# ABSTRACT

FROM

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# A SYSTEM OF ANATOMY, PHYSIOLOGY, &c.

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AND
# PHYSIOLOGY,
WITH THE
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## OF ANIMALS.

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A SYSTEM

A

# SYSTEM

OF

# ANATOMY,

WITH THE

# PHYSIOLOGY.

## PART VI.

Containing a DESCRIPTION of the

## DIFFERENT VISCERA.

### CHAP. IV.

### OF THE PELVIS.

#### § 6. *Menſtruation.*

THE deſcriptions which we have hitherto given of the female parts, are in common to all ages of the ſex; but about the thirteenth year, or later, nearly at the ſame time when ſemen begins to form itſelf in the male, conſiderable changes are likewiſe produced in the female. For at this time the whole maſs of blood begins to circulate with an increaſed force, the breaſts ſwell, and the pubes begins to be cloathed : at the ſame time the menſes in ſome meaſure make their appearance by a common law of nature, although in different countries both the time and quantity of the flux is different.

But, before the menſtrual flux commences, various ſymptoms of pain are excited in the loins ; and pains reſembling the cholic, an increaſed pulſe, headaches, cutaneous puſtules, and a diſcharge of a whitiſh liquor, generally pronounce its approach. For now the fleecy veſſels of the uterus, which in the ſtate of the fœtus were white, and tranſuded a ſort of milk, as in the young girl they tranſuded a ſerous liquor, now begin to ſwell with blood; the red parts of which are depoſited through the veſſels into the cavity of the uterus. This continues ſome days, while in the mean time the firſt troubleſome ſymptoms abate, and the uterine veſſels gradually contracting their openings, again diſtil only a little ſerous moiſture as before. But then the ſame efforts return again at uncertain intervals in tender virgins; till at length, by degrees, they keep near to the end of the fourth week, when the flux of blood follows, as before, which is periodically continued till between the 45th and 50th year; though the diet, country, conſtitution, and way of life, cauſe a great variation in this diſcharge. Pregnancy commonly produces a temporary ſtoppage of the menſes.

This diſcharge of blood from the veſſels of the uterus itſelf is demonſtrated by inſpection in women who have died in the midſt of their courſes; and in living women, having an inverſion of the uterus, the blood has been plainly ſeen to diſtil from the open orifices: in others, when the menſes have been deficient, the uterus has appeared full of concreted blood. Another argument, in favour of the ſame opinion, is drawn from the nature of the uterus itſelf, which is full of ſoft ſpongy veſſels; and from comparing this organ with the thin, callous, by no means fleecy, and almoſt bloodleſs ſubſtance of the

the vagina. That this is good blood in an healthy woman, appears both from the foregoing and innumerable other obſervations. Nevertheleſs ſome blood may be diſcharged through the coats of the vagina, as in other caſes it is through the inteſtinum rectum, and in ſhort, through the remoteſt parts of the body.

Since none but the human ſpecies are properly ſubject to this menſtrual flux of blood (although there are ſome animals who, at the time of their vernal copulation, diſtil a ſmall quantity of blood from their genitals), and ſince the body of the male is always free from the like diſcharge, it has been a great inquiry in all ages, what ſhould be the cauſe of this ſanguine excretion peculiar to the fair ſex? The attraction of the moon, which is known to raiſe the tides of the ſea, has been, in all ages, ſuppoſed to produce this effect; other authors have referred it to a ſharp ſtimulating humour, ſecreted in the genital parts themſelves, the ſame which is the cauſe of the venereal diſeaſe. But if the moon produces this effect, it would appear in all women at the ſame time, which is contrary to experience, ſince there is never a day in which there are not many women ſeized with this flux; nor are there fewer in the decreaſe than in the increaſe of the moon. As to any ſharp ferment ſeated in the uterus, it will be always inquired for in vain, where there are none but mild mucous juices, and where venery, which expels all theſe juices, neither increaſes nor leſſens the menſtrual flux: for women deny that, during the time of their menſes, they have any increaſed deſire of venery; for at that time moſt of the parts are rather pained and languid; and the ſeat of venereal pleaſure ſeems rather in the entrance of the pudendum than in the uterus, from which laſt the menſes flow. Beſides, that the menſtrual blood is forced out by ſome cauſe exciting the motion of the blood againſt the veſſels, appears moſt probable; becauſe, by a retenſion, the courſes have been known to break through all the other organs of the body, where no vellicating ferment could be ſeated, ſo as to burſt open the veſſels of each organ; and becauſe the effect produced by the retention of the blood, is not confined to thoſe parts which pour out the venereal humour.

Nature has, in general, given women a more delicate body, and ſolids that are leſs elaſtic; their muſcles are alſo ſmaller, with a greater quantity of fat interpoſed both between them and their fibres; the bones too are ſlenderer, and their ſurfaces have fewer proceſſes and aſperities, than in males. Moreover the pelvis of the female is, in all its dimenſions, larger; the oſſa ilia ſpread farther from each other; and the os ſacrum recedes more backward from the bones of the pubes, while the oſſa iſchii depart more from each other below: however, the angle in which the bones of the pubes meet together to form an arch, is in the female remarkably more large; which differences are confirmed by the obſervations of great anatomiſts, and from neceſſity itſelf, which requires a greater ſpace for a greater number of viſcera in the pelvis.

The female infant new born has her lower limbs very ſmall; and the greater part of the blood, belonging to the iliac arteries, goes to the umbilicals, ſending down only a ſmall portion to the pelvis. Hence the pelvis is ſmall, and but little concave; ſo that the bladder and uterus itſelf, with the ovaries, project beyond the brim of the pelvis. But when the fœtus is born, and the umbilical artery tied, all the blood of the iliac artery deſcends to the pelvis and lower limbs, which of courſe grow larger, and the pelvis ſpreads wider and deeper; ſo that, by degrees, the womb and bladder are received into its cavity, without being any longer compreſſed by the inteſtines and peritonæum, when the abdominal muſcles preſs upon the lower parts of the abdomen. When the increaſe is perfect, or nearly ſo, then in general we find thoſe arteries of the uterus largeſt, and eaſily injected with wax, which in the fœtus were leaſt; and all things are ſo changed, that the hemorrhoidal

dal artery is now in place of the hypogaſtric, when formerly the umbilical had been the trunk of that artery. More blood, therefore, at that time comes into the uterus, vagina, and clitoris, than formerly uſed to do.

At the ſame time, when the growth of the body begins conſiderably to diminiſh, and the blood, finding eaſy admittance into the completed viſcera, is prepared in a greater quantity; and the appetite being now very ſharp, in both ſexes, a plethora conſequently follows. In the male, it vents itſelf frequently by the noſe, from the exhaling veſſels of the pituitary membrane being dilated to ſo great a degree without a rupture, as to let the red blood diſtil through them; and now the ſemen firſt begins to be ſecreted, and the beard to grow. But in the female, the ſame plethora finds a more eaſy vent downward; being directed partly by the weight of the blood itſelf, to the uterine veſſels now much enlarged, of a ſoft fleecy fabric, and ſeated in a looſe hollow part, with a great deal of cellular fabric interſperſed, which is very yielding and ſucculent, as we obſerve in the womb: for theſe cauſes, the veſſels being eaſily diſtenſible, the blood finds a more eaſy paſſage through the very ſoft fleecy exhaling veſſels, which open into the cavity of the uterus, as being there leſs reſiſted than in its return by the veins, or in taking a courſe through any other part; and at the ſame time the return of the blood from the uterus is impeded, both becauſe the flexures of the arteries, from the increaſed afflux of the blood, become more ſerpentine and fit for retarding the blood's motion, and likewiſe becauſe it now returns with difficulty through the veins. The blood is, therefore, firſt collected in the veſſels of the uterus, which at this time are obſerved, in diſſections, to be ſwelled; it is alſo accumulated in the arteries of the loins and the aorta itſelf, which, urging on a new torrent of blood, augments the force, ſo far as to diſcharge the red blood into the ſerous veſſels of the uterus, which at firſt tranſmit an increaſed quantity of warm

mucus,

mucus, afterwards a reddiſh-coloured ſerum; and by ſuffering a greater diſtenſion, they at laſt emit the red blood itſelf. The ſame greater impulſe of blood, determined to the genital parts, drives out the hitherto latent hairs, increaſes the bulk of the clitoris, dilates the cavernous plexus of the vagina, and whets the female appetite to venery. Accordingly we find, that the quantity of the menſtrual flux, and the earlineſs of their appearance, are promoted by every thing that either increaſes the quantity or momentum of the blood with reſpect to the body in general, or directs the courſe of the blood more particularly towards the uterus; ſuch as joy, luſt, bathing of the feet, a rich diet, warm air, and lively temperament of the body. It is diminiſhed by thoſe things which leſſen plethora and the motion of the blood, as want, grief, cold air, ſloth, and antecedent diſeaſes.

When five or ſix ounces of blood have been thus evacuated, the unloaded arteries now exert a greater force of elaſticity, and, like all arteries that have been overcharged with blood, they gradually contract themſelves to a leſs diameter, ſo as at length to give paſſage only to the former thin exhaling moiſture; but the plethora, or quantity of blood, being again increaſed from the ſame cauſes, a like diſcharge will always more eaſily enſue through the veſſels of the uterus, after they have been once thus opened, than through any other part. Nor is there any occaſion to perplex ourſelves about the cauſe, why this periodical diſcharge is, for the moſt part, nearly regular or menſtrual; for this depends upon the proportion of the quantity and momentum of the blood daily collected, together with the reſiſtance of the uterus, which is to yield again gradually to the firſt courſe. This critical diſcharge of the blood, therefore, never waits for the interval of a month, but flows ſooner or later, according as the greater quantity of blood in plethoric women is determined, by luſt or other cauſes, towards the uterus. Finally, they ceaſe to flow altogether, when the

the uterus, like all the other ſolid parts of the body, has acquired ſo great a degree of hardneſs and reſiſtance, as cannot be overcome by the declining force of the heart and arteries, by which the blood and juices are driven on through all the veſſels. This increaſed hardneſs in the old uterus is ſo remarkable in the arteries and ovaries, that it eaſily diſcovers itſelf both to the knife and the injections of the anatomiſt. But, in general, brute animals have no menſes; becauſe, in them, the womb is in a manner rather membranous than fleſhy, with very firm or reſiſting veſſels: Beſides, the difference of their poſture, never permits a natural hemorrhagy from the noſtrils or other parts. They are wanting in men, becauſe in that ſex there is no ſpongy organ fit for retaining the blood; and likewiſe becauſe the arteries of the pelvis are both harder, and leſs in proportion, than the veins; and thus the impetus of the blood is directed to the lower limbs, where the veſſels are larger in proportion as thoſe of the pelvis are ſmaller.

It will, perhaps, be demanded, why the breaſts ſwell at the time of the approach of the menſes? We are to obſerve, that the breaſts have many particulars in their fabric, common with the uterus; as appears from the ſecretion of the milk in them after the birth of the fœtus, which increaſes or diminiſhes in proportion as the lochial flux is either increaſed or diminiſhed; from the ſimilitude of the ſerous liquor, to milk or whey, which is found in the uterus of thoſe who do not ſuckle their children; it is of a thin white conſiſtence, and appears very evidently in the brute animals; alſo from the turgeſcence or erection of the papillæ or nipples of the breaſt by friction, analogous to the erection of the clitoris. The ſame cauſes, therefore, which diſtend the veſſels of the uterus, likewiſe determine the blood more plentifully to the breaſts; the conſequence of which is an increaſed bulk and turgeſcence of the conglomerate glandules and cellular fabric which compoſe them.

§ 7. Of

## § 7. *Of the Gravid Uterus.*

### Art. I. Structure of the Ovum in early Gestation.

When the rudiments of the fœtus get into the uterus, impregnation is ſaid to take place. The ovum, ſoon after its introduction, adheres to ſome part of the internal ſurface of the uterus: at firſt it appears like a ſmall veſicle, ſlightly attached; and gradually increaſes in bulk, till it apparently comes in contact with the whole cavity of the uterus.

The embryo, with umbilical cord, membranes, and waters, in early geſtation, conſtitute the ovum; which then appears like a thickened fleſhy maſs, the more external parts, which are afterwards ſeparate and diſtinct, being blended in ſuch a manner that they cannot be readily diſtinguiſhed.

In the progreſs of geſtation every part of the ovum becomes more diſtinct; and then a thick vaſcular part on the outſide of the chorion, called *placenta*, can be readily perceived.

The external membranous part of the ovum is originally compoſed of three coats: the internal lamella, or that next the fœtus, is called *amnios;* the next is the *true chorion;* and the external is called the *falſe* or *ſpongy chorion.* It is ſuppoſed to derive an extraordinary lamella immediately from the uterus, which conſtitutes the external covering of the ovum. This production, which is ſuppoſed to be entirely formed by a continuation of the internal membrane of the uterus, is at firſt looſely ſpread over the ovum, and afterwards comes in contact with the falſe chorion. Theſe two lamellæ, which form the external vaſcular ſurface of the ovum, are much thicker than the internal membranes of the true chorion and amnios; and the proportion which they bear to the other parts is ſo great, that, in early conception, the maſs of the ovum is chiefly compoſed of them. Dr Ruyſch called this exterior coat the *tunica filamentoſa;* more modern authors, the

the *falſe* or *ſpongy chorion*. But Dr Hunter has found the ſpongy chorion to conſiſt of two diſtinct layers: that which lines the uterus he ſtyles *membrana caduca* or *decidua*, becauſe it is caſt off after delivery; the portion which covers the ovum, *decidua reflexa*, becauſe it is reflected from the uterus upon the ovum. The membrana decidua is perforated with three foramina, viz. two ſmall ones, correſponding with the inſertion of the tubes at the fundus uteri; and a larger ragged perforation oppoſite to the orificium uteri.

Thus, according to Dr Hunter, the embryo, on its firſt formation in the ovum, and the fœtus during the whole time of geſtation, is incloſed in four membranes, viz. the double, falſe, or ſpongy chorion, called *membrana decidua*, or *decidua reflexa*; the true chorion, and the amnios, which include a fluid called the *liquor amnii*, in which the embryo floats.

The true chorion and the amnios are very thin tranſparent membranes. The decidua, and decidua reflexa, differ in appearance, and ſeem to reſemble thoſe inorganic ſubſtances which connect inflamed viſcera, and have been conſidered by ſome late writers as being compoſed of inſpiſſated or coagulated lymph.

Between the amnios and chorion, a quantity of gelatinous fluid is contained in the early months; and a ſmall bag, or white ſpeck, is then obſerved on the amnios, near the inſertion of the umbilical cord. It is filled with a white liquor, of a thick milky conſiſtence; and is called *veſicula umbilicalis*, *veſicula alba* or *lactea*: it communicates with the umbilical cord by a ſmall funis, which conſiſts of an artery and vein. This veſicle, and duct or tube leading from it, are only conſpicuous in the early months; they afterwards become tranſparent, and of conſequence inviſible. Their uſe is not yet underſtood.

Though the bag, or external parts of the conception, at firſt form a large proportion of the ovum in compariſon to the embryo or fœtus, yet in advanced geſtation the proportions are reverſed.

reverſed. Thus an ovum between the eighth and ninth week after conception, is nearly about the ſize of a hen's egg, while the embryo ſcarcely exceeds the weight of a ſcruple: at three months, the former increaſes beyond the magnitude of a gooſe's egg, and its weight is above eight ounces; but the fœtus does not then amount to three ounces: at ſix months, the fœtus weighs twelve or thirteen ounces, and the placenta and membranes only ſeven or eight: at eight months, the fœtus weighs between four and five pounds, the ſecundines little more than one pound: at birth, the fœtus, according to Dr Hunter, weighs from five to eight pounds; and this agrees nearly with the obſervation of Dr Wriſberg; but the placenta ſeldom increaſes much in bulk from between the ſeventh and eighth month.

Having deſcribed the ovum in early geſtation, we ſhall next take a view of the germ; trace the progreſs of the embryo and fœtus; then reſume the ſubject of the ovum, to explain the ſtructure of the membranes, placenta, &c. in advanced geſtation, and point out the moſt remarkable changes which the uterus ſuffers during impregnation.

## Art. II. Evolution of the Foetus.

There can be little doubt that all the parts of an animal exiſt completely in the germ, though their extreme minuteneſs and fluidity for ſome time conceal them from our ſight. In a ſtate of progreſſion, ſome of them are much earlier conſpicuous than others.

The embryo, in its original ſtate, ſeems to contain, in a ſmall ſcale, all the other parts which are afterwards to be progreſſively evolved. Firſt the heart and liver, then the brain and ſpinal medulla, become conſpicuous; for the ſpine or carina of the embryo is formed ſome time before any veſtige of the extremities begin to ſprout. The encephalon, or head, and its appendages,

appendages, firſt appear; then the thoracic viſcera; next, the abdominal: at length the extremities gradually ſhoot out; the ſuperior firſt, then the inferior; till the whole is evolved.

As ſoon as the embryo has acquired ſufficient conſiſtence to be the ſubject of any obſervation, a little moving point, which is the heart, diſcovers itſelf. Nothing, however, but general circumſtances relating to the particular order and progreſs of the ſucceſſive germination or evolution of the viſcera, extremities, vaſcular ſyſtem, and other parts of the human fœtus, can be aſcertained, as it is beyond the power of anatomical inveſtigation.

It is alſo exceedingly difficult to determine the age or proportional growth of the fœtus. The judgement we form will be liable to conſiderable variation: 1ſt, From the uncertainty of fixing the period of pregnancy; 2dly, From the difference of a fœtus of the ſame age in different women, and in the ſame woman in different pregnancies; and, laſtly, Becauſe the fœtus is often retained in *utero* for ſome time after the extinction of its life.

The progreſs of the fœtus appears to be much quicker in the early than latter months: but the proportional increaſe is attended with difficulty in the calculation; for, beſides other reaſons, we have not an opportunity of knowing the magnitude or weight of the ſame fœtus in different months. It will alſo, probably, be materially influenced by the health, conſtitution, and mode of life, of the parent.

A fœtus of four weeks, is near the ſize of a common fly; it is ſoft, mucilaginous, ſeems to hang by its belly, and its bowels are only covered by a tranſparent membrane. At ſix weeks, the conſiſtence is ſtill gelatinous, the ſize about that of a ſmall bee, the head larger than the reſt of the body, and the extremities then begin to ſhoot out. At eight weeks, it is about the ſize of a field bean, and the extremities project a little from the body. At twelve weeks, it is near three inches long, and its formation is pretty diſtinct. At four months, the fœtus meaſures above five inches; at five months, between ſix and ſeven inches; at ſix months, the fœtus is perfect in all its external parts, and commonly about eight, or between eight and nine inches long; at ſeven months, it is between eleven and twelve inches; at eight months, about fourteen or fifteen inches; and at full time, from eighteen to twenty-two and twenty-three inches. But theſe calculations, for the above reaſons, muſt be very uncertain.

### Art. III. Contents of the Gravid Uterus in advanced Gestation.

These conſiſt of the fœtus, umbilical cord, placenta, membranes, and contained fluid. We have already traced the progreſs of the fœtus; and ſhall proceed to deſcribe the other parts of the ovum in advanced geſtation, as juſt now enumerated.

*Umbilical cord.* The fœtus is connected to the placenta by the umbilical cord or navel-ſtring; which may be defined, a long vaſcular rope, compoſed of two arteries and a vein, covered with coats derived from the membranes, and diſtended with a quantity of viſcid gelatinous ſubſtance, to which the bulk of the cord is chiefly owing.

The cord always ariſes from the centre of the child's belly, but its point of inſertion in the cake is variable. If the placenta adhere to the fundus, or is fixed over the mouth of the uterus, it is then of a round form, and the cord ariſes from its middle; but if the placenta adhere elſewhere, the cord is inſerted nearer its edge. Its ſhape is ſeldom quite cylindrical; and its veſſels are ſometimes twiſted or coiled, ſometimes formed into longitudinal ſulci. Its diameter is commonly about the thickneſs of an ordinary finger, and its length ſufficient to admit the birth of the child with ſafety, though the placenta ſhould

ſhould adhere at the fundus uteri. In length and thickneſs, however, it is liable to conſiderable variation. The extremity next the fœtus is generally ſtrongeſt; and ſomewhat weaker and more ſlender next the placenta, according to its place of inſertion; which, though commonly not far from the centre, is ſometimes very near the edge. This ſuggeſts an important advice to practitioners, to be cautious of pulling the rope to extract the placenta when they feel the ſenſation of its ſplitting as it were into two diviſions, which will proportionally weaken its reſiſtance, and render it liable to be ruptured with a very ſlight degree of force in pulling. The uſe of the cord is to connect the fœtus to the cake, to convey the nutritious fluid from the mother to the child, and to return what is not employed.

*Placenta.* The placenta, cake, or after-birth, is a thick, ſoft, vaſcular maſs, connected to the uterus on one ſide, and to the umbilical cord on the other. It differs in ſhape and ſize; it is thickeſt at the centre, and gradually becomes thinner towards the edges, where the membranes go off all round, making a complete bag or involucrum to ſurround the waters, funis, and child.

Its ſubſtance is chiefly vaſcular, and probably in ſome degree glandular. The ramifications of the veſſels are very minute, which are unravelled by maceration, and, when injected, exhibit a moſt beautiful appearance, reſembling the buſhy tops of a tree. It has an external convex, and an internal concave, ſurface. The former is divided into a number of ſmall lobes and fiſſures, by means of which its adheſion to the uterus is more firmly ſecured. This lobulated appearance is moſt remarkable when the cake has been raſhly ſeparated from the uterus; for the membrana decidua, or connecting membrane between it and the uterus, being then torn, the moſt violent and alarming hemorrhagies frequently enſue.

The internal concave ſurface of the placenta is in contact with

with the chorion, and that with the amnios. From its internal ſubſtance ariſe innumerable ramifications of veins and arteries, which inoſculate and anaſtomoſe with one another; and at laſt the different branches unite, and form the funis umbilicalis.

The after-birth may adhere to every part of the internal ſurface of the uterus, as at the poſterior and anterior, ſuperior and lateral parts; and ſometimes, though more rarely, part of the cake extends over the orificium uteri; from whence, when the orifice begins to dilate, the moſt frightful and dangerous floodings ariſe. But the moſt common place of attachment of the cake is from the ſuperior part of the cervix to the fundus.

Twins, triplets, &c. have their placenta, ſometimes ſeparate, and ſometimes adhering together. When the placentæ adhere, they have generally the chorion in common; but each fœtus has its diſtinct amnios. They are commonly joined together, either by an intervening membrane, or by the ſurfaces being contiguous to one another; and ſometimes the veſſels of the one cake anaſtomoſe with thoſe of the other.

The human placenta, according to Dr Hunter, and others who believe that the child is nouriſhed by a ſecreted liquor, is compoſed of two diſtinct ſyſtems of parts, a ſpongy or cellular, and a vaſcular ſubſtance; the ſpongy or cellular part, formed by the decidua, being derived from the mother, the more internal vaſcular part belonging entirely to the fœtus; but, according to thoſe who are of opinion that a real circulation is carried on between the mother and the child, the placenta is chiefly compoſed of veſſels which are connected by the common cellular ſubſtance.

*Membranes.* Theſe conſiſt, externally, of two layers of the ſpongy chorion, called *decidua* and *decidua reflexa*; internally, of the true chorion and the amnios. They form a pretty ſtrong bag, commencing at the edge of the cake, going round

round the whole circumference, and lining the internal furface of the womb. When feparated from the uterus, this membranous bag is flender and yielding, and its texture readily deftroyed by the impulfe of the contained fluid, the preffure of the child, or of the finger in touching; but in its natural ftate, while it lines the womb, and is in clofe contact with its furface, the membranous bag is tough and ftrong, fo as to give a confiderable degree of refiftance. It is alfo ftrengthened in proportion to the different layers of which it is compofed, whofe ftructure we fhall proceed to explain more particularly.

1. The *membrana decidua*, or that lamella of the fpongy falfe chorion which is in immediate contact with the uterus, is originally very thick and fpongy, and exceedingly vafcular, particularly where it approaches the placenta. At firft, there is a fmall intervening fpace between it and the ovum, which is filled with a quantity of gelatinous fubftance. It gradually becomes more and more attenuated by ftretching, and approaches nearer to the decidua reflexa; and about the fifth month the two layers come in contact, and adhere fo as to become apparently one membrane.

2. *Decidua reflexa.* In its ftructure and appearance it is fimilar to the former, being rough, fleecy, and vafcular, on its external furface. In advanced geftation, it adheres intimately to the former membrane, and is with difficulty feparated from it.

