emulgent arteries and veins*, but they frequently go under the name of *arteriæ et venæ renales*.

The artery and vein are not of an equal length, and the difference depends on the ſituation of the aorta and vena cava: for the left renal artery is ſhorter than the right, becauſe the aorta lies neareſt the left kidney; and the left renal vein is longer than the right, becauſe the vena cava lies furtheſt from the left kidney.

Theſe veſſels are likewiſe diſpoſed in ſuch a manner, as that the veins lie more anteriorly than the arteries; becauſe the aorta lies cloſe to the ſpina dorſi; whereas the vena cava, which perforates the diaphragm at ſome diſtance from the vertebræ, does not join them till after it has given off the renal veins.

Nerves of the kidneys. Each artery is ſurrounded by a nervous net-work, called *plexus renalis;* which furniſhes a great number of filaments to the kidneys, that come partly from the ſemilunar ganglions of the two great ſympathetic nerves, and partly from the plexus hepaticus and ſplenicus. This renal plexus ſends likewiſe ſome filaments round the renal veins.

Coats of the kidneys. The kidneys are ſurrounded by a very looſe membranous and cellular covering, called *membrana adipoſa;* becauſe, in fat perſons, the cells of this ſubſtance are filled with fat. This was for a long time impertinently taken for a duplicature of the peritonæum; the true membranous lamina of which covers only the foreſide of the kidneys; and conſequently they lie

lie without the peritonæum, becauſe the portion of that membrance that covers them cannot be looked upon as an entire coat: ſo that the only common coat they have is the cellular ſubſtance, which likewiſe inveſts the renal arteries and veins in form of a vagina.

The proper coat or membrane of the kidneys is ſtrong and denſe, and adheres very cloſely to their ſurface; for it penetrates every where by numerous elongations into their ſubſtance, from which it cannot be ſeparated without tearing theſe.

The external ſurface of this lamina is very ſmooth, poliſhed, and gliſtening; and it renders the whole ſurface of the kidney very even and uniform in adults. In children, this convex ſurface is in a manner divided into ſeveral lobes and tubercles, almoſt as in oxen and calves; and in grown perſons we ſometimes obſerve the ſame inequalities.

The blood-veſſels having entered the kidneys, are ramified every way; and theſe ramifications ſend out other capillary rami, which go all the way to the ſurface, where they appear like irregular ſtars, and furniſh the proper membrane of the kidneys. Sometimes theſe two ramifications penetrate to the membrana adipoſa, and communicate there with the arteriæ and venæ adipoſæ.

The proper membrane having ſurrounded the kidney all the way to the ſinus, joins the veſſels at that place, and accompanies all their ramifications through the body of the kidney in form of a vagina or capſule, and likewiſe contributes in part to form the pelvis and calices or infundibula; of which hereafter.

We ſometimes obſerve a conſiderable veſſel to go in or come out from the convex ſurface of the kidney; but this is not common: and in that caſe there is a depreſſion, by which the proper membrane enters, and communicates with that portion which goes in by the ſinus.

The tunica adipoſa, or common coat, which likewiſe

inveſts the great veſſels to their entry into the kidneys, does not ſeem to accompany them any further, but terminates at the ſinus, in the interſtices between the ramifications.

Structure of the kidneys. We may diſtinguiſh three kinds of ſubſtances in the kidney; an exterior ſubſtance, which is thick, granulated, and in a manner cortical; a middle ſubſtance, which is medullary and radiated, called *ſtriata*, *ſulcata*, or *tubularis*, becauſe it ſeems to be made up of radiated tubes; and an inner ſubſtance, which is only a continuation of the ſecond, and terminates on the inſide by papillæ; for which reaſon it goes under the name of *papillaris*.

Theſe three ſubſtances may be ſeen diſtinctly in a kidney cut into two equal parts through the great curvature. The cortical ſubſtance may be obſerved round the whole circumference; and, by the microſcope, we perceive it to be of a ſpongy, granulated, and waving texture, all its parts adhering together in a radiated manner. Its colour is a bright whitiſh grey.

By fine anatomical injections and inflammations, we diſcover an infinity of ſmall capillary veſſels, which run in various directions between and round the different portions of this ſubſtance; and, by the help of a microſcope, we ſee likewiſe great numbers of ſmall red corpuſcles more or leſs round, and diſpoſed almoſt like bunches of currants. Theſe ſmall corpuſcles are perhaps only the extremities of veſſels, filled either with blood or with a coloured injection.

The other two ſubſtances, that is, the medullary or ſtriated, and the papillary, are really but one and the ſame maſs, of a more reddiſh colour; the convex ſide of which riſes at ſeveral places into narrow tubercles, lodged in the ſame number of cavities or depreſſions. The radiated ſtriæ are afterwards continued to the papillary portion; and the papillæ form in ſome meaſure ſo many centres of theſe radii, oppoſite to the tubercles.

The medullary ſubſtance is likewiſe diſtinguiſhed

from the cortical, by the arterial and venal arches, which ſend capillary ramifications on all hands; and its colour is more or leſs red.

The papillæ, which are only a continuation of the medullary ſubſtance, as has been ſaid, are often a little paler than that ſubſtance. They are ten or twelve in number, very diſtinct from each other, reſembling the ſame number of cones, with very broad baſes and obtuſe apices.

At the point of each papilla we ſee, even without a microſcope, in a ſmall depreſſion, ſeveral very ſmall holes, through which little drops may be perceived to run when the papillæ are compreſſed. Theſe are little drops of urine; which being filtered, partly in the cortical, partly in the medullary or tubular ſubſtance, do afterwards paſs through the ſubſtance of the papillæ, and are diſcharged by theſe orifices.

The pelvis of the kidneys. Each papilla lies in a kind of membranous calix or infundibulum, which opens into a common cavity, called the *pelvis*. This pelvis is membranous, being of the ſame ſtructure with the calices, of which it is a continuation; and its cavity in man is not uniform, but diſtinguiſhed into three portions, each of which contains a certain number of infundibula or calices, together with the papillæ which lie therein; and ſometimes we find two or three papillæ in the ſame infundibulum.

At the place where theſe infundibula ſurround the baſes of the papillæ, they ſend productions into the medullary or radiated ſubſtance of the kidney, which accompany the blood-veſſels, and ſerve for capſules or vaginæ to all the vaſcular arches, both arterial and venal, and to their different ramifications, quite thro' the cortical ſubſtance, and as far as the ſurface of the kidney.

Ureters. After the infundibula have contracted in a conical form round the apices of the papillæ, each of them forms a ſmall ſhort tube or gullet, which uni-

ting at different diſtances along the bottom of the ſinus of the kidney, form three large tubes which go out from the ſinus, in an oblique direction from above downwards, and immediately afterwards unite into one trunk.

This trunk becomes a very long canal, called the *ureter*. In men, the three tubes ſupply the place of what is called the *pelvis* in brutes, and might more properly be called the *roots* or *branches* of the ureters than the pelvis; which name would agree beſt to the trunk, as being larger than the reſt of the ureter. The ureters are commonly two in number, one for each kidney; but ſometimes there are more than two.

The ſituation of the trunk, and of the roots and branches of each ureter, with reſpect to the renal artery and vein, is in the following manner: The artery is in the upper part of the ſinus, and partly before the vein. The vein is about the middle, and between the artery and ureter. The ureter is in the lower part, a little behind the vein, and it is partly ſurrounded by one branch of the artery.

This diſpoſition appears plainer near the anterior than near the poſterior ſide of the kidney, becauſe this laſt is broader than the former; and we likewiſe ſee there the three branches of the ureter; of which the uppermoſt is the longeſt, and the loweſt is the ſhorteſt, becauſe of their oblique direction downward.

From this deſcription, we ſee, that in the human kidney there is no other common or uniform pelvis, but the trunk or head of the ureter, and the three great branches. To have a true idea of their diſpoſition, we muſt imagine that the ureter enters the kidney by the lower part of the oblong ſinus; that it increaſes gradually in breadth as it advances; and that it is divided into three branches, before it enters the ſubſtance of the kidney.

One of theſe branches may be reckoned a direct continuation of the ureter, and it is longer than the reſt, being

being extended from the lower to the upper part of the ſinus; and it may be found without much preparation. The other two branches are ſhorter, and cannot be well diſcovered without an artificial ſeparation. The angles between theſe branches at their baſes, or at the head of the ureter, are not pointed as thoſe of other ramifications, but formed by a round incurvation, which is generally ſurrounded by fat.

Theſe firſt branches of the ureters produce other ſmall branches at the bottom of the ſinus, which are diſpoſed in pairs. Theſe ſmall collateral branches extend in breadth, and form the infundibula or calices, in which the papillæ are lodged; the great circumference of which produces, in the ſubſtance of the kidney, the different vaginæ of the vaſcular arches and of their ramifications. The internal lamina of the kidney is continued round theſe vaginæ; and the external lamina is expanded round the firſt branches, round the trunk, and round all the reſt of the ureter.

If the trunk of the ureter be ſplit on that ſide which is next the vertebræ, and this ſection be continued to the extremity of the ſuperior branch, we may obſerve, immediately above the trunk, two holes lying near each other, which are the orifices of the ſmall collateral branches and gullets of the infundibula. A little above theſe holes, there are other two very much like them, and ſo on all the way to the extremity of the ſuperior branch, which terminates likewiſe by theſe gullets of the infundibula; and in each of theſe gullets we may obſerve at leaſt the apex of one papilla.

A ſection begun on the convex ſurface of the kidney, and carried from thence to the trunk of the ureter, diſcovers the extent of the papillæ very plainly, and likewiſe the infundibula, their gullets, &c.; but it will be difficult to give beginners a juſt idea of the ſtructure of theſe parts without the other ſection.

The ureters run down obliquely, and with a very ſmall degree of inflexion, from the kidneys to the late-

ral parts of the inner or anterior ſide of the os ſacrum; and paſſing between the rectum and bladder, they terminate in the laſt of theſe viſcera, in the manner that ſhall be explained hereafter.

They are compoſed of three proper coats; the firſt of which, that ſurrounds the reſt, is of a whitiſh colour, and of a very compact filamentary texture, being ſtretched with difficulty, and appearing like a filamentary ſubſtance degenerated. The next coat is of a reddiſh colour, ſtronger than the firſt, and is compoſed of muſcular fibres, although this has been doubted by ſome authors.

The innermoſt coat is in ſome meaſure ligamentary, and lined by a very fine membrane, which covers a very delicate reticular texture of veſſels, and is moiſtened all over by a mucilaginous liquor.

Beſides theſe proper coats, the ureters are inveſted by the cellular ſubſtance of the peritonæum; the membranous lamina of which covers likewiſe about two thirds of their circumference, ſometimes more, ſometimes leſs, but never ſurrounds them entirely: ſo that when they are examined in their natural ſituation, they appear like ropes lying behind the peritonæum, and jutting out more or leſs toward the cavity of the abdomen, together with that portion of the peritonæum which covers them.

All that has been ſaid about the ſtructure of the ureters, pelvis, arches, ſtriæ, foſſulæ, and holes at the apex of the papillæ, appears moſt diſtinctly when theſe parts are examined in clear water.

§ 19. *Glandulæ renales, vulgo Capſulæ atrabilariæ.*

Situation, figure, and ſize of the renal glands. Immediately above each kindney lies a glandular body, called by the ancients *capſulæ atrabilariæ;* by others, *capſulæ renales*, *renes ſuccenturiati*, and *glandulæ renales;* and they might be properly enough termed *glandulæ*

ſupra

ſupra renales. They are ſituated on the upper extremity of each kidney a little obliquely, that is, more toward the inner edge and ſinus of the kidney than toward the outer convex edge.

Each gland is an oblong body with three ſides, three edges, and two points, like an irregular creſcent with its great or convex edge ſharp, and the ſmall concave edge broad. Its length is about two-thirds of the greateſt breadth of the kidney, and the breadth of its middle portion is about one-third of its extent between the two extremities, ſometimes more, ſometimes leſs. Its colour is a dark yellow.

It has one anterior, one poſterior, and one lower ſide, which laſt may be termed the *baſis;* and it has one upper, and two lower edges, whereof one is anterior, the other poſterior. The upper edge may be called the *criſta*, and the two lower edges the *labia*. One of its extremities is internal, or turned inward toward the ſinus of the kidney; the other is external, or turned outward toward the gibbous part of the kidney. The figure of this glandular body may likewiſe be compared to that of a ſingle cock's-comb, or to the top of an helmet.

Structure of the renal glands. The ſurface of theſe glands is uneven; the fore-ſide is the broadeſt, and the lower ſide or baſis the narroweſt. Along the middle of the anterior ſide, a ridge runs from the edge of the inner extremity a little above the baſis, to the point of the other extremity, and divides this ſide into two equal parts, like the middle rib of the leaf of a tree, and on the lower ſide, under the baſis, there is a kind of raphe or ſuture.

The arteries of theſe glands come from the arteriæ renales, and diaphragmaticæ, and likewiſe from the aorta, from the arteria cæliaca, &c. Theſe veſſels are termed the *capſular arteries;* and as they enter the glands, they ſeem to be inveſted by a vagina. They are not always derived from the ſame ſources, neither

is their number the ſame in all ſubjects: and there is commonly a pretty large vein which runs along the ridge. One principal vein returns the blood from each of theſe glands; the right goes into the vena cava, the left paſſes into the renal vein. The nerves on each ſide are furniſhed by the neighbouring ſemilunar ganglion, and by the renal plexus which depends on it.

