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ABSTRACT

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A

SYSTEM

OF

ANATOMY,

PHYSIOLOGY, &c.

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WITH THE

COMPARATIVE ANATOMY OF ANIMALS.

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SYSTEM

OF

ANATOMY,

WITH THE

PHYSIOLOGY.

PART VI.

CONTAINING A DESCRIPTION OF THE

DIFFERENT VISCERA.

CHAP. I.

Of the HEAD.

BESIDES the brain, which is contained within the cranium, the head prefents to us the organs of fight, of found, of fmell, of tafte, and the greater part of thofe which ferve for deglutition.

THE PERICRANIUM.

BESIDES the external integuments of the head, viz. the hair, fkin, and cellular fubftance, there are two other 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 is generally conſidered as one of the three principal cavities of the human body. On its outſide are ſituated the ſeats and baſes of ſeveral very complex particular organs; whereas on the inſide it contains only one, namely the brain, which is indeed the primum mobile of the whole animal oeconomy. The mechaniſm of this organ is very little known; and the ſtructure of its different parts, even of thoſe with which we are ſuppoſed to be moſt acquainted, 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 antients, 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 fills the great canal of the ſpina dorſi, and is known 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 *arachnoïdes*, 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

ter from the ſkull, cauſe a great number of red points to 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, when the filaments become 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 continually moiſtened, much in the ſame manner as the peritonaeum and pleura are, by a fine fluid diſcharged through its pores.

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, 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 cerebelli,* 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 galli, along the ſagittal ſuture, to the middle of the tranſverſe ſeptum; which

which it joins in ſuch a manner, as that the lateral laminae of the falx are continuous 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 occipitis, along the grooves of the lateral ſinuſes, and thoſe of the great angles of the apophyſes petroſae, all the way to the poſterior clinoid 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 large, 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

immediately to loſe its tenſion and firmneſs; and the ſame thing will be obſerved in the falx, if 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 it 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 cella turcica, each running from the poſterior to the anterior clinoid apophyſis on the ſame ſide. Theſe two folds, together with the anterior or poſterior parts of the cella turcica, 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 foſſulae 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 vertebrae, 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 vaginae, which are more numerous than the nervous trunks reckoned in pairs. For the olfactory nerves, there is the ſame number of of diſtinct vaginae as there are holes in the lamina ethmoidalis; and ſome nerves, as the ninth pair, are accompanied by ſeveral vaginae through one hole.

There are two particular elongations which form the perioſteum of the orbits, together with the vaginae 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 foſſae; 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 foſſulae 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 durae 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

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, as was 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 antients. Two great lateral

lateral ſinuſes, the ſecond and third of the antients. The ſinus called *torcular Herophili*, the fourth of the antients. 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 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 venae angulares, frontales, naſales, maxillares, &c. as the lateral ſinuſes likewiſe communicate with the venae 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 the blood, if obſtructed in one place, finds, in conſequence of theſe communications, a paſſage at another, though perhaps 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 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 middle of its breadth, a kind of fine raphe or ſuture 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 towards 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 ſuture along the bottom of the ſinus, that is, along the union of the two lateral ſides.

In this ſinus we obſerve ſeveral openings and ligamentary fraena. 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 are very thin near the ſinuſes.

This miſtake gave riſe to another, namely, 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

veins being broader than the arteries, their two edges are feen on each fide of the arteries like capillary veffels. Thefe veins are, for the moft part, branches of the finufes, and the fmall trunks of fome of them open into the head of the vena jugularis interna. We may eafily be fatisfied that the arteries on both fides of the dura mater communicate with each other above the falx, either by injecting or blowing into them.

The internal fraena of this great finus appear to be tendinous, and to be defigned to prevent the too great dilatation of the finus by the blood. They vary, however, in different fubjects, and do not always reach from one fide to the other. It has been pretended, that glands have been found there; but we ought to take care that fome fmall corpufcles, which feem to poffefs little or no glandular nature, are not miftaken for glands.

The inferior finus of the falx is fituated in the lower edge of its duplicature, being very narrow, and, as it were, flatted on both fides. It communicates immediately with the fourth finus of the ancients, and in fome fubjects feems even to be a continuation of it. It likewife communicates with the great or fuperior finus by fmall veins, which go from one to the other, and with the veins of the cerebrum by the fame means.

The lateral finufes reprefent two large branches of the fuperior longitudinal finus, one going to the right hand, the other to the left, along the great circumference of the tranfverfe feptum, all the way to the bafis of the apophyfis petrofa of the offa temporum. From thence they run down, having firft taken a large turn, and then a fmall one; and being ftrongly fixed in the lateral grooves of the bafis cranii, they follow its courfe all the way to the foramina lacera and foffulae of the jugular veins.

They do not always rife by an equal bifurcation of the fuperior longitudinal finus; for, in fome fubjects, one of the lateral

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 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 fraena: And it has alſo the ſmall venal openings, which indeed are common to it, the longitudinal, and moſt other ſinuſes. The poſterior, or outer ſide of this cavity, is formed by the external part of the dura mater, and the other two ſides 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 foſſulae of the venae 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 Heropholi*, from an ancient author, who imagined that the blood was as it were 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 cavernous ſubſtance, full

of

of blood, much like that of the corpus cavernofum of the urethra.

Nerves and glands. We obferve fome nervous filaments, which appear to go to the dura mater from the trunk of the fifth pair, at the entry of the cavernous finus; and from the common trunk of the eighth pair and nervus acceflorius or fpinalis, as they pafs through the foramen lacerum. Inflammation, as well as furgical phenomena, fhew that the dura mater is not void of fenfibility, though, in the found ftate, this is not very obvious. The fmall tubercles, found on the lateral fides of the longitudinal finus of the falx and contiguous parts of the brain, deferve ftill to be examined before we can determine any thing about them: They have been called *glands* by Pacchioni, and feem to belong rather to the conglomerate than to the conglobate kind. The whole infide of the dura mater is moiftened in the fame manner as the peritonaeum and pleura.

The prominent fibres which appear interfecting each other in different manners on the infide of the dura mater, efpecially near the falx and tranfverfe feptum, and which have been taken for a kind of flefhy fibres, feem to be only ligamentary and elaftic. The univerfal adhefion of this membrane to the cranium, proves that it can have no particular motion, and confequently, that fuch flefhy or mufcular fibres would be altogether ufelefs. This adhefion was plainly demonftrated by Vefalius, Riolan, &c. long before Roonhuyfen.

§ 2. *Pia Mater.*

Situation in general. This membrane is a much fofter and finer fubftance than the former, being exceedingly delicate, tranfparent, and vafcular; and is connected to the dura mater only by the veins which open into the finufes, as has been already faid.

Structure.

Structure. It is compofed of two laminae, of which the external one is named *tunica arachnoidea*, from its refemblance to a cobweb. They adhere clofely to each other at the upper part of the brain; but are eafily feparable at the bafis, and through the whole length of the fpinal marrow.

The tunica arachnoidea is a remarkable thin and tranfparent membrane, having no veffels, that can be injected, entering into its compofition. It is fpread uniformly over the furface of the brain, inclofing all the circumvolutions, but without entering in between any of them; while the pia mater forms a great number of plicae, duplicatures, and fepta; which not only cover the brain in general, but infinuate themfelves into all the folds and circumvolutions, and between the different ftrata of the cerebrum and cerebellum, and are likewife continued into the different cavities.

The two laminae of the pia mater are connected by a cellular fubftance, which accompanies them through their whole extent, except at fome places of the bafis of the cerebrum, &c. where, the internal lamina continuing its infertions, the external remains uniformly ftretched over the prominent parts, the interftices of which are entirely feparated from the other lamina, without any cellular fubftance between them. Thefe feparate portions of the external lamina have made it be looked upon as a third membrane of the brain, diftinct from the pia mater.

§ 3. *Cerebrum.*

Situation and figure. The cerebrum, properly fo called, is a kind of medullary mafs, of a moderate confiftence, and of a greyifh colour on the outer furface, filling all the fuperior portion of the cavity of the cranium, or that portion which lies above the tranfverfe feptum. The upper part of the cerebrum is of an oval figure, like half an egg cut lengthwife,

or

or rather like two quarters of an egg cut lengthwife, 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 correfpond with the cavities at the bafe of the cranium.

Divifion and lobes. The cerebrum is divided into two lateral portions, feparated by the falx, or great longitudinal feptum of the dura mater. They are generally termed *hemifpheres*, but they are more like quarters of an oblong fpheroid. Each of thefe portions is divided into two extremities, one anterior, and one pofterior, which are termed the *lobes of the cerebrum*, between which there is a large inferior protuberance which goes by the fame name; fo that in each hemifphere there are three lobes, one anterior, one middle, and one pofterior.

The anterior lobes lie upon thofe parts of the os frontis which contribute to the formation of the orbits and of the frontal finufes, commonly called the *anterior foffae of the bafis cranii.* The middle lobes lie in the middle or latteral foffae of the bafis cranii; and the pofterior lobes on the tranfverfe feptum of the dura mater. The anterior and middle lobes of the cerebrum, on each fide, are parted by a deep narrow fulcus, which afcends obliquely backward, from the temporal ala of the os fphenoides to near the middle of the os parietale; and the two fides of this divifion have each their particular ridges and convolutions, which gives a very great extent to the cortical fubftance. This fulcus is termed *fiffura magna Sylvii*, or fimply *fiffura cerebri.*

Sides and inequalities. Each lateral portion of the cerebrum has three fides; one fuperior, which is convex; one inferior, which is uneven; and one lateral, which is flat, and turned to the falx. Through the whole furface of thefe three fides we fee inequalities or windings, like the circumvolutions of inteftines, formed by weaving ftreaks or furrows, very deep and narrow, into which the ſepta or duplicatures of the pia mater 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 laminae 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 laminae 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 foetus. 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

tudinal portion of a white convex body, which is named *corpus callofum.* It is a middle portion of the medullary fubftance, which, under the inferior finus of the falx, and alfo a little towards each fide, is parted from the mafs of the cerebrum, to which it is fimply contiguous, from one end of that finus to the other; fo that, at this place, the edge of the infide of each hemifphere only lies on the corpus callofum, much in the fame manner as the anterior and pofterior lobes lie on the dura mater. Both extremities of this medullary body terminate by a fmall edge bent tranfverfely downward.

The furface of the corpus callofum is covered by the pia mater, which runs in between the lateral portions of this body and the lower edge of each hemifphere. Along the middle of its furface, from one end to the other, a kind of raphe is formed, by a particular intertexture of fibres croffing each other. This raphe is made more perceivable by two fmall medullary cords, which accompany it on each fide, and adhere clofely to the tranfverfe fibres. The fame ftriated appearance is to be obferved in the inner parts of this fubftance.

Medullary arch, and centrum ovale. The corpus callofum becomes afterwards continuous on each fide with the medullary fubftance; which, through all the remaining parts of its extent, is entirely united with the cortical fubftance, and, together with the corpus callofum, forms a medullary arch or vault of an oblong or oval figure. To perceive this, the whole cortical fubftance, together with the medullary laminae mixed with it, muft be cautioufly and dextreoufly cut in the fame direction with the convexity of the cerebrum; after which we obferve a medullary convexity, much fmaller than that which is common to the whole cerebrum, but of the fame form; fo that it appears like a medullary nucleus of the cerebrum, efpecially when we confider it together with the medullary fubftance of the inferior part or bafis of the cerebrum; for the deeper we go, the medullary part becomes the broader. 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 gradually ſeparating from each other in their progreſs. Afterwards they bend downward, and return obliquely from behind foreward, 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, a particular elongation runs backward on each ſide, 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 laminae, 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, as well as the other cavities of the brain, has been found full of water, in caſes of internal hydrocephalus.

Fornix.

Fornix. The feptum lucidum is united, by its lower part, to the anterior portion of that particular medullary body, called improperly *the fornix* with three pillars, becaufe of fome refemblance it is thought to bear to the arches of ancient vaults. It is, in reality, nothing but the corpus callofum; the lower fide of which is like a hollow ceiling with three angles, one anterior, and two pofterior; and three edges, two lateral, and one pofterior. The lateral edges are each terminated by a large femicylindrical 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 feparately toward the two pofterior angles, they have then the name of *the pofterior pillars.*

The anterior pillar being double, is larger than either of the pofterior; and the marks of this duplicity always remain. Immediately below the bafis of this pillar, we obferve a large, white, fhort, medullary rope, ftretched tranfverfely between the two hemifpheres, and commonly called *the anterior commiffure of the cerebrum.* It is to this pillar that the feptum lucidum adheres. The pofterior pillars are bent downward, and continued through the lower portions of the ventricles all the way to their extremities, refembling a ram's horn, which is a name that has been given to them. They gradually diminifh in thicknefs during this courfe; and at their outfides they have each a fmall, thin, flat, collateral border, to which the name of *corpora fimbriata* is applied.

The pofterior pillars of the crura of the fornix unite with two medullary protuberances, called *pedes hippocampi.* The inferior furface of the triangular ceiling, which lies between thefe arches, is full of tranfverfe, prominent medullary lines; for which reafon the antients called it *pfalloides* and *lyra,* comparing it to a ftringed inftrument, fomething like what is now called a *dulcimer.*

Under

Under the fornix, and immediately behind its anterior crura, there is a hole of a confiderable fize, by which the two lateral ventricles communicate (*See* Monro on the Nervous Syftem, Tab. IV.); and another paffage leads down from this, under the different appellations ot *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 fee firft of all a vafcular web, called *plexus choroides*, and feveral eminences more or lefs covered by the expanfion of that plexus. There are four pairs of eminences which follow each other very regularly, two large and two fmall. The firft two great eminences are named *corpora ftriata*; and the fecond, *thalami nervorum opticorum*. The four fmall eminences are clofely united together, the anterior being called *nates*, and the pofterior *teftes*; but it would be better to call them fimply *anterior* and *pofterior tubercles*. Immediately before thefe tubercles there is a fingle eminence, called *glandula pinealis*.

Corpora ftriata. The corpora ftriata got that name, becaufe in cutting them with the knife we meet with a great number of white and afh-coloured lines alternately difpofed, which are only the tranfverfe fection of the medullary and cortical laminae mixed together in a vertical pofition in the bafis of the cerebrum, as appears evidently by incifions made from above downward. Thefe two eminences are of a greyifh colour on the furface, oblong, roundifh, pyriform, and larger on the fore than on the back part, where they are narrow and bent.

They lie in the bottom of the fuperior cavity of the lateral ventricles, which they refemble in fome meafure in fhape, their anterior parts being near the feptum lucidum, from which they gradually feparate as they run backward, and diminifh in fize. They are in reality the convex bottoms of the

the ventricles; and it is at the lower part of the interftice, between the largeft portions of them, that we obferve the greateft tranfverfe cord, named *the anterior commiſſure of the cerebrum*, which we mentioned already in defcribing the anterior pillar of the fornix callofus. This cord communicates more particularly with the bottom of the corpora ftriata, by a turn toward each fide.

Thalami nervorum opticorum. The thalami nervorum opticorum are fo named, becaufe thefe nerves arife chiefly from them. They are two large eminences placed by the fide of each other, between the pofterior portions or extremities of the corpora ftriata. Their figure is hemifpheroidal and a little oval, and they are of a whitifh colour on the furface; but their inner fubftance is partly greyifh and partly white, fo that, in cutting them, we fee ftreaks of different colours like thofe of the corpora ftriata.

Thefe two eminences are clofely joined together; and at their convex part they are fo far united, as really to become one body, the whitifh outer fubftance being continued uniformly over them both.

At the bottom thefe two eminences are elongated downward toward both fides, into two thick, round, whitifh cords, which feparate from each other like horns, by a large curvature; and afterwards, by a fmall curvature turned forward in an oppofite direction to the former, and reprefenting the tip of an horn, they approach each other again. The fize of thefe nerves diminifhes gradually from their origin to their anterior re-union. We fhall have occafion to mention them more particularly in fpeaking 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 paffage between the two lateral ventricles, and fends down from its under

der 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, gradually contracting, and terminates by a ſmall membranous and ſtraight 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 towards 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. By the help of a microſcope we then ſee

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 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 ſpongy body lodged in the ſella turcica, between the ſphenoidal folds of the dura mater. It is a ſingular kind of ſubſtance, and ſeems to be neither medullary nor glandular. On the outſide it is partly greyiſh and partly reddiſh, but 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 antients to theſe tubercles, are not very proper, there being little 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.

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. The name of *anus* is 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.

§ 4. *Cerebellum.*

Situation and figure. The cerebellum is contained under the tranfverfe feptum of the dura mater, in the under and back part of the cranium. It is broader laterally than on the fore or back fides, flatted on the upper fide, and gently inclined both ways, anfwerable to the feptum, which ferves it as a kind of tent or ceiling. On the lower fide it is rounder; and on the back fide it is divided into two lobes, feparated by the occipital feptum of the dura mater.

Structure. It confifts, like the cerebrum, of two fubftances. It has no circumvolutions on its furface; but, inftead of them numerous fulci, which are deep, and difpofed in fuch a manner as to form thin flat ftrata, more or lefs horizontal, between which the internal lamina of the pia mater infinuates itfelf by a number of fepta equal to that of the ftrata.

Under the tranfverfe feptum, it is covered by a vafcular texture, which communicates with the plexus choroides. It has two middle eminences, called *appendices vermiformes;* one anterior and fuperior, which is turned forward; the other pofterior and inferior, which goes backward. There are likewife two lateral appendices, both turned outward. They are termed *vermiformes*, from their refemblance to a large portion of an earth-worm.

Befides the divifion of the cerebellum into lateral portions, or into two lobes, each of thefe lobes feems to be likewife fubdivided into three protuberances; one anterior, one middle or lateral, and one pofterior: They are not, in all fubjects, equally diftinguifhed either by their convexity or limits; but they may always be diftinguifhed by the direction of their ftrata, thofe of the middle and anterior protuberance being lefs tranfverfe than the pofterior.

Fourth ventricle. When we feparate the two lateral portions or lobes, having firft made a deep incifion, we difcover, firft of all, the pofterior portion of the medulla oblongata, of which hereafter; and, in the pofterior furface of this portion, from the tubercula quadrigemina, all the way to the pofterior notch in the body of the cerebellum, and a little below that notch, we obferve an oblong cavity, which is called the *fourth ventricle;* this terminates backward, like the point of a writing pen. Hence the under end of it is called *calamus fcriptorius.*

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 fides, and then contracts again to its firft fize. It is lined by a thin membrane, and feems often to be diftinguifhed into two lateral parts, by a kind of fmall groove, from the valvular lamina to the point of the calamus fcriptorius.

This membrane is a continuation of that part of the pia mater which lines the fmall canal, the third ventricle, infundibulum, and the two great ventricles. To be able to fee the fourth ventricle in its natural ftate, in which it is narroweft, it muft be laid open while the cerebellum remains in the cranium; and, in order to that, the os occipitis muft be fawen very low down.

On each fide of this ventricle, the medullary fubftance forms a trunk which expands itfelf in form of laminae through the cortical ftrata. But here we find the medullary bearing a lefs proportion to the cortical than it does in the cerebrum. We difcover thefe medullary laminae according to their breadth, by cutting the cerebellum in flices almoft parallel to the bafis of the cerebrum; but, if we cut one lobe of the cerebellum vertically, the medullary fubftance will appear to be difperfed in ramifications through the cortical fub-

ftance,

ſtance. Theſe ramifications have been named *arbor vitae*; and the two trunks, from whence theſe different laminae 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 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 gradually diminiſh 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, connecting theſe two laminae, 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 ſhall 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

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 lining the baſis of the cranium. The medulla oblongata is therefore juſtly eſteemed to be a third general part of the whole maſs of the brain, or as the common production, or united elongation, of the whole medullary ſubſtance of the cerebrum and cerebellum.

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

The lower ſide of the medulla oblongata, in an inverted ſituation, preſents to our view ſeveral parts, which are in general either medullary productions, trunks of nerves, or trunks of blood veſſels.

The chief medullary productions are theſe; the large or anterior branches of the medulla oblongata, which have likewiſe been named *crura anteriora*, *femora*, and *brachia medullae oblongatae*, and *pedunculi cerebri:* The tranſverſe protuberance, called likewiſe *proceſſus annularis* or *pons Varolii:* The ſmall or poſterior branches, called *pedunculi cerebelli*, or *crura poſteriora medullae oblongatae:* 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 theſe productions we muſt add a production of the infundibulum and two medullary papillae.

The great branches of the medulla oblongata are two very conſiderable medullary faſciculi; the anterior extremities of which are ſeparated, and the poſterior united, ſo that, taken together, they ſomewhat repreſent a Roman V. Theſe faſciculi are flat, much broader before than behind; their ſurfaces being compoſed of ſeveral longitudinal and diſtinctly prominent

prominent medullary fibres. Their anterior extremities ſeem to be loſt at the lower part of the corpora ſtriata; and, it is for that reaſon that they are eſteemed the pedunculi of the cerebrum.

The tranſverſe annular, or rather ſemi-annular protuberance, is a medullary production, which ſeems at firſt ſight to ſurround the poſterior extremities of the great branches; but the medullary ſubſtance of the protuberance is in reality intimately mixed with that of the two former. Varolius, an ancient Italian author, viewing theſe 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 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 ſtriae, 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 ſtriae 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, thoſe medullary expanſions, a vertical ſection of which ſhews the white ramifications commonly called *arbor vitae*; 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

to be taken notice of. We fee, firft 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 fide, the other on the lower. They both run into the fubftance of the medulla, as between two cylinders, flatted on that fide by which they are joined together.

When we feparate thefe ridges with the fingers, we obferve a crucial intertexture of feveral fmall medullary cords, which go obliquely from the fubftance of one lateral portion into the fubftance of the other. M. Petit, member of the Royal Academy of Sciences, and doctor of phyfic, is the author of this difcovery, by which we are enabled to explain feveral phenomena, both in phyfiology and pathology; of which in another place.

The corpora olivaria and pyramidalia are whitifh eminences, fituated longitudinally near each other, on the lower fide of the extremity or cauda, immediately behind the tranfverfe or annular protuberances. The corpora pyramidalia are in the middle; fo that the interftice between them, which is only a kind of fuperficial groove, anfwers to the inferior groove of the following portion.

The corpora olivaria are two lateral eminences fituated at the outfide of the former, and are thus termed by Willis, Duverney, Haller, &c. but Winflow reverfes the names. Thefe four eminences are fituated on the lower half of the medulla; which obfervation we here repeat, to make it be remembered, that, in all the figures and demonftrations, thefe parts are reprefented as fuperior, which, in their natural fituation, are inferior. Thus thefe eminences are under the fourth ventricle, and under the pedunculi cerebelli.

The tubercula mammillaria, which are fituated very near the production of the infundibulum, have been taken for glands; probably becaufe of their greyifh inner fubftance, which,

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 *papillae medullares*.

Theſe tubercles ſeem to have ſome immediate relation to the roots or baſes of the anterior pillar of the fornix; ſo that we might call them, as M. Santorini has done, *the bulbs of theſe roots*, though they appear to be likewiſe part of 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 pituitaria, 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 peculiarities obſervable in examining the internal ſtructure of the brain.

From

From this common portion of the cerebrum and cerebellum, arife almoft all the nerves which go out of the cranium, through the different foramina perforating its bafe. It likewife produces the medulla fpinalis, which is no more than a common elongation of the cerebrum and cerebellum, and of their different fubftances; and therefore the medulla oblongata may juftly be faid to be the firft origin or primitive fource of all the nerves which go out through the fpina dorfi, and confequently of all the nerves of the human body.

§ 6. *Medulla Spinalis.*

The medulla fpinalis 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 fpina dorfi. It is confequently a continuation or common appendix of the cerebrum and cerebellum, as well becaufe of the two fubftances of which it is compofed, as becaufe of the membranes by which it is invefted.

In the defcription of the frefh bones, mention was made of a ligamentary fubftance which lines the inner furface of this bony canal, from the great occipital foramen to the os facrum. Befides this, the dura mater, after it has lined the whole internal furface of the cranium, goes out by the foramen magnum occipitis, and forms a kind of funnel, in its progrefs downward, through the bony canal of the vertebrae. As it goes out at the occipital hole, it joins the beginning of the ligamentary funnel already mentioned, and adheres very ftrongly to it. That portion of the pericranium which terminates exteriorly at the edge of the great foramen, joins the funnel likewife, which, by all thefe acceffions becomes very ftrong, and capable of refifting the greateft violences.

This

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 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 thoſe of the cranium. It is ſurrounded by a ſlimy ſubſtance, which, near the lower end of the canal, reſembles fat.

The ſpinal marrow conſiſts 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 appears to be of the form of a horſe ſhoe, the convex ſide being turned forward and the extremities backward.

The body of the medulla ſpinalis runs down 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 vertebrae 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 ſeemingly 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 eaſily 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 paffing outwards, they go through the dura mater by two diftinct openings very near each other. Having penetrated the dura mater, the pofterior bundle forms a ganglion, from the oppofite end of which the trunk comes out again, and is there joined by the anterior bundle.

The dura mater which invefts the medulla, fends out on each fide the fame number of vaginae, as there are ganglious and nervous trunks. Thefe vaginae are productions of the external lamina; the internal lamina, which is very fmooth and polifhed on the infide, being perforated by two fmall holes very near each other, where each vagina goes off, through which holes the anterior and pofterior fafciculi are tranfmitted, and, immediately after their paffage through the internal part, they unite.

The triangular fpaces left between the anterior and pofterior fafciculi and the edge of the medulla, are filled from one extremity to the other by an indented ligament very thin and fhining, having the fame number of indentations as there are pairs of fafciculi. It is clofely connected by numerous threads to the pia mater at each fide of the medulla, while the oppofite fide fends out indentations, the greater number of which run tranfverfely, though others go obliquely upwards or downwards; and all of them, after being fplit into threads, are fixed to the inner fide of the dura mater. The under end of the ligamentum denticulatum, runs as far as the os coccygis, and is what authors have confidered as the fortieth pair of nerves *; from whence it fends filaments to the internal part of the dura mater, by which the anterior fafciculi are diftinguifhed from the pofterior.

The membrana arachnoides is here very diftinct from the internal lamina of the pia mater: So that, by blowing through a hole made in the arachnoides, it will fwell from one

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

one end to the other, like a tranfparent gut. The internal lamina, called in this place fimply the *pia mater*, adheres very clofely to the medulla fpinalis, and fends many productions and fepta through its fubftance. If, by a hole made in the pia mater, we inflate the fubftance of one lateral portion of the medulla, the air penetrates through the whole of it, and the pia mater, which covers the other lateral portion, is feparated from it.

The membrana arachnoides adheres more clofely to the pia mater at the lower, than at the upper part, being, as it were, fufpended by the indented ligament which runs along both edges of the medulla, and is fixed, as was mentioned above, by a filament, to the internal lamina of the dura mater in each interftice between the nervous fafciculi. It alfo gives off elongations, in the fame manner as the dura mater, to each nervous trunk or rope, as we fhall fee hereafter.

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

The nerves arife either from the brain, medulla oblongata, or fpinalis; and they go out in fafciculi difpofed in pairs. They may be divided into three claffes, viz. nerves which pafs through the cranium, nerves immediately from the fpinal marrow, and nerves from the brain and fpinal marrow conjointly; to which laft clafs the great fympathetic nerve belongs. Ten pairs belong to the brain and medulla oblongata, of which nine go out through the foramina of the cranium, and the tenth arifes from the extremity of this medulla as it paffes through the great occipital hole; and laftly, 29 pairs belong to the medulla fpinalis, of which feven pafs through the lateral notches of the vertebræ cervicis, twelve through thofe of the back, five through thofe of the loins, and five through the anterior holes of the os facrum.

We

We ſhall, at preſent, only make ſome particular obſervations on the nerves while they remain within the bones, and reſerve the deſcription of their courſe through the whole body to its proper place.

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 ſtriata, between the anterior and middle lobe, on each ſide of the cerebrum, and afterwards by another filament more internally; and laſtly, 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 clinoid apophyſis to the os ethmoides.

They are firſt of all conſiderably incurvated from without inward 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 their bulk gradually increaſes in their courſe forward toward each ſide of the criſta galli, where they terminate in elongated papillae, the ſubſtance of which appears to be ſofter and leſs white than that of the nerves, as Dr Soemmering hath beſt deſcribed in his book, *De Baſ. Enceph. et Orig. Nervor.* to which the reader is referred.

Theſe papillae lie on the two ſides of the lamina cribroſa, and ſend down a nervous filament through each hole of that lamina. At the ſame place, the dura mater ſends off the ſame number of vaginae, 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*;

ticorum; and we have defcribed their great curvature, and traced them all the way to their re-union, which happens immediately before the fuperior part of the glandula pituitaria, and confequently before the beak or production of the infundibulum. The internal carotids run upon the outfides of thefe nerves, immediately after their union, and before they pafs through the foramina optica.

Befides their origin from the optic thalami, thefe nerves have likewife a kind of communication with the tubercula quadrigemina anteriora, by very fine filaments; one extremity of which is loft in the tubercles, the other in the roots of the great arches or bodies of the optic nerves. They are alfo connected with the crura cerebri. The internal ftructure of thefe nerves feems to change at their entrance into the optic holes, as we fhall fee in another place.

The union of thefe nerves, by the fmall curvatures of their cornua, is very difficult to be unfolded in human bodies. This union is commonly found to be very clofe; but, in fome fubjects, it feems to be no more than a ftrong adhefion; in others, to be partly made by an interfection or croffing of fibres. They have indeed been found quite feparate; and in other fubjects, one of them has been obferved to be very much altered, both in fize and colour, through its whole paffage, the other remaining in its natural ftate.

The third pair, called *nervi motores, oculi communes, oculares communes,* and *oculo-mufculares,* arife from the crura cerebri, between the corpora albicantia and a fulcus that feparates the crura from the tuber annulare, by numerous threads collected into two bundles, the one a little longer than the other. Thefe foon unite into their refpective trunks, which pierce the dura mater behind the lateral parts of the pofterior apophyfis of the fella turcica, and pafs afterwards along the finus cavernofi, by the fide of the carotid artery, and all the way

to

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 extremities 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 cavernoſi.

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

The sixth pair, named *motores oculorum externi*, *oculares* or *ophthalmici 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 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 outside of the internal carotid artery in their way to the foramen lacerum. In this course, they communicate with the first branch of the fifth pair, and by a filament or two, which arise from the great sympathetic nerve, and run up with the carotid 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 *nervus 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 portio 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 *glossopharyngeum*, the other *par vagum*, or *nervus sympatheticus medius*. This runs toward the foramen lacerum, 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

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 hyppogloſſi externi*, *hyppogloſſi majores*, and commonly *guſtatorii*, ariſe each from the furrow that ſeparates the corpora olivaria and pyramidalia. Theſe branches ſoon unite into a trunk which paſſes through the anterior condyloid hole; 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 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 condyloid 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. One or two threads frequently 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 vertebrae, into ſeven pair of cervical nerves, twelve pair of dorſal, five pair of lumbar, and five pair of nervi ſacri.

As

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 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.

The cervical faſciculi therefore 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 conſiſt 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 vertebrae and of the os ſacrum, a large bundle of nervous

 ropes,

ropes, called by anatomifts *cauda equina*, becaufe of fome refemblance which it bears to a horfe's tail, efpecially when taken out of the canal, and extended in clear water.

Though the medulla fpinalis ends at the firft vertebra of the loins, the vagina of the dura mater, by which it is invefted, is continued through the reft of the bony canal all the way to the extremity of the os facrum, and involves the great bundle or cauda equina, the cords of which pierce it on each fide nearly oppofite to the places where they pafs through the intervertebral holes, and the anterior holes of the os facrum, almoft in the fame manner as was faid above in defcribing the general formation of the vertebral nerves.

After this vagina of the dura mater is detached from the fpinal canal, by cutting the tranfverfe branches which go out of the intervertebral holes, it appears to have evident marks of elafticity, for it immediately fhrinks up, as an artery or other elaftic ftring would do, when cut acrofs. Therefore its true length muft be taken while it is *in fitu*, and likewife the true fituation of the lateral elongations.

From all this, a conclufion may be drawn, of great importance, not only in anatomical and philofophical inquiries, but alfo for underftanding local difeafes, wounds, &c. which is, that, when we have occafion to confider any particular nerves near the vertebrae of the back or loins, or near the os facrum, we muft remember that, in the fpina dorfi, the origin of thefe nerves is not even with their paffage out of the fpine, but proportionably higher. If, for inftance, we enquire about any of the loweft nervi facri near the os coccygis, we muft not ftop at the extremity of the os facrum, but trace its origin as high as the laft vertebra of the back, or firft of the loins.

The membrana arachnoides accompanies the original fafciculi feparately, to their paffage through the lateral elongations of the dura mater, forming a kind of duplicature,

breaks,

breaks, or difcontinuations, between the cords which run in the vagina of the dura mater. The pia mater adheres very clofely both to the fafciculi and filaments of which they are compofed.

Among the original productions of the nerves of the medulla fpinalis, we ought ftill to reckon the formation of the nervi acceflorii of the eighth pair. They arife from the lateral parts of this medulla by feveral filaments, about the third or fourth vertebrae of the neck, and fometimes lower. They run up on each fide between the anterior and pofterior ranks of the nervous fafciculi, gradually increafing in fize by the acceffion of new filaments from the pofterior fafciculi.

Having reached above the firft vertebra of the neck, they have a kind of adhefion or communication with the neighbouring ganglions of the nervi fub-occipitales, or thofe of the tenth pair. Above this adhefion they receive two filaments each, from the back fide of the medulla, and afterwards continue their courfe 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 thofe of the eighth pair, with which they return out of the cranium.

§ 8. *Blood Veffels of the Brain and Medulla Spinalis.*

Arteries. The arteries which fupply the cerebrum, cerebellum, and medulla oblongata, come partly from the carotids which enter the cranium through the canals in the apophyfes petrofae of the offa temporum, and partly from the vertebrales which enter by the great occipital foramen, and fend off the arteriae fpinales into the canal of the fpine for the medulla lodged there.

All thefe arteries are divided into feveral branches, which fend out a great number of ramifications diftributed through both fubftances of the brain, and through the whole extent of the

the pia mater. The dura mater, both of the cerebrum and cerebellum, has arteries peculiar to itſelf, 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 common to the dura mater and inferior pericranium, to which the artery adheres only by a looſe filamentary ſubſtance, wherein the plexiform filaments, belonging to the great ſympathetic nerve, run.

Having paſſed through the bony canal, it immediately bends upward towards 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 clinoid 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

ting 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 an additional ramus to the ſecond, goes to the poſterior lobe of the cerebrum. This third ramus is often 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 is then 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, 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 each ſend 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;

rebellum; infinuate themfelves between the ftrata, always invefted by the duplicature of the pia mater; and are at length loft in both fubftances of the cerebellum.

The two vertebral arteries afterwards turn toward each other, for the moft part immediately under the pofterior edge of the great tranfverfe or femi-annular protuberance of the medulla oblongata, where they unite and form one common trunk. This trunk paffes directly from behind forward, under the middle of the great protuberance, and partly in the middle groove of the convex furface of that protuberance, at the anterior edge of which it terminates.

In its paffage through the groove, this trunk fends off feveral fmall branches on each fide, which furround tranfverfely the lateral portions of the protuberance, and are partly lodged in the fmall lateral grooves of thefe portions. Thefe lateral branches are afterwards diftributed 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 again divided into fmall branches; each of which foon communicates with the trunk of the internal carotid on the fame fide. Inftead of this bifurcation, each of the two laft, or more anterior lateral branches, fometimes fend a fmall branch forward, which form anaftomofes with the internal carotids.

The principal arteries of the medulla fpinalis, called commonly *arteriae fpinales*, are two in number, one anterior, and one pofterior, lodged in the grooves by which the medulla is divided into lateral portions on both fides. They arife from the vertebral arteries, a little above the great occipital foramen, where thefe arteries each fend a fmall ramus downward, as foon as they enter the cranium; and having got under the extremity of the medulla oblongata, they fend off two other branches backward.

The

The firſt two branches uniting ſoon after their origin, form the arteria ſpinalis anterior, which runs down within the canal of the vertebrae, 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 or 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; ſometimes they ſeem to be ſplit for a little way, and then unite again.

The veins of the cerebrum and cerebellum, &c. may, in general, be conſidered 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

From the foregoing hiſtory of the arteries belonging to the brain, it appears that a very great quantity of blood, derived from trunks that are near the heart, is, at every pulſation, ſent to this organ: Dr Haller ſays a ſixth part, Dr. Monro a tenth part of the whole circulating maſs. Hence it is probable, that the ſtrongeſt parts of the blood, and ſuch as are moſt retentive of motion, go to the head. 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 effects not in the head alone; ſince it occaſions in ſome patients a diaphoreſis, in others a diarrhoea, and in others it acts as a diuretic. The well guarded paſſage of the great and important veſſels in their aſcent to the head, defends them from any material injury. The frequent inoſculations of the one trunk, with the other going to the head, as well as the frequent communication 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 we may add, that the arteries in their aſcent, grow larger and 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, which ſuffer it to extend, and at the

ſame

ſame time effectually guard it againſt external preſſure. The dura mater lines the internal ſurface of this bony ſphere, and is ſo firmly attached to it by a vaſt number of ſmall veſſels, as to be no where eaſily ſeparable in a healthy perſon; this membrane being very thin and ſmooth, adheres leſs firmly to the bones, and more ſtrongly to the ſutures. In younger ſubjects, the adheſion of the dura mater to the ſkull is ſo great, that the ſeparation of it pulls of the fibres of the bones, to which it is connected. In adults, many of the veſſels being effaced, it becomes more eaſily ſeparable; yet it is not without ſome force that the dura mater can, even in old men, be ſeparated from the ſkull. The bloody drops which appear on the ſurface of the dura mater, after removing the cranium, are occaſioned by the rupture of the veſſels going from the membrane into the ſubſtance of the brain. 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, it ſeems to be in conſequence of the beating of the arteries, or of the brain ſwelling during expiration. 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, however, obſerve in general, that the dura mater has few nerves, and only little ſenſibility in the ſound ſtate; but ſurgical phenomena ſhew that it is not totally deſtitute of ſenſibility.

The internal part of the dura mater, leaving 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. Theſe proceſſes likewiſe hinder one part of the brain from bruiſing the other by any ſhock or concuſſion. Hence it is, that in active quadrupeds, where a concuffion is more likely to happen, the brain and cerebellum are divided by a bony partition.

With refpect to the glands of Pacchioni placed near the falx, their ufe is not yet fufficiently known. The vapour, which exhales from the furface of the pia mater, is not feparated by thefe glands, for it is every where exhaled, even into the ventricles, where there are no glands; but it plentifully tranfpires every where from the mouths of the leaft arteries; as we fee by experience, when water or glue are injected, which fweat out through every point in the furface of the pia mater.

The next covering of the brain is the arachnoides, which furrounds the whole furface of the brain, as the former does the internal cavity of the cranium. This very thin or tender member, being pellucid like water, every way furrounds the brain, whofe inequalities it climbs over; and although it be fo extremely thin, yet it is tolerably ftrong, and furrounds the larger veffels, fo as to make them feem to run between the pia mater and arachnoides.

The third or innermoft covering of the brain, which is foft and cellular, is properly the *pia mater*. This immediately invefts the whole furface of the brain and fpinal marrow on all fides, is tender, and confifts of a vaft number of fmall veffels which are joined together by cellular matter, and conveyed into the fubftance of the brain.

The *veins* of the brain are not difpofed in the fame manner with thofe in other parts of the body. For they have no valves; nor do they run together in company with the arteries, nor have their trunks the ftructure which is commonly obferved in the other veins. The veins from the different parts of the brain run into finufes already defcribed.

The great quantity of blood which goes to the brain, the greater impulfe with which it is fent into the carotid arteries, the

the ſecurity of this part from every kind of preſſure by a ſtrong bony fence, the ſlower motion of the blood through the abdominal viſcera and lower extremities, and the perpetual exerciſe of the brain and ſenſes, all determine a copious flux of blood to theſe parts; ſome other cauſes alſo ſerve to fill the head largely with blood. Hence it is that a redneſs of the face, a turgeſcence, a ſparkling of the eyes, with a pain of the head, a pulſation or throbbing of the arteries, and a bleeding at the noſe, are produced by violent exerciſes or motions of the body. Hence, therefore, it is evident, that if the veins were of a thin ſtructure, and round ſhape in the brain, they would unavoidably be in greater danger of rupturing, (to which, even in their preſent ſtate, they are often liable), and conſequently apoplexies would be much more frequent. To avoid this inconvenience, therefore, nature has given a different figure to the veins carrying 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; but 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, or fraena, 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, ſtrengthening and guarding it from a rupture. She has likewiſe furniſhed theſe veins with numerous inoſculations, by which they communicate with one another, with the external veins of the head, and with thoſe of the ſpinal marrow; and by this contrivance, they are capable of evacuating themſelves more eaſily whenever they are overcharged with blood.

Some writers have doubted, Whether a part of the arterial blood is not poured into the ſinuſes of the brain; and whether

whether the ſinuſes have not a pulſation excited from that blood? That they have no pulſation, Dr Haller ſays, is paſt doubt; becauſe the dura mater every where 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 they 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.

All the blood of the brain is finally conveyed into the jugular veins, which are very dilatable, and are 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 much 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, that they afford the beſt and eaſieſt paſſage for the blood to return to the heart in a direct courſe. The branches of theſe, *i. e.* jugular veins, are nearly the ſame with the branches of the arteries, namely, one going to the brain, and another to the face.

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

Whether

Whether lymphatic veſſels are to be ſeen in the brain, is queſtioned by ſome writers. Dr Haller thought it probable that no lymphatic veſſels are 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 ſhewn.

"Scarcely in any 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, I could not, however, aſſert that, where glands do not appear, lymphatic veſſels are wanting. 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 middle of its ſubſtance, although I myſelf have never ſeen any other than thoſe going on the choroid plexus towards the tentorium, and on the inner ſurface of the dura mater, in the courſe of the ſuperior longitudinal ſinus. The induſtrious and celebrated Sommering confirms the obſervations of King, Collins, and Pacchioni, who ſaw lymphatics 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 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. Theſe veſſels, in their natural ſtate, convey a juice much thinner than blood; although, in ſome diſeaſes, and by ſtrangling, they often, eſpecially in brutes and birds, receive even the red parts of the blood. 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 diſſimilar parts are apparent in the cortex, whilſt it is in an entire or natural ſtate; and hence we are not permitted to conclude that part of it is tubular, and part ſolid. As to glandules making the fabric of the brain, that notion has been diſcarded by univerſal conſent, as not being founded on the leaſt probability.

In order to gain a knowledge of the nature of the 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. This part of the brain, therefore, which lies 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 circumference.

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, they generally, but not always, gradually become ſofter, and leſs bulky, 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, as we obſerve in the optic nerve. The rectilineal courſe of the fibres, continued from the brain itſelf, is never broken off by the diviſion or ſplitting of a nerve into ſmaller threads; but the fibres themſelves 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 of the body,

body, by injuries of the brain; as a loſs of the voice, deafneſs, dumbneſs, and palſies of particular muſcles. The nerves 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 cut, but only expel, by the contraction of their integuments, the ſoft medulla which they include. Though they be ever ſo much irritated, they are neither contracted, nor rendered ſhorter during the muſcular motion which they produce. A great many nerves, ſays Haller, are ſent into the muſcles; many of them go to the ſkin; fewer to the viſcera, and very few 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 no nerves go to the dura and pia pater, arachnoides, tendons, capſules, and ligaments. That theſe parts have few nerves is certain; but that nerves can be traced into ſome of them, eſpecially into 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 from the conjunction of theſe branches, the nervous ganglia are principally 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 fibrillae, intermixed with a yellowiſh or reddiſh brown ſubſtance, ſomething ſimilar to the cortical ſubſtance of the brain.—See Obſervations on the Nervous Syſtem.

Thus much we are taught by anatomy concerning the brain and nerves; it now remains that we explain the phyſiological uſes of theſe parts. Every nerve that is irritated by any cauſe produces a ſharp ſenſe of pain. To feel or perceive is to have the mind changed or affected by a change or

affection

affection of the body. It is the medullary part of the nerve which feels. If the nerve was endowed with any peculiar ſenſe, that ſenſe periſhes when the nerve is compreſſed or cut through; the ſenſes of the whole body are loſt by a compreſſion of the brain, and a preſſure of the ſpinal marrow deprives only thoſe parts which are below it of ſenſation. If a preſſure be made on the brain where particular nerves ariſe, then only thoſe ſenſes depending on theſe nerves are loſt. Thoſe parts of the body that are furniſhed with nerves, are the only parts endued with ſenſation, which is greater in proportion to the quantity of nerves ſent to the parts, of which we have examples in the eye and the penis; 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. It 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, by the ceſſation of all pain when the nerve is compreſſed, and by defects or faults of the ſenſes in conſequence of 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 an injury or compreſſion of the brain; and 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, in the muſcles. When a nerve is irritated, every muſcle to which it goes is immediately convulſed; or, if it ſends branches to ſeveral muſcles, they are all convulſed at the

the ſame time. This happens both during the life of the animal, and a little after its death, while all the parts remain moiſt. By a great irritation other muſcles, beſides thoſe to which it ſends branches, 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, 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; that is, the muſcles which have their nerves from it lie unmoved, when they are commanded by the will to act; but they 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 body; and this effect is univerſally produced, what part of the brain ſoever be irritated; whether it be the brain itſelf, the cerebellum, or the corpus calloſum. The ſame conſequences alſo follow, if the ſpinal marrow be irritated. But if the encephalon itſelf be compreſſed in any part whatever, there follows thence a loſs of ſenſe and motion in that part of the body whoſe nerves come from the affected or compreſſed quarter of the brain. This fact is proved by experiments made in diſeaſes of the brain, where the origin of particular nerves have been compreſſed; thus the voice, the power of deglutition, the motion of an arm or a leg are loſt, if the origin of the nerves, on which theſe faculties and motions depend, be compreſſed. This is ſtill more evident in irritations or compreſſions of the ſpinal marrow, which produce reſpectively convulſions or palſies of thoſe parts that receive nerves from or below the place injured. If any large portion of the brain be compreſſed by an extravaſation of blood, by a collection of water, by a ſcirrhus, or by an impacted bone, or by any mechanical cauſe whatever, then, in proportion to the violence of the compreſſion, there will follow either a partial or a total lofs of the power of motion, thofe organs obedient to the will being affected in confequence of a flighter compreffion; but all the organs, if the preffure be great. The effects above recited ceafe when the caufe is removed. It may be proper to add, that if the fpinal marrow be hurt in the neck, death immediately follows, probably becaufe the nerves of the heart chiefly arife from that part.

From thefe confiderations, we cannot doubt that the caufe of all motion in the human body arifes from the brain, and its annexed cerebellum and fpinal marrow; and that it thence proceeds through the nerves to all the mufcular parts of the body. Befides, the caufe of this motion cannot refide in the parts themfelves, becaufe otherwife the moving caufe would continue to act after being feparated from the brain; nor would it be increafed by irritating the brain, or weakened by a compreffure of it.

Is there in the brain any principal part, in which the origin of all motion, and the end of all the fenfations refide, and where the foul has its feat? Is this opinion proved by the frequent obfervation, that the fenfes are fometimes entire, and that motion likewife remains, though the brain be materially injured? Is the feat of the foul in the corpus callofum? Is this opinion fhewn by the greater fatality of wounds or difeafes in the corpus callofum! Is this body fufficiently connected with the nerves? Are there any experiments which prove that from thence the fifth, feventh, and other nerves arife? Doth not the fame, or even greater mortality of wounds in the medulla fpinalis prove the fame thing? Yet this is not the feat of the foul, fince though it is compreffed, or even deftroyed, the perfon will furvive a long time with the perfect ufe of all his mental faculties. Laftly, this opinion is oppofed by numerous facts: Birds have no corpus callofum; and wounds in that body are not more mortal

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than thofe in other parts of the brain, as appears from undoubted experiments.

The prerogative of exciting vital motions, is not more peculiar to the cerebellum than to the other parts of the encephalon; nor does it fufficiently appear, that the vital and animal functions are diftinct: For the cerebellum does not produce the nerves of the heart and of the other vital organs, and the brain thofe which go to the organs of fenfe and voluntary motion. From the cerebellum the fifth nerve is moft evidently produced; but that goes to the tongue, pterygoid, buccinator, temporal and frontal mufcles, to the ear, the eye, the noftrils; parts which are either moved by the will, or deftined for fenfe. Again, the fame nerve, like the eighth, fends vital branches to the heart and lungs, animal and voluntary ones to the larynx, and fenfitive ones to the ftomach. Again, it is not even true that diforders of the cerebellum bring on fo certain and fpeedy death as is generally imagined; for fome experiments, even of our own making, fhew that it has born wounds and fcirrhi, without taking away life. Laftly, it is not much different from the brain, only that it is fofter and more tender; and we have often known wounds of the cerebellum cured. The power, however, of this part, in exciting convulfions, is fomewhat greater than that of the brain.

We muft inquire experimentally concerning the feat of the foul. In the firft place it muft be in the head, and not in the fpinal marrow: For though this is obftructed, the conftancy of the mind remains the fame. Again, from the experiment of convulfions arifing, when the inmoft parts of the brain are irritated, it appears to be feated, not in the cortex, but in the medulla; and, by a probable conjecture, in the crura of the medulla, the corpora ftriata, thalami, pons, medulla oblongata, and cerebellum. And again, by another not abfurd conjecture, it is perhaps feated at the origin of

every

every nerve, as the firft origin of all the nerves taken together make up the cenforium commune. Are the fenfations of the mind reprefented there, or do the voluntary and neceffary motions arife in that place? This feems very probable; for it is fcarcely poffible, that the origin of motion can lie below that of the nerve, fince the nerve is fimilar throughout its whole length. The origin of motion cannot be in the arteries, which have neither the faculty of fenfation nor that of voluntary motion. It therefore follows, that the feat of the foul muft be where the nerve firft begins its formation or origin.