The decidua reflexa becomes thicker and more vafcular as it approaches the placenta, and is then blended with its fubftance, conftituting the cellular or maternal part of the cake, as it is termed by Dr Hunter. The other or more internal part belongs to the fœtus, and is ftyled the *fœtal* part of the placenta.

The double decidua is opaque in comparifon of the other membrane; the blood-veffels are derived from the uterus, and

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can be readily traced into it. Dr Hunter fuppofes that the double decidua lines the uterus nearly in the fame manner as the peritonæum does the cavity of the abdomen, and that the ovum is inclofed within its duplicature as within a double night-cap. On this fuppofition the ovum muft be placed on the outfide of this membrane, which is not very readily to be comprehended; unlefs we adopt Signior Scarpa's opinion, and fuppofe it to be originally entirely compofed of an infpiffated coagulable lymph.

3. The *true chorion*, or that connected with the amnios, is the firmeft, fmootheft, and moft tranfparent of all the membranes, except the amnios; and, when feparated from it, has a confiderable degree of tranfparency. It adheres pretty clofely to the internal furface of the cake, which it covers immediately under the amnios, and gives alfo a coat to the umbilical cord. It is connected to the amnios by means of a gelatinous fubftance, and is eafily feparated from it.

4. The *amnios*, or internal membrane, forms the external coat of the umbilical cord. This lateral lamella of the membranous bag is the moft thin, attenuated, and tranfparent of the whole; and its veffels are fo delicate, that they can hardly be difcovered; their diameters are fo fmall as to be incapable in their natural ftate of admitting globules of red blood. It is, however, firmer, and ftronger than the chorion, and gives the greateft refiftance in the breaking of the membranes.

The fmall bag, called *veficula umbilicalis*, formerly defcribed, and only confpicuous in the early months from its fituation, is placed between the amnios and chorion, near the attachment of the cord; and, from the colour of its contents, has been miftaken for the urachus: but there is no allantois in the human fubject.

The allantois in quadrupeds is an oblong membranous fac, or pouch, placed between the chorion and amnios. This membrane communicates with the urachus, which in brutes

is

is open, and tranfmits the urine from the bladder to the allantois.

5. The *waters* are contained within the amnios, and are called the *liquor amnii*. They are pureft, cleareft, and moft limpid in the firft months; acquiring a colour, and becoming fomewhat ropy, towards the latter end. They vary in different fubjects, both in confiftence and quantity; and, after a certain period, they proportionally diminifh as the woman advances in her pregnancy. This liquor does not, in any refpect, refemble the white of an egg; it is generally faltifh, and therefore unfit for the nutrition of the child; fome of it may perhaps be abforbed by the fœtus, but the child is chiefly nourifhed by the navel-ftring. In the early months, the organs are not fit for fwallowing; and monfters are fometimes born alive, where fuch organs are altogether wanting.

Water is fometimes collected between the chorion and amnios, or between the lamellæ of the chorion. This is called the *falfe water*. It is generally in much fmaller quantity than the true water; and, without detriment to the woman, may flow at any time of pregnancy.

Having defcribed the contents of the gravid uterus, let us confider the changes which that organ fuffers during the progrefs of geftation, and explain the manner of circulation between the parent and fœtus, and within the body of the fœtus; after which we fhall enumerate the moft remarkable peculiarities of the *non-natus*.

## Art. IV. Changes of the Uterine System from Impregnation.

Though the uterus gradually increafes in fize from the moment of conception till full time, and although its diftention is proportioned to that of the ovum, with regard to its contents, it is, ftrictly fpeaking, never completely diftended;

for in early geftation, they are entirely confined to the fundus, and, at full time, the finger can be paffed for fome way within the orificium uteri without touching any part of the membranes. Again, though the cavity of the uterus increafes, yet it is not mechanically ftretched, for the thicknefs of the fides does not diminifh. The increafed fize feems therefore to depend on a proportionable quantity of fluids fent to that part, nearly in the fame way that the fkin of a child, though it fuffers fo great a diftention, does not become thinner, but preferves its ufual thicknefs.

This is proved from feveral inftances of extra-uterine fœtufes, where the uterus, though there were no contents, was nearly of the fame fize, from the additional quantity of fluids tranfmitted, as if the ovum had been contained within its cavity. Boehmerus relates the fame circumftance, without attempting to explain it, in the hiftory of a cafe of extra-uterine conception in the fifth month. The uterus is painted of a confiderable fize, though the fœtus was contained in the ovarium.

The gravid uterus is of different fize in different women; and will vary according to the bulk of the fœtus and involucra. The fituation alfo varies according to the increafe of its contents, and the pofition of the body. For the firft two or three months, the cavity of the fundus is triangular as before impregnation; but, as the uterus ftretches, it gradually acquires a more rounded form. In general, the uterus never rifes directly upwards, but inclines a little obliquely; moft commonly to the right fide: its pofition is never, however, fo oblique as to prove the fole caufe either of preventing or retarding delivery.

Though confiderable changes are occafioned by the gradual diftention of the uterus, it is difficult to judge of pregnancy from appearances in the early months. For the firft three months, the os tincæ feels fmooth and even, and its orifice is nearly

nearly as ſmall as in the virgin ſtate. When any difference can be perceived, it will conſiſt in the increaſed length of the projecting tubercle of the uterus, and the ſhortening of the vagina from the deſcent of the fundus uteri through the pelvis. This change in the poſition of the uterus, by which the projecting tubercle appears to be lengthened, and the vagina proportionally ſhortened, chiefly happens from the third to the fifth month. From this period the cervix begins to ſtretch and be diſtended, firſt at the upper part; and then the os tincæ begins alſo to ſuffer conſiderable changes in its figure and appearance. The tubercle ſhortens, and the orifice expands; but during the whole term of geſtation, the mouth of the uterus is ſtrongly cemented with a ropy mucus, which lines it and the cervix, and begins to be diſcharged on the approach of labour. In the laſt weeks, when the cervix uteri is completely diſtended, the uterine orifice begins to form an elliptical tube, inſtead of a fiſſure; and ſometimes, eſpecially when the parietes of the abdomen are relaxed by repeated pregnancy, it diſappears entirely, and is without the reach of the finger in touching Hence the os uteri is not placed in the direction of the axis of the womb, as has generally been ſuppoſed.

The progreſſive increaſe of the abdominal tumor, from the ſtretching of the fundus, affords a more deciſive mark of the exiſtence and period of pregnancy than any others; and the progreſs is nearly as follows.

About the fourth, or between the fourth and fifth month, the fundus uteri begins to riſe above the pubes or brim of the pelvis, and the cervix to be ſomewhat diſtended. In the fifth month, the belly ſwells like a ball, with the ſkin tenſe, the fundus extends about half way between the pubes and navel, and the neck is ſenſibly ſhortened. In the ſeventh month, the fundus, or ſuperior part of the uterine tumor, advances as far as the umbilicus; and the cervix is then nearly three-fourths diſtended. In the eighth, it reaches mid-way between the navel and ſcrobiculus cordis; and in the ninth, to the ſcrobiculus itſelf, the neck then being entirely diſtended; which, with the os tincæ, become the weakeſt parts of the uterus. Thus, at full time, the uterus occupies all the umbilical and hypogaſtric regions: its ſhape is almoſt pyriform, that is, more rounded above than below, and having a ſtricture on that part which is ſurrounded by the brim of the pelvis.

During the progreſs of diſtention, the ſubſtance of the uterus becomes much looſer, of a ſofter texture, and more vaſcular, than before conception; and the diameter of its veins is ſo much enlarged, that they have acquired the name of *ſinuſes*. They obſerve a more direct courſe than the arteries, which run in a ſerpentine manner through its whole ſubſtance, and anaſtomoſe with one another, particularly at that part where the placenta is attached: It is in this part alſo that the vaſcular ſtructure is moſt conſpicuous.

The arteries, according to Dr Hunter, &c. paſs from the uterus, through the decidua, into cells in the placenta: and veins, correſponding with the arteries, return the blood to the mother. According to other authors, the arteries end partly in the veins of the mother, and partly in the veins of the child.

The muſcular ſtructure of the gravid uterus is extremely difficult to be traced with any exactneſs in the unimpregnated ſtate; but in the gravid uterus they appear more diſtinctly. In the wombs of women who die in labour, or ſoon after delivery, fibres running in various directions are obſervable more or leſs circular. Theſe ſeem to ariſe from three diſtinct origins, viz. from the place where the placenta adheres, and from the aperture or orifice of each of the tubes: but it is almoſt impoſſible to demonſtrate regular plans of fibres continued any length without interruption.

The appendages of the uterus alſo ſuffer conſiderable changes; for the tubes, ovaries, and ligaments, gradually go off

off below the fundus as it ſtretches, and at the full time are almoſt entirely obliterated. At the full time, eſpecially in a firſt pregnancy, when the womb riſes higher than in ſubſequent impregnations, the ligamenta rotunda are conſiderably ſtretched; and to this cauſe thoſe pains are probably owing which ſtrike from the belly downwards in the direction of theſe vaſcular ropes, which are often very painful and diſtreſſing towards the latter end of geſtation. Again, as the uterus, which is chiefly enlarged towards the fundus, at the full time ſtretches into the cavity of the abdomen without any ſupport, leaving the broad ligaments below the moſt bulky part, we can readily ſee, that by pulling at the umbilical cord to deliver the placenta, before the uterus is ſufficiently contracted, the fundus may be pulled down through the mouth of the womb, even though no great violence be employed. This is ſtyled the *inverſion* of the uterus; and is a very dreadful, and generally fatal accident. It is the conſequence only of ignorance or temerity; and can ſcarcely happen but from violence, or from an officious intruſion on the work of nature, by pulling at the rope while the woman is faint or languid, and the uterus in a ſtate of atony.

In ſome rare inſtances, where the cord is naturally ſhort, or rendered ſo by circumvolutions round the body of the child, the force of labour which propels the child may, when the placenta adheres to the fundus uteri, bring it down ſo near the os tincæ, that little force would afterwards be ſufficient to complete the inverſion. This ſuggeſts a precaution, that in the above circumſtances, if ſtrong labour-pains ſhould continue, or a conſtant bearing down enſue, after the delivery of the child, the practice of pulling by the cord ſhould be carefully avoided, and the hand of the operator be prudently conducted within the uterus, to ſeparate the adheſion of the cake, and guard againſt the hazard of inverſion.

The ovaria alſo ſuffer ſome change from pregnancy.

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A roundiſh figure of a yellow colour appears in one of them, called by anatomiſts the *corpus luteum*; and in caſes of twins, a corpus luteum often appears in each ovarium. It was imagined to be the calyx ovi; and is obſerved to be a gland from whence the female fluid or germ is ejected. In early geſtation, this cicatrix is moſt conſpicuous, when a cavity is obvious, which afterwards collapſes.

If the ovarium be injected in the latter months, the corpus luteum will appear to be compoſed chiefly of veſſels. A portion of it, however, in the centre, will not be filled; whence there is reaſon to ſuſpect that it is a cavity, or that it contains a ſubſtance not yet organized.

## Art. V. Circulation in the Foetus.

The circulation in the ſubſtance of the placenta, notwithſtanding what has been ſaid by different authors, ſeems to be not yet fully underſtood; but it is certain, that the blood paſſes directly from the placenta into the umbilical vein; which, running along the funis, perforates the belly of the fœtus, and enters under the liver, where it divides into two branches, nearly at half a right angle. One of theſe branches, called the *ductus venoſus*, carries part of the blood to the left branch of the vena cava hepatis, and from that to the vena cava. The other carries the reſt to the vena portarum; where, after circulating through the liver, it alſo gets into the vena cava, and ſo to the heart: but the circulation here is carried on without any neceſſity for the lungs being dilated: For fœtuſes have an oval hole open between the auricles of the heart, and a communicating canal, called *canalis arterioſus*, going between the pulmonary artery and aorta; which two paſſages allow the reſt of this circulating fluid, that returns by the cava ſuperior, to be tranſmitted to the aorta, without paſſing through the lungs.

The blood is returned from the fœtus by the *arteriæ umbili-*

*cales*,

*cales*, which take their rifes fometimes from the trunk of the aorta, but commonly from the iliac arteries of the fœtus; and, running by the external fides of the bladder, afcend to go out at the navel.

### Art. VI. Position of the Foetus in Utero.

The fœtus is commodioufly adapted to the cavity of the uterus, and defcribes an oblong or oval figure; its feveral parts being collected together in fuch a manner as to occupy the leaft poffible fpace. The fpine is rounded, the head reclines forward towards the knees, which are drawn up to the belly, while the heels are drawn backwards towards the breech, and the hands and arms are folded round the knees and legs. The head of the child is generally downwards. This does not proceed, as was commonly alledged, from the funis not being exactly in the middle of the child's body, for it is not fufpended by the funis: the reafon is, becaufe the fuperior parts are much larger, and heavier in proportion, than the inferior. When other parts prefent, it feems owing to the motion of the child altering its figure when the waters are much diminifhed in quantity, or to circumvolutions of the cord: when the pofition is once altered, it becomes confined or locked in the uterus, and cannot eafily refume its original pofture.

As the figure of the fœtus is oval, and the head naturally falls to the moft depending part of the uterus, the vertex generally points to the os tincæ, with the ears diagonally in the pelvis. The fœtus is mechanically difpofed to affume this pofition from its peculiar figure and conftruction, particularly by the bulk of the head and articulation with the neck, by the action of its mufcles, and by the fhape and conftruction of the cavity in which it is contained.

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## Art. VII. Peculiarities of the Foetus.

The fœtus, both in external figure and internal ftructure, differs materially, in many ftriking circumftances, from the adult. It is fufficient for our prefent purpofe to mention a few particulars.

The head is very large in proportion to the reft of the body; the bones of the head are foft and yielding, and the futures not yet united, fo that the bulk of the head may be diminifhed in every direction, and its paffage confequently be rendered more commodious. The bones of the trunk and extremities, and all the articulations, are alfo remarkably flexible. All the apophyfes are epiphyfes; even the heads and condyles and brims of cavities, inftead of bone, are of a foft cartilaginous confiftence.

The brain, fpinal marrow, and whole glandular as well as nervous and fanguiferous fyftems, are confiderably larger in proportion in the fœtus than in the adult. It has a gland fituated in the fore-part of the cheft between the laminæ of the mediaftinum, called the *thymus*. The liver and kidneys are much larger in proportion: and the latter are divided into a number of fmall lobes, as in brutes.

The fœtus alfo differs in feveral circumftances from a child who has breathed.

The cavity of the thorax is lefs in proportion than after refpiration. The lungs are fmaller, more compact, of a red colour like the liver, and will fink in water; but putrefaction, a particular emphyfema, as in difeafes of cattle, and blowing into them, will make them fwim; which fhould prevent us from haftily determining, from this circumftance, whether a child has breathed or not; which we are often called on to do. Neither does their finking prove that the child never breathed;

breathed; for a child may die, or be ftrangled in the birth, or immediately after, before the lungs are fully inflated.

The arterial and venous fyftems are alfo different from that of the child. Hence the difference in the manner of circulation already taken notice of.

### § 8. *Of Conception.*

To inveftigate what happens in the interior parts of a female during the production of a new living animal, is indeed a very arduous undertaking. We fhall firft relate what experience fhews to be true, and then add the hypothefes by which the learned have endeavoured to fupply what fhe does not teach. How few particulars are yet attained, and how difficultly they are attainable, I have learnt by too many fruitlefs experiments.

That fome light may be thrown on fo dark a fubject, we fhall begin with the moft fimple animals, and afterwards take notice of what nature has added in others whofe fabric is more compounded. The fmalleft animals, then, which have very few or no limbs, the leaft diftinction of parts, the fhorteft life, and the vital functions both few and very fimilar to one another, bring forth young ones like themfelves, with no diftinction of fexes; all of them are fruitful, and none imparts fecundity to the reft. Some animals exclude their young through a certain cleft of their bodies; from others, limbs fall off, which are completed into animals of a kind fimilar to thofe from which they have fallen. This kind of generation is extended very wide, and comprehends the greater part of animal life.

Thofe again, which are a little more compounded, all bring forth their young; yet in fuch a manner, that a certain particle peculiar to themfelves is generated in their bodies, diffimilar to the whole animal, and contained in fome involucra, within which lies the animalcule that is afterwards to become ſimilar to its parent; this is commonly called an *egg*. A great part of theſe animals is immoveable.

Animals that are ſtill more complex have both eggs, and male ſemen beſides; ſo that both ſexes are joined in the ſame animal; this claſs is the moſt numerous. The *male ſemen* is that ſubſtance which it is neceſſary to ſprinkle on eggs to render them prolific, although it never grows alone into a new animal. In this claſs, therefore, a juice is prepared by its own proper organs, which is likewiſe poured on the eggs through organs proper to itſelf, but different from the former, in order to generation.

Thoſe animals are much more numerous which have both a male juice and female eggs; yet cannot fecundate themſelves, but require true coition. For two animals of this kind muſt ſo agree in the work of fecundation, that each impregnates the other with its male organs, and again ſuffers itſelf to be impregnated in its female ones by the male parts of the other.

Approaching nearer and nearer to man, we come next to that claſs, of which, ſome individuals have only male organs, and the ſame males ſprinkle their ſeed on the female eggs of others. Several of the animals with cold blood ſprinkle their ſeed upon the eggs after they are poured out of the body of the mother. Warm animals inject their ſemen into the uterus of the female. If eggs are generated in the female, ſhe expels the lifeleſs embryo included in ſhells or membranes; but if a living fœtus, ſhe then retains it ſo long as that it may be born free from any involucrum. The difference between theſe oviparous and viviparous animals is ſo ſmall, that in the ſame claſs, and the ſame genus, ſome animals lay eggs, others produce live fœtuſes; and laſtly, the ſame animal ſometimes lays eggs, and ſometimes brings forth live young.

From this review of animals it appears, that all animals are produced

produced from one ſimilar to themſelves; many from a part only of a ſimilar one; others from an egg of a peculiar ſtructure; but that all theſe have no need of male ſemen. Laſtly, the more moveable and lively animals only, whoſe bodies are of a more complicated ſtructure, are endowed with a double ſyſtem for generation; and the difference of ſexes ſeems to be added for the bond of ſocial life, and for the ſafety of a leſs numerous progeny.

For the effuſion of this male juice into the female organs, both ſexes are inflamed with the moſt vehement deſires; the male indeed has the moſt lively ones; for ſince the female is always prepared for the venereal congreſs, it was neceſſary for the male to be more ſtrongly excited, eſpecially at the time when he abounded with good and prolific ſeed, which indeed is the principal incentive to venery in him. In females, of the brute kind eſpecially, ſome inflammation in the vagina, which excites an intolerable itching, ſeems the principal cauſe of venereal deſire.

Nature has added to the womb, both in women and in quadrupeds, a vagina, or round membranous cavity, eaſily dilatable, which, as we have already ſeen, embraces and ſurrounds the projecting mouth of the uterus; it deſcends obliquely forward under the bladder, reſting upon the rectum, with which it adheres, and laſtly opens under the urethra with an orifice a little contracted. This opening, in the fœtus and in virgins, has a rema[illegible] wrinkled valve, formed of the ſkin and cuticle of the vag[illegible] under the denomination of *hymen*, which ſerves to exclude the air or water: ſince only the human race have this membrane, it is perhaps not without ſome kind of moral uſe. It is circular; except that a part of it is ſometimes wanting under the urethra, and it is broader behind. Being inſenſibly worn away by copulation its lacerated portions at laſt diſappear. The caruncles, which are called *myrtiformes*, are partly the remains of the ſhattered hymen, partly the rugæ and the valves of the mucous lacunæ hardened into a kind of flefh.

At the entrance of the vagina are prefixed two cutaneous appendages, called *nymphæ*, continued from the cutis and gland of the clitoris; and thefe, being full of cellular fubftance in their middle, are of a turgefcent or diftenfible nature; they are jagged and replenifhed with febaceous glandules on each fide, fuch as are alfo found in the folds of the prepuce of the clitoris. Their ufe is principally to direct the urine, which flows between them both from the urethra, that it might run off and not trickle down the fkin, in which office the nymphæ are drawn together with a fort of erection. Thefe membranous productions defcend from the cutaneous arch furrounding the clitoris, which is a part extremely fenfible, and wonderfully prurient; it is compofed, like the penis, of two cavernous bodies, arifing from the fame bones, and afterwards conjoining together in one body, but without including any urethra. It is furnifhed with blood-veffels, nerves, and levator mufcles, and a ligament fent down from the fynchondrofis of the os pubis; like the penis in men, the clitoris grows turgid and erect in the time of coition, but lefs fo in modeft women; from friction, however, the clitoris always fwells up and is erected.

The mufcle, termed *oftii vaginæ conftrictor*, rifing from the fphincter ani and receiving an acceffion from the os ifchium, covers the venal plexus, comes forward by the fides of the labia, and is inferted into the crura of the clitoris; it feems to comprefs the lateral venal plexufes of the vagina, and to retard the return of the venal blood. The tranfverfe mufcle of the urethra, and the bundle from the fphincter inferted into it, have the fame fituation as in men.

When a woman is invited either by moral love, or a luftful defire of pleafure, and admits the embraces of the male, the penis, entering the vagina, rubs againft its fides, until the male

feed

ſeed breaks out and is poured into the uterus. In like manner, as in the male, the attrition of the very ſenſible and tender parts, excites a convulſive conſtriction of all the parts of the vagina. By theſe means the return of the venous blood being ſuppreſſed, the clitoris, eſpecially in ſalacious women, grows turgid and erect, the nymphæ on each ſide ſwell, as well as the venal plexus, which almoſt ſurrounds the whole vagina, and the pleaſure is increaſed to the higheſt pitch: in conſequence of which there is expelled, by the muſcular force, but not perpetually, nor equally in all women, a quantity of lubricating mucous liquor, of various kinds. The principal fountains of this are ſeated at the opening of the urethra, where there are large mucous ſinuſes placed in the protuberant margin of this uriniferous canal. Moreover, at the ſides of the urethra in the bottom of the ſinuſes which are formed by the membranous valves ſulcated upwards, two or three large mucous ſinuſes open into the vagina. Laſtly, at the ſides of the vagina, between the bottoms of the nymphæ and the hymen, there is one opening, on each ſide, from a very long duct; which, deſcending towards the anus, receives its mucus from a number of very ſmall follicles.

But the ſame action which, by increaſing the pleaſure to the higheſt degree, cauſes a greater conflux of blood to the whole genital ſyſtem of the female, occaſions a much more important alteration in the interior parts. For the hot male ſemen, penetrating the tender and ſenſible cavity of the uterus, which is itſelf now turgid with influent blood, there excites, at the ſame time, a turgeſcence and diſtention of the lateral tubes, which are very full of veſſels creeping between their two coats, and diſtended with a great quantity of blood. Theſe tubes, thus copiouſly filled and florid with the red blood, become erect, and the ruffle or fringed opening of the tube aſcends and is applied to the ovary. In the truth of all theſe changes, we are confirmed by diſſections of the human body and brute animals, and from the appearances of the parts when difeafed.

But, in a female of ripe years, the ovary is extremely turgid, with a lymphatic coagulable fluid, with which alfo the veficles are diftended. In a prolific copulation, fome one of the more ripe veficles is burft, a manifeft cleft appears, which at length pours out a clot of blood. Within this veficle, after copulation, a kind of flefh grows up, at firft flocculent, then granulated, and like a conglomerate gland, confifting of many kernels joined together by a cellular fubftance; which flefh by degrees becoming larger and harder, fills the whole cavity of the veficle, and is hardened into the nature of a fcirrhus, in which, for a long time, a cleft, or a veftige of one remains. This is the *corpus luteum*, common to all warm quadrupeds, in which fome late celebrated anatomifts have faid they found a fort of juice before copulation; which, however, experience does not admit, fince there is no corpus luteum before that event. Nor is the veficle, which is the human ovum, contained in a veffel like a cup.