In the inſide of theſe capſulæ, there is a narrow triangular cavity, the ſurface of which is full of ſhort, ſtrong villi of a yellowiſh colour; but in children it is reddiſh, and of a dark brown in aged people. The ſides of this cavity are connected by a great number of filaments; and they appear to be wholly glandular, that is, to be filled with very fine ſmall folliculous corpuſcles. Along the top of the gland theſe ſides touch each other immediately.

In opening this cavity, we find a granulated or follicular ſubſtance, which fills it almoſt entirely; and the blood-veſſels are diſtributed on this ſubſtance, as well as on the ſides of the cavity. If the ſection be begun at the great extremity of the capſula, and be continued through the upper edge, and if the lateral portions be afterwards ſeparated, the glandular body appears like a kind of criſta, raiſed from the middle of the bottom of the cavity.

This glandular body or nucleus adheres more cloſely to the bottom or baſis of the cavity, than to the two ſides, eſpecially near the great extremity; but yet it may be ſeparated both from the baſis and ſides, being connected to them by a great number of ſmall filaments. It adheres leaſt to the baſis near the ſmall extremity.

The capſular vein, which comes ordinarily from the vena renalis, is much larger than the arteries; and it communicates with the inſide of the capſula much in the ſame manner as the vena ſplenica with the cells of the ſpleen, for it may be inflated by blowing into any part of

of the capſular cavity, and the air likewiſe paſſes into the vena renalis, &c.

This cavity contains an unctuous viſcid liquor, of a yellowiſh red colour, which, with age, changes gradually into a yellowiſh purple, a dark yellow, and a black yellow: ſometimes it is perfectly black; but even then if it be ſpread thin on a large ſurface, it appears yellow. It is ſometimes found not only reddiſh, but mixed with real blood.

The uſes of theſe renal glands have not as yet been diſcovered; and all that we know about the liquor contained in them is, that it has ſomewhat the appearance of the bile. They are very large in the fœtus, and diminiſh in adults. Theſe two phænomena deſerve our attention.

They lie ſometimes directly on the top of the kidneys, but ſeldom, if ever, on the gibbous part. The gland on the right ſide is partly connected to the diaphragm, under and very near the adheſion of the great lobe of the liver to that muſcle. That on the left ſide adheres to the diaphragm below the ſpleen; and both theſe connections are confined to the contiguous portions of the inferior muſcle of the diaphragm. They are involved, together with the kidneys, in the membrana adipoſa, of which a very thin portion inſinuates itſelf between the kidneys and glands, and alſo between them and the diaphragm; ſo that they adhere to both by the intervention of the cellular ſubſtance, which in ſome ſubjects contains a ſtratum of fat.

The venal ridge already mentioned, ſinks ſo deep into the fore-ſide in ſome ſubjects, that the upper part of this ſide appears to be ſeparated from the lower; but this is ſeen moſt diſtinctly when the capſula is examined in clear water.

When the capſular vein is opened lengthwiſe with the point of a lancet, we diſcover in it a great many ſmall holes, many of which are only the orifices of the rami of the vein, others are ſimple holes; and it is perhaps

perhaps through theſe that the air paſſes into the gland, as already mentioned.

On the outer ſurface of theſe capſulæ we obſerve a very thin, diſtinct coat, ſeparate from the cellular ſubſtance that ſurrounds them. Sometimes this coat is raiſed by an uneven ſtratum of fat, which makes it appear granulated; and, for the ſame reaſon, the capſulæ are of a pale colour like a corpus adipoſum.

The liquor contained in them appears ſometimes, in the fœtus, and in young children, of a bluiſh colour inclined to red.

To be able to diſcover the uſes of theſe capſulæ, we muſt not only attend to the two circumſtances already mentioned, but alſo to their external conformation, which is commonly more regular in the fœtus and in children than in adults and old people. We muſt likewiſe conſider the conſiſtence and ſolidity of their ſubſtance; which is greater before birth, and in childhood, than in advanced old age; in which they are often very flaccid, and very much decayed; and this perhaps may be the reaſon why the figures given of theſe glands, taken out of their membrana adipoſa, are ſo very irregular and different from others.

CHAP.

CHAP. IV.

Of the PELVIS.

§ 1. *Vesica Urinaria.*

Situation, figure, and division of the bladder.

THE bladder is a kind of membranous and fleshy pouch or bottle, capable of dilatation and contraction, situated in the lower part of the abdomen immediately behind the symphysis of the ossa pubis, and opposite to the beginning of the intestinum rectum. The figure of it is nearly that of a short oval. It is broader on the fore and back sides than on the lateral parts; rounder above than below, when empty; and broader below than above, when full.

It is divided into the body, neck, and bottom; into an anterior, posterior, and two lateral parts. The upper part is termed the *fundus*, or *bottom;* and the neck is a portion of the lower part, which is contracted like the gullet of some vessels.

Structure of the bladder. The bladder is made up of several coats, almost like the stomach. That part of the external coat which covers the upper, posterior, and lateral sides of the bladder, is the true lamina or membrane of the peritonæum; and the rest of it is surrounded by a cellular substance, by the intervention of which, the peritonæum is connected to the muscular coat.

The proper coats are three in number; one muscular, one cellular, and an internal smooth one commonly called *villous coat*. The muscular coat is composed of several strata of fleshy fibres; the outermost of which are mostly longitudinal; the next to these are more inclined

clined toward each hand; and the innermoſt more and more oblique; and they become at length almoſt, tranſverſe. All theſe fibres interſect each other in various manners; and they are connected together by a fine cellular ſubſtance, and may be ſeparated by inflating that ſubſtance.

Round the neck of the bladder the muſcular fibres are cloſely connected, and form what has been called *ſphincter veſicæ*. But this part is not a diſtinct muſcle, nor is its action diſtinct from the reſt of the muſcular coat.

The cellular coat is nearly of the ſame ſtructure with what is called the *tunica nervoſa* of the ſtomach.

The internal coat is ſomething granulated and glandular, ſays Winſlow; but later anatomiſts deny the exiſtence of glands here. A mucilaginous ſerum is continually diſcharged through it, which moiſtens the inner ſurface of the bladder, and defends it againſt the acrimony of the urine. It appears ſometimes altogether uneven on the inner ſide, being full of eminences and irregular rugæ when empty and in its natural ſtate of contraction. Theſe inequalties diſappear when the bladder is full, or when it is artificially diſtended by air, or by injecting any liquid.

Urachus. At the top of the bladder above the ſymphyſis of the oſſa pubis, we obſerve a ligamentary rope, which runs up between the peritonæum and the linea alba of the abdomen, all the way to the navel, diminiſhing gradually in thickneſs as it aſcends. This rope in the fœtus is in part a production of the inner coats of the bladder, which production is termed *urachus*.

Arteriæ umbilicales. This rope is compoſed likewiſe of two other ligamentary elongations, which are the extremities of the umbilical arteries. Theſe arteries come from the hypogaſtricæ, run up by the ſides of the bladder, and remain hollow and filled with blood, even in adults, as high as the middle of the bladder, through all which ſpace they likewiſe ſend off ramifications,

tions. Afterwards they loſe their cavity, and become ligamentary as they aſcend. At the upper part of the bladder they approach each other; and joining the urachus, form that rope, which may be termed the *ſuperior ligament of the bladder*.

The external fibres of the muſcular coat are more numerous than the internal; and the moſt longitudinal anterior fibres form a kind of incurvation round the urachus at the top of the bladder, much like that of one of the fleſhy portions which ſurround the ſuperior orifice of the ſtomach and lower extremity of the œſophagus. This incurvation paſſes behind the urachus.

The portion of the peritonæum, which covers the opſterior convex ſide of the bladder, forms a very prominent tranſverſe fold, when the bladder is contracted, which diſappears when the bladder is extended. This fold ſurrounds the poſterior half of the bladder, and its two extremities are elongated toward each ſide; by which elongations a kind of lateral ligaments of the body of the bladder are formed, which are more conſiderable in children than in adults. Beſides theſe, the bladder has other two ligaments, which are fixed at their fore-part to the upper and inner ſide of the oſſa pubis, near the ſymphyſis of theſe two bones; from whence they run back, becoming gradually broader, to be fixed to the ſides of the bladder; or, as Sabatier deſcribes them, as the inferior anterior ligaments of the bladder.

The lower part of the bladder, which deſerves the name of *fundus* much better than the upper part, is perforated by three openings, one anterior, and two poſterior. The anterior opening is formed by an elongation of all the proper coats, in form of a gullet, turned much in the ſame manner with the inner orifice of the roſtrum of the head of an alembic. This elongation is called the *neck of the bladder*, the deſcription of which belongs to that of the parts of generation in men.

The

The other two openings in the true fundus of the bladder, are formed by the ureters, which in their courſe downward, already deſcribed, run behind the ſpermatic veſſels, and then behind the lower part of the bladder, approaching each other. Each ureter lies between the umbilical artery and vas deferens of the ſame ſide; the artery lying on the outſide of the ureter, and the vas deferens on the inſide.

Afterwards they get between the vaſa deferentia and the bladder, croſſing theſe canals: and then, at about a finger's breadth from each other, they begin to pierce the coats of the bladder. They run a little way between the muſcular and nervous coats, and open into the bladder obliquely, ſomething nearer each other than when they firſt entered in coats.

The orifices of the ureters in the bladder are ſomething oval and narrower than the cavity of the ureters immediately above them. The edge of theſe orifices is very thin, and ſeems to be formed merely by the union of the internal coat of the bladder with that of the ureters.

Blood-veſſels and nerves of the bladder. The arteries of the bladder are furniſhed by the hypogaſtricæ or iliacæ internæ, being rami of the arteria ſciatica, epigaſtrica, and umbilicalis on each ſide. The veins return to the internal iliac veins.

The nerves of the bladder come from the crurales, and alſo from the ſympathetici maximi, by means of their communication with the crurales. It has likewiſe ſome nerves from the plexus meſentericus inferior.

Beſides the ligaments already mentioned, there are likewiſe two ſmall ones, by which the anterior part of the true fundus of the bladder is connected to the oſſa pubis, which ſhall be deſcribed with the neck and ſphincter, after the hiſtory of the parts of generation in both ſexes; and we refer to the ſame place, all that relates to the connection of the bladder with the other neighbouring parts.

§ 2. *Secretion*

§ 2. *Secretion of Urine.*

THE chyle, which is taken into the blood, contains a good deal of water; the proportion of which would be too great in the veſſels, ſo as to paſs into the cellular ſubſtance, if it was not expelled again from the body. Therefore a part of this is exhaled through the ſkin; and another part as large, or often larger than the former, is ſtrained through the kidneys, and is expelled out of the body.

Dr Haller obſerves, "that the blood of the renal artery being leſs fluid, as is generally believed, than that of the brain, and probably ſtored with more water, brought by the ſerpentine circles of the arteries, depoſites great part of its water into thoſe rectilineal tubes of the papillæ; a great portion of which water contains oils and ſalts, intermixed with earthy particles, or ſuch other matters as are thin enough to paſs through with it. But the ſmall diameter of each uriniferous duct itſelf at its origin, and its firm reſiſtance, ſeem to exclude the milk or chyle and the coagulable lymph, Hence, therefore, it is, that the blood paſſes ſo eaſily through the open uriniferous tubes, whenever it is urged with an increaſed celerity; or, by a morbid relaxation, they tranſmit not only the oily parts of the blood, but even the milk and ſalts of the meat and drink. But when the ſtrength of the kidney is reſtored by aſtringent medicines, the urine returns to its natural ſtate. The nerves likewiſe have a power of contracting or relaxing theſe paſſages; and thus we ſee that urine, which, in health, is of a yellow colour, becomes watery from ſudden grief of mind. A vaſt quantity is prepared; equal to that of perſpiration, and ſometimes even more." Later phyſiologiſts explain the ſecretion of urine by obſerving, that part of the blood by the kidney is changed into this fluid.

The urine, by fire or putrefaction, ſometimes by diſeaſe,

eaſe, and in ſome animals more eaſily, changes into a volatile alkaline nature, intimately mixed with a fetid oil, partly empyreumatic, yellow, and volatile, and in part very tenacious, to be ſeparated only by the laſt degrees of fire, under the denomination of phoſphorus; a ſubſtance ſhining of itſelf, and taking fire in the air: and laſtly, it abounds more with earth than any other juice of the human body, both of a cretaceous and ſparry nature; the latter coming chiefly from the drink, the former alſo from the ſolid parts of the body themſelves diſſolved and mixed with the blood. But there is alſo a conſiderable proportion of ſea-ſalt reſiding in freſh urine; from which it is even ſeparable, after a long putrefaction, in the making of phoſphorus; in which proceſs a very great part of the urine is changed into volatile alkali. Nor is the urine wholly deſtitute of a vitriolic acid, or at leaſt one much a-kin to it; both in that taken from men, as well as cattle. There is, again, a ſort of fuſible ſalt ſeparable in the urine, which is cooling, and a-kin to nitre. In fevers, the oily and ſaline parts of the urine are greatly augmented both in bulk and acrimony.

That the urine is ſeparated in the kidneys, is ſhown by the very nature of the thing, as it can be drawn out by preſſing on its ſmall canals. That it deſcends by the ureter is ſhown by the ſurpriſing ſwelling of the kidney, and that part of the ureter which is above the ligature, as well as the emptineſs of that part which is below it. In the bladder alſo, as well as in the kidneys and ureters, there is an immenſe ſwelling as often as the bladder cannot receive the urine, or cannot emit it; an obſtacle being generated in either place.