We come now to explain the manner in which the nerves become the organs of fenfe or motion, which, lying hid in the ultimate elementary fabric of the medullary fibres, feem to be placed above the reach both of fenfe and reafon. We fhall neverthelefs endeavour to make this as plain as experiments will enable us. And firft, it is demonftrated, that the fenfation does not come through the membranes from the fentient organ to the brain, nor that motion is fent through the coverings from the brain into the mufcle; for the brain itfelf lies deeper than thefe membranes, and receives the impreffions of fenfe, and, when hurt, throws the mufcles into convulfions. Moreover it is certain, that the nerves arife from the medulla of the brain; for by ocular infpection we fee that to be the cafe in all the nerves of the brain, more efpecially in the olfactory, optic, fourth, and feventh pair of nerves, which continue their medullary fabric a long way before they put on the covering of the pia mater.

We muft therefore next inquire what this medulla is. It is a very foft fubftance; its compofition is fibrous, as appears from innumerable arguments: Its fibres are vifible in the corpus callofum, in the ftriatum, in the thalami of the optic nerves, and fpinal marrow; and ftill more evidently in the

brain,

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 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 here a controverſy begins concerning the nature of theſe fibres, a congeries of which 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 phenomena of wounded nerves will not allow us to imagine the nervous fibres to be ſolid; for, if irritation cauſes a nerve to ſhake, (in a manner ſomewhat ſimilar to 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, and are well guarded, they retain the ſame ſoft texture, and are not covered with membranes; as the intercoſtal nerves, and the ſecond nerves of the fifth pair. Some alſo are ſoft throughout their whole length, whatever their ſize be. For example, the ſoft olfactory and acouſtic nerves, from which laſt we would moſt readily expect a tremor produced by ſound. Again, though the nerves are

are hard, they are ſoftened in the viſcera, muſcles, and ſenſoria, before they exert their operations. The nervous fibres, being neither firmly fixed at each end, nor tenſe, cannot therefore tremulate like a tight ſtretched cord. Another argument againſt their tremulation is, that, through their whole length, the nerves are firmly attached to the ſolid parts by the cellular fabric. An example of this fact is ſeen in thoſe very material nerves, the nerves of the heart, which are tied to the great arteries and pericardium. Finally, that the nerves are deſtitute of all elaſticity, is demonſtrated by experiments, in which the nerves cut acroſs neither ſhorten, nor draw back their divided ends to the ſolid parts; but are rather more elongated by their laxity, and expel their medulla in form of a protuberance. Again, the extreme ſoftneſs of the medulla in the brain, with all the phenomena 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 elaſticity; for an elaſtic cord propagates its tremors every way, from the point of percuſſion to both extremities. But, if neither phenomena or ſenſe nor motion can be explained from the nature of elaſticity, the only probable ſuppoſition that remains is, that there is a liquor ſent from the brain, which, deſcending through the nerves, flows out at their extremities; 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; ſince

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it is refifted by no fenfitive torrent coming from the brain in a contrary direction.

It is therefore probable, that the nervous fibres, and thofe of the medulla of the brain, which are of the fame nature, are hollow. The objections againft this doctrine are fo few, and at the fame time fo frivolous, that they need not be mentioned. If they are tubes, it is very probable that they have their humours from the arteries of the brain.

There are many doubts concerning the nature of this nervous liquid. Several of the moderns will have it to be extremely elaftic, of an etherial or of an electrical nature; the ancients fuppofed it to be incompreffible and watery, but of a lymphatic or albuminous nature. Indeed, it is not to be denied that we have many arguments againft admitting either of thefe opinions. An electrical matter is doubtlefs very powerful, and fit for motion; but then it is not confineable within the nerves, fince it penetrates throughout the whole animal to which it is communicated, exerting its force upon the flefh and fat, as well as upon the nerves. In a living animal, the nerves only, or fuch parts as have nerves running through them, are affected by irritation; and therefore this liquid muft be of a nature that will make it flow through, and be contained within, the narrow tubes of the nerves. And a ligature on the nerve takes away fenfe and motion, but cannot ftop the motion of a torrent of electrical matter.

A watery and albuminous matter is common to moft of the juices in the human body, and may therefore be readily granted to the juice of the nerves. The nervous fluid may probably be fimilar to the water exhaled into the ventricles of the brain; and this opinion is ftrengthened by the flux of a gelatinous or lymphatic juice from the brain of fifhes, and nerves of large animals, when cut. But, are thefe properties fufficient to explain the wonderful force of convulfed nerves,

obfervable

obfervable in the diffections of living animals, even of the fmalleft infects? or to account for the great ftrength of mad and hyfterical people? Is not this difficulty fomewhat leffened from the hydroftatical experiments of attraction in fmall tubes; which, although it may explain the ftrength and motion, is neverthelefs inconfiftent with the celerity?

The nervous liquor, then, which is the inftrument of fenfe and motion, muft be exceedingly moveable, in order to carry the impreffions of fenfe, or the commands of the will, to the places of their deftination, without any remarkable delay; nor can it receive its motions only from the heart. Moreover, it is very thin and invifible, and deftitute of all tafte and fmell; yet reparable from the aliments. It is carefully to be diftinguifhed from that vifible, vifcid liquor, exhaling from the veffels in the intervals between the nervous cords.

That this liquor moves through tubes rather than through a fpongy folid, we are perfuaded, from its celerity, and from the analogy of all the fluids of the body, fat only excepted, running through their proper veffels.

On the whole, therefore, it certainly appears, that, by the veffels of the cortex, fome kind of fluid is inftilled into the tubes of the medulla; which fluid is continued through the extremely fmall tubes of the nerves to their extremities, and is the caufe both of fenfe and motion. But there will be a twofold motion in that humour; the one flow and conftant, from the heart; the other not continual, but exceedingly fwift, which is excited either by fenfe, or any other caufe of motion arifing in the brain.

The fame nerves moft evidently prefide over both fenfe and motion; as we cannot admit a diftinction between the two fyftems of motory and fenfitive nerves. If fenfe fometimes remain after motion is deftroyed, this feems to be becaufe much more ftrength is required for the latter. Dying people hear and fee when they are incapable of motion.

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If it be aſked, What becomes of this nervous juice, which cannot but be ſeparated in great abundance, from ſo large a quantity of blood paſſing through the brain very ſwiftly, ſince we ſee very large ſecretions in parts remote from the heart, and through which the blood circulates more ſlowly, as in the ſmall renal and meſenteric arteries? We anſwer, that it probably exhales through the cutaneous nerves. The laſſitude, both with reſpect to ſenſe and motion, which may be overcome by ſpiritous medicines, ſhews that this liquid may be both loſt and repaired. Many anatomiſts have thought 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; for it is too moveable to adhere; and, beſides, this property of adhering belongs only to ſlow moving and viſcid humours.

What is the deſign of ſo many protuberances in the brain? What are the particular uſes of the ventricles, nates, and teſtes; 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 uſeful in preſerving a neceſſary diſtinction of the parts, and in ſeparating them from each other. 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 between them; and the ſame is true with regard to the parts of 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 adminiſtering a degree of warmth to the cloſe medulla of the brain may be one of the uſes of theſe cavities; eſpecially as the arteries, by their means, are diſtributed in greater 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 likewiſe 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 are as yet unknown, and muſt be learned from anatomical experiments made on animals the likeſt to man. Experiments on parts ſo ſmall, and ſo deeply ſeated as to be inacceſſible in living animals, ſeem to afford little hopes of ſucceſs. Are theſe parts the diſtinct provinces which our different ideas inhabit? Do the thalami ſeem to be an inſtance of this ſuppoſition? In conſidering this ſubject, it will be neceſſary to remember that moſt of theſe protuberances ſend out no nerves at all.

The ſtriae or internal ducts ſeem to afford ſome kind of communication between the motions, and perhaps between the ſenſes. Some of theſe ducts join the brain with the cerebellum; others join the ſpinal marrow with the nerves of the brain itſelf, as the acceſſory nerve; and moſt of them join the right and left parts together, as the anterior and the two poſterior commiſſures of the corpus calloſum, and the ſtriae between the proceſſes of the cerebellum and teſtes; to which add the medullary croſs-bars in the medulla oblongata and ſpinalis. This ſtructure explains, in a very ſatisfactory manner, the obſervation, 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

ſeems to have provided, that, in whatever part of the br in any injury may happen, the nerve thence ariſing is not always deprived of its uſe. For, if the 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 numerous inſtances of wounds, and with a conſiderable loſs of ſubſtance from the brain, which 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, 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 conſiſt 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 palpebrae or eye lids, the caruncula lachrymalis, and the puncta lachrymalia; and the internal parts

parts are the muſcles, fat, lachrymal gland, nerves, and blood-veſſels.

The orbits. Seven bones are concerned in the compoſition of each orbit, viz. the os frontis, os ſphenoidale, os ethmoides, os maxillare, os malae, 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 malae; 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*, already mentioned 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 palpebrae*.

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 being 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

the temporal or external angle of the orbit lying more backward than the nasal or internal angle.

§ 2. *The Globe or Ball of the Eye.*

Compofition. THE globe of the eye, being the moft effential of all the foft parts belonging to the organ of fight, and being likewife a part which we are obliged to mention as often as we fpeak of the other foft parts, muft be firft defcribed. It confifts of feveral proper parts; fome of which, being more or lefs folid, reprefent a kind of fhell formed by the union of feveral membranous ftrata, called the *coats of the globe of the eye;* and the other parts being more or lefs fluid, and contained in particular membranous capfulae, or in the interftices between the coats, are termed *the humours of the globe of the eye.* Thefe capfules are likewife termed *coats.*

The coats of the globe of the eye are of three kinds. Some of them form chiefly the fhell of the globe; others are additional, being fixed only to a part of the globe; and others are capfular, which contain the humours. The coats which form the globe of the eye are, the *fclerotica* or *cornea*, the *choroides*, and the *retina.* The additional coats are two; one called *tendinofa* or *albuginea*, which forms the white of the eye; and the other, *conjunctiva.* The capfular tunicae are likewife two, the vitrea and the cryftallina.

The globe of the eye, thus formed, receives from behind a large pedicle, which is the continuation of the optic nerve. It is fituated about the middle of the orbit, in the manner which we fhall afterwards fee; and is tied to it by the optic nerve, by fix mufcles, by the tunica conjunctiva, and by the palpebrae. The back part of the globe, the optic nerve, and mufcles, are furrounded by a foft fatty fubftance, which fills the reft of the bottom of the orbit.

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The humours are three; the aqueous, vitreous, 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 graſs; 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 foreſide, 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 coat of the eye, is the ſclerotica or cornea, and it inveſts all the other parts of which the globe is compoſed. It is divided into two portions, one called *cornea opaca*, or *ſclerotica*, the other *cornea lucida*, which is only a ſmall ſegment of the ſphere ſituated anteriorly.

The ſclerotica is of a white colour, and conſiſts 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 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 through this coat is very ſingular; they enter the convex ſide at ſome

diſtance

diſtance from the optic nerve; and running thence obliquely through its ſubſtance, they pierce the concave ſide near the cornea lucida.

The *cornea lucida*, called alſo ſimply the *cornea*, conſiſts of ſeveral ſtrata or laminae cloſely united by cellular ſubſtance, and of a different 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 readily ſeparates 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 Memoires of the Academy for 1721.

Tunica

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 proceſſes 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 in it, 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.*

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At the anterior edge of the choroides we find the *iris* compofed of two laminae; the pofterior of which, being of the colour of a grape, was called *uvea* by the antients. In the middle of the iris there is a hole termed *pupil:* This, in a foetus, is covered with a membrane called *pupillaris*, which generally difappears about the feventh month; or between the feventh and ninth month, according to Wrifberg. Between the two laminae of the iris, we find two very thin planes of fibres, which have been fuppofed to be mufcular; but this matter is not yet fully afcertained. The fibres of one plane are orbicular, and lie round the circumference of the pupil; and thofe of the other are 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 fuch a nature, that the pupil is contracted at the approach of a ftrong light, and is dilated upon being expofed to a weak one. The different colours which appear in the iris, feem to be owing to an intermixture of veffels and nerves. That the iris poffeffes red veffels is evident from injection, and from obfervations on the eye during life. (*See* Monro on the Structure and Phyfiology of Fifhes).

The plicae or proceffus ciliares are fmall radiated and prominent duplicatures of the anterior edge of the choroid coat; and their circumference anfwers partly to that of the ciliary circle. They are oblong thin plates; their external extremities, or thofe next the choroides, being very fine and pointed; the internal are broad, prominent, bifurcated, and alternately long and fhort, making flight depreffions on the fore part of the vitreous humour. In the duplicature of each ciliary fold we find a fine reticular texture of veffels; and fome anatomifts pretend to have feen flefhy fibres in the fame place, lying in fmall grooves of the membrana vitrea, as we fhall fee 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 chalmers 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 like a kind of paſte ſpread upon a fine reticular web; it lines the bottom of the eye, and is 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 accompany 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 center of its inſertion, the following phenomena will appear;

That

That the nerve contracts a little at its infertion into the globe; that its outer covering is a true continuation of the dura mater; that this vagina is very different from the fclerotica, both in thicknefs and texture, the fclerotica being thicker than the vagina, and of another ftructure; that the vagina from the pia mater forms, through the whole medullary fubftance of the nerve, feveral very fine cellular fepta; and that, where it enters the globe of the eye, the pia mater does not directly anfwer to the choroides, and is divided into many fmall threads, which go through the bottom of the eye to form the retina.

The infertion of the optic nerve in the globe of the eye is not directly oppofite to the pupilla; fo that the diftance between thefe two parts is not the fame when meafured on all the parts of the globe. The greateft diftance is on the fide next the temples, and the fmalleft next the nofe. Winflow obferves an inequality of the fame kind in the breadth of the uvea, which, in many fubjects, is lefs near the nofe than near the temples; fo that the center of the pupilla is not the fame with that of the great circumference of the iris; and he has feen the fame difference in the breadth of the corona ciliaris.

§ 4. *The Humours of the Eye, and their Capfulae.*

The vitreous humour. The vitreous humour is a clear and very liquid gelatinous fluid, contained in a fine tranfparent capfula, called *tunica vitrea*, together with which it forms a mafs nearly of the confiftence of the white of an egg. It fills the greateft part of the globe of the eye, that is, almoft all that fpace which anfwers to the extent of the retina, except a fmall portion behind the uvea, where it forms a foffula, in which the cryftalline lens is lodged. This humour being dexteroufly taken out of the globe, preferves its confiftence

fiftence for fome time in the capfula, and then runs off by little and little, till it quite difappears.

The tunica vitrea is defcribed by Winflow as being compofed of two laminae very clofely united, which quite furround the mafs 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 ftreaks from the pigmentum nigrum, and by different authors has been called *membranula coronae ciliaris;* by Zinn, *zonula ciliaris.* When a puncture is made through this, and air is blown in, it forms a paffage which runs round the lens; and has been termed *Canalis Petitianus,* after the difcoverer *Petit,* who defcribes it in the Memoirs of the Royal Academy, 1728.

The internal furface of the tunica vitrea gives off, through the whole fubftance of this humour, a great number of cellular elongations or fepta difcovered by Riolin, fo extremely fine, as to be invifible in the natural ftate, the whole mafs appearing then to be uniform, and equally tranfparent, through its whole fubftance; but they are difcovered by putting the whole humour, foon after it is taken out of the body, into fome acefcent and gently coagulating liquor. Thefe cells muft communicate with each other; for, by puncturing the membrane, and hanging up the eye for a fhort time, a confiderable part of the humour runs out, fo that the eye becomes lighter.

The radiated fulci of the tunica vitrea, which may be termed *fulci ciliares,* are perfectly black when the coat is taken out of the body. This proceeds from the black fubftance with which the laminae or proceffus ciliares, as well as all the reft of the choroides, are naturally covered, and which remains in the bottom of the fulci after the laminae have been

been taken out. We obferve very fine veffels in this humour, which fhall be defcribed afterwards.

The cryftalline humour. The cryftalline is a fmall lenticular body, of a firm confiftence, and tranfparent like cryftal. It is contained in a tranfparent membranous capfula, and lodged in the anterior foffula of the vitreous humour, as has been already faid. It is very improperly called *an humour*, becaufe it may be handled and moulded into different fhapes by the fingers, and fometimes almoft diffolved by different reiterated compreffions, efpecially when taken out of the capfula.

The figure of the cryftalline is lenticular; but its pofterior fide is more convex than the anterior, the convexity of both fides being very rarely equal. Steno obferved, that the lens was compofed of concentric lamellae; and this has been confirmed by later authors: And Zinn has difcovered radiated ftreaks of a pearl colour, dividing the lens into little triangles.—See Zinn de Oculi, tab. vii. fig. vii.

The colour and confiftence of the cryftalline varies in different ages, as was difcovered by M. Petit the phyfician. (See Memoirs for 1726). Till the age of 30 it is very tranfparent, and almoft without any colour. It afterwards becomes yellowifh, and that yellowifhnefs gradually increafes. The confiftence varies almoft in the fame manner, being of an uniform foftnefs till the age of 20, and afterwards growing gradually more folid in the middle of the mafs; but in this there are varieties, explained in the Memoirs for 1727. Haller takes notice of a watery liquor fituated betwixt the cryftalline lamellae, which in old age turns, of its own accord, to a yellow colour; and Steno and Morgagni defcribe a little water effufed betwixt the lens and its capfule.

The cryftalline capfula or coat is formed by a duplicature of the tunica vitrea, or of a proper capfula to which the tunica vitrea is connected. The anterior portion of the cryftalline

line 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 pelliculae, 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 laminae as far as the vitreous coat. Having made a ſmall hole in the middle of the capſula 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 foetus, and 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 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

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 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 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

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, 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 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 towards 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 towards 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

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 shewn 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 abductor.

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 abductor, 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 ufes attributed to thefe mufcles feem to be without foundation, from the confideration of their infertions, and of the ftructure of the parts with which they are concerned; both which reafons are explained in the Memoirs of the Academy for 1721.

§ 6. *The Supercilia, and Mufculi Frontales, Occipitales, and Superciliares.*

Supercilia. The fupercilia, or eye-brows, peculiar to the human fpecies, are the two hairy arches fituated at the lower part of the forehead, between the top of the nofe and temples, in the fame direction with the bony arches which form the fuperior edges of the orbits. The fkin in which they are fixed does not feem to be much thicker than that of the reft of the forehead; but the membrana adipofa is thicker than on the neighbouring parts. The colour of the eye-brows is different in different perfons, and often, in the fame perfon, different from that of the hair on the head; neither is the fize of them always alike. The hairs of which they confift are ftrong and rather ftiff, and they lie obliquely, their roots being turned to the nofe, and their points to the temples.

The fupercilia have motions common to them with thofe of the fkin of the forehead, and of the hairy fcalp. By thefe motions the eye-brows are lifted up; the fkin of the forehead is wrinkled more or lefs regularly and tranfverfely; and the hair and almoft the whole fcalp is moved, but not in the fame degree in all perfons; for fome people by this motion alone can move their hat, and even throw it off their head. The eye-brows have likewife particular motions which contract the fkin above the nofe; and all thefe different motions are performed by the occipital, frontal, and fuperciliary mufcles. (*See* Vol. I.)

The occipital and frontal mufcles appear to be true digaftrici, both in regard to their infertions and action. The fixed infertions of the occipitales at the lower part of the occiput, and the moveable infertions of the frontales in the fkin of the forehead and of the fupercilia, being well confidered, together with their reciprocal infertions in the fame aponeurofis, feem to be very convincing proofs that they are digaftric mufcles.

Thefe four mufcles feem always to act in concert, the occipitales being only auxiliaries or affiftants to the frontales, the office of which is to raife the fupercilia by wrinkling the fkin of the forehead; thefe wrinkles following the direction of the eye-brows regularly in fome fubjects, and very irregularly in others.

To be convinced of the co-operation of thefe four mufcles, we need only hold the hand on the occipitales, while we raife the eye-brows and wrinkle the forehead feveral times, and we fhall perceive the occipitales to move each time, though not in the fame degree in all fubjects. In fome perfons the occipitales feem to be relaxed, while the frontales being in contraction move the whole fcalp and pericranium forward, and then contract to bring them back to their natural fituation.

The action of the mufculi fuperciliares is to deprefs the eye-brows, to bring them clofe together, and to contract the fkin of the forehead immediately above the nofe into longitudinal and oblique wrinkles, and the fkin which covers the root of the nofe into irregular tranfverfe wrinkles. This action, as well as that of the frontales, and of the mufcles of the nofe and lips, is not always arbitrary, but fometimes mechanical and involuntary. Thefe mufcles may perhaps likewife ferve to keep the mufculi frontales in equilibrio during their inaction, they being moveable by both extremities.

§ 7.

§ 7. *The Palpebrae and Membrana Conjunctiva.*

Palpebrae. The palpebrae are a kind of veils or curtains placed tranfverfely above and below the anterior portion of the globe of the eye, and accordingly there are two eye-lids to each eye, the one fuperior and the other inferior. The fuperior is the largeft and moft moveable in man. They both unite at each fide of the globe, and the places of their union are termed *angles*, one large and internal, which is next the nofe, the other fmall or external, which is next the temples.

Structure of the palpebrae. The palpebrae are made up of common and proper parts. The common parts are the fkin, epidermis, and membrana adipofa. The proper parts are the mufcles, the tarfi, the puncta or foramina lacrymalis, the membrana conjunctiva, the glandula lacrymalis, and the particular ligaments which fuftain the tarfi. The tarfi and their ligaments are in fome meafure the bafis of all thefe parts.

Tarfi. The tarfi are thin cartilages, forming the principal part of the edge of each palpebra, and they are broader at the middle than at the extremities. Thofe of the fuperior palpebrae are a little more than a quarter of an inch in breadth; but in the lower palpebrae they are not above the fixth part of an inch, and their extremities next the temples are more flender than thofe next the nofe.

Thefe cartilages are fuited to the borders and curvature of the eye-lids. The lower edge of the fuperior cartilage, and the upper edge of the inferior, terminate equally, and both may be termed the *ciliary edges*. The oppofite edge of the upper tarfus is fomething femicircular between its two extremities; but that of the inferior tarfus is more uniform, and both are thinner than the ciliary edges. Their inner fides, or thofe next the globe, are grooved by feveral fmall tranfverfe

channels,

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 palpebrae.

Membrana conjunctiva. The membrana conjunctiva is a thin membrane, one portion of which lines the inner ſurface of the palpebrae, that is, of the tarſi and their broad ligaments. At the edge of the orbit it has a fold, and is continued from thence on the anterior half of the globe of the eye, adhering to the tunica albuginea; ſo that the palpebrae 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 palpebrae;* but we may very well name the one *membra oculi conjunctiva*, and the other *membrana palpebrarum conjunctiva*. That of the palpebrae is a very fine membrane, adheres cloſe to the palpebrae, and is full of ſmall capillary blood-veſſels. It is perforated by numerous imperceptible pores, through 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;

colour; and being tranſparent, the alubginea 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 membrane 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 levator, the other toward the abductor. 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

The borders of each palpebra, taken together, are formed by the edge of the tarfus, and by the union of the internal membrane with the fkin and epidermis. This border is flat, and of fome fenfible breadth, from within about a quarter of an inch of the internal angle, all the way to the external angle, near which the breadth diminifhes. This breadth is owing only to the thicknefs of the palpebrae, which at this place have their edges oblique or flanting, in fuch a manner as when the two palpebrae touch each other flightly, a triangular fpace 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-lafhes*. Thofe belonging to the fuperior palpebra are bent upward, and are longer than thofe of the lower palpebra which are bent downward. Thefe rows are placed next the fkin, and are not fingle, but irregularly double or triple. The hairs are longer near the middle of the palpebrae than toward the extremities; and, for about a quarter of an inch from the inner angle, they are quite wanting.

Glandulae ciliares. Along the fame border of the palpebrae, near the internal membrane, or toward the eye, we fee a row of fmall holes, which may be named *foramina* or *puncta ciliaria*. They are the orifices of the fame number of fmall oblong glands which lie in the fulci, channels, or grooves, on the inner furface of the tarfus. Thefe little glands are of a whitifh colour; and, when examined through a fingle microfcope, they appear like bunches of grapes, thofe of each bunch communicating together; and, when they are fqueezed between two nails, a febaceous matter, like foft wax, is difcharged through the puncta ciliaria. They are more numerous in the upper than in the under eye-lids, and were firft painted by Cafferius, but afterwards defcribed by Meibomius, by whofe name they are frequently called.

Puncta

Puncta lacrymalia. Near the great or internal angle of the palpebrae, 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 *ſacculus lacrymalis,* which ſhall be deſcribed with 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, ſeems ſometimes to wrinkle 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 palpebrae and globe of the eye, but it is not fleſhy, as its name would inſinuate. The ſubſtance of it ſeems to be wholly glandular; and it appears through a ſingle microſcope in the ſame manner as the other conglomerate

rate glands. We difcover upon it a great number of fine hairs, covered by an oily yellowifh matter, furnifhed by this gland; and, on the globe of the eye, near this glandular body, we fee a femilunar fold formed by the conjunctiva, the concave fide of which is turned to the uvea, and the convex fide to the nofe.

This fold, which has the name of *membrana femilunaris*, appears moft when the eye is turned toward the nofe; it is fhaped like a crefcent, the two points of which anfwer to the puncta lacrymalia, and conduct the tears into the puncta.

§ 8. *The Mufcles of the Palpebrae.*

THE mufcles of the palpebrae are commonly reckoned to be two; one peculiar to the upper eye-lid, named *levator palpebrae fuperioris;* the other common to both, called *mufculus orbicularis palpebrarum*, which has been fubdivided by different authors in different manners. *See* Defcription of Mufcles, Vol. I.

The fkin of the fuperior palpebra is folded arch-wife, almoft in a parallel direction to that of the femioval fibres; the plicae interfecting the levator, whereas the other folds only interfect the orbicularis. The radiated and oblique plicae feldom appear in young perfons, except when the firft and fecond portions of the orbicularis are in action; but in aged perfons its marks are vifible at all times.

In man, the fuperior palpebra has much more motion than the inferior. The fmall fimple motions, called *twinkling*, which frequently happen, though not equally often in all fubjects, are performed by the alternate contraction of the levator palpebrae and orbicularis.

Thefe flight motions, efpecially thofe of the upper palpebra, are not very eafy to be explained according to the true ftructure of the part. The motions which wrinkle the

 palpebrae,

palpebrae, and which are commonly performed to keep one eye very clofe fhut, while we look ftedfaftly with the other, are explicable by the fimple contraction of all the portions of the orbicularis. Thefe motions likewife deprefs the fupercilia, which confequently may be moved in three different manners, upwards by the mufculi frontales, downward by the orbiculares, and forward by the fuperciliares.

§ 9. *The Veffels of the Eye, and its Appendages.*

THE external carotid artery, by means of the arteria maxillaris externa, and the temporal and frontal arteries, give feveral ramifications to the integuments which furround the eye, and to all the portions of the mufculus orbicularis; and thefe ramifications communicate with thofe which are diftributed to the membrana conjunctiva palpebrarum, and to the caruncula. Some fmall branches alfo come in through the fpheno-maxillary future, to be diftributed chiefly on the periofteum of the orbit, and to the fat of the eye. The internal carotid artery having entered the cranium, fends off a confiderable branch called the *ocular*, which accompanies the optic nerve, to be diftributed to the mufcles and globe of the eye, to the levator palpebrae, to the fat, glandula lacrymalis, membrana conjunctiva, caruncula lacrymalis, &c. It likewife communicates with the external carotid, and fends one or two very fmall branches to the nofe. The branches which fupply the globe of the eye have the name of *ciliares;* they perforate the back part of the tunica fclerotica in five or fix places, after which they run a little way through its fubftance, where each branch forms a plexus, which fends numerous branches to the choroides.

Dr Wrifberg obferves, they next perforate the external lamina of the choroides, and form, between that and the internal lamina, the vafcular ftellae mentioned in the defcrip-

tion

tion 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, in a direct courſe to the circumference of the iris, ſome ſmall arteries, which there form a vaſcular circle that gives capillaries to the membrana cryſtallina. Theſe veſſels may be eaſily injected in new born children. The poſterior part of the capſule of the lens is ſupplied from another ſource: Albinus, and after him many others, have injected, in a foetus, a branch from the arteria centralis retinae, which paſſes through 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 of this ſufficient proofs are wanting.

The veins of all theſe parts anſwer nearly to the arteries; 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 foetus, 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 foetus of about ſix months, the injected liquor ſeemed to me to have penetrated a part of the cryſtalline and vitreous humour.

§ 10.

§ 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 by 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 portio 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 motores oculi, having entered the orbit through the ſuperior orbitary fiſſure, or foramen lacerum of the ſphenoid bone, produces four branches. The firſt runs upwards, and divides into two; one for the muſculus levator oculi, and the other for the levator palpebrae ſuperioris. The trunk continuing its courſe, gives off the ſecond

cond 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 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 through 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 partly on it, and partly on the neighbouring parts of the orbicularis, the caruncula, &c. This branch ſends off a filament, which, paſſing through the internal anterior orbitary hole, enters the cranium, and preſently returns 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 malae.

The ſecond branch of the fifth pair, called *nervus maxillaris ſuperior*, ſends off a ramus through the bony canal of the

lower

lower part of the orbit, which, going out at the anterior inferior orbitary hole, is diftributed to the neighbouring portion of the mufculus orbicularus, and communicates with a ramus of the portio dura. The reft of the fuperior maxillary nerve fhall be defcribed afterwards.

The portio dura of the feventh pair, or auditory nerve, gives branches to the fuperior, inferior, and external lateral parts of the orbicularis palpebrarum; one of which communicates with the nervus fuperciliaris, and another with the fub-orbitarius, to be afterwards defcribed.

§ 11. *Sight.*

The eye is the organ of vifion. The greater part of it is compofed of pellucid humours capable of refracting the rays of light. The complexity of this organ is neceffary for the defence of its tender parts; and the diverfity of the feveral humours, together with the various offices which this curious machine performs, neceffarily required a very compound inftrument.

Outwardly, a defence is afforded to this organ by the eyebrow or *fupercilium;* and the thick hairs placed there, which are capable of being pulled down by the action of the frontal, corrugator, and orbicular mufcles afford a fhade to the eye in too ftrong a light. A depreffion of the eye-brow ferves alfo to exprefs concern of the mind, as an elevation of it denotes the mind to be in a ferene quiet ftate. This guard alfo conduces to throw off the fweat and retained duft, or the infects which might fall into the eye.

The palpebrae are the peculiar guards of the eye; and that they might fhut the more exactly for the defence of this fenfible and delicate organ, their margins are furnifhed with cartilaginous arches, which, accurately correfponding with each other, form a tight and unwrinkled future. The cartilage of each alfo hinders it from being drawn into wrinkles,

kles, while it is either elevated or depreſſed. The elevation of the upper eye-lid is performed by a muſcle ariſing from the involucrum of the optic nerve gradually ſpreading, and extending by its expanſion to the tarſus. This elevator is conſiderably aſſiſted in its action by the frontalis, and by various connections with the orbicularis when this laſt is 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 the 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, which, by excluding the extraneous rays, might afford a more 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*, that diſcharge a ſoft liniment, which mixes and waſhes off with the tears.

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, by a foreign cauſe, in larger than uſual quantity. This liquor is exhaled partly from the arteries of the conjunctiva, and partly 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, and waſh the whole ſurface of the eye and conjunctiva.

After the tears have performed their office, part of them fly off into the air; and the reſt, that they might not offend by their quantity, are propelled by the orbicular muſcle, towards its origin near the noſe, to the loweſt part of the palpebral margins, which, wanting the tarſus in this place, do not, on that account, exactly meet together. Here the caruncula lacrymalis interpoſes, and prevents the meeting of the eye-lids, at the ſame time furniſhing a liniment to thoſe parts which have no 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, between the eye-lids, appears the *punctum lacrymale*, which drinks up the tears from the ſinus in which they are collected, 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 parts 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 writers 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 it is broad, is ſeated in the cavity of a bony orbit, larger than the eye itſelf; the exceſs is on all ſides occupied by a very ſoft

ſoft fat, ſurrounding the globe of the eye, and allowing it 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 contracted 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, or ſucceeding ſyncope and death. The contraction is more obſcure, and perhaps only depends on the ſtronger afflux of humours into the colourleſs converging veſſels of the iris; ſo that this motion has ſomething in common with a beginning inflammation. In an animal twenty or thirty hours dead, Dr Haller has ſeen the radii of the iris extend by heat, and ſhut the pupil.

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

The *retina*, which is a continuation of the medulla from the optic nerve, immediately embraces the vitreous humour. Dr Haller ſays, that it extends to the ſurface of the cryſtalline lens; while Dr Monro obſerves, that it ends ſome way behind the ciliary circle.

Before we can attain any ſatisfactory knowledge of the nature of viſion, it will be neceſſary to point out ſome of the properties of light. Light is an extremely ſubtile fluid, penetrating with facility bodies of the cloſeſt texture, and greateſt denſity in a rectilineal direction, with the amazing velocity of ten millions of miles in a minute. Every luminous body has the peculiar property of fending forth rays of light in every poffible direction, which falling on the furfaces of furrounding objects, are reflected thence to our eyes. Hence the colour and form of the object become known. Each ray, fo extremely fmall as to have fcarce any conceivable thicknefs, is feparable into feven permanent and immutable rays of a leffer kind, namely red, orange, yellow, green, blue, indigo, and violet. Thefe rays are of different degrees of refrangibility, in the order in which they are enumerated, the red rays being moft refrangible; and, when they are varioufly compounded, they conftitute the different apparent colours of bodies.

The colours which feem peculiar to certain bodies may be thus explained: The furfaces of bodies, on which a whole ray of light falls, have, by fome peculiar form or conftruction, the power of reflecting fome of the primitive rays, and abforbing the others. If, for example, the furface is fo denfe as to reflect all the primitive rays, the body appears white; if the furface reflects only the red rays, the body appears red, and fo of others with their combinations. Thofe bodies are opake which retain the rays within their fubftance, without permitting any to pafs through them; but thofe which fuffer the rays of light to pafs through them, are called tranfparent or pellucid.

Rays of light falling perpendicularly on the furface of a tranfparent body, pafs through the body without changing their direction; but rays falling obliquely on the furface pafs through the body with a change of their direction nearer to the perpendicular; and this change of direction is called *refraction*. All tranfparent fubftances are, in optics, called *refracting mediums*. In general, the denfer the medium, the more the rays are 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

the denſity of the liquor. The angle which the oblique ray makes with the perpendicular, is called the *angle of incidence*; and, after having been bent by entering the medium, the angle it then makes with the perpendicular is called the *angle of refraction*. We have hitherto conſidered the rays as paſſing out of void ſpace, or vacuum, into a refracting medium; but moſt of the rays we have occaſion to conſider paſs out of one refracting medium into another. If the ray paſs from a leſs into a more denſe medium, it is refracted, as if it had paſſed out of vacuum; but, if it paſs out of a denſer into a rarer medium, it is bent from the perpendicular. The proportions of the angles of incidence to thoſe of refraction are obſerved to be conſtant enough; the ſine of the angle of refraction from air into water is to the ſine of the angle of incidence as 3 to 4; and, in paſſing from air into glaſs, the ſine of the angle of incidence is to the ſine of that of refraction as 17 to 11; and from water into glaſs, as 51 to 44.

Rays that are parallel to one another, falling on a ſpherical tranſparent body, if the angle of incidence be greater than 48½ degrees, are reflected, and do not enter the ſphere; but, if that angle be leſs than 48½, they enter the ſphere, and are refracted, ſo as all to meet in one point, called the *focus*.

The rays of light, therefore, whether direct or inflected, fall upon the tunica cornea of the eye, ſo as to form a very ſharp cone between 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 the radiant point; yet ſo that all rays may, without any ſenſible error, 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

and fall in betwixt the iris and the 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 of 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.

The rays falling on the cornea are therefore refracted, and paſs through the aqueous humour in a more parallel, or perhaps converging direction, by which contrivance a greater number of rays fall on the cryſtalline than if they had not previouſly paſſed through the cornea and the aqueous humour.

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

This vitreous body 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 in a natural eye when the back part of the ſclerotica is cut off, and a piece of paper placed to receive the object. The image is painted on the retina at the end of the viſual axis, which is ſituated on the exterior ſide of the place where the optic nerve enters the ſclerotica; it is not, however, a mere point, but has ſome degree 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 feen moft diftinctly, becaufe the rays arrive thither nearly perpendicular. But frequently this point of vifion does not fall on the fame place on both of the eyes. When the lens has been couched or difplaced, the vitreous body, although it has a weaker refracting power, ufually fuffices to bring the vifual rays together to a focus.

Is it altogether falfe that the object is painted on the retina? Or is this picture made on the choroides? Is this laft opinion confirmed by an experiment which proves 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 vifion? But this is repugnant to a very well known obfervation, namely, that the retina is a moft fenfible nervous medulla; and that the choroides confifts only of a few fmall nerves, and almoft entirely of veffels moft certainly blind. It is likewife contradicted by the very great apparent differences obfervable in the choroides of different animals, and by the perfect famenefs of the retina in all, and alfo by the black fpots on the retina, which always produce partial blindnefs. This experiment fhews alfo the reafon why the optic nerve is not inferted into the axis of the eye, but into its fide. Thus, except only in one fingle cafe, namely, when the object is in the concourfe of the lines drawn through the centre of the optic nerves, the one eye fees, and affifts the other, which has the center of its optic nerve turned to the object.

Since the neceffary offices of human life require a diftinct object to be painted upon the retina, not only by the rays which come from one certain diftance, but likewife by rays which come from very different parts more or lefs diftant; it has therefore been thought that a neceffary change, produced by its own caufes, is made on the eye. Other eminent anatomifts have fuppofed the lens moveable by the powers before

mentioned,

mentioned. This art of feeing diftinctly at different diftances is faid to be learned by experience, it being unknown to thofe who have been lately couched. It is alfo faid, that, in an artificial eye, the ufe and neceffity of this motion may be plainly perceived. Too great a divergency of the rays, as in thofe which come from objects very clofe to the eye, is corrected by a removal of the lens farther from the retina, fo as to bring the focus upon the retina itfelf, which would otherwife have fallen behind the eye; for, the refracting power of the eye being the fame, if the focus of rays coming from the diftance of three feet fall perfectly upon the retina, thofe rays which come from the diftance of three inches will not be collected into a focus at the retina, but beyond it; and rays ftill more diverging will meet together yet farther behind the eye, if they are not collected together by a greater refracting power.

But thofe rays which come from very remote objects, and which may therefore be counted parallel, will meet together before the retina, in the vitreous humour, and feparate again at their point of concourfe, as if it was a lucid point: To remedy which, therefore, it is fuppofed that thofe powers above mentioned remove the cryftalline lens back from the cornea nearer to the retina, that the rays may form the focus on the retina: For an eye that will collect the rays coming from feven inches, fo as to unite them on the retina, will collect thofe together before the retina which come from a diftance of three feet. It was therefore perfectly neceffary for the eye to be made thus changeable, that we might be able to fee diftinctly at various diftances. The point of diftinct vifion is in that part of the retina where the given object is painted in the leaft compafs poffible. The powers caufing the vifual rays to unite on the retina, are often very different in the two eyes of the fame perfon, the one being long-fighted and the other fhort-fighted.

Thefe, and other commonly received opinions, are taught by mathematicians, who more readily perceive the neceffity of thefe changes. But yet there is no power in the human eye which can either move the cryftalline humour out of its place, or comprefs it: Befides, we do not perceive this faculty in ourfelves; for we move a book nearer to our eyes when it is too far off, fo as to appear confufed, which we would have no occafion to do, if by changing the internal figure of the eye we could correct the fault of the diftance: And through a fmall hole, we perceive an object fingle, only in the point of diftinct vifion, but double in every other. Perhaps the contraction of the pupil may enable us to fee near objects more diftinctly.

This contraction, however, is not in all people fufficient for the purpofe. There are feveral people, efpecially fuch as lead a fedentary life, and fuch as are employed in examining minute objects, whofe cornea is too convex and denfe, whofe cryftalline lens is too gibbous and folid, and whofe eye is lengthened by the incumbent weight of the humours, and perhaps the humours themfelves are too denfe; and in the fame perfon the eye may probably have all thefe defects joined together. People labouring under one or more of thefe inconveniencies have an iris that is fenfible in a very fmall degree of light, which circumftance makes them twinkle with the eye-lids when they are in a ftrong light, and they are called *myopes* or fhort-fighted. In thefe, the point of diftinct vifion is very near to the eye, commonly from one to feven inches from the cornea; but they fee remoter objects more obfcurely, without being able to diftinguifh their parts. The reafon of this is evident; fince, from the forementioned caufes, there is a greater refracting power of the humours, by which the diftant, and confequently parallel, rays are obliged to meet in their focus before the retina, from whence fpreading again, they fall upon the retina in many points,

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On the contrary, to a good eye, objects which are too near the cornea appear confused; because the rays coming from them are spread over several parts of the retina, and are not collected in a point on it.

The remedy for this fault in the sight is to correct it in its beginning, by looking at distant, rather than near and minute objects; 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 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 square of the distance of distinct vision from the naked eye, multiplied by the distance of distinct vision in the armed eye, and that product divided by the difference between them. Age itself advancing, gives some relief to the short-sighted, for children are mostly near-sighted; but, as the eye grows older it becomes flatter, in proportion as the solids grow stronger; and, contracting to a shorter axis, the refracting powers of the lens and cornea are diminished.

The other disorder of the sight, contrary to the former, troubles people who often look at 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 beyond the retina, and throw the point of their pencil behind the eye, from whence vision is confused. The point of distinct vision among

among prefbyopi, or old or long-fighted people, is from the diftance of fifteen inches to three feet.

Such perfons are, in fome meafure, relieved by looking through a black tube held before the eye; by the ufe of which the retina grows tenderer, and the rays come to the eye in a parallel direction. The remedy here is a convex lens, which caufes the rays to converge and unite together fooner in a focus, that it may not fall behind the eye, but upon the retina. The diameter of the fphere, of which fuch a lens ought to be a portion, is determined as before. There is no hope of relief from age, which increafes the malady.

The medium between the fhort and long fighted eye is the beft, by which a perfon can fee diftinctly enough objects that are both near and remote; and of this kind we reckon an eye that is able to read diftinctly at the diftance of one foot. But a good eye requires other neceffary conditions, fuch as a perfect clearnefs of the humours; a due mobility of the eye itfelf, and its parts; a fenfibility of the pupil, and a retina neither too prurient nor too callous.

The mind only receives a reprefentation of the image of the object by the eye, impreffed on the retina, and transferred to the common fenfory or feat of the foul. Several circumftances relative to vifion are not determined by the inftrumentality of the eye, but are perceived by the mind from mere experience; and fometimes the mind interprets the reprefentation to be very different from that which the eye gives to her. The magnitude of an object, for inftance, is not determined by the eye, but by the optical angle, which is formed by lines fuppofed to be drawn from the extremities of the object to the cornea. Hence near objects feem large, and thofe at a diftance fmall. On this circumftance alfo the power of microfcopes depends, which magnify in proportion to the difference between the focal length of the magnifier and the diftance of diftinct vifion. Objects, by the means of this inftrument, not only appear larger, but brighter and more diftinct, and hence the mind thinks them nearer.

The brightnefs of objects fituated in the fame light depends partly on the fize of this fame angle, partly on the number of rays which they reflect, and partly on the fmallnefs of the picture on the retina; hence near objects appear bright, while thofe that are more remote feem obfcure; and hence alfo, when remote objects are more enlightened, the mind fuppofes them either greater or nearer than they really are.

The apparent place of an object, feen with one eye, is in the line which divides the optical angle. But, if we look at an object with both eyes, its apparent place will be in the point where lines, drawn through the axes of both eyes to the object, meet.

Diftance we cannot perceive; and if a blind man, who never faw, fhould by any means be reftored to fight, he would imagine every thing he faw to touch his eyes. Even we, who are accuftomed to judge by fight, make many fallacious conjectures concerning the diftance of objects. We judge of the diftance of an object from the diminution of its known bulk; from its diminifhed brightnefs; from the faintnefs of its image, by which we are lefs capable of diftinguifhing its parts; and, laftly, from the number of bodies, whofe diftance is known, that are interpofed between us and the object.

A body does not feem convex, until we have learnt by experience, that a body, which is convex to the feeling, caufes light and fhadow to be difpofed in a certain manner. Hence it is, that microfcopes frequently pervert the judgment, by tranfpofing or changing the fhadows. The fame alfo happens in that phenomenon which is not yet fufficiently under-

ftood,

ftood, by which the concave parts of a feal are made to feem convex, and the contrary

The vifible *fituation* of the parts of an object, is judged by the mind to be the fame with that which thefe parts naturally have in the object, and not the inverted pofition in which they are painted upon the retina. The faculty of correcting this inverfion feems to be innate; for new-born animals always fee objects upright; and men who have been born with cataracts are obferved, upon couching the cataracts, to fee every thing in its natural fituation, without the ufe of any feeling, or previous experiences.

The mind is often impofed on by the continuance of the fenfation after it has been conveyed to the mind, by which means objects, although inftantly removed, continue to be feen for about a fecond. Hence proceeds the idea of a fiery circle from the circumrotation of a lucid body; and hence alfo proceeds the continuance of the fhining image of the fun, and fometimes of other bodies, after they have been viewed by the eye.

Do we diftinctly perceive only one object fituated in the axis of diftinct vifion? And does the eye perfuade itfelf, that it fees many objects at a time, partly from the duration of the ideas, and partly from the quicknefs of the motions of the eye? In diftinct vifion, we may certainly anfwer thefe queftions in the affirmative, but not in more imperfect vifion. Why do we fee only one object with two eyes? becaufe, when the impreffions of two objects are fimilar, the fenfation becomes fingle. Even without the concourfe of optic nerves, infects who have numerous eyes perceive objects fingle. Hence the images of two objects excite only one fenfation, when they fall upon the fame point of the retina; but two fenfations arife from one object, when the images fall upon different parts of the retina. Whence proceed diurnal and nocturnal blindnefs? The former is common to many nations

living

living in the warmeft climates, under the brighteft fun, and to old men. The other happens in inflamed eyes, and to young men of a hot temperament, who are endowed with eyes vaftly fenfible. Whence do animals fee in the dark? From a large dilatable pupil, and tender retina; and a fhining choroides, which reflects the light very ftrongly. Why are we blind when brought out of a ftrong light into a weak one? Becaufe the optic nerve, having fuffered the action of ftronger rays of light, is incapable of being moved by thofe that are weaker. Whence have we a pain, by paffing fuddenly from a dark place into the light? Becaufe the pupil, being widely dilated in the dark, fuddenly admits too great a quantity of light before it can contract; whence the tender retina, which is eafily affected by a fmall light, feels, for a time, an impreffion too fharp and ftrong. Whether do we fee with one eye, or with both? Moft frequently with one, and more efpecially the right eye: But, when both are employed together, we fee more objects, and more plainly; and we alfo diftinguifh more points of the fame object, and judge better of their diftances.

Sect. III. The Nose.

The parts of which the nofe is compofed, may be divided in two different ways, viz. from their fituation, into external and internal parts; and, from their ftructure, into hard and foft parts.

The external parts are the root of the nofe, the arch, the back or fpine of the nofe, the fides of the nofe or of the arch, the tip of the nofe, the alae, the external nares, and the part under the feptum.

The internal parts are the internal nares, the feptum narium, the circumvolutions, the conchae fuperiores, or offa fpongiofa fuperiora, conchae inferiores, the pofterior openings of the

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, conchae 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, ſacculus 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 notice their diſtribution and diſpoſition, as far as relates to 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 criſtae of the oſſa maxillaria, and riſing edges of the oſſa palati. The fore part of the noſe is formed by the oſſa naſi; and the ſides, by the ſuperior apophyſes of the oſſa 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 upward 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 conchae or oſſa 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 large probe may eaſily be paſſed from the external nares, under the great apophyſis of the occipital bone.

bone. The openings of the maxillary ſinuſes are nearly oppoſite to the upper edge of the oſſa 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 nearly of a regular figure. The reſt are only additional, ſmaller, more irregular, and the number 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 its principal part.

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

curvated extremities being commonly filled with a kind of fatty ſubſtance. The two poſterior cartilages form the alae 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 alae 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, 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 alae narium, are pierced with the ducts of a great number of glandulae ſebaceae, 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 ſmaller acceſſorii. The noſe may alſo be moved, in ſome meaſure, by the neighbour-

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ing mufcles, which, in many cafes, become affiftants to the proper mufcles of this organ.

The firft pair of thefe mufcles raifes and dilates the alae of the nares when they act. They likewife wrinkle the fkin on the fides of the nofe. The fecond pair have the contrary effect; and the third pair comprefs the fides of the nofe to the feptum, as in fmelling.

Membrana pituitaria. The membrana pituitaria is that which lines the whole internal nares, the offa fpongiofa, the fides of the feptum narium, and, by an uninterrupted continuation, the inner furface of the finus frontales and maxillares, and of the ductus lacrymales, palatini, and fphenoidales. It is likewife continued down from the nares to the pharynx, feptum palati, Euftachian tubes, &c. as we fhall fhew hereafter. It is likewife known by the name of *Schneideriana*, from the anatomift who has given a defcription of it.

It is termed *pituitaria*, becaufe through the greateft part of its large extent, it ferves to feparate from the arterial blood a mucilaginous lymph, called *pituita* by the antients, which, in its natural ftate, is nearly liquid; but it is fubject to very great changes, becoming fometimes glutinous or fnotty, fometimes limpid, &c.; neither is it feparated in equal quantities through the whole membrane.