The tube compreffing the ovarium in a prolific congrefs, is thought to prefs out and abforb a mature ovum, from a fiffure in the outer membrane, from whence it is continued down, by the periftaltic motion of the tube, to the uterus itfelf; which periftaltic motion begins from the place where the firft contact was made, and urges the ovum downward fucceffively to the opening into the fundus uteri, as is very manifeft in brute animals. The truth of this appears from the conftant obfervation of a fcar or fiffure produced in the ovarium after conception; from a fœtus being certainly found in quadrupeds, both in the ovarium and in the tube of the female; from the analogy of birds, in which the defcent of the ovum from the ovarium is very manifeft. Yet we muft acknowledge, that a true ovum was never found in quadrupeds, unlefs after a long time. It is probable, that at the time of conception, the true ovum is almoft almoſt fluid, very ſoft and pellucid, and cannot be diſtinguiſhed from the mucus with which the tube is filled; it muſt alſo be very ſmall to be able to paſs through ſo narrow a tube. The veſicle itſelf which was in the ovary remains fixed in it, and becomes the covering of the corpus luteum. But the accounts of ova ſaid to have fallen from women a few days after conception are not certain; and are contradicted by the ſmallneſs of the fœtus obſerved many days after; by the ſhape in which it is firſt obſerved, which is always oblong, and in brutes even cylindrical; and likewiſe by the ſmallneſs of the tube.

All this is performed, not without pleaſure to the future mother, nor without a peculiar ſort of ſenſation of the internal parts of the tube, threatening to induce a ſwoon. Neither is the place of conception in the uterus, whither certain experience ſhews that the male ſemen comes. For the power of the male ſemen fecundates the ovum in the ovaria themſelves, as we ſee in the caſe of fœtuſes found in the ovaries and tubes; from the analogy of birds, in which by copulation one egg indeed falls into the uterus, but very many are fecundated at once in the ovaria. Nor is the ſmall quantity of the male ſemen any objection to this, nor even its ſluggiſh nature, which by eminent anatomiſts has been thought to render it leſs fit for performing ſuch a journey through ſuch ſmall veſſels. For it is certain that the male ſemen fills the tubes themſelves at the firſt impregnation, both in women and brute animals.

The uterus is cloſed ſoon after conception certainly in animals, and probably in women, leſt the very ſmall ovum, together with the hope of the new progeny, ſhould periſh. At that time the new mother ſuffers many diſagreeable affections, which probably ariſe from the ſubputrid and ſubalkaline male ſemen reſorbed into the blood. A nauſea is occaſioned by conception, almoſt in the ſame manner as by ſwallowing a bit of rotten egg. Fleſh is at this time chiefly nauſeated; a vomiting alſo occurs; ſome puſtules break out, and the teeth ach.

Moſt

Moſt of theſe complaints we attribute to the ſwelling of the uterus, the retention of the menſes, and the compreſſion of the abdominal viſcera. What we have hitherto advanced, coming under the teſtimony of our ſenſes, may be either confirmed or corrected. What follows is rather conjectural; and its developement is the more difficult, as we have few experiments to determine the facts, and as even thoſe experiments we have are diſcrepant with one another. At the firſt outſet a difficult queſtion immediately preſents itſelf. Whence proceed the firſt ſtamina of the animal? Are they from each parent, and is the new animal formed by a junction of the ſeeds? The ſimilarity of the offspring to both parents ſeems to confirm the opinion. If analogical reaſoning might be permitted, we might adduce numerous examples from the vegetable kingdom which clearly ſhew that the offspring is a compound of each parent. The opinion is ſtill farther confirmed by morbid and vicious habits being conveyed from both parents to their children. On the other hand, we have no certain proof that ſeed exiſts in the female; and again, animals may be propagated without any mixture of ſeeds. Laſtly, the reſemblance of the young animal to its father ſeems only to ſhew, that in the male ſeed there is ſome power, which alone can form the ſoft matter of the little embryo; in like manner this ſame power, in peculiar animals, lengthens the pelvis, dilates the thorax, expands the horns, &c.

Some anatomiſts have attributed every thing to the father, eſpecially after the noted animalcula appeared in the male ſeed under the microſcope, whoſe figure perfectly agreed with that of the embryo in all animals. But then there is wanting a proportion between theſe animals and the number of fœtuſes produced. Another objection to this doctrine is, that in moſt of the animal tribes animalcula are not to be found. And laſtly, there is too great a ſimilarity between theſe animalcula and thoſe commonly found in other fluids, which always preſerve preferve their own peculiar fhape, and are never obferved to be changed by growth from a fimple worm into a handfome articulated animal, wholly diffimilar from themfelves.

Other anatomifts, again, not lefs celebrated or lefs worthy of credit, have taught that the fœtus exifted in the mother and maternal ovary; which the male femen might enliven and varioufly modify, fo that, at length, it might be brought into the world a perfect animal. Yolks are manifeftly found in the female ovaries, even although they have not been impregnated with any male femen. But a yolk is known to be an appendix to the inteftine of fowls, to have its arteries from the mefenteric artery, and the covering of the yolk to be continued with the nervous membrane of the inteftine, which is continuous with the fkin of the animal. Along with the yolk, therefore, the fœtus feems to be prefent in the mother hen, of whom the yolk is a part, and who gives veffels to the yolk. Laftly, the analogy of nature fhows, that many animals generate eggs without any connection with a male of the fame fpecies, but that a male animal never becomes prolific without a female. This reafoning will equally apply to all claffes of animals formerly mentioned, from the viviparous to the oviparous, and from the oviparous to thofe which produce their young by a part falling from the parent. Certainly, therefore, the males muft give fome addition to that fex which produces the fœtus from its own body; which addition is neceffary in fome tribes of animals, but in others, even the moft fruitful, may be wanting. It is impoffible to admit the opinion, that the navel of the conceived animal from the male is inoculated into the veffels of the female; for this navel would be too fmall at the time when the yolk is of a confiderable fize; nor could the very fmall umbilical arteries be applied to the very large yolk without any hope of a continuance of the circulation.

Thus much concerning the materials: but we are as much at a lofs concerning the formation; namely by what means the rude and ſhapeleſs maſs of the firſt embryo is faſhioned into the beautiful ſhape of the human body. We readily reject ſuch cauſes as a fortuitous concourſe of atoms, the blind attractions between the particles of the nutritious juices, and the ſtrength of ferments, not knowing the reaſons how they operate; the ſoul is certainly an architect unequal to the taſk of producing ſuch a beautiful fabric; and as we can never form any adequate ideas of the internal models, we ſhall refer them to thoſe hypotheſes, which the deſire of explaining what we ardently wiſh to know, has produced.

Experience indeed ſeems to agree with the following deductions which reaſoning affords, namely, that this moſt beautiful frame of animals is ſo various, and ſo exquiſitely fitted for its proper and diſtinct functions of every kind, and the offices and manner of life for which the animal is deſigned; that it muſt be calculated according to laws more perfect than any human geometry; that the ends have been foreſeen in the eye, in the ear, and the hand; ſo that to theſe ends every thing is moſt evidently accommodated: it appears, therefore, certain, that no cauſe can be aſſigned for it below the infinite wiſdom of the Creator himſelf. Again, the more frequently, or the more minutely, we obſerve the long ſeries of increaſe through which the ſhapeleſs embryo is brought to the perfection neceſſary for animal life, ſo much the more certainly does it appear, that thoſe parts which are obſerved in the more perfect fœtus, have been preſent in the tender embryo, although their ſituation, figure, and compoſition, ſeem at firſt to have been exceedingly different from what they are at laſt; for an unwearied and laborious patience has diſcovered the intermediate degrees by which the ſituation, figure, and ſymmetry, are inſenſibly reformed. Even the tranſparency of the primary fœtus alone conceals many things which the colour afterwards added does not generate, but only renders conſpicuous to the eye. And it ſufficiently appears that thoſe parts which emi-

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nent anatomifts have fuppofed to be afterwards generated, and to be added to the primeval ones, have been all contemporary with the primeval parts, and only fmall, foft, and colourlefs.

It is highly probable, that for a long time the latent embryo neither increafes, not is agitated, except by a very gentle motion of the humours, which we may fuppofe to librate from the heart into the neighbouring arteries, and from thefe into the heart of the fœtus. But we may alfo fuppofe, that the ftimulus of the male femen excites the heart of the fœtus to greater contractions, fo that it infenfibly evolves the complicated veffels of the reft of the body by the impulfe of the humours, and propagates the vital motion through all the canals of the little body of the animal, quicker in fome parts, and flower in others; and that thence fome parts of the body of the animal feem to be produced very early, others to fupervene afterwards, and laftly, fome do not appear until a long time after birth, as the veficles of the ovaries, the veffels of the male tefticles, the teeth, hairs of the beard, and horns of brute animals. In all animals, heat affifts this evolution; in the more fimple ones, whofe veffels are few, and lefs complicated in their various organs, heat is the fole inftrument of bringing it to perfection.

Of the objections which are ufually brought againft this doctrine, fome are not true; fuch as the fuppofition of an excrefcence of a different ftructure from the reft of the body; others feem to belong to caufes depending on fome accident, fuch as moft kinds of monfters; fome to the increafe of particular parts, occafioned by the powers of the male feed; fome to the cellular texture varioufly relaxed, as it feems to increafe in the parts newly formed, or to be itfelf produced, by indurated juices. Although it is not eafy to explain every thing mechanically, yet we ought to remember, that if indeed the new animal is fhewn by experience to be, and really is, prefent in the egg, no objections can overturn what has been demonftrated.

It muſt however be acknowledged, that many facts are, from the infancy of human knowledge, as yet inexplicable.

After the human ovum is brought down into the uterus, we become ſenſible of its change of ſhape in a few days. The ovum itſelf ſends out every where ſoft branchy flocculi from the ſuperficies of its membrane hitherto ſmooth, which adhere to, and inoſculate with, the exhaling and reſorbing flocculi of the uterus. This adheſion happens every where in the uterus; but chiefly in that thick part which is interpoſed between the tubes, and is called the *fundus uteri*. Thus the thin ſerous humour of the uterus, proceeding from its arterial villi, is received into the ſlender venous veſſels of the ovum, and nouriſhes it together with the fœtus. Before this adheſion, if at any time it does not adhere, it is nouriſhed either by its own, or by abſorbed juices.

At this time, the ovum abounds with a great proportion of a limpid watery liquor, which, like the white of an egg, hardens by heat, or by mixture with alcohol. The fœtus remains long inviſible, being never ſeen before the 17th day, when it is an unformed maſs of mere mucus in a cylindrical ſhape. When ſome diſtinction of parts is viſible, it has a very great head, a ſmall ſlender body, no limbs, and is fixed by a very broad flat navel to the obtuſe end of the ovum.

Henceforward the fœtus continually increaſes as well as the ovum, but in an unequal proportion: for while the arterial ſerum is conveyed by more open paſſages into the veſſels of the ovum, the fœtus, which ſeems to receive, by its very capacious umbilical vein, the greateſt part of the nouriſhment, increaſes very faſt. The ovum alſo increaſes, but in a leſs degree; and the proportion both of it and its water to the fœtus continually diminiſhes. The fleecy productions of the egg leſſen, they do not cover ſo much of its ſurface, and are gradually covered with a continued membrane. Thoſe, however, which ſprout from

from the obtuſe end of the egg increaſe, and are by degrees formed into a round and circumſcribed *placenta*.

Such is the general appearance of the ovum in the ſecond month; from which time it changes only by increaſing in bulk. That part of the ovum fixed to the uterus makes about a third of its whole ſurface, and is in the form of a flat round diſh or plate; ſucculent, fibrous, full of protuberances, but throughout perfectly vaſcular; theſe tubercles change into others of the ſame kind; it is for the moſt part accurately, and often inſeparably, connected with the uppermoſt part of the uterus. This ſubſtance, commonly called the placenta, is remarkable for its large veſſels, is of a thin cellular texture, and collects the veſſels every where, but chiefly in the circumference of its greateſt circle; the exhaling arteries of the uterus correſponding with the veins of the placenta, and the arteries of the placenta with the veins of the uterus. In the common ſurface of the uterus and placenta, a communication is made, by which the uterus ſends to the fœtus, firſt that white ſerous liquor not unlike milk, and laſtly, as it ſeems, red blood itſelf. This communication of the humours ſeems to be demonſtrated by the ſuppreſſion of the menſes in women with child, whoſe blood muſt be turned into another channel; by the loſs of blood which follows a ſeparation of the placenta in a miſcarriage; and by the blood of the fœtus being exhauſted from an hemorrhagy in the mother; by hemorrhagies that enſue from the navel-ſtring, ſo as to kill the mother when the placenta has been left adhering to the uterus; and, laſtly, by the paſſage of water, quickſilver, tallow, or wax, injected from the uterine arteries of the mother into the veſſels of the placenta, as is confirmed by the moſt faithful obſervations of eminent anatomiſts. That blood is ſent into the fœtus is evinced by the magnitude of the ſinuſes of the uterus and placenta; the diameter of the ſerpentine arteries of the uterus; the hemorrhagy that follows, even when the placenta is very

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ſlightly hurt; but eſpecially by the motion of the blood, which, in a fœtus deſtitute of a heart, could only be given to the humours of the fœtus by the blood of the mother.

Though it is probable the child is nouriſhed in the way above mentioned, yet as it is not fully proved, and as many phyſiologiſts take up the oppoſite ſide of the queſtion, it may not be improper to repeat what Wriſberg has ſaid on the ſubject.

" The manner in which the fœtus is nouriſhed after conception, labours under a like difficulty with the origin of conception itſelf. Of the two moſt noted conjectures which uſually explain the communication of the uterus with the placenta, namely, reſorption, or the immediate anaſtomoſis of the blood-veſſels, the laſt has always had the moſt partizans. I am ſorry that various arguments, ſufficiently weighty, prevent me from ſo eaſily embracing the ſame ſide; which arguments my celebrated pupils, Balthaſar and Moeller, have already mentioned, and which ſhall now be partly delivered by myſelf. They may be conveniently divided into two claſſes; the firſt contains the doubts of anaſtomoſis; the laſt, the arguments tending to prove it. In the firſt claſs it is denied,

" 1. Becauſe the young of birds, removed at a great diſtance from their mother, ſo that they cannot get any blood from her, prepare true blood from their own nouriſhment, the yolk and white.

" 2. The great hemorrhagy, which follows an abſtraction of the placenta from the uterus, indicates an anaſtomoſis between veſſels of great magnitude and importance; the number of ſuch veſſels, however, we find neither in the uterus nor placenta.

" 3. As often as I have taken the egg from the uterus of animals which have died at different periods of pregnancy, I always found in the uterus a liquor reſembling milk, rarely blood.

" 4. By the moſt ſucceſsful injections made, with all due care,

care, once into the uterus of a pregnant woman who died in the feventh month of geftation of a wound, feveral times into the wombs of mares, cows, goats, rabbits, dogs, and cats, &c. preparations of which I poffefs, I never could convey the fmalleft quantity of the moft fubtle liquor into the uterus from the veffels of the cord, nor from the veffels of the uterus into the placenta: the liquor entered only the cellular texture of the fungous chorion, and filled it with irregular particles.

" 5. I have fometimes filled the recent fecundines of women, and feveral brutes, that have come away fpontaneoufly immediately after birth; but I never faw the mercury rufhing forward, as we fhould have obferved in the rupture of anaftomofing veffels, which neverthelefs penetrates the moft fubtle veffels.

" 6. I have filled the uterine veffels of bitches (killed juft before parturition, by cutting the carotids, and which were almoft half alive) with a very fubtle liquor. The preparations which I poffefs are proofs of the moft happy and fuccefsful injection. However, I have done nothing more in thefe than to pufh the fluid and coloured matter into the cells of the fungous chorion; but there are not the fmalleft traces of its entering the veffels of the placenta. As to the other fide of the queftion, the arguments there are not of lefs weight; for

" 1. The fuppreffion of the menfes in pregnancy cannot fo much prove it, fince (*a*) feveral animals have no menfes; (*b*) they are not fuppreffed in all women; (*c*) the mafs of menftrual blood fuppreffed after conception, amounting to twelve, fixteen, or even twenty ounces, cannot poffibly be expended upon the fmall mafs of embryo of the firft or fecond month, which, together with the fecundines, weighs fcarce an ounce.

" 2. Thofe great and dangerous hemorrhagies which happen after the abftraction of the human placenta, excite no fmall fufpicion of an immediate anaftomofis. But (*a*) the flow of blood does not happen in all with the fame force; it is fometimes

times ſeveral pounds, ſometimes only a few ounces and drachms: (*b*) and the ſame flux is the more gentle the more carefully the abſtraction has been performed, and *vice verſa*; and in very profuſe fluxes the uterus is, for the moſt part, more or leſs injured. (*c*) I have ſeen abortions of two or three months attended with a very ſmall profuſion; and I now remember five in which ſcarce an ounce was loſt. (*d*) In the birth of brutes, ſo large effuſions never happen, or do not laſt ſo long.

" 3. It would truly be a weighty argument, which would eaſily determine me to embrace the doctrine of anaſtomoſis, if I could reconcile it with my own obſervations, that the fœtus is deprived of great part of its blood if the mother has died of an hemorrhagy. But I have ſeen (*a*) a human fœtus whoſe mother had died in the ſeventh month of geſtation of a bleeding wound, and had ſuffered a great effuſion, which had loſt no blood out of the heart nor larger veſſels; nay, not even in the placenta itſelf did the ſtate of the blood-veſſels exhibit any mark of hemorrhagy. (*b*) I have killed pregnant bitches and cats, juſt upon the time of birth, by cutting the carotids; I have examined the uterus of cows and mares, killed by means of a very large wound of the heart, without finding in any of them either the ova or fœtus ſhewing the leaſt defect of blood.

" 4. That mothers may ſuffer fatal hemorrhagies from cutting and not tying the cord, neither my own obſervations, nor thoſe of Roederer, will allow; and no perſon at preſent directs midwives to begin the tying of the cord towards the placenta.

" 5. What are called the venous ſinuſes in the uterus, except the cellular ſubſtance of the fungous chorion, ſeem to afford no proof. I have obſerved ſuch reputed ſinuſes in the uterus, if a very great part of the ſpongy chorion has cohered to the uterus. I have perceived them on the placenta, if it had adhered to it. The blood detained here does not abſolutely

lutely demonftrate the continuation of veffels: it only fhews, that a certain ftore is prepared, from which the abforbent veffels of the placenta may receive their nourifhing matter, which contains a mixture of the blood itfelf tranfmitted through the increafing veins, whofe refiduum is reabforbed by the veins of the uterus, and at length mixed with the blood. Does not the like happen in other fpongy parts?

"6. As to examples of fœtufes wanting the heart, whofe circulation therefore fhould have depended upon the mother alone, although I am not fo certain of the truth of them, I could oppofe as many other obfervations of a fimilar monftrous mechanifm in birds."

To refume our fubject, the remaining part of the ovum, and likewife the furface of the placenta, are covered by an external villous and fleecy membrane, (full of pores and fmall veffels, of a reticular fabric, and eafily lacerable,) fo as to refemble a thin cake, called the *fpongy chorion:* (this is elegantly delineated by Dr Hunter). But even this is connected to the flocculent furface of the uterus, which is very like to itfelf, but fofter, by veffels fmaller than thofe of the placenta, but manifeftly inofculated from the chorion into the veffels of the uterus.

Under the fpongy chorion lies a continuous, white, opaque, and firm membrane, and not vafcular; it does not cover the part of the placenta turned towards the uterus, but is concave, and turned to the fœtus. It coheres by a cellular texture both to the fpongy chorion and amnios. The moft fimple name we can give it is the *læve chorion*.

The innermoft coat of the fœtus, which is called *amnios*, is a watery pellucid membrane, very rarely fpread with any confpicuous veffels, extremely fmooth, and in all parts alike; it is extended under the placenta with the former, and its furface is every way in contact with the waters. If there are more

 fœtufes

fœtuſes than one in man or beaſt, each of them has its proper amnios.

The nouriſhment of the fœtus, from the beginning to the end of the conception, is without doubt conveyed to it through the *umbilical vein*. This vein, ariſing from the exhaling veſſels of the uterus, and from the umbilical artery with which it is continuous, makes the venous ſinuſes under the ſurface of the placenta; when all its branches are collected, it forms a large trunk that is twiſted, though not ſo much as its concomitant arteries, into circular folds; it is ſufficiently long to allow a free motion: after being ſurrounded with cellular mucus including alſo other veſſels, and the whole being covered with a continuation of the amnios, it is known by the name of the umbilical cord. The umbilical vein, after forming ſome protuberances, enters through the navel, in an arch made by a parting of the ſkin and abdominal muſcles, and goes to the proper ſinus of the liver, into which the ſmaller portion of the blood that it conveys is poured through the ſlender ductus venoſus into the vena cava ſeated in the poſterior foſſa of the liver; but the greater part of its blood goes through the large hepatic branches, which conſtantly ariſe from its ſulcus, and remain even in the adult; and the blood goes thence to the heart by the continuous branches of the vena cava. The ſinus, or left branch of the vena portarum itſelf, is a part of the umbilical vein, and its branches bring the blood from the placenta to the cava, while the right branch alone carries the meſenteric and ſplenic blood through the liver.

But this is not all the uſe of the placenta; for the fœtus ſends great part of its blood to the placenta by two large *umbilical arteries*, which are continued in the direction of the aorta; and after giving ſome ſlender twigs to the femorals, with ſtill ſmaller arteries to the pelvis, they aſcend reflected in the direction of the bladder, ſurrounded with the cellular plate of the peritoneum, and with ſome fibres ſpreading to them from

from the bladder and urachus; they then proceed on the outſide of the peritonæum into the cord at the navel, in which, paſſing alternately in a ſtraight and contorted courſe, they form various twiſtings and windings, ſomewhat ſharper than thoſe of the vein which they play round; and at laſt they arrive at the placenta, whoſe ſubſtance is entirely made up of their branches, in conjunction with thoſe of their correſponding veins, and a ſlippery cellular ſubſtance following both veſſels; ſo that the kernels themſelves, that are conſpicuous in the placenta, are convolutions of thoſe veſſels. By theſe branches the blood ſeems to paſs out through the minute arteries of the placenta into the veins of the maternal uterus, that after undergoing the action of the lungs by the mother's reſpiration, it may return again in an improved ſtate to the fœtus. What other reaſon can be aſſigned for ſuch large arteries, which carry off above a third part of the blood of the fœtus?

But it will perhaps be aſked, Whether the fœtus is nouriſhed by the mouth likewiſe? Whether it drinks the lymphatic liquor contained in the cavity of the amnios, which is coagulable unleſs putrified, and in the middle of which the fœtus ſwims, and whoſe origin is not ſufficiently known? Whether this opinion is not in ſome meaſure confirmed by the open mouth of the fœtus, and the analogy of chickens, which are under a neceſſity of being nouriſhed from the contents of the egg only? to which add the abſence of a navel-ſtring in ſome fœtuſes; the quantity of meconium filling the large and part of the ſmall inteſtines; the ſimilitude of the liquor found in the cavity of the ſtomach to that which fills the amnios; the proportionable decreaſe of the liquor amnii, as the fœtus enlarges; the glutinous threads which are found continued from the amnios through the mouth and gula, into the ſtomach of the fœtus; the true feces found in the ſtomach of the fœtus of quadrupeds; the open mouth of the fœtus, which we have certainly obſerved; the gaping of a chicken ſwimming in this liquor, and its attempts as it were to drink it up? Again, what are the fountains or ſprings from whence this lymph of the amnios flows? whether it tranſudes through the inviſible veſſels of the amnios, or through certain pores from the ſucculent chorion, which is itſelf ſupplied from the uterus? It muſt be confeſſed, that theſe inquiries labour under obſcurities on all ſides; notwithſtanding which, ſays Haller, there ſeems more probability for them than otherwiſe, ſince the liquor is of a nutritious kind, at leaſt in the firſt beginnings of the fœtus, and is derived from the uterus.

All the excremental feces, which are collected in the fœtus during the whole time of its reſidence in the womb, amount to no great quantity, as they are the remains of ſuch thin nutritious juices, percolated through the ſmalleſt veſſels of the uterus. Haller obſerved, that the bladder was often almoſt empty in the fœtus. A quantity of urine is, however, generally collected in a long conical bladder: But in the cavity of the inteſtines, a large quantity of a dark green pulp is collected, which appears very like a mixture of the bile and the remains of the exhaling juices.