Nor does there ſeem to be any other way for the urine to paſs. For although it is certain, that the ſtomach, like all other membranes, exhales a moiſture through its coats; though it is not improbable, from experiments, that the bladder alſo abſorbs; and altho'

the paſſage of mineral Spaw waters, by urine, be extremely quick; yet it does not thence follow, that there muſt be ways, different from that of the ureters, to convey the water from the food to the bladder. For the bladder is, on all ſides, ſeparated from the cavity of the abdomen by the peritonæum; nor is it very likely that the vapours, which either go out from the bladder, or which are derived towards it from other parts, can here find open pores through the peritonæum; nor do membranes imbibe much that are already wetted, ſo as to fill their pores with humours. But the urine alſo which is contained in the bladder diſtends it even to death; nor does it find any paſſage through which it can eſcape into the pelvis; and, on the other hand, when the ureters are obſtructed with ſtones, ſo that the bladder receives nothing from them, it is either quite empty, or contains a very acrimonious and thick urine, manifeſtly indicating that the water can find no other way from the pelvis into the bladder. And a careful attention to the manner in which mineral waters are diſcharged by urine, ſufficiently demonſtrates, that there is no ſuch rapidity therein as is commonly imagined; but the ſtimulus of the cold water drank, does, like the external cold applied to the ſkin, cauſe a concuſſion of the bladder and urinary parts, by which they are ſolicited to repeated diſcharges of the old urine which was before in the body, and not immediately of that which was laſt drank. Again, the largeneſs of the renal veſſels demonſtrates, that not much leſs than an eighth part of the blood ſent to the body is received at a time, and conſequently there are above 1000 ounces of blood conveyed through the kidneys in an hour; whence it will appear but a moderate allowance, for 20, or even 50, ounces of water to diſtil from that quantity of blood driven through the kidneys in the ſame time. Finally, it is certain, that both man and brute animals periſh if the ureters are cloſed up by a ligature; we then obſerve alſo, that no urine can be found in the bladder.

Into the bladder the urine conſtantly flows, in a continued thread, as we are aſſured from experience, in morbid and uncommon caſes, in which the extremities of the ureters have appeared to the eye. By ſtaying ſome time in the bladder, and from the abſorption of the more watery part, the urine acquires an higher colour, becomes ſharper and reddiſh-coloured. Nor are we fully acquainted with the cauſe which retains the urine in the bladder. The ſphincter is obſcure; the depreſſion of the bladder ſeems to aſſiſt, as it deſcends convex below its mouth upon the inteſtinum rectum, ſo that at laſt the urine arrives at the entrance of the urethra when any quantity of it is collected. Certain it is, that the urine does not flow ſpontaneouſly even from a dead carcaſe.

At length, by its bulk and acrimony irritating the ſenſible fabric of the bladder, it is thence expelled, firſt by the motion of the diaphragm and abdominal muſcles, by which the inteſtines are urged againſt the bladder in a perſon who is erect, whereby the urine makes itſelf a way through a narrow and impeded paſſage; and again, by the periſtaltic motion of the bladder itſelf, ariſing from the contraction of its muſcular fabric.

By the urine, beſides the particles of food and water, much matter ſeems to paſs off that is noxious to the human body; eſpecially calcareous earth reſorbed from the bones and ſolid parts, and which would not fail to produce bony cruſts and calculi wherever it was ſtopped; the ſparry or gypſeous earth of fountains; an acrid oil mixed with ſalt, ſo as to aſſume a volatile nature. The urine, by its retention, diſpoſes to the generation of the ſtone and gout: when ſuppreſſed, it produces ſharp fevers; and at laſt flows back to the brain, and overflows and deſtroys it.

§ 3. *The parts of Generation in Males.*

Situation in general, and diviſion of theſe parts. The parts of generation in males are of different kinds, ſome of them being wholly contained in the abdomen, and others lying without it. From this ſituation, they might properly enough be divided into external and internal parts; and all thoſe belonging to the firſt claſs might be deſcribed before thoſe of the ſecond.

But as it is ſtill more proper to have a regard to the œconomy of theſe parts, according to which, their functions begin in ſome internal parts, are continued in ſome external parts, return again to the internal, and are finiſhed in the external; we ſhall follow the ſame order in deſcribing them.

The firſt of theſe four claſſes comprehends the ſpermatic veins and arteries; the ſecond, the teſtes, epidydimis, and ſcrotum; the third, the vaſa deferentia, veſiculæ ſeminales, and proſtates; and the fourth, the corpora cavernoſa, urethra, integuments, &c.

Scrotum. The ſcrotum is the cutaneous covering of the teſtes. Outwardly, it is a bag common to both, formed by a continuation of the ſkin of the neighbouring parts, and commonly very uneven, having a great number of rugæ on its outer ſurface. Interiorly, it is fleſhy, and forms a muſcular capſula for each teſticle, termed *dartos*.

The exterior or cutaneous portion of the ſcrotum is nearly of the ſame ſtructure with the ſkin in general, of which it is a continuation; only it is ſomething finer, and it is likewiſe plentifully ſtored with ſebaceous glands and bulbs of roots of hairs.

Though it is a common covering for both teſticles, it is nevertheleſs diſtinguiſhed into two lateral parts by a ſuperficial and uneven prominent line, which appears like a kind of ſuture, and from thence has been termed *raphe*.

This line is a continuation of that which divides, in the ſame manner, the cutaneous covering of the penis; and it is continued through the perinæum, which it divides likewiſe all the way to the anus. It is only ſuperficial, and does not appear on the inſide of the ſkin.

The inner ſurface of this cutaneous bag is lined by a very thin cellular membrane, through which the bulbs and glands appear very diſtinctly when we view its inſide. The rugæ of the ſcrotum are in the natural ſtate commonly a mark of health, and then its ſize is not very large. It increaſes in ſize, chiefly according to its length; and then the rugæ diſappear more or leſs, according to the degrees of the preternatural ſtate or indiſpoſition.

The dartos of the ſcrotum has been looked upon as a true cutaneous muſcle; but is chiefly a cellular ſubſtance condenſed, with a great number of blood-veſſels entering into its compoſition, but without fat. This ſubſtance is thin; and by the diſpoſition of its fibres, forms a bag with two cavities, or two ſmall bags joined laterally to each other, and contained within the cutaneous portion.

The lateral parts of theſe two bags, which are turned from each other, are longer than thoſe which are joined together; and by this union a ſeptum is formed between the teſtes, which may be called *mediaſtinum ſcroti*.

The raphe or ſuture already mentioned, adheres to the edge of this ſeptum, and thereby braces down the middle of the cutaneous portion; which from thence appears to have in part two cavities; and this was perhaps what gave occaſion to make the French word for the ſcrotum to be in the plural number. The other edge of the ſeptum adheres to the urethra.

The dartos has a ſtrict connection with the reſt of the cellular ſubſtance, eſpecially at the upper part below the groin, where its anterior and external lateral portions terminate by a kind of tendinous or ligamentary

tary expanſion, which is ſtrongly united to the internal cellular membrane. We have often ſhown this as a particular faſcia lata, which gives inſertion to the portions of the dartos juſt mentioned, and as a broad frænum which keeps the ſame portions together.

The aponeurotic or ligamentary expanſion of the dartos is fixed in the ramos of the os pubis, between the muſculus triceps and the origin of the corpus cavernoſum of the ſame ſide, which ſhall be deſcribed hereafter, all the way to the lower part of the ſymphyſis of theſe bones. The internal portion of theſe muſcular bags, or that which forms the ſeptum ſcroti, is fixed to the urethra by means of a communication between the ſame ligamentary expanſion; and another, which ſhall be explained in its proper place.

Coats of the teſtes. The particular coverings of the teſtes are commonly called *coats;* and they are reckoned to be three in number, the tunica muſculoſa named *cremaſter*, vaginalis, and albuginea. The firſt two are common to each teſticle, and to the ſpermatic rope that belongs to it; and the third is peculiar to the teſticle alone.

The tunica vaginalis is the moſt conſiderable of the three, and muſt be deſcribed firſt, in order to conceive the ſtructure and connection of the cremaſter, which is very improperly called a *coat.* The albuginea ſhall be deſcribed with the teſtes.

The tunica vaginalis is a continuation of the vagina of the ſpermatic rope, which, as it approaches the teſticle, is gradually dilated, and forms two capſulæ, one contained within the other, the external being the longeſt and broadeſt at bottom; ſo that there is a void ſpace there left between them, in which the teſticle is lodged.

This ſtructure may likewiſe be explained in the following manner. The vagina having reached as low as the teſticle, is divided into two laminæ; the innermoſt of which is the bottom of the vagina, and the outermoſt

is expanded round the teſticle, and gives it a coat, called *vaginalis*, from the Latin word *vagina*. The ancients termed it likewiſe *elytroides*, from a Greek word that ſignifies the ſame thing.

The inner ſurface of this coat is lined by a fine membrane, which ſtrengthens the bottom of the vagina, and forms a kind of diaphragm; which prevents all communication between the vagina of the ſpermatic rope and the tunica vaginalis of the teſticle.

Cremaſter. The cremaſter, improperly termed *a coat*, is a thin muſcle or fleſhy plane, which runs down round the vagina of the ſpermatic rope, and terminates in the tunica vaginalis of the teſticle.

It ſurrounds almoſt the whole vagina; and afterwards expands itſelf on the upper and external part of the tunica vaginalis, in which it is inſerted and loſt.

It ariſes partly from the ligamentum Fallopii, but chiefly from the lower edge of the internal oblique muſcle of the abdomen.

It is covered by a very fine cellular membrane, detached from the outſide of the aponeuroſis of the obliquus externus, round the opening commonly called the *ring*. This membrane is loſt in the cellular ſubſtance of the inſide of the dartos.

From all this we ſee, that the cremaſter is rather a Tuſcle of the tunica vaginalis than a particular coat. thoſe among the ancients who believed it to be a coat called it *tunica erythroides*, from a Greek word which ſignifies *red;* but this muſcle is not always red, neither is that colour eſſentially neceſſary to a fleſhy ſubſtance.

Teſtes. The teſtes are two glandular bodies, ſituated near each other, without the abdomen, below the interſtice between the groins in an adult. The ancients named them *didymi* or *gemini*. Their ſize is nearly that of a pigeon's egg, and they are of an oval figure, a little flatted at each ſide. But they are frequently unequal in ſize in the ſame perſon. Fabricius ab

Acqua-

Acquapendente, was consulted frequently by persons who belived they had got a diseased testicle, because it was larger than the other one; but, upon examination, it was found they had no inconvenience from it. We may consider in each testicle two extremities, two edges, and two sides. One extremity is situated forward and a little upward, the other backward and a little downward; and their edges lie upward and downward.

At the upper edge they have each an appendix, called *epidydimis*, together with which it is involved in several coverings; and they are both suspended in the common covering, called the *scrotum*.

Each testicle is a spermatic gland formed by a vast number of fine whitish tubes, folded and twisted in different manners, and distributed in different fasciculi, between membranous septa; the whole being surrounded by a strong common covering, named *tunica albuginea*.

These septa are disposed longitudinally, divaricating from each other on one side, and approaching on the other. They approach each other along one edge of the testicle, and terminate in a long narrow whitish body, as in a kind of axis.

From thence they divaricate in a regular manner, and are fixed by their opposite edges in the inner surface of the tunica albuginea, of which they appear to be a continuation. This white body may be termed the *nucleus* of the testicle, or by some has got the name of *corpus Highmorianum*.

From this description we see, that all these septa are not of an equal breadth; that the interstices between them are in some measure triangular; and that the extent of the small tubes, which lie therein, must be very considerable. They have been reckoned to amount to many yards, by taking the sum of all their several portions; and they may be easily unfolded by a long maceration, which destroys the delicate substance by which

all their folds and convolutions are connected and tied down

The seminal vessels are serpentine, firm, or solid, and exceedingly small; but have been filled with quick-silver, &c. by several anatomists, and first by Dr Monro, Hunter, and Haller. They are collected into bundles above twenty in number, divided by distinct cells or partitions, which descend from the tunica albuginea to conduct the arteries and veins. In each of these cells there is a seminiferous duct to convey the secreted humour from the testicle. The ducts form a net-work, adhering to the surface of the albuginea, and forming inosculations one with another. From the said net, in the upper part of the testicle, ascend ten or twelve ducts; which being contorted together into folds, form as many vascular cones, that are joined together by an intermediate cellular substance; and, lying incumbent one upon another, there form the

Epidydimis, which goes round the outer and posterior margin of the testicle, to which it adheres by its thicker head, joined with a good deal of cellular substance: While in its lower, middle, and more slender part, it adheres in some measure, and is in part free; in such a manner that it intercepts a sort of impervious bag betwixt itself and the testicle. The vascular cones, at the upper part of the epidydimis, by degrees uniting, form at length one duct, which composes the greater part of the testicle (*see* Monro de Testibus), and which grows larger as it descends, being largest at the bottom of the testicle; from whence again ascending along the posterior face of the testicle, in a direction contrary to itself, it by degrees spreads open its spiral convolutions, and comes out much larger, under the name of *vas deferens*.

The epidydimus thus formed, may be reckoned a production of the testicle, or a kind of testis accessorius; and it resembles in some measure an arch supported by its centre or frame. It is more contracted

at

at the middle than at the extremities, by which it is closely united to those of the testicle.

Between its extremities it does not immediately touch the testicle; but is only loosely connected to it by the duplicature of a very fine and almost transparent membrane, as by a kind of ligament. This membrane is the continuation and duplicature of the tunica albuginea, or proper coat of the testicle; which having supplied the place of a ligament to the epidydimis, afterwards invests it.

The epidydimis is flat, a little concave on the under side or that next the testicle, irregularly convex on the upper side or that turned from the testicle: and these two sides are distinguished by two angular edges; by the innermost of which it is connected to the testicle in the manner already said, but the outer edge and flat side are loose and free.