When we carefully examine this membrane, it appears to be of a different ftructure in different parts. Near the edge of the external nares it is very thin, appearing to be the fkin and epidermis in a degenerated ftate. All the other parts of it, in general, are fpongy, and of different thickneffes. The thickeft parts are thofe on the feptum narium, on the whole lower portion of the internal nares, and on the conchae; and, if we make a fmall hole in it at any of thefe places, and then blow through a pipe, we difcover a very large cellular fubftance. In the finufes it appears to be of a more flender texture.

Winflow

Winflow obferves, that, on the fide next the periofteum and perichondrium, it is plentifully ftored with fmall glands, the excretory ducts of which are very long near the feptum narium, and their orifices are very vifible; and that, by applying a pipe to any of thefe orifices, the ducts may be blown up almoft through their whole extent; but that, in order to this, the parts muft firft be very well cleaned and wafhed in lukewarm water. Sabatier gives fomewhat of a different defcription: He admits of mucous follicles; but fays they are very different from thofe which are properly called glands.

Sinus. The frontal, maxillary, and fphenoidal finufes open into the internal nares, but in different manners. The frontal finufes open from above downward, anfwering to the infundibula of the os ethmoides defcribed in the hiftory of the fkeleton. The fphenoidales open forwards, oppofite to the pofterior orifices of the nares; and the maxillares open a little higher, between the two conchae or offa fpongiofa. Therefore the finus frontales difcharge themfelves moft readily when we ftand or fit; and the fphenoidales, when the head is inclined forward.

The finus maxillares cannot be emptied wholly, or both, at the fame time, in any one fituation. Their openings, which in fome fubjects are fingle, in others double, &c. lie exactly between the two offa fpongiofa of the fame fide, about the middle of their depth; fo that, when the head is held ftraight, or inclined forward or backward, they can only be half emptied; but, when we lie on one fide, the finus of the oppofite fide may be wholly emptied; the other remaining full.

It is proper here to obferve the whole extent of the maxillary finus. Below. there is but a very thin partition between it and the dentes molares, the roots of which, in fome fubjects, perforate that feptum. Above, there is only a very thin tranfparent lamina between the orbit and the finus.

Backward, above the tuberofity of the os maxillare, the fides of the finus are very thin, efpecially at the place which lies before the root of the apophyfes pterygoides. Inward, or toward the conchae narium, the bony part of the finus is likewife very thin.

Sacculus lacrymalis. The lacrymal facculus is an oblong membranous bag, into which the ferous fluid is difcharged from the eye, through the puncta lacrymalia already defcribed, and from which the fame fluid paffes to the lower part of the internal nares. It is fituated in a bony groove and canal, formed partly by the apophyfis nafalis of the os maxillare and os unguis, partly by the fame os maxillare and lower part of the os unguis, and partly by this lower portion of the os unguis, and a fmall fuperior portion of the conchae narium inferior. This groove and canal are the bony lacrymal duct, about which beginners fhould confult what was faid in the defcription of the fkeleton.

With refpect to the fituation 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 fide, where its lower extremity opens on one fide of the finus maxillaris under the os fpongiofum inferius, nearly at the place from which a perpendicular line would fall in the interftice between the fecond and third dens molaris. The upper part of this duct is only an half-canal or groove; the lower is a complete canal, narrower than the former.

The facculus lacrymalis may be divided into a fuperior or orbitary portion, and an inferior or nafal portion. The orbitary portion fills the whole bony groove, being fituated immediately behind the middle tendon of the mufculus orbicularis. About one fourth of its length is above this tendon, and the reft below; the upper part is the lacrymal fac properly fo called; while the nafal portion, which lies in the bony canal of the nofe, being narrower and fhorter than the

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 difpofed at its upper extremity, much in the manner of an inteftinum caecum, and at the lower extremity is fomewhat narrower than the portio nafalis. Towards the internal angle of the eye, behind the tendon of the orbicular mufcle, it is perforated by a fmall fhort canal formed by the union of the lacrymal ducts.

The nafal portion becomes gradually larger towards its under end, and having reached the lower part of the bony duct under the inferior concha is perforated by a round opening, which at firft fight appears oblong.

If a tranfverfe line be drawn between the lower part of the nofe and os malae, and another line be drawn directly upward, oppofite to the third dens molaris, or oppofite to the fecond and third, thefe two lines will interfect each other nearly at the lower extremity of this facculus.

Sometimes the upper extremity of this bag has been found divided into an anterior and pofterior part, by a kind of valvula connivens lying in the anterior portion, a little lower than the tendon of the mufculus orbicularis. The fmall common canal of the two lacrymal ducts opens in the pofterior part of this facculus, and confequently behind the valve.

The fubftance of this facculus is fomething fpongy or cellulous, and thickifh, being ftrongly united by its convex fide to the periofteum of the bony canal, which may be very diftinctly fhewn. Sabatier obferves, that its fubftance is fimilar to that of the membrana pituitaria, and that it is lined with the fame kind of mucous within. Its ufe has been compared, by fome late writers, to that of the bladder of urine, as was mentioned in the defcription of the eye.

Ductus inciforii. The ductus inciforii, or nafo-palatini of Steno, are two canals which go from the bottom of the internal

ternal nares, crofs the arch of the palate, and open behind the firft or largeft dentes inciforii. Their two orifices may be diftinctly feen in the fkeleton at the lower part of the nafal foffae, on the anterior and lateral fides of the criftae maxillares; and we may likewife perceive their oblique paffage through the maxillary bones; and laftly, their inferior orifices, in a fmall cavity or foffula, called *foramen palatinum anterius*. In frefh fubjects they are not fo apparent, efpecially in human fubjects; but in fheep and oxen they are eafily difcoverable.

Arteries and veins. The arteries of all thefe parts come chiefly from the external carotid. Thofe of the external parts of the nofe 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 likewife fmall branches from the ocular artery. The veins are, almoft in the fame manner, branches and ramifications of the external jugular; and they communicate with the orbitary finufes, and, by that means, with the finus of the dura mater, and with the internal jugulars.

Nerves. The principal nerves belonging to the nofe are filaments of the nervi olfactorii, which run down through the holes of the tranfverfe lamina of the os ethmoides, and are diftributed to the common membrane of the internal nares, efpecially to its villous portions. The inner ramus of the orbitary or ophthalmic fends 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 diftributed partly to the facculus lacrymalis, partly to the upper portion of the mufculus levator alae nafi, and of the integuments of the nofe. The fuborbitary nerve, which

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 conchae 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 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 a roundiſh figure, has given to the organ of ſmelling only a ſmall extent of ſurface; but, to enlarge this the more, nature has made the internal parts of the noſe hollow, and variouſly complicated in a ſurpriſing manner.

§ 1. *Of Smelling.*

The taſting noxious food might in many inſtances be highly dangerous. We can by this ſenſe, independent of taſte, diſcover the noxious quality of aliments, eſpecially ſuch as are putrid, and conſequently peculiarly hurtful to the human frame; and at the ſame time that it directs us to avoid what is dangerous, it enables us to diſcern what is grateful and wholeſome. This uſe of ſmelling in chooſing food, is more obſervable in brutes than in men; yet men left to themſelves, and who are undebauched by a variety of ſcents, poſſeſs this ſagacious faculty in a very eminent degree. The powers and virtues of medicinal plants are hardly to be better known than by the ſimple teſtimony of taſting and ſmelling. Hence it is, that in all animals theſe organs are placed together; and hence the ſmelling is ſtronger, and the organs larger, in thoſe animals which are to ſeek their prey at a confiderable diftance, or to reject malignant plants from among thofe that are fit for food.

The fenfe of fmelling is performed by means of a foft pulpy membrane, full of pores and fmall veffels, which lines the whole internal cavity of the noftrils; it is thicker upon the feptum and principal convolutions, but thinner in the finufes. Within this membrane are diftributed veffels and nerves which have been already defcribed.

The nerves of the nofe, being almoft naked, require a defence from the air, which is continually drawn through the noftrils, and blown out again by refpiration. Nature has therefore fupplied this part, which is the organ of fmelling, with a thick infipid mucus, very fluid in its firft feparation, but, by the air, condenfing into a thick, dry, and more confiftent cruft. By this mucus the nerves are defended from drying and from pain. It is poured out from many fmall arteries, and depofited partly into numerous cylindrical ducts, and partly into round vifible cryptae or cells, fcattered all over the noftrils. It flows out all over the furface of the olfactory membrane, which is anointed with it on all fides. This mucus is accumulated in the night time; but, in the day, it either flows fpontaneoufly, or may be more powerfully expelled by blowing the nofe. By becoming dry and harfh, it irritates the very fenfible nerves of the membrane, whence a fneezing is excited for its removal. The finufes of this part, which abound with mucus, are evacuated in the manner already defcribed in page 121. The tears defcend, by a channel proper to themfelves, into the cavity of the nofe, by which they moiften and dilute the mucus.

The cartilages render the nofe moveable by its proper mufcles, fo as to be raifed and dilated by a mufcle common to the upper lip, and to be contracted together into a narrow compafs by the proper depreffor and compreffor mufcle pulling down the feptum. Thus the prominent organ of fmelling

ling is adapted to the reception of fcents; and it is dilated in proportion to the quantity of inhaled air, and again contracted, when the air is expelled in the fame abundance.

The air, filled with the fubtle and invifible effluvia of bodies, confifting of their volatile, oily, and faline particles, is, by the powers of refpiration, urged through the nofe, and applied to the almoft naked, and conftantly foft, olfactory nerves, in which a kind of feeling is excited, which we call *fmelling;* and by this fenfe we diftinguifh feveral kinds of oils and falts, by different fcents or odures, which are difficultly reducible to claffes, and difficultly recalled to memory. The odours, however, already eftablifhed, are fufficient enough for our purpofes. This fenfe ferves to admonifh us of pernicious putrefaction; of violent acrimony; or of a mild and foapy quality in bodies. As falt, joined with an oil, is the object of tafte; and a volatile oil, added to falts, ferves to excite fmells, we may perceive the affinity of thefe two fenfes, which affinity feemed to be the more neceffary on account of thefe fenfes mutually and jointly affifting each other in performing their offices. Volatile particles are chiefly diftinguifhed by fmell, and fixed ones by tafte; perhaps becaufe the thick mucous cuticle, fpread over the tongue, intercepts the action of the more fubtle faline effluvia from acting upon the tafte, which yet eafily affect the fofter and lefs covered nerves of the internal nofe. We are ignorant of the reafon why fome fmells pleafe, and others difpleafe; perhaps cuftom may have much influence in this refpect.

The power of odours is ftrong and quick, becaufe minute particles of matter are immediately applied to naked nerves fituated very near the brain: Hence the force of poifonous vapours, and hence alfo the quality certain odours poffefs, of recovering people from faintings, or after drowning: Hence alfo that violent fneezing which often arifes from acrid particles, and a diarrhoea from the fmell of fome medicines; hence the

the power of particular antipathies: Hence alfo the pernicious effects of exceffive fneezing, more efpecially in producing blindnefs, which may, in fome meafure, alfo be more eafily brought on by the confent of the nerves that are exceedingly numerous in thefe neighbouring organs. Among the various parts of the nofe, the feptum, and more efpecially the os turbinatum, have a confiderable fhare in the organ of fmelling, fince thefe parts are multiplied in quick fcented animals. In dogs, and other quadrupeds, they are prodigioufly lengthened, and beautifully formed into fpiral laminae; in fifhes they are elegantly formed, like the teeth of a comb.

Sect. IV. The Ear.

The ear in general. The ears are two; they are fituated in the lateral parts of the head, and are the organs of hearing. Anatomifts commonly divide or diftinguifh the ear into external and internal. By the external ear they mean all that lies without the external orifice of the meatus auditorus in the os temporis; by the internal ear, all that lies within the cavities of that bone, and alfo the parts that bear any relation thereto.

The greateft part of the external ear confifts of a large cartilage, very artificially framed, which is the bafis of all the other parts of which this portion of the ear is compofed. The internal ear confifts chiefly of feveral bony pieces, partly formed in the fubftance of the os temporis, and efpecially in that portion of it called *apophyfis petrofa;* and partly feparated from, but contained in, a particular cavity of that bone.

The external ear. Two portions are diftinguifhed in the external ear; one large and folid, called *pinna,* which is the fuperior, and by much the greater part; the other fmall and foft, called the *lobe,* which makes the lower part. We may likewife confider two fides in the outward ear, one turned obliquely

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, 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 ſhews 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 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 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 backſide, it ſhews all the eminences and cavities of 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, in conſequence of this obliquity, 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 two ligaments, 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 glenoid 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 maſtoid apophyſis; and by the other, to the poſterior

part

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, 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 Walſalva 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 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

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 *glandulae ceruminoſae*, 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 Duverney.

The

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 with 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, both 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-maſtoideum, 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 alſo ſends 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 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

little bones lodged in the tympanum, called *incus*, *malleus*, *ſtapes*, and *os orbiculare* or *lenticulare*.

The external auditory paſſage begins by the external auditory hole, the edge of which is rough and prominent; but, backward toward the maſtoid proceſs, it appears very much ſloped. The paſſage itſelf is ſomewhat more than half an inch in length, running obliquely from behind forward 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, the bottom of it being turned inward, and the mouth joined to the circular groove already mentioned.

The remarkable eminences are three: 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; its apex is perforated

forated by a ſmall hole, and on one ſide of its 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 openings of the maſtoid cells are 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 opening 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. Its bony portions, 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 in ſome meaſure be conſidered as prolongations of the tympanum.

The bony half canal lies immediately above the Euſtachian tube, toward the upper ſide of the pars petroſa. In a natural ſtate, 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

fore backwards. Toward the labyrinth, this opening has a little border quite 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 the 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.

Oſſicula auditus. The tympanum contains ſeveral little bones, called *the bones of the ear.* They are generally four in number, denominated from ſomething to which they are thought 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 crop of the dentes molares.

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

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 authors 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 towards 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 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 that 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, inward, being fixed in the feneſtra ovalis; the longeſt leg backward, the ſhorteſt forward; and both in the ſame plane. 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,

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 diſcovered them; but Veſalius is the firſt who has named the malleus and incus; Arantius or Sylvius, the os orbiculare; Ingratius 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 internal meatus auditorius, oppoſite to the feneſtra ovalis, by a number of very ſmall holes, for the paſſage 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 of it being turned upward. The oblique canal lies farther back than the former, and runs parallel to the length of the procefs, the convex fide being turned backward, with one extremity upward, the other downward. The fuperior extremity of this canal meets and lofes itfelf in the internal extremity of the former.

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

The horizontal canal is generally the leaft of the three; the oblique is often, and the vertical fometimes, the greateft; and fometimes thefe two are equal. All the three canals are larger than a femicircle, forming nearly three quarters; they are broader at the orifices than in the middle. Thefe orifices open into the back-fide of the veftibulum, and are but five in number, becaufe two of them open into each other; fo that, in the pofterior part of the veftibulum, two appear toward the infide, and three toward the outfide.

In children, the fubftance of thefe canals is compact, while that which furrounds them is fpongy. Hence they may be eafily feparated from the reft of the pars petrofa. In adults, all the parts of the bone are fo folid, that thefe canals appear only like paffages formed in a piece of ivory. From this defcription, it is eafy to diftinguifh the right labyrinth from the left.

Cochlea. The cochlea is a fort of fpiral body with two ducts, formed in the anterior part of the pars petrofa, fomewhat refembling the fhell of a fnail. The parts to be diftinguifhed in it, in its true fituation, are, the bafis; the apex; the fpiral lamina, or half feptum, by which its cavity is divided into two half canals; the modiolus or fpindle, round which

which the cochlea turns; and, laftly, the orifices and union of the two ducts. The bafis 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 muft be made for the obliquity of the pars petrofa in which they lie.

The bafis of the cochlea is gently hollowed; and, toward the middle, perforated by feveral fmall holes. The modiolus is a kind of fhort cone, with a very large bafis, which is the middle of the bafis of the cochlea. Through its whole length runs a double fpinal groove, which, through a microfcope, fhews a great number of pores. The cochlea makes about two turns and a half from the bafis to the apex; and the two half canals, being firmly united together through their whole courfe, form a half feptum, called *lamina fpiralis*; which muft not be confounded, as it often is, with the complete feptum in the recent fubject. One edge of the lamina fpiralis is ftrongly 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 ftate, the other half of the feptum is membranous, and completes the partition between the two canals. The two half canals turn jointly about the modiolus; one being fituated toward the bafis of the cochlea, the other toward the apex; for which reafon we have always called one of them *internal*, the other *external*.

The fpiral or volute of the cochlea begins at the lower part of the veftibule; runs from thence forward to the top, then backward down to the bottom, afterward upward and forward; and fo on from the bafis, which is turned inward, to the apex which is turned outward. From this defcription, it is eafy to know to which ear any cochlea belongs when we fee it prepared: It likewife teaches us, that, in the right cochlea, the direction of the turnings is the fame as in gar-

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den ſnails, and almoſt all the other common ſhells; but, in the left cochlea, the turnings are in a contrary direction. The two half canals communicate fully at the apex of the cochlea. Their ſeparate openings are towards the baſis, one of them being immediately into the lower part of the foreſide of the veſtibulum, the other into the feneſtra rotunda. Theſe two openings are ſeparated by a particular turning, which ſhall be afterwards deſcribed.

The *meatus auditorus internus*, is on the backſide 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 foſſulae, 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, that 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 ſtylomaſtoideum, through which it goes out, and is diſtributed in the manner to be hereafter deſcribed. 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.

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The ſoft parts of the internal ear are chiefly the membrana tympani, the perioſteum of the tympanum, and of the oſſicula auditus, labyrinth, and of all its cavities, the membrana maſtoidea interna, the muſcles of the oſſicula, 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 foſſae, 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 conſiſts 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 glenoid 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 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 thefe the innermoft is formed by the fide of the apophyfis petrofa, the outermoft by the fide of the apophyfis fpinalis of the os fphenoides. Of the two inferior parts, the internal, or that next the os fphenoides, is cartilaginous; and the external, or that next the pars petrofa, membranous.

The Euftachian tube, thus formed, is very narrow next the ear, but grows gradually wider, efpecially near the pofterior nares, where the inner cartilaginous fide terminates by a prominent edge, and the outer fide joins that of the neighbouring noftril. 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 confiderably increafed in thicknefs, reprefenting a kind of half pad.

The fituation of the two tubes is oblique, their pofterior extremities at the ears being at a greater diftance than the anterior at the nares; and the convex fides of the prominent edges are turned toward each other. The openings of the tubes are oval at this place, as is likewife their whole cavity, efpecially that of the mixed portion.

The membrana tympani is a thin, tranfparent, flattifh pellicle, the edge of which is round, and ftrongly fixed in the orbicular groove which divides the bony meatus of the external ear from the tympanum or barrel. This membrane is very much ftretched or very tenfe, and yet not perfectly flat: For on the fide next the meatus externus it has a fmall hollownefs, which is pointed on the middle; and on the fide next the tympanum it is gently convex, and alfo pointed in the middle.

This membrane is fituated obliquely, the upper part of its circumference being turned outward, and the lower part inward, fuitably to the direction of the bony groove already mentioned. It confifts of feveral very fine laminae, clofely united

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 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 foetus.

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 feneſtrae, and enters the Euſtachian tube, where it is loſt in the inner membrane of that duct.

The cellulae maſtoidae are very irregular cavities in the ſubſtance of the maſtoide apophyſis, which communicate 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.

pituitaria. The maſtoid opening is oppoſite to the ſmall opening of the Euſtachian tube, but a little higher.

The ligaments of the oſſicula 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 maſtoid 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. Veſalius 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. Caecilius Folius is ſaid to have been the diſcoverer.

A third muſcle has by ſome been deſcribed under 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 Sabatier have been able

able to difcover mufcular fibres in it. Cafferius firft defcribed it.

The mufcle of the ftapes is fhort and thick, and lies concealed within the fmall bony pyramid at the bottom of the tympanum. It runs forward to be inferted in the neck of the ftapes, on the fide of the longeft and moft crooked leg of that bone.

The three parts of the labyrinth, that is, the veftibulum, femicircular canals, and cochlea, are lined by a fine periofteum, which is continued over all the fides of their cavities, and fhuts the two feneftrae of the tympanum. Upon this fine periofteum the veffels and nerves are difperfed.

The femicircular canals are fimply lined by a periofteum adhering to their inner furfaces without any particular membranous bands. The two half canals of the cochlea are lined in this manner; the periofteum of the two fides of the bony fpiral lamina advances beyond the edge of that lamina, and forms a membranous duplicature, which, extending to the oppofite fide, completes the fpiral feptum.

The feptum feparates the two half canals from the bafis to the apex; but there it leaves a little opening, by which the fmall extremities of the half canals communicate with each other. The large extremity of the external half canal ends by an oblique turn in the feneftra rotunda, which is fhut by a continuation of the periofteum of that canal. The large extremity of the other half canal opens into the veftibulum; and thefe two extremities are entirely feparated by a continuation of the periofteum.

The whole internal cavity of the labyrinth is filled with a watery fluid fecreted from the veffels, which are difperfed upon the periofteum. This fluid tranfmits to the nerves the vibrations it receives from the membrane fituated between the tympanum and labyrinth.

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The ſuperfluous part of this fluid is ſuppoſed to paſs off through two ſmall canals called the *aqueducts 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 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 veſtibule. 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 veſtibule. For a full account of theſe ducts, ſee an excellent Diſſertation by Dr Meckel of Berlin.

All the perioſteum of the internal ear, eſpecially that of the oſſicula 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 vertebralis, the ſmall capillary ramifications of which may be obſerved to accompany the auditory nerve through

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the internal foramen auditorium. 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 finus; the other lies near the aqueduct of the veftibule, and carries the blood from that cavity, and from the femicircular 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 foffula of the internal auditory hole, from whence the filaments pafs through feveral fmall holes in the bafis of the cochlea, to be diftributed through the cochlea, the veftibule, and the femicircular canals. *See* Monro on the Nervous Syftem, Tab. XXIX. XXX. XXXI.

The portio dura runs firft of all into the fmall foffula of the foramen auditorium internum, then paffes through the whole bony duct called *aquaeductus Fallopii*, and comes out again through the ftylo-maftoid hole of the os temporis. In this courfe it communicates with the dura mater on the upper or anterior fide of the apophyfis petrofa, at the place where the bony duct is interrupted.

Having reached behind the fmall pyramid in the bottom of the tympanum, this nerve fends a fmall filament to the mufcle of the ftapes; and, a little before it goes out by the ftylo-maftoid hole, it gives off another more confiderable filament, which enters the tympanum from behind forward, paffes between the long leg of the incus and handle of the malleus, and afterwards runs crofs the whole breadth of the tympanum a little obliquely, and goes out at the fame place at which the tendon of the anterior mufcle of the malleus enters.

This fmall nerve is generally called *chorda tympani*, becaufe in its paffage 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 fide of the bafis of the tongue, where

where having joined the nervus lingualis of the fifth pair, it is confidered as a kind of recurrent; but the remaining part of its courfe muft be referred to the defcription of the tongue.

The portio dura of the auditory nerve having paffed through the foramen ftylo-maftoideum, is diftributed in the manner to be afterwards mentioned in the defcription of the nerves; and we ought very carefully to obferve its different communications with the branches and rami of the nerves of the fifth pair, with the fympatheticus medius or eighth pair, with the fecond pair of cervical nerves, and with the nervi fub-occipitales, or tenth pair of the medulla oblongata, &c.

Hearing. As the fenfe of hearing perceives the elaftic tremors or impulfions of the air, fo we obferve the fenfitive organ of the ear to be compofed in a different manner from that of any of the other fenfes. It confifts, for the moft part, either of hard bones, or elaftic cartilages and membranes, which are the moft exquifitely enabled to receive and communicate the neceffary tremors.

As we have already defcribed the feveral parts of this complicated organ, we fhall proceed to its phyfiology.

The fonorous waves of the air flow into the external ear, which, from principles of mechanics, it muft of courfe collect together. Elaftic air receives, and is the principal means of transferring fonorous tremors; for found is increafed in condenfed air, and is loft in vacuo. Other bodies, however, have the property of conveying found; and Dr Monro has fhewn, in his Phyfiology of Fifhes, that water conveys found nearly as quickly as the atmofphere. The transferring medium receives thefe tremors, either from fome body ftriking againft it, or from the medium itfelf colliding againft another body, or laftly, from the collifion of two bodies againft each other. Every particle of the body which produces found, ought to tremble or vibrate in fuch a manner as alter-

nately

nately to elevate and depreſs its plain ſurface into the form of arches or curves, ſo as to produce the above mentioned ſonorous waves. 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.

Acute ſounds are, in general, produced from bodies that are hard, brittle, and violently ſhook or ſtruck; but grave ſounds from bodies of a contrary nature. Thoſe ſounds, in general, are called *acute*, which are produced from more numerous tremors in an equal time; and thoſe *obtuſe* or *grave*, which are produced from few tremors. As to any medium between 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 in *uniſon;* if one cord vibrates twice while another vibrates once, it produces an *octave;* if one vibrates thrice while the other vibrates twice, it produces a *fifth;* and other proportions between the number of vibrations produce different tones or notes. Shorter cords produce ſharper tones; and the contrary; and the tenſions being the ſame, the ſharpneſs of the tones will be inverſely proportional to their lengths. The lengths being the ſame, the ſharpneſs will be in the ſubduplicate proportion of the ſtretching force. Experiments to this purpoſe 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 velocity equal to about 1142 feet in a ſecond, or above 3 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 one-twelfth of its velocity. Denſity and dryneſs of the air increaſe the ſound, as a rarefaction and moiſture of the air leſſen

leſſen it. Hence, in ſummer time, ſounds move ſwifter; and in Guinea it has been obſerved to paſs at the rate of 1170 feet in a ſecond.

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 to ſuch as are in uniſon with the original tone, but alſo to others. 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 time, or the diſtance of 55 feet between the echoing body and the ear.

The ſonorous waves of the elaſtic air, being driven into the cartilaginous funnel of our ear, are repelled and collected together, by alternate reflections from its elaſtic ſides, into the cavity of the concha, whence they proceed through the auditory paſſage; where their force is increaſed, (in proportion to the difference between the ſurface of the outer ear and the area of the paſſage), by being contracted into ſo narrow a compaſs. They are likewiſe increaſed by new ſounds from the percuſſion of the elaſtic cartilages and hard bones, which mix imperceptibly with the primitive ſounds.

The bottom or end of the auditory paſſage is terminated internally by the *membrana tympani;* which Dr Haller ſays is not naturally perforated, as far as he has been able to diſcover; and that the tranſmiſſion of tobacco-ſmoke from the mouth through the ear is fabulous. Authors in general agree with him now in the former of theſe opinions; but that an accidental

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*, containing 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 the better diſpoſed to hear weak ſounds; and the other muſcle ſerves to moderate thoſe that are too violent, by drawing the malleus from the incus; by which means 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 it alſo ſerves to convey the mucus that covers the little bones and the tympanum: 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, 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 through 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 feneſtra ovalis, 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 feneſtra rotunda, which again agitates the air contained in the cochlea.

The preceding conjecture is plauſible; ſince the ſpiral plates form a triangle, with a very acute vertex, on whoſe ſurface it is poſſible that a number of tranſverſe nervous cords may be ſtretched; and theſe cords, being of different lengths, will be in uniſon with a variety of tones, ſo as to tremble iſochronally with them; namely, the longeſt cords in the baſis of the cochlea with grave ſounds; and the ſhorteſt cords nearer the tip or apex, with ſharper ſounds. Whether are ſounds perceived in the middle ſemicircular canals, ſince theſe alone are found in all claſſes of animals? Are they detained in theſe canals, in the cochlea, and by the membrane

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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 come 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 the nervous pulp. It ſeems to be ſtruck by the nervous pulp ſuſpended in the veſtibulum, and that tremor ſeem 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 proceeds from the celerity of the tremors excited in the hearing nerve, according as they ſucceed each other more ſwiftly or ſlowly. It is not neceſſary that the mind ſhould number them; it is ſufficient that ſhe perceive their numbers to be different, and that this difference excites a variation in the thoughts and ideas thence ariſing. Does the harmony or agreeableneſs of ſounds ariſe from the number of parts ſounding together in uniſon? and does the mind number 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 are in a proportion very difficult to determine. Why do do ſounds often become too ſharp for the ear? becauſe our auditory nerves ſeem to be ſo ſtrained upon the ſpiral plates, as to be in danger of breaking. Thus, drinking glaſſes are broken by ſharp ſounds; and 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 vertebrae 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, amygdalae, 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

thefe might be added the mufcles of the lower jaw, and of the os hyoides.

§ 1. *The Cheeks, Lips, and Gums.*

The cheeks and lips form the fides and entry of the cavity of the mouth. They are formed in general by the connection of feveral flefhy portions of different breadths, fixed round the convex fides of the two jaws, covered on the outfide with the fkin and fat, and lined on the infide by a glandular membrane. Befides all this, the lips feem likewife to have a fat foft fpongy fubftance in their compofition, which fwells and fubfides on certain occafions, independently of the action of the mufcles belonging to them.

The fubftance which forms the red border of the lips is very different from the reft of the fkin, being a collection of very fine, long, villous papillae, clofely connected together, and covered by a fine membrane, which feems to be both a continuation of the epidermis, and of that pellicle which covers the glandular membrane of the cavity of the mouth. This fubftance is extremely fenfible, and very painful when the outer membrane is by any accident deftroyed. The internal membrane of the upper lip forms a fmall middle fraenum above the firft dentes incifori.

The gums are that reddifh fubftance which covers the two fides of the whole alveolary border of both jaws, infinuates itfelf between all the teeth, furrounds the collar of each tooth in particular, and adheres very ftrongly to them. Therefore the outer and inner gums are continuous, and both together form juft as many openings as there are teeth.

The fubftance of the gums is of a very fingular ftructure, refembling, in fome meafure, the texture of a hat, fuppofed to be very compact and elaftic. It is not immediately fixed to the bones of the jaws, but by the intervention of the periofteum, with which it is perfectly united; and it is covered by a fine ftrong even membrane, which fticks very clofe to the fubftance of the gums; and feems 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 thofe branches called *maxillares externae et internae.* The veins are ramifications of the external jugular.

The nerves of thefe parts come from the maxillaris fuperior and inferior, which are branches of the fifth pair; and alfo from the portio dura of the auditory nerve, or fympatheticus minimus; the ramifications of which are fpread in great numbers on all thefe parts, and communicate in a fingular manner with the nerves of the fifth pair in feveral places, as may be feen in the Defcription of the Nerves.

The mufcles of the lips are commonly divided into common and proper. The common mufcles are thofe which end at the angles or commiffures of the two lips; and thofe are proper which are fixed in one lip only; which are again fubdivided into the proper mufcles of the upper lip, and proper mufcles of the under lip All thefe mufcles have particular names; fome of them are taken from the peculiar conformation of the mufcles, fome from the infertions or fituation, and fome from the ufes attributed to them, as has been already defcribed.

The mufcles may be enumerated in the following order: Levator anguli oris; levator labii fuperioris alaeque nafi; depreffor labii fuperioris alaeque nafi; depreffor anguli oris; depreffor labii inferioris; levator labii inferioris; buccinator; zygomaticus major, zygomaticus minor, orbicularis oris. *See* Vol. I.

The common mufcles of the lips either draw both corners of the mouth at once, or only one at a time, according to the

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. 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 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 alveolary 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 rugae of its ſuperior portion, where Mr. Heiſter obſerved a conſiderable orifice, and a canal proportioned to that orifice, which he could eaſi-

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ly inflat 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 portion lie in the duplicature of a glandular 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, which hangs down without adhering to any thing, is called *uvula*.

On each ſide of the uvula there are two muſcular half arches, called *columnae 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 *amygdalae*, 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 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 palate we have found the conſtrictores iſthmi, faucium, palato phyryngei, tenſores palati, levatores palati, and azygos uvulae.

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 by the noſe.

§ 3. *The Tongue.*

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. 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 linguae 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 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 papillae. 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 papillae, which are the organs of taſte. In brute animals, a perforated mucous net-work receive the papillae, which are in a manner wrap-

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ped up in capfules of this mucous body covered with the cuticle.

Three forts of papillae may be diftinguifhed in the upper fide of the tongue; capitatae, femi-lenticulares, and villofae. Thofe of the firft kind are the largeft, and are of a lenticular form, having round heads with fhort ftems. They lie on the bafis of the tongue in fmall fuperficial foffulae.

They have a fmall depreffion in the middle of their upper or convex fide, which opens into a mucous follicle. They occupy the whole furface of the bafis of the tongue; and they are fituated near each other in fuch a manner as that the moft anterior form an angle. They are glandular papillae, or fmall falival or mucilaginous glands, of the fame kind with thofe that are to be defcribed hereafter.

We commonly obferve about the middle of this part of the tongue a particular hole of different depths, the inner furface of which is entirely glandular, and filled with fmall papillae like thofe of the firft kind. It is called *foramen caecum Morgagni*, as being firft defcribed by that author. It is nothing elfe than the meeting of excretory ducts of glands fituated in the tongue, and which throw out a thick faliva.

The papillae of the fecond kind, or femi-lenticulares, are fmall orbicular eminences, only a little convex, their circular edges not being feparate from the furface of the tongue. When we examine them in a found tongue with a good microfcope, we find their convex fides full of fmall holes or pores, like the end of a thimble.

They lie chiefly in the middle and anterior portions of the tongue, and are fometimes moft vifible on the edges. They appear to be very fmooth and polifhed even to the naked eye, and they are often feen in living fubjects. They foon lofe their confiftence after death, fo that, by rubbing them feveral times, they may be drawn out in form of fmall foft pyramids inclined to one fide.

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The papillae of the third kind, or villoſae, 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 papillae. They would be more properly named *papillae conicae* than *villoſae*, 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 which go no further than the tongue, may be termed *muſculi linguae 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 ſtylo-gloſſi, 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

monly 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-hyoidaei*, *genio-hyoi-daei*, *ſtylo-hyoidaei*, *omo-hyoidaei*, *ſterno-hyoidaei*.

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 *fraenum*, 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

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 pterygoidaeus 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 fraenum; and they conſiſt of one artery and one vein, which accompany each other, and are called *arteriae et venae ſublinguales* or *raninae*. The veins lie next the fraenum, 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-hyoidaeus and hyo-gloſſus, under the genigloſſus, 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

paſſage between the pterygoid 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 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 genio-hyoidaei, 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 that 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, pa-

late,

late, or cheeks, we apply a fapid body, we do not perceive the fenfe of pain, but of tafte; and from fome bodies, as arum, pepper, &c. the fenfation produced will be ftronger and more diftinct in thefe parts than any where elfe. That fenfation which is fometimes excited in the ftomach, oefophagus, and fauces, by the regurgitation of the aliments, feems alfo to belong to the tongue, to which the fapid vapours are fent back, uncommonly acrid and penetrating; and even that fenfe which is fometimes occafioned in the ftomach, oefophagus, and fauces, from a rifing of the aliments, feems alfo to be owing to the tongue, to which the tafteable vapours are conveyed.

The *papillae* of the tongue, which are larger and fofter than thofe of the fkin, and perpetually moift, perform the office of touch more exquifitely than the fmall and dry cutaneous papillae. The papillae of the tongue being raifed a little protuberant to perform the office of tafte, are affected in a particular manner by falts diffolved in water, or faliva, and applied againft their tips or fummits; which being diftinguifhed by the mind, and referred to certain claffes, are called *taftes*, either four, fweet, acerb, bitter, faline, urinous, fpirituous, aromatic, or pungent and acrid, infipid, putrid, and others refulting partly from pure falts, and in part from an intermixture of the fubtile, animal, or vegetable oils, varioufly compounding and changing each other.

Does the diverfity of taftes arife from the different figures which are natural to falts? Is the cubical figure of fea-falt the reafon of its having a different tafte from nitre that is prifmatical, or from other falts of a different form? we anfwer, that this does not feem probable; for, even taftelefs cryftals have their particular configurations; and the tafte arifing from very different falts, and differently qualified objects of this fenfe, are too much alike each other, and at the fame time too inconftant or changeable, to allow fuch a theory; as, for example, in nitre. The mechanical reafon, therefore,

of

of the diverſity of taſtes, ſeems to reſide in the intrinſic fabric of the elements of ſapid bodies, which do not fall under the ſcrutiny of our ſenſes.

But the nature or diſpoſition of the covering with which the papillae are clothed, together with that of the juices, and of the aliments lodged in the ſtomach, 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 temperaments; nor even in the ſame perſon at different times, and in different ſtates of health or diſeaſe. In general, whatever contains leſs ſalt than the ſaliva itſelf, ſeems inſipid.

The ſpirituous parts, more eſpecially of vegetables, either penetrate into the papillae themſelves, or elſe are abſorbed by the adjacent villi of the tongue; as appears from the ſpeedy reſtitution of the ſtrength by vinous, or aromatic liquors. For this reſtitution takes place 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 wholeſome aliment that is of a diſagreeable taſte; nor are there any ill taſted ſubſtances that are fit for our nouriſhment. By exceſs, indeed, the moſt wholeſome food becomes prejudicial. 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 us, the advantage of learning from each other by inſtruction, have the faculty of diſtinguiſhing flavours more accurately, by which they are admoniſhed cautiouſly to avoid poiſonous or unwholeſome food; and therefore it is that, in herbivorous cattle, to which a great diverſity of noxious plants is offered among their food, the tongue is of a more exquifite texture, and furnifhed with larger and longer papillae than in man, to whom they are lefs neceffary.

The tongue is likewife one of the principal inftruments of fpeech, and of the articulation of the voice. Riolan, in his Anthropographia, mentions a child of five years of age, who, though he had loft his tongue by the fmall-pox, but not the uvula, continued ftill to fpeak almoft as diftinctly as before. Probably the bafis of the tongue ftill remained. M. de Juffieu has publifhed an obfervation in the Memoirs of the Royal Academy, concerning a little girl who could fpeak though fhe was born without a tongue; in room of which there was only a kind of fmall tubercle.

The tongue ferves alfo to collect all the morfels which we chew; to turn them in different manners, and to different parts of the mouth; and to rub off whatever fticks to the palate; and it is ufeful in fpitting, fucking, &c. It bears a great part in deglutition, being affifted by the digaftric mufcles; which, by contracting at the fame time that the other mufcles prefs the lower jaw againft the upper, raife the os hyoides, and fix it at a convenient height; that the ftylo-gloffi and hyo-gloffi may make the bafis of the tongue bear back upon the morfel which is to be fwallowed, and fo force it into the pharynx; the portions of which, that are at that time immediately above the morfel, inftantly contract, and pufh it into the oefophagus.

§ 4. *The Larynx.*

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

It confifts chiefly of five cartilages; the names of which are thefe: Cartilago-thyroides, which is the anterior and largeft; cricoides, the inferior, and bafis of the reft; two arytenoides,

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 thyroidaea. The cartilago thyroidaea is large 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 *alae*. 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 thyroid 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 alae and the convex ſide of the anterior portion are very uniform; and this cartilage oſſifies gradually in old age.

Cartilago cricoides. The cricoid 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 it is diſtinguiſhed into a baſis and top, into an anterior, poſterior, and two lateral ſides. The baſis is almoſt horizontal

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 arytenoïdaeae, and the two inferior for the articulation of the inferior cornua or appendices of the cartilago thyroides.

Cartilagines arytenoidaeae. The cartilagines arytenoidaeae 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

their inner edges they form a kind of fiſſure, and their outer oblique edges each terminate 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 foreſide, and concave on the backſide. It is ſituated above the anterior or convex portion of the cartilago thyroides; and its lower extremity is tied by a ſhort, 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 arytenoidaeae.

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

the trachea is likewife fixed to the pofterior part of the bafis of the cricoides.

Glottis. The cartilagines arytenoidaeae are connected to the cricoides by ligaments, which furround their articulations with the top of that cartilage. Anteriorly the bafis of each arytenoides is fixed to one end of a ligamentary cord, which, by its other end, is inferted about the middle of the concave fide of the anterior portion of the thyroides. At their infertions in the thyroides, thefe two ligaments touch each other; but a fmall fpace is left between them, where they are fixed in the two arytenoides; and they feem likewife to have a fmall adhefion to the top of the cricoides. This is what is called *the glottis.*

Under thefe two ligamentary cords there are two others which run likewife from behind forward. The interftice between the fuperior and inferior cords on each fide form a tranfverfe fiffure, which is the opening of a fmall membranous bag, the bottom of which is turned outward, that is, toward the ala of the thyroides. Thefe two facculi are the ventricles mentioned by the antients, and reftored by M. Morgagni, who has given an excellent defcription of them. They are chiefly formed by a continuation of the internal membrane of the larynx, and the inner furface of their bottom fometimes appears to be glandular.

On the anterior furface of the arytenoid cartilages, there is a fmall depreffion between the bafis and the convex upper part. This depreffion is filled by a glandular body, which not only covers the anterior furface of each arytenoides, but is likewife extended forward from the bafis over the pofterior extremity of the neighbouring ligamentary cord. They are larger and more fenfible in fome fubjects than in others; and they are covered by the membrane which lines the neighbouring parts. Thefe glands were difcovered by M. Morgagni.

The

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 ligament, 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 glandular bodies called *amygdalae*.

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 lacunae 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-thyroidaei, thyro-hyoidaei or hyo-thyroidaei.

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-thyroidaei; crico-arytenoidaei laterales; crico-arytenoidaei posteriores; thyro-arytenoidaei; arytenoidaei; thyro-epiglottici; aryteno-epiglottici.

By

By the collateral mufcles, is underftood thofe which are inferted by one portion in the larynx, without appearing to contribute any thing to its motions. Of this kind are the thyro-pharyngaei, crico-pharyngaei, &c.

The larynx may likewife be moved by mufcles which are not immediately inferted in it, but are wholly in other parts. Such are the mylo-hyoidaei, genio-hyoidaei, ftylo-hyoidaei, omo-hyoidaei, fterno-hyoidaei, and efpecially the digaftrici of the lower jaw, by reafon of their particular adhefion to the os hyoides. It is likewife probable, that thofe mufcles of the pharynx, which are inferted in the bafis cranii, may, in certain circumftances, move the larynx in fome fmall degree. The blood-veffels of the larynx, &c. are the arteriae and venae, thyroideae, fuperiores, and inferiores. The nerves are the fuperior and inferior laryngeals, which are branches of the eighth pair.

Ufes. The larynx ferves particularly to admit and let out the air in refpiration; and the folidity of the pieces of which it is compofed, hinders not only external objects, but alfo any hard thing which we fwallow, from difordering this paffage. The glottis being a narrow flit, modifies the air which we breathe; and, as it is very eafily dilated and contracted, it forms the different tones of the voice, chiefly by means of the different mufcles inferted in the cartilagines arytenoidaeae, to which the other mufcles of the larynx, both proper and common, are affiftants.

The whole larynx is likewife of ufe in deglutition, as has been already obferved, by means of its connection with the os hyoides, to which the digaftric mufcles of the lower jaw adhere; which mufcles raife the larynx, together with the os hyoides, every time we fwallow.

The facility of varying and changing the tone of the voice depends on the flexibility of the cartilages of the larynx, and decreafes in proportion as we advance in age; becaufe thefe cartilages

cartilages gradually harden and offify, though not equally foon in all perfons: And this change happens not only in the cartilago thyroides, but alfo to the cricoides and arytenoides.

The mufculi fterno-thyroidaei ferve in general to pull down the thyroid cartilage, and the whole larynx along with it. They may likewife affift the fterno-hyoidaei in its action, and comprefs the thyroid gland; of which hereafter. The thyro-hyoidaei may, as occafion 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 ufe of the crico-thyroidaei from their fituation. They may either pull the cricoides obliquely backward, or the thyroides obliquely forward; and by this action the inferior cornua of the thyroides, and fmall articular furfaces of the cricoides, muft flide upon each other.

Both the lateral and pofterior crico-arytenoidaei may feparate the arytenoid cartilages, and thereby open or dilate the glottis; but they do not both perform this action in the fame manner. The lateral mufcles feparate thefe cartilages obliquely forward, and at the fame time loofen or relax the fides of the glottis; but the pofterior mufcles feparate them obliquely backward, and at the fame time ftretch or extend the fides of the glottis; and when both mufcles act equally, they feparate the cartilages directly.

The thyro-arytenoidaei acting together, draw both the arytenoid cartilages forward, and confequently loofen the glottis, and render it capable of the fmalleft quaverings of the voice. They may likewife probably comprefs the lateral finufes or ventricles of the larynx, and alfo the arytenoid glands.

The arytenoidaei bring the arytenoid cartilages clofe together, and prefs them againft each other; and when the cartilages are in this ſituation, they may at the ſame time be inclined either forward by the thyro-arytenoidaei, or backward, by the crico-arytenoidaei 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 ſhewn 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 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.

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.

We ſhall now conſider what action the air produces, when it is driven from the lungs in exſpiration through the trachea into the larynx, and through the glottis into the mouth. 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,

tis, 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. From the conjunct trembling of the ligaments and cartilages of the larynx, a ſound is produced which we call the *voice*. It is different in different animals, and depends entirely on the form and ſtructure of the larynx and glottis. When a trembling is not excited, the exſpired air cauſes a whiſper.

The ſtrength of the voice is proportional to the quantity of air blown out, together with the narrowneſs of the glottis; and, therefore, a large pair of lungs eaſily dilatable, an ample cartilaginous and elaſtic larynx and windpipe, a free echo of the noſtrils, and 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. 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 in the ſame time are more numerous; but, when the glottis is dilated, the contrary of all this follows. And moreover, from the greater tenſion of the ligaments, the tremors 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 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. It is alſo confirmed by comparative anatomy, which diſcovers the narroweſt glottis and the cloſeſt approximation of cartilages

lages in ſinging birds, but an ample or broad glottis in hoarſe animals, and ſuch as bellow or bleat. We obſerve the ſame fact in whiſtling, where the voice becomes manifeſtly more acute by a contraction or narrowneſs at the mouth: Alſo in muſical inſtruments, in which a narrowneſs of the mouth, 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; 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 arytenoid ones backward? Are acute tones produced in proportion as the ligaments are ſtretched, and thus vibrating with great celerity? This has been confirmed by repeated experiments; 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

from the example of women, in which the larynx is ſofter, but the voice more acute, than in men; from experiments which ſhew, 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 the ſcutiform cartilage brought forward from the annular one. But, ſince it appears from experiments, that a tenſion of the ligaments 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 between two contrary powers; and herein lies the principal difference between the chanting of ſimple notes and the expreſſion of words. Hence ſinging appears to be a laborious action, on account 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 trachea grows dry, from the quicker paſſage or current of air; to prevent which, a great deal of mucus is required; and therefore great numbers of mucous receptacles are found in the larynx; among which the ventricles before deſcribed ought ſurely to be numbered.

Speech is performed by the larynx at reſt, or held in the ſame place, with 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

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 their general properties are alike all the world over. Of theſe, ſome are called *vowels*, which are made by an expreſſion of the voice, 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 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 oeſophagus, which is a continuation of the pharynx. This ſpace is bounded poſteriorly by the muſcles which cover the bodies of the firſt vertebrae of the neck, and laterally by the ſuperior portions of both the internal jugular veins and of both the internal and carotid arteries, by the ſpinal apophyſes of the os ſphenoides, by the extremities of the apophyſes petroſae, by the os ſphenoides immediately above the internal alae of the apophyſes pterygoides, and by the neighbouring portion of both pterygoid muſcles.

From

From thefe limits and adhefions of the pharynx we may nearly determine its figure. It may be compared to the wide part of a covered funnel, of which the oefophagus is the narrow part or tube; or it may be called the *broad end of the oefophagus*, that and the pharynx taken together being compared to a trumpet. The pharynx may be divided into three parts; one fuperior, 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 fphincter. We are likewife to obferve it in three openings; that of the arch, toward the nares; that of the body, toward the mouth; and that of the bottom, toward the oefophagus.

The arch is the broadeft part of the pharynx; and ends on each fide in an angle or point, toward the jugular foffulae of the bafis cranii. Afterwards the great cavity contracts a little toward the fides, all its other dimenfions continuing the fame; and behind the larynx it is again enlarged on each fide, a very fmall fpace being left between it and the cricoid cartilage. The extremity of the lower portion is very narrow, and joins the bafis of the cartilage juft named.

The pharynx confifts partly of feveral diftinct flefhy portions, which are looked upon as fo many different mufcles fo difpofed as to form a large cavity; and partly of a membrane which lines the inner furface 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 fuperior and middle portions of the pharynx than on the bottom or lower portion. Immediately above the firft vertebra it forms feveral longitudinal rugae very thick, deep, and fhort; and we generally find therein a collection of mucus in dead bodies. In the great cavity there are no rugae, the membrane adhering, both there and in the upper part, very clofely to the mufcles. At the lower part, where it is thinneft, it covers likewife the pofterior part of the larynx; and

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is very loofe, and formed into irregular folds. It runs in a little on each fide between the edges of the pharynx.

Mufcles of the pharynx. Though almoft all the mufcular or flefhy portions of which the pharynx is compofed concur in the formation of one continued bag or receptacle, they are neverthelefs very diftinguifhable from each other, not only by their different infertions, from which they have been denominated, but alfo by the different directions of their fibres. They may be looked upon as three digaftric mufcles; the middle tendons of which lie backward in one longitudinal line, which in fome fubjects appears plainly like a linea alba.

The loweft of the mufcular fibres make a complete circle backward between the two fides of the bafis of the cartilago cricoides. This circle is the beginning of the oefophagus, and has been thought by fome to form a diftinct mufcle, called *oefophagus.* Befides the mufcles which form the body of the pharynx, there are feveral other fmall ones connected with it; but of thefe fufficient defcriptions have been already given in a former part of the work.