It may then be aſked, Whether there is any allantois? ſince it is certain that there paſſes out from the top of the bladder a duct called the *urachus*, which is a tender canal, firſt broad, covered by the longitudinal fibres of the bladder as with a capſule; and afterwards, when thoſe fibres have departed from each other, it is continued ſmall, but hollow, for a conſiderable length through the umbilical cord, yet it vaniſhes in the cord itſelf. Whether this, although it be not yet evident in the human ſpecies, is not confirmed by the analogy of brute animals, which have both an urachus and an allantois? But as for any proper receptacle continuous with the hollow urachus, it either has not yet been obſerved with ſufficient certainty, or elſe the experiment has not been often enough repeated, to render the opinion general in the human ſpecies; and thoſe eminent anatomiſts tomifts who have obferved a fourth kind of veffel to be continued along the umbilical rope into its proper veficle, will not allow that veffel to be called the urachus, and very lately have referred it to the omphalo-mefenteric genus. Wrifberg has feen two fœtufes with a fimilar filament. He injected a third with wax, and that filament which might impofe upon us for the urachus was likewife filled. In man only a fmall quantity of urine is fecreted; but it perhaps may be no improbable conjecture, that fome portion of the urine is conveyed to a certain length into the funiculus umbilicalis, and is there transfufed into the fpongy cellular fabric which furrounds it; this circumftance may ferve as a reafon why man has a longer umbilical cord than brutes, and no allantois.

The fœtus continues to advance in growth; the limbs gradually fprout from the trunk, under the form of tubercles; and the other outworks of the human fabric are by degrees beautifully finifhed, and added to the reft. The manner in which all this is performed anatomifts have not hitherto fufficiently defcribed. At prefent I fhall not enter fully on the fubject; yet it feems neceffary to fubmit the following compendium to the reader's confideration.

The embryo which we firft obferved in the uterus of the mother was a gelatinous matter, having fcarcely any properly defined fhape, and of which one part could not be diftinguifhed from another. There was, however, in that gluten a heart, which was the caufe of life and motion; there were veffels which generated the humour of the amnios; there were therefore veffels of the umbilicus and yolk, the little trunks of which, being received from the fœtus, are at that time very large. There was a head and fpinal column, bearing a larger proportion to the other parts of the body than they do afterwards. There were likewife, without doubt, all the reft of the vifcera, but, being pellucid and of a mucous nature, they were

not

not ſo apparent as they would have been, had they been more opaque and ſolid.

But in the whole fœtus, an immenſe quantity of water is mixed together with a very little earth, as the cellular texture ſurrounds it in a ſtate between fluid and ſolid, having large drops of water interpoſed between the particles of the ſolid parts.

To this the vivifying gluten or white of the egg, which is of the nature of lymph, there is added in birds a yolk, which is of an oily nature: in man ſomething of a milky nature, not altogether unlike the yolk of an egg, is added to the coagulable lymph. That the blood is perfected from the fat by the proper powers of the fœtus, we are perſuaded from the example of birds. From it are inſenſibly prepared all the other humours; but all of them at firſt mild, glutinous, void of taſte, colour, and ſmell. It is long before they acquire their peculiar nature and properties, and ſome of them are not produced till many years after birth, for inſtance the ſemen.

The firm parts, even in a grown perſon, make much the ſmalleſt portion even of the harder parts of the human body; in the fœtus they differ from the fluids, by a ſomewhat greater degree of coheſion; as yet, however, they are like a gluten, at firſt fluid, and afterwards more conſiſtent. In theſe the fibres which we could not diſtinguiſh in the primeval embryo are by degrees produced; the gluten, as it would ſeem, being ſhaken between the neighbouring veſſels, part of the water expreſſed, and the terreſtrial parts attracting one another. Theſe fibres variouſly embrace one another, and form a cellular texture, as is the caſe in certain diſeaſes, and intercept little ſpaces, in which there is a kind of humour. From this cellular ſubſtance the membranes and veſſels, and almoſt the whole body are formed.

The veſſels are the oldeſt parts of the body, and are prepared in the firſt delineation of the embryo. What firſt appears in an an egg during the time of incubation, having any diftinct form, are venous circles: and thefe veins produce the arteries, by which they both receive their juice, and the motion of that juice. They are not generated mechanically from an obftacle, againft which the arterial blood ftrikes. At firft the trunks of the veins are confpicuous, afterwards the branches which convey the humours to the trunks. If they were produced from the arteries reflected, the branches would firft be feen, and the trunks would be formed laft. Neither could the arterial blood, driven back by an obftacle, form thofe moft beautiful circles, and bring back the veffels into the heart. It would rather flow irregularly through the cellular texture. And the primeval heart would foon lofe its life, unlefs as much of the humours returned to the heart as was fufficient to keep up its pulfations.

There are, therefore, in the primeval fœtus, fuch as we firft obferve it, fome parts more perfect and confpicuous; others involved, invifible, and very fmall. The heart is the moft perfect; it is the only moveable and irritable part; although it is in many refpects different from what it is in an adult perfon. The brain is large and fluid; the veffels firft appear formed near the heart, and are vifible in the back. The vifcera, mufcles, nerves, and limbs, are not yet to be feen; nor the bones, whofe firft appearance is a mucus, nor the veffels of the reft of the body. The other vifible portion of the fœtus is the abdomen, of which the umbilical capfule is an immenfe hernia.

To this embryo is fuperadded motion, in man almoft of the heart alone; as alfo in birds, whofe formation does not take place without heat rather greater than that of the human body: yet, without the heart, heat deftroys, inftead of forming the fœtus. In the beginning the proportion of the heart to the reft of the body is the greateft; and is ever after continually growing lefs. Its pulfations are alfo at this time the moft frequent, and are very powerful for impelling the humours, and

diftending

diftending and producing the veffels of the foft and tender fœtus.

The vifcidity of the vital humours which collect the earthy elements is oppofed to the force of the heart, and by that means the formation of the fœtus is affifted. For there is in the embryo both an impelling force, which increafes the parts longitudinally; and a refifting force, which moderates the increafe, and increafes the lateral preffure, and thus the diftention. By the force of the heart, the artery, * with all its furrounding cellular texture, is lengthened; its folds are ftretched, and the artery itfelf is dilated. The blood by its lateral preffure makes an effort againft the almoft blind branches of the arteries, fills and evolves them, and fets them off at more obtufe angles: thus are produced fpaces which make very little refiftance, in which the gluten is depofited. In the very fubftance of the artery itfelf, while it is every where dilated, between its inconceivably fmall folid threads, are prepared little reticulated fpaces like a ftretched-out net, which are equally fit for receiving humours. The largeft of thefe are framed round the heart and in the head, whither the impulfe of the heart drives the humours in a ftraight direction; and in the placenta: the leffer ones are in the inferior parts of the body, whence the umbilical arteries fubtract the greateft part of the blood.

The fœtus increafes very quickly, as is moft evident in the example of a chicken, whofe length the twenty-fecond day is to its length the firft day at leaft as 1,000,000 to 1; and the whole increafe of bulk in the bird during the remainder of its life does not exceed the fifth part of the increafe of the egg the firft day. For the fœtus has a larger and more irritable heart, veffels larger in proportion, and likewife more numerous and relaxed, and the folid parts are mucous and diftenfible.

* Artery is here ufed to exprefs the whole of the arterial fyftem.

The

The breaſt is later of coming to perfection, being ſurrounded with membranes ſo fine that they cannot be ſeen.

The embryo not only increaſes in bulk, but is ſo remarkably altered in ſhape, as to be brought forth totally unlike the appearance it had at firſt. It is probable, that the limbs are produced from the elongated arteries; that they are laterally knit together by a certain gluten; that they are ſeparately evolved; that at firſt they ſprout out very ſhort, but afterwards increaſe by inſenſible degrees, and appear divided into diſtinct articulations; as the wings of a butterfly are formed from vaſcular net-work. Thus likewiſe the right ventricle of the heart is expanded by the blood coming to it in greater quantity; and, being increaſed by degrees, equals the left.

On the other hand, the cellular texture, from its glutinous aqueous nature, by earthy particles being continually brought to it, becoming inſenſibly harder, by a gentle attraction contracts its parts, which were before ſtraight, into various flexures; and ties the auricles to the heart, from which they were as yet at a diſtance. So the muſcles draw out proceſſes from the bones by their continual pulling, and open ſmall cavities into large cells: the ſame likewiſe incurvate the bones, and give them different ſhapes.

Preſſure can do a great deal: to it we muſt attribute the deſcent of the teſticles into the ſcrotum, after the irritable force of the abdominal muſcles has taken place: to this alſo we muſt aſcribe the repulſion of the heart into the breaſt, when the integuments of the breaſt are larger: to it we are to aſcribe the length of the breaſt and the ſhortneſs of the abdomen, and the ſmaller ſize of the viſcera of the latter; becauſe the air received into the lungs dilates the cavity of the thorax. But even the bones are variouſly hollowed out by the preſſure of the muſcles, blood-veſſels, and even of the very ſoft brain itſelf; and by the ſame means fleſh is changed into a tendinous ſubſtance.

 The

The power of derivation brings the blood into the pelvis and lower extremities from the clofed umbilical arteries: this fame power, when the foramen ovale is contracted by the auricles being drawn towards the heart, evolves the right ventricle of the heart: when the veffels of the yolk have taken up the whole length of the egg, and can receive no farther elongation, it dilates the umbilical arteries of the chick, and produces a new membrane with incredible celerity. On the other hand, but ftill by the fame power, after the blood has got an eafy paffage through fome veffels of any part, the other parts which do not afford a like eafy paffage increafe the lefs. Thus the head grows lefs after the lower limbs have begun to increafe in bulk.

A membrane may be formed from a humour when its thinneft part is exhaled, as we have an example in the epidermis: from the fame humour may be formed a cartilage, as happens in the bones, or even a bone itfelf, or fomething of a ftony nature, which is very frequent in the tefticles of aquatic animals. The bones at firft are foft, and of a mucous nature; then they become of the confiftence of a jelly; this afterwards becomes a cartilage; without any change made on the parts, as far as can be obferved.

A cartilage, however, is not afterwards invifibly changed into a bone. That never happens, unlefs lines and furrows have firft run along the cartilage: nay, unlefs the red blood has made a paffage for itfelf through the veffels of the bones; and unlefs thefe veffels manifeftly come from the nutritious trunks in the interior parts of the bone, and ftrike as it were in right lines on the cartilaginous extremity of the body of the bone, removing the extremity of the bone farther and farther from the middle of it. Round thefe veffels is formed a cellular texture and laminæ, which the veffels themfelves feem to prefs towards the medullary tube. Laftly, in the epiphyfis, which both remains much longer cartilaginous, and denies entrance to the blood, the red veffels, as well as the others which come

come from the exterior veſſels of the limbs, penetrate through the cruſt that covers the extremity. Thus alſo in the epiphyſis a red nucleus of a vaſcular texture is produced, which, being gradually increaſed by veſſels ſent out from its ſurface, changes the reſt of the cartilage into a bony nature.

In theſe long bones it ſeems evident, that the increaſe is owing to the arteries elongated by the force of the heart, and gradually extended to the extremities of the bones; and that the hardneſs is owing to groſs particles, at laſt depoſited in the cartilage when its veſſels admit the red blood. We know by experience that even a bony callus never becomes ſound till the newly formed red veſſels have penetrated its ſubſtance.

The flat bones originate from ſomething of a membranaceous nature. Over this the fibres ſpread themſelves, at firſt in a looſe net-work; but afterwards they become more denſe, having the membrane for their baſis; the pores and clefts between theſe fibres being gradually contracted and filled with a bony juice, at laſt perfect the nature of the bones; but at the ſame time, in theſe flat bones, red veſſels are interſperſed among the fibres.

That a heavy bony juice, conſiſting of groſſer particles, is depoſited between the primeval fibres, is proved by the phenomena of the growing callus, which exſudes in ſmall drops, not from the perioſteum, but from the inmoſt ſubſtance of the bone, and is hardened by degrees. But even a chymical analyſis extracts that gluten from the bones; and in an anchyloſis it appears poured round the joint in a fluid, and manifeſtly fills up the chinks of the bones and intervals of the ſutures. It contains groſs earthy particles, which have been diſcovered by various experiments; and the juice of madder which adheres to it, manifeſtly diſtinguiſhes it by its colour.

The perioſteum covers the bones, as a membrane does any of the viſcera; and the cellular productions from it follow the interior veſſels of the bones: but, in the perioſteum, there are neither ftraight fibres, nor an appearance of alveoli or laminæ, nor red veffels, while the bone grows hard in the egg; nor does the periofteum at all adhere to the bone, except in the epiphyfis, when that has affumed a bony nature in the middle; and it is thinneft, but every where complete, when the bone is in a cartilaginous ftate. In the flat bones it every where affords a bafis for the bony fibres.

The head of the fœtus is large, every where membranaceous, in a few places cartilaginous on firft days of geftation, with a mouth deeply cut, and with very long jaws. In the fœtus come to maturity, there are alfo rudiments of the teeth, which have a great deal of membrane as an appendage: the brain, at firft fluid, and always foft, is itfelf very large, with large nerves: the eyes are big, and the pupil fhut by a membrane: the breaft is very fhort, but capable of extenfion, on account of a great quantity of cartilage: the abdomen is large, furrounded with membranes, and contains a very large liver: the bile is infipid and mucous: the inteftines are irritable, and full of foft, green excrement. When the fœtus has at laft arrived at its ftate of maturity, the kidneys are divided into lobes, are large, and have very big capfules: the pelvis is very fmall, fo that the bladder, ovaries, and tubes, project from it: the genital fyftem is denfe, not yet evolved, nor preparing its juices: all the glands are large, particularly the conglobate ones, and full of a ferous juice: the fkin is at firft pellucid, then gelatinous, and at laft covered with a foft cuticle and febaceous ointment: the fat is firft gelatinous, and then grumous: the tendons foft, fucculent, and not yet fhining.

There is a great difference between the circulation of the blood in the fœtus and in the adult: that this may be underftood, it is neceffary to defcribe the organs by which it is performed. The firft is the *thymus*, a foft loofe gland, confifting of very many lobes, collected into two large upper horns, and two inferior fhorter ones, which are however joined together by by a great deal of long and lax cellular texture: this gland is large in the fœtus, and occupies a great part of the breaſt: it is ſeated in the cavity of the mediaſtinum, and part of the neck: and is wholly filled in its very inmoſt ſtructure with a white ſerous liquor, which cannot be diſcovered without wounding it. This gland in an adult, being continually leſſened by the increaſe of the lungs, and by the aorta now become larger, gradually diſappears. What is the uſe of this gland, or of its liquids, we are altogether ignorant; but even all the other glands, eſpecially the conglobate ones, are larger in the fœtus than the adult, as we have already obſerved.

The cavity of the breaſt, as was ſaid, is ſhort in the fœtus, and greatly compreſſed by the enormous bulk of the liver; the lungs are ſmall in proportion to the heart, and ſo ſolid as to ſink in water, if they are every way excluded from taking the atmoſphere into their ſpongy ſubſtance, in making the experiment. Since therefore the like quantity of blood which paſſes the lungs by reſpiration in adults, cannot be tranſmitted thro' the inactive lungs of the fœtus, who has no reſpiration, there are other ways prepared in the fœtus, by which the greater part of the blood can paſs directly into the aorta, from the lower cava and umbilical vein, without entering the lungs. In the primeval fœtus there is no right ventricle of the heart; and therefore there is ſo large an opening of the right auricle into the left, that all the blood which comes by the vena cava immediately paſſes into the aorta, a very ſmall quantity only excepted, which goes to the inconſiderable and inconſpicuous lungs. Afterwards in the fœtus, now grown bigger, the lungs are indeed larger, and the paſſage from the part of the auricle into the left one is narrower, ſince the auricular canal is now taken into the heart, and the auricles themſelves are become much ſhorter. But yet the ſeptum joining the right and left auricle, is perforated with a broad oval foramen; through which the blood coming from the abdomen,

domen, and a little directed or repelled by the valvular ſides of the right auricle, flows in a full ſtream into the cavity of the left auricle. The membrane of each ſinus gradually ſlants upwards and backward, and fixes itſelf to the pulmonary ſinus above the foramen ovale on each ſide, by ſeveral rows of fibres that are palmated below, ſo as to cloſe at firſt a ſmall and then a greater part of this foramen, in ſuch a manner that only a tranſverſe oval oblique paſſage remains, by which a communication is open between the round margin of the foramen ovale and the valve. This paſſage, in a mature fœtus, is nearly equal to the 15th part of the vena cava.

That the blood takes this courſe in the fœtus, and that it does not, on the contrary, flow from the left ſinus into the right, is evident from every circumſtance. For the column of blood in the right ſinus is greater than any other, as it conſiſts of the whole flow from every part of the body: again, the left auricle muſt have ſo much leſs blood than the right, in proportion to the part which paſſes through the ductus arterioſus; hence another cauſe why the contents of the left are leſs than thoſe of the right auricle. Moreover, the valve of the ovale foramen, in a mature fœtus, is ſo large, and placed ſo much to the left of the muſcular arch or iſthmus, that when it is impelled by the blood from the left ſide, the valve, like a palate or ſhutter, cloſes up the foramen; but being impelled from the right ſide, it yields ſo as eaſily to tranſmit either blood or air; it ſhuts ſo cloſe as to retain even air blown from the right, nor ſuffering it to return, if blown from the left.

Moreover, there is but a ſmall portion of the ſame blood, which firſt entered the right auricle and ventricle of the heart, that takes its courſe through the lungs: for the pulmonary artery, being in the fœtus much larger than the aorta, is directly continued into the ductus arterioſus; which is larger than the capacity of both the pulmonary branches together, and greatly larger than the opening of the foramen ovale.

This

This ductus arteriofus enters that part of the aorta which comes firft in contact with the fpine, under its left fubclavian branch; by which means it transfers more than half the blood to the defcending aorta, which muft otherwife have paffed through the left auricle and ventricle into the afcending branches of the aorta; and this is the reafon why the aorta in the fœtus is fo fmall at its coming out from the heart. By this mechanifm an overcharge of blood is turned off from the lungs, and directed in a ftraight courfe to the umbilical arteries, and the powers of both fides of the heart are united in propelling the blood.

Thofe who have afferted that the fœtus refpires in the uterus have made very few experiments: they have not even attended to the fact, that the fœtus in utero fwims in a body of water; and that the lungs of a fœtus immerfed in water always fink: nor have they given due confideration to the evident fhortnefs of the breaft, and the fmallnefs of the lungs. Whether it can take in air through the vagina of the mother is very difficult to be determined: but we fufpect it to be poffible in a certain fituation, that a well grown fœtus, which is not too much compreffed, may fometimes draw in air, while it is in the birth.

As the fœtus grows larger, fo the uterus increafes proportionally. The ferpentine arteries are extended by the impelled blood, and ftretched into a more direct courfe; the veins, having their trunks compreffed by the great bulk of the uterus, and being unable to return the blood, fwell out into immenfe finufes; and laftly, fome of the menftrual blood is retained in the uterus, and not yet fpent on the fœtus. Thefe changes are the caufe why the thicknefs of the womb continues the fame; becaufe the greater quantity of the blood and the dilatation of the arteries and veins make up for the extenuation of its folid parts. The fundus, or upper part of the womb, increafes beyond the reft; fo that the tubes feem to be fituated below the middle of the uterus, which now by degrees goes out of the pelvis, even as high as the colon and ſtomach, ſo as to compaſs all the abdominal viſcera, more eſpecially the bladder and rectum. The os uteri in the firſt months of geſtation is drawn upwards with the uterus itſelf, and recedes from the entrance of the vagina: after the third month, according to Haller, but not till the beginning of the ſixth month, according to Wriſberg, it again deſcends, and ſtretches into the vagina. Becoming again perpetually ſhorter, it projects only a little into the vagina: it is, however, conſtantly tender; and, from that cartilaginous hardneſs which is obſerved in the virgin womb, is relaxed into a mucous ſoftneſs. It is never perfectly cloſed, but only ſtopped up and defended from the air by the thick mucus from the ſinuſes, and perhaps alſo by that from the veſicles which are ſeated in the cervix uteri. Moreover, the cervix or neck of the womb itſelf, which has long remained unchanged, becomes much ſhorter during the laſt months of pregnancy, and at length forms a broad flat opening, which, toward the time of parturition, grows continually wider. As theſe matters advance, the fœtus, which in the firſt months had no certain ſituation, being now grown to a conſiderable bulk, is, about the middle of the time of geſtation, folded together into a globe, ſo that the head lies betwixt the knees; and this being the heavier part, ſubſides by degrees more and more into the pelvis towards the cervix uteri.

The various complaints in the uterus are now increaſed to the higheſt degree. Being diſtended by the great quantity of blood retained in it, all its nerves are highly irritable. Nothing is more painful than a violent tenſion, unleſs it is done very gradually. From the head of the fœtus ſinking down into the pelvis, the rectum, bladder, and that part of the uterus next the neck, and which is the moſt ſenſible, are preſſed, and become painful: the fœtus, having received its full increaſe of bulk, diſtends the uterus every way; and that with the

the greater uneafinefs, becaufe, the waters being now leffened, the limbs which are fully formed, and the head, prefs much more vehemently on the uterus. It is thought alfo that the placenta itfelf, now very large, hurts the internal and naked furface of the uterus. From thefe caufes arife, at firft, flight endeavours of the uterus to free itfelf; and at laft, when thefe caufes are increafed to their utmoft height, an uneafy fenfation is occafioned by the impacted head of the fœtus, fimilar to that which arifes from a collection of feces in the rectum; and, from the pain which fhe fuffers, the mother is conftrained to attempt the birth of the child. The time of delivery comes on after the expiration of nine folar months, and is kept pretty exactly in every fpecies of animals, although by fome caufes it may be accelerated or retarded for a few weeks: thefe caufes, whofe power, however, we muft not extend too far, are very various and undetermined.

The tenefmus increafing till it becomes intolerable, the mother ufes all her efforts, by very deep infpirations, to prefs the abdominal vifcera down on the uterus; and at the fame time the womb itfelf, by its contractile vital force, conftringes itfelf fo powerfully about the fœtus, as fometimes to exclude it, without further attempts from the mother. The difficulties of the birth, however, are evidently overcome principally by the efforts of the mother, while the mouth of the uterus, now very foft, fuffers itfelf to be diftended by the head of the fœtus. The amnios, filled with the water, is firft protruded vertically, before the head of the fœtus, fo as to dilate the os internum uteri: in which, the membranes being by degrees extenuated and dilated, eafily break, and pour out their waters, which lubricate the paffages, and relax all the parts of the vagina. The naked head of the fœtus now prefents naturally with the face to the os facrum, directed that way by its weight: and, being urged forward like a wedge or cone, it further dilates the os uteri; till at length by the more powerful efforts of the mother, which often loofen the bones of the pubes in young women, the head is thruft out through the dilatable vagina, with confiderable pain to the mother, and an univerfal tremor of body; and if none of the bones of the pelvis happen to prefs unequally, the infant eafily advances, and is delivered into the world. This operation is attended with difficulty even in quadrupeds; but in the human race, whofe fœtus has a very large head in proportion to its body, it is very dangerous.

It is natural for women to have but one child at a birth; which law they have in common with all the larger animals, except the carnivorous kind. Frequently, however, they have two, more rarely three, and fcarcely ever five. It is not to be doubted, however, that a fecond fœtus may be conceived while the firft remains in the uterus; for women have frequently borne children, when a hard and offified fœtus had been for a long time retained in their uterus.

The placenta of the fœtus, connected with the fundus uteteri, is, in the next place, feparated from the womb, without much difficulty in a mature birth, partly by the weaker throes of the mother, and partly by the affiftance of the deliverer. The fleecy or vilous furface of the placenta being withdrawn from that of the womb, a confiderable flow of blood immediately follows, and the fecundines are expelled. The umbilical cord of the fœtus is next tied, before it is cut off; for it cannot be left open without danger of a fatal hemorrhagy. The umbilical vein is deprived of all the fupplies of blood which it ufed to receive, and at the fame time an infuperable obftacle is oppofed to the blood, conveyed by the arteries of the fame name.

The uterus, which hitherto had been diftended beyond due bounds, now contracts itfelf by the elaftic power of its fibres, fo fuddenly and powerfully, as often to catch and embarrafs the hand of the deliverer, and frequently retain the placenta, if it be not ſoon looſened and withdrawn. By this contraction of the womb, the bleeding veſſels are compreſſed, no leſs than by the contraction of their own coats; whence the large quantity of blood that was collected in the uterine ſubſtance abundantly flows out under the denomination of the *lochia;* at firſt pure, but afterwards, as the openings of the veſſels contract themſelves, the diſcharged fluid is yellow, and becomes at laſt whitiſh. The ample wound of the uterus is healed, and the uterus ſoon ſhrinks up to a bulk not much exceeding that of a virgin.