The anterior extremity or head of the epididymis arises from the testicle; and the posterior extremity or tail, which likewise adheres very closely to it, is incurvated from behind, forward and a little upward, and contracting by degrees forms the *vas deferens*. Besides the ducts commonly described in the epidydimis, late anatomists have sometimes found a duct wandering off from the epidydimis; but its termination was not well understood. It was supposed to terminate in the lymphatic system; but in a few subjects Dr Monro has found such a duct arising from one end of the epidydimis and running into the other end.

By this description of the extremities and edges of the epidydimis, Winslow demonstrated, many years ago, a method to discover whether a testicle, viewed extra situm, belongs to the right or left side.

The spermatic vessels. The spermatic arteries go out most commonly from the anterior part of the inferior aorta, near each other, and about an inch lower than the arteriæ renales. Their origin oftentimes varies: for I have observed them to arise from the renal artery; and

and ſometimes they go out higher, lower, or more laterally than is common, and each artery has been ſeen to ariſe from different places. Sometimes there are two on each ſide, one ariſing a little below the other; or at other times one comes from the aorta, the other from the renal artery on the ſame ſide; and here they give off branches to the cremaſter muſcle, &c.

They run down obliquely in the poſterior part of the abdomen within the cellular ſubſtance of the peritonæum, paſſing inſenſibly from behind forward; and ſo parting gradually more and more from the aorta, they croſs over the foreſide of the ureters, and run through the openings or rings of the abdominal muſcles along with the elongations or productions of the cellular portion of the peritonæum.

They are ſmall at their origin; and, in their courſe downward, they give off pretty conſiderable latteral ramifications, to the membrana adipoſa, peritonæum, and alſo to the meſentery, where they ſeem to communicate with the meſenteric arteries. After producing numerous branches to theſe parts their ſize is not diminiſhed: ſometimes, on the contrary, it is much increaſed, owing ſeemingly to the arteries, which are very long, and their coats thin, not being ſufficiently able to reſiſt the preſſure of the blood.

They ſometimes paſs through the areolæ or meſhes of the ſpermatic veins; and before they go out of the abdomen, they are divided into very fine rami, which run in a more or leſs winding courſe, almoſt parallel to each other.

Afterwards they enter the cellular productions of the peritonæum, which ſerve them for vaginæ. They do not fluctuate indifferently from one ſide to the other of theſe vaginæ; but are connected along their inner ſurface by thin membranous laminæ, which are likewiſe continuations of the cellular ſubſtance of the peritonæum.

The arteries continue the ſame winding courſe within

in theſe vaginæ, paſſing before the vaſa deferentia, which are likewiſe contained in them; and at length they terminate by ramifications in the epidydimis and teſtes, in the manner that ſhall be afterwards explained.

The ſpermatic veins accompany the arteries, and have nearly the ſame courſe. The right vein ends commonly in the trunk of the vena cava, and ſometimes it ends in the union of the right renal vein with the vena cava, and ſometimes three veins on the right ſide end ſeparately in the trunk of the vena cava. The left ſpermatic vein ends moſt commonly in the vena renalis ſiniſtra.

After getting into the abdomen they receive a branch which communicates with the vena meſeraica, and conſequently with the vena porta. A little higher, but below the place where they croſs over the ureters, they receive a conſiderable branch, one of which communicates with the vena capſularis, the other frequently with the vena renalis; and in their whole courſe thro' the abdomen, they receive branches from the peritonæum, meſentery, &c.

They differ from the ſpermatic arteries, not only in that they are larger, and their coats thinner, but alſo in being more divided and multiplied in the abdominal muſcles; and as they are formed of a larger faſciculus of ramifications, the ancients gave to them, and to the arteries, the name of *vaſa pyramidalia*.

Theſe ramifications often commuicate with each other in this courſe, and form a great number of areolæ, contortions, and convolutions, ſo as to repreſent a kind of plexus, which is connected to the cellular vagina of each ſide by very fine laminæ; and the artery which accompanies the vein croſſes it in ſeveral places, and runs through the areolæ in different directions. Theſe frequent convolutions gave riſe to the name of *vaſa pampiniformia*, formerly given to theſe veſſels; and their particular adheſions to each other at ſome places,

places, made it believed that there were real anaſtomoſes between the artery and the vein.

Leal Lealis, an Italian anatomiſt, not attending to the lateral ramifications of the ſpermatic arteries and veins, believed himſelf able to eſtabliſh and demonſtrate theſe pretended anaſtomoſes. The experiments made by him on living animals prove nothing. His way was, to make a common ligature on both veſſels a little above the teſticle, and another on the trunk of the vein, after he had emptied it. Then preſſing the aorta to force the blood into the ſpermatic artery, the vein which he had before emptied was found to be preſently filled.

From thence he concluded, that the courſe of the blood to and from the teſticle being obſtructed by the inferior ligature, there muſt be ſome anaſtomoſes between the two ligatures, through which the vein was ſupplied with blood. But it is very plain, that this effect was owing to the lateral ramifications of the ſpermatic artery and vein, and not to his pretended anaſtomoſes. Theſe fine lateral ramifications were well known to Euſtachius, but had eſcaped Leal Lealis.

Vaſa deferentia. The vaſa deferentia are two white ſolid flatted tubes; one lying on the right ſide, the other on the left. From the epidydimis, of which they are continuations, as has been already ſaid, each of them runs up in the cellular vagina of the ſpermatic veſſels, as high as the openings in the abdominal muſcles; the blood-veſſels lying forward, and the vas deferens behind them.

This faſciculus thus formed, by the blood-veſſels, vas deferens, and their common covering, is termed the *ſpermatic rope.* The covering is ſmoother on the outer than on the inner ſide; and for that reaſon it has been looked upon as a vagina; the internal ſubſtance of which is moſt cellular, and connects all the veſſels together, while the external forms a covering to inveſt them.

The

The vas deferens having reached the membranous lamina of the peritonæum, where that lamina runs over the orifice of the vagina, ſeparates from the blood-veſſels, and runs backward, in form of an arch, in the cellular ſubſtance of the peritonæum, as far as the neareſt ſide of the bladder.

It paſſes afterwards behind the body of the bladder, to which it adheres very cloſely, as alſo to the lamina of the peritonæum which covers it, and then continues its arched courſe towards the neck of the bladder, where both vaſa deferentia meet, and their arches terminate.

In this courſe, the vas deferens paſſes behind and croſſes the neighbouring umbilical artery; croſſes the extremity of the ureter of the ſame ſide, in its paſſage between that extremity and the bladder; and having got behind the bladder, it meets the vas deferens of the other ſide between the inſertions of the ureters, and they run down together to the neck of the bladder.

This canal, which at the origin of the epidydimis is pretty large and plaited, becomes immediately afterward ſmaller and ſmoother, and continues in that form till it gets behind the bladder, where it begins again to be larger and more uneven.

It ariſes from the angular portion or poſterior extremity of the epidydimis; and from thence runs forwards in a very oblique courſe, on the poſterior half of the epidydimis, where it is a little incurvated as it joins the back-ſide of the ſpermatic veſſels.

The texture of the ſmooth portion of this canal is very ſolid, and in a manner cartilaginous, eſpecially near the ſurface of its cavity; which, though very narrow, is ſtill kept open by means of the ſolidity and thickneſs of its ſides.

The cavity of the vas deferens is cylindrical, though the whole tube is flat, and its external circumference oval, as may be ſeen by cutting it tranſverſely; and the cavity enlarges as it paſſes behind the bladder. The

termination of these canals must be referred to the history of the urethra.

Vesiculæ seminales. The vesiculæ seminales are soft whitish knotted bodies, about three or four fingers breadth in length, one in breadth, and about three times as broad as thick, situated obliquely between the rectum and lower part of the bladder, in such a manner, as that their superior extremities are at a distance from each other, and their lower extremities are contiguous.

They are irregularly round on the upper part, and their breadth decreases gradually from thence. By the union of their lower extremities they form a kind of fork, the branches of which are broad, and bent like rams horns. These extremities are very narrow, and form a small neck, which runs behind the bladder toward its orifice, and continues its course in the groove of the prostates, through the substance of the contiguous portion of the urethra, till its extremities pierce the caruncula in the manner already said.

The inner substance of the vesiculæ is plaited, and in a manner distinguished into several capsulæ by contorted folds. Their external surface is covered by a fine membrane, which serves for a border and frænum to the folds, and is a true continuation of the cellular substance of the peritonæum. The vesiculæ may easily be unfolded, and all their contortions straightened; and by this means they become much longer than in their natural state.

Their inner surface is villous and glandular, and something similar to the inner surface of the gall-bladder, or like the cells of a honeycomb. This furnishes a particular fluid, which exalts, refines, and perfects the semen, which they receive from the vasa deferentia, and of which they are the reservatories for a certain time.

The passage of the vasa deferentia into the vesiculæ is very particular. We have already observed, that these canals

canals are incurvated behind the bladder, and that their contracted extremities unite at that place. They unite in an angle, and run between the contiguous extremities of the veſiculæ; and this union is ſo cloſe, that the adhering portion ſeem to form only one middle ſeptum, between two ſmall tubes; each of which is formed, partly by the extremity of one vas deferens, and partly by that of the neighbouring veſicula.

This lateral union of the extremities of the vas deferens, and veſicula ſeminalis on each ſide, forms likewiſe a kind of ſhort ſeptum, which terminates in a creſcent, like a ſmall ſemilunar valve; and the extremity of the vas deferens is narrower than that of the veſicula. By this mechaniſm, the fluid contained in each vas deferens has liberty to enter the contiguous veſicula; but that contained in the veſicula cannot return into the other canal.

If we blow into one of the vaſa deferentia, after having compreſſed the urethra, the air inflates the contiguous veſicula ſeminalis, and the bladder of urine, without paſſing into the veſicula or canal of the other ſide, except we blow with too great violence.

Afterwards the two ſmall tubes, formed each by the extremities of the vas deferens and veſicula, run in between the baſis of the proſtates and canal of the urethra; and perforating the ſides of that canal obliquely, they terminate in the caruncula in the manner already ſaid. That of the right has no communication with that of the left.

The veſiculæ ſeminales receive their blood-veſſels from thoſe which ſupply the rectum and bladder. They have lymphatic veſſels which carry off the thinneſt part of the ſemen into the circulating ſyſtem.

Proſtatæ. The firſt portion of the urethra, or that which is not covered by the cavernous ſubſtance, and which from the bladder to the bulb is only a membranous canal, is ſuſtained by a large ſolid whitiſh maſs, of the figure of a cheſnut, and ſituated between the bladder

der and the bulb of the urethra; its basis being toward the bladder, the apex or point toward the urethra, and the sides lying upward and downward.

This body is termed the *prostates*, from a Greek word that expresses its situation before the vesiculæ seminales, and implies a plurality, because it appears to be divided into two lateral lobes by a hollow groove, which runs through its upper side from the basis to the apex. The first portion of the urethra lies in this groove, adhering very closely to the prostates which surround it for about half an inch in length; but there is only a very small part of the prostate upon the fore-side of this passage.

The body of the prostates lies on the intestinum rectum, and the apex is under the internal labium of the cartilaginous arch of the ossa pubis. The inner substance is spongy, but very compact; and in each lobe there are several folliculi, which open into the first portion of the urethra, toward the bottom of the groove, as we shall see hereafter. The small portion of the urethra, between the apex of the prostates and the bulb, perforates a ligamentary substance, which is situated at the under and back part of the symphysis pubis. This portion is very short, its length being no more than what is sufficient to pass through the hole in the ligament; the backside of which consequently touches the apex of the prostates, and its foreside the bulb of the urethra. This portion might be called the *neck* of the urethra, and that which lies between the body of the bladder and the prostates might be called the *neck* of the bladder.

Glans. The spongy substance of the urethra having reached the extremity of the corpora cavernosa, forms a large head called the *glans*, which crowns the three spongy pillars; with this difference, however, that it is a continuation of the spongy substance of the urethra, and only adheres to the extremity of the corpora cavernosa, without any direct communication.

It is for this reaſon, that if we blow into the ſpongy ſubſtance of the urethra, the glans is preſently inflated, and no air paſſes into the corpora cavernoſa: but when we blow into one of theſe bodies, the air paſſes immediately into the other, the urethra and glans remaining as they were.

The figure of the glans is that of a rounded cone, a little flattened at the lower part, and with an oblique prominent baſis; the circumference of which is ſomething greater than that of the corpora cavernoſa.

The ſpongy ſubſtance of the glans is thick and uniform next the corpora cavernoſa; but next the urethra it is perforated by a continuation of that canal, and is there no thicker than the urethra before the formation of the glans.

Therefore the canal of the urethra does not lie in the middle of the glans; but continues its direct courſe through the lower flat ſide of it, all the way to the extremity, where it terminates by an oblong orifice.

All the convex ſurface of the glans is covered by a fine villous ſubſtance, and that again by a fine membrane, reſembling the red part of the lips. The circumference of the baſis of the glans has a double row of ſmall papillæ, which may be reckoned ſebaceous glands, from which a thick matter is diſcharged.

Caruncula. We have ſeveral things to take notice of in the cavity of the urethra. At the bottom of the cavity of the firſt portion, or that which lies within the proſtates, there is a ſmall oblong oval eminence, pretty large on the back part, and terminating forward in a point, called *caruncula*, or *verumontanum*. The large portion of it is commonly perforated by two holes, ſometimes only by one, and very ſeldom by three; and theſe are the excretory orifices of the veſiculæ ſeminales; of which hereafter. Each orifice has a ſmall thin membranous border, which may ſerve for valves to the excretory ducts of the veſiculæ.

On each ſide of the large portion of the caruncula,

there are five or six holes ranked in form of a crescent round its lateral parts, which are the orifices of the excretory ducts of the prostates that come from the folliculi already mentioned, and run in an oblique course to the orifices, in a kind of membranous duplicature.