The particular ufes of thefe mufcles are very difficult to be determined. It is certain that thofe of the middle and lower portions of the pharynx ferve chiefly for deglutition. Thofe of the upper portion, and fome of thofe of the middle portion, may, among other functions, be ufeful in modifying the voice, according to the opinion of M. Santorini.

§ 6. *The Salival Glands, &c.*

By faliva we mean in general that fluid by which the mouth and tongue are continually moiftened in their natural ftate. This fluid is chiefly fupplied by glands, called, for that reafon, *glandulae falivales,* of which they commonly reckon three pairs, two parotides, two maxillares, and two fublinguales. Thefe are indeed the largeft, and they furnifh the

the greateft quantities of faliva; but there are a great number of other leffer glands of the fame kind, which may be reckoned affiftants or fubftitutes to the former. All thefe may be termed *falival glands*, and they may be enumerated in the following manner: Glandulae parotides, glandulae maxillares, glandulae fublinguales, glandulae molares, glandulae buccales, glandulae labiales, glandulae linguales, amygdalae, glandulae palatinae, glandulae uvulares, glandulae arytenoidaeae, glandula thyroidaea.

The parotides are two large, whitifh glands, irregularly oblong and protuberant, fituated on each fide, between the external ear and the pofterior or afcending ramus of the lower jaw, and lying on fome part of the neighbouring mafleter mufcle. The fuperior portion of this gland lies before the cartilaginous meatus of the ear, and touches the apophyfis zygomatica of the os temporis; and it is extended forward and backward under the lobe of the ear, as far as the maftoid apophyfis.

From the anterior and fuperior portion of this gland, a white membranous duct or canal is produced by the union of a great number of fmall tubes reprefenting fo many roots. This duct runs obliquely forward on the outfide of the mafleter; and then perforates the buccinator from without inward, oppofite to the interftice between the fecond and third dentes molares, where the hole or orifice reprefents the fpout of an ewer.

This canal is named *ductus falivalis Stenonis*, or *ductus fuperior*. It is about the twelfth part of an inch in diameter, and on the outer fide of the mafleter mufcle it receives fometimes one and fometimes two fmall ducts, from a like number of little glands, which Haller calls *glandulae accefforiae*. The external carotid artery and vein, and the portio dura of the feventh pair of nerves, pafs through the fubftance of the parotid gland, to which they give branches; and the facial artery and vein pafs over its duct.

The maxillary glands are fmaller and rounder than the parotides; and are fituated each on the infide of the angle of the lower jaw, near the mufculus pterygoidaeus inferior. From the infide, or that which is turned to the mufculus hyo-gloffus, each of them fends out a duct in the fame manner as the parotides; but it is fmaller and longer, and goes by the name of *ductus falivalis Whartoni*, or *ductus inferior*.

This duct advances on the fide of the mufculus genio-gloffus, along the inner part and fuperior edge of the glandula fublingualis, to the fraenum of the tongue, where it terminates by a fmall orifice, in form of a papilla.

The glandulae fublinguales are likewife two in number, of the fame kind with the former, only fmaller, fomething oblong, and flatted like a blanched almond. They are fituated under the anterior portion of the tongue, one on each fide, near the lower jaw, on the lateral portions of the mufculi mylo-hyoidaei which fuftain them. The two extremities of each gland are turned backward and forward, and the edges obliquely inward and outward.

They are covered on the upper fide by a very thin membrane, which is a continuation of the membrane that covers the under fide of the tongue. They fend out laterally feveral fmall fhort ducts which open near the gums by the fame number of orifices, all arranged in the fame line, at a fmall diftance from the fraenum, and a little more backward. In many animals we find particular ducts belonging to thefe glands, like thofe of the glandulae maxillares, but they are not to be found fo diftinctly in men. The mufculi genio-gloffi lie between the two fublingual glands, and alfo between the two maxillary ducts. The arteries and veins of thefe, and of the former glands, belong to the lingual veffels, and the nerves are from the lingual branch of the fifth pair.

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The molares are two glands nearly of the fame kind with the former, each of them being fituated between the mafleter and buccinator; and in fome fubjects they may eafily be miftaken for two fmall lumps of fat. They fend out fmall ducts which perforate the buccinator, and open into the cavity of the mouth, almoft over againft the laft dentes molares; and from thence Mr Heifter, who firft defcribed them, called them *glandulae molares*.

All the infide of the cheeks, near the mouth, is full of fmall glandulous bodies, called *glandulae buccales*, which open by fmall holes or orifices through the inner membrane of the mouth. The membrane which covers the infide of the lips, which is a continuation of that on the cheeks, is likewife perforated by a great number of fmall holes, which anfwer to the fame number of fmall glands, called *glandulae labiales*. The glandulae linguales are thofe of the foramen caecum of the bafis of the tongue, which have been already defcribed.

We have alfo explained the glandulae palatinae, or thofe that belong to the arch and feptum of the palate; and the glandulae arytenoidaeae were defcribed with the larynx. The uvular glands are only a continuation of the membrane of the palate, in form of a fmall bunch of grapes. We might likewife reckon among the falival glands thofe of the fuperior portion of the pharynx mentioned in the defcription of that part, and alfo the follicles of the membrana pituitaria of the nares, and of the finufes which communicate with them.

The amygdalae are two glandular bodies of a reddifh colour, lying in the interftices between the two lateral half-arches of the feptum palati, one on the right, the other on the left fide of the bafis of the tongue. Their appearance is not unlike that of the outfide of an almond-fhell, both becaufe their furface is uneven, and becaufe it is full of holes big enough to admit the head of a large pin.

Thefe

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 thyroid 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 cricoid 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 thyroid cartilage, from which its name is taken. The two lateral portions lie on the musculi thyroidaei, and the middle or inferior portion on the crico thyroidaei. The thyro-pharyngaei inferiores send fibres over this gland; and they communicate on each side, by some such fibres, with the sterno-thyroidaei and hyo-thyroidaei.

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 thyroid gland; and is lost between the musculi sterno-hyoidaei, behind the basis of the os hyoides, or between that basis and the epiglottis.

The glandulae lymphaticae will come in more properly in another part of this work, with the description of the absorbent system.

§ 7.

§ 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 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 aſſimulated.

Moſt animals, therefore, are provided with teeth extremely hard; and, as the materials of our food are various in their texture and firmneſs, nature has accordingly furniſhed us with 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 long trituration by the grinders.

Between the molares the moſt compact foods are interpoſed and broke, the more tough and hard are ground ſmaller, the lower teeth being urged obliquely and laterally againſt the immoveable upper ones. Theſe teeth are the principal inſtruments of maſtication; and, that they 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. This lower jaw is a ſingle bone, and ſo joined with the temporal bones, that it may be drawn down from the upper jaw, and pulled up againſt it with a great force; and may be moved laterally

laterally to the right or left, forward and backward. The various motions of the lower jaw have been already deſcribed.

The muſcles moving the lower jaw, which are weak in a man, but very ſtrong in brute animals, are the temporalis and maſſeter, which act in concert, the temporal muſcle bringing the jaw more backwards, and the maſſeter forwards. The *pterygoidaeus internus* elevates or draws it to one ſide or the other alternately. The *pterygoidaeus externus* draws it forward and ſidewiſe.

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-hyoidaeus, genio-gloſſus, ſterno-hyoidaeus, ſterno-thyroidaeus, coraco-hyoidaeus, and lattiſſimus colli; although the latter rather draws the ſkin of the neck and face downward than the jaw itſelf. The genio-hyoidaeus 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 pterygoid 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 are performed by the external and internal pterygoidaei, acting either alone or together. Thus the food is cut, lacerated, and ground to pieces; and, if the maſtication be continued, it is, together with the liquors of the mouth, reduced to a kind of pulp.

During the trituration of the food in the mouth, there is continually poured into it, from numerous ſprings, a large quantity of a watery, clear, evaporable, inſipid, or at leaſt but very

very ſlightly, ſaline liquor, containing but little earth *. 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 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 fire, with ſcarce any taſte, unleſs what is 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. It is for the moſt part ſwallowed, and indeed it cannot be thrown away without hurting the digeſtion.

By the motion of the jaw in maſtication, the ſalival glands, which have been already deſcribed, 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-hyoidaeus, 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 being ground between the teeth, and intermixed with the watery ſaliva and air, is broken down into a ſoft, juicy pulp, replete with elaſtic air; the food afterwards undergoes a farther diſſolution from the warmth of the parts cauſing the air to expand, and, by its elaſticity, burſt aſunder the

* This earth is neither acid nor alkaline, although from thence may be obtained a very ſmall portion of lixivial ſalt.

the particles of the food, between which it is included and confined. In this act of maftication, the oily, aqueous, and faline parts of the food are intermixed the one with the other; the fmell and tafte of different ingredients are loft in one, which, by the dilution of the faline parts with faliva, renders the food flavourable; but fuch particles as are more volatile and penetrating, being directly abforbed by the bibulous veffels of the tongue and cheeks, enter ftraight into the blood-veffels and nerves, fo as to caufe an immediate recruit of the faculties.

The motions which are neceffary for turning round the food, applying it to the teeth, and conveying it through the different parts of the mouth in maftication, are performed by the tongue, cheeks, and lips. And firft, the tongue being expanded fo as to form a fmall concavity in its back or furface, takes up the food, and conveys it to the parts for which it is defigned. At one time the tongue, rendered narrow by lateral contraction, fearches 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 foreteeth, and raifing itfelf up fucceffively, 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.

Thefe motions of the tongue are likewife governed by the mufcles and membranes inferted in the os hyoides; and this bone being drawn down by its refpective mufcles, depreffes the tongue, and alfo the lower jaw, if its mufcles be relaxed. Thefe mufcles are the fterno hyoidaeus, fterno thyroidaeus, hyo-thyroidaeus, thyro-pharyngaeus, and coraco-hyoidaeus.

The other mufcles which elevate the os hyoides, together with the tongue, are the *ftylo gloffus*, fuftained by a peculiar ligament of the upper jaw. The *ftylo-hyoidaeus*, and fecond *ftylo-*

hyoidaeus

hyoideus, which, when it is prefent, refembles the former. All thefe mufcles draw the tongue back, but laterally they elevate it. The *mylohyoidaeus* elevates the tongue, and fixes it in making various motions, or in like manner depreffes the jaw. The *geniohyoidaeus*, being a companion of the genio-gloffus, pulls the tongue forward out of the mouth.

The mufcles of the cheeks varioufly move and prefs 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 fee in the buccinator when the mouth is fhut. Others open the mouth for receiving the food, fuch as the double-headed proper elevator of the upper lip, and the elevator anguli oris; to which add the zygomatici, upper and lower; the buccinator, depreffor anguli oris, and depreffor labii inferioris. Others again clofe the lips, that the food received may not return out of the mouth; as the orbicularis of each lip, the proper depreffor of the upper lip, and the proper elevator of the lower lip, and that which ferves in common for the elevation of both.

By thefe means the food, ground and mixed with the faliva into a foft pulp, collected from all parts of the mouth by the tongue, into the arched fpace between the teeth, is afterward, by the expanfion and fucceffive preffure of the tongue, conveyed backward behind the teeth; and, in this action, the tongue is expanded by the hyogloffi and geniogloffi, and rendered a little concave by the ftylogloffus. And from thence it is next conveyed into the fauces.

For the tongue being raifed by the ftylogloffi, and broadly applied to the palate, firft by its apex, then alfo infenfibly by its pofterior extremity, preffes the food fucceffively towards the fauces, which at that time only afford an open paffage. After this, the thick root and back part of the tongue itfelf, by the forementioned mufcles, and by the ftylohoidaei and biventers carried backward, preffes down the epiglottis, which

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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, geniohyoideus, genioglоſſus, ſtylohyoideus, ſtyloglоſſus, 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 toward 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 cloſely covers the paſſage into the larynx, over which the aliments paſs, as over a bridge, 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 of the epiglottis, above the larynx, that it may from thence fall into the oeſophagus.

That the aliment might not regurgitate into the noſtrils at the time when it is 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 thyreo-palatinus 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 the thyreo-palatinus, 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

the moveable velum of the palate. Thus the pharynx being contracted like a ſphincter, drives down the food, without permitting any part to return 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 palato-pharyngei, and by the circumflex muſcles of the ſoft palate. Theſe muſcles, together with the gloſſo-palatinus, 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 trachea, 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 by 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 oeſophagus. At the ſame time the depreſſing muſcles of the larynx, coraco-hyoidaeus, ſterno-hyoidaeus, and ſterno-thyreoidaeus, 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 arytaenoidei 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

which is collected in all parts of the fauces, greatly conduces. Therefore, in general, between the nervous and innermoſt coat of the pharynx, a great number of ſimple mucous follicles or cells are placed, pouring out their mucus through ſhort mouths; of a ſoft, and ſomewhat watery nature; but ropy and viſcid, abounding with oil and volatile ſalts, and more earth than the ſaliva itſelf.

The aliments are moved through the oeſophagus 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 oeſophagus where the morſel is ſeated, being irritated, contracts, and moves the food downward. This muſcle is ſtrong, and very irritable.

The 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 it; nor do they ever aſcend but by a morbid affection.

CHAP.

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 vertebrae 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 mammae; 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 antients 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 in or from them: Through it, likewiſe, the oeſophagus paſſes to the ſtomach; and part of the nerves are contained in it which go to the contents of the abdomen.

External

External conformation of the thorax. The whole extent of the thorax in a living ſubject is commonly determined, not only by the ſternum, vertebrae of the back and ribs, but alſo by all that ſpace contained between the articulations of the two arms with the ſcapulae and claviculae; and in this ſenſe the outſide of the thorax 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 *mammae*, 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 vertebrae 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

All thefe hard and foft parts, taken together, reprefent a kind of cage, in fome meafure of a conical figure, flatted on the forefide, depreffed on the backfide, and in a manner divided into two nooks by the figure of the vertebrae of the back, and terminated below by a broad arched bafis inclined backward. The intercoftal mufcles fill up the interftices between the ribs, and fo complete the fides of the cavity: The bafis is the diaphragm; and the pleura not only covers the whole inner furface of the cavity, but, by forming the mediaftinum, divides it into two, one on the right, the other on the left.

§ 1. *Mammae.*

THE name of *mammae*, or *breafts*, is given to two eminences, more or lefs round, fituated in the anterior, and a little toward the lateral parts of the thorax, their centre or middle part lying almoft oppofite to the bony extremity of the fixth true rib on each fide. Their fize and figure vary in the different fexes and different ages.

In children of both fexes, and in males of all ages, they are commonly no more than cutaneous tubercles, or foft verrucae of a reddifh colour, called *papillae* or *nipples*; each of them being furrounded by a fmall, thin, and pretty broad circle or difk, more or lefs of a brownifh colour, and an uneven furface, termed *areola*.

In females come to the age of puberty, which is fometimes fooner, fometimes later, a third part is joined to the two former, which is a convex protuberance, more or lefs round, of about five or fix fingers in breadth; the papilla and areola being fituated near the middle of its convex furface. This is what is properly called *mamma*; and it may be termed the *body of the breaft*, when compared with the other two parts. It increafes with age, and is very large in women with child, and in thofe that give fuck. In old age it it decreafes, and becomes flabby, lofing its natural confiftence and folidity.

Body of the mamma. The body of the mamma is partly glandular, and partly confifts of fat; or it is a gland of the conglomerate kind, furrounded on all fides with cellular fubftance and fat. The glandular part is divided into little maffes, feparated alfo by fat, and again fubdivided into fmall granulae, from which the lactiferous ducts arife: The cellulous pelliculae fupport a great many blood-veffels, lymphatics, and ferous or lactiferous ducts, together with the fmall glandular moleculae already mentioned; all of them being clofely furrounded by two membranes continued from the pelliculae.

The innermoft of thefe two membranes, which is in a manner the bafis of the body of the mamma, is thick, and almoft flat, adhering to the mufculus pectoralis major. The fecond, or external membrane, is thinner, forming a particular integument for the body of the mamma, more or lefs convex, and adhering clofely to the fkin.

The corpus adipofum of the mamma, in particular, is a fpongy clufter, more or lefs interlarded with fat, or a collection of membranous pelliculae, which, by the particular difpofition of their outer fides, form a kind of membrane in fhape of a bag, in which all the reft of the corpus adipofum is contained. The anterior or outer portion of this bag, or that which touches the fkin, is very thin; but that fide next the pectoralis major is thick.

Ductus lactiferi. The glandular body contains a white mafs, 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 fuppofed by fome to form a circle of communication; but, from the obfervations of the lateft anatomifts, the ducts have little or no communication with each other at this place.

place. They are named *ductus lactiferi;* and, in their courfe, are accompanied by a ligamentous elaftic fubftance, which terminates with them in the nipple. Both this fubftance, and the ducts it contains, are capable of confiderable extenfion and contraction; but, in their natural ftate, they are moderately corrugated, fo as to prevent an involuntary flow of milk, unlefs the diftending force be very great, from the accumulation of too great a quantity.

Areola. The coloured circle or difk, already mentioned, is formed by the fkin; the inner furface of which fuftains a great number of fmall glandular moleculae, of that kind which Morgagni calls *glandulae febaceae.* They appear very plainly all over the areola, even on the outfide, where they form little flat heights or eminences, at different diftances, quite round the circle.

Thefe tubercles are perforated by fmall holes, through which a kind of febaceous matter, more or lefs 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 furface of the areola. Hence 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 fizes in different ages and conftitutions, and in the different conditions of females in particular. In women with child, or who give fuck, it is large, and generally longer or higher than it is thick or broad; and, when it happens to be fhort, it caufes great uneafinefs to the child.

The texture of the nipple is fpongy, elaftic, and liable to divers changes of confiftence, being fometimes harder, fometimes more flaccid. It feems to confift chiefly of ligamentary fafciculi; the extremities of which form the bafis and apex of the nipple. Thefe fafciculi appear to be gently folded, or curled, during their whole length; and if, by drawing the fibres out, thefe folds be deftroyed, they return again as foon as that action ceafes.

Between thefe fpongy and elaftic fafciculi, from twelve to fifteen or twenty particular tubes are lodged at fmall diftances from each other, and all in the fame direction. Thefe tubes go to the bafis of the papilla, and run through the apex by the fame number of almoft imperceptible holes or orifices; and as they are clofely united to the elaftic fafciculi, they are folded in the fame manner with them.

The body of the papilla is covered by a thin cutaneous production, and by the epidermis. Its outer furface is uneven, being full of fmall tubercles and wrinkles; among which, thofe near the circumference of the nipple feem to have a tranfverfe or annular difpofition, which, however, is not uniform.

This difpofition or direction feems to be owing to the elaftic folds already mentioned: And, from this fimple ftructure, it is eafy to explain how infants, in fucking the nipple, and women in drawing the teats of cows, bring out the milk. For the excretory tubes, being wrinkled in the fame manner as the fafciculi, do, by thefe wrinkles or folds, as by fo many valves, hinder the milk contained in the ducts from flowing out; but, when the nipple is drawn and elongated, the tubes lofe their folds, and the paffage becomes ftraight. Befides this, when they are drawn with a confiderable force, the whole body of the mamma is increafed in length, and contracted in breadth, and thereby the milk is preffed into the open tubes; and thus, by barely preffing the body of the breaft, the milk may be forced toward the nipple, and even through the tubes. Thofe who underftand 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, diftributed through the mammae, are ramifications of the arteriae and

and venae mammariae; of which one kind comes from the ſubclaviae, and are named *mammariae internae;* the others, from the axillares, called *mammariae externae.*

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; 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.

§ 3. *Pleurae 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-coſtales, 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 peritonaeum; and likewiſe in its conſiſting 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 vertebrae and the ſternum, their other ſides adhering to the ribs and diaphragm.

This particular duplicature of the two pleurae is termed *mediaſtinum.* The two laminae of which it conſiſts are cloſely united together near the ſternum and vertebrae; but, in the

middle,

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 oeſophagus, to which they ſerve as a covering; and in the moſt poſterior part a triangular ſpace is left between the vertebrae and the two pleurae from above downward, which is filled chiefly by the aorta.

Before the heart, from the pericardium to the ſternum, the two laminae 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 was commonly ſuppoſed. 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

Sabatier obferves that this is rare; but he has likewife met with feveral examples, where an inftrument thruft through the middle of the fternum got into the left cavity of the thorax: And he has fometimes feen the right lamina of the mediaftinum fixed to the middle of the fternum, while the left one was fixed oppofite to the articulation with the cartilages of the ribs; a fpace being left between the two, which was filled with cellular fubftance, intermixed with fat. From hence we may judge of the uncertainty of trepanning the fternum, which the antients have recommended in fome cafes of abfceffes, &c. between the layers of the mediaftinum.

The pleura is connected to the membranous portion of the fternum, ribs, and mufcles; to the diaphragm, pericardium, thymus, and veffels; and, in a word, to whatever lies near its convex fide.

The furface of the pleura turned to the cavities of the breaft is continually moiftened by a lymphatic ferofity which tranfudes through the pores of the membranous portion. This fluid is faid to be fecreted by imperceptible glands; but the exiftence of thefe glands has not been hitherto demonftrated.

Arteries and veins. The arteries and veins of the pleura are chiefly ramifications of the intercoftales; and thefe ramifications are exceedingly numerous, and for the moft part very fmall. The mammariae internae and diaphragmaticae likewife fend branches hither, which communicate very frequently with thofe that come from the intercoftals.

The mediaftinum has particular veffels, called *arteriae* and *venae mediaftinae*, which are commonly branches of the fubclaviae. The mammariae internae fend likewife ramifications to the fore-part of it, the diaphragmaticae to the lower part, and the intercoftales and oefophageae to the back-part.

Nerves. The nerves, which are few, are ramifications of the true intercoftales. Near the vertebrae they communicate

with

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, and hinders one lung from preſſing on the other when we lie on one ſide. It likewiſe forms receptacles for the heart, pericardium, oeſophagus, &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 coagulated lymph or accumulated blood; the nervous filaments being likewiſe, in this caſe, very much compreſſed in inſpiration by the ſwelling of the intercoſtal muſcles.

§ 1. *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 ſide is the longeſt. In the foetus it is of a large ſize, leſs in children, and in aged perſons very little. 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 pleurae, ſo that ſome part of it is out of the cavity of the thorax; and in the foetus and in children, it lies as much without, as within the thorax, and is then compoſed of numerous lobules, each

incloſed

inclofed in a thin covering, and united together by cellular fubftance: Thefe are hollow within, and communicate together fomewhat like the cells of the lungs; but they contain a milky fluid, which readily appears after an opening is made, but this fluid vanifhes foon after birth. Among the various opinions about the ufe of this fubftance, fome have thought it ferved only to fill a part of the thorax of the foetus in the collapfed ftate of the lungs, becaufe its fize decreafes after the lungs are dilated.

Its particular inward ftructure and fecretions are not as yet fufficiently known, fo as to enable us to determine its ufes; which, however, feem to be defigned more for the foetus than for adults. It has veffels belonging to it, called *arteriae* and *venae thymicae;* which are branches from the laryngaea inferior and mammaria interna.

§ 5. *Pericardium.*

The heart, with all the parts belonging to it, is contained in a membranous capfula, called *pericardium,* which is in fome meafure of a conical figure, and fomewhat bigger than the heart; but the difference muft be lefs during life when the heart is full of blood. It is not fixed to the bafis of the heart, but round the large veins above the auricles, before they fend off the ramifications, and round the large arteries, before their divifions.

The pericardium is made up of three laminae, the middle and chief of which is compofed of very fine tendinous filaments, which are beft feen in old perfons; they are clofely interwoven, and crofs each other in different directions. The internal lamina feems to be a continuation of the outer coat of the heart, auricles, and great veffels. The trunks of the aorta and pulmonary artery have one common coat, which contains them both as in a fheath, and is lined on the infide by 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 having a particular elongation which ſurrounds the great veſſels, as amply as the other portion ſurrounds the heart.

The pericardium is cloſely connected to the diaphragm, not to 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 more properly be called, 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 peritoneum; there being no glands for this purpoſe, as ſome have ſuppoſed. The pericardium, at its fore part, 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

excepting ſome which go to the vena azygos. The nerves are chiefly from the eighth pair, and great ſympathetics. 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, 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 laminae of the mediaſtinum. It is nearly 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 *auriculae*, 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 thefe orifices are found feveral moveable pelliculae, called *valves* by anatomifts; of which fome are turned inward toward the cavity of the ventricles, called *triglochines*, or *tricufpides;* others are turned toward the great veffels, called *femilunares*, or *figmoidales*. The valvulae tricufpides of the left ventricle are likewife termed *mitrales*.

Ventriculi. The inner furface of the ventricles is very uneven, many eminences and cavities being obfervable in it. The moft confiderable eminences are thick flefhy productions, called *columnae*. To the extremities of thefe pillars are faftened feveral tendinous cords, the other ends of which are joined to the valvulae tricufpides. There are likewife other fmall fhort tendinous ropes along both edges of the feptum between the ventricles. Thefe fmall cords lie in an oblique tranfverfe fituation, and form a kind of net work at different diftances.

The cavities of the inner furface of the ventricles are fmall deep foffulae or lacunae placed very near each other, with fmall prominent interftices between them. The greateft part of thefe lacunae are orifices of the venal ducts, to be defcribed hereafter.

Structure of the ventricles. The flefhy or mufcular fibres, of which the heart is made up, are difpofed in a very fingular manner, efpecially thofe 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 thofe which are only bent into arches. The middle of thefe arches, and the angles of the folds, are turned toward the apex of the heart, and the extremities of the fibres toward the bafis. Thefe fibres differ not only in length, but in their directions,

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 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

The anterior or right ventricle is ſomewhat larger than the poſterior or left, as was well obſerved by the antients, 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 find it. 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, 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 columnae, to which the looſe floating portion of the tricuſpidal valves is faſtened by tendinous ropes.

Beſides

Befides thefe flefhy pillars, the internal fibres form a great many eminences and depreffions, which not only render the inner furface of the ventricles uneven, but give it a great extent within a fmall compafs. Some of thefe depreffions are the orifices of the venal ducts found in the fubftance of the ventricles, which have been already mentioned. The circumferences of the great openings at the bafis of the heart are tendinous, and may be looked upon as the common tendon of all the flefhy fibres of which the ventricles are compofed.

Valvulae. 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 fame way; the other kind allows the blood to go out of the heart, but hinders it from returning. The valves of the firft kind terminate the auriculae; and thofe of the fecond lie in the openings of the great arteries. The firft are termed *femilunar* or *figmoidal valves*; the others, *triglochines*, *tricufpidal*, or *mitral*.

The tricufpidal 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 furface of the ventricle. The circular membrane of the valve foon divides into many parts, three of which are more confiderable than the reft; and thefe have got the name of *tricufpid valves*, though they are now generally confidered as forming one. That which is next the mouth of the pulmonary artery is the largeft, and fome anatomifts think that it prevents the blood from getting into the artery while the ventricle is filling. It has three triangular productions, very fmooth and polifhed on that fide which is turned toward the auricle; but on the fide next the cavity of the ventricle, they have feveral membranous and tendinous expanfions, and their edges are notched or indented. The valve of the auricular orifice of the left ventricle is of the fame fhape and ftructure, but it is only divided

divided into two parts; and, from fome fmall refemblance to a mitre, has been named *mitralis*. That which is next the mouth of the aorta is the largeft.

The femilunar valves are fix in number, three belonging to each ventricle, fituated at the mouths of the great arteries; and they may be properly enough named *valvulae arteriales*. Their concave fides are turned toward the cavity of the arteries, and their convex fides approach each other. In examining them with a microfcope, we find flefhy fibres lying in the duplicature of the membranes of which they are compofed.

They are truly femilunar, or in form of a crefcent, on that fide by which they adhere; but their loofe edges are of a different figure, each of them reprefenting two fmall crefcents; the two extremities of which meet at the middle of this edge, and there form a kind of fmall papilla, firft defcribed 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, and then bends obliquely backward, to form what is called *aorta defcendens*; which we fhall have occafion to mention again hereafter. At the beginning of the aorta, and behind the femilunar valves, three elevations are obferved on the outfide: Thefe correfpond to an equal number of pits on the infide, which, from the difcoverer, have been called *finufes of Valfalva*. Their ufe is not well known. From about the middle of the convex fide of this curvature three great branches arife, which furnifh an infinite number of ramifications to the head and upper extremities of the body; as the defcending aorta does in the fame 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*.

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.

Auriculae. 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 the orifices of each ventricle, called *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 venae cavae: 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

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 foetus; but it is found likewiſe in perſons 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 foetus. 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.

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 thoſe of 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 conſiderable thickneſs, and unequally ſquare, into which the four venae pulmonares open, 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 they 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,

teriorly, 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.

Arteriae et venae coronariae. 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 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.

There are ſeldom more than two arteries; of which one lies toward the right, 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 runs on the baſis, it ſends off a capital branch, which runs in between the two ventricles.

 Another

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.

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 *venae innominatae.* 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.

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.

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 the 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 between the ventricles. And it may be proper here to remark, that, though commonly received terms of art may be ſtill 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 the 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 compoſed 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 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, preſſes the tricuſpidal valves againſt each other, opens the ſemilunares,

milunares, and rufhes with impetuofity through the arteries and their ramifications, as through fo many elaftic tubes.

Syftole. The blood thus pufhed out by the contraction of the ventricles, and afterwards preffed by the elaftic arteries, enters the capillary veffels, 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 anatomifts termed *fyftole.*

Diaftole. The contraction or fyftole of the ventricles ceafes immediately, by the relaxation of their flefhy fibres; and, in that time, the auricles which contain the venal blood, being contracted, force the blood through the tricufpidal valves into the ventricles, the fides of which are thereby dilated, and their cavities enlarged. This dilatation is termed *diaftole.*

Circulation. In this manner does the heart, by the alternate fyftole and diaftole of its ventricles and auricles, pufh 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 firft and moft univerfal kind of circulation is that by which almoft all the arteries of the body are filled by the fyftole of the heart, and the greatft part of the veins evacuated by the diaftole.

The fecond kind of circulation, oppofite to the firft, is through the coronary veffels of the heart, the arteries of which are filled with blood during the diaftole of the ventricles, and the veins emptied during the fyftole.

The third kind of circulation is that of the left ventricle of the heart; through the venal ducts of which a fmall quantity of blood paffes, without going through the lungs, which is the courfe of all the remaining mafs of blood.

Befides thefe three different, kinds of circulation, there are fome peculiarities in the courfe of the blood, which may be looked

looked upon as particular circulations. Such is the paſſage of the blood through the liver, corpora 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, and are irritable throughout their whole body; they are alſo ſometimes very large, as we ſee in many ſpecies of the hydra. Thoſe animals which have no hearts have alſo no veſſels.

The blood of the two venae cavae is propelled by a muſcular force, in either vein, into the right auricle. Theſe veins, while they lie within the thorax, 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. 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; afterwards the appendix of the auricle deſcends, and is contracted tranſverſely, while the lower part aſcends; and thus the auricle becomes ſhorter: And, laſtly, the left edge turns evidently to the right, and the right edge a little to the left; and thus the auricle is rendered narrower. The blood of both cavae muſt neceſſarily, therefore, be driven through the open valves of the right ventricle of the heart: becauſe the blood is hindred from returning again into the lower cava, by the contraction of the auricle, by the reſiſtance of the ſucceeding blood from the abdomen, and by means of the *Euſtachian valve;* and is hindered from aſcending, both by the motion and weight of the conſequent blood. It is driven

back,

back, however, on both ſides, if there happens to be any obſtacle in the lungs.

The uſe of the valvulae tricuſpides is ſufficiently evident; for the right auricle being contracted, the blood is forced through the auricular orifice, and, like a wedge, ſeparates the pendulous portions of the valves, and preſſes them to the ſides 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 its ſtrong contraction, 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 fibres of the heart, like other muſcles, are furniſhed with nerves of various origin, in great abundance.

That theſe nerves conduce powerfully to move the heart is highly probable, from a conſideration of the common nature of muſcles; 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 langour that enſues upon tying theſe nerves, which proves fatal, either ſuddenly or within a few days, even though the ligature be made only on a few of them; 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 foetus, 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 to the whole heart, and ſometimes affecting only a particular part of it.

There reſides in the heart a kind of deſire to be ſtimulated, ſo that, even when it is almoſt dead, wrinkles radiating from a point appear in many places, and trembling motions are propagated through different parts of its ſurface. 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; for, by ſtimulating the heart, its motion may be renewed at a time when that of no other muſcle can. The heart of the foetus is moſt irritable, as well as larger in proportion, than in adults, and moſt tenacious of its motion, even in the cold. The motion of the heart appears to be innate, coming neither from the brain nor the ſoul; it remains even when the heart is removed from the body, and it can neither be increaſed nor retarded by the will.

It is, therefore, evident, that the ſtimulus occaſioned by the venous blood driven into the heart, cauſes it to contract. This contraction is convulſive, made with great celerity, and a manifeſt corrugation of the fibres. The whole heart, in the

the contraction, 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 *. 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. Of this fact we may be convinced, by thruſting the finger into the ventricle of the heart in an animal newly killed. That the heart is accurately enough emptied in this action, appears from the event; from 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. 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 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; it is driven from the muſcular ſides, towards the axis of the ventricle, and that part of it which is contained between the ſides of the ventricle and the annulus of the auricular orifice, puſhes the annulus within the auricle, and by this action upon the whole circumference of the annulus, it becomes extended. A ſmall quantity of blood is indeed returned into the auricle before the

* 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.

the preffure becomes fufficient to clofe the tricufpid valves. When thefe valves are fhut, the violent preffure of the blood againft them might confiderably injure them, or even pufh them back into the auricle; but to prevent any accident of that kind, their mufcular columns, which contract with the heart, keep their edges firmly united.

The blood being impelled from the fides toward the axis of the contracting heart, endeavours to efcape in that direction, and, by rufhing like a wedge between the valves, preffes their loofe edges againft the fides of the pulmonary artery, fo as to run freely out of the heart. The truth of this appears from the fabric of the parts, from injections, and from ligatures, which, by obftructing the lungs, will not fuffer the cavities in the right fide of the heart to be emptied.

The blood now received into the pulmonary artery, circulates through the lungs. That the blood goes directly from the arteries into the pulmonary veins, appears evidently from their ftructure; from a ligature, which, confining the blood between the heart and lungs, caufes an aneurifmatic dilatation of the artery; from polypufes, by which the mouth of the pulmonary artery being obftructed, the right cavities of the heart become enlarged, and at length burft, while the left remain empty; from injections, for water, ifinglafs, and milk, are very eafily forced from the pulmonary artery into the vein, and from thence into the left cavity of the heart. And laftly, the direct anaftomofes, or final openings of the arteries into the veins in the lungs, may be feen by microfcopes, in frogs, &c.

The blood which has once entered the pulmonary artery cannot return to the heart; becaufe its valves are of fuch dimenfion, that when diftended, they perfectly fhut up the opening at the heart; and they are fo ftrong that they refift a much greater force than the contraction of the pulmonary artery. Sometimes, however, 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 between the duplicature of the valves. When the blood, by the contraction of the artery, returns towards the heart, it meets and enters the open concavities of the valves, which are by that means expanded, and the mouth of the artery is completely ſhut. Any opening that might be left, is precluded by the ſmall callous bodies in the middle of the valves.

The *pulmonary veins*, of which we ſhall ſay more hereafter, run into larger branches, which at laſt terminate in four (ſeldom two, and ſtill more rarely 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 into the corners of the left or poſterior ſinus, which is ſometimes likewiſe called the *pulmonary ſinus*. In this courſe the upper veins deſcend, and the lower ones aſcend. 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 being retained, between the ligature and the lungs.

In this left ſinus the blood waits for the heart's relaxation, when it is driven into the left ventricle, in the ſame manner as the right auricle impelled its blood into the right ventricle.

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 venae cavae into the right auricle. 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 antients. It is proved by the increaſed bulk of the pulmo-

nary

nary veins on the left ſide, and likewiſe of the right cavities of the heart, from the entrance into the left ventricle being obſtructed.

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, make, that part of the heart which we before called its convex ſuperior ſide. It is ſomewhat narrower, a little longer, rounder, and generally of a leſs capacity, in Dr Haller's opinion, than the right ventricle; for its contents are about two ounces, while thoſe of the right amount to three. Its internal fabric 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 as ſtrong. 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, but ſolid, and incapable of ſuffering any injected liquid to paſs from one ventricle to another.

Again, this left ventricle being excited to motion by the impelled blood, from the ſame irritable nature already mentioned, contracts, and drives its contained blood with a violent motion in the direction of its axis, the tip or cone of the heart being at the ſame time drawn nearer to its baſis. And ſince the apparatus of the mitral valves is here the ſame as in the tricuſpids, the blood now expanding the ring from whence they ariſe, removes that valve which lay againſt the mouth of the aorta, and opens a way for itſelf to the artery. 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 of the pulmonary artery: Only, as the opening is here greater, ſo the valves are proportionally larger and ſtronger, and are

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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 increaſes all its dimenſions. 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. The blood then collected in the venae cavae 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 dentated proceſſes of the creſted margin.

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 both the ventricles are relaxed: So that the contraction of the auricles precedes the contraction of the ventricles. This fact is aſcertained by experiments on dying animals, and on animals with cold blood. Thoſe who have inadvertantly 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 certainly true. The auricle, with its ſinus, forms one cavity; and both are filled and both emptied in the ſame inſtant.

It may be aſked, Why the heart is not wearied, or becomes painful, by ſo rapid, long continued, uninterrupted, and violent a motion? The heart contracts, in a healthy perſon, about

about 5000 times in an hour, and never ceaſes its alternate contractions and dilatations from the firſt beginning of its exiſtence till death? Why, then, does it not, like other muſcles, become tired, in a very few hours, by ſuch violent motions? How is its ſtrength preſerved? Different anſwers have been given to theſe queſtions by different profeſſors, founded either on a compreſſure of the cardiac nerves between the large arteries, or on an alternate repletion of the coronary arteries and cavities of the heart, &c. But to Dr Haller the ſimplicity of nature in this matter is very conſpicuous. When the auricle is relaxed, it is directly filled by the muſcular force of the continuous great vein; and the heart contracts when it is irritated by the blood driven into it from the auricle, and thus empties itſelf of the blood. Being freed from the ſtimulus, it immediately reſts or relaxes itſelf. The heart being now relaxed, the auricle is, in like manner, irritated by its contained blood, and, by contracting, fills the heart 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 cauſe of the heart's motions is proved from actual experiment and obſervation. The ſucceſſive repletions and contractions made in the great vein, auricle, ventricle, and artery, are plainly and 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 it is more unequivocally corroborated by injection, and by the experiment of inflating a frog's heart with a ſmall bubble of air, which we ſee alternately paſs from the ventricle to the auricle and back again for many hours.

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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 venae cavae. Whatever motion is in the venae cavae, 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.

Dr Haller believes that nothing more is requiſite to produce the heart's motion than a continual ſtimulus applied to a very irritable part. For, on the approach of death, the coldneſs of the limbs contracts the veins, and drives the blood to the heart; the lungs, being impermeable for want of reſpiration, tranſmit no blood to the cavities of the left ſide; and the heart, after it is thoroughly emptied, remains at reſt.

The velocity of the blood, at its entrance into the aorta, and the force with which it is expelled from the heart, have been ſubjects of much controverſy; and different anatomiſts have computed them differently. To determine the velocity, modern writers proceed on the following data. They ſuppoſe that two ounces are expelled by each ſyſtole, that each ſyſtole is the third part of the whole pulſation, and is performed in healthy perſons in $\frac{1}{225}$ part of a minute, that the area of the aorta is 0.4187, of an inch, and that two ounces of blood occupy a ſpace of 3.318 cubic inches; or, in other words, that a cylinder of blood, whoſe ſolidity is 3.318 inches, and baſe 0.4187, is expelled by the heart in $\frac{1}{225}$th part of a minute. Since the ſolidity of a cylinder is the product of the area of its baſe into the length, its length will be equal to the ſolidity divided by the baſe; therefore, in this caſe, 3.318 divided by .4187 gives 7.9245 for the length which the blood runs in $\frac{1}{225}$ of a minute; that is, 148 feet 7 inches in a minute. To determine the force, they ſuppoſe that the perpendicular jet from the heart is 7 feet 6 inches, and the area of the ſurface of the ventricle is 15 inches; theſe two numbers multiplied give 1350 cubical inches, or 51 pounds of blood againſt which

which the heart acts. The heart, therefore, sends a weight of 51 pounds, with the velocity of 149 feet in a minute.

The above computation may perhaps be inaccurate, both from the omission of some circumstances that ought to have been taken into the account, and from the inaccuracy of the data; but that the heart appears to be a very powerful machine, is evident from the great difficulty we have in filling all the red blood-vessels by anatomical injections, and the utter impossibility of filling all the smaller ones; yet 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 velocity. 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 powerful muscle perceptible; even in such animals as are scarcely visible to the naked eye, and in the small embryos of insects. And, from some of the least arteries, I have seen the blood start several feet, the jet describing a parabola, whose height was four feet, and the amplitude of projection seven; and some anatomists assert that 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 of the whole mass of blood; a mass perhaps of fifty pounds and upwards: For all the quantity of fluids, once stagnant in a person lately drowned or fainting away, are easily put into their former motion by the heart alone. We must also consider the great decrease of the blood's velocity, arising from the greater capacity of the dividing branches; and yet, even in the least vessels, its velocity is very considerable, as appears by the Sanctorian perspiration seen to fly rapidly

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off like ſmoke, and by the quick motion of the blood ſeen, by the help of microſcopes, in fiſhes tails. Frictions in every machine always conſume the greateſt part of the moving forces; and theſe frictions will doubtleſs be very large in the human body, whoſe blood and juices are extremely viſcid, and whoſe veſſels are ſo ſmall as ſcarcely to allow more than a ſingle globule to paſs at a time, and even that not without changing its figure. All theſe reſiſtances being conſidered, we may without doubt conclude that the force of the heart muſt be extremely great, in order to preſerve the motion ſo ſtrong as we perceive it in the leaſt arteries. Another argument of the heart's force is, 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, ruſhes firſt of all into the coronary arteries, by which the heart is ſupplied 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 run in company with thoſe of the arteries, but their trunks run in a different courſe.

Some authors ſuppoſe that the coronary arteries are filled with blood, not by the contracting of the heart, but of the aorta; and the arguments by which they ſupport their hypotheſes are, the retrograde angle at which the coronaries go off, the paleneſs of the contracted heart, and the valves

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of the aorta covering the mouths of the coronary arteries. But the two laſt of theſe arguments are contradicted by experience; and the firſt can only impede or leſſen, and not intercept, the flux into the heart: For the injections of air 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 their natural courſe, though they retard them. But a proof, ſtill more evident, is, that the coronary artery beats 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.

§ 7. *Of the Nature of the Blood and Juices of the Human Body.*

The liquor which is contained in the arteries and their correſponding veins, is known by the general name of *blood*: It appears homogeneous, is coagulable, and of a red colour; it is redder in ſtrong and well fed animals, and generally yellow in ſuch as are weak and ſtarved. White ſtreaks ſometimes appear in it, in conſequence of 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. Dr Wriſberg ſays, that daily experience ſhews 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 rife to the greateft pitch of fummer heat. We can live in a much greater heat than the heat of the warmeft fummer, as is proved by perfons employed in fugar-houfes, melting-furnaces, by mowers, and the ufe of baths and ftoves in Finland and Ruffia; and alfo by the late experiments of Fordyce, Blagden, Hunter, and Dobfon. The heat of the blood is fometimes fo diminifhed in an intenfe cold, that in a perfon froft bitten, but not dead, a thermometer applied to the mouth, arm-pits, groins, and even the vagina, would not rife above 76° of Fahrenheit. Is the matter of heat in the blood alone? This is fufficiently probable from phenomena; for the heat of the body is diminifhed by hémorrhagy, or when the blood is intercepted by ligature and compreffion from reaching the joints, and is reftored when the blood returns. I muft obferve, however, that my experiments upon living animals, particularly upon fwine, did not difcover fo great a difference as might have been expected, between the heat of the heart, arteries, veins, brain, ftomach, inteftines, tunica vaginalis, and even the interftices of the cellular texture in the mufcles. Again, a kind of volatile vapour or exhalation continually flies off from the warm blood, which has a fort of foetid fmell, intermediate between that of the fweat and urine. This vapour, after collection and condenfation in convenient veffels, partakes of an aqueous nature, with fomewhat of an alkaline quality.

After this vapour has diffipated, the blood of a healthy perfon fpontaneoufly congeals into a fciffile, trembling mafs, efpecially in a heat of about 150 degrees, and fooner in feverifh perfons than in fuch as are in health. It fometimes coagulates in the veins of a living perfon, and is found clotted in wounds of the arteries. But even within the veffels of a living perfon, and in one dying of a fever, the blood has been feen, by the violence of that diftemper, changed into a concreted tremulous jelly throughout all the veins. The principal

principal part of this coagulated mafs 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 into a confuſed compact, but 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. 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 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.

The white, yellowiſh, watery part of the blood, commonly called the ſerum, which ſeparates from this coagulum, tranſuding, as it were, through its pores, forms a fluid in which the coagulum ſinks; this again ſeems, though it really is not ſo, a homogeneous liquor; it is, in general, one thirty-eighth part heavier than water, and almoſt a twelfth part lighter than the red globular maſs of craſſamentum: By a heat of 150 degrees, or by mixture of mineral acids or alcohol, and by a concuſſive motion, it is coagulable into a much harder maſs than the red cruor, and forms firſt an indiſſoluble glue, then a fleſh-like membrane, and at length ſhrinks up to a horn-like ſubſtance or friable gum. The pleuritic cruſts or ſkins, polypuſes, and artificial membranes, are formed from this part of the blood. Beſides this coagulable albumen, the ſerum contains a very conſiderable portion of ſimple water, and ſome 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.

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By putrefaction alone, or the diffolving power of the air, in a heat equal to 96 degrees, the whole mafs, but efpecially the ferum, diffolves or melts into a foetid liquor; firft the ferum, and then the cruor more flowly, till at length the whole mafs, both of ferum and cruor, is turned into a volatile and foetid exhalation, leaving very few foeces behind The blood being a little diffolved by the beginning putrefaction, becomes foetid; with the foetor it affumes an alkaline nature, and effervefces with acids. This property it afterwards lofes, the alkaline falt being deftroyed by the complete putrefaction. The putrid blood cannot by any art be infpiffated, and it is very difficult to refolve it, after it has been coagulated by fpirit of wine. By two fevere exercifes, heat, and malignant diforders, the cohefion of the blood is diffolved, and it affumes an alkaline nature, almoft as if from putrefaction.

The blood contains in its fubftance a quantity of *fea falt*, which is difcernible to the tafte, and fometimes vifible by the microfcope. That there is *earth* in the blood is demonftrated from nutrition, and from a chemical analyfis; and this earth is chiefly found in the moft fluid, and efpecially in the oily parts of the blood. By fome very late experiments, it appears, that a confiderable quantity of ferruginous earth, eafily reducible into metal by the addition of phlogifton, is contained in the blood when calcined. Laftly, another part in the blood is *air* in an unelaftic ftate, and that in a very confiderable quantity, as is proved by the putrefaction and diftillation, or by removing the ambient air by the pump; but we are not to fuppofe that the blood-globules are bubbles full of air, for they are fpecifically heavier than the ferum.

By the admixture of neutral falts the colour of the blood becomes deeper and brighter, without the blood's being either diffolved or thickened. It is fcarcely altered by a weak acid. By fermented liquors it is coagulated. Fixed alkaline falts have almoft the fame effects as the neutrals. The vola-

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tile alkalies 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, ſhewn us the nature of the blood. 1. When freſh drawn, before it has time to putrify, 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 towards the end of the operation, when it is proportionally more charged with a foetid oil. 2. The reſiduum, expoſed to a ſtronger fire, yields various alkaline liquors, of which the firſt, being acrid, foetid, and of a reddiſh colour, is uſually called the *ſpirit* of blood; it conſiſts of a volatile ſalt, with ſome little oil, diſſolved in water, to the amount of one twentieth part of the original maſs of blood. This ſame acrimonious ſubſtance is obſervable in the fat, and likewiſe in putrid fleſh and blood. 3. A little before, and together with the oil, a dry *volatile ſalt* ariſes, and adheres in branchy flakes to the neck and ſides of the glaſs. The quantity of this ſalt is very ſmall, being leſs than an eightieth part of the whole maſs. 4. The next liquor is *oil;* it is at firſt yellow, afterwards black, and at laſt it reſembles pitch, being very acrid and inflammable: It makes about a fiftieth part of the whole maſs. 5. There remains in the bottom of the retort a ſpongy inflammable coal or cinder, which, being kindled, burns and leaves aſhes behind. From theſe aſhes, 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 maſs, and of this only one fourth part is alkaline: But being calcined with an intenſe fire, the whole ſalt affords ſome portion of *an acid ſpirit;* which we ſuppoſe to be owing partly to the ſea ſalt in the blood, ſome of which is demonſtrable even in the ſpirit of blood; and partly to the vegetable aliments, not yet di-

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gefted into an animal nature. For which laft reafon an acid is procurable from the blood of graminivorous animals as well as from that of man. The earth, feparated from the lixivium by filtration, makes about an hundred and fiftieth part of the original mafs, and contains fome particles which are attracted by the load ftone.

From the preceding analyfis of the blood, it evidently contains a variety of particles, differing in bulk, weight, figure, and tenacity; fome watery, others inflammable, and moft of them greatly inclined to putrefaction, and of an alkaline nature. The blood, in a found healthy ftate, not injured by putrefaction, or too violent a degree of heat, is neither alkaline nor acid, but mild or gelatinous, and a little faltifh to the tafte; yet, in fome difeafes it is very acrid, and comes near to a ftate of putrefaction; as for inftance, in the fcurvy, where it corrodes its containing veffels; and in dropfies, the waters of which are frequently alkaline. But an alkalefcent calx is found in the blood of infects, which effervefces with acids.