Two or three days after the birth, when the lochial diſcharge has almoſt ſpent itſelf, the *breaſts* begin to ſwell conſiderably; and their ducts, which in the time of geſtation often diſtil a little thin ſerum, become now very turgid with a liquor, which is at firſt thin or like whey, but is ſoon after followed by the thicker chyle itſelf. *Milk* very much reſembles chyle, but human milk leſs than that of other animals. It is white, thickiſh, ſweet, and replete with a very ſapid eſſential ſalt; it grows ſour ſpontaneouſly, but is tempered by the oil and lymph added to it. It has alſo a volatile and ſomewhat odorous vapour, a good deal of fat or oily parts, a larger portion of a white craſſamentum or cheeſy curd, and ſtill more of a diluting water; and again, in the craſſamentum, are contained parts of a more earthy, alkaleſcent, or animal nature. But when the chyle is once changed into ſerum, by faſting a conſiderable time, the milk becomes ſalt to the taſte, alkaleſcent, and diſpleaſing to the infant. The milk frequently retains the nature of the aliments and medicines taken into the ſtomach, as chyle does. The cauſe of this increaſed ſecretion in the breaſts, ſeems to be owing to the revulſion, in conſequence of the plentiful uterine ſecretion, by which the fœtus was nouriſhed, being ſuppreſſed; in the ſame manner as a diarrhœa is ſuppreſſed by increaſing the perſpiration. For it has been obſerved, that true milk will ſometimes make its way through other parts befides the breafts, and even efcape through wounds. There is apparently between the uterus and breafts fome kind of nervous fympathy, and a fimilar fitnefs for generating a white liquor; for the uterus in infancy, and during the time of pregnancy, manifeftly generates it. But the inofculations between the mammary and epigaftric arteries, though true, are fo fmall, that they can have but a very little fhare in this account.

The *breafts* confift of a very large quantity of foft furrounding cellular fat, of a white colour; and of conglomerate glandules; it is affembled into bunches of a convex figure, fomewhat round and hard, of a reddifh blue colour, outwardly furrounded and connected by a firm web of the cellular fubftance, feparating off into leffer kernels, which are common both to men and women. To thefe glandules a great number of blood-veffels are diftributed from the internal mammaries, from the external veffels of the thorax, and alfo from thofe of the fhoulders, all which inofculate together around the nipple. The trunks of the mammary arteries, but not the *mammales*, inofculate with the epigaftric veffels; the veins more evidently than the arteries. The nerves are both large and numerous, like thofe of the more fenfible cutaneous parts, and are derived from the fuperior intercoftals.

From the middle of this gland of the breaft, and likewife from the furrounding fat, an infinite number of fmall ducts or roots arife, very flender, foft, white, and dilatable, which come from all fides to the middle of the nipple, and likewife into the circle which fubtends its bafis, and then run together on the area of that circle, and emerge at the root of the nipple, or *papilla*; by which denomination we call that cavernous or fpongy cellular body, into which the blood may be received, fo as to caufe a kind of erection, as in the penis. Through this papilla about twenty or more of the excretory lactiferous ducts pafs from the breaft. None of thefe in-

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ofculate or join with the others, they are greatly contract-ed at their opening in the nipple, compared to what they were in the breaft: in a loofe or flaccid ftate of the nipple, they are compreffed, wrinkled, and collapfed together; but when the nipple is erected by any kind of titillation, they be-come ftraight, and open with patulent mouths between the cutaneous wrinkles. This papilla or nipple is furrounded by a circle, full of febaceous fmall glandules, which defend the tender fkin againft the repeated attrition and perpetual moif-ture.

Thus the infant is naturally provided with its firft food, which is otherwife exceedingly falutary to man. This the in-fant by inftinct knows how to receive, although it is as yet a ftranger to all the other offices of human life. Taking the nipple in its mouth, it caufes it to fwell by gentle vellications; the lips are preffed clofe to the breaft, fo as to exclude the air; at the fame time the infpiration is deep, and a fpace formed in the back part of the mouth, in which the air is more dilated or rarefied; and thus, by the preffure of the external air, joined with the force of the lips of the infant, the milk is urged from the breaft through the nipple, in which it would otherwife be collected in fo great a quantity, as fometimes to diftil fponta-neoufly and be very ready to flow out; and thus the infant fucks, and is nourifhed. The firft milk, which is like whey, termed *coloftra*, loofens the tender bowels of the infant, and purges out the meconium, to the great advantage of the child. It may be remarked here in general, that the lactiferous ducts are fo open, that when the nipples of the breaft are diftended by titillation, and a greater quantity of blood fent into the breafts, they have yielded milk even from virgins; fometimes from old women, or even from men. Milk is only generated after puberty; before that time a ferous humour flows from the breaft; and for the moft part it is generated only about the middle of pregnancy. After the menfes have ceafed, the

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breafts, as well as the uterus, become decayed, and ceafe to perform their office.

Great changes happen to the little new-born infant; and the firft is *refpiration*, which it endeavours to exert, even before it is well fet at liberty from the vagina of the mother; being probably excited, from the pain or anguifh it feels, to thofe cries with which it falutes the light, and perhaps from the defire of food, which it had hitherto only taken in from the liquor of the amnios. At firft, therefore, a portion of air is admitted into the lungs, which are as yet fmall and full of moift vapours; but being dilated by the air, change from a fmall denfe body, finking even in falt water, into a light fpongy floating fabric, extended to a confiderable bulk with air, and of a white colour. The blood paffes more eafily into the enlarged and loofe fabric of the lungs; in confequence of which, a large portion of the blood that went before from the pulmonary artery, through the canalis arteriofus, into the aorta, goes now into and through the lungs themfelves, by the pulmonary artery. And fo much the more is the arterial duct or canal deferted, inafmuch as there is made a new obftacle to the defcent of the blood into the abdomen; for the umbilical arteries being now tied, the blood of the defcending aorta dilates all the arteries of the pelvis and lower extremities, with the fame force with which it was before expelled through the umbilical arteries. Finally, as the lungs now receive more blood, fo the aorta itfelf receives a greater quantity, and with greater force likewife, from the heart; whereupon the intermediate canal, between the protuberant part of the aorta and pulmonary artery, clofes up or fhrinks to fuch a degree, that, in adults, it is not only an empty ligament, but likewife of very little length; the natural ftructure of this canal likewife affifts much to obftruct it, for it is fingularly red in the inner part, foft, and very fit for con-

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creting with the ſtagnating blood. This courſe of the blood, therefore, is ſoon aboliſhed, generally within the year.

In the like manner, the foramen ovale is, from the ſame cauſes, gradually cloſed up. For when the way is rendered more free and pervious into the lungs, it will likewiſe be more free into the right ſide of the heart; whence the blood, both of the aſcending and deſcending cava, will flow thither more plentifully, eſpecially as it is invited there by the more lax pulmonary artery, and will no longer need the paſſage through the ſeptum of the ſinuſes. Again, the umbilical vein, being now deſtitute of any ſupply of blood from the ligature of the navel, leſs blood will from thence flow into the lower cava, and conſequently the preſſure againſt the foramen will be diminiſhed; by which means the blood of the upper cava, being turned off by the iſthmus, will be ſcarcely able to penetrate the obliquity of the foramen ovale. Thence again, as more blood is derived through the lungs into the left ſinus and auricle, its greater dilatation and extenſion will ſtrain the little horns of the oval valve, ſo as to draw up and preſs the valve, together with the iſthmus; whereby it is extended ſo far, as wholly to ſhut up the opening in the mature infant, while, at the ſame time, the blood, within the left ſinus, props up the valve, ſo as to ſuſtain the impulſe of the blood on the other ſide within the right ſinus. Thus, by the acceſſion of a little friction of the uppermoſt margin of the valve againſt the upper part of the iſthmus, the foramen ovale cloſes up by degrees, and the upper margin of the valve forms a concretion to the poſterior face of the iſthmus. But this is performed very ſlowly; inſomuch that frequently, in an advanced age, there will be ſome ſmall aperture or tube ſtill remaining; and where there is no tube, yet there are the remains of one, as a kind of ſinus, hollow to the left ſide, that makes a tube opening upward to the right ſide, and blind or cloſed to the left; becauſe the power of the blood in the right ſide is al-

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ways greater than its refiftance on the left, or certainly not lefs, even in the advance of life.

The *umbilical vein*, being deprived of blood, foon clofes up. The blood of the vena portarum, having no oppofition from that which formerly flowed through the umbilical vein, occupies the left finus and curve of the umbilical foffa, and fends its blood through thofe branches by which that of the umbilical vein before paffed. Thence the *ductus venofus* being neglected, fhrinks up and clofes, by the new compreffure which the defcending diaphragm makes upon the liver by infpiration; and by which the left lobe of the liver is preffed towards the lobule, and perhaps too from the obtufe angle which it makes with the left finus of the vena portarum; for it is certainly firft clofed in that part which lies next the vena portarum.

The *umbilical arteries* are alfo clofed up from the fame caufes, as other arteries ufually are after a ligature; and fome of the blood, being at the fame time compacted into a polypus, fills up the blind void part; while the other blood, flowing above, whofe impulfe was fuftained by the refifting membranes, fpreads itfelf through the adjacent lefs refifting branches, which are thereby rendered more open or diverging. Part of this effect muft be attributed to the force of the abdominal mufcles, by which thofe arteries are compreffed againft the full abdomen in each refpiration; and to the very acute angle in which the umbilicalis goes off from the iliac artery, returning with it along the fides of the bladder; and alfo to the ftraight pofition which the thighs now have, compared with the crooked one they had in the uterus. Thus the capacity of thefe arteries is foon fhut up, leaving only a fmall tube, that gives paffage into two or three arteries of the bladder. The *urachus* being a very thin tube, extended perpendicularly upward from the bladder, is therefore eafily clofed up; fo that the contents of the bladder make no endeavours to pafs that way, finding a ready outlet by the defcending urethra.

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From the like caufes the bulk of the liver is leffened, and by degrees contracts itfelf within the ribs; in the mean time the inteftina craffa, from the fmallnefs they had in the fœtus, dilate to a confiderable diameter; the ftomach itfelf is gradually elongated; the large convexity of the cæcum forms itfelf by the force of the feces preffing perpendicularly downward to the right fide of the vermicular appendix; and the lower limbs are likewife confiderably enlarged by the return of the blood, fent back from the umbilical arteries now tied; and by degrees all the other changes are made, by which a fœtus infenfibly advances to the nature and perfection of an adult perfon.

### § 9. *Nutrition, Growth, Life and Death.*

After birth the child continues to grow, but always more flowly the older it is. There are many concurring caufes, why the growth is continually rendered lefs and lefs. Many veffels feem to be ftopped up, both becaufe they are compreffed by the neighbouring torrent of blood flowing through the great arterious tube, and becaufe the blood being now become more vifcid more eafily coagulates. But the harder kind of food that is now ufed, throws into the blood more terreftrial parts; which being carried through the whole body along with the nutritious juice, renders all the parts harder, as the bones, teeth, cartilages, tendons, ligaments, veffels, mufcles, membranes, and cellular texture; fo that an increafe of hardnefs may be perceived in them, even by touching them with the finger. Wherefore, fince the blood flows from the heart through fewer canals, and fince all parts which fhould be lengthened or diftended are grown harder, it neceffarily follows, that thofe which ought to increafe in bulk, will yield lefs and lefs to the impulfe of the heart.

But the heart likewife, which is the part that is firft confolidated among all the soft ones, increases less than any other part of the whole body; and while the much more tender limbs and softer viscera are distended, the proportional bulk of the heart to the rest of the body grows continually less and less, till at last its proportion to the body of the adult becomes eight times less than what it was in the new-born infant. At the same time, from that very density which it has so quickly acquired, it becomes less irritable, and is contracted less frequently within a given time. Thus, while the resisting forces are augmented, the distending ones are at the same time diminished.

There will therefore, sooner or later, be an end of the increase of bulk; and that will happen so much the sooner as the heart has had the more frequent and vivid contractions: but this cessation of growth will take place when the cartilaginous crusts of all the bones are now become so thin, that they cannot yield to the increase of the bony part. In women, the menses seem to put an earlier than usual stop to the growth. In cartilaginous fishes, the growth is perpetual.

There is no state in which nature by a perennial progress induces a continual decrease from the first conception. It is said however to take place, when there is neither any increase of bulk, nor yet does any visible decrease take place.

For we are all perpetually consuming. Nor do we only lose the fluid parts of our bodies, but in short even those which are reckoned to be the most solid. For even the bones are changed; and the teeth, which are harder than the bones, increase in bulk when the attrition of the opposite teeth has ceased to wear them away, and therefore their elements are changed: even the fibres of ivory in an elephant's tooth, after having been divided by the entrance of a leaden bullet, have grown in a curve direction, and completely inclosed the ball. The bony juice likewise is changed; for in some cases the bones grow soft, in others they swell out in bony tu-

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mours: even cicatrices themfelves have a manifeft growth, otherwife they would not be fufficient in an adult perfon to clofe up a wound which he had received when a boy; and a great quantity of the earthy part of our bodies goes off by urine, as is feen in fome difeafes.

The caufe of the deftruction of the folid parts is in their perpetual extenfion and retraction, at every pulfe of the heart, of which there are an hundred thoufand every day; and by this motion even metals themfelves are worn. Other caufes are from the friction of the fluid againft the folid parts: from the wearing away of all the membranes which cover moveable parts, either on the furface or in the internal cavities of the body; in the alternate fwelling and fubfiding of the mufcles; and in the attraction and preffure which our flefhy parts exert. But all parts of our body are the fooner worn away, in proportion as they are compofed of a greater quantity of gluten and a lefs quantity of earth; for that gluten when it is extended, if the extenfion has been a little fuperior to the force of its cohefion, muft of neceffity fall away and be carried off from the earthy parts. Thus wrinkles or furrows are generated; fuch as are vifible in the arteries of old men. The cellular texture, which otherwife would be diffolved into water or jelly, is worn away by the impetus of the blood preffing againft the neighbouring blood-veffels and mufcles, by friction, and by perpetual alternate flexion and extenfion.

The decreafe would be very quick, and indeed there would be no great diftance between the beginning of our life and its end, unlefs thefe loffes were repaired. The fluids are quickly reftored by food, as appears from the example of a chicken, in which blood is generated out of its aliment within two days. The fat, however, and red globules of blood, are formed out of the fat, as is fhewn elfewhere; the lymphatic juice from jelly; the mucus from mucus; and the reft of the humours from thefe and water. The folid parts are repaired by almoſt the ſame methods which we have deſcribed in the hiſtory of the fœtus. A gelatinous juice is brought from the aliments, through the arteries, to all parts of the body, and exudes into all parts of the cellular texture. The furrows, which we might imagine to be made in the inmoſt arterial membrane by the impetus of the blood, are filled up by a viſcid matter brought into them by the lateral preſſure; nor is it poſſible that theſe furrows can be overfilled, becauſe every exuberant particle of nutritious juice muſt neceſſarily be carried off by the current of the blood. This juice will not be deficient while there is a ſufficient quantity of aliment; and while there is more reſt, and leſs reſiſtance, in the bottom of the furrow than elſewhere, which muſt always be the caſe, becauſe the bottom is that part of the veſſel which is at the greateſt diſtance from the main current of the blood flowing through it. There ſeem to be certain powers in the air, by which the aliment is attached to the ſolid parts, altho' we are ignorant of the manner in which they act.

The decreaſe of the cellular texture ariſing from attraction or preſſure, will be repaired by the viſcid vapour exhaling from the artery, and preſſing towards thoſe places which ſtand in need of reparation by the force of the neighbouring arteries and compreſſing muſcles, its aqueous part being preſſed out and reſorbed. The gluten repairs moſt of the organic parts, tendons, and membranes; being formed into a new cellular texture, as in the fœtus.

The waſte which takes place in moveable parts adhering by their other extremity to the reſt of the body, can be repaired by protruſion alone, while the lymph fills up the intervals or hollows that are thus produced.

When the growth of the body can proceed no farther, obeſity is produced, which is a kind of imitation of real growth. This proceeds from the fat generated by the aliment; which by reaſon of the impetus of the blood being leſſened, and its

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entering the fmalleft veffels with more difficulty, is carried to the fides of the veffels; enters the lateral ones and the inorganic pores of the arteries; exudes into the cellular texture; and there, the power of conquaffation of the blood, and the abforption by the veins, being now diminifhed, the fat is confequently collected.

We feel the beginnings of decay even in youth itfelf. Even in that blooming feafon, the folid elements of the body are augmented, the chinks through which the humours flow are leffened, fmall veffels are obliterated, and the greater attraction of the cellular texture has added a denfity to the whole body. Throughout the whole body, that hardnefs occafioned by age is very confpicuous, in the bones now wholly brittle, in the fkin, in the tendons, in the conglobate glands, in the arteries, and likewife in the weight of all the parts, and of the brain itfelf. The parts moft exercifed by motion fooneft grow rigid, as is obfervable in thofe limbs of mechanics which are moft ufed in their feveral occupations.

Moreover, the arteries alfo continue to become more denfe, more narrow, and even to be quite filled up, as well by the internal preffure of the blood flowing through the large arterial tube, as by the attraction of the cellular texture of which the greater part of the artery confifts. An infinite number of parts of the cellular texture ceafe to be nourifhed; for the fmalleft arteries, which hitherto brought them nourifhment, are now obliterated, and ceafe to convey more nourifhment. The extending force being removed, the cellular flocculi draw themfelves together, contract the little fpaces intercepted between them, degenerate into membranes, or fubftances of a hard texture, which intercept, and as it were choak up other veffels. The gelatinous vapour likewife concretes in the fmall hollows of the cellular texture, and unites with the fides of thefe hollows into a hard folid. The mufcles degenerate into hard denfe tendons deftitute of all irritable power, becaufe

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the blood which they contained is expelled, and their fibres are condenfed.

At the fame time the nerves become more and more callous to the impreffions of the fenfes, and the mufcles grow lefs fenfible to the folicitations of the animal powers; thus the contractile force of the heart, the frequency of its pulfations, and confequently the whole force which drives the blood into the fmalleft veffels, are diminifhed.

The quantity of humours is diminifhed in a denfe body, as is evident in the perfpiration, femen, humours of the eye, and of the conglobate glands; the vapour alfo which bedews the folid parts of the body every where decreafes. For this reafon, nutrition now languifhes, becaufe there are more parts of the body which require nourifhment, and lefs nutritious juice.

Nor is the quantity of humours only diminifhed: they themfelves are likewife corrupted. They were mild and vifcid in children: but thefe fame humours are in old men acrid, falt, fetid, with a great quantity of earth. This circumftance is owing to the ufe of falt or putrid food, which generate acrimony in the fluids; and the acrimony by a continual ufe of vitiated aliments perpetually increafes, being at the fame time augmented by a decreafed perfpiration and alvine evacuation neceffary for carrying off the putrid liquamen. Hence the fetor of the urine, of the breath, and the difficult healing of wounds.

But the worft quality of the humours is, that they abound with earthy particles, which are either fuch as are collected infenfibly from the aliments after the fecretions have become lefs free, or fuch as are carried off from the folid parts and returned into the blood; as is proved by the prefence of earth in fome difeafes, and by the nature of the gouty earth. The quantity of this earth is continually increafing, efpecially if the nutritious liquor abounds with it, hence the brittlenefs

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of the bones, and the hardneſs of all the other parts, increaſes. This earth is likewiſe every where depoſited in the cellular texture, but chiefly in the coats of the arteries, and produces cruſts, which are firſt callous, and then of a bony or ſtony nature.

The hardneſs or rigidity of the whole body, the decreaſe of the muſcular powers, and the debility of the ſenſes, conſtitute *old age*,—an evil, alas! which ſooner or later attends every mortal: It makes an earlier attack on thoſe who have been ſubjected to violent labour, or given themſelves up to pleaſure, or lived upon unwholeſome diet; than on thoſe who have followed a moderate way of life, and uſed temperance in their diet, or if they have removed from a cold to a warm country.

If theſe cauſes continue their operation of rendering the matter of the body more denſe, of diminiſhing its irritability, and augmenting the quantity of earth, it is not poſſible but decrepid old age muſt follow. In it the ſenſes are almoſt deſtroyed, the natural power of the muſcles is extremely weak, the limbs loſe their ſtrength, the feet eſpecially are not ſufficient for ſupporting and directing the body. The callous inſenſibility of the nerves cannot be incited to perform the office of generation: the very inteſtines become inactive, and refuſe to anſwer to the accuſtomed ſolicitations: by the induration of the cartilages interpoſed between the vertebræ, the body bends forward; by the falling out of the teeth, the jaws but ill ſupport the wrinkled lips; and laſtly, the heart loſes one half of the frequency of its pulſation, which it had in the infant ſtate.

Thus, at laſt natural death neceſſarily follows; but very many people are carried off before this time by diſeaſes. Scarce one in a thouſand exceeds the age of 90: one or two perhaps may be found in a century that live to the age of 150. Man is long lived when compared with other animals; he is alſo

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more tender than any of them, has loofer flefh, and fofter bones. Among the long-lived people, it is not eafy to fay what was the caufe of that privilege. England feems to excel all other nations in producing old men; and in general the inhabitants of temperate climates live longeft. The commonalty has almoft folely afforded thefe rare examples of longevity already mentioned; as indeed from the more numerous clafs, we might expect a greater number of examples. Sobriety; a moderate and not very rich diet; a mildnefs of manners; a mind not endowed with very great vivacity, but cheerful, and little fubject to care; all conduce to long life. Among animals, fowls are longer lived than many others, but fifhes the moft of all; the latter have the fmalleft heart, and the floweft growth, and their bones are never hardened.

Death happens fometimes, but rarely, from mere old age. This we fay happens when the powers, firft of the mufcles fubject to the will, then of thofe that are fubfervient to the vital functions, and laftly, of the heart, gradually fail; fo that old men ceafe to live through mere weaknefs, rather than through the oppreffion of any difeafe. We have often obferved the fame kind of death in brutes. The heart becomes unable to propel the blood to the extremities, the pulfe and heat defert the feet and hands; yet the blood continues to be fent from the heart into thofe arteries that are next to it, and to be again carried back to it: thus the flame of life is fupported for a little while; but it is foon extinguifhed, for the heart itfelf being totally deprived of its powers, and not irritable by the blood to any effectual motion, cannot drive the blood through the lungs, that the aorta may receive its due quantity. The utmoft force of refpiration is exerted in order to open a paffage to the blood through the lungs, until even the powers, given by nature for performing the action of infpiration, become unequal to their tafk, and ceafe altogether. The left fide of the heart neither receives blood, nor is irritated, and

and therefore remains at reft; the right ventricle, and laftly the auricle of the fame fide, for a while receive the blood brought by the veins from the cold and contracted limbs, and being thus irritated they continue to beat weakly. But laftly, when the reft of the body has become perfectly cold, and the fat itfelf congealed, even this motion ceafes, and death becomes complete.

We would call that death, when the whole irritable nature has left the heart; for the mere refting of the heart is not without hope of a revival of motion: neither does the putrefaction of any part of the animal body demonftrate the death of the whole animal; nor does its infenfibility or coldnefs do fo; but all thefe circumftances joined together, and perpetually increafing, with the ftiffnefs which follows the coagulation of the fat by reft and cold, can only be admitted figns of death in any doubtful cafe.

The dead body now haftens to putrefaction. The fat, water, and gluten, in confequence of feparation and diffolution, evaporate: the earth, deprived of its bonds of union, infenfibly moulders away, and mixes itfelf with the duft: the fpirit departs whither God hath deftined it. By death it is indeftructible; as may be proved by an attention to the following fact, that many dying people, though their bodily powers are wafted, and their bodies are even decayed, give evident figns of a ferene, vigorous, and happy mind.

## CHAP. V.

### *Of the* ARTERIES *in general.*

THE arteries are long extended cones, whofe diameters decreafe as they divide into more numerous branches; but where the arteries run for fome length, without giving off large branches, their convergency, if any, is not very evident: at their extremities they are cylindrical, or very imperceptibly diminiſhed, and are called *capillaries*, which admit only of a ſingle globule of blood at once, and whoſe tranſverſe ſection is always circular. Where the arteries ſend off large branches, the cavity is there ſuddenly diminiſhed, inſomuch that the arteries might be taken for a chain of cylinders, of which every one is narrower than the preceding. If you reckon them cones, then the common baſis of the cone in all arteries is either in the one or the other ventricle of the heart; and the apex of the cone terminates either in the beginning of the veins, or in the beginning of the cylindrical part of the artery, or in the exhaling veſſel, unleſs it is cylindrical. In ſome places they ſeem to diverge or dilate; at leaſt they become there of a large diameter, after they have been filled or diſtended with wax; which poſſibly may ariſe from ſome ſtoppage of the wax, by whoſe impulſe that part of the length of the artery becomes more diſtended than the reſt. Examples of this kind we have in the baſilar artery at the baſis of the ſkull, in the ſplenic artery, in the flexure of the carotid artery, according to Mr Cowper's injections; in the humeral artery near its diviſion; and, laſtly, unleſs theſe experiments deceive us, in the ſpermatic arteries. The arteries are univerſally wider at, than a little before, a ramification.