Corpora cavernosa. The corpora cavernosa are two ligamentary and very limber tubes, united laterally to each other through the greatest part of their length, and solid at their two extremities; two of which are connected together, and rounded like the end of a finger; the other two divaricate, like the branches of the Greek T; and, diminishing gradually in size after the divarication, terminate in an oblique point. These divaricated and pointed extremities may be called the *roots*, and the round extremities the *heads*.

These two bodies are almost cylindrical, being round, and of an equal diameter from the roots to the heads, where they are in some measure conical. The ligamentary substance of their sides is elastic, and composed of fine close fibres; which are partly transverse, and partly more or less oblique.

The cavity of these ligamentary tubes is entirely filled by a strong cellular or cavernous substance, which does not seem to be a continuation of the substance of the sides. These cells communicate with each other, and are always more or less full of blood, resembling pretty much the cellular substance of the spleen, only with this difference, that the sides of the cells are thicker in these cavernous bodies, and without any additional substance.

By the union of the two corpora cavernosa, two external grooves are formed; one on the upper side, the other on the lower. The lower groove is something broader than the upper; and it is filled through its whole length by a third tube, narrower than the corpora cavernosa, called the *urethra;* which shall be presently described.

The roots of the corpora cavernosa are fixed, each, to

to the edge of the ſmall ramus of the iſchium and os pubis. They meet at the ſymphyſis of the oſſa pubis, where each of them becomes a cylindrical tube, and unites with the other in the manner already ſaid.

The heads or rounded extremities join the baſis of a diſtinct body, called the *glans*, which is an expanſion of the urethra, and cloſely united to it in the manner that ſhall be explained hereafter.

By the union of the corpora cavernoſa from their roots to their round extremities or heads, a particular ſeptum is formed by the tranſverſe fibres of both. Between the fibres of this ſeptum ſeveral ſmall void ſpaces are left, by which the corpora cavernoſa communicate with each other; and therefore, by blowing into one of them, we preſently inflate the other. Toward the rounded extremities the ſeptum diminiſhes every way.

Urethra. The urethra is the third ſpongy tube which compoſes the penis; and it adheres to the corpora cavernoſa, through the whole length of the inferior groove formed by their union. It differs from the other two, both as it is narrower, and as it forms a true hollow canal. Its ſubſtance is ſpongy or cavernous, except a ſmall portion next the bladder; and its inner and outer ſurfaces are membranous. It extends from the neck of the bladder to the extremity of the penis.

It is at firſt no more than a membranous canal continued from the anterior opening of the bladder, at the place called the *neck* of the bladder, which is a name that would be more proper for this portion of the urethra. It deſcends from its origin to the under end of the ſymphyſis pubis; then it aſcends before the ſymphyſis to the root of the penis; and at laſt redeſcends to the point of the glans.

About a finger's breadth from this part, it joins a cavernous ſubſtance like that of the two other tubes, only ſmaller, which ſurrounds it through the whole extent of the inferior groove of the corpora cavernoſa.

But before this ſpongy ſubſtance begins to ſurround

the urethra, it forms a distinct oblong body, like a pear, which is connected only to the lower convex side of the canal; and afterwards being split on each side, invests it quite round. This body is called the *bulb* of the urethra, being larger than any other part of that canal, and divided interiorly by a very fine membranous septum into two lateral parts; and therefore, when it is inflated, it appears to be double, or with two heads.

Lacunæ of the urethra. The inside of the canal of the urethra is lined by a fine membrane, full of capillary blood-vessels; and its surface is perforated by a great number of oblong holes, or small lacunæ of different sizes, the largest lying near the glans.

These lacunæ or orifices of the excretory ducts of the same number of small glands, are dispersed through the substance of the urethra: which ducts run for some way in the spongy substance along the convex side of the internal membrane of the urethra, and open obliquely from behind forward into the great canal. The edges of the lacunæ are semilunar, or like a crescent, because of the obliquity of their opening.

Anti-prostatæ. A little way before the verumontanum, without the urethra, we meet with two lacunæ more considerable than the rest, and their ducts are very long. These lacunæ and ducts lead to two glandular bodies, situated, one on each side, between the posterior and lateral parts of the musculi acceleratores urinæ, and the bulb of the urethra. Each of them is about the size of a garden pea; but they are oblong and flat, and covered entirely by the accelerator muscles. They are known by the name of *prostatæ inferiores;* but if their situation be carefully examined, they will be found to be higher than the true prostatæ. They are likewise termed *glandulæ mucosæ of Cowper*, who has given a description of them (*See* Phil. Transf. 1699); but they were first described by Mery in 1684. They seem

ſeem to be a-wanting in ſome ſubjects; for certain anatomiſts of accuracy have ſearched for them without finding them. A third gland of this kind is deſcribed by Cowper as being ſeated a little more anteriorly; but this alſo, Heiſter obſerves, is wanting in bodies diſſected by our beſt anatomiſts.

Orifice of the urethra. The cavity of the urethera reſembles nearly that of a ſmall writing-pen. It is not every where round, and towards the glans becomes broader and flatter on each ſide, eſpecially in the glans itſelf, where there is a kind of oval or navicular foſſula.

This canal terminates at the extremity of the glans by a narrow oblong orifice or fiſſure, which is much leſs than the reſt of the cavity. The commiſſures of this ſmall fiſſure are turned, one toward the convex, the other toward the flat ſide of the glans; and the labia of the fiſſure are its lateral parts; and it ſeems to be ſurrounded by fleſhy fibres.

The common integuments. The integuments which cover all theſe parts are three or four in number. The firſt is the ſkin with the cuticula; the ſecond is the common cellular membrane, which in this place ſeldom contains any fat; the third is termed *nervous;* and the fourth is a particular cellular membrane, which is not always to be found.

Præputium. The firſt of theſe integuments, the ſkin, is a continuation of that of the pubes and ſcrotum; and it adheres to the ſecond all the way to the baſis of the gland, where that ſecond integument ends. The reſt of the cutaneous integument covers the glans without adheſion, and terminates by an opening. This portion is named *præputium;* and along the whole lower or back ſide, both of the whole integument in general, and of the præputium in particular, there runs a fine ſuture, which is a continuation of the raphe of the perinæum and ſcrotum.

The inner ſurface of the præputium is lined with a fine membrane from the opening all the way behind the baſis of the glans, and the ſame membrane is folded from behind, forward, round the glans, forming the proper integument thereof, and covering very cloſely its whole villous ſurface, as far as the orifice of the urethra, where it joins the membrane which lines the inſide of that canal.

This proper membrane of the glands, and internal membrane of the præputium, form conjointly along the flat part of the glans, from its baſis to the orifice of the urethra, a membranous duplicature, which like a ſeptum or mediaſtinum divides this part into two lateral portions, and limits the motions of the præputium; for which reaſon it is called *frænum præputii.*

The ſurface of the internal membrane of the præputium diſcharges a fluid which prevents it from adhering to the glans, and perhaps ſerves likewiſe to dilute that which is collected at the baſis of the glans, from the glandulæ ſebaceæ, already mentioned.

The ſecond common integument of theſe parts, is nearly the ſame with what is every where found under the ſkin, except that it is not filled with fat, and that it is more fibrous than cellular, and a little looſe. It accompanies the ſkin to the baſis of the glans, as has been already obſerved.

Ligamentum ſuſpenſorium. The third common integument, improperly called *tunica nervoſa*, is of a firm, elaſtic, ligamentary ſubſtance, and its fibres are ſometimes of a yellowiſh colour. It inveſts the corpora cavernoſa and urethra from the glans to the ſymphyſis of the oſſa pubis; and at ſome diſtance from theſe bones, it forms on the ſuperior groove of the corpora cavernoſa a cloſe duplicature; and by this duplicature, a flat broad ligament which runs directly upward, and is inſerted in the forementioned ſymphyſis, as far as the tendinous

tendinous baſis of the muſculi pyramidales of the abdomen.

This ligament has been called *ligamentum elaſticum*, becauſe it yields and recovers itſelf; and *ſuſpenſorium*, becauſe it ſuſpends theſe parts, by means of its inſertion in the ſymphyſis. It ſends off a detachment or ala toward each ſide, one edge of which is fixed between the muſculus triceps and the corpus cavernoſum, and forms the ligamentary expanſion in which the dartos is inſerted, as has been already ſaid. It ſeems likewiſe to ſend down another elongation directly to the perinæum and anus.

The fourth integument of theſe parts is the tunica celluloſa of M. Ruyſch, which immediately ſurrounds the corpora cavernoſa and urethra, lying between theſe and the third integument, from which it ſeems to be diſtinguiſhed only by the cloſeneſs and fineneſs of its texture; and it is ſometimes hardly perceivable.

The muſcles. Several muſcles are inſerted in the parts which we have juſt deſcribed. They may be reckoned to be ſix in number, two for the corpora cavernoſa, two for the urethra, and two common muſcles called *tranſverſales*. (*See* Vol. I.)

Blood veſſels. The arteries of theſe parts come chiefly from the iliacæ internæ or hypogaſtricæ, and the reſt from the iliacæ externæ or crurales. The principal arteries are termed *pudicæ*, of which one is external, the other internal.

The pudica externa ſends a branch to each ſide, which having paſſed out of the pelvis by the ſide of the os ſacrum, runs on the inſide of the tuberculum iſchii, to the roots of the corpora cavernoſa, along the inſide of the muſculi iſchio cavernoſi or erectores. It ſends ramifications to the bulbous head of the urethra and to the corpora cavernoſa; and together with the gluteæ, with which it communicates in its paſſage, it likewiſe ſupplies the ſcrotum.

The pudica interna having furniſhed the inteſtinum

rectum, bladder, veſiculæ ſeminales, and proſtates, communicates with the hæmorrhoidales, paſſes under the arch of the oſſa pubis, and partly enters the corpora cavernoſa, and partly runs along their upper ſide, ſending off ſmall lateral branches, which ſurround theſe bodies, like irregular half arches, and penetrate them by numerous ramifications.

The crural arteries ſend each likewiſe a branch, which, running behind the contiguous crural vein, is diſtributed to the integuments of the penis, by the name of *pudica externa*, and communicates, by lateral ramifications, with thoſe of the pudica interna. Theſe communications are not only between the internal and external pudicæ of the ſame ſide, but alſo between thoſe of both ſides, which reciprocally communicate with each other.

The diſtribution of the veins follows nearly that of the arteries; but they have more ramifications and communications, as in other places. The principal vein is that which runs along the whole ſuperior groove formed by the union of the corpora cavernoſa. It paſſes directly under the ſymphyſis of the oſſa pubis, between the two arteries. It is very large, often double, and very ſeldom triple, but the trunks do not ſeparate while in the groove; and it has a great number of valves.

This great middle vein opens into the branches of both hypogaſtric veins. The lymphatic veſſels of the penis appear to go chiefly into the plexus in the groin, on the two inner ſides of the pelvis, about the middle of the arch of the oſſa pubis. At this place we obſerve a venal plexus, which covers the upper convex ſide of the firſt portion of the urethra, before it is ſurrounded by the ſpongy ſubſtance.

The ſpermatic veſſels, of which we have already deſcribed the origin and courſe all the way to where they go out of the abdomen, having reached on each ſide near the teſticle, are divided into two principal faſciculi, one

of

of which is larger than the other. The largeſt is the anterior, and is diſtributed through the teſticle, by a prodigious number of very fine capillary ramifications, which accompany all the convolutions and folds of the ſmall canals.

The other faſciculus is poſterior, and is diſtributed to the epidydimis in the ſame manner.

The ſpermatic artery is accompanied by a ramus of the epigaſtric artery, which runs down on the ſide of it as far as the teſticle, where they communicate reciprocally with each other. There is ſometimes a ſmall ramus of the hypogaſtric artery, which accompanies the vas deferens to the epidydimis, and there communicates with the arteria ſpermatica. The teſticle has likewiſe numerous lymphatic veſſels, which run in the ſpermatic cord, and join the lymphatics of the pelvis and loins.

Nerves. The nerves of theſe organs come from the lumbares and ſacri; and they communicate with the ſympatheticus maximus, and plexus meſenterici. Near the arch of the os pubis, they form together, on each ſide, a particular rope, which paſſes under that arch along the upper ſide of the neighbouring corpus cavernoſum, near the artery already mentioned.

In their paſſage over the corpora cavernoſa, they ſend off a great many rami, which ſurround theſe bodies on all ſides, between the ſkin and ligamentary integument; being ſo diſpoſed, as that the arteries lie between them and the middle vein. They muſt be examined preſently after the ſkin has been raiſed, becauſe when the ramifications are dried by the air, they diſappear.

The nerves of the teſticle are very ſmall. They are formed by the renal and meſenteric plexus. The nerves of the loins ſend ſmall branches likewiſe along with theſe. They run along the ſpermatic cord; but it is exceedingly difficult to trace them into the teſticle.

There is likewiſe one nerve on each ſide; which being

ing produced from the union of the second, third, and fourth pairs of the nervi sacri, especially from the third, goes out of the abdomen above the ligamentum ischio-sacrum, passes by the inside of the tuberosity and small branch of the os ischium, and is distributed to the corpora cavernosa, to the muscles belonging to them, and to the neighbouring parts.

§ 4. *Secretion of the Semen.*

THE vessels belonging to the genitals constantly arise near the kidneys, and almost in all kinds of animals; by which nature seems to have intended a double usefulness in one organ, which might be able to discharge the urine and semen, and to bear a relation likewise to the genital parts, though placed at a considerable distance, in a space betwixt the tops of the thighs, and subservient to cleanliness, modesty, easiness of birth, and the force of straining in delivery.