By a microfcope we perceive in the blood red globules; which, doubtlefs, make that part called *cruor* or *craffamentum*. If it be queftioned, whether thefe are not rather lenticular particles of the fame kind with thofe obferved by Leuwenhoek in fifh, and lately difcovered in our own fpecies, we confefs it is a point difficult to determine: Hewfon, however, obferves that the particles are flat like a guinea. (See his Treatife on the Blood.)

The colour of thefe globules is red; and the intenfenefs of their colour, and the proportion they bear to the whole mafs, increafes with the ftrength of the animal. Their diameter is very fmall, being between $\frac{1}{2000}$ and $\frac{1}{1000}$ of an inch. They are faid to change their figure into an oblong egg like fhape, which Dr Haller could never obferve with fufficient certainty. They are alfo faid to diffolve into other leffer globules

globules of a yellow colour, which he had neither obferved himfelf, nor can eafily admit.

From the red part of the blood, fibres are generated in abundance; from the ferum, in fmaller quantities. They are procured by pouring the blood into a linen-cloth, and wafhing 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 mafs. Thefe are formed of the gluten, and are not generated in a living animal; fince they are neither to be perceived by the microfcope, which fo eafily renders vifible the red globules; nor yet does their long thread-like figure feem adapted for receiving motion.

From the preceding experiments compared together arifes that knowledge which we at prefent have of the blood; namely, that the craffamentum or cruor is compofed of globules. The inflammable or combuftible nature of thefe globules is proved from dried blood, which takes flame and burns; as alfo from the pyrophorus, which is generated from the human blood: And from globules alfo moft probably arifes the greater part of the pitchy oil that is obtained from blood by the violence of fire.

The ferum of the blood diftilled with a ftrong fire gives over almoft the fame principles with the cruor, viz falt, oil, and earth. It yields, however, much more water, but no iron at all. Similar principles, but with a lefs proportion of oil and falt, are obtained from the aqueous humours prepared from the blood, as the faliva and mucus.

The exact mafs or quantity of blood contained in the whole body cannot be certainly computed. The weight of the mafs of humours, however, is much greater than that of the folids; but many of them, as the gluten and fat of particular parts, do not flow in the circulation. But, if we may be allowed to form a judgment from thofe profufe haemorrhagies that have been fuftained without deftroying the life

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of the patient, and from experiments made on living animals by drawing out all their blood, the mafs of circulating humours will be at leaft fifty pounds; of which, about 28 will be true red blood, running in the arteries and veins; of which the arteries contain only four parts, and the veins nine.

The blood does not always contain the fame proportion of the principles above mentioned: For an increafed celerity, whether by laborious and ftrong exercifes, a full age, fever, or otherwife, augments the craffamentum, the rednefs, the congealing force, and the cohefion of the particles; and the hardnefs and weight of the concreted ferum with the alkaline principles are increafed by the fame means. On the other hand, the younger and lefs active animal, and the more watery or vegetable the diet on which it is fed, the craffamentum of the blood is proportionally leffened, and its ferum and mucus increafed. Old age, again, leffens the craffamentum, and the gelatinous part likewife.

From thefe principles, and a due confideration of the folid fibres and veffels, the different temperaments are derived. For a *plethoric* or *fanguine* habit arifes from an abundancce of the red globules; a *phlegmatic* temperature from a redundancy of the watery parts of the blood; a *choleric* difpofition of the humours feems to arife from a more acrid and alkalefcent property of the blood; as appears from thofe who live on flefh and on the human fpecies, being fo much fiercer and more paffionate than thofe who live on vegetable food. A great firmnefs in the folid parts, joined with an exquifite fenfibility, or nervous irritability, difpofes to a choleric habit; a lefs irritability, with a moderate denfity, to a fanguine habit; and a leffer degree, both of denfity and irritability, are to be referred to a phlegmatic temperament. There is alfo a kind of dull heavy temperament, in which there is the greateft ftrength of body, joined with no great degree of irritability. In the melancholic, again, a weaknefs of of the solids is joined with the higheſt degree of nervous irritation or ſenſibility. But we muſt not deſcribe the temperaments too ſyſtematically; for they are found to be not only four or eight, but almoſt infinitely varied.

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 or 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 new blood. For, by large hemorrhagies, we ſee the blood loſes its red and 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 ſhall be afterwards ſhewn. 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 external cavities, to preſerve the flexibility of the ſolids, and conduce to the motion of the nerves, the ſight, &c. The ſaline particles ſeem ſerviceable for diſſolving the aliment, and ſtimulating the veſſels. The properties of the aerial part are not yet well known. The heat occaſions the fluidity, and is not eaſily raiſed to ſuch a degree as to coagulate the humours

Health, therefore, cannot ſubſiſt without a denſe and red blood; and, if its quantity be too much diminiſhed, a ſtagnation of the juices takes place, whence the whole body becomes pale, cold, and weak. Nor can life or health ſubſiſt without a ſufficiency of thinner juices intermixed with the red blood; ſince the cruor, deprived of its watery part, congeals and obſtructs the ſmalleſt paſſages of the veſſels, and cauſes too great a heat.

It ſhould ſeem that there ought to be a difference between the arterial and venous blood, on account of the former's having lately ſuffered the action of the lungs: But, in experiments, I ſcarcely find any obſervable difference, either in colour, denſity, or any other property. 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. The dark colour of the blood in a chicken, while in the egg, ariſes only from the deep ſeat of the 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 greater degree of fluidity and proportion of watery parts, may ſo far differ from the venous darker coloured blood. But, to clear up this circumſtance, 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 to one 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.

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" 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, favours too much of the antient and particularly of the Galencial 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 in perfect animals, may be observed in the performance of the corporeal and mental functions, in either preserving or endangering the health and life, 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 health of the animal. If, therefore, we 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 we would do to any plant, or other particular natural body; or if we wish to keep the antient denominations sanguineous, choleric, phlegmatic, and melancholic, in preference to all others, we must be aware, that neither the various habits nor temperaments of mankind can originate solely from the different natures of the blood, nor can they all be comprehended under these four modifications.

" The causes of diversity of temperament seem to be, 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, theſe people 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. Theſe people therefore require from external objects ſtronger impreſſions upon the organs of ſenſe, and theſe impreſſions 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 act with ſo incredible quickneſs, deſpatch, and conſtancy. On the contrary, if you examine a phlegmatic perſon, you obſerve the contractile power of the muſcles languid, difficulty yielding to ſtimuli, unleſs powerful; ſince the muſcles of plegmatico 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 toucht he body of a phlegmatic perſon; or a ſeeming hardneſs and dryneſs in melancholic habits: Along with which particularities the phlegmatics 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 its 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.

" There are then sufficient causes, which, from our birth, may bring on, in the first growth of the parts of the body, an irrevocable determination to this or that habit or temperament. I therefore can scarcely admit a complete transmutation of temperament, which, during the exercise of these natural lasw, 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 aro-

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matics, wines, and medicines, has supervened. Vegetables, on the contrary, increafe the lentor of the fibres, weaken the ftrength, diminifh fenfibility and irritability; in a word, induce a phlegmatic difpofition; in which potatoes have a wonderful effect. It would be of great confequence to pay regard to this in the bringing up of children, viz to invigorate the inertia of the mental and corporeal faculties by the ufe of animal food, but to temper the vehement paffions peculiar to choleric perfons, by ufing a vegetable diet. 2. The particular mode of education and examples. It need fcarce be infifted on that thefe poffefs great influence, particularly in infancy. Hence it happens that whole nations are of one temperament. 3. Climate, weather, native country. Rarely in an unfettled climate or country, in hot climates, or in moift countries, will you find in choleric perfons that alacrity of temper, agility of body, and quicknefs of underftanding, which is fo common in a ferene and temperate climate, and high hilly countries. 4. The increafe of knowledge. I have often admired that change which a ftrenous induftry produces in fome of the moft dull men; fo that, with the increafe of knowledge, they became of a more cheerful temperament. 5. Abundance and want of neceffaries, both in life, and for the purpofe of forwarding improvement. For this reafon, it may happen that, according to the diverfity of the form of government, whether under mild or more fevere and tyrannical laws, the temperament of the fubject may be either lively or languid. 6. The fort of life itfelf, intercourfe with men, and public employment, may have a great fhare in changing temperaments; fince rarely, after the 36th year of a man's life, do you find the blood ftill pure; and a choleric perfon fcarcely preferves his former alacrity after his 50th. It is difficult to fay into how many fpecies temperaments fhould be divided, and what kind of character fhould be affigned to each, according to nature, and not conjecture. I doubt I may not be more fucceſsful than the celebrated Kaempſius and Gerreſhemius, as I exhibit the outlines only The ſanguineous and phlegmatic temperaments ſeem, with various intermedia, to comprehend all modifications. 1. 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, ſhewing 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 in common with the choleric. 3. The choleric: Here you will always obſerve the body lean, though not emaciated and dry, as in the caſe with 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

tured with envy and diffidence, and are called by fome *cholerico-melancholic*. 6. The melancholic have a dejected afpect: The eyes, for the moft part, fmall, retracted, and winking; the hair black, and fkin rigid; remarkable for its drynefs and leannefs; a fmall and flow pulfe, fparing and black bile, a flow periftaltic motion. They indeed have quick perceptions, and ponder long; they fubmit to toilfome labour with the greateft patience, but finifh it with incredible flownefs; for the moft part they pay no regard to time. They eafily bear the difadvantages of life; but, when once their anger is excited, they love revenge. 7. The boeotic or ruftic joins a great fhare of the fanguineous temperament with the melancholic and phlegmatic. The body is lufty, full of juices, a fmall irritability in its ftrong mufcles, and fome ftupor in its fmall nerves. Perfons of this fort are capable of no education; and whatever they undertake favours of a low turn of mind. 8. The gentle and mild temperament. This is compofed of the fanguineous, choleric, and phlegmatic. They are a good race of men, wifhing well to all: In them we always perceive a calmnefs and fweetnefs of manners. They ftrongly hate a prating, noify loquacity. If devoted to ftudy, they calmly undertake the tafk, anxioufly ponder what they learn, and are capable of great proficiency. 9. The flow phlegmatic is diftinguifhed by a foft and moftly whitifh fkin, a very lax body, very prominent eyes, drowfy afpect, a flow and weak pulfe: For the moft part they fpeak flow, are patient of the weather's inclemency, and other people's affronts; born to obey; and on account of their flighter irritability, difficultly enraged, and eafily pacified again.

§ 8.

§ 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 thofe arteries and veins which we call *red*, or of the firft order, and which have their origin in the heart. Sometimes they are very loofely and imperfectly diftended by the blood, and at other times they are rendered very full and turgid. After death, the veins are found fuller of blood than the arteries; and fometimes, when the perfon has been dead a confiderable time, the fmall veins have been found diftended with air. But the arteries of a dead body commonly contain only a fmall quantity of blood.

This diftending blood is rapidly moved through all the veffels of a living body, as is demonftrated to us from wounds; and the patient fooner or later expires from the lofs of fo much blood as was neceffary for the maintenance of life; this lofs of blood happens almoft inftantly from the larger arteries, and fometimes very fuddenly from the fmaller ones: But from the veins, unlefs they are fome of the largeft, it is generally flow; yet are there not wanting inftances of fatal hemorrhagies from wounds of the veins, in the inner corners of the eyes, and thofe under the tongue. Experiments made upon living animals fufficiently evince the impulfe and rapidity with which the blood is moved, particularly through the arteries. The height to which blood afcended from the carotids, when cut, according to Hale's calculation, Dr Wrifberg faw confirmed in robuft men who were beheaded: It is generally about feven feet, with this difference, however, that in two examples the blood fprung higher from the vertebrals than from the carotids. In the larger trunks it runs fwifteft, but in the leaft of them, fomewhat flower. In the larger veins, the blood's celerity is lefs than in the arterial trunks, in the fame proportion as the fections of the arteries are lefs than thofe of the veins, *i. e.* twice or almoft thrice as flow. Another argument of the circulation is the compreffure and relaxation of a vein, whereby the motion of the blood is promoted from one valve to another. The motion of the blood through the veins is uniform or equable; but in the arteries, it is alternately greater when the veffel is more dilated, and lefs when it is contracted. This is proved by ocular infpection in living animals.

That the motion of the blood is a continued courfe through the fanguineous arteries into the veins, is difcovered from experience. For, firft, it is certain, that all the arteries and veins communicate or open the one into the other; becaufe, often from one, and that a fmall artery, all the blood of the whole body may be evacuated. We have numerous examples of fatal hemorrhagies from an inner artery of the nofe, from the gums, from a finger, from a tooth, from a cutaneous pore enlarged, from the punctum lacrymale, from the wound of cupping, and even from the bite of a leech. There are, therefore, of courfe, open ways, by which the blood fpeedily flows from the venous into the arterial fyftem.

That the blood, again, in the arteries, flows from the heart towards the extreme parts of the body, is proved by the microfcope, and by a ligature on the artery of a living animal, and likewife by the fabric, mechanifm, and proportion of the femilunar valves between the arteries and their correfponding ventricles. Whatever artery is ftopped by a ligature, the fwelling enfues in that part between the heart and the ligature, whilft the other part beyond the ligature, which is more remote from the heart, is emptied. Neither has it there any pulfation, nor, if it be there wounded, will it yield any blood. The fame effects which we fee follow from a ligature, are likewife often produced by dif-

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eafe; as when fome tumour, by compreffure or an aneurifm, intercepts the blood's motion from the heart. Experiments of this kind have been made on moft of the arteries; anaftomofes, however, or the blood flowing through a neighbouring branch, or the retroceffion of the blood in a dying animal, form exceptions to this rule.

But the courfe or motion of the venous blood, has been always more doubted; almoft all the antients have been perfuaded, 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 falfe in the pulmonary vein. But that the blood did not move from the heart in the vena cava was known to ftill fewer anatomifts of the antients: Only to Andreas Caefalpinus by chance, and (from an extraordinary accident) to Vefalius.

Dr. William Harvey was the firft who experimentally afferted the motion of the blood returning in the veins to the heart, in fuch a manner as to render the whole intelligible, and leave no room for doubt. The valves of the veins lead us to this truth: For the common ufe or office of thefe valves is, to determine the preffure that is made from any quarter upon the veins, towards the heart, by allowing no opportunity to the venous blood that has once entered the trunk to flow back to the branches. For, fince the valves open upwards towards the heart, the blood enters and expands them; and thofe parts of the valves which project into the cavity of the vein, approach towards the axis, until the oppofite fides, by meeting together, fhut up the tube. This we know from inflations, ligatures, and injections of the veins; for you never can force a liquor eafily into the veins by propelling it againft their valves. They do not, indeed, every where

where ſhut up the whole cavity of the veins; but where they do not ſhut cloſe, they always intercept the greateſt part of the tube.

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 column. This is the reaſon why valves are placed in the veins of the limbs and necks, in which parts they are both more numerous and more robuſt than elſewhere. This is alſo 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 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 ſide of the heart are ſo conſtructed, 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, make this circumſtance more evident. When the veins of the limbs are tied, either by deſign or accident, 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

above the ligature, nor any of the veins to be ſeen there. The ſame phenomenon happens when the veins are compreſſed by ſwelled or ſcirrhous glands in the viſcera; and from polypuſes the veins are often greatly ſwelled or enlarged into tumours. 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 which have been made in living animals, to prove this courſe of the blood, 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 ſhew, that, into whatever vein you inject chemical acid ſpirits, the force of the poiſon is driven along with the blood to the heart itſelf. That the brain is affected with the narcotic virtue of opium, and the inteſtines and ſtomach with the virtue of purgatives and emetics injected into the veins, 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.

We have another proof 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, becomes ſo turgid, and well repleniſhed, that they produce a remarkable degree of vivacity in the animal, or even cauſe it to labour under a plethora.

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That the blood paffes from the leaft arteries into the leaft veins, we are clearly taught by *anatomical injection;* where, by one arterial trunk, we eafily fill all the arteries and veins, almoft throughout the whole body, provided the liquor be watery, or very fluid, fo as to pafs eafily into the veffels of the head, mefentery, heart, and lungs.

Laftly, *the microfcope* has put the matter beyond all doubt; in the pellucid tails, feet, and mefenteries, of animals, we fee that the blood, brought to the extreme parts by the arteries, is poured either into fmall veins continuous with the reflected artery, or elfe goes through branches of the arterial trunk into the parallel communicating vein, by which it goes on to the parts neareft the heart. This is the way in which the blood paffes, as well into the leaft veins which are capable of receiving only one globule, as into thofe that are fomewhat larger, and are able to admit two or more globules to advance forward together. That there is no fpongy or parenchymous interpofition between the arteries and veins, in the general courfe of the circulation, is proved both from microfcopic obfervations and injections. For, if there were any fuch parenchyma or fpongy mafs between the arteries and veins, the hardening injections would fhew it, by appearing extravafated in an unfhapen mafs.

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 mafs is again tranfmitted into the leaft veins, which convey it to the larger, and from them into the cava and heart itfelf; in which courfe it perpetually goes and returns during life.

Yet there are not wanting fome inftances where, by paffions of the mind, by copious blood-letting, or convulfions, the blood has been forced to recede back from the fmaller ſmaller into the larger arteries; and, on the other ſide, where an obſtruction has been 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, when tied, ſwells between its ſmaller extremities and the thoracic duct; but grows flaccid between the 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 cavities, are all abſorded by the leaſt pellucid veins, and ſo conveyed to the blood veins, that their contained juices may paſs on to the heart: And from thence it is that oedema enſues, when a vein is compreſſed by a ligature; becauſe, by intercepting the courſe of the abſorbing veins by the ligature, the vapours being unabſorbed, ſtagnate. In the other ſmaller veſſels we can make no experiments; but they appear conformable to what we have ſaid of the larger veſſels, both from reaſon and analogy. This doctrine is likewiſe ſupported by the experiments of water, or other liquors, abſorbed out of the cavity of the inteſtines, thorax, and pulmonary veſicles.

All the juices, therefore, in the human body, are driven out of the heart into the aorta; from whence they are all returned again to the heart by the veins; thoſe humours only excepted which are exhaled or diſcharged out of the body.

body. To complete this circle, it only remains for us to find out a courſe for the blood from the right to the left cavities of the heart; but this firſt ſuppoſes us to be acquainted with the hiſtory of the lungs and the pulmonary veſſels.

§ 9. *Lungs.*

Situation in general, and figure. The lungs are two large ſpongy bodies, of a reddiſh colour in children, greyiſh in adult ſubjects, and bluiſh in old age: They fill the whole cavity of the thorax, one being ſeated in the right ſide, the other in the left, and are parted by the mediaſtinum and heart. They are of a figure anſwering to that of the cavity which contains them; that is, convex next the ribs, concave next the diaphragm, and irregularly flatted and depreſſed next the mediaſtinum and heart.

When the lungs are viewed out of the thorax, they repreſent, in ſome meaſure, an ox's foot, with the forepart turned to the back, the back part to the ſternum, and the lower part to the diaphragm.

Diviſion and figure in particular. They are diſtinguiſhed 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, anſwerable 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.

Struc-

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 theſe 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 or 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; in the ſubſtance of the membrane are a 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

ſend out from all ſides a vaſt number of ſhort capillary tubes of the ſame kind.

Veſiculae 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 proportional 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 vaginae, 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 in this interlobular ſubſtance, the air compreſſes and flattens the lobuli; and, when we blow into the bronchial veſicles, they immediately 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.

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, 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 through 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 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; and likewiſe with the arteries and veins of the oeſophagus, and with the branches of the coronary artery and vein.

The

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 anoſtomoſis 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 part 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 oeſophagaeae. 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 the ramifications of the bronchia.

The left bronchial artery frequently comes 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

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 eighth 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 broad membranous ligament which ties the poſterior edge of each lung to the lateral parts of the vertebrae of the back, from that root all the way to the diaphragm.

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 pluerae, 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, the other toward the left, which enter the lungs, and are diſtributed through them in the manner already deſcribed. Theſe two branches are called *bronchia*; and that on the right fide is fhorter than that of the left, whereas the right pulmonary artery is the longeft.

The trachea confifts of fegments of circles or cartilaginous hoops, difpofed in fuch 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 foft glandular membrane, which completes the circumference of the canal; but this cannot be to give way to the oefophagus, for, inftead of defcending immediately upon the middle of that canal, the trachea inclines a little to the right fide, and the fame ftructure is found in the back part of the great bronchial veffels, which are at fome diftance from the oefophagus.

Each circle is about the twelfth part of an inch in breadth, and about a quarter of that fpace in thicknefs. Their extremities are round; and they are fituated horizontally above each other, fmall interftices being left between them, and the lower edge of the fuperior fegment being turned towards the upper edge of thofe next below them.

They are all connected by a very ftrong elaftic membranous ligament fixed to their edges. I have obferved the firft three fegments united into one fubftance, bent alternately in two different places, according to its breadth. Sometimes two are continuous in the fame manner.

The trachea is covered externally with a quantity of cellular fubftance, which unites it to the neighbouring parts, and it is lined on the infide by a particular membrane, which appears to be partly flefhy or mufcular, and partly ligamentary, perforated by an infinite number of fmall holes, more or lefs imperceptible, through which a mucilaginous fluid continually paffes, to defend the inner furface of the trachea againft the acrimony of the air which we breathe.

This fluid comes from fmall glandular bodies difperfed through the fubftance of the membrane, but efpecially from glands

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 commonly diſpoſed 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 place theſe three kind 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

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 rugae, which are destroyed when these vessels are elongated. This is an observation made by M. Helvetius.

In consequence 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. These vessels are elongated in exspiration, and shortened in inspiration.

These three vessels lie in a sort of cellular vagina, which accompany all their ramifications; and is a continuation of their interlobular cells, or cellular substance, in the interstices of the lobuli. The pelliculi 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 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

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 pelliculae 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 laminae or ſtrata, partly muſcular and partly tendinous; the external or poſterior lamina conſiſting 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 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 veficles or cells, which open from within outwards.

Ufes. Refpiration is performed by organs of two kinds, one of which may be looked upon as active, the other as paffive. The lungs are of the fecond kind, and the firft comprehends chiefly the diaphragm and intercoftal mufcles.

As foon as the intercoftal mufcles begin to contract, the arches of the ribs are raifed together with the fternum, and placed at a greater diftance from each other; by which means the cavity of the thorax is enlarged on the two lateral and anterior fides.

At the fame inftant 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 inferted. The external furface of the thorax being thus in a manner increafed, and the cavity of the bronchia being at the fame time, and by the fame means, lefs refifted or preffed upon, the ambient air yields to the external preffure, and infinuates itfelf into all the places where the preffure is diminifhed; that is, into the afpera arteria, and into all the ramifications of the bronchia, all the way to the veficles. This is what is called *infpiration.*

This motion of infpiration is inftantaneous, and ceafes in a moment, by the relaxation of the intercoftal mufcles; the elaftic ligaments and cartilages of the ribs bringing them back at the fame time to their former fituation. This motion, by which the ribs are depreffed and brought nearer to each other, is termed *exfpiration.*

The pulmonary arteries and veins, which accompany the bronchia through all their ramifications, and furround the veficles, tranfmit the blood through their narrow capillary extremities, and thereby change or modify it, at leaft in three different manners.

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The firſt change or modification which the blood undergoes in the lungs, is to have the coheſion of its parts broken, to be attenuated, 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 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. Between the lungs and

pleura

pleura is found a watery or rather ferous vapour, of a coagulable nature, like that of the pericardium; which vapour tranfudes from the furface of the lungs continually in the foetus, and not unfrequently in the adult. This is fometimes increafed fo as to form a dropfy, or thickens into a kind of febaceous matter; or, laftly, concreting into fibres, joins the lungs to the pleura.

The vefîcles of the lungs do not receive the air by a fingle orifice from the trachea, as a vial; but the air, exhaling from the leaft branches of the trachea, is admitted in fuch a manner into their irregular fpaces, that it freely fpreads through them from any one part of the lungs into all the reft, and returns again in like manner. This is demonftrated by inflation, which drives the air even through the leaft branches of the trachea into the fmalleft lobes; from whence it readily paffes into all the reft. Nor, in man and fmaller animals, fays Haller, is the cellular fabric of the intervals fhut up from the vefîcles of the lungs; but according to Sabatier and other late writers, there is no communication between the common cellular fubftance and the cells of the lungs.

The air is driven into thefe vefîcles through the trachea, which arifes from the larynx; and in the upper part of the thorax is received between the laminae of the pofterior part of the mediaftinum.

Its laft branches are invifible, which exhale the air into the cellular fpaces of adult lungs, and likewife receive the watery vapours exhaling from the arteries into thefe fpaces from whence they are thrown by exfpiration.

The quantity of blood which enters into the lungs is exceedingly great, equal to (or even perhaps greater than) that which is fent in the fame time throughout the reft of the body; which, therefore, demonftrates fome very confiderable ufe proper to this vifcus. And that air is concerned in the

ufe

ufe of the lungs, appears from the univerfal confent of nature, fince we fcarce find any animal without breathing; it appears alfo from the ftructure of the lungs in the foetus, in which, for want of air, they are ufelefs, receiving only a fmall portion of the blood, which the pulmonary artery conducts from the heart. We come next, therefore, to fpeak of refpiration, *i. e.* the operation by which the air is drawn into, and expelled from the lungs,

The element of air appears from the principles of philofophy, to be an elaftic and fonorous fluid, with a fpring which cannot be deftroyed But the atmofpherical air, which we commonly receive into the lungs, is impure, filled with a great quantity of watery and other vapours, alfo with falts and the univerfal acid, with the feeds of plants and animals, and other foreign matters, but in very minute particles; the fpecific gravity of air 859 times lefs than water, a cubic foot of air weighing between 610 and 694 grains. This air, which furrounds the earth on all fides, being preffed by the incumbent columns of its own mafs, perpendicularly, laterally, and in all directions, enters forcibly wherever it meets a lefs refiftance, as appears from experiments made with the air-pump. Its preffure upon the human body is not lefs than 3000 pounds weight. It is repelled chiefly by the pores of the membranes, which are yet permeable by water: It likewife penetrates oil or mucus with difficulty.

This air is excluded from all parts of the human body by the furrounding clofe fkin, which, even when dry, is impervious to the air; and, in the living body the fkin becomes ftill more impervious, on account of the fat under it filling the pores. We fhall next inquire into the reafon why, and the manner in which the lungs receive air into their fubftance; and this inveftigation becomes the more difficult, when we reflect that the lungs of an adult are always full of air, which, on a flight view of the fubject, we might imagine would

would reſiſt the entrance of a freſh quantity. 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 foetus, after they have been inflated but a few times, they always ſwim; whereas they ſink in 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. Air will not enter the lungs, if it is not ſo denſe as to overcome the force of the air already in the lungs, the reſiſtance of the bronchia, and the preſſure of the lungs themſelves. Hence an animal lives better in a denſe than in a light air; although light air is always more tolerable, if it be at the ſame time pure, than denſe air; ſuch as that of the high mountains of the Alps. That air may enter the lungs, the air which is already in the cellular fabric of the lungs muſt be rarified: 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 external air deſcends into the lungs, ſufficient to reſtore the rarified air in the lungs to the ſame denſity with that of the external air.

In order to dilate the lungs, and thus to induce ſuch a ſtate as 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

action of the internal intercostals; because their lower part is inserted into that portion of the rib which is nearest its articulation with the vertebrae, and which therefore seems to be the least moveable: However, they nevertheless elevate the ribs; 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. It also appears, from a flexible thread being fixed to the rib of a 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 circumstance, 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 vertebrae; 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 vertebrae and from the ribs. Thus the ribs are both removed farther from the vertebrae,

tebrae, and the right ribs from the left; and each diameter of the thorax, *i. e.* the diſtance between the right and left ribs, and the diſtance between the ſternum and the vertebrae, are increaſed almoſt to two lines: And therefore this enlargement, in every imaginable ſection of the thorax, will ſufficiently dilate its cavity. 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 cartilages 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 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 between the right and left fleſhy portions, which ariſe from the middle of the bodies of the vertebrae 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

the other opening remains immoveable. The tendons are but little changed in the motion of the mufcles.

The ftructure of the parts, and the diffection of living animals, demonftrate, that the flefhy portions of the diaphragm, which on all fides afcend from the firm parts to the middle and more moveable, do, by their contraction, deprefs the middle, and by that means draw down the lateral bags of the thorax, which contain the lungs; and, by this means, the perpendicular diameter of the thorax is confiderably increafed. The flefhy parts are more depreffed; the tendon lefs; both becaufe it is fixed to the pericardium, and becaufe its own fubftance does not contract. Even the oefophagus and vena cava are contracted, while the diaphragm exerts its action. So that the diaphragm almoft alone performs the office of refpiration in a healthy man at reft. The diaphragm is alfo the chief inftrument of refpiration in the cafe of fractured ribs or fternum, or where the ribs cannot be moved without exciting confiderable pain. The force of the diaphragm alfo, in dilating the breaft, is greater, according to the calculations that have been made, than all the reft of the powers which contribute to refpiration. A great infpiration is fomewhat hindered; becaufe, during the greateft exertio of the diaphragm, the lowermoft ribs are brought inwards, and thus the thorax is ftraightened. Left this fhould always happen, the intercoftal mufcles interfere in ordinary infpirations; in the very great ones, they are inferior to the diaphragm. The phrenic nerve, which is more eafily irritated than in moft other mufcles, forces the diaphragm to perform its office. The lungs themfelves are altogether paffive or obedient to the action of the air; and alfo to that of the ribs and diaphragm, to which they are preffed into clofe contact on all fides; and we fometimes fee them even preffed through a large wound of the thorax; and fometimes, when the cavity is whole, we fee them through the tranfparent pleura, and part of the diaphragm

But, in larger infpirations, when a greater quantity of blood is driven into the lungs, and when there is any obftacle or difficulty oppofed to the action of the lungs themfelves; in thofe cafes, feveral other powers confpire to elevate the thorax. Which powers are inferted either into the thorax, clavicles, or fcapulae; fuch as the fcaleni mufcles, trapezii, cervicales defcendentes, ferrati fuperiores, and pectorales; together with the fmall elevators.

We have now defcribed the powers which are able to increafe the capacity of the thorax in all its three dimenfions. By thefe the cavity of the breaft is dilated, fo that it compreffes the lungs lefs than before: The lungs then ftrive to diffufe themfelves over that fpace, by the expanfion of the air contained in them, when the preffure is removed. Without that mufcular force, the lungs have no proper power of their own, by which they are capable of attracting air. Even when they are full of air, if the afpera arteria be clofed, the animal vehemently attempts to infpire, by the efforts of its intercoftal mufcles and diaphragm. The air, which is preffed on all fides by the incumbent columns of the atmofphere, enters the thorax with the greater force, in proportion as the lungs contain lefs air; and yet more powerfully if they contain no air; but with no force at all, if the air admitted through a wound in the breaft preffes upon the external furface of the lungs. In this action, therefore, which is called infpiration, the bronchia are every way increafed, both in length and diameter; becaufe all the diameters of the thorax are increafed; and the inflated lungs always keep contiguous to the pleura, without leaving any intermediate fpace. At the fame time, the pulmonary blood veffels being contained in the fame cellular covering with the bronchia, are, with them, extended in length, and fpread out into larger angles; by which means the

the circulation through them is rendered eafier. While this is performing, the veficular fubftance, or flefh of the lungs themfelves, filled with air, increafes thofe fpaces through which the capillary blood veffels of the lungs advance; whereby the veficular preffure upon each other, and upon thofe veffels adjacent, is leffened. Thus, therefore, the blood will flow with greater eafe and celerity into, and through, the larger and fmaller veffels of the lungs. Hence a dying animal is revived by inflating its lungs, and facilitating the paffage of the blood to the left ventricle of the heart; and thus people, feemingly dead by being kept a long time under water, are again recovered. The preffure of the air upon the blood in the lungs, in this action, is fo inconfiderable as not to deferve our notice, being at leaft 300 times lefs than the force of the heart, and can never urge the air into the blood.

Some anatomifts fuppofe, that a quantity of air is contained between the lungs and the fides of the thorax; and that this air is contracted during infpiration, and being again expanded, preffes the lungs, and caufes expiration. They fupport their opinion by producing inftances of birds where this fact undoubtedly obtains. But we fee every thing concurs to confute thefe opinions with refpect to man and quadrupeds, &c.; for, immediately under the pleura, in living quadrupeds, as well as in dead human bodies, the lungs are vifible, without any intermediate fpace between them; but the pleura being perforated, the lungs are immediately, by the contiguous air that enters, preffed together towards the vertebrae. In birds, indeed, the lungs being pervious to the air, admit it into the cavity of the thorax through large holes in their fubftance. But in thefe animals there is a manifeft fpace between the lungs and the pleura. Large wounds, admitting the air only into one cavity of the thorax, diminifh the refpiration; but, fuch wounds as let the air into both cavities, quite fuffocate or fupprefs the refpiration. The thorax being opened

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under water, ſends out no bubbles of air through the water; but, in birds, it does, becauſe they have air in their thorax. If there ſhould accidentally be any ſpace between the lungs and the thorax, it 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 between the lungs and thorax. Finally, the external air 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 ſub-putrid 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, ſince 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 that coming from the head, ſtagnates before the right ventricle of the heart, which is 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,

tines, kidneys, and laftly of the lungs and even right auricle of the heart. This ftagnation of the blood occafions prodigious anxiety and uneafinefs to the fpirits; it is alfo the caufe of death in compreffed air, in drowned people, and fuch as are ftrangled, which is much more fudden than is commonly imagined. A living perfon, therefore, that he may remove thofe inconveniences which proceed from an obftruction of the paffage of the blood, flackens the powers of infpiration, and excites thofe of expiration, which free the breaft from an air too greatly rarified.

Thefe powers are, firft, the elafticity of the ribs; which being drawn upwards out of their natural fituation, as foon as the powers which elevated them ceafe to act, fpontaneoufly place themfelves, fo as to make more acute angles with the fternum and vertebrae. To this end conduces likewife the elaftic force of the bronchia and veficles diftended with air, which ftrive to contract themfelves. Hence exfpiration is performed more eafily and quickly than infpiration; and hence it is the laft action of dying people.

The abdominal mufcles all contribute to contract the thorax. The recti, which are fixed to the offa pubis by one end, and to the lower ribs by the other, being contracted, deprefs the arch or convexity, into which the abdominal vifcera are thruft by the diaphragm: At the fame time the abdominal vifcera are preffed by thofe mufcles upward and backward againft the diaphragm, which alone is able to give way, and yield toward the thorax, which at that time is rendered fhorter. The obliqui, for the fame reafons, comprefs the lateral parts of the abdomen, and urge the liver and ftomach backwards, and prefs them towards that place where there is the leaft refiftance. Laftly, they draw down the ribs which were before elevated by the intercoftals. The tranfverfales, indeed, do not draw the ribs; but they pull the cartilages of the falfe ribs a little inward, and render the whole capacity

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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 ſterno-coſtal and long intercoſtal muſcles, which are called *depreſſores*. By this joint force the ſuperior ribs deſcend; but the middle ones more, the uppermoſt leſs, the loweſt moſt of all; and their margins being brought inward, 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 produce 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 air from the lungs; by which means part of the blood adhering 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, therefore, will ſtop the eaſy paſſage of the blood through the lungs; and when the whole thorax is compreſ-

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fed together, repels the venous blood into the veins of the head, and fills the brain and its finufes.

The inconveniences produced by exfpiration, excite new efforts for repeating the refpiration; becaufe the collapfed veffels of the lungs refift the blood expelled from the right ventricle of the heart. Hence the caufe of death in thofe animals which expire in veffels exhaufted of air: For their lungs being void of air, become denfe, folid, and heavier than water, whence they are rendered impervious to the blood. Of the fame kind is the death of thofe who are killed by lightning, and, perhaps, by the noxious vapours of caverns. How admirable are the ftructure and mechanifm in thefe organs of refpiration! The uneafy fenfations of a too long continued exfpiration, which arife from hindrances of the blood's paffage through the lungs, excite into action the powers of infpiration whereby the blood's paffage through the lungs is rendered again more free and eafy; and, *vice verfa*, the uneafinefs proceeding from a too long continued infpiration, excite the powers of exfpiration.

It is queftioned, by fome authors, Whether or no there are not other caufes of alternate refpiration? Whether or no we may hope for any difcovery in this matter by compreffing the vena fine pari, the phrenic nerve, or intercepting the blood fent to the brain? But thefe opinions are repugnant to comparative anatomy, by which we always find the fame alternation in the breathing of the animal, independent of any fuch nerve or vein. Whether or no refpiration is from the alternate contraction of the antagonift mufcles, among which thofe of exfpiration relax the others of infpiration, and the reverfe? This doctrine feems improbable, becaufe all the mufcles of the human body are perpetually in an alternate motion.

From what has been hitherto faid, it appears, that refpiration is unavoidably and abfolutely neceffary to life in a healthy

healthy adult perſon; becauſe, whether the lungs remain long in a ſtate either of exſpiration or inſpiration, we ſee death will ſoon be the conſequence. No animal, therefore, 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 foetus. 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 trachea diſperſed through all parts of the body.

In order to diſcover this uſefulneſs of reſpiration, let us compare the blood of an adult perſon with that of a foetus, and alſo with the ſame vital fluid in fiſhes. It appears then in a foetus, that the blood is deſtitute of its florid redneſs and ſolid denſity; and in the blood of fiſhes, we obſerve there is no heat, the denſity inconſiderable, and but little craſſamentum contained in it; and therefore we are perſuaded, by the nature of theſe circumſtances, that the blood acquires all theſe properties 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 the lungs are obſtructed, ulcerated, and almoſt deſtroyed, a morbid heat ſeizes upon the body; and in the lungs the cold air very nearly touches the blood.

The denſity of the blood is ſomewhat increaſed in the lungs, 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 gives a roundneſs 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 between the parts of the globules, ſo as to compreſs and bring them cloſer to each other. Neverthelefs, 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 ſide of the heart, by which the blood is driven forward, is alſo weaker.

It is queried by ſome anatomiſts, 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; from the air found in the blood veſſels, in the cellular ſubſtance, and in certain cavities of the human body; from the cracking obſerved by an extenſion of the joints; from air manifeſtly extravaſated from the trachea into the hearts of certain animals, as in the locuſt; from our being able to extract air out of the blood and humours of animals in vacuo; from a neceſſity of a vital oſcillation in the blood itſelf; and, laſtly, from 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; from the mucus that perpetually lines the ſides of the veſicles in the lungs; from the nature of the elaſtic air itſelf, which is very unapt to paſs through capillary veſſels; from a repulſion of it by water, for it is hindered from paſſing through paper, linen cloth, or ſkins, when they are wet. Again, the air taken in by the trachea never paſſes to the heart; or, whenever it does ſo, 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. 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, certainly and ſpeedily kills it. 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 are there any reaſons why the air ſhould either be more ſpeedily abſorbed by the blood, or why it ſhould retain its elaſticity after it is ſo abſorbed.

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"If, in a few words," ſays Dr Wriſberg, "I might offer my opinion about the air found in our bodies, the origin of 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 primogenial fluid as a vehicle, make the common air we inhale in inſpiration. This primogenial 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 particle 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 we ſhall be able to correct unwholeſome air, provided we know what qualities that air ſhould poſſeſs which is moſt properly ſuited to reſpiration.

Is the blood cooled in the lungs? Is this opinion confirmed by the death of animals in too great a degree of heat? Are not the pulmonary veins leſs than the arteries? Is this the reaſon why laborious people prefer cold? 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. That this was not the principal deſign of nature, is evident from the well known fact, that the venous blood is not hotter than the arterial; and nobody ever obſerved the left ventricle of the heart cooler than the right. Beſides, a perſon may live in an air much hotter than the blood itſelf, of which we have examples in baths and warm countries. In a foetus

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tus which does not refpire, the right auricle and ventricle of the heart, and alfo the pulmonary artery, are much greater in proportion than in an adult, which feems neceffary to referve and retard the blood.

Is the rednefs of the blood produced by the air? This feems alfo to be contradicted by the well known fact obferved in frogs, that the rednefs of their blood is in proportion to the quantity of food they ufe. Befides, we have before fhewn that the air does not come into immediate contact with the blood in the lungs. We cannot, however, deny that, when the air comes into immediate contact with the blood, its rednefs is increafed, and its colour becomes again pale when the air is excluded. It feems probable, from analogy, that, as light produces colour in vegetables, fome fubtle principle, imbibed by the blood from the air received into the lungs, may be the caufe of its red colour.

Does blood, by means of the lungs, abforb nitre from the air? or is the florid colour, obfervable in the furface of a cake of blood, owing to the abforption of nitre from the air, while the bottom parts are of a dark and blackifh colour? If any thing be abforbed, is it a prefervative againft the putrefaction of the animal? Dr Haller fhews the abfurdities of thefe fuppofitions, by chemical reafoning and experiment. What he advances would have been acknowledged as a complete refutation of the doctrine, according to the received fyftem of chemiftry at the time he wrote. But, laying all chemical reafoning afide, the opinion will be found to be altogether unfupportable, by attending to the following fact, with which, indeed, Dr Haller clofes his refutation. No nitrous falt is difcovered in the blood.

If it be afked, Why tortoifes, frogs, lizards, fnails, and feveral infects, live long without air? we anfwer, That in them the lungs are given, not fo much for the preparation of the blood, as for the ufe of fwimming: And from hence

hence it is that their lungs, which receive only a ſmall quantity of blood, are immediately joined with the vena cava and aorta. But inſects, we know, draw the air in, and exhale it again, through pores in the ſkin If it be aſked, Why all animals periſh in air that is not renewed ? we anſwer, Becauſe the air which has once entered the lungs, and been contaminated by watery alkaleſcent vapours, is rendered leſs elaſtic, and conſequently unfit for reſpiration : 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 denſer than the atmoſphere in its uſual ſtate ; for in that caſe there is a greater proportion of the elaſtic element, which takes up a longer time to corrupt. Even in other caſes, confined air is rendered deſtructive only by ſtagnation, and filling it with vapours. The reaſon why animals ſwell in an exhauſted receiver is, from the extrication of the unelaſtic air lodged in the blood and other juices.

Reſpiration ſeems ſomehow to agree with the pulſation of the heart, there being ordinarily three or four pulſes to one reſpiration. And, if a greater quantity of 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, after exerciſe, or any conſiderable motion, which increaſes the return of the blood to the heart. If the blood meets with a reſiſtance in the lungs, ſo that it cannot paſs freely from the right into the left ventricle of the heart ; then the reſpiration is increaſed, both in quickneſs and magnitude, in order to forward its courſe: And this is the cauſe of ſighing, yawning, and panting ; of which the firſt is a deep inſpiration ; the ſecond a ſlow and very great one ; and the third, a frequent and imperfect one. The number of reſpirations, however, does not always increaſe with the

pulſe,

pulſe, as we ſee 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. Its quantity, adheſion, or acrimony, therefore, excite a cough; which operation, cauſed by an irritation of the organs of reſpiration, is performed by alternate large inſpirations, ſucceeded by large and quick exſpirations, together with ſudden ſhocks of the abdominal muſcles; and by theſe means 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 alſo in its action, which is one large inſpiration ſucceeded by ſeveral imperfect quick exſpirations through the contracted glottis, the lungs being never totally evacuated of air. Hence laughter, in a moderate degree, conduces to health; becauſe, inſtead 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, and 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 it 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; it evacuates with great violence any acrid or other ſubſtance irritating the noſtrils.

The

The ſecondary uſes of reſpiration are very numerous. It abſorbs from the blood ſome noxious particles which might perhaps ſuffocate, if they were ſuffered to remain. Thus, the breath of many people, ſhut up in a cloſe place, impregnates the air with a ſuffocating quality. And the blood abſorbs from the air a thin vapour, of which the uſe is perhaps not yet ſufficiently known.

"Among the various uſes of reſpiration, (ſays Wriſberg), all of which, indeed, are of conſiderable conſequence, we may eſteem as a principal one, the abſorption of ſome parts of the atmoſphere more peculiarly adapted to the ſupport of life. The lungs perhaps ſeparate, in conſequence of their peculiar ſtructure, this vivifying principle from the other conſtituent elements of the atmoſphere, and, through proper veſſels, convey it, thus ſeparated, into the circulating maſs.

"This ſubſtance has not as yet received any proper name *, nor do we ſufficiently know its nature and properties. The denomination *pabulum vitae*, given to it by the celebrated Ray, ſeems to accord tolerably well with its nature; for, when it was exhauſted from the air by animals breathing in cloſe veſſels, ſuch animals inevitably died, unleſs a freſh quantity of atmoſpheric air was introduced into the veſſel. The name of *electric principle* ſeems more fitly adapted to the ſubſtance. By the obſervations of Gilbert, Guerick, Boyle, the Florentine academicians, Hawkſbee, Du Fay, Muſchenbroeck, Watſon, Ludolph, Winckler, Nollet, Franklin, Hartman, Prieſtley, and ſeveral others, both on the electricity of bodies in general, as well as of the atmoſphere in particular, our knowledge of it has been much increaſed; and, by the experiments of Wilſon, Volta, Wilkens, Gallitzin, Lichtenberg, and others, it may ſafely be aſſerted that the electric matter of

* Subſequent phyſiologiſts have at length aſcertained the true nature of this ſubſtance; and the French philoſophers have very appoſitely called it *vital air*. It was known to the Engliſh philoſophers by the name *dephlogiſticated air*.

of the air is collected in the moſt ſimple manner by almoſt every body. From all theſe 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 by proper machines, exhibits electric ſparks; but, when collected in the clouds, breaks forth in thunder and lightning.

" 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, and our ſtrength grows languid; but they are quickly renewed after a thunder ſtorm, the equilibrium of the electric matter in the atmoſphere being reſtored, as it were, by the flaſhes of lightning.

" 3. Perhaps we may at length arrive at the knowledge of ſome artificial means by which we may be able to ſupply this defect of electricity in the atmoſphere. A farther inveſtigation of this ſubject may perhaps be not altogether uſeleſs.

" 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 the number, condition, and the 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. As ſufficient obſervations on this new ſubject have not yet been made, it is difficult to determine what uſe this ſubſtance ſerves in animal bodies, and what functions depend upon it. Is the tone and irritability of the fibres of the body principally ſupported by it? Do the cauſes of animal heat proceed from it? The animal electricity, which is very conſpicuous in cats, horſes, and alſo in men, by the numerous ſparks ſeen to iſſue from their bodies, probably proceeds proceed from the electricity abſorbed by the lungs from the air. This is perhaps the cauſe of the greater danger to which ſome men are liable of being ſtruck with thunder than others. The ſpontaneous burning of ſome natural bodies, is undoubtedly to be aſcribed to the ſame cauſe; and the alacrity and vigour of ſome temperaments are wonderfully increaſed by the preſence of this fluid. May this ſubſtance be joined with the acidum pingue and inflammable principle *?

Some of the ſecondary uſes of reſpiration are to compreſs the abdominal viſcera, ſo that the ſtomach, inteſtines, gall-bladder, receptacle of the chyle, bladder, inteſtinum rectum, and the womb itſelf, may diſcharge their contents; that the aliments may be triturated or diſſolved, and the blood urged through the ſluggiſh veſſels of the liver, ſpleen, and meſentery. Reſpiration 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. Moreover, inſpiration ſerves to convey odours along with the air to the organ of ſmelling; and is alſo the principal means by which a new born infant is enabled to perform the operation of ſucking.

§ 11. *Oeſophagus.*

Situation and figure. The oeſophagus 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 vertebrae 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,

* This doctrine of Dr Wriſberg's is extremely hypothetical.

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 oeſophagus 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 oeſophagus 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 papillae. It is folded lengthwiſe like the third coat; ſo that the oeſophagus, when cut acroſs, repreſents one tube within another. Through the pores of this coat a viſcid lymph is continually diſcharged.

The upper end of the oeſophagus is ſupplied with arteries from the laryngeae inferiores; farther down it has branches from

from thoſe which ſupply the pericardium; the reſt of it is ſupplied by the arteriae bronchiales. The veins go into the ſuperior laryngeals, to the top of the ſuperior vena cava, to the vena azygos and bronchial veins.

The nerves are chiefly from the eighth pair; but ſome ſmall branches come from the great ſympathetics.

§ 12. *Ductus Thoracicus.*

This duct, and its ſituation in the thorax, is deſcribed in Volume Third, along with the lymphatic ſyſtem.

CHAP.

CHAP. III.

OF THE ABDOMEN.

THE whole fore part of the abdomen forms an oblong convexity like an oval vault, more or lefs prominent in the natural ftate, in proportion to the quantity of fat upon it, and the food contained in it, or to the different degrees of pregnancy in women. The hypogaftric and umbilical regions are more fubject to thefe varieties than the epigaftric.

On the fides, between the hypochondria and os ilium, the abdomen is generally a little contracted; and backward, about the middle of the regio lumbaris, it is gently depreffed, forming a kind of tranfverfe cavity, anfwering to the natural incurvation of the lumbar portion of the fpina dorfi.

This anterior convexity, and pofterior cavity, change as we fit, ftand, kneel, lie at our full length, or with the thighs bent; and thefe variations depend on the particular fituation of the offa innominata in thefe different poftures.

In ftanding, the convexity of the belly, and cavity of the loins, are more confiderable than in moft other fituations; for then the lower extremity of the os facrum is turned very far back, and confequently the os pubis very much down. In this fituation of the pelvis, the inteftines fall naturally forward, and thus increafe the convexity of the abdomen; and, as the vertebrae of the loins are very much bent at the fame time, the cavity in that place muft likewife be very confiderable.

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 abdominal muſcles; which is ſo uneaſy to ſome perſons, as to cauſe fainting.