The arteries have no external proper coat univerſally extended over them, but the office of ſuch a coat is ſupplied to ſome of them by one ſingle external and incumbent integument, which in the thorax is the pleura, and in the abdomen the peritonæum. In the neck, arm, and thigh, a ſort of thicker cellular ſubſtance ſurrounds the arteries. The membrane of the pericardium, which on all ſides ſurrounds the aorta, returns back with the veſſels to the heart. The dura mater imparts a capſule, that ſurrounds the carotid artery as it paſſes out through a hole in the ſkull. But the firſt true exter-

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nal membrane common to the arterial tube in all parts of the body, is the cellular fubftance, which in fome parts (as in the thorax) we fee replenifhed with fat.

This cellular coat is, in its external furface, of a more lax texture, full of a great many fmall arteries and veins; and it has nerves running through its fubftance, which are none of the fmalleft. There is fometimes fo much of this cellular fubftance about the artery, as might occafion us to think it hardly belonged to the veffel as an external coat or lamella, but rather as fome foreign net-work added to it. Thus we find it in the arteries of the neck, groins, and fubclavians; in the mefenteric, cæliac, and hepatic arteries; where it is chiefly interwoven with long fibres. Thefe are the vaginæ or capfules of the arteries, formerly obferved by fome eminent anatomifts, and which, according to Wrifberg, are beft feen in young animals, or in fuch as have laboured under a congeftion or kind of fuffocation.

As this cellular coat advances more inward, it becomes more denfe, folid, and of the confiftence of felt, and may be called the *proper coat* of the artery. That there is no tendinous coat of the arteries diftinct from this laft part of the cellular fubftance, is evident from maceration, whereby the inner ftratum of this arterious tunic changes into a cellular fabric, which may be divided into feveral layers.

Within the former, there is a coat of mufcular fibres, which are, in general, imperfect circles: that is to fay, no fibre any where makes a complete circle round the veffel; but a number of fegments conjoined together, with their extremities turned off fideways, feem to form one ring round the artery. Thefe fibres, in the larger arterial trunks, from many ftrata, appear of a reddifh colour, and are remarkably firm and folid; but in the fmaller arteries they are by degrees more difficult to demonftrate; and they feem to be wanting in the arteries of fmall animals. Dr Haller has never obferved them to run along the veſſel lengthwiſe. Under theſe membranes, but rather difficult to demonſtrate, is an exceeding ſhort cellular texture, into which a chalky concreting matter is poured when an artery oſſifies.

The *innermoſt coat* of the artery is thin, and finely poliſhed by the blood running in it; it forms a continued incruſtation that every where lines the fleſhy fibres, which are not very continuous one to the other, and prevents the blood from inſinuating itſelf into the ſpaces between them: It is every where ſmooth and without valves; although in ſome places there are peculiar eminences that form a kind of folds; theſe folds, at the origin of branches are, by a mechanical neceſſity, formed into ſemicircles, eſpecially in the larger branches, thoſe, for inſtance, which come from the arch of the aorta. Yet, in arteries of the viſcera, the innermoſt coat is ſoft, lax, wrinkled, and almoſt friable, eſpecially in the ductus arterioſus.

The arteries themſelves *have arteries* which are more particularly ſpread through their external cellular coat, which ſpring on all ſides from the next adjacent ſmall arterial trunks: they are numerous, branchy, and like net-work; they are very minute, but plainly appear, even in the fœtus, without injection. Nerves alſo deſcend, for a long way together, through the ſurface of the artery, and at laſt vaniſh in the cellular ſubſtance of the veſſel; of which we have a ſpecimen in the external and internal carotids and in the arch of the aorta; and Dr Waller has ſhewn them in ſeveral arteries in the thorax and abdomen. Do not the arteries ſeem to derive from theſe nerves a muſcular and convulſive force, very different from that of their ſimple elaſticity? Does not this force ſhew itſelf plainly enough in fevers, faintings, palſies accompanied with atrophy, and paſſions of the mind? Haller conſiders the artery as being in a manner inſenſible and unirritable; and if it is conſtricted by the application of poiſons, he ſays it has every property of the

the dead ſkin. This, however, is not agreeable to the opinions of the preſent phyſiologiſts.

The *ſections* of the arteries are circular, becauſe they are elaſtic; and this is the reaſon why, from the ſmall arteries of the teeth, hemorrhagies are ſometimes fatal. The aorta, indeed, of the thorax and abdomen, the carotids of the neck, and ſome other arteries of the dead body, from their leſſened extenſion, appear ſomewhat flat or depreſſed; but their round figure, or circular ſection, is every where reſtored by injection. *Their elaſticity* is alſo evident by that powerful compreſſure, which a ſegment of a large artery makes upon the finger that diſtends it, and which is much ſtronger in a dead than in a living body. In the living body, indeed, this force yields to that of the heart; but inſtantly recovers itſelf when the heart is relaxed, and reſtores the artery to its former diameter; and this makes the *pulſe*, which all arteries poſſeſs, although the ſyſtole and diaſtole can be perceived by the finger, only in the larger, not in the ſmaller ones: in the ultimate inflection of the arteries, the pulſe totally vaniſhes; but, by an increaſed motion of the blood, even the leſſer arteries make a violent pulſation, as we ſee in an inflammation, or in preſſure depending on an internal cauſe. Theſe veſſels ſtrongly contract lengthwiſe, and are rendered ſhorter on diſſection.

The *ſtrength* of the arteries is conſiderable enough: but as the denſe hard net-work of the outer cellular coat refuſes to yield to a diſtending force, it breaks without much difficulty, and almoſt eaſier than the coats of the veins; and hence aneuriſms ariſe. But, in general, the trunks are, in all parts of the body, weaker, and the branches ſtronger in their coats; whence the impulſe of the blood may exert a conſiderable effect upon the former, but leaſt of all on the arteries of the limbs. Hence it is, that aneuriſms are moſt frequently formed near the heart; for, in the lower extremities, and in the ſecreting

creting organs, the ſtrength of the arteries, and of the veins too, is much increaſed.

Nature has diſperſed the arteries through the whole animal body, except in a few membranes where they have not yet been obſerved. She hath diſpoſed of the trunks, every where, in places of ſafety; becauſe wounds in the ſmaller trunks are always dangerous, and in the larger trunks frequently mortal. The ſkin is ſpread with numerous ſhort and ſmall arterial branches; but the larger trunks, defended by the ſkin and muſcles, creep along near the bones. In general, the arteries are in proportion to the parts of the body to which they are ſent. The largeſt go to the ſecretory organs, the brain, and ſpleen; the leſſer ones to the muſcular parts.

The proportion of the cavity of the artery to its ſolid part is not every where the ſame, nor is it conſtant even in the ſame artery. This proportion, in the firſt place, is leaſt of all at the heart, and increaſes as the arteries remove farther from it. Secondly, in a full-fed plethoric animal, whoſe blood paſſes freely, and with great force through its arteries, the proportion of the ſolid parts of theſe veſſels is leſs than in a famiſhed extenuated animal, whoſe blood has a feeble motion.

Branches are ſent from the trunks of all the arteries, and the branches are again ſubdivided almoſt without end. The ſections of any two branches taken together, exceed that of the trunk from whence they proceed, in the proportion of three to two, or ſomewhat leſs. Every trunk juſt above its diviſion is ſomewhat broader, or more expanded, than at a little diſtance from the diviſion. The angles at which the branches go out from their trunks, are generally acute, either half right angles, or nearly ſo; which, as we learn from mechanics, is the angle in which projectiles are carried to the greateſt diſtance. We have inſtances of their going off at right angles, or nearly ſo, in the lumbal or intercoſtal arteries; of their going off in a retrograde or reflected courſe, we have one

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inftance in the coronaries of the heart, and another in the fpinal arteries, which are produced by the vertebrals. But, generally fpeaking, thofe which are efteemed retrograde or reflected, were fent off, at their origin, in acute angles; fuch as the afcending artery of the pharynx, the defcending one of the palate, the umbilical mammary arteries, and the nutritious arteries of the large bones. Laftly, we often obferve large branches arifing at a lefs angle, and fmaller ones at a greater angle. We rarely obferve two arteries of a large diameter run together into one trunk. An example of this, however, we have in the artery formed by the junction of the vertebrals. In the fmaller ones it is frequent; as in both the fpinal arteries, and that of the fincipital foramen. The arteries often have ferpentine flexures, efpecially thofe that are diftributed on parts fubject to much motion, or to an increafe of fize, as the arteries of the large inteftines, womb, face, fpleen, lips, and iris. Arteries that are rectilineal in a natural ftate, become ferpentine if they are much diftended. Arteries are fometimes twifted or writhed, as the carotids under the mamillary procefs.

Arteries are frequently conjoined by intermediate branches, by a twig of fome certain artery running to meet one of the fame kind from another neighbouring artery, and by joining together with that, they both form one trunk. Inftances of this kind we have among the large trunks in the inteftines, among the middling ones in the kidneys, womb, &c. and among the fmaller in all parts of the body; infomuch that there is no part of the human body, wherein the neighbouring arterial trunks, whether of the fame or of different denominations, do not form anaftomofes or joinings one to another by intermediate branches. Of rings diverging laterally from the arteries, and returning into themfelves, we have inftances in the eye and brain. The extremities of the arteries, which are either cylindrical or nearly fo, fend off fmaller branches in greater er abundance than the large arteries do, and theſe extremely ſmall ramifications anaſtomoſing with one another form a kind of net-work; as we ſee more particularly in all membranes. By this means, though the paſſage from the heart to any part of an artery is obſtructed, the blood may nevertheleſs flow through the arteries which are near the obſtructed one. Thus a gangrene or languor of the part is very ſtrongly prevented, and the obſtruction is more eaſily reſolved by the repulſion of the obſtacle into the larger part of the trunk.

Laſtly, one of the leaſt arteries is either changed by a continuation of its canal into a vein, in ſuch a manner, that the ultimate little artery, which is generally reflected, having paſſed the angle of its reflection, becomes now a ſmall vein; or elſe a branch, ſent out at right angles from the artery, is inſerted by a like angle into the branch of a ſmall vein. Both theſe kinds of mechaniſm are demonſtrated to us by the microſcope, and the eaſy return of injections through the veins into the arteries. We ſometimes ſee theſe veſſels large enough to receive only one, and ſometimes ſeveral blood-globules at a time. A large artery is never obſerved to open into a vein.

In the viſcera, we find the ſmall arteries diſpoſed not ſo much in net-work as in a fabric of a peculiar kind, wherein the ſmall branches deſcend very thick, or in cluſters parallel to the trunk, ſo as to reſemble bruſhes, a variety of little trees or buſhes, ſmall ſerpents, or threads, according to the various diſpoſition of the parts.

Sometimes the arteries end in another manner, namely, by being converted into veſſels of the ſmaller kinds, which are continuous to the arteries, and indeed real arterial trunks; as may be obſerved in the ophthalmic artery, by tracing the arteries of the tunica choroides, or the colourleſs ones of the circle of the uvea and iris. That a net-work of pellucid arteries is continuous with the red branches of the ophthalmic one,

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is evident from inflammations, and the rednefs of the parts when relaxed by vapour or by cupping; from repletion, and the microfcopical experiments of Lieberkuhn upon frogs, in which colourlefs globules were feen to pafs from a red artery into a lateral veffel. In a fabric of this kind the red blood is eafily forced into the fmaller veffels.

In other places the fmaller veffels feem to proceed laterally as branches from the trunks of the leaft fanguineous arteries; and thefe again are drawn out into trunks ftill fmaller. Thefe are called *excretory ducts*. It is with difficulty that thefe veffels are filled with red blood; of this, however, we have examples in the kidneys, the liver, and the breafts. Indeed the blood, when vitiated, penetrates the excretory ducts of the whole body, even without hurting the veffels; nor is that aberration found to be productive of any evil confequence after the diforder of the blood is cured.

Another termination of the arterial extremities is into the exhaling veffels; and this manner of their ending is very frequent in all parts of the body. The whole fkin, all membranes of the human body which form any clofe cavity, all the ventricles of the brain, the anterior and pofterior chambers of the eye, all the adipofe cells and pulmonary veficles, the whole cavity of the ftomach and inteftinal tube, and the trachea, are all of them replenifhed with exhaling arteries of this kind. Thefe emit a thin, watery, gelatinous humour, which, by congeftion, ftagnation, or excefs, is converted into a watery but coagulable lymph, as we fee in feveral difeafes, and in death. The exhalants are eafily demonftrable from the watery fweat that enfues after injecting the arteries with any warm liquor. In fome places, they exhale indeed not a thin vapour, but blood itfelf, as we fee in the heart, the cellular fabric of the penis, urethra, clitoris, and nipple of the female breaft; in all which blood in its natural ftate is poured out. Does not every fecretion, that is made in true glands, or hollow cryptæ, bear fome analogy to this exhaling fabric?

Whether or no, in all parts of the human body, do the pellucid veffels, arifing from the fanguine ones, and carrying a humour thinner than blood, again fend out fmaller veffels, to be fubdivided into ftill fmaller orders? We feem, indeed, not to want examples of this circumftance. Several anatomifts have feen, in various parts of the body, a new rife of blood-veffels, after the courfe of the blood to the heart had been obftructed. That an aqueous vapour is fecreted by very fine veffels, from the colourlefs arteries of the iris, is very probable. We are almoft certain that the red coloured veffels in the cortical fubftance of the brain, feparate a juice pervading the medullary fubftance, by the intermedium of another order of veffels; and that an eryfipelas, or yellow inflammation arifes from the impaction of yellow globules into the fmaller veffels.

It may then be afked, if there are not yellow arterious veffels of a fecond order, which fend off lymphatic ones of a third order, from whence by degrees ftill leffer kinds of veffels branch out? Such a fabric does not feem agreeable to the very eafy tranfition that is made by the blood, mercury, or wax, into the exhaling and perfpiratory veffels, into the uriniferous tubuli, and into the adipofe and pulmonary cells; nor is it very difficult for the blood to ftray into the lactiferous, lymphatic, and lachrymal ducts, whither it fhould feem not able to penetrate if it had to make its way through any other intermediate vafcular fyftem fmaller than the blood globules. Nor can this opinion be admitted, on account of the great retardation to which the humours in a third order of veffels would be liable, and which would continually increafe in proportion to the fmallnefs of the veffels.

§ I. *Of*

### § 1. *Of the common Offices of the Arteries.*

The blood is driven from the left ventricle of the heart in a ferpentine ftream, into the aorta, ftriking firft againft the right fide, and then the left fide of this great veffel; whence it flows with repeated illifions and repercuffions through the whole arterial fyftem.

The arteries are, in a living perfon, always full of blood; fince the jet or ftream from an artery, is not interrupted by alternate ftops, while the heart is inactive, but flows on in a continued thread. The microfcope alfo fhews the arteries, in living animals, to be full both in their fyftole and diaftole; nor can the circular fibres of the arteries fo far contract themfelves as entirely to evacuate thefe tubes. Every contraction of the ventricle fends a new wave of blood into the arteries; this wave feldom exceeds two ounces, and confequently bears only a fmall proportion to the whole circulating mafs, yet it is fo forcibly propelled by the heart as to drive the preceding waves before it. In confequence of this propulfion, the dimenfions of the cylindrical artery are augmented, the arterial coats are preffed near each other, and the ferpentine flexures are confiderably increafed as we often fee in injections. This dilatation of the artery, whereby its capacity is changed from a lefs to a greater circle, is called the *pulfe*, the diaftole of which is an expanfion of the artery beyond its natural diameter. This action is the characteriftic of life; it refults from the heart only, and is in no wife natural to the arteries themfelves. Hence when the motion of the heart is intercepted, whether by aneurifm, ligature, or otherwife, pulfation of the arteries is to be felt; and hence a fudden ceffation of the pulfe, by a wound through the heart. The artery is proportionally more dilated, the more the velocity of the new wave exceeds that of the former one.

The ſyſtole or contraction of the artery follows the dilatation of it. For the heart having emptied itſelf, and removed the ſtimulus of the blood, comes into a quieſcent ſtate. But the artery, at this ſame time, by its innate elaſticity, and by the contractile power reſiding in its circular fibres, irritated likewiſe by the ſtimulus of the blood, contracts itſelf, and expels as much blood as ſerved to dilate it beyond its mean or natural diameter: this quantity of blood is either forced into the ſmaller and ſcarce-beating arteriolæ, or into the veins, as the ſemilunar valves of the aorta oppoſe the return of the blood. As ſoon as the artery has freed itſelf from this wave or column of blood, being no longer ſtimulated by diſtention, it directly collapſes by its own proper contractile force, and is now again ready to yield to a new wave or column of blood ſent into it from the heart; whence follows a repeated diaſtole and ſyſtole.

That the arteries thus contract, and, by that force, propel their contained blood, is proved from their ſtrongly contractile nature; from the evident remiſſion of the dilatation they receive from the heart; from the evacuation of the blood contained between two ligatures, through the lateral branches; from the return of the blood to the heart through veins when the artery going to theſe veins is tied; from the wave of blood being greateſt when the heart is in its diaſtole, as obſerved by ſome eminent anatomiſts; from the ſtrength with which the blood is ejected below a ligature on the aorta; and laſtly, from the evacuation which the arteries make of their contained blood, even after death, into the veins, whereby theſe latter appear much fuller than the arteries.

The blood's velocity in the arteries is diminiſhed during the heart's ſyſtole, but increaſed during its diaſtole; at a medium it is ſomewhat leſs than one foot in a ſecond of time. The conſtant plenitude of the arteries renders it impoſſible for us to perceive any ſucceſſion in the pulſes of different arteries; whence all the arteries of the body ſeem to beat at one and the ſame

ſame inſtant, whilſt the heart ſtrikes againſt the breaſt: and yet there is certainly a ſucceſſion in the ſyſtole of the arteries, by which the aorta ſeems to contract ſucceſſively, as it is filled with blood expelled from the heart; ſo that the part of the artery next the heart is firſt conſtringed, and thence the arterial contracting force gradually proceeds to the extremities. We have an inſtance of this in the inteſtines; and very evidently in inſects, who have a long fiſtulous and knotted heart, manifeſtly contracting in a ſucceſſion from the beginning to the end; but in the human arteries the ſucceſſions are ſo quick as to be imperceptible.

The pulſe is continued to, and ends in, the expillary and cylindrical arteries, or the originations of the veins. We have already mentioned the velocity with which the blood comes from the heart; but that velocity continually decreaſes. The tranſverſe ſections of all the arteries at a diſtance from the heart, are in one ſum greater than the ſection of the aorta; and the aggregate area of their ſections increaſes, but in an uncertain proportion, as the diſtance from the heart increaſes: The velocity will conſequently decreaſe as the diſtance increaſes, for it muſt always be inverſely proportional to the area of the tube through which the fluid runs. Again, the thickneſs of the coats of arteries increaſes, as their bores decreaſe; and is largeſt in the leaſt of them, which tranſmit only one globule at a time. The truth of this is proved from anatomy; and from the greater difficulty we find in burſting ſmall than large arteries, by inflating them. Another cauſe of the decreaſe of the blood's velocity is the friction of the globules againſt the ſides of the veſſel; and this friction will be very conſiderably increaſed by the length of the arteries, by their ramification, by their winding direction, and alſo by their diminiſhed diameter and conical form. Moreover, the inflections and folds of the veſſels greatly ſlacken the blood's motion; ſince always ſome part of the impelling force is ſpent and loſt in removing the convex parts of the folds, and

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changing the figure of the inflected veſſel. The angles alſo, formed by the lateral branches, greatly diminiſh the blood's motion; and that in proportion to the ſize of the angle. A conſiderable allowance muſt be made for the great viſcidity or tenacity of the blood, which entirely coagulates by reſt; its circulatory motion alone overcomes the mutual attraction of its parts, and prevents it from adhering to the ſides of the veſſels in a coagulated ſtate, as we ſee in aneuriſms and wounds of the arteries, and after death. The oppoſition which the blood meets with in the branches leſſens its velocity in the trunk: and the oppoſition of torrents of blood to one another in the anoſtomoſes of veſſels alſo deſtroys ſome parts of its motion. We may eaſily perceive the amount of this retardation will be very conſiderable, although it be difficult to eſtimate it juſtly. In the larger trunks the blood of a living animal flows with the rapidity of a torrent: but, in the leaſt branches, it creeps along very ſlowly; and begins to coagulate. It is alſo well known to ſurgeons, that a ſmall branch of an artery near the heart bleeds more dangerouſly than a much larger one at a greater diſtance. The weight of the incumbent atmoſphere, of the muſcles and fleſhy parts lying above the artery, and the contractile power of the veſſel itſelf, alſo make a reſiſtance to the heart; but they do not leſſen the velocity of the blood, for they add as much in the diaſtole as they diminiſh in the ſyſtole.

It is certain, however, from inciſions made in living animals, that the ſingle globules of blood, which move ſeparately in the ſmall veſſels, do not loſe ſo much of their velocity as, by calculation, they ought to do. We muſt therefore aſſign ſome cauſes which leſſen the decreaſe of the blood's velocity. In the firſt place, the great area of all the ſmall branches compared with the area of the trunk, and the exceſſive ſmoothneſs of the inner coats of the veſſels, both contribute to diminiſh the friction. The facility likewiſe with which the blood flows through the veins, expedites its paſſage through the little arteries,

teries, immediately communicating with theſe veins. No great aſſiſtance toward aſcertaining theſe particulars is to be expected from conſidering the effect of ligatures, or the weight of the blood; the latter is capable both of diminiſhing and accelerating the motion; nor can we ſuppoſe that in live animals a great effect depends upon the former. The power of derivation, whatever that is, and the motion of the muſcles, are capable of producing a new velocity.

The pulſe therefore enſues, becauſe the anterior wave or column of blood moves on ſlower, while the ſubſequent or poſterior wave comes faſter; ſo that the preceding is an obſtacle to the conſequent blood. But ſince the force of the heart weakens as the blood goes on, and the contractile power of the arteries increaſes, the exceſs of the celerity of the conſequent wave puſhed on by the heart, above the celerity of the antecedent wave puſhed on by the contractile power of the artery, will grow continually leſs and leſs; and when the blood arrives to a certain diſtance, the celerities of both waves become equal, and the pulſation ceaſes. This place of equality in motion cannot be in the larger and more conſpicuous arterial branches: for in them the wave laſt coming from the heart moves quicker than what went before. The inflammatory pulſation of the ſmall arteries of the eye ſhews that they have a pulſe. We may however ſafely conclude that in the leaſt red arteries, the pulſe at length begins to vaniſh. This is evident from the equable motion of the blood, as ſeen by a microſcope, through the arteries of a frog. In the larger veſſels, however, ſuch as may be about the ſixth part of a line in diameter, the pulſe becomes imperceptible. In the leaſt veins there is no ſenſible pulſation or accelerated motion of the blood, whilſt the heart contracts, demonſtrable either by the microſcope or any other experiment.

That the blood preſſes againſt the ſides of the veins, appears from the furrows made on the bones over which they paſs, and the ſwelling of the veins on being tied. Why do not the vein's beat? * The reaſon ſeems to be, that the blood is more retarded immediately on its leaving the heart, than it is in the ſmalleſt veſſels. Hence, the difference of the velocities of the conſequent and antecedent waves is greateſt at the heart, and grows gradually leſs, till it at laſt totally vaniſhes. This is illuſtrated by the following experiment: If water be made to paſs through a leathern tube, in a diſcontinued ſtarting ſtream, and a ſponge be fixed at the diſcharging extremity of the tube, the water will flow through the ſponge in a continued ſtream. It is alſo illuſtrated by another experiment, in which the ſame thing happens, by injecting the meſenteric arteries with an alternate impulſion of water; for then the water flows out through the veins in one continued even ſtream.