The semen masculinum is first formed in the testicle; then reposited in the seminal vesicles; afterwards ejected from the penis into the uterus, where it renders the female ovum prolific: and therefore this must be the order of our inquiry into these particulars.

The testicle is defended by various integuments, and is composed of various kinds of vessels and of nerves.

The blood, moved slowly and in a small quantity through the spermatic artery, by which it is brought to the inner fabric of the testicle, is there drained into very small vessels, which carry their fluids to the *seminal vessels*, although we are ignorant of the manner by which the arteries communicate with these canals, the bundles of which form the whole substance of the testicle. These seminiferous vessels are exceeding small, serpentine, firm, or solid, and have a very small light in proportion to their membranes. They are collected together into bundles, about twenty in number, divided by

by distinct cells or partitions, which descend from the albuginea to conduct the arteries and veins. In each of these cells there is a seminiferous duct, to convey the secreted humour from the seminiferous vascules. Twenty or more of these ducts form a *net-work*, adhering to the surface of the albuginea, and forming inosculations one with another; and quicksilver is very easily poured from them into the surrounding cellular texture. From that net in the upper part of the epidydimis, ascend twenty or thirty ducts, which, being contorted into folds, form as many *vascular cones*, that are joined together by an intermediate cellular substance; and lying incumbent one upon another, then form the head of the epidydimis, and in that head soon meet together into one duct without the testicle.

This duct being intricately wove by an infinite number of folds and serpentine flexures, after a manner not imitated in any other part of the body, and connected together by a great number of loose cellular strata, is afterwards collected by a membrane of the albuginea into one bundle, called the *epidydimis*. But the duct of which it is composed grows larger as it descends, being largest at the bottom of the testicle; from whence again ascending along the posterior face of the testicle, in a direction contrary to itself, it by degrees spreads its spiral convolutions, and comes out much larger, under the denomination of *ductus deferens*.

This is the course described by the semen, propelled forward by the motion of the succeeding juices in the testicle; and perhaps, in some measure, though slowly, by the contraction of the cremaster: as we may reasonably suppose, from the numberless spires and convolutions formed by the epidydimis, obstructing almost every kind of injection; and, as we may conclude, from the length of time that is required to fill the seminal vesicles again, after they have been once exhausted.

The

The cylindric ductus deferens being made of a very thick ſpongy ſubſtance, included betwixt two firm membranes, bored through with a very ſmall tube, aſcends in company with the cord of the ſpermatic veſſels, and together with them paſſes through the ring of the abdomen: thence it deſcends into the pelvis; and applying itſelf to the bladder betwixt the ureters, it ſoon after meets the ſubjacent receptacles, called the right and left *veſiculæ ſeminales*. Here it goes along the inner ſide of the veſicle, as far as the proſtate glandule; and dilating in its paſſage, forms a ſerpentine flexure, that begins itſelf to put on a cellular appearance. But very near the proſtate, being continued from theſe cellular bendings, with a conical duct coming out from the veſicle, it unites in a very acute angle, which does at the ſame time itſelf form a conical duct; which being continued rather with the vas deferens, and ſinking through the proſtate gland, is there wrinkled into a large fold, and going off outward at right angles from its companion on the other ſide, and afterwards ſtraitened, it opens into the urethra, through a little hollow protuberance, which has a long tail or deſcent, and is laterally perforated with two very ſmall openings, one on each ſide. By injecting a liquor into the ductus deferens of a dead ſubject, we perceive that it flows both into the urethra and into the ſeminal veſicle, but more readily into the former: but in a living perſon the ſemen never flows out but in the act of venery; and conſequently the ductus deferens conveys all its ſemen, without further delay, over a retrograde angle, to the *ſeminal veſicles*.

The liquor depoſited into this reſervoir, is in the teſticle yellowiſh, thin, and watery: and the ſame nature it retains in the veſicle, only becomes there ſomewhat thicker and higher coloured; and laſtly, it is white in mankind, when it has mixed with the liquor of the proſtate. It has a ſort of heavy or ſtrong ſmell, of a peculiar

peculiar kind in each claſs of animals; and it is the heavieſt humour in the human body. In water, however, a part goes off into a kind of cuticle, like a cobweb, that ſwims in the liquid; the greater part, which is ſeemingly of a pulpy nature, falls to the bottom. In the ſemen which is long kept by chaſte people, ſhining globules mixed with the white liquor are eaſily to be ſeen. It has a very great quantity of mucus.

Without the conveyance of this into the womb, according to the opinion of Haller, no claſs of animals, of which there are two ſexes, can be fecundated ſo as to propagate their ſpecies; but Spallanzani has clearly proved, that in certain kinds of the animals commonly called *oviparous* (excepting birds), fecundation takes place without the body of the female. The microſcope ſhows, that in man, as well as in all other male animals, the ſeminal liquor is full of living animalcules, reſembling eels, only with a thicker head; and that theſe are always preſent in healthy ſemen, from the time that a perſon comes of age; but, before that time, and in thoſe who are ſterile from a gonorrhæa, they are abſent. That they are animalcules, appears evidently from their various motions, reſtings, and geſtures of body.

It has been much doubted what could be the uſe of theſe animalcules; and in another place we ſhall conſider the diſpute concerning the opinion that they are as it were the firſt appearance of the future animal. Haller conſiders the nature of the ſeminal animalcules as the ſame with that of the eels in vinegar or paſte.

That the ſemen is produced from the lymph of the blood, and that the chyle is added to the lymph, will appear probable from the ſudden alacrity to venery that happens after eating, and which is leſſened by faſting. It is compounded of the liquor of the teſticles and ſeminal veſſels, the former indeed being more evident in ſome animals, and the coagulable milk of the

proſtate

proſtate gland. That liquor, however, only fecundates which is generated in the teſticles; as we ſee from geldings, which, though they have the ſeminal veſſels and proſtate, are yet barren.

The ſeminal fluid is retained in the veſicles as long as a man neither exerciſes venery, nor ſports in imaginary dreams. But it is always a ſtimulus to the animal appetite of venery, as long as it is there preſent in any quantity. But beſides this, there is a conſiderable ſtrong, volatile, and odorous part of the ſemen abſorbed again into the blood, where it produces wonderful changes as ſoon as it begins to be formed; ſuch as the protruſion of the beard, the covering of the pubes, a change of the voice and paſſions, horns in cattle, &c. for theſe changes in the animal are not the conſequences of age, but of the ſeminal fluid, and are always abſent in eunuchs. The growth and ſtrength of caſtrated animals are conſtantly diminiſhed; and in like manner the fierceneſs of their temper, and the ſtrong ſmell of their whole body, are remarkably weakened. And from the examples of ſome animals, and even of mankind, it appears, that the irritation of this fluid has occaſioned death, by exciting convulſions. A retention of the ſemen may follow from a narrowneſs of the excretory duct, a ſcirrhoſity of the proſtate, and other cauſes not ſufficiently known.

The quantity of ſemen expelled at one time from the human veſicles is but ſmall, more eſpecially in a man who has not long abſtained from venery; and it is natural to think that the liquor can be but ſlowly produced from ſo ſmall a ſubcutaneous artery. Its generation is accelerated by love, by the preſence of the beloved woman; ſo that it diſtends its veſſels with a ſenſe of pain. Nature herſelf, therefore, enjoins venery, both for preſerving the human race, and likewiſe the health of every ſound man. That it comes from the teſticle, is ſhown by diſeaſes; in which the ductus deferens being obſtructed, a ſwelling of the teſticle has enſued.

enſued. The veſicles never are emulged, except by venereal actions and appetites.

Seeing the ſemen is in ſmall quantity, that it might be projected with a greater force, and to a farther diſtance, nature has joined another humour, which is generated by the *proſtate;* which prepares a thick, white, ſoft, or cream-like liquor in a large quantity, which is poured out at the ſame time and from the ſame cauſes with the ſemen itſelf, into a little valley or channel at each ſide of the openings of the ſeminal veſicles, where, mixing with the ſeminal fluid, it imparts the white colour and viſcidity which the ſemen poſſeſſes.

But it was neceſſary for this canal of the urethra to be firm and capable of a direct figure, that it might be able to throw the ſemen with ſome ſtrength into the diſtant womb; and therefore a threefold cavernous body ſurrounds it.

Into the cavernous body of the urethra, the blood is poured out from the arteries, which come from deep branches ſent off from the external hæmorrhoidals; the truth of which is demonſtrated by the injection of any kind of fluid, which, being urged into the ſaid arteries, eaſily flows into theſe cellular ſpaces ſurrounding the urethra. But theſe are not naturally turgid with blood, becauſe there are veins open and numerous enough in proportion to receive and return what is poured in by the arteries; but if the return is impeded by compreſſing thoſe veins from the powers hereafter mentioned, the blood is then retained within the cellular ſpaces, while the arteries continue to import it more ſwiftly and ſtrongly than the veins return it. Thus the ſtagnant blood diſtends the bulb of the urethra, together with its cavernous body, and the glans itſelf. But this is performed generally at the ſame time, when the other cavernous bodies of the penis, with which this of the urethra has no communication, are likewiſe rigidly diſtended.

These cavernous bodies of the penis, having their spongy fabric distended in coition by the blood retained by the veins, and still propelled by the arteries, become rigidly turgid, and sustain the otherwise flaccid or but weakly filled urethra, in such a manner that it may be able to conduct the semen into the distant womb. All this is demonstrated from the dissection of brute animals in the act of venery, from an artificial erection, and from the injection of liquid matters into the vessels of the penis. The cause is love, the desire of pleasure, the friction of the glans, various irritations of the bladder, testicles, seminal vessels, urethra, from the urine, from abundance of good seed, from the venereal poison, from cantharides, whipping with rods, or convulsion of the nerves. But the cause of this distention remains still to be explained.

In order to distend the penis, there must be either a compressure of the vein, bringing back the blood from the cavernous bodies of the penis or urethra; or at least it is necessary that there be a constriction of the lesser veins that every where open within the cavernous bodies, to hinder them from absorbing and returning the blood from the arteries. The first, however, may be effected by the levator, drawing up the prostate and bladder: but it is very probable, that, as we see in the nipples of the suckling mother, in the gills of the peacock, and in the blushing or redness of the face from passions of the mind, as well as from brute animals, which all couple without the use of any erector muscle; from the erections which take place in animals totally different from man, and especially those which take place in birds very quickly; from the rest of the erector muscles themselves in the libidinous erection of the penis, and from their unfitness for compressing the veins; from all these, we say, it is probable, that the course of the blood through the vein may be retarded without the immediate use of any muscle; and that by the power of the numerous, small, latent, nervous bridles,

bridles, by whoſe conſtriction, from the force of pleaſure, the veins are compreſſed and ſtraitened, ſo as to return leſs blood to the trunks, at that time, than what is imported by the arteries, which are not only free from any ſtricture, but, by the increaſe of pulſation, bring a greater quantity of blood, which cauſe alſo contributes to produce the erection. But the cauſe of this conſtriction in the nervous bridles or ſpincters themſelves depends upon a mechanical irritation of the nerves, and from ſomething more ſubtle, by which means the penis is immediately erected.

A long continued and violent erection is at laſt joined commonly with an expulſion of the ſemen; and this requires much greater force than is requiſite for the erection only. For the ſemen follows at that time when the irritation of the nerves is arrived at its greateſt height: and in natural venery indeed, when at length the cellular ſpaces of the urethra and its continuous glans, which are at laſt filled, become ſo far diſtended with a large quantity of warm blood, that the nervous papillæ, ſtretched out in the latter, become violently affected from the irritating or pleaſing cauſe; the ſeminal veſicles are emptied by the levator muſcles of the anus, which preſs them againſt the reſiſting bladder with a convulſive motion, excited either by a voluptuous imagination, or from the pruritus that is exquiſite in the nerves of the glans, principally in its lower part, which is in the neighbourhood of the frenum. Hence the ſemen is never diſcharged with any of the urine, in an healthy man; becauſe the expulſion of it requires the bladder to be cloſed or drawn up firmly together; for, while lax, it affords little or no reſiſtance to the ſeminal veſicles. The tranſverſe muſcles ſeem to dilate the canal of the urethra for the reception of the ſemen expreſſed from the veſicles.

Soon afterwards the powers conſtringing the urethra are, from the irritation of the very ſenſible fabric of that canal, put into action. To this conſtriction con-

duces principally the accelerator, which makes a powerful concuſſion of the bulb and adjacent part of the urethra, ſo as to propel the contents more ſwiftly, in proportion as the bulb has a larger diameter than that of the urethra. But that this may act firmly, the ſphincter of the anus, together with that of the bladder, muſt be well ſhut. The accelerator muſcle ſeems alſo principally concerned in the erection, by compreſſing the veins of the corpus cavernoſum of the urethra. At the ſame time the *erectores penis*, as they are called, ariſing from the tubercles of the iſchium, become ſtrong, and are inſerted into the cavernous bodies, ſuſtaining the penis as a ſort of medium betwixt the tranſverſe and perpendicular direction. Thus the ſemen is drove into the vagina, and into the uterus itſelf, in a prolific coition: the whole action of which is very impetuous, and comes near to a convulſion; whence it wonderfully weakens the habit, and greatly injures the whole nervous ſyſtem, as the maladies ariſing from thence ſeem to indicate, in conſequence of the affection of the nerves, without which the ſemen cannot be expelled.

§ 5. *The Parts of Generation in Females.*

The parts of generatioon in females are ſeveral in number, ſome of them external and ſome internal; and they are all ſubordinate to one principal internal part, called the *uterus*. The other internal parts are the tubæ Fallopianæ, ovaria, vaſa ſpermatica, ligamenta lata, the ropes or bands called *ligamenta rotunda*, and the canal of the uterus. The external parts are the pubes, the alæ nymphæ, clitoris, orifice of the urethra, and orifice of the vagina.