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 condyloid 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 ſkin on the anterior portion of the abdomen is thinner and more compact than the poſterior, and it has likewiſe the peculiar property of being capable of receiving a conſiderable increaſe in breadth, and ſometimes in a very extraordinary manner, without loſing any 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,

ner, as we difcover by diffecting the fkin from the mufcles; for then there appears on the inner furface of the membrana adipofa a longitudinal line like a kind of raphe, produced by the meeting of the cellular rows, which form angles fucceffively, one above another, oppofite to the linea alba of the abdomen. The cells in thefe rows are more oblong than the reft, and in a manner oval, or like a grain of wheat.

Cavity of the abdomen. The appendix enfiformis of the fternum, the cartilaginous portions of the laft pair of true ribs, thofe of the firft four pairs of falfe ribs, all the fifth pair, the five lumbar vertebrae, the offa innominata, the os facrum, and os coccygis, form the bony fides of the cavity of the abdomen.

The *diaphragm*, the *mufculi abdominis*, the *quadrati lumborum*, *pfoai*, *iliaci*, the *mufcles of the coccyx*, and of the *inteftinum rectum*, form the chief part of the furface of this cavity; and its whole inner furface is lined by a membranous expanfion, termed *peritonaeum*, all thefe parts being covered by the integuments already mentioned. As additional or auxiliary parts, we might likewife add fome portions of the facro lumbares, longiffimi dorfi, vertebrales, glutaei, &c.

The cavity of the abdomen is of an irregularly oval figure, but ftill fymmetrical. On the forefide it is uniformly arched or oval, and its greateft capacity is even with the naval and neareft part of the hypogaftrium. On the upper fide it is bounded by a portion of a vault, very much inclined. On the back-fide it is in a manner divided into two cavities by the jetting out of the vertebrae of the loins. On the lower fide 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 ifchium, terminating in the void fpace between thefe three parts.

§ 1.

§ 1. *Peritonaeum.*

Having carefully removed the muſcles of the abdomen, the firſt thing we diſcover is a very conſiderable membranous covering, which adheres immediately to the inner ſurface of the muſculi tranſverſi, and of all the other parts of this cavity, and involves and inveſts all the viſcera, as in a kind of bag. This membrane is named *peritonaeum*, from a Greek word, which ſignifies to be ſpread around.

The peritonaeum, in general, is a membrane of a 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 laminae. But, properly ſpeaking, the internal portion alone deſerves the name of a *membranous lamina*, as being the main body of the peritonaeum. The external portion may properly enough be termed the *cellular ſubſtance of the peritonaeum.*

The inner ſubſtance of the peritonaeum 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 peritonaeum 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 no proof of the glands, which ſome anatomiſts place there in the natural ſtate.

The cellular ſubſtance, or external portion of the peritonaeum, 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 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 laminae, which, in diſeaſed ſubjects, becomes 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 peritonaeum.*

Beſides theſe differences in thickneſs, the cellular ſubſtance has ſeveral elongations, which have been called *productions of the peritonaeum.* Two of theſe productions accompany and inveſt the ſpermatic ropes in males, and the vaſcular ropes, commonly called the *round ligaments*, in women. Two other 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 peritonaeum, 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

The great blood veſſels, that is, the aorta and vena cava, are likewiſe involved in this cellular ſubſtance of the peritonaeum. In a word, it involves immediately and ſeparately, all the parts and organs which are commonly ſaid to lie in the duplicature of the peritonaeum.

The true lamina, or membranous portion of the peritonaeum, 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 peritonaeum 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 peritonaeum, ſome are ſimply folded like a duplicature; others are expanded like inverted bags, or ſacculi, to contain ſome viſcus; others begin by a ſimple duplicature, and are afterwards expanded into a cavity which contains ſome organ; others are alternately extended in the form of ſimple duplicatures and of cavities; and, laſtly, others form only a ſmall eminence on the inner ſurface of the great cavity of the peritonaeum.

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 meſentry; the fourth in the meſocolon; and the fifth at the kidneys and ureters.

Befides the external productions of the cellular fuftance of the peritonaeum, it has the fame number of internal elongations with the true lamina, which lie between all the duplicatures, and line the infides of all the cavities, or that fide next the vifcera contained in them.

The veffels and nerves of the peritonaeum are from thofe that fupply the neighbouring parts. The arteries come from the mammariae internae, the intercoftales inferiores, the lumbares, the arteriae facrae, the ilio lumbares, the epigaftricae, the fmall anterior iliacs, the inferior diaphragmatics, and from the veffels which fupply the abdominal vifcera. The veins correfponding with thefe arteries have the fame courfe and bear the fame names. The nerves of this membrane are few in number, and fmall: They come from the great intercoftals, from the lumbars and facrals.

The ufes of the peritonaeum, in general, feem to be very evident from the defcription which has been given of it: The chief of thefe ufes are, to line the cavity of the abdomen, to inveft the vifcera contained in that cavity as in a common bag, to fupply them with particular coats, and to form productions, ligaments, connections, folds, vaginae, &c. as we fhall fee hereafter.

The fine fluid which tranfudes through the whole internal furface of the peritonaeum prevents the inconveniencies which might arife from the continual frictions and motions to which the vifcera of the abdomen are expofed, either naturally or by external impulfes.

We muft here obferve, that it is the common cuftom to demonftrate four ligamentary ropes, termed the *umbilical veffels*, before the peritonaeum is opened, becaufe they adhere to the umbilicus; three of them are really veffels in the foetus, viz. two umbilical arteries and one vein. We are in a manner obliged to fubmit to this cuftom in public anatomical demonftrations, where we have but one fubject for the whole;

whole; but as we are here under no fuch neceffity; we refer the defcription of thefe ligaments to other more proper places of this work. The venal ligament fhall be defcribed in the hiftory of the liver; and the two arterial ligaments, together with the urachus, which is the fourth, in the hiftory of the bladder.

It is fufficient to obferve here in general, that three of thefe umbilical ropes or ligaments are involved feparately, and fuftained by a production or duplicature, which the peritonaeum fends into the cavity of the abdomen in form of a falx.

§ 2. *Ventriculus.*

Situation and figure of the ftomach. The ftomach is a great bag or refervoir, fituated partly in the left hypochondrium, and partly in the epigaftrium.

The figure of the ftomach is like that of a bag of a bag-pipe; that is, it is oblong, incurvated, large, and capacious, at one end, and fmall and contracted at the other. We fee this figure moft evidently when the ftomach is moderately filled with air, or with any other fluid.

The curvature of the ftomach gives us occafion to diftinguifh two arches in it; one large, which runs along the greateft convexity; and one fmall, directly oppofite to the former. Thefe arches are named the *great* and *fmall* curvatures of the ftomach; and by the fides of the ftomach, we underftand the two lateral portions which lie between the two arches.

The ftomach has two extremities, one large and one fmall. It has two openings, called the *orifices of the ftomach;* one between the great extremity and the fmall curvature, the other at the end of the fmall or contracted extremity. The firft

opening

opening is a continuation of the oesophagus; the other joins the inteftinal canal, and is called by the name of *pylorus*.

The ftomach is not fituated in the left hypochondrium and epigaftric region, in the manner reprefented in moft of the figures. It lies tranfverfely, obliquely, and almoft laterally; in fuch a manner as that the great extremity, and the orifice next it, are on the left fide; and the fmall extremity, with its orifice, or the pylorus, on the right fide, and lower and more inclined than the former: Therefore we ought, with the antient anatomifts, to call one of thefe orifices *fuperior*, the other *inferior*.

The great extremity of the ftomach is in the left hypochondrium, and for the moft part immediately under the diaphragm: Yet the fuperior orifice is not in the left hypochondrium, but almoft oppofite to, and very near the middle of, the bodies of the loweft vertebrae of the back.

The fmall extremity of the ftomach does not reach to the right hypochondrium. It bends obliquely backwards toward the upper orifice; fo that the pylorus lies about two fingers breadth from the body of the vertebrae immediately under the fmall portion of the liver; and confequently lower down, and more forward, than the other orifice by almoft the fame diftance. This extremity of the ftomach has fometimes a particular dilatation on the fide next the great curvature.

According to this natural fituation, the ftomach, efpecially when full, is fituated with its great curvature forward and a little downward, and its fmall curvature backward and a little upward.

One of the lateral convex fides is turned upward, the other downward; and not forward and backward, as they appear in dead bodies, where the inteftines do not fupport them in their natural fituation.

If we divide the ftomach along the two curvatures into two equal parts, we fhall fee that the two orifices do not both adhere

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 oeſophagus, 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 oeſophagus, 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 *tunicae* or *coats*. Theſe coats are commonly 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 peritonaeum. 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

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 areolae 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 ſurround this orifice in oppoſite directions, and interſect each other where they meet on the two lateral ſides.

Along the middle of each lateral ſide of the ſmall extremity, there runs a tendinous or ligamentary flat portion, above a quarter of an inch in breadth, which terminates in the pylorus. Theſe two portions lie between the common and muſcular coats, and adhere very ſtrongly to the firſt.

Between the two ſame coats, there is a cellular ſubſtance which adheres very cloſely to the external coat, and inſinuates itſelf between the fleſhy fibres of the ſecond, all the way to the third, as may be perceived by blowing it up. Some make it a diſtinct coat, and call it *tunica celluloſa*; but it is no more than the cellular portion of the membranous coat, like the cellular portion of the peritonaeum.

The third coat, commonly called *tunica nervoſa*, but properly *tunica celluloſa*, is compoſed of capillary veſſels and nerves, with a very large proportion of cellular ſubſtance.

On

On the concave ſide, it ſeems to be of a very looſe ſpongy or filamentary texture, reſembling fine cotton, as may be ſeen by macerating it a little in clear water, which ſwells it conſiderably in a very ſhort ſpace of time. It is ſupported by a kind of ground-work of a very fine ligamentary or aponeurotic filaments which interſect each other obliquely, much in the ſame manner as the third coat of the inteſtines; of which hereafter; and it adheres to the convex ſide of the villous coat.

The fourth coat of the ſtomach has been termed by Fallopius *tunica villoſa*, becauſe, when it ſwims in clear water, ſomething is ſeen in it like the pile of velvet. The antients called it *tunica fungoſa;* and perhaps this name agrees beſt with its true ſtructure.

Theſe two coats are of a larger extent than the two former, and they join in forming large rugae on the 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 rugae are in a manner radiated, and ſeem to be a continuation of the plicae or folds of the oeſophagus; only they are thicker; and where theſe rugae and plicae meet, they form a ſort of crown, which diſtinguiſhes the ſuperior orifice of the ſtomach from the inferior extremity of the oeſophagus.

In the interſtices of theſe rugae 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

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-epiploica dextra, which ariſes from the arteria hepatica, and runs along the great curvature; arteria gaſtro-epiploica ſiniſtra and vaſa brevia, which ariſe from the arteria ſplenica, and run along the left end of the great curvature.

Theſe

Thefe two arterial arches fend a great number of branches towards each other on both fides of the ftomach; and thefe branches are gradually ramified in different directions, by very different divifions and fub-divifions; the greateft part of which communicate with thofe from the other artery.

From thefe frequent ramifications and communications of the arterial arches of the ftomach, two different reticular textures arife; one, which is the largeft, lies between the common and mufcular coats in the cellular fubftances found there; the other, which is very fine, lies on the furface of the tunica nervofa. This latter is a production of the firft, being formed by means of a great number of very fhort rami, which go out from the other, and pafs through the fmall interftices between the fibres of the mufcular coat.

By artificial injections we can fhew a third extremely fine reticular texture of capillary veffels, which run between the glandular bodies and papillae of the tunica villofa. Thefe do not feem, in their natural ftate, to be purely blood veffels, as inflammations and injections may incline us to think

The arteries of the ftomach come originally from the caeliaca, by means of the hepatica, fplenica, and coronaria. The pylorica and mefenterica fuperior likewife contribute to them by communications, more or lefs immediate. They communicate alfo with the mammariae internae, and diaphragmaticae, and, by means of the epigaftrica finiftra, with the mefenterica inferior.

Veins of the ftomach. The veins of the ftomach are ramifications of the vena portae in general; and in particular of the meferaica major, fplenica, and mefenterica inferior; the diftribution of which may be feen in the defcription of the veins. They accompany the arteries more or lefs, and form nearly the fame kinds of arches and reticular textures; with this difference, that they are proportionally greater, their re-

 ticular

ticular areolae 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 oeſophagus, 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 through the canal of the oeſophagus: 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

but very weak, and nowife fufficient for digeftion, without the affiftance of the alternate motions of the diaphragm and mufcles of the abdomen.

The pylorus, or flefhy circle of the inferior orifice of the ftomach, ferves to retain the aliments in it till they have acquired a fufficient degree of fluidity to pafs eafily through that opening. But by a particular irritation of the mufcular coat of the ftomach, and ftill more by a violent contraction of the diaphragm and mufcles of the abdomen, the contents of the ftomach may be very foon forced towards the fmall extremity, and pufhed through the pylorus.

The gentle and alternate motions of the orbicular fibres of the mufcular coat may affift in fending through the pylorus, in the natural way, the aliment that is fufficiently digefted. This was called the *periftaltic* or *vermicular motion*, by thofe who believed that it is fucceffively reiterated, like that of earth-worms when they creep.

Trituration might be a proper enough term for this operation, provided it be made to fignify only a gentle agitation or action of the flefhy fibres in a fubftance continually moiftened by the gaftric liquor, and not a violent grinding of a dry fubftance.

The fituation of the ftomach, which is nearly tranfverfe, is likewife of ufe in making the aliment remain long enough in that cavity; and may ferve to make the length of this ftay, in fome meafure, arbitrary, by means of the different poftures of the body; for, when we lie on the left fide, the aliment muft remain longer than when we lie on the right, &c.

The obliquity of the ftomach may ferve to clear up a difficulty that very much torments thofe who believe that both orifices of the ftomach lie on the fame level; which is, how any heavy fubftance, once got into the ftomach, can ever rife again to this level, to pafs into the inteftines.

§ 3.

§ 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 the whole extent to membranous productions or continuations of the peritonaeum, 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 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, *caecum, 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 peritonaeum.

This

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 cellulofa*.

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 of 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

The nervous coat fends off from its inner furface a great number of portions or fepta, more or lefs circular, which contribute to the formation of what are called *valvulae conniventes;* of which hereafter. It likewife feems to fuftain feveral different glandular bodies, which we difcover in the cavity of the inteftines.

The fourth or innermoft coat is very foft, and is named *tunica villofa.* It has the fame extent with the third coat, which fupports it; and it lines all the fepta of that third coat; but it is not uniform through the whole canal, as we fhall fhew in the particular defcription.

It is now generally believed that the fourth coat is a continuation of that in the ftomach, and, of confequence, from the epidermis.

Inteftina tenuia. The fmall inteftines form one continued uniform canal; and, although three portions of it have three different names, yet we have no fufficient marks whereby to diftinguifh them, to fix the precife extent or length of each portion, or to fettle its juft limits.

The firft and fmalleft portion of the whole canal is called *duodenum;* the fecond, which is much longer, *jejunum;* and the third, which is ftill longer than the fecond, *ileum.*

§ 4. *Inteftinum Duodenum.*

The firft portion of the fmall intenftines was called *duodenum,* from the length afcribed to it by the antients, viz. the breadth of twelve fingers; and the moderns need not cavil much about this length, if it is meafured with the ends of the fingers of the fubject.

This inteftine having arifen from the pylorus, is immediately bent a little backward and obliquely downward; then it bends a fecond time toward the right kidney, to which it is a little connected; and from thence paffes before the renal artery

artery and vein, afcending infenfibly from right to left, till it gets before the aorta, and laft vertebrae of the back. It continues its courfe obliquely forward by a gentle turn, which may be reckoned a third incurvation, and alfo the extremity of the duodenum.

Through this whole courfe the duodenum is firmly bound down by the folds of the peritonaeum, efpecially by a tranfverfe duplicature which gives origin to the mefocolon. The two lamina of this duplicature being at firft feparate, and foon afterward uniting, muft leave a triangular fpace between them, which is lined with a cellular fubftance.

It is in this fpace that the duodenum adheres, by means of the cellular fubftance, to the parts already named; and the inteftine is contained therein, as in a cafe; fo that, without diffection, we can fee nothing but its two extremities; and even thefe are hid by the colon, and by the firft convolutions of the jejunum.

Structure of the duodenum. The firft coat of the duodenum is confequently different from that of the other fmall inteftines, having this peculiar to it, that it does not inveft the whole circumference of the inteftine; becaufe, through the greateft part of the length, it lies in the triangular fpace already mentioned; and, for the fame reafon, there is a greater quantity of cellular fubftance belongs to the outer coat of the duodenum than to that of the other inteftines.

The mufcular coat of the duodenum is thicker than in the jejunum and ileum.

The tunica nervofa and villofa form conjointly, on the infides of this inteftine, a great number of fmall duplicatures, which advance into the cavity more or lefs directly, like portions of circular planes, with one edge fixed to the inteftine, and the other loofe. Thefe are what anatomifts call *valvulae conniventes.*

The

The loofe or floating edge of thefe valves is formed into fmall gathers or waves in the natural ftate. The whole furface of thefe duplicatures or valves is villous, as well as that of the inteftines between them.

The villi of this inteftine are thicker than in the ftomach; but the texture of them in man is not like hairs, as they are commonly reprefented in figures, but rather like that of a fungous granulated fubftance, compofed of an infinite number of very fine papillae of different figures; in which we fee, through a microfcope, a multitude of depreffed points or pores, by which their whole furface feems to be pierced.

By the fame help we obferve, on different places of the inner furface of this inteftine, feveral round villous tubercles, rifing like fmall verrucae at different diftances from each other.

This fubftance fuftains an infinite number of capillary veffels of different kinds; for, befides the blood-veffels, we fometimes obferve a great number of white filaments which run through it, and end at its inner furface like fo many capillary roots of the veffels called *venae lacteae*. When the villous fubftance is examined in the microfcope, befides the blood-veffels, numerous follicles are obferved lodged in cellular fubftance. Thefe have been confidered as the origin of the lacteal veffels, and have been called *ampullulae of Leiberkuhn*, becaufe he firft difcovered them.

The fungous fubftance which bind thefe capillary filaments together, and furrounds them, is very tender; and the capillary extremities of the fmall blood-veffels diftributed through it, feem to be turned toward the pores of the papillae. Through thefe pores a mucous fluid, more or lefs tranfparent, is difcharged, which continually moiftens the cavity of the inteftine.

Glands of the duodenum. The internal furface of the duodenum is furnifhed with a great number of fmall flat glan-

dular

dular tubercles, named after Brunner, which are raifed on the fides, and depreffed in the middle by a kind of foffula; and they are more numerous near the beginning of this inteftine than any where elfe. About the pylorus they lie as it were in heaps or clufters; and from thence the diftance between them increafes gradually all the way to the other extremity where they are fingle.

Thefe glands, when examined carefully, appear like little bladders, with the orifices turned towards the cavity of the inteftine, and the bodies fixed in the fpongy fubftance next the nervous coat. They furnifh a particular fluid, which is often found to be vifcid.

The biliary orifice of the duodenum. In the inner furface of the duodenum, almoft at the lower part of the firft incurvation, and on the fhorteft fide, there is a longitudinal eminence, in the point or apex of which lies a particular opening, which is the orifice of the ductus biliarius, within which the ductus pancreaticus likewife opens.

This inteftine is commonly the wideft, though the fhorteft, of the inteftina tenuia, and has been called by fome authors *ventriculus fuccenturiatus;* and is invefted with more cellular fubftance, efpecially while within its triangular cafe, where it wants the outer coat which the others have; and confequently it is more eafily dilatable by the fubftances which might otherwife ftick within it.

§ 5. *Inteftinum Jejunum.*

Situation and fize of the jejunum. The jejunum, fo called becaufe it is oftener found empty than the ileum. begins at the laft incurvation of the duodenum, and is there connected to the beginning of the mefocolon.

From thence it bends downward from left to right, and obliquely forward, or from the vertebrae, and makes feveral 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 difficult matter to fix the exact bounds between this inteſtine and the ileum. The external marks of a redder colour in the one than the other, though generally common, are not conſtant; and the internal marks fixed from the plurality of valvulae conniventes are indeterminate, and oftentimes appear only from diſſection.

Theſe two inteſtines may be better diſtinguiſhed by their different ſituations, which are very 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 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

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 valvulae 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 papillae of the tunica villosa are here more raised, 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 nearly agree 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 papillae, and the whole tunica reticularis, very justly.

The glandular lacunae of the jejunum are of the same structure with the glandulae 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

near the great curvature, and they crofs through feveral valvulae conniventes at once.

The veffels, nerves, connections, &c. muft be referred till the mefentery has been defcribed.

§ 6. *Inteftinum Ileum.*

Situation of the ileum. The convolutions of this inteftine furround thofe of the jejunum on the two lateral and lower fides, and it paffes in a winding courfe from the left fide, by the hypogaftrium, to the right fide, where it terminates a little below the right kidney, joining the inteftina craffa, in the manner that we fhall relate hereafter. The lateral convolutions are fupported by the offa ilium, fo called, not from this inteftine, but from the region of the abdomen termed *ilia.*

Structure of the ileum. The ftructure of the ileum is much the fame with that of the jejunum; only the internal duplicatures, or valvulae conniventes, decreafe gradually both in number and fize. Near the extremity of the ileum their direction is changed; and, inftead of being tranfverfe or circular, they become longitudinal, and terminate in a kind of pylorus, which advances into the cavity of the great inteftines, as we fhall fee prefently.

We obferve likewife in this inteftine, as in the jejunum, fingle or folitary glands or lacunae, and alfo reticular glands, or glands in clufters; the laft of which, at the extremity of this inteftine, are often of a large extent: But the greateft part of thefe glands appear to be flatter here than in the jejunum. The cellular fubftance of the external coat is in lefs quantities than in the foregoing inteftines; and the ileum appears commonly more pale, or not fo red as the jejunum.

Sometimes, though rarely, we meet with proceffes fent off from the jejunum or ileum, and of the fame ftructure with thefe inteftines. Their form, being fimilar to that of the finger of 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 herniae.

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 ſacculus or bag, which is reckoned the firſt of the three portions, and called *caecum*. 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, 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 caecum. The inteſtinum caecum 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 caecum lies an appendix, reſembling a ſmall inteſtine, nearly

of

of the ſame length with the caecum, 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 caecum; 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 lacunae, which continually diſcharge a fluid into its cavity.

It has often been diſputed whether this appendix, or the large portion, which is, as it were, the head of the colon, ought to be called the *caecum*; 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 caecum, 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 caecum 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 caecum to be ligamentary, they are made up anteriorly of fleſhy fibres which accompany and ſtrengthen the longitudinal fibres of the muſcular coat.

The

The villous ſubſtance of the inner coat of the caecum is very ſhort, and furniſhed in ſeveral places with glandular lacunae or ſolitary glands, broader than thoſe of the ſmall inteſtines.

Theſe glandular lacunae or folliculi are flattened and depreſſed in the middle like ſmall pox. When we blow through a pipe into theſe lacunae without touching them, the folliculi are inflated, and repreſent little cups 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 caecum, of which it is a continuation, it reaches, in form of an arch, above the 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 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, and of the ſame ſtructure with, thoſe of the caecum. 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 it 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 fraena between which this inteſtine is, through its whole length, alternately depreſſed into tranſverſe folds, and raiſed

raiſed into conſiderable eminences. All the folds are duplicatures, which form portions of valvulae 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 rugae; and therefore, if theſe bands alone are cut acroſs, the inteſtine is not ſufficiently elongated 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 caecum; only the glandular lacunae 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; it then turn backward under the ſpleen, in the left hypochondrium; it runs down on the foreſide of the left kidney, to which

which it is connected; below this kidney, it turns toward the vertebrae, 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 adipoſae*, which we ſhall afterwards explain, as alſo the connections of the colon with the meſocolon and omentum.

Valvula coli At the place where the caecum 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 *caecum*, or of the *colon*. Some have named it after Bauhin, who was ſaid to have diſcovered it accidentally in 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 deſcribed it ſeveral years before this. It is a little open in the middle, and its extremities are very thick, by the mutual duplicature of the coats of the caecum 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 caecum and colon.

This union forms a thick ring, which likewiſe advances into the common cavity of the caecum and colon, where it is wrinkled or formed into gathers, almoſt like the lower extremity of the oeſophagus, 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 caecum and colon, it forms two productions, which M. Morgagni calls the *retinacula valvulae Bauhini.*

The membranous coat of the extremity of the ileum is continued on the caecum 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 caecum 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 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 caecum 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 ſide 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 already mentioned; but it is often a little more inclined toward the caecum 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 caecum 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

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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 caecum.

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 peritonaeum, 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 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

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 faeces, 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 adipoſae 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 ſeem to be owing.

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 rugae in its cavity, which diſappear in proportion as that cavity is filled.

The innermoſt coat is very improperly termed *villoſa*, and ſcarcely 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 conſiſtencies, diſcharged by theſe glands or folliculi, and perhaps by the corpuſcles alſo.

Near

Near the extremity of this inteftine the rugae or folds become in a manner longitudinal; and at laft, towards the circumference of the inner margin of the anus, they form little bags or femilunar lacunae, the openings of which are turned upward, toward the cavity of the inteftine. Thefe lacunae are fomething like thofe of the lower extremity of the oefophagus, or upper orifice of the ftomach.

Mufcles of the anus. At length the extremity of the rectum contracts, and terminates by a narrow orifice called the *anus*, the fides of which are difpofed in clofe folds or gathers.

This extremity of the inteftine has feveral mufcles belonging to it, fome of which furround it like fphincters; the reft are broad flefhy planes inferted in it, and which, being likewife fixed to other parts, fuftain it in its natural fituation, and reftore it to that fituation after being difturbed by the force neceffary for the exclufion of the faeces. Thefe latter mufcles are termed *levatores ani;* the firft go by the general name of *fphincters*. See defcription of Mufcles in Vol. I.

§ 10. *Mefenterium et Mefocolon.*

Divifion of the Mefentery, &c. This great bundle of inteftines is not left to move at random in the cavity of the abdomen; but artfully bound down by a membranous web, which prevents the inteftinal convolutions from being intangled in each other, and from being twifted or compreffed in all their different ways of meeting; and yet allows them a gentle floating, but limited motion.

This web goes ftill by the antient Greek name of *mefentery*, as being in fome meafure in the middle of the inteftines. It is diftinguifhed into two portions; one of which being very broad, and very much plaited, connects the fmall inteftines; the other, which is long and incurvated, does the fame office to the great inteftines.

Thefe

Thefe two portions are in reality only one and the fame continuation of the membranous lamina of the peritonaeum doubled back upon itfelf, and they are diftinguifhed only by their breadth. Taken both together, they form a kind of fpiral roll, more or lefs plaited in it's circumference. The firft portion has retained the name of *mefentery;* the other is termed *mefocolon.*

Structure of the mefentery, &c. The mefentery begins at the laft incurvation of the duodenum, and runs obliquely from left to right, along the vertebrae of the loins. In this fpace, the membranous portion of the peritonaeum is detached on both fides, produces a duplicature by two elongations or particular luminae applied to each other, and thus forms the mefentery.

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 inteftines is every where very much plaited. Thefe plaits or folds are only waving inflexions, fuch as may be obferved in the edge of a piece of fhamoy which has been often drawn through the fingers. They make this edge of the mefentery very long, and they run through about one third of its breadth.

The two laminae are joined together by a cellular fubftance, which contains glands, veffels, and nerves, that fhall be defcribed hereafter; and in fome fubjects it has a great quantity of fat, which keeps the two laminae at a good diftance from each other.

Along the whole circumference of the mefentery, the two laminae are naturally feparated, and applied to the two fides of the fmall inteftines, which they inveft by their union, or rather reciprocal continuation on the great curvature of that canal, and carry it as in a fcarf or fling. This is what forms the external or membranous coat of the inteftines.

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The mefocolon is the continuation of the mefentery; 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 fide, forms a fmall tranfverfe fold, called *ligamentum coli dextrum*.

Afterwards the mefocolon afcends toward the right kidney, where it feems to be loft by the immediate adhefion of the colon to that kidney, and to the firft incurvation of the duodenum. Then it appears again, and, increafing in breadth, it continues its courfe almoft tranfverfely under the liver, ftomach, and fpleen, where it begins to turn downward, under the left hypochondrium, toward the kidney on the fame fide.

Through this whole courfe the mefocolon extends in breadth, and forms nearly a tranfverfe femicircular 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 inteftine, which runs along its fmall curvature. By its fhort or fmall edge, it forms the triangular cafe of the duodenum; and, by its great edge, the external coat of the colon, in the fame manner as the mefentery does that of the fmall inteftines. As it paffes under the large extremity of the ftomach, 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 tranfverfe fold, called *ligamentum coli finiftrum*. Afterwards it expands again, but not fo much as in the upper part, and runs down on the left pfoas mufcle, toward the laft vertebra of the loins. This defcending portion is fixed to the convolutions of the colon, in the fame manner as the fuperior portion is to the arch of that inteftine.

The inteftinum rectum is likewife invefted by a particular production of the peritonaeum, called commonly by the name of of *meso-rectum*. This production is very narrow, and about the middle of the fore-side 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 laminae 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 *glandulae conglobatae*, 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 Malphigi 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 though, 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 an infinite number of small lymphatic vessels 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;

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 *venae lacteae*. 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 ramae of the vena portae, and the diſtribution and denomination thereof is much the ſame with that of the arteries; only they communicate more with each other than the arteries, and alſo with the great haemorrhoidal 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 haemorrhoidalis interna.

The principal ſubaltern trunks of theſe arteries and veins accompany each other through the cellular ſubſtance between the laminae 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, laminae, 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 venae lumbares and ſpermaticae.

The arteries of the caecum 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 two parts are ramifications of the great meſeraica; and one of theſe rami is by Riolan termed *vaena caecalis*.

The

The ftraight portion of the arch of the colon, or that which is an immediate continuation of the caecum, is fupplied with arteries by the fecond branch that comes from the concave fide of the mefenterica fuperior, and likewife a little by the third, when there is a third.

The fuperior or middle portion of the arch of the colon, is furnifhed by the firft branch from the fame fide of the mefenterica fuperior, 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 firft branch of the fame mefenterica, and partly from that of the mefenterica inferior; which two branches form the celebrated communication or common arch of the two mefentericae.

By means of this communication or continuation, in cafe one artery fhould be obftructed or compreffed, the other would furnifh blood to all the branches below the place of the obftruction. The fecond branch of the mefenterica inferior, gives likewife fmall arteries to the left extremity of the colon.

The defcending convolutions of the colon which reprefent a Roman S, are fupplied by the other branches of the mefenterica inferior, the laft of which forms the haemorrhoidalis interna.

The veins of all thefe portions of the colon form trunks which terminate chiefly in the haemorrhoidalis interna or mefaraica minor and major, and likewife in the vena portae ventralis. The diftribution of thefe branches and ramifications is in fome meafure the fame with that of the arteries, as may be feen in the defcription of the veins.

The arteries of the rectum are furnifhed by the haemorrhoidalis interna, the laft branch of the mefenterica inferior, which communicates with the hypogaftrica, and particularly with

with the haemorrhoidalis externa, a production of one of thefe arteries.

The veins of the rectum go to form the beginning of the meferaica minor or haemorrhoidalis interna; and they communicate with the haemorrhoidales externae, which are rami of one of the hypogaftricae. They communicate likewife with the capillary ramifications of the other hypogaftric veins, which come from the internal parts of generation of both fexes.

It is here to be obferved in general, that there is a fucceffive continuation, more or lefs fimple or multiplied, between all the arteries of the inteftinal canal, and likewife between all the veins; and alfo, 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 inteftines. The nerves of the duodenum are the middle plexus of the femilunar ganglion, and fome filaments of the plexus ftomachicus and hepaticus.

The nerves of the jejunum, ileum, and mefenteric glands, are the plexus mefentericus fuperior, the pofterior mefenteric fafciculi, and the plexus mefentericus inferior.

The nerves of the caecum are the pofterior mefenteric fafciculi or plexus, and the plexus mefentericus inferior.

The nerves of the arch of the colon are the fame fafciculi, and the two plexus mefenterici.

The nerves of the laft convolutions of the colon are the pofterior mefenteric fafciculi, and the plexus mefentericus inferior and fub-mefentericus.

The nerves of the rectum are the plexus mefentericus inferior, plexus fub-mefentericus or hypogaftricus, and the two ganglions of that plexus.

The nerves of the anus, and of its mufcles, are the ganglions of the plexus fub-mefentericus, the inferior rope of both

both ſympathetici maximi, and the common arch of the extremities of both ropes.

§ 12. *Digeſtion.*

WITHIN the human ſtomach we find great quantities of mucus, ſpread upon its villous coat, and not unfrequently tinged by ſome of the bile returning into the ſtomach. Beſides this mucus, we find, eſpecially in an empty ſtomach, a limpid humour, of the ſame nature with the ſaliva, but rather more mucous. When it can be had pure and unmixed with the food, (which it may, by bending the body forward when it returns through the oeſophagus into the mouth) it is by no means acid. Left to itſelf, when untainted with the acid illuvies of the aliments, it is changed into a lixivial nature, both in men and brutes, eſpecially in hungry animals. This liquor diſtils from the arteries of the ſtomach, through its villous coat, as we ſee by anatomical injections, by which water, iſinglaſs, and oil, may be eaſily urged into the veſſels of the ſtomach, ſo as to ſweat through its numerous pores.

The ſtomach being contained within the cavity of the abdomen which is always full, will be preſſed on every ſide by the diaphragm and abdominal muſcles; and the more it is filled the greater will this preſſure be, both on account of the diſtention of the integuments of the abdomen, and the altered ſituation of the ſtomach, which, when full, touches the peritonaeum at right angles.

Both the pain of hunger, and the pleaſure of gratifying the appetite, excite us to the performance of an action abſolutely neceſſary for our ſupport, viz. the taking a due portion of aliment in order to counterbalance the waſte of the body by the inſenſible perſpiration and other evacuations. This neceſſity of frequently taking food is increaſed by the blood, which being naturally of a ſaline quality, ſoon acquires an

acrimonious

acrimonious putrefcency, by the evaporation of its thin watery parts; and this evaporation being increafed by the heat of the body, and the motion of the heart and arteries, nature calls ftrenuoufly for a recruit of the watery element, by which the cohefive globules of the blood are feparated from each other, and hindered from running together into a folid mafs.

Thefe truths are proved, not only from their caufes, but likewife by the appearances which they exhibit in men and other animals ftarved to deat For, in fuch, we commonly obferve the breath fharp and fetid, the teeth loofened by the diffolving acrimony of the juices, violent pains in the ftomach, acute fevers, and even madnefs. All thefe diforders arife fooner and ftronger, as the perfon is more robuft and more accuftomed to exercife; but they enfue very flowly in phlegmatic people, who are unactive, perfpire little, and put the blood into no great motion. Laftly, thofe who have lived fome time without food and bodily exercife have, for the moft part, laboured under a difeafe of the nerves.

The frefh chyle, prepared, for the moft part, from acefcent vegetable food, is of a confiftence always thinner than that of the blood itfelf; being received into the circulation, it temperates the putrefcent acrimony, dilutes the threatened coagulation, and reduces the whole mafs to that moderate degree of faline nature which is natural to man: And finally, the chyle, but more efpecially that derived from animal food, and likewife what is formed of farinaceous vegetables, being replenifhed with gelatinous lymph, ferves to repair the confumption or wafte which is made from the body itfelf, to the vacuities of whofe broken folids it is applied by the caufes which promote the growth of the body. The drink dilutes the cohefive diathefis of the blood, hinders its putrefaction, and carries off by the emunctories fuch particles as are already putrid: And hence it is that

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, as was ſaid above, to take food, as well from the ſenſe of pain we call hunger, as from the pleaſure received by the taſte. The firſt of theſe proceeds doubtleſs from the folds or plicae of the ſtomach, whoſe ſenſation is extremely acute, rubbing againſt each other by the periſtaltic motion, and from a preſſure of the diaphragm and abdominal muſcles, by which the naked villi of the nerves on each ſide of the ſtomach are made to grate againſt thoſe of the other, producing, at the ſame time, an intolerable ſenſe of pain. 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. The gaſtric liquor, becoming acid from faſting, may alſo perhaps conduce to excite the ſenſe of hunger; but it will not produce any effect if it is putreſcent.

Thirſt is perceived by the tongue, fauces, oeſophagus, and ſtomach. For, whenever theſe very ſenſible parts, which are conſtantly and naturally moiſtened by mucous and ſalival juices, grow dry from a deficiency of theſe or ſimilar humours, or are irritated by a redundancy of muriatic or alkaleſcent ſalts, a ſenſe called thirſt, which is much more intolerable and dangerous than the former, ariſes; this diſagreeable ſenſation 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; and why ſimple water is leſs efficacious in abating thirſt than acid liquors, that not only moiſten and render fluid, but alſo,

by

by their mild irritation of the tongue and mouth, provoke forward the humours, and at the ſame time correct their putrid tendency.

Being under the neceſſity of ſeeking food for the ſupport of life, we have choſen it from a great variety of both animals and vegetables, adding to each of them certain portions of water and ſalt, either to aſſiſt their ſolution, or render them more ſapid. 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 us, and as the ſtrength or recruit of our faculties, from their uſe, 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 different kinds of food, ſo intermixed, that none of them may exceed their reaſonable bounds; and this mediocrity we are taught from the loathing which follows any one kind of food continued for too long a time together.

Animal food appears a neceſſary part of our nouriſhment, from the fabric of the human ſtomach reſembling that of carnivorous animals; and from teeth being inſerted into each jaw; from the ſmallneſs and ſhortneſs of the inteſtinum caecum;

cum; and from the neceſſary vigour which we require. Animal food alone contains the gelatinous lymph ready prepared for the recruit both of our fluids and ſolids; and this lymph, 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 diarrhoea. In the ſize and length of the inteſtina craſſa, man agrees with herbivorous animals.

Eſculent vegetables are generally of the aceſcent kind; ſome few of them however are alkaleſcent or aromatic. 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 proper juices. The uſe of vegetables is extremely neceſſary in order to prevent a too great quantity of blood, and to hinder its putreſcency. Too much animal food produces, as we ſee more particularly in Athropophagi, the hot alkaleſcent ſcurvy, a fierce or ſavage temper, a peculiar fetor, and leproſy, 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, and which is cold, clear, light, and inſipid. Whenever we are unprovided with ſuch pure water, as is frequently the caſe in low 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 with water. Liquors of the ſame kind, replete with a vinous or inflammable ſpirit, but more flatulent, heavy, and leſs palatable, are extracted by boiling water from grain of different kinds previouſly malted, and prepared by fermentation, as ſubſtitutes for wine in thoſe countries where the grape does not ripen.

Mankind have invented various pickles and ſauces, as ſalt, vinegar, and acids of various kinds, to correct the putreſcent diſpoſition of fleſh-meats; and pepper, and other hot ſpices, to ſtrengthen the action of the ſtomach, which is perpetually weakened by the uſe of vegetables: To theſe we may add ſugar, and the eaſtern ſpices, which are generally uſed 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 previous maſtication, which is particularly

neceſſary

neceſſary in man, whoſe ſtomach has but few and weak muſcles. Previous maſtication alſo aſſiſts digeſtion, and therefore prevents the food from ſtaying ſo long upon the ſtomach as to become putrid.

The meaſure of our food is determined by hunger, which is different in different circumſtances. 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 we are ſubjected to much labour.

Aliments of various kinds are received into the ſtomach, either whole or maſticated. Some of them are alkaleſcent, as animal ſubſtances; others ranceſcent, as fat; others aceſcent, as vegetables; and others glutinous, as milk, bread, and moſt of the farinaceous ſeeds. The aliments are digeſted in a heat nearly equal to that neceſſary for hatching an egg, produced by the circumjacent liver, ſpleen, and other viſcera. During digeſtion, the ſtomach is perfectly cloſed, both at its ſuperior, and inferior orifices; and, although the muſcular fibres of the ſtomach contract, yet no food is propelled into the inteſtines, until it has been thoroughly digeſted; even milk itſelf is often retained in the ſtomach of ſtrong animals ſeveral hours after a meal, without paſſing into the inteſtines. The aliments, either naturally containing air in themſelves, or mixed with air in maſtication, are macerated in the juices of the ſtomach. In conſequence of the heat, this included air is expanded, and by an operation ſomewhat ſimilar to fermentation, breaks the cells in which it was included, and thus the contents of the ſtomach are reduced to a pulpy ſtate. The ſolidity of animal ſubſtances is occaſioned ſolely by their being impregnated with air, and the air being extricated or ſet free in the ſtomach, theſe ſubſtances are reduceable to a friable or ſoluble ſtate. This laſt fact is illuſtrated by Papin's digeſter. This air, ſet at liberty by the digeſtion, often, under

der the denomination of flatus, diſtends the ſtomach more than the food itſelf. While it is extricated, the aliments 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. It is frequently ranceſcent, as appears from the flatus, and often of a moſt fetid, cauſtic, and inflammable nature. 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 Digeſton, &c.) During digeſtion there is no ſenſe of hunger, for the nervous plicae of the ſtomach are kept from grating on each other by the interpoſition of the food; and they are not affected by the gaſtric juice, which, in digeſtion, acts on the aliment.

The aliment is prevented from becoming completely acid, by the heat; by the gaſtric juices; by the ſaliva, which is rather alkaleſcent, and ſwallowed to the amount of half an ounce in an hour; and by the bile which frequently regurgitates into the ſtomach. There is 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, eſpecially in fiſhes, diſſolves the bones of other fiſhes, which they had devoured. (See Spallanzani's Experiments)

To the preceding theory of digeſtion, taken from Haller, we ſhall add an abridged account of ſome experiments, extracted from the ingenious Mr Smellie's Philoſophy of Natural Hiſtory.

"Dr Stevens, in an Inaugural Diſſertation concerning Digeſtion, publiſhed at Edinburgh in the year 1777, made ſeveral

ſeveral experiments upon a German, who gained a miſerable livelyhood by ſwallowing ſtones for the amuſement of the people He began this ſtrange practice at the age of ſeven, and had at that time continued in it about twenty years. He ſwallowed ſix or eight ſtones at a time, ſome of them as large as a pigeon's egg, and paſſed them in the natural way. Dr Stevens thought this poor man would be an excellent ſubject for aſcertaining the ſolvent power of the gaſtric juice in the human ſtomach. The Doctor, accordingly, made uſe of him for this purpoſe. He made the German ſwallow a hollow ſilver ſphere, divided into two cavities by a partition, and perforated with a great number of holes, capable of admitting an ordinary needle. Into one of theſe cavities he put four ſcruples and a half of raw beef, and into the other five ſcruples of raw bleak. In twenty one hours the ſphere was voided, when the beef had loſt a ſcruple and a half, and the fiſh two ſcruples. A few days afterwards, this German ſwallowed the ſame ſphere. which contained, in one cavity, four ſcruples and four grains of raw, and, in the other, four ſcruples and eight grains of boiled beef. The ſphere was returned in forty-three hours: The raw fleſh had loſt one ſcruple and two grains, and the boiled one ſcruple and ſixteen grains. Suſpecting that, if theſe ſubſtances were divided, the ſolvent would have a freer acceſs to them, and more of them would be diſſolved, Dr Stevens procured another ſphere, with holes large enough to receive a crow's quill. He incloſed ſome beef in it a little maſticated. In thirty eight hours after it was ſwallowed, it was voided quite empty. Perceiving how readily the chewed meat was diſſolved, he tried whether it would diſſolve equally ſoon without being chewed. With this view, he put a ſcruple and eight grains of pork into one cavity. and the ſame quantity of cheeſe into the other. The ſphere was retained in the German's ſtomach and inteſtines forty-three hours; at the end of which time, not the ſmalleſt quantity

of

of pork or cheeſe was to be found in the ſphere. He next ſwallowed the ſame ſphere, which contained, in one partition, ſome roaſted turkey, and ſome boilt ſalt herring in the other. The ſphere was voided in forty ſix hours; but no part of the turkey or herring appeared; for both had been completely diſſolved. Having diſcovered that animal ſubſtances, though incloſed in tubes, were eaſily diſſolved by the gaſtric juice, the Doctor tried whether it would produce the ſame effect upon vegetables. He therefore incloſed an equal quantity of raw parſnep and potatoe in a ſphere. After continuing forty eight hours in the alimentary canal, not a veſtige of either remained. Pieces of apple and turnip, both raw and boiled, were diſſolved in thirty ſix hours.

"It is a comfortable circumſtance, that no animal, perhaps, except thoſe worms which are hatched in the human inteſtines, can reſiſt the diſſolving power of the gaſtric juice. Dr Stevens incloſed live leeches, and earth-worms, in different ſpheres, and made the German ſwallow them. When the ſpheres were diſcharged, the animals were not only deprived of live, but completely diſſolved by the operation of this powerful menſtruum. Hence, if any live reptile ſhould chance to be ſwallowed, we have no reaſon to apprehend any danger from ſuch an accident.

"The German left Edinburgh before the Doctor had an opportunity of making a farther progreſs in his experiments. He therefore had recourſe to dogs and ruminating animals. In the courſe of his trials upon the ſolvent power in the gaſtric fluid of dogs, he found that it was capable of diſſolving hard bones, and even balls of ivory; but that, in equal times, very little impreſſion was made upon potatoes, parſnep, and other vegetable ſubſtances. On the contrary, in the ruminating animals, as the ſheep, the ox, &c. he diſcovered, that their gaſtric juice ſpeedily diſſolved vegetables, but made no impreſſion on beef, mutton, and other animal bodies. From theſe

laſt

laſt experiments, it appears that the different tribes of animals are not leſs diſtinguiſhed by their external figure, and by their manners, than by the quality and power of their gaſtric juices. Dogs are unable to digeſt vegetable, and ſheep and oxen cannot digeſt animal ſubſtances. As the gaſtric juice of the human ſtomach is capable of diſſolving, nearly with equal eaſe, both animals and vegetables, this circumſtance affords a ſtrong, and almoſt an irreſiſtible proof, that nature originally intended man to feed promiſcuouſly upon both.

"Live animals, as long as the vital principle remains in them, are not affected by the ſolvent powers of the ſtomach. 'Hence it is,' Mr Hunter remarks, 'that we find animals 'of various kinds living in the ſtomach, or even hatched 'and bred there; but the moment that any of theſe loſe 'the living principle, they become ſubject to the digeſtive 'powers of the ſtomach. If it were poſſible, for example, 'for a man's hand to be introduced into the ſtomach of a 'living animal, and kept there for ſome conſiderable time, 'it would be found that the diſſolvent powers of the ſto'mach could have no effect upon it: But, if the ſame hand 'were ſeparated from the body, and introduced into the 'ſame ſtomach, we ſhould then find, that the ſtomach would 'immediately act upon it. Indeed, if this were not the 'caſe, we ſhould find that the ſtomach itſelf ought to have 'been made of indigeſtible materials; for, if the living 'principle was not capable of preſerving animal ſubſtances 'from undergoing that proceſs, the ſtomach itſelf would be 'digeſted. But we find, on the contrary, that the ſtomach, 'which at one inſtant, that is, while poſſeſſed of the living 'principle, was capable of reſiſting the digeſtive powers 'which it contained, the next moment, viz. when deprived 'of the living principle, is itſelf capable of being digeſted, 'either by the digeſtive powers of other ſtomachs, or by the

'remains

'remains of that power which it had of digefting other 'things.'

"When bodies are opened fome time after death, a confiderable aperture is frequently found at the greateft extremity of the ftomach. 'In thefe cafes,' fays Mr Hunter, 'the 'contents of the ftomach are generally found loofe in the 'cavity of the abdomen, about the fpleen and diaphragm. 'In many fubjects, this digeftive power extends much farther 'than through the ftomach. I have often found, that, af-'ter it had diffolved the ftomach at the ufual place, the 'contents of the ftomach had come into contact with the 'fpleen and diaphragm, had partly diffolved the adjacent 'fide of the fpleen, and had diffolved the ftomach quite 'through; fo that the contents of the ftomach were found 'in the cavity of the thorax, and had even affected the 'lungs in a fmall degree."

The flefhy fibres of the ftomach being irritated by the flatus, the weight, and the acrimony of the food, begin to contract themfelves more powerfully than when the ftomach is empty, and with a greater force in proportion as it is more full. And, firft, the mufcular ftratum, which paffes along the leffer curvature, draws the pylorus to the oefophagus; and, being inferted only into the left face of the former, draws it to the right. The principal ftratum of the circular fibres contracts the capacity of the ftomach according to its length; grinds or intermixes its contents with the liquors; and determines them both, like the preffure of two hands placed oppofite, to flow towards the pylorus: But this flux through the pylorus is not continual, on account of the valvula pylori, and likewife becaufe this motion begins from fome part that is more irritated, and, as we fee by numerous experiments, part of it is very foon received into the blood. Thefe alternate contractions at laft terminate in a full evacuation. In this action of the ftomach, there is nothing

thing which resembles the triture made by the ſtrong gizzards of granivorous fowls, which ſome anatomiſts have aſcribed to the human ſtomach. The ſtomach, however, 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 part of its diameter. The ſtomach is alſo frequently obſerved to be diminiſhed to much leſs than its third part, even to the breadth of an inch, ſo that it can expel the ſmalleſt ſubſtances, and entirely evacuate itſelf. The compreſſing force of the ſtomach muſt be very ſmall, as it bruiſes neither berries nor worms

The motions which the ſtomach receives from the diaphragm and abdominal muſcles is greater than its proper periſtaltic motion. It is principally by the force of theſe muſcles that the drinks are urged on continually, but the ſolid foods only when they are diſſolved, leſt thoſe parts which are too groſs ſhould be expelled through the pylorus into the duodenum; for the ſolid aliments do not ſeem to leave the ſtomach before they have changed their fibrous or other texture for that of a mucus; being, as it were, a cineritious, yellowiſh, ſomewhat fetid, mucilaginous, and liquid pulp. That which is firſt prepared and become fluid goes out of the ſtomach before the reſt; but, ſuch things as are hard, or too large to paſs the pylorus, are retained in the ſtomach for a longer time.