The pulſe is therefore the meaſure of the powers which the heart ſpends on the blood; becauſe it is the immediate and full effect of thoſe powers. Hence, *cæteris paribus*, the pulſe is ſlow in the moſt healthy people, where there is no ſtimulus, nor any unnatural reſiſtance; and where the heart is at liberty to propel the blood with eaſe. You muſt except thoſe caſes where there is ſome obſtacle which prevents the blood from entering the aorta. For this reaſon the pulſe in aſthmatic people is ſlow. A debility or inſenſibility of the heart, when the uſual ſtimulus is not capable of exciting it to contraction, alſo occaſions a ſlow pulſe. A ſtrong full pulſe is cauſed by the arteries being full, and the heart at the ſame time vigorous and powerful; a ſmall pulſe by the emptineſs of the arteries, and a leſſer wave of blood ſent from the heart. A hard pulſe denotes ſome obſtacle or ſtimulus; or elſe that the heart's force, the thickneſs of blood, or the rigidity of the artery, are increaſed. A quick pulſe denotes ſome ſtimulus, obſtacle, or greater

* We do not allow that to be a pulſe which happens from reſpiration, from the rejection of the blood from the right auricle, or from the muſcular part of the vena cava.

greater fenfibility or irritability of the heart. The pulfe is beft felt where the artery lies expofed bare to the touch, upon fome refifting bone; but obftructions fometimes render the pulfe perceptible where it is never fo naturally.

The pulfe is flower in animals as they are larger or more bulky; becaufe their heart, in proportion to the reft of the body, is lefs than that of fmaller animals; it is alfo lefs irritable, and is obliged to propel the blood to a greater diftance; whence in large animals, the proportion between the refiftances to be overcome and the force of the heart is lefs than in fmall ones. Hence, fmall animals are more voracious than large ones; as the whale and elephant. The pulfe of a healthful perfon, in the morning, beats at leaft 65 in a minute; but, after the fatigue of the day, it will beat 80; and again, by the night's reft or fleep, it will become gradually lefs frequent, till in the morning you will find it returned to its primitive number of 65. For the motions of the mufcles, and actions of the external and internal fenfes, the warmth of the atmofphere, and the action of the aliments, urge the venal blood on to the heart, whence a more than ordinary ftimulus and a greater number of contractions. Hence alfo thofe paroxifms, or fits of increafe, obfervable in all fevers towards the evening. Sleep retards the motion not only of the blood, but of all the other humours and actions in the body whatever.

A frequent and a quick pulfe are often confounded; but they are in reality very different. The pulfe is quicker in children, and becomes afterwards flower in perfons as they grow older. The falient point beats 134 in a minute: the pulfe of new-born infants, 120; and of old people 60.

A feverifh pulfe is ufually between 96 and 120, to which number indeed it is often increafed by laborious exercifes alone; if it is increafed to 130 or 140, (which laft number we have never known it exceed) the patient feldom recovers.

The pulſe beats ſlower in winter, and quicker in ſummer, by about 10 ſtrokes per minute; and under the torrid zone, it often increaſes to 120. The different paſſions of the mind variouſly accelerate, retard, and diſturb the pulſe. Whatever obſtructs the circulation is alſo found to accelerate the pulſe; not from the laws of hydroſtatics, or on account of the canal being made narrower, nor from the action of the ſoul; but by the ſtrenuous and more frequently repeated contractions of the heart in order to free itſelf from an irritating ſtimulus: Thus an irritation from acrid blood is the cauſe of the frequent pulſe in fevers.

The blood moves very ſlowly through the leaſt veins, partly by the force of the heart, and partly by the contractile force of the arteries. A renewal of the motion of the blood in perſons drowned, where, merely by exciting the action of the heart, the whole maſs is again propelled, is a proof of the former; and the contractile force of the artery is proved by what has been ſaid above.

The motion of the blood is quicker in the larger veins. For whenever the impelling powers remain ſufficient, and the ſmall veſſels are rendered narrower, the motion of their contained fluids muſt of courſe be accelerated; ſince the ſection of the venal trunk is much leſs than that of all its branches, in the ſame manner as that of an artery is leſs than the ſum of the branches into which it divides.

Since the blood moves thus ſlowly in the leaſt arterial veſſels and incipient veins, and as the weight of the blood itſelf in many places greatly hinders its return to the heart, while, at the ſame time, the very thin coats of the veins have but little contractile power; nature has therefore uſed various precautions, leſt, from the ſlowneſs of its motion, it ſhould any where ſtagnate or concrete. To obviate this, ſhe has ſupplied the veins with more watery vapours and fluxile lymph, than the arteries; and this was the more neceſſary in order to counterbalance the great exhalation that is made from the arterial blood in the lungs.

She has likewiſe placed the veins near the muſcles, that by the turgeſcence or contractions of the latter the veins may be preſſed; and this preſſure muſt neceſſarily determine the blood to the heart, for the valves of the veins prevent its return to the extremities. Hence an increaſed pulſe, heat and redneſs of the body; and hence alſo quick breathing after a violent exerciſe.

Moreover, thoſe muſcles which conſtantly urge or violently preſs the contiguous viſcera contained in any of the common cavities, powerfully promote the return of the venal blood to the heart. The conjunct preſſure of the diaphragm and the abdominal muſcles, produces this effect in the abdomen. The pulſations of the arteries, which every where run contiguous and parallel to the ſides of the veins, have no inconſiderable effect in promoting the return of the venal blood; and we have before ſhewn, that any impulſe acting on the veins can determine their blood to the heart only.

To theſe is added a force, not yet ſufficiently known, by which the blood is brought from a more compreſſed to a more lax, and leſs reſiſting part. In this matter alſo reſpiration is of great efficacy; in which the motion of the blood into the lungs, when relaxed, is accelerated by the derivation from all parts of the body: and again, in expiration, it is driven into the trunks of the veins of the head and abdomen; hence the ſwelling of the veins of the brain, in the time of expiration. The circulation is not indeed aſſiſted by theſe cauſes, but the blood is agitated and preſſed. The anaſtomoſes of the arteries contribute to the ſame end; for they facilitate the paſſage of the blood from thoſe places where it is obſtructed to ſuch as are more free.

By theſe means, in a healthy perſon uſing ſufficient exerciſe of body, the blood moves with ſuch a velocity, as ſuffices to deliver as much of it by the vena cava to the heart, as is ſent out by the aorta. But reſt or inactivity of body, and a weakneſs of the contracting fibres of the heart and other muſcles, frequently render this motion of the venal blood more difficult. Hence follow the varices in women with child, and the piles; which latter are alſo partly owing to the deficiency of valves in the vena portarum. Hence alſo the menſes. And when the veins return their blood too ſlowly to the heart, the ſubtile vapours ſtagnate; whence that frequency of œdematous ſwellings in weak people.

The time in which an ounce of blood, ſent out from the left ventricle of the heart, returns to the right, and which is commonly reckoned the time in which the greater circulation is performed, is uncertain. Suppoſe the quantity of blood thrown out of the heart at every pulſation to be $1\frac{1}{2}$ ounces, and the whole quantity of the blood to be 336 ounces, then a complete circulation is performed in the time of 224 pulſations; that is in about three minutes.

The effects which the motion of the heart and arteries produces upon the blood are various. They may be deduced and eſtimated from their cauſes; if we compare the blood of a living with that of a dead animal; that of a healthy with that of a diſeaſed animal; and laſtly, that of an active with that of an inactive animal. In the living animal, the blood is conſiderably warm; it looks red, with a ſort of purple florid hue; it ſeems to be homogeneous or uniform, and alike in all its parts, though it is really a mixture of different principles. It conſiſts almoſt entirely of particles commonly called globules; it flows very readily through the leaſt veſſels; and laſtly, when drawn from the veſſels, it exhales a volatile vapour, which we have already particularly deſcribed. In the dead animal which has not yet begun to corrupt or putrify, we obſerve, that the blood has loſt a great deal of its redneſs; that it ſeparates into two parts, namely, one more denſe, called ed craſſamentum, and the other more fluid called ſerum; and that when drawn from its veſſels, it exhales no vapour, and coagulates either wholly or in part. When the living animal becomes weak, and ſome ſmall remains of pulſe and reſpiration continue, we find the blood conſiderably cold. If, again, you compare the blood of a human perſon, inactive both in body and mind, with the blood of one that is naturally diſpoſed to much exerciſe, you will obſerve the latter has a greater heat; a more intenſe redneſs; a ſubſtance more compact; that it is ſpecifically heavier; and that the volatile parts are more abundant. All which appearances ſeem manifeſtly to be the effects of the motion of the heart and arteries, ſince they increaſe and diminiſh with that motion, and diſappear when it ceaſes.

That we may underſtand the manner in which theſe appearances are produced in the blood, we muſt conſider what are the effects of the heart impelling it; and of the arteries alternately compreſſing and urging it forward. And firſt we ſee, that the heart throws the blood with very great velocity into the crooked or inflected arteries, in ſuch a manner that the globules, expelled through the right ſide of the opening of the aorta, ſtrike againſt the left ſide of the artery; from whence being repelled, they incline towards the right ſide, whereby all the particles of the blood are agitated with a confuſed or turbulent and whirling motion. The blood thus impelled againſt the flexile and curved ſides of the arteries, of neceſſity dilates and diſtends them; and laſtly, in the ſmaller veſſels, capable of receiving only one, or a few globules of blood, all the particles of blood come ſo intimately into contact with, and grate againſt, the ſides of the artery, that they are even obliged to change their figure in order to gain a paſſage into the veins.

But the arteries, by their claſtic force, reacting upon the impinging blood, repel it from their ſides towards their axis; and at laſt tranſmit every ſingle particle of it through the circular mouths of the leaſt veſſels, by which the arteries and veins join together.

There is, therefore, a very great degree of friction, as well from the blood particles upon the ſides of the arteries as from the arteries themſelves contracting round the blood; to which add, the attrition of the particles of blood againſt each other by the confuſed and vortical motion with which they are propelled. The effects of this friction may be computed from the viſcid and inflammable nature of the blood itſelf, from the narrowneſs of the veſſels through which it runs, from the ſtrong impulſe of the heart, from the powerful re-action of the arteries, and from the weight of the incumbent parts. This friction is the principal cauſe of the blood's fluidity, by perpetually removing the points of contact in its particles, by reſiſting their attraction of coheſion, and by mixing together particles of different kinds. It alſo in ſome meaſure augments the roundneſs of the particles, by breaking off the protuberances and rounding their corners. But even theſe very ſmall particles themſelves, which are broken off from the large particles of the blood, put on a round figure by their friction againſt the ſides of the canals, and by their rotatory motion. By a deficiency of motion, the blood coagulates in the veſſels before death. The loſt fluidity of the blood is again reſtored by recovering the motion of the heart, as we are taught by experiments made on living animals. It is probable that the motion of the blood, and the denſity proceeding from it, are the cauſe of the red colour of the blood, ſince the redneſs is in proportion to the denſity, and increaſes or decreaſes from the ſame cauſes which increaſe or diminiſh the denſity. The redneſs ſeems to ariſe from a mixture of the ferruginous with the oily part of the blood.

Does the heat of the blood alſo proceed from its motion? We obſerve, by experiments, that heat ariſes from the motion of all kinds of fluids, even of air itſelf; but much more does

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attrition produce heat in the inflammable animal-juices, which are denfer than water, and confiderably compreffed by contractile and converging tubes. Is not the truth of this fufficiently evinced, by the blood's being warm in thofe fifh which have a large heart, and cold in fuch as have a fmall one; their refpective heats having the fame proportion to each other, as their hearts have to their whole body? Is it not alfo proved from the more intenfe heat of birds that have a larger heart, and quick pulfations? from the increafe of animal heat, that enfues from exercife of all kinds, and even from the bare friction of parts? from the congelation of all the humours of the human body in a certain degree of cold, in which a man grows ftiff, although he yet retains fome warm blood, and is alive? and from the coldnefs of fuch people as have a weak pulfe? The heat does not proceed from any degree of putrefaction in the blood; for the humours themfelves, when left at reft, generate no heat; nor can we explain the phenomenon of heat from the action of fuch an obfcure being as the *vital power*. Although the heat may be greater when the pulfe is flow, and lefs when it is more frequent, the difference may arife from the different difpofition of the blood, from the different denfities of the veffels, or the increafe or diminution of perfpiration.

The fame caufe alfo hinders putrefaction, by not fuffering the inteftine motion to be diminifhed, and by diffipating fuch particles as have already begun to be corrupted.

But the different natures of the feveral particles themfelves, which conjunctly make up the mafs of blood, are the caufes by which, from the impetus of the heart alone, different effects are produced in different particles of the blood; namely, thofe particles move quicker, whofe greater denfity makes them receive a greater impetus, and whofe apt figure or lefs extended furface makes them meet with lefs refiftance in the fluid in which they move. Thofe alfo are driven along more

more ſwiftly, which, either from the weight, or from the direction in which they paſs out from the heart, are urged chiefly into the axis of the veſſel. Thoſe again, which have the greateſt projectile motion, will ſtrike againſt the convexities of the flexures in the arteries; while the other parts of greater bulk and tenacity, having leſs projectile motion, will move ſlowly in the concavity of the veſſel. And in this manner, the blood is prepared or diſpoſed for the ſeveral ſecretions.

The ſyſtole of the arteries renders the parts of their contained fluids more denſe or compact: for they contract round the blood as round a viſcid and compreſſible obſtacle, and thus they expel the more liquid parts into the lateral ducts, at the ſame time increaſing the points of contact between the particles themſelves, combining the more large and denſe particles, and condenſing the looſer particles. The denſity of the blood is partly as the number of globules, and partly as the denſity of the materials which compoſe them.

Moreover, the mouths of the leaſt veſſels, pervious to only one globule at a time, ſeem to be moulds for breaking off the angular eminences of the particles of the blood, and reducing them to a globular figure. According to the obſervation of Mr Hewſon, the particles of the blood are not perfect globules, but flat like a piece of money.

The reticular diſtributions and inoſculations of arteries remove any danger of obſtruction; ſince in any part of the artery, where the blood begins to form an obſtruction, by ſticking in it, a contrary flux is admitted, by which the obſtructing matter is repelled to a larger part of the trunk; and thus between the reflux and the direct torrent of the blood, the matter is broken and attenuated. This mechaniſm alſo ſupplies the deficiency from an irremoveable obſtruction or the loſs of a veſſel, by cauſing a greater diſtention or enlargement of the next adjoining or anaſtomoſing veſſel; as is proved by experience in ſurgery, after tying and cutting a great artery.

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The collifon of thefe oppofite torrents of blood fomewhat decreafe its velocity; and the reticular diftribution augments the friction of the particles.

As the quicker motions of the blood in the trunks conduce to fanguification, fo the flower motions of it in the leaft veffels conduce to the fecretions. In the larger arteries we fee the different particles of the blood are whirled about among each other with a rapid and confufed motion; but, in the leffer ramifications, the progreffive motion of the blood being diminifhed, the more loofe colourlefs particles depart laterally from the more denfe and red particles; while the latter, keeping on their courfe more firmly along the axis of the veffel, expel the former laterally. Thus the attractive powers of the particles of the blood increafe as their progreffive motion abates: hence the oily or fat particles are drawn one to another, and go off by the open lateral ducts that lead to the cellular fubftance; which particles we know are both grofs and fluggifh: and again, other thinner juices are fent off through lateral branches of a much fmaller orifice, till at length little more than the red blood alone remains to pafs through the coalefcent artery into the incipient vein: But we fhall confider, in another place, all the particulars by which the blood is difpofed for the fecretions.

## § 2. *Of the particular Arteries.*

*Introduction.* The heart throws the blood into two great arteries; one of which is named *aorta*, the other *arteria pulmonalis.*

The aorta diftributes the blood to all the parts of the body, for the nourifhment of the parts, and for the fecretion of the different fluids.

The arteria pulmonalis carries the venal blood through all the capillary veffels of the lungs.

Both theſe great or general arteries are ſubdivided into ſeveral branches, and into a great number of ramifications.

*The pulmonary artery.* The pulmonary artery goes out from the right ventricle of the heart; and its trunk having run almoſt directly upward as high as the curvature of the aorta, is divided into two lateral branches, one going to the right ſide, called the *right pulmonary artery*; the other to the left ſide, 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. From the pulmonary arteries the blood is returned by the veins; which, contrary to the courſe of the arteries, begin by very minute canals, and gradually become larger, forming at length four large trunks called *pulmonary veins*, which terminate in the left auricle. The aorta goes out from the left ventricle nearly over-againſt the fourth vertebra of the back. Its courſe is direct with reſpect to the heart; but with reſpect to all the reſt of the body, it aſcends obliquely from the left to the right, and from before, backward.

Soon after this, it bends obliquely from the right to the left, and from before, backward, reaching as high as the ſecond vertebra of the back; from whence it runs down again in the ſame direction, forming an oblique arch. The middle of this arch is almoſt oppoſite to the right ſide or edge of the ſuperior portion of the ſternum, between the cartilaginous extremities or ſternal articulations of the firſt two ribs.

From thence the aorta deſcends in a direct courſe along the anterior part of the vertebræ, all the way to the os ſacrum, lying a little toward the left; and there it terminates in two ſubordinate or collateral trunks, called *arteriæ iliacæ*.

*General diviſion of the aorta.* The aorta is, by anatomiſts, generally divided into the aorta aſcendens, and aorta deſcendens, though

though both are but one and the fame trunk. It is termed *afcendens*, from where it leaves the heart to the extremity of the great curvature or arch. The remaining part of this trunk from the arch to the os facrum, or bifurcation already mentioned, is named *defcendens*.

The aorta defcendens is further divided into the fuperior and inferior portions; the firft comprehending what lies above the diaphragm; the other, what lies between the diaphragm and the bifurcation.

The aorta afcendens is chiefly diftributed to part of the thorax, to the head, and upper extremities. The fuperior portion of the aorta defcendens furnifhes the reft of the thorax; the inferior portion furnifhes the abdomen and lower extremities.

The great trunk of the aorta, through its whole length, fends off immediately feveral branches, which are afterwards differently ramified; and thefe arterial branches may be looked upon as fo many trunks with refpect to the other ramifications, which again may be confidered as fmall trunks with regard to the ramifications that they fend off.

The branches which go out immediately from the trunk of the aorta, may be termed *original* or *capital branches*; and of thefe, fome are large and others very fmall.

The large capital branches of the aorta are thefe; two arteriæ fubclaviæ, two carotides, one cæliaca, one mefenterica fuperior, two renales formerly termed *emulgentes*, one mefenterica inferior, and two iliacæ.

The fmall capital branches are chiefly the arteriæ coronariæ cordis, bronchiales, œfophagææ, intercoftales, diaphragmaticæ inferiores, fpermaticæ, lumbares, and facræ.

Thefe capital branches or arteries are for the moft part difpofed in pairs; there being none in odd numbers but the cæliaca, the two mefentericæ, fome of the œfophagææ, the bronchialis, and fometimes the facræ.

The ramifications of each capital branch are in uneven numbers with refpect to their particular trunks; but with refpect to the ramifications of the like capital trunks on the other fide, they are difpofed in pairs. Among the branches none but the arteria facra when it is fingle, and the œfophagææ, the ramifications of which are fometimes found in pairs, are in odd numbers.

Before we enter upon the detail of each of thefe particular arteries, many of which have proper names, it will be convenient to give a fhort view of the difpofition and diftribution of the principal arterial branches, as a general plan to which all the particularities of each diftribution may afterwards be referred: for we have found by experience, that the common method of defcribing the courfe of all the ramifications of thefe veffels, without having firft given a general idea of the principal branches, is very troublefome to beginners.

From the upper part of the arch or curvature, the aorta fends out commonly three, fometimes four, large branches, their origins being very near each other. When there are four, the two middle branches are termed *arteriæ carotides;* the other two, *fubclaviæ;* and both are diftinguifhed into right and left.

When there are but three branches, which is ofteneft the cafe, the firft is a fhort trunk, common to the right fubclavian and carotid; the fecond is the left fubclavian; and the third the left carotid. Sometimes, though very rarely, thefe four arteries unite in two trunks.

The origin of the left fubclavian terminates the aorta afcendens; but we have fometimes obferved four branches, the firft three of which were thofe already mentioned, and the fourth a diftinct trunk of the left vertebral artery.

It muft be obferved, that thefe large branches which arife from the curvature of the aorta are fituated obliquely, the firft, or that which is moft on the right, lying more forward than the reft, and the laft, which is moft on the left, more

more backward. The firſt and ſecond, or middle branches, are generally in the middle of the arch, and the third lower down. Sometimes the firſt alone is in the middle; all which varieties depend on the obliquity of the arch.

The carotid arteries run up directly to the head, each of them being firſt divided into two, one external, the other internal. The external artery goes chiefly to the outer parts of the head and dura mater, or firſt covering of the brain. The internal enters the cranium through the bony canal of the os petroſum; and is diſtributed through the brain by a great number of ramifications.

The ſubclavian arteries ſeparate laterally, and almoſt tranſverſely, each running toward that ſide on which it lies, behind and under the claviculæ, from whence they have their name. The left ſeems to be ſhorter, and runs more obliquely than the right.

The ſubclavian on each ſide terminates at the upper edge of the firſt rib, between the lower inſertions of the firſt ſcalenus muſcle; and there, as it goes out of the thorax, takes the name of *arteria axillaris*.

During this courſe of the ſubclavian artery, taking in the common trunk of the right ſubclavian, ſeveral arteries ariſe from it, viz. the mammaria interna, mediaſtina, pericardia, diaphragmatica minor ſive ſuperior, thymica, and trachealis.

The thymica and trachealis on each ſide are, in ſome ſubjects, only branches of one ſmall trunk which ſprings from the common trunk of the right ſubclavian and carotid.

They are generally ſmall arteries, which run ſometimes ſeparate, and ſometimes partly ſeparate and partly joined.

The ſubclavian ſends off likewiſe the mammaria interna, vertebrales, cervicales, and ſometimes ſeveral of the upper intercoſtales.

The axillary artery, which is only a continuation of the ſubclavian, from the place where it goes out of the thorax to the axilla,

axilla, detaches chiefly the mammaria externa or thoracia superior, thoracia inferior, fcapulares externæ, fcapularis interna, humeralis or mufcularis, &c. Afterwards it is continued, by different ramifications and under different names, over the whole arm, all the way to the ends of the fingers.

The fuperior portion of the aorta defcendens gives off the arteriæ bronchiales, which arife fometimes by a fmall common trunk, fometimes feparately, and fometimes do not come immediately from the aorta. It next fends off the œfophagææ, which may be looked upon as mediaftinæ pofteriores, and the intercoftales, from its pofterior part, which in fome fubjects come all from this portion of the aorta, in others only the loweft eight or nine.

The fmall anterior arteries here mentioned are generally, at their origins, fingle or in uneven numbers, but they divide foon after toward the right and left.

The inferior portion of the defcending aorta, as it paffes through the diaphragm, gives off the diaphragmaticæ inferiores or phrenicæ, which however do not always come immediately from the aorta. Afterwards it fends off feveral branches anteriorly, pofteriorly, and laterally.

The anterior branches are cæliaca, which fupplies the ftomach, liver, fpleen, pancreas, &c.; the mefenterica fuperior, which goes chiefly to the mefentery, to the fmall inteftines, and to that part of the great inteftines which lies on the right fide of the abdomen; the mefenterica inferior, which goes to the great inteftines on the left fide, and produces the hæmorrhoidalis interna; and laftly, the right and left arteriæ fpermaticæ.

The pofterior branches are the arteriæ lumbares, of which there are feveral pairs, and the facræ, which do not always come from the trunk of the aorta.

The lateral branches are the capfulares and adipofæ, the origin of which often varies; the renales, formerly termed *emulgentes*;

*emulgentes*, and the iliacæ, which terminate the aorta by the bifurcation already mentioned.

The iliac artery on each ſide is commonly divided into the external or anterior, and internal or poſterior.

The internal iliaca is likewiſe named *arteria hypogaſtrica*; and its ramifications are diſtributed to the viſcera contained in the pelvis, and to the neighbouring parts, both internal and external.

The iliaca externa, which is the true continuation of the iliac trunk, and alone deſerves that name, goes on to the inguen, and then out of the abdomen, under the ligamentum Fallopii; having firſt detached the epigaſtrica, which goes to the muſculi abdominis recti. Having quitted the abdomen, it is called arteria cruralis, which runs down upon the thigh, and is diſtributed by many branches and ramifications to all the lower extremity.

We ſhall now go on to examine particularly all the capital or original branches of the aorta, from their origin to the entry of them, and of their ramifications into all the parts of the body, and all the different viſcera and organs.