Uterus. The uterus lies between the bladder and the inteſtinum rectum. It is a body inwardly hollow, outwardly of a whitiſh colour, of a pretty ſolid ſubſtance, and, except in time of pregnancy, of the figure of a flat

flat flask, being in adults about three fingers breadth in length, one in thickness, and two in breadth at one end, and scarcely one at the other. This size varies, according to the age of the subject.

The broadest portion is termed the *fundus*, and the narrowest the *neck*. Its situation is oblique, the fundus being turned backward and upward, and the neck forward and downward; the broad sides lie next the rectum and bladder, and the narrow sides are lateral.

The cavity of the uterus is flat; and resembles an oblong triangle, the shortest side of which answers exactly to the fundus; and the two longest sides lie one on the right hand, the other on the left; and they are all bent inward, or toward the cavity formed by them.

Of the three angles of this cavity, the two which terminate the fundus are perforated each by a narrow duct, which with difficulty admits a hog's bristle. The third angle forms a flat duct wider than the former, which perforates the neck of the uterus lengthwise, and terminates at the extremity of that neck, by a transverse opening.

This opening is termed *the internal orifice of the uterus;* and in the natural state is narrower than the duct of the colum uteri, so that only a small stilet can be passed through it. At the edge of this orifice are several small holes, answering to the same number of glandular corpuscles, which discharge a viscid lympha.

The inner surface of the cavity of the uterus, is lined by a very fine membrane, which at the fundus or broad portion is smooth and even, but in the narrow portion which leads to the orifice, it is wrinkled in a particular manner.

The portion of this membrane, which covers the bottom of the cavity, is perforated by a great number of considerable holes, through which small drops of blood may be observed to pass, when the whole uterus is compressed; and sometimes it appears to have very small

hairs or villi. Both theſe villi and holes are obſerved to be more or leſs tinged with blood, in thoſe women who die in the time of their menſes.

In the narrow part, which anſwers to the colum, each ſide is divided into two lateral parts by a kind of prominent longitudinal line, which is larger in the upper or anterior ſide, than in the lower or poſterior.

On each ſide of theſe two longitudinal lines, there are lines or rugæ obliquely tranſverſe, and diſpoſed like branches, the longitudinal lines repreſenting trunks. Between and round theſe rugæ, there are ſmall lacunæ, through which a mucilaginous fluid is diſcharged that cloſes the orifice of the uterus. We ſometimes obſerve in the interſtices between the rugæ, ſeveral tranſparent globular corpuſcles, which vary much in ſize. Their nature is not yet well underſtood: they appear to be filled with a mucous lymph. Naboth conſidered them as ova.

Structure of the uterus. The ſubſtance of the body of the uterus is ſpongy and compact, with a copious intertexture of veſſels. Its thickneſs is nearly equal and uniform in the ſides and edges; but the fundus is thicker toward the middle than toward the two angles, where the thickneſs decreaſes gradually. The edges are likewiſe much thinner near theſe angles, than near the extremity of the neck.

The uterus is covered by a portion of the peritonæum, which ſerves it for a coat, and is the continuation of that which covers the bladder and inteſtinum rectum, running up from the lower and poſterior part of the bladder, over the anterior part of the uterus, and from thence over the fundus, and down the backſide, and afterwards going to the rectum.

On each lateral part or edge of the uterus this portion of the peritonæum forms a broad duplicature, which is extended on each ſide, more or leſs directly to the neighbouring lateral parts of the pelvis, forming a kind

kind of membranous ſeptum, between the anterior and poſterior halves of the cavity of the pelvis; and it is afterwards continued in a looſe manner, with the peritonæum, on the ſides of the pelvis.

Broad ligaments of the uterus. Theſe two broad duplicatures have the name of *ligamenta lata*, and *veſpertilionum alæ*. The upper edge of each is partly double, or folded, forming two ſmall diſtinct duplicatures, which may be termed the *pinions of the broad ligaments*. The anterior pinion is more raiſed than the poſterior, and they are both very looſe.

The laminæ of all theſe duplicatures are connected by a cellular ſubſtance, in the ſame manner as the other duplicatures of the peritonæum; and they contain the Fallopian tubes, the ovaria, a part of the ſpermatic veſſels, and of thoſe that go to the body of the uterus; the ropes called the *round ligaments*, the nerves, &c.

Ovaria. The ovaria are two whitiſh oval, flat, oblong bodies, ſituated on the ſides of the fundus uteri, to which they are fixed by a kind of ſhort round ligament, and incloſed, together with it, in the duplicature of the poſterior pinion of the ligamenta lata.

They are compoſed of a compact ſpongy ſubſtance, and of ſeveral little balls, or tranſparent veſiculæ, which are called *ova;* the number of which, according to Dr Haller, is found to be fifteen and upwards; tho' Sabatier ſays they are about ten or twelve, ſometimes more, ſometimes leſs; and that the liquor contained in them has all the qualities of lymph. The ſpongy ſubſtance ſurrounds each of theſe veſiculæ very cloſely, and ſeems likewiſe to furniſh them with diſtinct ſpongy coverings or calices. Theſe veſiculæ are to be carefully diſtinguiſhed from other preternatural ones, termed *hydatides*.

The ligaments of the ovaria lie in the edges of the poſterior pinions of the ligamenta lata, much in the ſame manner as the umbilical vein, in the anterior or

umbilical ligament of the liver. They are round ropes of a filamentary texture, fixed by one extremity to the corner of the fundus uteri, a little above and behind the level of that fundus. They were formerly believed to be hollow, and looked upon as vasa deferentia.

Tubæ Fallopianæ. The Fallopian tubes are two flaccid, conical, and vermiform canals, situated more or less transversely on each side of the uterus, between the fundus and the lateral parts of the pelvis, and included in the anterior duplicatures or pinions of the ligamenta lata.

Each of them is fixed by its narrow extremities in the corner of the fundus uteri, into which it opens, tho' by so narrow a duct, as hardly to admit a large bristle. From thence their diameter augments by degrees all the way to the other extremity, where it is about one-third part of an inch. The body of the tubæ goes in a winding course, and their large extremity is bent toward the ovaria.

These large extremities are irregularly round, and terminate by a narrow orifice, a little plaited and turned toward the ovarium, where it presently expands in form of a membranous fringe, full of plaits and incisures. These fringes are called the *broad ends of the Fallopian tubes.*

The breadth of the fringe is not equal in all parts. Its circumference is in a manner oval, and the longest segment of the fringe reaches to, and is fixed in the ovarium. The folds are disposed like laminæ on the concave side.

These tubes are composed of fleshy fibres, whereof some are longitudinal, and some obliquely circular, with an intertexture of another very fine substance.

The anterior pinions of the ligamentum latum serve for a common or external coat to both tubæ, and also to connect them, in the same manner as the mesentery connects the intestines. From thence the tubæ, and especially

eſpecially their fringes, come to be looſe, and their direction to be very imperfectly determined in the greateſt part of the figures.

Their cavity is lined by a ſoft glandular membrane, which is plaited longitudinally, almoſt like the inner ſurface of the aſpera arteria; and theſe folds are ſtronger and broader near the great extremities, than any where elſe. Their ſubſtance ſeems to be ſpongy, and the interſtices between them are moiſtened more or leſs by a fluid, which is continually diſcharged there.

Blood-veſſels. The blood-veſſels of theſe parts are of different kinds, viz. the hypogaſtric arteries and veins, the ramifications of which belong chiefly to the body of the uterus; the ſpermatic veſſels, and the two vaſcular ropes, called *ligamenta rotunda*, which might be more properly termed the *vaſcular ropes of the uterus* or of the *ligamenta lata.*

The hypogaſtric branches are arterial and venal ramifications, ariſing from the artery and vein of the ſame name; which having reached the lateral edges of the uterus, are diſtributed to all the parts thereof, both internal and external, forming a great number of incurvations and particular intertextures.

The arteries of one ſide communicate both upon the uterus, and through its whole ſubſtance, with thoſe of the other ſide, and the arterial ramifications of each ſide form numerous anaſtomoſes with each other. The veins communicate together on each ſide in the ſame manner; and all theſe blood-veſſels communicate likewiſe with the ſpermatic veſſels, with the vaſcular ropes of the ligamenta lata, and with the hæmorrhoidales.

Theſe frequent anaſtomoſes may be demonſtrated by injecting or blowing into the hypogaſtric veſſels, having firſt made proper ligatures to prevent the liquor or air from running into other parts. The extremities of theſe arteries terminate and open into the cavity of the uterus, as has been already ſaid; and there is this peculiar

culiar to the veins, that they communicate with the hæmorrhoidales, and conſequently with the vena portæ.

The ſpermatic veſſels have nearly the ſame origin in females as in males, and likewiſe the ſame courſe and intertextures; but they never paſs out of the abdomen, being wholly diſtributed to the ovaria and tubes; and they communicate with the uterine hypagaſtrics, and with the vaſcular ropes of the ligamenta lata. The veins are very large in proportion to the arteries; and theſe veſſels ſend out lateral ramifications, which ſeem to communicate with the meſeraicæ and vena portæ.

The vaſcular ropes, commonly called the *round ligaments*, are two long ſmall faſciculi of arteries, veins, and ligamentous fibres, interwoven and connected together by a fine cellular ſubſtance; and they run in the great duplicature of the ligamenta lata, from each corner of the fundus uteri, as far as the annular openings of the abdominal muſcles.

In this courſe, each rope thruſts outward or raiſes the anterior lamina of the duplicature, which conſequently gives a kind of coat to theſe vaſcular faſciculi, and makes them appear like diſtinct ropes connected to this foreſide of the duplicatures.

They ſeem to ariſe from the communication between the vaſa ſpermatica and hypogaſtrica, and might be reckoned a particular continuation of the ſpermatic veſſels. The diſpoſition of their adheſions to the angles of the fundus uteri, with reſpect to that of the tubes and ligaments of the ovaria, which lie all near each other, is this: The tubes lie higheſt, the ligaments of the ovaria moſt backward, and the vaſcular ropes forward, and a little lower than the ligaments of the ovaria.

Afterwards they run in a courſe, nearly reſembling that of the ſpermatic veſſels in males, paſs out of the abdomen, through the openings of the abdominal muſcles, and are loſt in the fat of the upper and middle parts of the groins. As they paſs out of the abdo-

men,

men, they are accompanied by a production of the cellular portion of the peritonæum, as the ſpermatic rope in men, and by a faſciculus of fleſhy fibres, repreſenting a kind of cremaſter.

Nerves, lymphatics, &c. Beſides all the veſſels hitherto mentioned, we obſerve nerves and lymphatics, to which we may add the lactiferous ducts that are ſeen in an advanced pregnancy. The nerves come from the lumbares, ſacri, and ſympathetici maximi, in the ſame manner as in males. The lymphatic veſſels run chiefly in the coats continued from the peritonæum.

Pubis. The pubis is that broad eminence at the lower part of the hypogaſtrium, between the two inguina, on which the hairs grow at a certain age, called in Latin by the ſame name, and almoſt of the ſame kind with thoſe found under the axillæ. This eminence is owing to a particular thickneſs of the membrana adipoſa which covers the fore part of the oſſa pubis, and ſome ſmall portions of the neighbouring muſcles.

Sinus and alæ. The longitudinal cavity which reaches from the middle and lower part of the pubes, within an inch of the anus, was by the ancients termed *ſinus;* and they called the lateral parts of the cavity *alæ*, which is a more proper name than that of *labia*, commonly given to them. The places where the alæ are joined above and below, are termed *commiſſures;* and may likewiſe be called *the extremities* or *angles of the ſinus.*

The alæ are more prominent, and thicker above than below, and lie nearer each other below than above. They are chiefly compoſed of the ſkin, cellular ſubſtance, and fat. The exterior ſkin is a continuation of that of the pubes and inguina. It is more or leſs even, and furniſhed with a great number of glandular corpuſcles, from which a whitiſh ceruminous matter may be expreſſed; and after a certain age it is likewiſe covered in the ſame manner with the pubes.

The inner ſide of the alæ is ſomething like the red portion of the lips of the mouth; and it is diſtinguiſhed every

every where from the external ſide by a kind of line, in the ſame manner as the red portion of the lips from the reſt of the ſkin; being likewiſe thinner and ſmoother than the outward ſkin. A great number of pores are obſervable in it, and alſo numerous glandular corpuſcles, which furniſh a liquor more or leſs ſebaceous; and theſe corpuſcles are larger near the edges than in the other parts.

Lacunæ. Near the inner edge of the inner ſurfaces of the alæ, on each ſide of the orifice of the vagina, we find a ſmall hole more viſible than the reſt. Theſe two holes are termed *lacunæ;* and they communicate by two ſmall ducts with the ſame number of follicular bodies lying in the ſubſtance of the alæ, and which may be looked upon as ſmall proſtates anſwering to the glandulæ proſtaticæ inferiores in males. When compreſſed, they diſcharge a viſcid liquor.

Above the ſuperior commiſſure, a thin flat ligament runs down from each ſmall branch of the oſſa pubis, which penetrates the fat in the ſubſtance of each ala, and is loſt therein inſenſibly near the edge. Theſe may be looked upon as the ligamenta ſuſpenſoria of the alæ. The inferior commiſſure of the alæ is very thin, or like a membranous ligament; and, together with the neighbouring parts of the inner ſide, it forms a foſſula, termed *navicularis*, or *ſcaphoides*. The ſpace between the inferior commiſſure and anus, termed *perinæum*, is about a large finger's breadth in length.