The ſtomach being irritated by too great a quantity or acrimony of the food, by ſickneſs, by a repulſion of the bile, or other cauſes, does, by an antiperiſtaltic or reverted motion of its fibres, drive its contents upwards through the open and relaxed oeſophagus in the act of vomiting Any part of the whole inteſtinal canal, from the pharynx to the rectum, may be conſtricted, either ſuddenly or ſlowly, by an antiperiſtaltic motion. If it happens ſuddenly to the upper parts at the ſtomach, the diaphragm, and likewiſe the abdominal muſcles, being convulfed at the fame time, it is called *vomiting*; if it is flowly performed it may be called *ruminatio*; if the fmall, and particularly the great inteftines, return their contents upwards, the difeafe is called *ileus*. The effect of vomiting is partly from the preffure of the abdominal mufcles depreffing the falfe ribs, and urging the contents of the abdomen againft the diaphragm; which, at the fame time, contracting itfelf to a plane downwards, forces the ftomach, as between the fides of a prefs, to throw up its contents.

The aliments driven in their natural courfe to the duodenum, meet there with the influent bile and pancreatic juice, which often flow back into the ftomach.

A thin watery liquor diftils from the exhaling arteries into the cavity of the inteftines, like the juice of the ftomach, not acrid, but faltifh. The quantity of this liquor may be computed from the large extent or fum of all the excretory orifices, and from the fection of the fecretory artery, which is larger than any other in the body; add to this, the laxity of the parts perpetually kept warm and moift, and the copious diarrhoea or watery difcharge that often follows the ufe of purgative medicines. The mucus arifing from the pores or cells, ferves to lubricate and defend the internal furface of the villous membrane, and to guard the fenfible nerves from ftrongly acrid or pungent particles. Hence we fee, it is more abundant at the beginning of the larger inteftines, becaufe there the mafs of aliment begins to be more feculent, acrid, and tenacious.

The mixture of this liquor with the pulp-like mafs of the aliment, together with the bile and pancreatic juice, is made by the motion of the furrounding mufcles of the abdomen; but this force is fmall, and incapable of moving the aliments forward. The periftaltic motion, which is more particularly ftrong and evident in the fmall inteftines, is the chief power by which the digefted aliments are propelled along the intef-

tinal

tinal tube. Any part of the inteftine, irritated by flatus or any fharp or rough body, contracts itfelf, even after death, moft violently in that part where the ftimulus is applied, in order to free itfelf from the offending or diftending body, which it expels into the next open part of the lax inteftine; where, being received, it is again propelled forward, by exciting a like ftimulus and contraction as before. This contracting motion of the inteftines is made in various parts of the gut, either fucceffively or at the fame time, wherever the flatus or aliment excites a ftimulus, without obferving any certain order. So well fitted, however, are the inteftines for this motion, that they even exceed the irritability of the heart. When they are not irritated, they remain at reft; and we may fuppofe this to be the caufe why the fat is depofited in the abdomen. The principal ftimulus is the air; next to that is the aliment; and laftly, the bile. This motion is performed by a fort of alternate creeping and revolution of the inteftines, which diffection eafily demonftrates in brute animals, and cafes of wounds in the abdomen and ruptures have manifefted it in the human fpecies. Among fo many inflexions, the weight of the aliment is but of little confequence, for it eafily afcends or defcends through the irritated inteftine, which thus empties itfelf.

This periftaltic motion of the inteftines is performed by the conftriction of their circular fibres, which empty the tube exactly, without injuring it againft pins, needles, or any other fharp bodies accidentally introduced into it, they being at the fame time pufhed forward. But the revolutions, or thofe motions in which the tube is alternately fhortened and lengthened, and the ftraightening of crooked parts one before another, which is fo remarkably confpicuous in brute animals, are performed by the long fibres, which we fee contract themfelves at the feat of the prefent ftimulus, and dilate the following portion, in order to receive what follows. By the fame contraction,

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the villous membrane of the inteſtines, within their cavity, is urged and reduced into longer folds; whence the mucus is expreſſed and applied, by the force of irritation and ſtimulus, to that part of the alimentary maſs where it was required. 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, diluted with the pancreatic juice and that of the inteſtines, intimately mixed with the ſaponaceous bile and circumjacent mucus, is more perfectly diſſolved than it was 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. At the ſame time the acid or aceſcent quality is corrected, while the oily or fat parts, diſſolved by the bile, intermix with the watery juices, and give the chyle its uſual milky appearance. It is of a bright colour in the duodenum, at the firſt entrance of the biliary duct, and may be ſeen diſtinctly through the whole length of the ſmall inteſtines adhering to their villous coat. But the gelatinous juices of fleſh meats, diluted with a large portion of water, and likewiſe from their own ſubviſcid nature, adhere more particularly to the villous coat, and enter it by abſorption. Water and watery liquors are all very ſpeedily abſorbed, 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 they become foetid in any conſiderable degree, as well becauſe of the great quantity of diluting juices, as becauſe the quick progreſſion will not allow

them

them time enough for putrefying. Thofe remains, of a more earthy, grofs, and acrid difpofition, which were not received by the mouths of the abforbing lacteals, by their own weight, or by the mufcular contractions, defcend flowly into the large inteftines, fo as to complete their whole courfe in the fpace of about twenty-four hours: All the chyle of the aliment, however, is commonly extracted within three or four hours, or a little more.

The confiderable length of the fmall inteftine, which is upwards of five times longer than the body, the great furface of the villous membrane increafed by folds, the incredible number of exhaling or abforbent veffels, the flow courfe of the feces through the large inteftines, and the great quantity of the inteftinal juice poured into the alimentary mafs, all conduce to the preparation of the chyle; to its abforption into the lacteals and the mefenteric veins; to the abfterfion of vifcidities from the inteftine; to the avoiding adhefions and coagulations; to the deftruction of any acrid diathefis; and to the fubduing any poifonous quality in many juices, which, being directly mixed with the blood, would inftantly kill. Hence, in general, the inteftines are long in animals that feed upon hard diet, but fhort in carnivorous ones, and fhorteft in all thofe that live upon juices: And, even in man, an uncommon fhortnefs of the inteftines has been known to be attended with hunger, and a difcharge of foetid and fluid feces.

The heat, by which the aliment is fomented, and which is exceedingly proper for the folution of the gelatinous matter, and for exciting a beginning putrefaction, is the principal caufe of the foetor which is gradually produced in the aliment; hence alfo the ufeful part of the aliment, rendered more fluid, is the better adapted for abforption. The air alfo, inclofed in the vifcid aliment, operates here, as in the ftomach, by breaking the cohefion of the aliments, if any parts of it

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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, renders it miſcible with water.

What remains, after the chyle has been abſtracted, conſiſts of ſome portion of the bile, become mucilaginous, and degenerated; ſome part of the human mucilages; moſt of the earthy parts of the food; all thoſe parts which, by their acrimony, were rejected by the abſorbing mouths of the lacteals, yet changed by means of putrefaction; and laſtly, 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 caecum, in which they are collected.

The inteſtinal feces, therefore, retained in the beginning of the colon or large inteſtine, there grow dry by the abſorption of their 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 caecum elevated by the long ligaments, which end in the appendix vermiformis. And here the manner in which the feces are propelled by the contraction of the circular fibres, appears better than in the ſmall inteſtines. 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; the parts of the inteſtine, to which the feces are next 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, through the whole large inteſtine, in about twenty-four hours in a healthy perſon.

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, fide, which draws back the ligament common to each valve, in fuch a manner as to comprefs and exactly clofe the upper fold downward, that nothing may return back into the ileum; which might eafily happen in a fluid ftate of the feces, if this paffage was not fo accurately fhut up. The feces, when in danger of falling down from the upper parts, deprefs the upper valve, and thus accurately exclude themfelves. The feces continue to move flowly forward, becoming more dry, confiftent, and figured by the fame caufes, through the whole tract and repeated flexures of the colon. This inteftine is from five to feven feet long, and it is in general capable of retaining the feces for twenty-four hours, fo as to give no interruption to the common affairs of life; this retention, however, is always proportional to the velocity with which the fmall inteftines propel their contents.

At length the feces fall into the rectum, which being fituated in the midft of much furrounding fat and cellular fubftance, eafily expands, and fuffers the excrement to be collected in large quantities, and to be retained for a confiderable time.

The ftructure of the rectum differs very much from that of the other inteftines. The external membrane or peritoneum is only fpread before it; while behind it is fupported by a broad ftratum of the cellular fubftance, replete with fat and many conglobate glandules, connecting it all the way to the os facrum. The mufcular fibres are much ftronger and more numerous, efpecially the longitudinal ones, than in the other inteftines; being compofed of the three ligaments, expanded and fpread firft over the anterior furface, and then over the whole inteftine; they dilate the inteftine before the advancing feces, and draw it back after the feces are excluded. The tranfverfe fibres are alfo ftrong; and the laft of them are oval, forming a protuberant ring, called the internal

internal *sphincter*, by which the opening of the anus is closed.

The villous coat of the intestine has a very rough surface, is extremely porous, and full of reticulated polygonal wrinkles, and is furnished with some peculiar sinuses. 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. Between these folds are intercepted sinuses, hollow upwards, and of a greater depth towards the lower extremity of the intestine. The mouths of the large mucous glandules open into these cavities; while the margin of the anus itself is defended by sebaceous glandules, lest it should be excoriated by the hard acrid feces.

Whenever, therefore, the feces are collected within the rectum, in such a quantity as to become troublesome by their weight, irritation, or acrimony, they excite an uneasiness through the adjacent viscera; and are then, by the force of the diaphragm and abdominal muscles, pressed downwards 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 of the intestine. After the feces are expelled, the intestine, by its longitudinal fibres, is drawn back or up into the body; after which, the opening of the anus itself is closely contracted by the two proper sphincters as at first. The feces in men and carnivorous animals are very foetid, almost putrid, subalkaline, soft, and contain much oil intimately mixed with salts, which are left both by the aliments, as well as by the bile and other humours of the human body. An acrid and foetid water returns from the feces into the blood; hence costiveness in fevers is hurtful, putrefaction being increased by 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 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 hypochondrium, 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

lar 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 antients gave the general name of *portae.*

The depreſſions on the concave or lower ſide of the liver, which deſerve our attention, are four in number. 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 portae*, ſo called by the antients, 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 foetus, 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;

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 oesophagus, 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 peritonaeum. 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 *portae;* 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 peritonaeum, which is only folded quite round this adhesion, adhefion, to form the external membrane of all the reft of the body of the liver.

This broad adhefion is commonly, though improperly, called *ligamentum coronarium*: But, in the firft place, it is not a ligament, as has been already obferved; and, fecondly, it is not circular, but oval, and very oblong.

It is not on the upper part of the convex fide of the liver, but along the pofterior part of the great lobe; the broad extremity of the adhefion lying nearer the notch, and the pointed extremity towards the right hypochondrium.

The middle ligament, called improperly *ligamentum hepatis fufpenforium*, contains, in its duplicature, a thick white rope, like a round ligament, which was the umbilical vein in the foetus. Thus the lower part reprefents a falx; the convex edge of which is fharp, and the other rounded.

All thefe ligaments ferve to keep the liver in its proper fituation, and to hinder it from inclining too much towards either fide: But we muft not imagine that any of them ferve to fufpend it; becaufe it is fufficiently fupported by the ftomach and inteftines, efpecially when they are filled.

When the ftomach is empty, or when we faft longer than ordinary, it is a common expreffion to fay the ftomach pinches us. As the liver is not then fuftained by the ftomach and inteftines, it defcends 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 uneafy fenfation; and not at the fuperior orifice of the ftomach, as is commonly believed.

The right or great lobe of the liver, which lies in the right hypochondrium, refts on the right kidney by a fmall fuperficial depreffion above mentioned; and it likewife covers a portion of the arch of the colon and the pylorus. About two third parts of the fmall or left lobe lie in the middle of the

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 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, 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 venae portae*, 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 that it is a continuation of the cellular membrane which covers the vena portae ventralis.

The veſſel which carries the blood to the liver is called *vena portae*, for the reaſon already given. In the deſcription of the veins, we obſerved that the vena portae might

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be confidered as two large veins, the trunks of which are joined endwife, and fend out branches and ramifications in oppofite directions to each other; that one of thefe veins is ramified in the liver, the other lying without the liver, and fending its branches and ramifications to the vifcera of the abdomen; and, laftly, that the firft of thefe large veins may be termed *vena portae hepatica* the other *vena portae ventralis*.

Vena portae hepatica. The particular trunk of the vena portae hepatica is fituated tranfverfely between the broad anterior eminence of the great lobe of the liver and the root of the lobulus in a particular fciffure, and forms what is called the *finus of the vena portae*. From this finus five principal branches go out, which are afterwards divided into millions of ramifications through the whole fubftance of the liver.

At this place the vena portae 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 thefe ramifications of the trunk of the vena portae hepatica end in the pulpy friable corpufcles of the liver.

Pori bilarii et ductus hepaticus. It is in thefe corpufcles that the bile is fecreted, and it is immediately collected in the fame number of extremities of another kind of veffels, which unite, by numerous ramifications, into one common trunk. Thefe ramifications are termed *pori bilarii*, and the trunk *ductus hepaticus*; and the ramifications of thefe two kind of veffels are invefted together by the capfula of the vena portae.

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, befides others that are lefs confiderable, 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 thofe of the vena portae, and accompany them through

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 portae; the firſt being thinneſt and largeſt, and adhering cloſeſt to the ſubſtance of the liver; whereas thoſe of the vena portae, 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 the branches of the hepatic artery and biliary ducts which do not follow thoſe of the vena hepatica: And Sabatier obſerves, that the direction of the branches of the vena hepatica is perpendicular to that of the vena portae.

Hepatic artery and nerves. The liver receives from the arteria caeliaca a particular branch, termed *arteria hepatica*; which being very ſmall when compared with the bulk of that viſcus, ſeem deſigned only for its nouriſhment, 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 portae 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 portae: 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 muſcu-

lar

lar nature of the capfula, and they have been followed in this opinion by modern anatomifts.

The liver is covered exteriorly by a particular membrane or coat, which is a continuation of the peritonaeum. A membranous or filamentary fubftance likewife runs through this whole vifcus, and connects the ramifications and extremities of all its veffels to each other. This fubftance feems to be a complicated production of the capfula of the vena portae, and of the external membrane of the liver.

The outer furface of this coat is very fmooth, but its inner furface is uneven, confifting of a great number of thin membranous laminae; between which we obferve very diftinctly, numerous lymphatic veffels, on both the convex and concave fides of the liver; but it is more difficult to trace thofe which accompany the filamentary fubftance through that vifcus. Some of the lympathetic veffels, from the fubftance and concave furface of the liver, run in the capfule of Gliffon; and after paffing through conglobate glands fituated there, they end at laft in the receptaculum chyli, or into fome of the large lacteals; others, upon the convex furface of the liver, run to the ligamentum fufpenforium, from which they pierce the diaphragm in company with the vena cava, to end in the thoracic duct.

We have already obferved, that the fubftance of the liver is chiefly made up of an infinite number of pulpy friable corpufcles; each of which is bounded, and in a manner furrounded, by a particular expanfion of the capfula Gliffoni; and all thefe expanfions are connected by common fepta, in fome meafure refembling a bee-hive.

Thefe corpufcles have feveral angles, efpecially in the inner furface of the liver; but near the furface they are raifed in the form of fmall tubercles. Their pulpy texture appears like radiated villi, a fmall void fpace being left in the middle of each.

If

If we blow through a pipe into the vena portae, vena cava, arteria hepatica, or trunk of the pori bilarii, but efpecially through the two veins, we obferve the liver to fwell, and the corpufcles near the furface are raifed, and become more fenfible. If we blow with much force, we burft thefe corpufcles; and the air getting between them and the external membrane, raifes it from the fubftance of the liver in blifters.

Ductus cholidochus. The ductus hepaticus, or trunk of the pori bilarii, having run a little way, joins another canal, called *ductus cyfticus* or *veficularis;* becaufe it comes from the veficula fellis, as we fhall fee in the defcription of that organ. Thefe two united ducts form a common trunk, named *ductus cholidochus;* becaufe it conveys the bile. This duct having reached the incurvation of the duodenum, infinuates itfelf through the coats of that inteftine, and opens into its cavity not by a round papilla, but by an oblong orifice rounded at the upper part, and contracted at the lower like the fpout of an ewer, or like a common tooth-picker.

The edges of this orifice are raifed, broad, and plaited, as we may fee by making this portion of the duodenum fwim in clear water. At the entry of this orifice we fee another fmall opening diftinct from it, which is the orifice of the ductus pancreaticus; of which hereafter. Gliffon was of opinion, that the extremity of the ductus cholidochus was furnifhed with a fphincter of mufcular fibres, which was capable of fhutting the orifice, and of preventing the contents of the duodenum from entering it; but no fuch duct has been found by others, and the obliquity of the paffage anfwers the fame purpofe.

Veficula fellis. The gall-bladder is a kind of fmall bag, fhaped 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 veficula lies in a depreſſion on the concave ſide of the liver, from the trunk or ſinus of the vena portae, 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 peritonaeum.

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 lacunae, like perforated papillae, 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 lacunae are looked upon to be glands. Sabatier admits only of the firſt and the laſt of theſe coats, aud conſiders the intermediate ſubſtance as being merely cellular and vaſcular.

That

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, 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 rugae and ſome folds, which appear like fragments of valvulae conniventes, ſituated very near each other, from the neck to the contraction of the cyſtic duct. The firſt of theſe folds is 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

ral flight, which may be feen through the neck on the outfide, where it fometimes appears like a fcrew, efpecially when the neck is filled with any fluid. This obfervation is owing to M. Heifter.

By flitting the neck and duct, we fee all thefe folds very diftinctly, efpecially when we examine them in clear water. When they are viewed in any other manner they eafily deceive us, being miftaken for true valves, becaufe of their tranfverfe fituation. They may, however, in fome meafure, fupply the place of valves, by hindering the bile from running too faft into the duodenum, and the contents of the duodenum from entering this duct. The ftructure of the biliary ducts appear to be entirely membranous, covered externally with a thick cellular fubftance, and lined within by a kind of tunica villofa, which is pierced with numerous holes, that make it appear like a fieve. Through thefe a mucous humour flows, to fave the ducts from the impreffion of the bile. And the internal furface of all thefe biliary ducts, that is, of the ductus hepaticus, cyfticus, and cholidochus being examined through a microfcope in clear water, appears to be nearly of the fame ftructure through their whole extent.

The cyftic and hepatic ducts, do not, in their ordinary and natural fituation, reprefent the capital Greek Υ, where they form the ductus cholidochus. After the incurvation of the neck of the veficula, thefe two ducts run very near each other, and they appear to be feparated only by raifing up the liver to view them. The fame diforder happens in an inverted liver extra fitum; for then the body of the liver fubfides and is flattened, and thereby feparates the ducts; whereas, in its true fituation, it is very much incurvated, and the ducts very near each other.

The ductus cholidochus appears rather to be a continuation of the ductus cyfticus, than the common trunk of that

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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 portae ventralis terminates between the lobulus and the oppoſite part of the great lobe; and there joins the trunk of the vena portae 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 foetus, joins the trunk of the vena portae 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 ſide; 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 foetus, therefore, the blood which comes from the umbilical vein does not run directly through that contained in the vena porta 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 portae, before it enters

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 portae 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 portae, and are ramified in all directions, in the manner already explained. The inferior 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 portae.

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 portae, the hepatic arteries, the ductus hepaticus, or trunk of the pori biliarii, and the nerves

nerves of the plexus hepaticus, form altogether a large bundle before they enter the liver. The trunk of the hepatic vena portae 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 biliarii, leave the trunk of the great vein, and join in the ſame manner the trunk of the ſmall or hepatic vena portae, and its ramifications in the capſula Gliſſoni explained above.

All theſe branches of the vena portae, and of the arteries, nerves, and pori biliarii, 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 were formed by their trunks. Each ramus of the vena portae, artery, nerve, and porus biliarus, has a proper vagina, and all the four have a common vagina diſtinguiſhed from the former cellular ſepta, which are only continuations of the vaginae 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 portae chiefly fill the cavity of it, and lie in a lateral ſituation. The arterial ramus, and porus biliarus 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 porous biliarius; the venae portae having by much the feweſt.

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The ufes of the liver fhall be explained after the defcription of the pancreas, fpleen, and omentum, all thefe vifcera having a great relation to the liver.

§ 14. *Pancreas.*

Figure, divifion, and fituation of the pancreas. The pancreas is a long flat gland, of that kind which anatomifts call *conglomerate*, fituated under the ftomach, between the liver and the fpleen. Its figure refembles that of a dog's tongue; and it is divided into two fides, one fuperior, the other inferior; two edges, one anterior, the other pofterior; and two extremities, one large, which reprefents the bafis of a tongue, and one fmall, and a little rounded, like the point of a tongue.

The pancreas is fituated tranfverfely under the ftomach, in the duplicature of the pofterior portion of the mefocolon. The large extremity is connected to the firft incurvation of the duodenum, and from thence it paffes before the reft of that inteftine all the way to its laft incurvation; fo that a great part of the duodenum lies between the pancreas and the vertebrae of the back. The fmall extremity is fixed to the omentum, near the fpleen.

Structure of the pancreas. The pancreas is compofed of a great number of foft glandular moleculae, combined in fuch a manner as to exhibit the appearance of one uniform mafs on the outfide, the furface of which is rendered uneven only by numerous fmall convexities, more or lefs flatted. When thefe moleculae are feparated a little from each other, we find, along the middle of the breadth of the pancreas, a particular duct, in which feveral fmaller ducts terminate laterally on each fide, like fmall rami in a ftem.

This canal, named *ductus pancreaticus*, or *ductus Virfungi*, from the difcoverer of it in the human body, is very thin, white,

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 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 part 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 nam d *arteriae pancreaticae*, 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 portae 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, 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, and 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 the experiment which ſhews that a great part of it may be cut out from a robuſt animal without occaſioning death; because, caufe; in the experiment, a part of the pancreas muft be left with the duodenum.

The pancreatic juice feems principally of ufe to dilute the vifcid cyftic juice, to mitigate its acrimony, and mix it with the food. Hence it is poured into a place remote from the cyftic duct as often as there is no cyftis. Like the reft of the inteftinal humours, this juice dilutes the mafs of aliments, refolves them, and does every other office of the faliva.

§ 15. *Lien.*

Situation, divifion, and figure of the fpleen. The fpleen is a bluifh mafs, fomething inclined to red, and of a long oval figure, being about feven or eight fingers breadth in length, and four or five in breadth. It is of a fottifh fubftance, and is fituated in the left hypochondrium, between the great extremity of the ftomach and the neighbouring falfe ribs, under the edge of the diaphragm, and above the left kidney.

It may be naturally divided into fides, edges, and extremities. It has two fides, one external and gently convex, and one internal, which is irregularly concave; two extremities, one pofterior, which is large, and one anterior, which is fmaller, and more depreffed; two edges, one fuperior, and one inferior, on both which there are, in fome fubjects, feveral inequalities.

The inner or concave fide is divided by a longitudinal groove or fciffure, into two planes or half fides, one upper, the other lower; and by this groove, the veffels and nerves enter in human fubjects. The fuperior half fide is broader and more concave than the inferior, being proportioned to the convexity of the great extremity of the ftomach. The inferior half fide lies backward on the left kidney, and forward on the colon; and fometimes this fide of the fpleen appears to have two fuperficial cavities, one anfwering to the con-

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 veins; 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, 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 varities.

The figure of the ſpleen is not always regular, and is as various as the ſize. Sometimes it has conſiderable 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 peritonaeum 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

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 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. When the ſtomach 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 the ſpleen ariſes upward and forward; and at the ſame time obliges it to change its ſituation, ſo as to lie almoſt tranſverſely with its lower end forward, and its upper end backward. Being of a very ſoft and looſe texture, it grows larger by diſtenſion when the ſtomach is empty, and becomes leſs again when it is preſſed by the full ſtomach againſt the ribs. Hence the ſpleen is found large in thoſe who die of lingering diſeaſes; but in thoſe who die ſuddenly, and in full health, it is ſmall. The ſpleen deſcends with the diaphragm in inſpiration, and aſcends again in exſpiration; and it often varies in its ſituation with 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 coeliac; 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 perforates by ſeveral diſtinct branches, ſuſtained by the right extremity of the omentum gaſtrocolicum. The denſity of this artery is greater than that of the aorta. The ſplenic

ſplenic vein, which accompanies the artery, is conſiderably ſofter than any other vein of the body; it forms the principal left branch of the vena portae. Beſides theſe, the ſpleen receives ſmall arteries from the great coronary deſcending behind the pancreas, and ſometimes from the internal haemorrhoidal. 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. 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. They are very evident in calves; but in men they are rendered conſpicuous 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 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 calves, altogether of arteries and veins. The arteries are ſubdivided into few large branches, but into very numerous ſmall twigs, which are difficult to fill with injections: Theſe twigs terminate in circles, which afford the fluid a ready paſſage into the concomitant veins. Theſe circles, with their parallel branches, form roundiſh bruſh-like pencils, that have been miſtaken for glands; but the injection,

tion, rightly managed, never efcapes out of the veffels, nor were any hollow glandules ever obferved. Every little arterial trunk, with the fmaller twigs that proceed from it, are each of them furrounded, like the fmall veffels of all the other vifcera, by a very fine cellular fubftance, but rather fofter than is ufual in other parts. The whole of the fpleen is outwardly furrounded by a fingle tender membrane, continued from the peritonaeum, and joined to the flefhy part of the fpleen by a thick cellular texture.

The fpleen contains more blood than the other vifcera; for it has no mufcles, fat, air-veffels, or excretory ducts, interpofed between its blood veffels. We learn alfo from obfervation, that the blood of this part fcarcely ever congeals. It is of a dark brown colour, and by its thinnefs, colour, and the great quantity of water it contains, it may be compared to the blood of a foetus. It abounds with water and a volatile falt, but has little oil.

The want of an excretory duct to the fpleen, has occafioned the ufe of it to be doubtful and controverted. Its fabric feems to lead us to the following, although, perhaps, not all the ufes of the fpleen. A great quantity of blood is carried to the fpleen, and with a flow motion, from the ferpentine courfe and denfity of the artery: When the ftomach is empty, the blood comes into the fpleen in a greater quantity than at any other time: The fpleen being then alfo lefs preffed, the blood feems to ftagnate in it; and this ftagnation is the more probable, both on account of the large capacity of the branches, in comparifon with the trunks of the artery, and on account of the difficult circulation from the fpleen through the liver. Hence the frequent fcirrhofities of the fpleen, and hence the immenfe quantity of blood with which the fpleen is diftended. The blood in the fpleen, which vifcus is warmed and fomented by the adjacent colon containing putrid feces, is refolved, attenuated, and affumes a putrefcent

trefcent ftate, as is evident from its colour and confiftence. But the greater fluidity of the blood may proceed not only from this diffolution, but becaufe all its watery juices that enter by the artery return alfo again by the vein; for there are no fecretory ducts in the fpleen.

Moreover, when the ftomach is full of food or flatus, the fpleen is thereby compreffed into a narrower compafs, againft the ribs and fuperincumbent diaphragm; by which means the blood, that before was fcarce able to creep along through the fplenic veins, being now preffed out more plentifully, returns with a greater celerity towards the liver, where it mixes in the trunk of the porta with the fluggifh blood, replete with oily particles from the omentum and mefentery, which it dilutes, and renders lefs apt to ftagnate or congeal: It conduces alfo to promote a larger fecretion of bile, at a time when that fluid is moft wanted, viz. during digeftion. The fpleen, therefore, feems to prepare the blood for fupplying a fort of watery juice, (probably of a fubalkaline nature, and rendered fomewhat fharp by the remora of the blood) to the bile.

Is the fpleen of a cellular fabric? Is the blood poured out into thofe cells fo as to ftagnate? or is the blood diluted with fome juice fecreted by peculiar glands? We fee nothing of this demonftrable by anatomy; nor does the liquor or wax injected ever extravafate into the cellular fubftance, unlefs urged with much greater violence than nature ever ufes or intended. As to the old queftion, Whether the fpleen prepares an acid to whet or fharpen the ftomach; that opinion has been long difcarded, as repugnant to the nature of all the animal juices. If it be afked, Whether the fpleen be not an ufelefs mafs, as it might feem to be from the little damage an animal fuftains after it has been cut out? we anfwer, That a robuft animal, fuffering but little injury from the lofs of a part, does not prove it to be ufelefs; but there are examples, after fuch an experiment has been made, that the li-

ver

ver becomes ſwelled, diſeaſed, and prepares 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 and Appendices Epiploicae.*

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 ſportſman'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 fuftains the ductus cholidochus, and connects it to the vena portae ventralis.

Below thefe adhefions, the other portions, that is, the anterior, pofterior, two lateral and inferior portions, which laft is the bottom of the facculus-epiploicus, have commonly no fixed connections, but lie loofe between the fore-fide of the cavity of the abdomen and the inteftines. The anterior and pofterior portions are generally called the *laminae* of the omentum; but as that term is ordinarily employed to exprefs the duplicature of fome compound membrane, it would be more convenient to call them *folia*, *alae*, or fome fuch name.

Structure of the omentum. The membrane of the omentum is, through its whole extent, made up of two extremely thin laminae joined by a cellular fubftance, the quantity of which is very confiderable along the blood veffels, which it every where accompanies in broad bands proportioned to the branches and ramifications of thefe veffels. Thefe cellular bands are more or lefs filled with fat, according to the corpulency of the fubject; and for that reafon I have called them *bands* or *portions of fat*.

Little omentum. Befides this large membranous bag, which I name the *great omentum*, there is another much fmaller, which differs from the large one, not only in fize, but alfo in figure, fituation, and connection; and this I name the *little omentum*. This fmall bag is fixed by its whole circumference, partly to the fmall curvature of the ftomach, and partly to the concave fide of the liver before the finus of the vena portae, fo as to furround and contain the prominent portion of the lobulus.

The little omentum is thinner and more tranfparent than the other, and its cavity diminifhes gradually from the circumference to the bottom, which in fome fubjects terminates in feveral fmall cavities or foffulae more or lefs pointed. Its ftructure is much the fame with that of the great omentum, it being compofed of two laminae, with a mixture

of

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 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 the two membranous ligaments, whereof one connects the beginning of the duodenum and neck of the veſicula fellis 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 it to 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 fraena 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

ceeds better in young lean fubjećts, than in old or fat fubjećts.

When we touch thefe membranes with dry fingers, they ftick to them fo clofely, as hardly to be feparated without being torn, as we fee by the reticular holes which appear in thofe portions of membranes that have been thus handled. In that cafe it is to no purpofe to blow through the natural orifice already mentioned; and it is owing to thefe fmall holes that the membranes of the omentum have been fuppofed to be naturally reticular.

The membranous laminae of the little omentum are continuous, partly with the external membrane of the liver, partly with that of the ftomach, and a little with the membrane that lines the neighbouring portion of the diaphragm. Thofe of the great omentum are continued partly with the fame coat of the ftomach, and partly with the external covering of the colon, and confequently with the mefocolon; and they likewife communicate with the covering of the fpleen.

We may fatisfy ourfelves concerning thefe continuations, by making a fmall hole in one of the laminae of the omentum near the ftomach, colon, &c and by blowing into that hole, through a pipe well fitted to it; for the air will gradually infinuate itfelf under the common coats of thefe vifcera; but, if the parts be dry, they muft be moiftened a little before the experiment is made.

Appendices epiploicae. The fatty appendices of the colon and rećtum are confidered by Winflow as a kind of fmall omenta or appendices epiploicae. They are fituated at different diftances, along thefe inteftines, being particular elongations of their common or external coat. They are of the fame ftrućture with the great omenta; and there is a cellular fubftance contained in their duplicature, more or lefs filled with fat, according as the fubjećt is fat or lean.

Next

Next the inteſtine, each of them forms a broad thin baſis; and they terminate by irregular papillae, 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 epiploicae, 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 conſidered 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 gaſtricae, and, for that reaſon, go by the name of *gaſtro-epiploicae dextrae* and *ſiniſtrae.* 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 arteriae meſentericae. The gaſtro-epiploic veins anſwer in the ſame manner of diſtribution to the vena portae.

The veſſels of the little omentum come chiefly from the coronariae ventriculi; and thoſe of the appendices and ſtrata are ramifications from the reticular texture of the arteries and veins of the colon and rectum.

§ 17.

§ 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 foetus. It is ſurrounded on all ſides by the neighbouring viſcera, and fixed by ligaments in ſuch a manner as to be 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.

This large viſcus is ſupplied with veſſels of various kinds. For, beſides the arteries, it has the vena portarum, which receives all the blood of the ſtomach, inteſtines, meſentery, ſpleen, omentum, and pancreas, by two trunks; viz. the tranſverſe ſplenic and aſcending meſenteric; and afterwards by one which is continued with the meſenteries. This is large, compoſed of ſtrong membranes, and ſurrounded with much denſe ſhort cellular ſubſtance, derived to it from the meſentery and ſpleen, and adding ſtrength to its membranes, which are ſtronger than thoſe of the aorta. Many of the ſmaller veſſels and hepatic nerves, which all come together under the denomination of a *capſula*, are intermixed with this cellular ſubſtance. By this the vena portarum is conducted to the liver, and firmly ſuſtained; inſomuch that the branches, being cut, do not collapſe but preſerve their round appearance. Each branch of this veſſel is divided into many others, again divided and ſubdivided, like the arteries, till they at length produce the ſmalleſt capillaries. In this courſe every branch of the vena portarum is accompanied with a concomitant branch of the hepatic artery, creeping upon the ſurface of the vein, and upon the contiguous hepatic ducts, almoſt in the ſame manner as the bronchial arteries uſually

creep

creep along the ramifications of the trachea 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 fubftance like a fpider's web. Some branches go out of the liver, being divided to the ligaments, and inofculating with the furrounding veins. And the fum of the branches in the vena portarum is always greater than the trunk; whence the area of the fections of all the branches together greatly exceed that of the trunk; from whence follow a great friction and refiftance, in the fame manner as in the arteries.

The blood brought to the liver by the vena portarum and hepatic artery muft of courfe be conveyed back again by fome other veins; and therefore the extreme branches of the vena portarum and hepatic artery inofculate ultimately into other veins, which are *branches of the cava* Thefe branches arife from the whole circumference of the liver, run together towards its pofterior gibbous part into branches and trunks, and at laft go off into ten or more large veffels. The greater number of thefe leffer trunks pafs out through the pofterior lobule of the liver, and go to the cava through the fulcus that lies on the right fide of the lobule, often completed into a circle by a fort of bridge or production of the liver; from whence they afcend together through the diaphragm towards the left fide. Two or three trunks, much larger than the former, are inferted into the cava, clofe to the diaphragm, whofe veins they often take in by the way. The branches of the vena cava are, in the adult, generally fewer and lefs than thofe of the vena portarum; which is an argument that the blood moves quicker, becaufe of the lefs friction, and of the collection of the blood into a lefs capacity, by which it is always accelerated when there is a fufficient compreffing force. As to any valves at the openings of thefe branches into the cava, there are none which deferve to be regarded. The trunk of the vena cava paffes through the foramen of the diaphragm,

diaphragm, obtufely quadrangular, and furrounded and terminated by mere tendons, fo as to be not eafily changeable. Having furmounted this opening of the diaphragm, it then immediately expands into the right auricle. The fmaller veins of the liver creeping about its furface are fent into the phrenics, renals, and azygos; or, at leaft, there is certainly a communication between thefe and the hepatic veins coming from the portae.

That the blood comes from all parts by the vena portarum to the portae, is proved by a ligature, by which any vein between thefe parts and the ligature fwells; but the porta itfelf, above the ligature, grows flaccid and empty. That it afterwards goes through the liver to the cava, appears by anatomical injections, which fhew open and free anaftomofes or communications between the vena portarum and the cava; and by the common nature of the veins going to the cava. Again, the difficult paffage through the vena portarum, like to that of an artery, together with its remotenefs from the heart, and the oily or fluggifh nature of the blood itfelf, occafion the blood to ftagnate, accumulate, and form fcirrhous fwellings in no part oftener than in the liver. This danger however is diminifhed by the motion of the adjacent mufcles, and by refpiration; but it is increafed by inactivity, and by fpur and vifcid aliments. Hitherto, we have been fpeaking of the adult liver, in which both the umbilical vein and the ductus venofus are empty and clofed 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 veffels* of the liver are numerous, arifing from all fides, and paffing into the thoracic duct

Through the whole fubftance of the liver go bundles of biliary veffels, of branches of the vena portarum, and of the

hepatic

hepatic artery. Each veſſel has its proper cellular texture ſurrounding it, and ligaments, by which it is tied to its fellow veſſels; and, laſtly, the whole bundle has its cellular texture round it. The branches of the vena cava lie on the outſide of the reſt, being leſs accurately received into the ſame bundle. The ultimate ſmall branches of the vena portarum, cava, and hepatic artery, together with the bilious ducts, are united together by means of the cellular ſubſtance into compound cluſters, ſomewhat reſembling mulberries, commonly called *acini*, of an hexagonal ſhape, ſurrounded with a lax cellular texture. In theſe acini, likewiſe, there are mutual anaſtomoſes between 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 inoſculations are demonſtrated by anatomical injections; for liquors injected by the vena portarum return again through the ductus cholidochus.

Many eminent anatomiſts have taught, that the fore mentioned acini are hollow, having arteries and veins ſpread upon their external ſurface, and that they depoſit the bile into their cavity, after it has been ſecreted from the branches of the vena portarum. This opinion they ſupport by arguments taken from comparative anatomy, theſe acini being in brutes rounder and more defined than in man; and from diſeaſes, in which we find 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, its ſimilarity 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 follicles would intercept the courſe of anatomical injections, and give us the appearance of knots, intermediate between the ſecretory veſſels and the biliary pores, which we have never yet been able to ſee: for the wax flows immediately into a cavity, in a continued thread from the vena portarum into the biliary ducts, without any interruption or effuſion. Again, a follicular or glandular fabric is not allowable in the liver, from the great length of the biliary ducts. For all follicles depoſit their contents into ſome ſpace immediately adjacent; for they are unfit to convey their ſecerned fluid to any length, as they deſtroy a great part of the velocity imparted by the arteries. Laſtly, the common preſſure which we muſt ſuppoſe to be on theſe acini, would ſo cruſh them, that no aſſiſtance could from thence be brought to promote the motion through 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

thence by the force of the blood urging behind, as well as by the auxiliary force of the diaphragm preffing the liver againft the reft of the vifcera in the abdomen when full; and again, the diaphragm contracted in exfpiration, will force the bile into the larger branches, and laftly into the two trunks of the *ductus biliarius hepaticus;* which trunks meet together upon the vena portarum, in the tranfverfe foffa of the liver, near the anonymous lobule.

The fabric of this duct is like that of the inteftines, except that there do not appear to be any mufcular fibres. From experiments it appears to be endowed with a moderate degree of irritability. That it is vaftly dilatable, and extremely fenfible, is fhewn from difeafes.

The hepatic duct goes on upon the vena portarum, more to the right than the artery, towards the pancreas; and then defcending obliquely, covered by fome part of that gland, it goes to the lower part of the fecond flexure of the duodenum, and is inferted backward about four or five inches from the pylorus, through an oblique oblong finus made by the pancreatic duct, into which it opens by a narrow orifice. This finus runs a great way through the fecond cellular coat of the duodenum obliquely downward; then it perforates the nervous coat, and goes on again obliquely between it and the villous coat; and, laftly, it opens into a protuberant long wrinkle of the duodenum. There is almoft the length of an inch taken up between the firft infertion, and the egrefs of this duct through the coats of the duodenum; by a finus which furrounds and receives the ductus cholidochus, in fuch a manner, that when the coats of the inteftine are diftended by flatus, or clofely contracted by a more violent periftaltic motion, the opening of the duct muft be confequently comprefied or fhut; 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

wrinkling of the duct, for it may be very eafily preffed together or clofed; the regurgitation may alfo be prevented by a fucceffion of frefh bile defcending perpendicularly from the liver. Air inflated into the inteftine finds no paffage into the duct.

Juft at the portae this duct receives from the gall-bladder another lefs canal of the fame kind, which lies for a good way parallel with it, and is inferted into it by a very acute angle: This, which is called the cyftic duct, from its origin, is fometimes firft increafed by another fmall duct from the liver before its infertion. The gall-bladder, from which this duct rifes, is a peculiar receptacle for the bile: Moft animals are furnifhed with it; fome, however, want it, as moft of the fwift running, and many of the herbivorous animals. Its fituation, figure, and texture, has been already defcribed.

The generality of animals have, between their gall bladder and liver, or between the ducts coming from both, fome peculiar openings in the gall-bladder, into which fome ducts, originating from the liver, or the hepatic biliary duct, difcharge their contents. In man thefe ducts have not been hitherto clearly demonftrated; and the gall bladder is eafily loofened from the liver, without a drop of bile diftilling either from it or from the liver. There is alfo a thin water in the bladder as often as the cyftic duct is obftructed.

The bile flows naturally both out of the bladder and liver, as long as there is no impediment in its way; fo that both ducts fwell when that paffage is obftructed, and the cyftic lies in a ftraight line with the cholidochus. There is no neceffity for all the bile to be diverted into the gall-bladder before it flows into the duodenum. There is not a perpetual obftacle which hinders the afflux, and peculiarly refifts the hepatic bile, and admits the cyftic; the paffage into the ductus cholidochus is larger and ftraighter, the ductus cyfticus much lefs than the hepatic, nor is that duct fo well formed

formed for receiving all the bile; the cholidochus being much larger than the cyftic duct, cannot therefore be made only for the reception of its bile There are many animals in which the hepatic duct difcharges its contents into the inteftine without any communication with the cyftic. In living animals, even when the cyftic duct is free, the bile appears to defcend into the duodenum in a perpetual current. That the quantity is very confiderable, appears from the magnitude of the fecretory organ, and the excretory duct, fo many times larger than the falival ones, and from difeafes, in which four ounces of the cyftic bile have flowed through an ulcer of the fide daily. The hepatic bile goes into the bladder, as often as there is any obftruction in the duodenal finus, from flatus or any other caufe compreffing the end of the ductus cholidochus. Accordingly, we find it extremely full, whenever the common biliary duct is obftructed or compreffed by fome fcirrhous tumor, whence the gall bladder is fometimes enlarged beyond all belief; and if the cyftic duct be tied, it fwells between the ligature and hepatic duct; and in living animals, the hepatic bile vifibly diftils into the wounded gall bladder. The retrograde angle, or direction of this duct, is not repugnant to fuch a courfe of the bile; for a very flight preffure urges it from the liver into the gall-bladder, and even air may be eafily driven the fame way, more efpecially if the duodenum be firft inflated. There does not feem to be any fort of bile feparated by the gall-bladder itfelf; for whenever the cyftic duct is obftructed by a fmall ftone, or a ligature made upon it, we find nothing feparated into the gall-bladder more than the exhaling moifture, and a fmall quantity of infipid mucus fecreted from the follicles. In many animals, we meet with no appearance of any gall-bladder, when at the fame time there is a plentiful flux of ftrong, well prepared, and falutary bile difcharged into the inteftines. Again, it does not feem probable, that the cyftic

branch

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 that from which the mild hepatic bile is prepared.

Laſtly, the bile flows alſo from the gall-bladder to the liver, and at length returns into the blood, when its paſſage into the inteſtines is totally intercepted. A latent cauſe in the nerves may alſo occaſion this regurgitation. 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

A portion of the hepatic bile being received into the gall-bladder, there ſtagnates, and is only a little ſhaken by reſpiration. By degrees it there exhales its thinner parts, which we ſee penetrate and filtrate through the adjacent membranes. The remainder being a fluid of an oily ſubalkaline nature, digeſted in a warm place, grows ſharp, rancid, more thick, bitter, and of a high colour: For this is the only difference between the cyſtic and hepatic bile; the later being weaker, leſs bitter, lighter coloured, and of a thinner conſiſtence, while it remains within its proper hepatic ducts. That the difference between 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 need for it, that afterwards it may be able to return it in greater plenty, when we principally

pally want it for the digeftion of the aliments now flowing in great quantity into the duodenum. This flow of the bile is quicker, in proportion, through the cyftic duct, as the fection of that duct is lefs than the fection of the gall-bladder.

The gall-bladder hardly touches the ftomach, but the beginning of the defcending duodenum. When the ftomach is extremely diftended, and the abdomen very full, it makes a confiderable preffure both upon the liver and duodenum; by which the gall-bladder is preffed, and its bile forced out. Thus the bile flows through a free paffage from the gall-bladder into the common duct and the duodenum: And this it does more eafily in perfons lying on their back; in which pofture the gall-bladder is inverted, with its bottom upward. Hence it is that the gall-bladder becomes fo full and turgid after fafting. The expulfive force of the bile is but little more than that of the preffure received from the ftomach and diaphragm; for, as to any mufcular force refiding in the fibres of the proper membrane, which may be thought to contract the gall-bladder, it muft be very weak and inconfiderable.

The hepatic bile is always bitter, but the cyftic is more fo; always vifcid; of a full yellow colour, with a tincture of green; mifcible, by triture, either with water, oil, or vinous fpirits; coagulable by mineral acids; diffoluble by alkalies, efpecially the volatile; and extremely well adapted to diffolve oily, refinous, or gummy fubftances; quickly putrefying, and by putrefaction fpontaneoufly degenerating to a mufk-like odour. Its chemical analyfis, and experiments of mixture with various fubftances, demonftrate, that it contains a large portion of water, and a confiderable quantity of inflammable oil, which appears very evidently in gall ftones. The bile, therefore, is a natural foap; but of that fort which is made from a volatile faline lixivium, mixed with oil and water. This, therefore, being intermixed with the aliment, reduced to a

pulp,

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 corrected, 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 the lacteals; the ſurrounding mucus 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 animal will periſh in a few days, if the flux of bile to the inteſtines be intercepted, by wounding the gall-bladder.

The bile deſcends ſlowly along with the alimentary maſs; and having ſpent its force, or changed its bitterneſs by putrefaction, moſt of it is afterwards excluded with the feces; but probably ſome of the more ſubtile, watery, and leſs bitter parts, are again taken up by the abſorbents. It returns with difficulty into the ſtomach, becauſe of the aſcent of the duodenum, which goes under the ſtomach; becauſe of the reſiſtance it meets with from the valvula pylori; and becauſe of 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 ſweet and mild in the foetus; for in them the blood ſeems not ſufficiently charged with putrid alkaline vapours, nor are there any oily or fat ſubſtances abſorbed from the inteſtines. As the bile is a viſcid fluid, in lazy, inactive, and fat animals and men, eſpecially if, from

from grief or any other caufes, the circulation is rendered more languid, it eafily coagulates into an hard, fomewhat refinous, and often ftony fubftance, infomuch that ftones of the gall are much more frequent, as experience teaches us, than thofe of the urinary bladder. Its ufe is manifeft, as, being triturated with the aliments, it diffolves oil, refifts acidity, and ftimulates the inteftines to contraction.

The ufe of the liver, befides fecreting the bile, is manifeft in the foetus. It feems to tranfmit the blood brought back from the placenta, and to break its force. Even in an adult perfon it has the fame ufe, though lefs manifeftly, namely, to retard the return of the blood coming back from the vifcera appointed for preparing the chyle.

§. 18. *Renes et Ureteres.*

Situation, figure, and divifion of the kidneys. The kidneys are two folid glandular bodies, fituated in the pofterior part of the cavity of the abdomen, on each fide of the lumbar vertebrae, between the laft falfe ribs and os ilium. The right kidney lies under the great lobe of the liver, and is confequently lower than the left, which lies under the fpleen.

The figure of the kidneys refembles that of a large bean, their circumference being convex on one fide, and concave on the other. The concave fide is turned to the vertebrae, and the convex fide the oppofite way. Their length anfwers to the diftance between the laft falfe rib and os ilium; they are about half as broad as they are long, and half as thick as they are broad.

In each kidney we obferve a fore and back fide, an upper and lower extremity, a great and fmall curvature, and a convexity and concavity.

The backfide is broader than the forefide; and the upper extremity is a little roader and more incurvated than the lower. The depreffion in the fmall curvature is oblong and

 uneven,

uneven, reſembling a ſinus, ſurrounded by ſeveral tubercles; and, as it is turned a little toward the foreſide, this ſide is ſomething narrower than the other.

Blood veſſels of the kidneys. The deſcending aorta and inferior vena cava lie between the kidneys, cloſe to the bodies of the vertebrae and to each other; the artery being on the left ſide, and the vein on the right. The renal artery commonly comes from the ſide of the aorta under the ſuperior meſenteric artery: That of the 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 antients termed the *emulgent arteries and veins*, but they frequently go under the name of *arteriae et venae 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 vertebrae, 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

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 improperly taken for a duplicature of the peritonæum; the true membranous lamina of which covers only the foreſide of the kidneys, and conſequently they lie without the peritonaeum, becauſe the portion of that membrane which covers them cannot be conſidered 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.

The external ſurface of this lamina is very ſmooth, poliſhed, and ſhining; 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 arteriae and venae adipoſae.

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,

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 till 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 papillae; 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. Thoſe ſmall

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 ſtriae are afterwards continued to the papillary portion; and the papillae 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 papillae, 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 papillae we ſee, even without a microſcope, in a ſlight depreſſion, ſeveral very ſmall holes, through which little drops may be perceived to run when the papillae are compreſſed. Theſe are little drops of urine, which, being filtered, partly in the cortical, partly in the medullary or tubular ſubſtance, afterwards paſs through the ſubſtance of the papillae, 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 papillae

pillae which lie therein; and ſometimes we find two or three papillae in the ſame infundibulum.

At the place where theſe infundibula ſurround the baſes of the papillae, they ſend productions into the medullary or radiated ſubſtance of the kidney, which accompany the blood-veſſels, and ſerve for capſules or vaginae to all the vaſcular arches, both arterial and venal, and to their different ramifications, quite through 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 papillae, each of them forms a ſmall ſhort tube or gullet, which uniting 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,

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 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 papillae are lodged; the great circumference of which produces, in the ſubſtance of the kidney, the different vaginae of the vaſcular arches and of their ramifications. The internal lamina of the kidney is continued round theſe vaginae; 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 vertebrae, 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

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 papillae 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 inflection, from the kidneys to the lateral parts of the inner or anterior ſide of the os ſacrum; and paſſing between the rectum and the 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 peritonaeum, 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

their natural ſituation, they appear like ropes lying behind the peritonaeum, and jutting out more or leſs toward the cavity of the abdomen, together with that portion of the peritonaeum which covers them.

All that has been ſaid about the ſtructure of the ureters, pelvis, arches, ſtriae, foſſulae, and holes at the apex of the papillae, appears moſt diſtinctly when they are examined in clear water.

§ 19. *Glandulae Renales, vulgo Capſulae Atrabiliariae.*

Situation, figure, and ſize of the renal glands. Immediately above each kidney lies a glandular body, called by the antients *capſulae atrabiliariae;* by others, *capſulae renales*, *renes ſuccenturiati*, and *glandulae renales;* and they might be properly enough termed *glandulae 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 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 arteriae renales and diaphragmaticae, and likewiſe from the aorta, from the arteria caeliaca, &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 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 capſulae, 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 greater 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

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 part of the capſular cavity, and the air likewiſe paſſes into the vena renalis, &c.

The cavity contains an unctous 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 phaenomena 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

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 through theſe that the air paſſes into the gland, as already mentioned.

On the outer ſurface of theſe capſulae we obſerve a very thin, diſtinct coat, ſeparated 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 capſulae are of a pale colour like a corpus adipoſum.

The liquor contained in them appears ſometimes, in the foetus, and in young children, of a bluiſh colour inclined to red.

To be able to diſcover the uſes of theſe capſulae, we muſt not only atend to the two circumſtances already mentioned, but alſo to their external conformation, which is commonly more regular in the foetus 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 ſome of 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 flefhy pouch or bottle, capable of dilatation and contraction, fituated in the lower part of the abdomen immediately behind the fymphyfis of the offa pubis, and oppofite to the beginning of the inteftinum rectum. The figure of it is nearly that of a fhort oval. It is broader on the fore and back fides 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, pofterior, 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 mouth of fome veffels.

Structure of the bladder. The bladder is made up of feveral coats, almoft like the ftomach. That part of the external coat which covers the upper, pofterior, and lateral fides of the bladder, is the true lamina or membrane of the peritonaeum; and the reft of it is furrounded by a cellular fubftance, by the intervention of which, the peritonaeum is connected to the mufcular coat.

The proper coats are three in number; one mufcular, one cellular, and an internal fmooth one commonly called *villous coat.* The mufcular coat is compofed of feveral ftrata of flefhy fibres;

fibres; the outermoſt of which are moſtly longitudinal; the next to theſe are more inclined toward each ſide; 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 veſicae*. 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 rugae when empty, and in its natural ſtate of contraction. Theſe inequalities 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 peritonaeum and the linea alba of the abdomen, all the way to the navel, diminiſhing gradually in thickneſs as it aſcends. This rope in the foetus is in part a production of the inner coats of the bladder, which production is termed *urachus*.

Arteriae umbilicales. This rope is compoſed likewiſe of two other ligamentary elongations, which are the extremities of the umbilical arteries. Theſe arteries come from the hypogaſtricae, run up by the ſides of the bladder, and remain hol-

low

low and filled with blood, even in adults, as high as the middle of the bladder, through all which ſpace they likewiſe ſend off ramifications. 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 oeſophagus. This incurvation paſſes behind the urachus.

The portion of the peritonaeum which covers the poſterior 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 towards 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 two other 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. Sabatier calls them 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;

bic. This elongation is called the *neck of the bladder*, the defcription of which belongs to that of the parts of generation in men.

The other two openings in the true fundus of the bladder, are formed by the ureters, which in their courfe downward, already defcribed, run behind the fpermatic veffels, and then behind the lower part of the bladder, approaching each other. Each ureter lies between the umbilical artery and vas deferens of the fame fide; the artery lying on the outfide of the ureter, and the vas deferens on the infide.

Afterwards they get between the vafa deferentia and the bladder, croffing thefe canals; aud 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 mufcular and nervous coats, and open into the bladder obliquely, fomething nearer each other than when they firft entered the coats.

The orifices of the ureters in the bladder are fomething oval, and narrower than the cavity of the ureters immediately above them. The edge of thefe orifices is very thin, and feems to be formed merely by the union of the internal coat of the bladder with that of the ureters.

Blood veffels and nerves of the bladder. The arteries of the bladder are furnifhed by the hypogaftricae or iliacae internae, being rami of the arteria fciatica, epigaftrica, and umbilicalis on each fide. The veins return to the internal iliac veins.

The nerves of the bladder come from the crurales, and alfo from the fympathetici maximi, by means of their communication with the crurales. It has likewife fome nerves from the plexus mefentericus inferior.

Befides the ligaments already mentioned, there are likewife two fmall ones, by which the anterior part of the true fundus of the bladder is connected to the offa pubis, which fhall be defcribed with the neck and fphincter, after the hif-

tory

tory 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 of Urine.*

THE chyle, when it enters the blood, contains a very large portion of water, which would be liable to lodge in the cellular ſubſtance, if it was not expelled again from the body. A part of it is therefore exhaled through the ſkin; and another part, as large, or often larger than the former, is ſtrained through the kidneys, and is thus expelled out of the body.

Dr Haller obſerved, "that the blood of the renal artery moving ſlower, 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 the rectilineal tubes of the papillae. This water contains fine oils and ſalts, intermixed with earthy particles, or ſuch other matters as are thin enough to paſs through with it. The ſmall diameter of the origin of each uriniferous duct, and its firm reſiſtance, ſeems to exclude the thick oil, chyle, and the coagulable lymph; but, as theſe uriniferous ducks are always open, if the velocity of the blood be increaſed, or a morbid laxity of the parts ſupervenes, they eaſily tranſmit the above mentioned thick parts of the blood along with the thinner. The diſeaſe hence ariſing, is called diabetes, which may be cured by reſtoring the kidneys to their former healthy ſtate, by the uſe of aſtringents and tonics. The nerves have ſome 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. A vaſt quantity of it 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 is changed by the kidney into this fluid.

The urine, by fire or putrefaction, ſometimes by diſeaſe, in ſome animals more eaſily than in others, changes into a volatile alkaline nature, intimately mixed with a fetid oil. This oil which is partly empyreumatic, yellow, volatile, tenacious, ſeparable only by the greateſt degrees of fire, is known by the denomination of phoſphorus; it is a ſhining ſubſtance, taking fire ſpontaneouſly in the air. The urine 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 from the ſolid parts of the body diſſolved and mixed with the blood. There is alſo a conſiderable proportion of ſea-ſalt 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, both of men and brutes, wholly deſtitute of a vitriolic acid, or at leaſt a ſimilar acid. There is likewiſe in the freſh urine a fuſible cooling ſalt, ſimilar to nitre. In fevers, the oily and ſaline parts of the urine are greatly augmented, both in quantity and acrimony.

That the urine is ſeparated in the kidneys is ſhewn experimentally, by preſſing it out of their veſſels. That it deſcends by the ureters is ſhewn by the ſurpriſing ſwelling of the kidney, and that part of the ureter which is above, as well as the emptineſs of that part which is below the ligature. 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.

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

der alſo abſorbs; and although 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 peritonaeum; nor is it probable 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 peritonaeum. Beſides, membranes, when wet, have their pores filled, and conſequently are leſs adapted for imbibing either vapours or fluids. The bladder may be ſo diſtended with urine as to produce death; yet, in theſe caſes, we never obſerve that the urine has found any paſſage through which it might eſcape into the pelvis. Again, 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 kidney 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 received into the ſtomach, like the external cold applied to the ſkin, cauſes a concuſſion of the bladder and urinary parts, by which they are ſollicited 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 they cannot receive much leſs than an eight part of the blood of the whole body at a time, and conſequently above 1000 ounces of blood are conveyed through the kidneys in an hour; and it will appear but a moderate allowance for 20 or even 50 ounces of water to diſtil from that quantity of blood in the ſame time. Finally, it is certain that both men and brute animals periſh if the ureters are

are obſtructed by a ligature, or otherways; we then obſerve alſo that no urine can be found in the bladder.

Experience aſſures us that the urine flows into the bladder in a continued ſtream: By ſtaying ſome time in the bladder, and from the abſorption of the more watery part, the urine acquires an higher colour, and becomes ſharper. We are not fully acquainted with the cauſe which retains the urine in the bladder. The ſphincter is obſcure; the ſituation of the bladder lying on the rectum may probably contribute to the retention of the urine. Certain it is that the urine does not flow ſpontaneouſly, even from a dead carcaſe.

At length, by the bulk and acrimony of the urine irritating the ſenſible fabric of the bladder, it is thence expelled, partly by the motion of the diaphragm and abdominal muſcles preſſing the inteſtines againſt the bladder, by which means, eſpecially in an erect poſture, the urine makes itſelf a way through the narrow and impeded paſſage; and partly by the periſtaltic motion of the bladder itſelf, ariſing from the contraction of its muſcular fibres.

By the urine, beſides the particles of food and water, much matter that is noxious to the human body ſeems to paſs off, 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; a ſparry or gypſeous earth; and 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 acute fevers, and ſeveral morbid affections of the brain.

§ 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

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 oeconomy 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, veſiculae 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 rugae 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 perinaeum, 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

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 rugae 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 rugae diſappear more or leſs, according to the degrees of the preternatural ſtate or indiſpoſition.

The dartos of the ſcrotum has been accounted a true cutaneous muſcle; but it 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 expanſion, which is ſtrongly united to the internal cellular membrane. We have often ſhewn this as a particular faſcia lata, which gives inſertion to the portions of the dartos juſt mentioned, and as a broad fraenum which keeps the ſame portions together.

The

The aponeurotic or ligamentary expanſion of the dartos is fixed in the ramus 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 capſulae, 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 laminae, 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 antients termed it likewiſe *elytroides* from a Greek word that ſignifies the ſame thing.

The

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 antients 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 antients named them *didymi* or *gemini*. Their ſize is nearly that of a pigeon's egg, and they are of an oval figure, a little flated at each ſide. But they are frequently unequal in ſize in the ſame perſon. Fabricius ab Aquapendente, was conſulted frequently by perſons who believed they had got a diſeaſed teſticle, becauſe it was larger

than

than the other one; but, upon examination, it was found they had no inconvenience from it. We may confider in each tefticle two extremities, two edges, and two fides. One extremity is fituated 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 feveral coverings; and they are both fufpended in the common covering, called the *fcrotum*.

Each tefticle is a fpermatic gland formed by a vaft number of fine whitifh tubes, folded and twifted in different manners, and diftributed in different fafciculi, between membranous fepta; the whole being furrounded by a ftrong common covering, named *tunica albuginea*.

Thefe fepta are difpofed longitudinally, divaricating from each other on one fide, and approaching on the other. They approach each other along one edge of the tefticle, and terminate in a long narrow whitifh body, as in a kind of axis.

From thence they divaricate in a regular manner, and are fixed by their oppofite edges in the inner furface of the tunica albuginea, of which they appear to be a continuation. This white body may be termed the *nucleus* of the tefticle, or by fome has got the name of *corpus Highmorianum*.

From this defcription we fee, that all thefe fepta are not of an equal breadth; that the interftices between them are in fome meafure triangular; and that the extent of the fmall tubes, which lie therein, muft be very confiderable. They have been reckoned to amount to many yards, by taking the fum of all their feveral portions; and they may be eafily unfolded by a long maceration, which deftroys the delicate fubftance by which all their folds and convolutions are connected and tied down.

The feminal veffels are ferpentine, firm, folid, and exceedingly fmall; they have been filled with quickfilver, &c. by feveral anatomifts, and firft by Dr Monro, Hunter, and Haller. They are collected into above twenty bundles, divided by diftinct cells or partitions, which defcend from the tunica albuginea to conduct the arteries or veins. In each of thefe cells there is a feminiferous duct to convey the fecreted humour from the tefticle. The ducts form a net-work, adhering to the furface of the albuginea, and forming inofculations one with another. From this net-work, in the upper part of the tefticle, ten or twelve ducts afcend; which being contorted together into folds, form as many vafcular cones, that are joined together by an intermediate cellular fubftance; and, lying incumbent one upon another, there form the

Epidydimis, which goes round the outer and pofterior margin of the tefticle, to which it adheres by its thicker head, joined with a good deal of cellular fubftance: While in its lower, middle, and more flender part, it partly adheres, and is partly free; fo as to intercept a fort of impervious bag between itfelf and the tefticle. The vafcular cones, at the upper part of the epidydimis, by degrees uniting, form at length one duct, which compofes the greater part of the tefticle (*fee* Monro de Teftibus), and which grows larger as it defcends, being largeft at the bottom of the tefticle; from whence again afcending along the pofterior face of the tefticle, in a contrary direction, it by degrees fpreads open its fpiral convolutions, and comes out much larger, under the name of *vas deferens*.

The epidydimis thus formed, may be reckoned a production of the tefticle, or a kind of teftis acceflorius; and it refembles in fome meafure an arch fupported by its centre or frame. It is more contracted at the middle than at the extremities, by which it is clofely united to thofe of the tefticle.

Between

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.

Besides the ducts commonly described in the epidydimis; late anatomists have sometimes found a duct going off from the epidydimis; but its termination was not well understood. It was supposed to terminate in the lymphatic system; 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 arteriae renales. Their origin oftentimes varies: for I have observed them to arise from the renal artery; 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

They run down obliquely in the poſterior part of the abdomen within the cellular ſubſtance of the peritonaeum, paſſing inſenſibly from behind forward; and ſo parting gradually more and more from the aorta, they croſs over the fore-ſide 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 peritonaeum.

They are ſmall at their origin; and, in their courſe downward, they give off very conſiderable lateral ramifications to the membrana adipoſa, peritonaeum, 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 areolae 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 peritonaeum, which ſerve them for vaginae. They do not fluctuate indifferently from one ſide to the other of theſe vaginae; but are connected along their inner ſurface by thin membranous laminae, which are likewiſe continuations of the cellular ſubſtance of the peritonaeum.

The arteries continue the ſame winding courſe within theſe vaginae, paſſing before the vaſa deferentia, which are likewiſe contained in the vaginae; 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

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 miſeraica, 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 through the abdomen, they receive branches from the peritonaeum, meſentery, &c.

They differ from the ſpermatic arteries, not only in being larger, and having thinner coats, but alſo in being more divided and multiplied in the abdominal muſcles; and as they are formed of a large faſciculus of ramifications, the antients gave to them, and to the arteries, the name of *vaſa pyramidalia.*

Theſe ramifications often communicate with each other in this courſe, and form a great number of areolae, contortions, and convolutions, ſo as to repreſent a kind of plexus, which is connected to the cellular vagina of each ſide by very fine laminae; and the artery which accompanies the vein croſſes it in ſeveral places, and runs through the areolae 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, made it be 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

ture 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 muſt be 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 conſidered as a vagina; the internal ſubſtance of which is moſtly cellular, and connects all the veſſels together, while the external forms a covering to inveſt them.

The vas deferens having reached the membranous lamina of the peritonaeum, 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 peritonaeum, 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

peri-

peritonaeum 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 large and plaited, becomes immediately afterwards 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.

Veſiculae ſeminales. The veſiculae 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

tremities 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 proſtrates, 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 veſiculae is plaited, and in a manner diſtinguiſhed into ſeveral capſulae by contorted folds. Their external ſurface is covered by a fine membrane, which ſerves for a border and fraenum to the folds, and is a true continuation of the cellular ſubſtance of the peritonaeum. The veſiculae 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, that the veſiculae receive from the vaſa deferentia, and of which they are the reſervatories for a certain time.

The paſſage of the vaſa deferentia into the veſiculae is very particular. We have already obſerved that theſe 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 veſiculae; and this union is ſo cloſe, that the adhering portion ſeems 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

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 two 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 veſicula 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.

Proſtatae. 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 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 veſiculae 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 foreſide 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 poſterior ſide 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

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 papillae, 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, 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 vesiculae seminales; of which hereafter. Each orifice has a small thin membranous border, which may serve for valves to the excretory ducts of the vesiculae.

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

and run in an oblique courfe to the orifices, in a kind of membranous duplicature.

Corpora cavernofa. The corpora cavernofa are two ligamentary and very limber tubes, united laterally to each other through the greateft part of their length, and folid 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 Υ; and diminifhing gradually in fize after the divarication, terminate in an oblique point. Thefe divaricated and pointed extremities may be called the *roots*, and the round extremities the *heads*.

Thefe two bodies are almoft cylindrical, being round, and of an equal diameter from the roots to the heads, where they are in fome meafure conical. The ligamentary fubftance of their fides is elaftic, and compofed of fine clofe fibres, which are partly tranfverfe, and partly more or lefs oblique.

The cavity of thefe ligamentary tubes is entirely filled by ftrong cellular or cavernous fubftance, which does not feem to be a continuation of the fubftance of the fides. Thefe cells communicate with each other, and are always more or lefs full of blood, refembling very much the cellular fubftance of the fpleen, only with this difference, that the fides of the cells are thicker in thefe cavernous bodies, and without any additional fubftance.

By the union of the two corpora cavernofa, two external grooves are formed; one on the upper fide, the other on the lower. The lower groove is fomething broader than the upper; and it is filled through its whole length by a third tube, narrower than the corpora cavernofa, called the *urethra*; which fhall be prefently defcribed.

The roots of the corpora cavernofa are fixed, each to the edge of the fmall ramus of the ifchium and os pubis. They meet at the fymphyfis of the offa pubis, where each of them becomes

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

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.

Lacunae 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 lacunae of different ſizes, the largeſt lying near the glans.

Theſe lacunae 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 lacunae are ſemilunar, or like a creſcent, becauſe of the obliquity of their opening.

Anti-proſtatae. A little way before the veru-montanum, without the urethra, we meet with two lacunae more conſiderable than the reſt, and their ducts are very long. Theſe lacunae and ducts lead to two glandular bodies, ſituated, one on each ſide, between the poſterior and lateral parts of the muſculi acceleratores urinae, 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 *proſtatae inferiores*; but if their ſituation be carefully examined, they will be found to be higher than the true proſtatae. They are likewiſe termed *glandulae mucoſae of Cowper*, who has given a deſcription of them (*ſee* Phil. Tranſ. 1699); but they were firſt deſcrib-

ed

ed by Mery in 1684 They feem to be wanting in fome fubjects; for certain anatomifts of accuracy have fearched for them without finding them. A third gland of this kind is defcribed by Cowper as being feated a little more anteriorly; but this alfo, Heifter obferves, is wanting in bodies diffected by our beft anatomifts.

Orifice of the urethra. The cavity of the urethra refembles nearly that of a fmall writing pen. It is not every where round, and towards the glans becomes broader and flatter on each fide, efpecially in the glans itfelf, where there is a kind of oval or navicular foffula.

This canal terminates at the extremity of the glans by a narrow oblong orifice or fiffure, which is much lefs than the reft of the cavity. The commiffures of this fmall fiffure are turned, one toward the convex, the other toward the flat fide of the glans; and the labia of the fiffure are its lateral parts; and it feems to be furrounded by flefhy fibres.

The common integuments. The integuments which cover all thefe parts are three or four in number. The firft is the fkin with the cuticula; the fecond is the common cellular membrane, which in this place feldom contains any fat; the third is termed *nervous;* and the fourth is a particular cellular membrane, which is not always to be found.

Praeputium. The firft of thefe integuments, the fkin, is a continuation of that of the pubes and fcrotum; and it adheres to the fecond all the way to the bafis of the glans, where that fecond integument ends. The reft of the cutaneous integument covers the glans without adhefion, and terminates by an opening. This portion is named *praeputium;* and along the whole lower or back fide of the whole integument in general, and of the praeputium in particular, there runs a fine future, which is a continuation of the raphe of the perinaeum and fcrotum.

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The inner ſurface of the praeputium 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 of it, 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 glans, and internal membrane of the praeputium, 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 praeputium; for which reaſon it is called *fraenum praeputii.*

The ſurface of the internal membrane of the praeputium 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 glandulae ſebaceae, 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 baſis of the muſculi pyramidales of the abdomen.

This

This ligament has been called *ligamentum elasticum*, becaufe it yields and recovers itfelf; and *fufpenforium*, becaufe it fufpends thefe parts, by means of its infertion in the fymphyfis. It fends off a detachment or ala toward each fide, one edge of which is fixed between the mufculus triceps and the corpus cavernofum, and forms the ligamentary expanfion in which the dartos is inferted, as has been already faid. It feems likewife to fend down another elongation directly to the perinaeum and anus.

The fourth integument of thefe parts is the tunica cellulofa of Mr Ruyfch, which immediately furrounds the corpora cavernofa and urethra, lying between thefe and the third integument, from which it feems to be diftinguifhed only by the clofenefs and finenefs of its texture; and it is fometimes hardly perceivable.

The mufcles. Several mufcles are inferted in the parts which we have juft defcribed. They are fix in number; two for the corpora cavernofa, two for the urethra, and two common mufcles, called *tranfverfales*. (See Vol. I.)

Blood veffels. The arteries of thefe parts come chiefly from the iliacae internae or hypogaftricae, and the reft from the iliacae externae or crurales. The principal arteries are termed *pudicae*, of which one is external, the other internal.

The pudica externa fends a branch to each fide, which having paffed out of the pelvis by the fide of the os facrum, runs on the infide of the tuberculum ifchii, to the roots of the corpora cavernofa, along the infide of the mufculi ifchio-cavernofi or erectores. It fends ramifications to the bulbous head of the urethra, and to the corpora cavernofa; and, together with the glutaeae, with which it communicates in its paffage, it likewife fupplies the fcrotum.

The pudica interna having furnifhed the inteftinum rectum, bladder, veficulae feminales, and proftates, communicates with the haemorrhoidales, paffes under the arch of the offa pubis, and partly enters the corpora cavernofa, and partly runs along their upper fide, fending off fmall lateral branches, which furround thefe bodies, like irregular half arches, and penetrate them by numerous ramifications.

The crural arteries fend each likewife a branch, which, running behind the contiguous crural vein, is diftributed to the integuments of the penis, by the name of *pudica externa*, and communicates, by lateral ramifications, with thofe of the pudica interna. Thefe communications are not only between the internal and external pudicae of the fame fide, but alfo between thofe of both fides, which reciprocally communicate with each other.

The diftribution 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 fuperior groove formed by the union of the corpora cavernofa. It paffes directly under the fymphyfis of the offa pubis, between the two arteries. It is very large, often double, and very feldom triple, but the trunks do not feparate while in the groove; and it has a great number of valves.

This great middle vein opens into the branches of both hypogaftric veins. The lymphatic veffels of the penis appear to go chiefly into the plexus in the groin, on the two inner fides of the pelvis, about the middle of the arch of the offa pubis. At this place we obferve a venal plexus, which covers the upper convex fide of the firft portion of the urethra, before it is furrounded by the fpongy fubftance.

The fpermatic veffels, of which we have already defcribed the origin and courfe all the way to where they go out of the abdomen, having reached on each fide near the tefticle, are divided into two principal fafciculi, one of which is larger than the other. The largeft is the anterior, and is diftributed through the tefticle, by a prodigious number of very fine capillary

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 the ligamentary integument; being ſo diſpoſed, as that the arteries lie between them and the middle vein. They muſt be examined ſoon after the ſkin has been raiſed, becauſe, when the ramifications are dried by the air, they diſappear.

The nerves of the teſticles 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 produced from the union of the ſecond, third, and fourth

pairs

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 parts of generation conſtantly ariſe near the kidneys, almoſt in all kinds of animals; by which nature ſemes to have intended a double uſefulneſs in one organ, which might be able to diſcharge the urine and ſemen. The ſituation of the parts of generation at the lower part of the trunk, and between the thighs, conduces much to cleanlineſs and to facilitate parturition.

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 iniquiry into theſe particulars.

The teſticle is defended by various integuments, and is compoſed of various kinds of veſſels and of nerves, as have been already deſcribed.

The blood, brought by a very ſlow motion through the ſpermatic artery to the anterior ſubſtance of the teſticle, is there diſtributed and conveyed into the ſeminiferous veſſels; but 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 exceedingly ſmall, ſerpentine, firm, ſolid, and have a very ſmall capacity in proportion to their membranes They are collected together, as has been deſcribed above, and terminate in the vaſa deferentia.

The

The ſemen is conveyed by the vaſa deferentia into the veſiculae ſeminales, being 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. This ſuppoſition is confirmed by the numerous ſpires and convolutions formed by the epidydimis, obſtructing almoſt every kind of injection; and, by the length of time that is required to fill the ſeminal veſicles again, after they have been once exhauſted.

The cylindric vas deferens, conſiſting of a very thick ſpongy ſubſtance, included between two firm membranes, 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 between the ureters, it ſoon after meets the ſubjacent receptacles, called the right and left *veſiculae ſeminales* Here it goes along the inner ſide of the veſicle, as far as the proſtate gland; and, dilating in its paſſage, forms a ſerpentine flexure, that begins 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 ve y acute angle, which at the ſame time forms a conical duct; which being continued 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 ſtraightened, 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 liquor into the vas 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 vas deferens conveys all its ſemen,

without

without further delay, in a retrogade angle, to the *ſeminal veſicles*.

The liquor brought from the teſticles by the vaſa deferentia, is yellowiſh, thin, aud watery; but in the veſicula ſeminales it becomes ſomewhat thicker and higher coloured. It is white in man when it has been mixed with the liquor of the proſtate. It has a peculiar ſmell in each claſs of animals; and it is the heavieſt humour in the human body In water a part ſeparates 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 retained 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 ſhews, that in man, as well as in all other male animals, the ſeminal liquor is full of living animalcula, reſembling eels, only with a thicker head; and that theſe are always preſent in healthy ſemen after puberty; but, before that time, and in thoſe who are ſterile from a gonorrhoea, they are abſent. That they are animalcula, appears evidently from their various apparent motions and geſtures.

It has been much doubted what could be the uſe of theſe animalcula; 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 animalcula as the ſame with that of the eels in vinegaror paſte.

That

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 gland. That liquor, however, only fecundates, which is generated in the teſticles, as we ſee in eunuchs, who, 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 exercifes venery, nor ſports in imaginary dreams. It is always a ſtimulus to the animal appetite of venery, as long as it is there preſent in any quantity. Beſides this, there is a conſiderable ſtrong, volatile, and odorous part of the ſemen reabſorbed 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 example 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 ſchirrhoſity 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 an

artery.

artery. Its generation is accelerated by love, by the prefence of the beloved woman; fo that it diftends its veffels with a fenfe of pain. Nature herfelf, therefore, enjoins venery, both for preferving the human race, and the health of every individual. That it comes from the tefticle, is fhewn by difeafes; in which the vas deferens being obftructed, a fwelling of the tefticle has enfued. The veficles are never emptied, except by venereal actions and appetites.

In order that the femen, which is only in a fmall quantity, fhould be projected with a confiderable force, it is previoufly mixed with another fluid from the proftate. This gland prepares a thick, white, foft, cream-like liquor, in a large quantity, which is poured out at the fame time, and from the fame caufes, with the femen itfelf, into a little channel at each fide of the openings of the feminal veficles, where, mixing with the feminal fluid, it imparts the white colour and vifcidity which the femen poffeffes.

It was neceffary for the canal of the urethra to be firm and capable of a direct figure, that it might be able to throw the femen with fome ftrength into the diftant womb; and therefore a threefold cavernous body furrounds it.

Into the cavernous body of the urethra, the blood is poured out from the arteries, which come from deep branches fent off from the external haemorrhoidals; the truth of which is demonftrated by the injection of any kind of fluid, which, being urged through the arteries, eafily flows into thofe cellular fpaces furrounding the urethra. Thefe cells are not naturally turgid with blood, becaufe 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 compreffing thofe veins, the blood is then retained within the cellular fpaces, while the arteries continue to carry it more fwiftly and ftrongly than the veins return it. Thus the ftagnant blood

blood diſtends the bulb of the urethra, together with its cavernous body, and the glans itſelf. This diſtention is generally performed 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 cauſes of this erection are love; the deſire of pleaſure; the friction of the glans; various irritations of the bladder, teſticles, ſeminal veſſels, and urethra, from the urine, from abundance of good ſeed, from the venereal poiſon, from cantharides, whipping the parts, and, laſtly, from convulſion of the nerves. The proximate 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 ſhould 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 breaſts, in the looſe pendulous gills of the turkey cock, and in the bluſhing or redneſs of the face from paſſions of the mind, erection may be produced without the immediate interpoſition of any peculiar muſcle. This ſuppoſition is confirmed by brute animals, which all couple without the uſe of any erector muſcle; by the

the erections which take place in animals totally different from man, and especially those which take place in birds very quickly; and by the inactivity of the erector muscles themselves in the libidinous erection of the penis, and from their unfitness for compressing the veins. It is also probable, that an erection may be produced by the numerous ramifications of the nerves exciting a convulsive constriction of the veins; while, at the same time, the arteries, by an increased velocity of the blood, bring more blood to the parts than the veins can carry off. The cause of this convulsion is perhaps inherent in these nervous sphincters themselves, and depends either on a mechanical irritation of the nervous fibres, or on the force of the imagination.

A long continued and violent erection is at last accompanied with an expulsion of the semen; and this requires much greater force than is requisite for the erection only. For the semen is expelled when the irritation of the nerves is arrived at its greatest height: and in natural venery, 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 papillae, 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 by the exquisite sensibility of 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

Soon afterwards the powers conftringing the urethra are, from the irritation of the very fenfible fabric of that canal, put into action. To this conftriction conduces principally the accelerator, which makes a powerful concuffion of the bulb and adjacent part of the urethra, fo as to propel its contents more fwiftly. But that this may act firmly, the fphincter of the anus, together with that of the bladder, muft be well fhut. The accelerator mufcle feems alfo principally concerned in the erection, by compreffing the veins of the corpus cavernofum of the urethra. At the fame time the *erectores penis*, as they are called, arifing from the tubercles of the ifchium, become tenfe, and are inferted into the cavernous bodies, fuftaining the penis as a fort of medium between the tranfverfe and perpendicular direction. Thus the femen is driven into the vagina, and into the uterus itfelf, in a prolific coition: the whole action of which is very impetuous, and comes near to a convulfion; whence it wonderfully weakens the habit, and greatly injures the whole nervous fyftem, as the maladies arifing from thence, in confequence of the affection of the nerves, without which the femen cannot be expelled, feem to indicate.

§ 5. *The Parts of Generation in Females.*

THE parts of generation in females are feveral in number, fome of them external, and fome internal; and they are all fubordinate to one principal internal part, called the *uterus*. The other internal parts are the tubae Fallopianae, ovaria, vafa fpermatica, ligamenta lata, the ropes or bands called *ligamenta rotunda*, and the canal of the uterus. The external parts are the pubes, the alae nymphae, clitoris, orifice of the urethra, and the orifice of the vagina.

Uterus. The uterus lies between the bladder and the inteftinum rectum. It is a body inwardly hollow, outwardly of

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a whitiſh colour, of a ſolid ſubſtance, and, except in time of pregnancy, of the figure of a 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 neck of the uterus, ſo that only a ſmall probe 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 lymph.

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

to paſs, when the whole uterus is compreſſed; and ſometimes it appears to have very ſmall hairs or villi. 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 neck, 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 rugae obliquely tranſverſe, and diſpoſed like branches, the longitudinal lines repreſenting trunks. Between and round theſe rugae, there are ſmall lacunae, through which a mucilaginous fluid is diſcharged that cloſes the orifice of the uterus. We ſometimes obſerve in the interſtices between the rugae, ſeveral tranſparent globular corpuſcles, which vary very 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 peritonaeum, which ſerves it for a coat, and is the continuation of that which covers the bladder and 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 poſterior ſide, and afterwards going to the rectum.

On each lateral part or edge of the uterus this portion of the peritonaeum forms a broad duplicature, which is extended on each ſide, more or leſs directly to the neighbouring la-

teral

teral parts of the pelvis, forming a 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 peritonaeum, on the ſides of the pelvis.

Broad ligaments of the uterus. Theſe two broad duplicatures have the name of *ligamenta lata*, and *veſpertilionum alae*. 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 laminae of all theſe duplicatures are connected by a cellular ſubſtance, in the ſame manner as the other duplicatures of the peritonaeum; 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 veſiculae, called *ova*; the number of which, according to Dr Haller, is found to be fifteen and upwards, though 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 veſiculae very cloſely, and ſeems likewiſe to furniſh them with diſtinct ſpongy coverings or calices. Theſe veſiculae are carefully to de 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 ligaments of 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 confidered as vafa deferentia.

Tubae Fallopianae. The Fallopian tubes are two flaccid, conical, and vermiform canals, fituated more or lefs tranfverfely on each fide 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, though by fo narrow a duct, as hardly to admit a large briftle. 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 tubae goes in a winding courfe, and their large extremity is bent toward the ovaria.

Thefe large extremities are irregulary round, and terminate by a narrow orifice, a little plaited and turned toward the ovarium, where it prefently expands in form of a membranous fringe, full of plaits and incifures. Thefe 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 longeft fegment of the fringe reaches to, and is fixed in the ovarium. The folds are difpofed like laminae on the concave fide.

Thefe tubes are compofed of flefhy fibres, whereof fome are longitudinal, and fome obliquely circular, with an intertexture of another very fine fubftance.

The anterior pinions of the ligamentum latum ferve for a common or external coat to both tubes, and alfo to connect them, in the fame manner as the mefentery connects the inteftines. From thence the tubes, and efpecially their fringes, come

come to be loofe, and their direction to be very imperfectly determined.

Their cavity is lined by a foft glandular membrane, which is plaited longitudinally, almoft like the inner furface of the afpera arteria; and thefe folds are ftronger and broader near the great extremities than any where elfe. Their fubftance feems to be fpongy, and the interftices between them are moiftened more or lefs by a fluid which is continually dif-charged there.

Blood veffels. The blood veffels of thefe parts are of different kinds, viz. the hypogaftric arteries and veins, the ramifications of which belong chiefly to the body of the uterus; the fpermatic veffels, and the two vafcular ropes, called *ligamenta rotunda*, which might be more properly termed the *vafcular ropes of the uterus* or of the *ligamenta lata.*

The hypogaftric branches are arterial and venal ramifications, arifing from the artery and vein of the fame name; which having reached the lateral edges of the uterus, are diftributed to all its parts, both internal and external, forming a great number of incurvations and particular intertextures.

The arteries of one fide communicate both upon the uterus, and through its whole fubftance, with thofe of the other fide; and the arterial ramifications of each fide form numerous anaftomofes with each other. The veins communicate together on each fide in the fame manner; and all thefe blood-veffels communicate likewife with the fpermatic veffels, with the vafcular ropes of the ligamenta lata, and with the haemorhoidales.

Thefe frequent anaftomofes may be demonftrated by injecting or blowing into the hypogaftric veffels, having firft made proper ligatures to prevent the liquor or air from running into other parts. The extremities of thefe arteries terminate and open into the cavity of the uterus, as has been already

already ſaid; and there is this peculiar to the veins, that they communicate with the haemorrhoidales, and conſequently with the vena portae.

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 hypogaſtrics, 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 meſeraicae and vena portae.

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 angle 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

through the openings of the abdominal mufcles, and are loft in the fat of the upper and middle parts of the groins. As they pafs out of the abdomen, they are accompanied by a production of the cellular portion of the peritonaeum, as the fpermatic rope in men, and by a fafciculus of flefhy fibres, reprefenting a kind of cremafter.

Nerves, lymphatics, &c. Befides all the veffels hitherto mentioned, we obferve nerves and lymphatics, to which we may add the lactiferous ducts that are feen in an advanced pregnancy. The nerves come from the lumbares, facri, and fympathetici maximi, in the fame manner as in males. The lymphatic veffels run chiefly in the coats continued from the peritonaeum.

Pubis. The pubis is that broad eminence at the lower part of the hypogaftrium, between the two inguina, on which the hairs grow at a certain age, called in Latin by the fame name, and almoft of the fame kind with thofe found under the axillae. This eminence is owing to a particular thicknefs of the membrana adipofa which covers the fore part of the offa pubis, and fome fmall portions of the neighbouring mufcles.

Sinus and alae. The longitudinal cavity which reaches from the middle and lower part of the pubes, within an inch of the anus, was by the antients termed *finus*; and they called the lateral parts of the cavity *alae*, which is a more proper name than that of *labia*, commonly given to them. The places where the alae are joined above and below are termed *commiffures*, and may likewife be called *the extremities* or *angles of the finus*.

The alae are more prominent, and thicker above than below, and lie nearer each other below than above. They are chiefly compofed of the fkin, cellular fubftance, and fat. The exterior fkin is a continuation of that of the pubes and inguina. It is more or lefs even, and furnifhed with a great

number

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 alae is ſomething like the red portion of the lips of the mouth; and it is diſtinguiſhed 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.

Lacunae. Near the inner edge of the inner ſurfaces of the alae, on each ſide of the orifice of the vagina, we find a ſmall hole more viſible than the reſt. Theſe two holes are termed *lacunae*, and they communicate by two ſmall ducts with the ſame number of follicular bodies lying in the ſubſtance of the alae, and which may be conſidered as ſmall proſtates, anſwering to the glandulae proſtaticae 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 conſidered as the ligamenta ſuſpenſoria of the alae. The inferior commiſſure of the alae 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 *perinaeum*, is about a large finger's breadth in length.

The other external parts are ſituated in the ſinus, and hid by the alae. Directly under the ſuperior commiſſure lies the clitoris with its cover, called *praeputium*. A little lower is the orifice of the urethra; and below that is the orifice of

the

the great canal of the uterus. The circumference of this orifice is bordered, either by a membranous circle, called *hymen*, or by flefhy portions, termed *carunculae myrtiformes*. On each fide of the clitoris begins a very prominent fold, like a crifta, which runs down obliquely on each fide of the orifice of the urethra. Thefe folds are termed *nymphae*, and they might likewife be named *crifta clytoridis*. On each fide of the great orifice lies the fmall proftatic hole already defcribed.

Clitoris. The clitoris appears at firft fight like a fmall imperforated glans. Its upper and lateral fides are covered by a kind of praeputium, formed by a particular fold of a portion of the inner fide of the alae, which appears to be glandular, and to difcharge a certain moifture, and its infide is granulated.

By diffection, we difcover in the clitoris a trunk and two branches, as in the penis, confifting of a fpongy fubftance, and of very elaftic coats, but without any urethra. This fubftance may be inflated either by air or anatomical injections into the artery, &c. The trunk is divided into two lateral parts by a middle feptum, from the bifurcation to the glans, where it is infenfibly loft.

The bifurcation of the trunk is on the edge of the cartilaginous arch of the offa pubis; and the branches, which refemble the roots of the corpora cavernofa, are inferted in the inferior rami of thefe bones, and in thofe of the offa ifchium, where they terminate by degrees; but there is fometimes a membranous tube on each fide, which reaches to the tuberofity of the ifchium.

The trunk of the clitoris is fuftained by a ligamentum fufpenforium fixed in the fymphyfis of the offa pubis, and containing this trunk in its duplicature, nearly as in the other fex.

Four

Four mufcles or fafciculi of flefhy fibres are inferted in the trunk of the clitoris, two on each fide. One of them runs down on the forefide of the neighbouring corpus cavernofum, and is inferted by a tendinous or aponeurotic portion, partly in the extremity of the corpus cavernofum, and partly in the tuberofity of the ifchium. Thefe two mufcles are called *erectores;* but the name of *ifchio-cavernofi* would be more proper.

The other mufcle on each fide lies under the former, and runs down on the fide of the urethra and great orifice of the uterus, all the way to the anus, increafing gradually in breadth in its paffage, and terminating partly like that which is called *accelerator* in males.

Thefe two mufcles furround very clofely the lateral parts of the urethra and of the great orifice. They expand very much as they defcend, and are fpread on the lower and lateral parts of the great orifice; for which reafon feveral anatomifts have confidered them as mufcular fphincters. All thefe four mufcles, and efpecially the two latter, are oftentimes almoft covered with fat.

The blood-veffels of the clitoris come chiefly from the hypogaftricae, and the nerves from the fecond and third pairs of the nervi facri, by means of which they communicate with the inferior mefenteric plexus, and with the great fympathetici.

Nymphae. The nymphae, criftae clitoridis, or, as they may likewife be termed, *alae minores five internae*, are two prominent folds of the inner fkin of the great or external alae, reaching from the praeputium of the clitoris to the two fides of the great orifice of the uterus. They begin very narrow, and, having increafed in breadth in their courfe downward, they are again contracted at their lower extremity.

They

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 nymphae below the glans of the clitoris. The ſides of this orifice are a little prominent and wrinkled, and perforated by ſmall lacunae, from which a viſcid or mucilaginous liquor may be ſqueezed. In time of pregnancy, this orifice is ſometimes drawn a little inward.

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 rugae, 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

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 caecum 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 alae.

The body of the canal is chiefly compoſed of a ſpongy ſubſtance, interwoven with numerous blood-veſſels; and it is commonly longer and narrower in virgins than in married women.

Its inner or concave ſurface has ſeveral tranſverſe rugae, and is covered by a particular membrane. The rugae 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 rugae, 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

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 alae, and repreſents a membranous circle of different breadths, and ſometimes uneven.

Carunculae. 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 *carunculae myrtiformes.* This circle may likewiſe ſuffer ſome diſorder 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 nymphae, 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 compofed of veffels which come chiefly from the hypogaftricae.

It ftill remains to be obferved, that, on each fide of the bottom of the pelvis, in both fexes, oppofite to the lower part of the bladder, there is an aponeurotic or tendinous ligament, which runs over the inner furface of the mufculus obturator internus from before backward. The anterior extremity of this ligament is fixed on one fide of the middle portion of the fymphyfis of the offa pubis, and the pofterior extremity to the middle part of the ligamentum facro-fciaticum, formerly defcribed.

A little above the elongation called the *neck* of the bladder, there is another ligamentary expanfion on each fide of the bladder; the fore part of which is narrow, and fixed to the anterior extremity of the ligament already mentioned; and the broad pofterior part to the fide of the bladder. Thefe two lateral expanfions may be confidered as proper ligaments of the bladder, by which it is connected to the inner fide of both offa pubis.

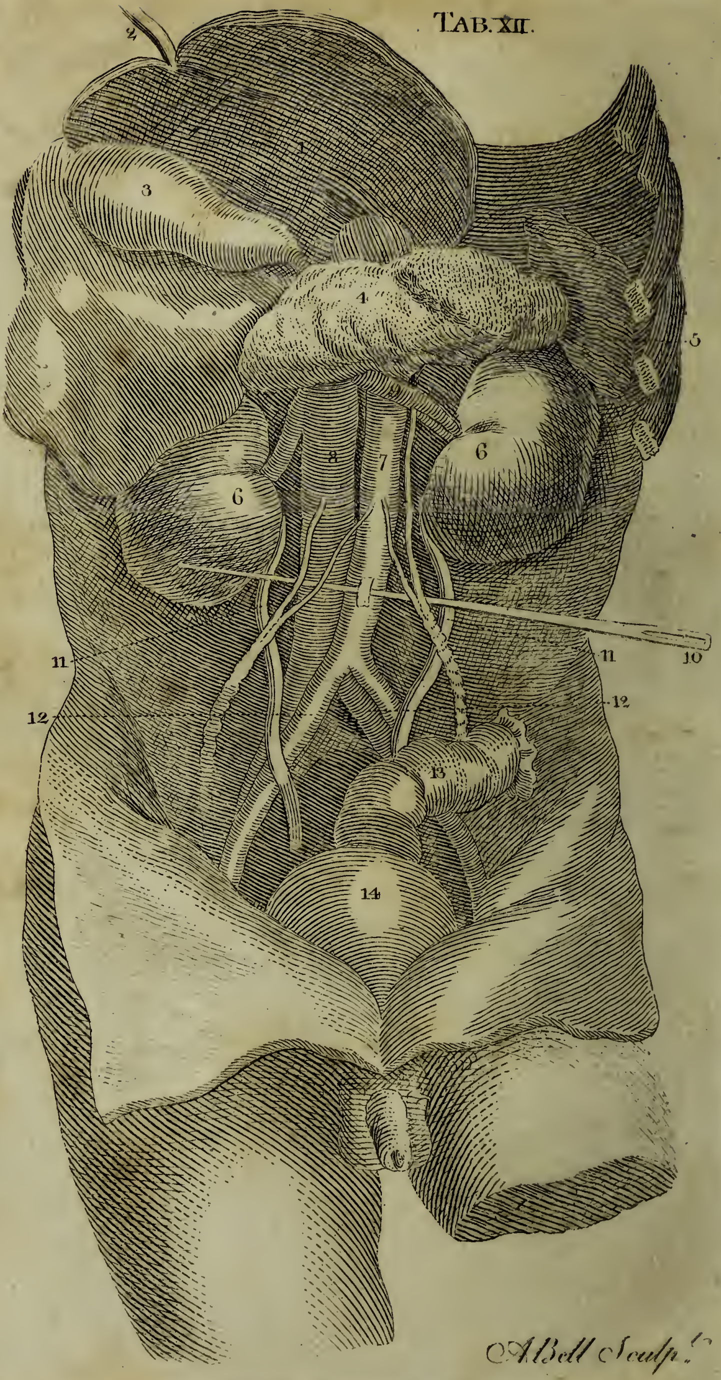
EXPLANATION of TABLE XI.

1. Trachea.
2. The internal jugular vein.
3. The fubclavian vein.
4. Vena cava defcendens.
5. The right auricle of the heart.
6. The right ventricle, the pericardium being removed.
7. Part of the left ventricle.
8. Aorta afcendens.
9. Arteria pulmonalis.
10. The right lobe of the lungs, part of which is cut off to fhew the great blood veffels.
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 ftomach, preffed by the liver toward the left fide.
17. The fmall guts.
18. The fpleen.

TAB. XI.

A.Bell Sculp

TAB. XII.



A. Bell Sculp.t

EXPLANATION OF TABLE XII.

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 inteſtinum rectum.
14. The bladder of urine.

EXPLA-

EXPLANATION OF TABLE XIII.

FIGURE I. Gives a front view of the *uterus in ſitu* ſuſpended in the vagina; the anterior parts of the oſſa iſchium, with the oſſa pubis, pudenda perinaeum, and anus being removed.

A The laſt vertebra of the loins.
BB The oſſa ilium.
CC The acetabula.
DD The inferior and poſterior parts of the oſſa iſchium.
E The part covering the extremity of the coccyx.
F The inferior part of the rectum.
GG The vagina cut open longitudinally, and ſtretched on each ſide of the collum uteri, to ſhew in what manner the uterus is ſuſpended in it.
HH Part of the veſica urinaria ſtretched on each ſide of the vagina, and inferior part of the fundus uteri.
I The collum uteri.
K The fundus uteri.
LL The tubae Fallopianae and fimbriae.
MM The ovaria.
NN The ligamenta lata and rotunda.
OO The ſuperior part of the rectum.

FIGURE II. Gives a view of the internal parts as ſeen from the right groin, the pelvis being divided longitudinally.

A The laſt vertebra of the loins.
BC The os ſacrum.
D The left os ilium.
E The inferior part of the left os iſchium.
F The os pubis of the ſame ſide.
G The foramen magnum.
H The acetabulum
III The inferior part of the rectum and anus.

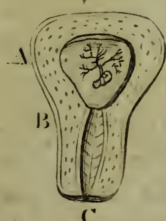
K The

TAB. XIII.

Fig. 1

Fig. 2

Fig. 3



D. Lizars Sculp^t

K The os externum and vagina, the os uteri lying loofely in it.

L The vefica urinaria.

MN The column and fundus uteri, with the view of the cavity of both. The attachment of the vagina round the outfide of the lips of the mouth of the womb is likewife here fhewn; as alfo the fituation of the, uterus, as it is preffed downwards and backwards by the inteftines and urinary bladder into the concave and inferior part of the os facrum.

O The ligamentum latum and rotundum of the left fide.

PP The Fallopian tube with the fimbriae.

Q The ovarium.

RR The fuperior part of the rectum, and inferior part of the colon.

Figure III. Gives a front view of the uterus in the beginning of the firft month of pregnancy, the anterior part being removed, that the embryo might appear through the amnios, the chorion being diffected off.

A The fundus uteri.

B The collum uteri, with a view of the rugous canal that leads to the cavity of the uterus.

C The os uteri.

EXPLANATION of TABLE XIV.

Repreſents the *abdomen* of a woman opened in the ſixth or ſeventh month of pregnancy.

AAAA The parietes of the abdomen opened and turned back to ſhew.

B The uterus.

CCC The inteſtines raiſed upwards.

From this figure it appears, that the ſtretching of the uterus can eaſily be felt at this period, in lean ſubjects, through the parietes of the abdomen, eſpecially if the inteſtines do not lie before it. In general, indeed, as the uterus ſtretches it riſes higher, by which means the inteſtines are alſo raiſed higher, and are likewiſe preſſed to each ſide. Hence the nearer the woman is to her full time, the ſtretching is the more eaſily felt.

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TAB. XIV.

D. Lizars Sculp!

INDEX

TO VOLUME SECOND.

A

B

C

END OF VOLUME SECOND.