The other external parts are ſituated in the ſinus, and hid by the alæ. Directly under the ſuperior commiſſure, lies the clitoris, with its cover, called *præputium*. A little lower is the orifice of the urethra; and below that is the orifice of the great canal of the uterus. The circumference of this orifice is bordered, either by a membranous circle, called *hymen*, or by fleſhy portions, termed *carunculæ myrtiformes*. On each ſide of the clitoris begins a very prominent fold, like a criſta, which runs down obliquely on each ſide of the

orifice

orifice of the urethra. Theſe folds are termed *nymphæ*, and they might likewiſe be named *criſta clytoridis*. On each ſide of the great orifice lies the ſmall proſtatic hole already deſcribed.

Clitoris. The clitoris appears at firſt ſight like a ſmall imperforated glans. Its upper and lateral ſides are covered by a kind of præputium, formed by a particular fold of a portion of the inner ſide of the alæ; which appears to be glandular, and to diſcharge a certain moiſture; and its inſide is granulated.

By diſſection, we diſcover in the clitoris a trunk and two branches, as in the penis, made up of a ſpongy ſubſtance, and of very elaſtic coats, but without any urethra. This ſubſtance may be inflated either by air or anatomical injections into the artery, &c. The trunk is divided into two lateral parts by a middle ſeptum, from the bifurcation to the glans, where it is inſenſibly loſt.

The bifurcation of the trunk is on the edge of the cartilaginous arch of the oſſa pubis; and the branches, which reſemble the roots of the corpora cavernoſa, are inſerted in the inferior rami of theſe bones, and in thoſe of the oſſa iſchium, where they terminate by degrees; but there is ſometimes a membranous tube on each ſide, which reaches to the tuberoſity of the iſchium.

The trunk of the clitoris is ſuſtained by a ligamentum ſuſpenſorium fixed in the ſymphyſis of the oſſa pubis, and containing this trunk in its duplicature, nearly as in the other ſex.

Four muſcles or faſciculi of fleſhy fibres are inſerted in the trunk of the clitoris, two on each ſide. One of them runs down on the foreſide of the neighbouring corpus cavernoſum, and is inſerted by a tendinous or aponeurotic portion, partly in the extremity of the corpus cavernoſum, and partly in the tuberoſity of the iſchium. Theſe two muſcles are called *erectores*; but the name of *iſchio-cavernoſi* would be more proper.

The other muſcle on each ſide lies under the former, and

and runs down on the ſide of the urethra and great orifice of the uterus all the way to the anus; increaſing gradually in breadth in its paſſage, and terminating partly like that which is called *accelerator* in males.

Theſe two muſcles ſurround very cloſely the lateral parts of the urethra and of the great orifice. They expand very much as they deſcend, and are ſpread on the lower and lateral parts of the great orifice; for which reaſon ſeveral anatomiſts have looked upon them as muſcular ſphincters. All theſe four muſcles, and eſpecially the two latter, are oftentimes almoſt covered with fat.

The blood-veſſels of the clitoris come chiefly from the hypogaſtricæ, and the nerves from the ſecond and third pairs of the nervi ſacri; by means of which they communicate with the inferior meſenteric plexus, and with the great ſympathetici.

Nymphæ. The nymphæ, criſtæ clitoridis, or, as they may likewiſe be termed, *alæ minores ſive internæ*, are two prominent folds of the inner ſkin of the great or external alæ, reaching from the præputium of the clitoris to the two ſides of the great orifice of the uterus. They begin very narrow; and having increaſed in breadth in their courſe downward, they are again contracted at their lower extremity.

They are of a ſpongy ſubſtance, intermixed with glands; ſeveral of which may be perceived by the naked eye. Their ſituation is oblique, their upper extremities lying near each other, and the lower at a much greater diſtance. In married women they are more or leſs flaccid and decayed.

Urethra. By the urethra in females, we mean the urinary duct; the orifice of which is between the nymphæ below the glans of the clitoris. The ſides of this orifice are a little prominent and wrinkled, and perforated by ſmall lacunæ, from which a viſcid or mucilaginous liquor may be ſqueezed. In time of pregnancy, this orifice is ſometimes drawn a little inward.

The

The body of the urethra is a ſpongy duct of the ſame ſtructure as in males, but much ſhorter, ſituated directly under the trunk of the clitoris, and above the great canal of the uterus, adhering to each of theſe canals between which it lies by membranous filaments. It paſſes under the cartilaginous arch of the oſſa pubis, and terminates by an oblique opening at the neck of the bladder, being bent a little downwards between its two extremities.

The internal membrane of the urethra is a little plaited, and perforated by ſmall holes, which communicate with folliculi, lying hid in its ſubſtance, as in males. If we blow into one of theſe holes, we obſerve a ſmall canal to be inflated, which runs from without inwards, and terminates in ſome places by a kind of ſacculus, by compreſſing which a viſcid liquor is diſcharged.

The continuation of this membrane, which lines the neck of the bladder, forms likewiſe ſeveral rugæ, more or leſs equal; but that which lines the cavity of the bladder is wrinkled in an irregular manner when the bladder is empty.

The vagina. The great canal, formerly called the *neck* of the uterus, is ſituated below the urethra, and above the extremity of the inteſtinum rectum, a little obliquely, being more raiſed on the inner and back part than on the outer and fore part.

Its inner or poſterior extremity joins the extremity of the body of the uterus, and ſurrounds its orifice much in the ſame manner as the duodenum ſurrounds the pylorus, or as the ileum is ſurrounded by the cæcum and colon.

The anterior extremity forms the great orifice, which lies under that of the urethra, and above the foſſula of the inferior commiſſure of the alæ.

The body of the canal is chiefly made up of a ſpongy ſubſtance, interwoven with numerous blood-veſſels; and it is commonly longer and narrower in virgins than in married women.

Its

Its inner or concave ſurface has ſeveral tranſverſe rugæ, and is covered by a particular membrane. The rugæ are formed by oblong narrow eminences, incurvated like portions of arches, placed very near each other, and diſpoſed in ſuch a manner as to divide the cavity of the canal into an upper and lower ſide.

By the union of the extremities of the upper and lower rugæ, a kind of raphe or ſuture is formed on the right and left ſides; and both arches are ſometimes interſected in the middle, and ſo form two half arches; but in this there is ſome variety.

In general, theſe arches are very conſiderable in young perſons; become gradually more ſuperficial in married women, and are quite loſt in time of delivery.

The inner or poſterior extremity of this great canal ſurrounds the orifice of the uterus a little obliquely, in ſuch a manner as that the upper ſide of the canal lies very near the orifice, and the lower ſide at a greater diſtance from it; and this makes the extremity of the uterus appear to advance more into the canal on the lower than on the upper part.

Circulus membranoſus. The exterior or anterior extremity of the great canal in virgins, and eſpecially before the firſt eruption of the menſes, is commonly bordered by circular membranous folds of different breadths, more or leſs ſmooth, and ſometimes ſemilunar; which in ſome ſubjects leaves but a very ſmall opening, in others a larger opening; and in all renders the external orifice narrower than the reſt of the cavity. This fold, called *hymen*, is formed by the union of the internal membrane of the great canal with that on the inſide of the alæ, and repreſents a membranous circle of different breadths, and ſometimes uneven.

Caruncuiæ. This membranous circle is commonly ruptured after the conſummation of marriage; is quite loſt in delivery, and afterwards only ſome irregular portions of it remain; which, from their ſuppoſed reſemblance to myrtle-leaves, have been termed *caruncuiæ myrtiformes.* This circle may likewiſe ſuffer ſome diſ-

order by too great a flux of the menſes, by imprudence, levity, and other particular accidents.

Plexus retiformis. Each ſide of the anterior portion of the great canal is covered exteriorly by a thin, broad, cavernous, and vaſcular plexus, called the *plexus retiformis* of that canal. Theſe two planes run down on each ſide of the clitoris behind the nymphæ, and likewiſe cover the urethra like a collar, before they are ſpread on the great canal.

This plexus is ſtrictly united to the muſcular portions, commonly taken for accelerators or conſtrictors, lying between theſe portions and the lateral parts of the urethra and of the great canal.

This plexus may be inflated by air like a flaccid ſpleen, or like the ſpongy ſubſtance of the clitoris, with which it ſeems to have ſome communication; and on this account the lateral portions of this reticular plexus have been named the *internal* crura of the clitoris. It is a kind of rete-mirabile, compoſed of veſſels which come chiefly from the hypogaſtricæ.

It ſtill remains to be obſerved, that on each ſide of the bottom of the pelvis, in both ſexes, oppoſite to the lower part of the bladder, there is an aponeurotic or tendinous ligament, which runs over the inner ſurface of the muſculus obturator internus from before backward. The anterior extremity of this ligament is fixed on one ſide of the middle portion of the ſymphyſis of the oſſa pubis, and the poſterior extremity to the middle part of the ligamentum ſacro-ſciaticum, formerly deſcribed.

A little above the elongation called the *neck* of the bladder, there is another ligamentary expanſion on each ſide of the bladder; the fore part of which is narrow, and fixed to the anterior extremity of the ligament already mentioned; and the broad poſterior part to the ſide of the bladder. Theſe two lateral expanſions may be looked upon as proper ligaments of the bladder, by which it is connected to the inner ſide of both oſſa pubis.

EXPLA-

Explanation of TAB. IX.

1. Trachea.
2. The internal jugular vein.
3. The ſubclavian vein.
4. Vena cava deſcendens.
5. The right auricle of the heart.
6. The right ventricle, the pericardium being removed.
7. Part of the left ventricle.
8. Aorta aſcendens.
9. Arteria pulmonalis.
10. The right lobe of the lungs, part of which is cut off to ſhow the great blood-veſſels.
11. The left lobe of the lungs.
12. The diaphragm.
13. The liver.
14. The ligamentum rotundum.
15. The bottom of the gall-bladder projecting beyond the anterior edge of the great lobe of the liver.
16. The ſtomach, preſſed by the liver toward the left ſide.
17. The ſmall guts.
18. The ſpleen.

Explanation of TAB. X.

1. The under ſide of the liver.
2. Ligamentum rotundum.
3. The gall-bladder.
4. The pancreas.
5. The ſpleen.
6. The kidney.
7. Aorta deſcendens.
8. Vena cava aſcendens.
9. The emulgent vein.
10. A probe under the ſpermatic veſſels and the arteria meſenterica inferior, and over the ureters.
11. The ureter.
12. The iliac veſſels.
13. The rectum inteſtinum.
14. The bladder of urine.

TAB. IX.

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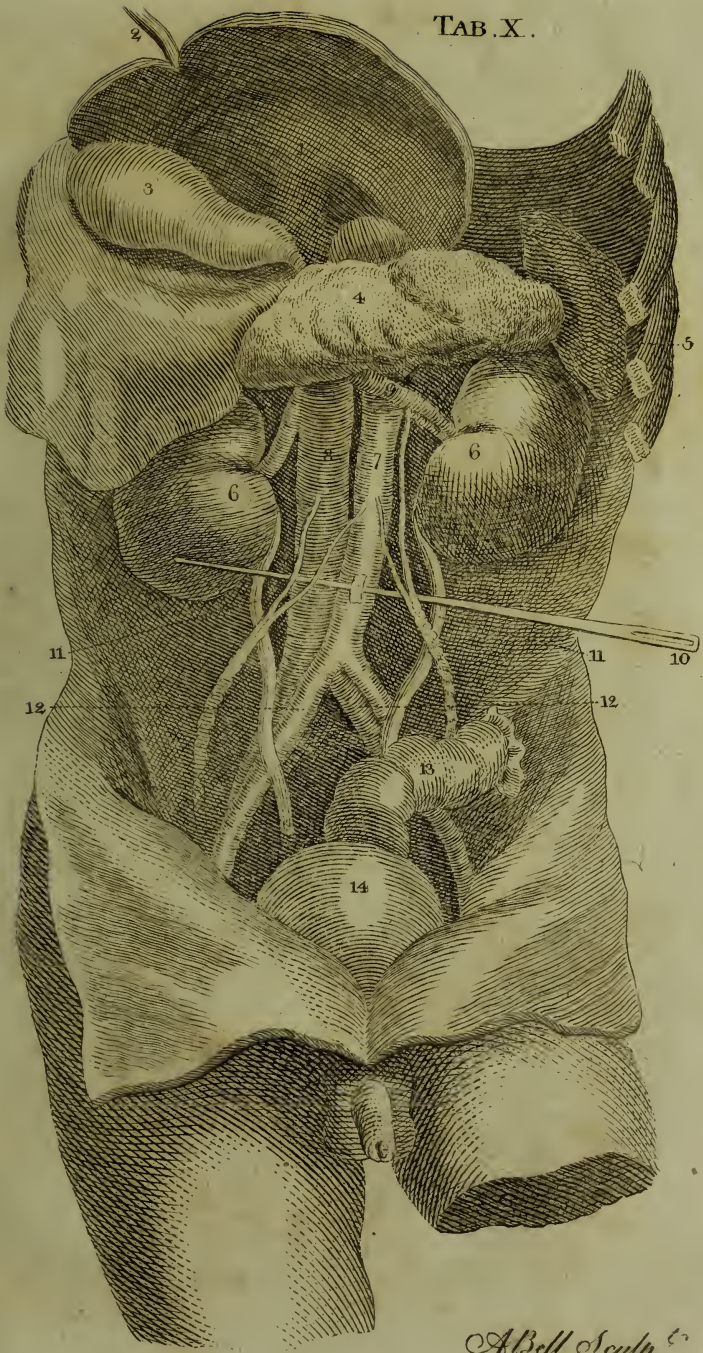
TAB. X.



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