*Arteriæ cardiacæ ſive coronariæ cordis.* The cardiac or coronary arteries of the heart, ariſe from the aorta immediately on its leaving the heart. They are two in number; and, according to the natural ſituation of the heart, one is rather ſuperior than anterior, the other rather inferior than poſterior.

They go out near the two ſides of the pulmonary artery; which having firſt ſurrounded, they afterwards run upon the baſis of the heart in form of a kind of crown or garland, from whence they are called *coronariæ*; they firſt run between the auricles, and then purſue the ſuperficial traces of the union of the two ventricles, from the baſis of the heart to the apex.

They ſend communicating branches to each other, which are afterward loſt in the ſubſtance of the heart. The right artery, after running between the auricle and ventricle of that

ſide,

ſide, ſends branches to the pulmonary artery, to the fat ſurrounding it, and to the beginning of the aorta; then it gives three branches to the convex ſide of the heart, and as many to the flat ſurface. The left artery runs between the pulmonary artery and left auricle, and afterwards divides into branches, one of which is anterior, and runs down ſending off branches that reach the point of the heart: ſome of theſe are reflected upon the flat ſurface ſo as to communicate with the branches of the right trunk; another branch runs between the left auricle and ventricle, to the obtuſe ſide of the heart, and then to its flat ſurface, where it is loſt in the ſubſtance of the left ventricle; but ſends branches likewiſe to the left auricle and pulmonary veins; and here it communicates with branches of the trunk on the right ſide.

We ſometimes meet with a third coronary artery, which ariſes from the aorta more backward, and is ſpent on the poſterior or lower ſide of the heart.

*The arteriæ carotides in general.* Theſe arteries are two in number; one called the *right carotid*, the other the *left*. They ariſe near each other, from the curvature or arch of the aorta; the left immediately, the right moſt commonly, from the trunk of the ſubclavia on the ſame ſide, as has been already obſerved.

They run upon each ſide of the trachea arteria, between it and the internal jugular vein, and behind the muſculi platyſma, myoides, and ſternocleido-maſtoideus, as high as the larynx, without any ramification. During this courſe, therefore, they may be named *carotid trunks*, or general, common, and original carotids. Each of theſe trunks is afterwards ramified in the following manner.

The trunk, which ſends off no branches till it has reached as high as the larynx, is divided into two particular carotids; one named *external*, the other *internal*; becauſe the firſt goes chiefly ly to the external parts of the head, the ſecond enters the cranium, and is diſtributed to the brain.

The external carotid is anterior, the internal poſterior; and the external is even ſituated more inward and nearer the larynx than the other; but the common names may ſtill be retained, as being taken, not from their ſituation, but from their diſtribution.

*Arteria carotis externa.* The external carotid is the ſmalleſt, and yet appears by its direction to be a continuation of the common trunk. It runs inſenſibly outward, between the external angle of the lower jaw and the parotid gland, which it ſupplies as it paſſes. Afterwards it aſcends on the foreſide of the ear, and ends in the temples.

In this courſe it ſends off ſeveral branches, which may well enough be divided into anterior or internal, and poſterior or external; and the principal branches of each kind are theſe.

The firſt anterior or internal branch goes out from the very origin of the carotid on the inſide; and having preſently afterward taken a little turn, and ſent off branches to the jugular glands near it, to the fat and ſkin, it runs tranſverſely, and is diſtributed to the glandulæ thyroïdææ, and to the muſcles and other parts of the larynx; for which reaſon it may be called *laryngæa*, or *gutturalis ſuperior*. It likewiſe ſends ſome branches to the pharynx and muſcles of the os hyoides.

The ſecond anterior branch paſſes over the neareſt cornu of the os hyoides to the muſcles of that bone and of the tongue; and to the glandulæ ſublingualis; afterwards paſſing before the cornu of the os hyoides, it loſes itſelf in the tongue; from whence it has been called *arteria ſublingualis*; and it is the ſame artery which other anatomiſts have named *ranina*. That part of the artery which goes commonly by this name lies at the inferior and lateral part of the tongue, and is accompanied by a large vein.

The third branch, or arteria maxillaris inferior, and pharyngea inferior of Sabatier, goes to the maxillary gland, to the ſtyloid and maſtoid muſcles, to the parotid and ſublingual glands, to the muſcles of the pharynx, and to the ſmall flexors of the head.

The fourth branch, which Winſlow, &c. names *arteria maxillaris externa*, and which Haller and Sabatier call *arteria labialis*, is at firſt covered by the ſtylo-hyoid and diagaſtric muſcles: in its paſſage it ſends branches to the pharynx, to the tongue, amygdalæ, and palate; at the angle of the jaw it gives branches to the ſkin, muſcles, glands, &c. in the neighbourhood of that bone. Afterwards it runs over the lower jaw, before the inferior edge of the maſſeter muſcle, and then gets under the muſculus depreſſor anguli oris, which it ſupplies, as well as the buccinator and the depreſſor labii inferioris.

It ſends off a particular branch, very much contorted, which divides at the angular commiſſure of the lips; and running in the ſame manner along the ſuperior and inferior portions of the muſculus orbicularis, it communicates on both ſides with its fellow, and thereby forms a kind of arteria coronaria labiorum.

Afterwards it aſcends towards the nares, and is diſtributed to the muſcles, cartilages, and other parts of the noſe, ſending down ſome twigs which communicate with the coronary artery of the lips. Laſtly, it reaches the great angle of the eye, and is ramified and loſt on the muſculus orbicularis palpebrarum, ſuperciliaris, and frontalis. Through all this courſe it is named *arteria angularis*.

The fifth branch, called *maxillaris interna*, ariſes over-againſt the condyle of the lower jaw, and is very conſiderable. It paſſes behind the condyle, and runs between the jaws, where it gives off numerous branches to the parts which lie near it. The moſt conſiderable of theſe are, (1.) The ſpheno-ſpinalis, or media duræ matris, which runs between the internal and external carotids: this paſſes through the foramen ſpinale

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of the ſphenoidal bone, and is diſtributed to the dura mater by ſeveral ramifications, which run forward, upward, and backward; the uppermoſt communicating with thoſe on the other ſide above the longitudinal ſinus of the dura mater. This artery of the dura mater may be termed *ſpheno ſpinalis* or *media duræ matris*, to diſtinguiſh it from thoſe that go to the ſame part by another courſe. (2.) The maxillaris inferior, which runs through the canal of the lower jaw, and being diſtributed to the alveoli and teeth, goes out at the hole near the chin, and loſes itſelf in the neighbouring muſcles, communicating with the branches of the arteria maxillaris externa. (3.) The pterygoideæ, and temporales profundæ, to the pterygoid and temporal muſcles. (4.) The arteria buccalis, to the buccinator muſcle, and other ſoft parts of the cheek. (5.) The alveolaris, to the teeth and ſubſtance of the upper jaw, and to ſeveral of the ſoft parts ſurrounding it. (6.) The infra-orbitaria, which, after ſending a branch to the noſe, paſſes through the poſterior opening of the orbitar canal; and having ſent branches to the orbit, antrum maxillare, and teeth, goes out by the infra orbitar hole, and on the cheek communicates with the angular artery. (7.) Palatina ſuperior, which goes through the palato-maxillary canal to the palate and bones ſurrounding it. Another ſmall branch terminates on the parts at the upper end of the pharynx.

The ſixth anterior or internal branch, which is very ſmall, is ſpent on the muſcle maſſeter.

The firſt external or poſterior branch is named *arteria occipitalis*. It paſſes obliquely before the internal jugular vein; and having given twigs to the muſculus ſtylo-hyoidæus, ſtyloglоſſus, and digaſtricus, it runs between the ſtyloid and maſtoid apophyſes, along the maſtoid groove, and goes to the muſcles and integuments which cover the os occipitis, turning ſeveral times in an undulating manner as it aſcends backwards.

It communicates by a deſcending branch with the vertebral and cervical arteries, as has been already ſaid, near the top of the head; it communicates likewiſe with the poſterior branches of the temporal artery, and it ſends a branch to the foramen maſtoidæum.

The ſecond external branch ſpreads itſelf on the outward ear, by a great many ſmall twigs on each ſide, ſeveral of which run inward, and furniſh the cartilages, meatus auditorius, ſkin of the tympanum, and internal ear.

The trunk of the external carotid aſcends afterward above the zygoma, paſſing between the angle of the lower jaw and parotid gland, and forms the temporal artery, which divides into an anterior, middle, and poſterior branch.

The anterior branch of the temporal artery goes to the muſculus frontalis, communicates with the arteria angularis, and ſometimes gives off a very ſmall artery, which pierces the internal apophyſis of the os malæ all the way to the orbit. The middle branch goes partly to the muſculus frontalis, partly to the occipitalis. The poſterior branch goes to the occiput, and communicates with the arteria occipitalis. All theſe branches likewiſe furniſh the integuments.

*Arteria carotis interna.* The internal carotid artery leaving the general trunk, is at firſt a little incurvated, appearing as if either it were the only branch of that trunk, or a branch of the trunk of the external carotid. Sometimes the curvature is turned a little outward, and then more or leſs inward, paſſing behind the neighbouring external carotid.

It is ſituated a little more backward than the carotis externa, and generally runs up without any ramification, as high as the lower orifice of the great canal of the apophyſis petroſa of the os temporis. It enters this orifice directly from below upward, and afterward makes an angle according to the direction of the canal, the reſt of which it paſſes horizontally, being covered by a production of the dura mater.

At the end of this canal it is again incurvated from below upward,

upward, and enters the cranium through a notch of the ſphenoidal bone. Then it bends from behind, forward, and makes a third angle on the ſide of the ſella ſphenoidalis; and again a fourth, under the clinoid apophyſes of that ſella. While it lies at the ſide of the ſella turcica, it ſends ſmall branches to the parts about the cavernous ſinus.

As it leaves the bony canal to enter the cranium, it ſends off a ſmall branch through the ſphenoidal fiſſure to the orbit and eye: and ſoon afterward a conſiderable branch, called *ophthalmica*, through the foramen opticum, to ſupply the contents of the orbit. The firſt branches ſent off from the ocular artery are very ſmall; they go to the dura mater on the optic nerve, and the beginning of the muſcles in the bottom of the orbit. Then the lacrymal and ciliary arteries are ſent off: the artery, covered with the levator muſcles of the eye and upper eye lid, afterwards turns inwards, between theſe muſcles and the optic nerve, almoſt at a right angle; but about the part where it makes this turn, it ſends off anterior ciliary branches; afterwards two go off to the levator of the eye and upper eye-lid; then the poſterior ethmoidal and the arteria centralis retinæ are ſent off. While it paſſes over the nerve, it gives off the muſculares ſuperior, inferior, and other ciliary branches. It lies now at the inner ſide of the orbit, under the ſuperior oblique and adductor muſcles. Theſe muſcles, the perioſteum, and inner part of the orbit and optic nerve, receive branches from it; then it produces the ethmoidal anterior; its trunk next deſcends under the cartilaginous pulley of the ſuperior oblique: here it frequently gives a branch to the lacrymal ſac; the arteries of the eye-lids alſo grow from it; at laſt it divides into four branches, namely, the ſuperciliary, the naſal, the ſuperficial, and deep frontals; which laſt go through the foramen ſupra orbitarium to be diſtributed to the forehead. At the inner angle of the eye, it communicates with the angular artery; and within the orbit it ſends one or two ſmall branch-

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es to the nose. This artery was by the ancients miſtaken for a vein. Ingraſſius was the firſt who conſidered it in its proper light; but Haller was the firſt who deſcribed it with accuracy. For a more minute deſcription, ſee Zinn and Sabatier.

Afterwards the internal carotid runs under the baſis of the brain to the ſide of the infundibulum, where it is at a ſmall diſtance from the internal carotid of the other ſide, and there it commonly divides into two principal branches, one anterior and one poſterior.

The anterior branch runs forward under the brain, firſt ſeparating from that on the other ſide, then coming nearer again, it unites with it by an anaſtomoſis or communication in the interſtice between the olfactory nerves. Afterwards, having ſent off ſmall arteries, which accompany theſe nerves, it leaves its fellow, and divides into two, but, according to Winſlow, two or three branches. The firſt of theſe is the ſmalleſt of the two, but it is very conſtant; it runs forward to the inner ſide of the anterior lobe, which it ſupplies in its paſſage. The ſecond, after it has got beyond the corpus calloſum, to which it ſends branches, is reflected back over that ſubſtance upon the inner ſide of the hemiſphere, and may be traced back as far as the poſterior lobe: in all this courſe it ſends off innumerable branches, which are at firſt ſpread out upon the ſurface, and afterwards ſink into the ſubſtance of the brain, communicating freely with the ramifications of the poſterior trunk.

The poſterior branch communicates firſt of all with the vertebral artery of the ſame ſide, and after running between the anterior and lateral lobes of the brain, divides into ſeveral rami, which run between its ſuperficial circumvolutions; and are ramified in many different directions on and between theſe circumvolutions, all the way to the bottom of the ſulci.

All theſe ramifications are covered by the pia mater, in the duplicature of which they are diſtributed, and form capillary reticular textures in great numbers; and afterwards they are loſt loft in the inner fubftance of the brain. The anterior and middle branches produce the fame kind of ramifications, and the anterior, in particular, fupplies the corpus callofum.

*Arteria fubclavia.* The fubclavian arteries are named from their fituation near the claviculæ, in the tranfverfe direction of which they run. They are two in number, one right, the other left; and they arife from the arch of the aorta, on each fide of the left carotid, which commonly lies in the middle between them; but when both carotids go out feparately, they both lie between the fubclaviæ. Thefe arteries terminate, or rather change their name above the middle of the two firft ribs, between the anterior infertions of the mufculi fcaleni.

The right fubclavian is larger at the beginning than the left, when it produces the right carotid; its origin is likewife anterior and higher, becaufe of the obliquity of the arch of the aorta; for which reafon alfo the left is fhorter than the right, and runs more obliquely. Both of them are diftributed much in the fame manner; and therefore the defcription of one may likewife be applied to the other.

The right fubclavian, the longeft of the two, gives off, firft of all, fmall arteries to the mediaftinum, thymum, pericardium, afpera arteria, &c. which are named *mediaftinæ*, *thymicæ*, *pericardiæ*, and *tracheales*. Thefe fmall arteries fometimes go out from the fubclavian itfelf, either feparately or by fmall common trunks; fometimes they are branches of the mammaria interna, efpecially the mediaftina.

Afterward this right fubclavian, at about a finger's breadth from its origin, generally produces the common carotid of the fame fide; and at a fmall finger's breadth from the carotid, it gives off commonly three confiderable branches, viz. the mammaria interna, cervicalis, and vertebralis, and fometimes an intercoftal artery, which goes to the firft ribs called *intercoftalis fuperior.*

*Arteria thymica.* The arteria thymica communicates with the

the mammaria interna, and ſometimes ariſes from the anterior middle part of the common trunk of the ſubclavian and carotid. The thymus receives likewiſe ſome rami from the mammaria interna and intercoſtalis ſuperior. The ſame obſervation may be applied to the mediaſtina and pericardia.

*Arteria pericardia.* The pericardia ariſes much in the ſame manner with the thymica, and runs down upon the pericardium all the way to the diaphragm, to which it ſends ſome ſmall ramifications.

*Arteria mediaſtina.* The mediaſtina ariſes ſometimes immediately after the thymica, and is diſtributed principally to the mediaſtinum.

*Arteria trachealis.* The trachealis, which may likewiſe be named *gutturalis inferior*, runs up from the ſubclavia, in a winding courſe, along the aſpera arteria, to the glandulæ thyroidææ and larynx, detaching ſmall arteries to both ſides, one of which runs to the upper part of the ſcapula.

*Arteria mammaria interna.* The internal mammary artery comes from the anterior and lower ſide of the ſubclavia, near the middle of the clavicula, and runs down behind the cartilages of the true ribs near the edge of the ſternum.

In its paſſage it ſends rami to the thymus, mediaſtinum, pericardium, pleura, and intercoſtal muſcles. It likewiſe detaches other branches, through theſe muſcles and between the cartilages of the ribs, to the pectoralis major, and other neighbouring muſcular portions, to the mammæ, membrana adipoſa, and ſkin.

Several of theſe rami communicate, by anaſtomoſes, with the mammaria externa, and other arteries of the thorax, eſpecially in the ſubſtance of the pectoralis major, and likewiſe with the intercoſtals. Afterwards it goes out of the thorax on one ſide of the appendix enſiformis, and is loſt in the muſculus abdominis rectus, a little below its upper part; communicating, at this place, by ſeveral ſmall ramifications, with the arteria epigaſtrica;

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and, in its courfe, it gives branches to the peritonæum, and to the anterior part of the oblique and tranfverfe mufcles of the abdomen.

*Arteria cervicalis.* The cervical artery arifes from the upper fide of the fubclavian, and is prefently afterwards divided into two, which come out fometimes feparately, fometimes by a fmall common trunk. The largeft of thefe two arteries is anterior, the other pofterior.

The anterior cervicalis, running behind the carotid of the fame fide, is diftributed to the mufculus coraco-hyoidæus, maftoidæus, cutaneus, fterno-hyoidæus, and fterno-thyroidæus, to the jugular glands, the afpera arteria, the mufcles of the pharynx, bronchia, œfophagus, and to the anterior mufcles which move the neck and head. This artery has been obferved to fend out the intercoftalis fuperior

The pofterior cervicalis arifes fometimes a little after the vertebralis, and fometimes from that artery. It paffes under the tranfverfe apophyfis of the laft vertebra of the neck; and fometimes through a particular hole in that apophyfis; and from thence runs up backward in a winding courfe, on the vertebral mufcles of the neck, and then returns in the fame manner.

It communicates with a defcending branch of the occipital artery, and with another of the vertebral artery above the fecond vertebra. It is diftributed to the mufculi fcaleni, angularis fcapulæ, and trapezius, and to the jugular glands and teguments.

*Arteria vertebralis.* The vertebral artery goes out from the pofterior and upper fide of the fubclavian, almoft oppofite to the mammaria interna and cervicalis. It runs up through all the holes in the tranfverfe apophyfis of the vertebræ of the neck, and in its paffage fends off little twigs through the lateral notches of thefe vertebræ, to the medulla fpinalis and its coverings. It alfo gives arteries to the vertebral mufcles, and to other mufcles near them.

As it paffes through the tranfverfe hole of the fecond vertebra, it is generally incurvated, to accommodate itfelf to the particular obliquity of this foramen. And between this hole and that in the firft vertebra, it takes another larger turn in a contrary direction to the former. Having paffed the tranfverfe hole of the firft vertebra, it is confiderably incurvated a third time, from before backwards, as it goes through the fuperior and pofterior notch in this vertebra.

At this third curvature, it fends off a fmall branch, which is ramified on the outer and pofterior parts of the occiput, and communicates with the cervical and occipital arteries. Having afterwards reached the great foramen of the os occipitis, it enters the cranium, and pierces the dura mater; and on thefe accounts it may be named *arteria occipitalis pofterior*, to diftinguifh it from the other which is lateral.

As foon as it enters the cranium, it fends feveral fmall ramifications to the back part of the medulla oblongata, and to the corpora olivaria and pyramidalia, which are likewife fpread on the back fides of the fourth ventricle of the brain, and form the plexus choroides of the cerebellum.

Afterwards it advances on the apophyfis bafilaris of the os occipitis, inclining by fmall degrees toward the vertebral artery of the other fide, all the way to the extremity of that apophyfis, where they both join in one common trunk, which may be named *arteria bafilaris*.

*Arteria bafilaris*. The arteria bafilaris runs forward under the great tranfverfe protuberance of the medulla oblongata, to which it gives ramifications, as well as to the neighbouring parts of the medulla. This artery fometimes divides again near the extremity of the apophyfis bafilaris into four lateral branches, which communicate with the pofterior branches of the two internal carotids, and are loft in the pofterior lobe of

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the brain. The firft and fmalleft forms on each fide the arteria fuperior cerebelli; which goes to the upper part of this vifcus, and to the nates, teftes, &c. and at laft is loft in the inner fubftance of the cerebellum. The other branch on each fide is much more confiderable: it forms the arteria pofterior, or profunda cerebri, which fupplies the pofterior lobe of the brain, and the parts lying near the third ventricle. The arteria pofterior cerebri, on each fide, likewife communicates with the trunk of the internal carotid, by a branch fomething fimilar to that between the anterior branches of the carotids: thefe branches affift in forming the circle of Willis.

*Arteriæ fpinales.* The fpinal arteries are two in number, one anterior, and one pofterior; both produced by both vertebrales; each of which, as foon as it enters the cranium, fends out a fmall branch, by the union of which the pofterior fpinalis is formed. Afterwards the vertebrales advancing on the apophyfis bafilaris, or production of the occipital bone, detach backward two other fmall branches, which likewife meet, and by their union form the fpinalis anterior. Thefe fpinal arteries run down on the fore and back fides of the medulla fpinalis, and, by fmall tranfverfe ramifications, communicate with thofe which the intercoftal and lumbar arteries fend to the fame part.

*Arteria auditoria interna.* The internal auditory artery goes off from each fide of the arteria bafilaris to the organ of hearing, accompanying the auditory nerve, having firft furnifhed feveral fmall twigs to the membrana arachnoides.

*Arteria meningæa pofterior.* The pofterior meningæa arifes from the fame trunk with the auditoria interna, and goes to the back part of the dura mater, on the occipital and temporal bones, and likewife fupplies the neighbouring lobes of the brain.

*Arteria intercoftalis fuperior.* When the fuperior intercoftal artery does not go out from the trunk of the aorta defcendens, it commonly arifes from the lower fide of the fubclavian, and runs down on the infide of the two, three, or four, uppermoft true ribs, near their heads, and fends off under each rib a branch which runs along the lower edge, and fupplies the intercoftal mufcles and neighbouring parts of the pleura.

Thefe branches or particular intercoftal arteries communicate with each other at different diftances by fmall rami, which run upward and downward from one to the other, on the intercoftal mufcles.

They likewife give branches to the mufculi fterno-hyoidæi, fubclavius, vertebrales, and bodies of the vertebræ; and alfo to the pectoralis major and minor, piercing the intercoftal notch; and laftly, they fend branches through the mufcles of the firft four vertebræ to the medulla fpinalis and its coverings.

Sometimes the fuperior common intercoftal artery comes from the cervicalis, and not immediately from the fubclavia. Sometimes it arifes from the aorta defcendens, either by fmall feparate arteries, or by a common trunk, which divides, as it runs obliquely up, upon the ribs. Laftly, it fometimes arifes from the neareft bronchiales, or from feveral bronchiales together.

*Ductus arteriofus in ligamentum verfus.* The ductus arteriofus, which is found only in the fœtus and in very young children, arifes from the aorta defcendens, immediately below the left fubclavian artery. In adults, this duct is fhrunk up and clofed, and appears only like a fhort ligament, adhering by one end to the aorta, and by the other to the pulmonary artery; fo that in reality it deferves no other name than that of *ligamentum arteriofum.*

*Arteria bronchialis.* The bronchial arteries are two or three in number, one on the right fide, and one or two on the left. The right generally comes from the fuperior intercoftal, the left from the aorta, and fometimes from the arteria œfophagæa.

gæa. Sometimes they arife feparately from each fide, to go to each lung, and fometimes by a fmall common trunk, which afterwards feparates toward the right and left hand, at the bifurcation of the afpera arteria, and accompany the ramifications of the bronchia.

The bronchial artery on the left fide often comes from the aorta, while the other arifes from the fuperior intercoftal on the fame fide; which variety is owing to the fituation of the aorta. Sometimes there is another bronchial artery which goes out from the aorta pofteriorly, near the fuperior intercoftal, above the bronchialis anterior.

Free communications are fometimes obferved between the branches of the bronchial and thofe of the pulmonary artery, which have been miftaken for direct communications between the bronchial artery and pulmonary vein, vena azygos, &c.

The bronchialis gives a fmall branch to the neighbouring auricle of the heart, which communicates with the arteria coronaria.

*Arteriæ œfophagææ.* The œfophagææ are generally two or three in number, fometimes only one. They arife anteriorly from the aorta defcendens, and are diftributed to the œfophagus, &c. Sometimes the uppermoft œfophagæa produces a bronchial artery.

*Arteriæ intercoftales inferiores.* The inferior intercoftals are commonly feven or eight on each fide, and fometimes ten, when the fuperior intercoftals arife likewife from the aorta defcendens; in which cafe thefe run obliquely upward, as has been already faid.

They arife along the backfide of the defcending aorta in pairs, all the way to the diaphragm, and run tranfverfely towards each fide, on the bodies of the vertebræ. Thofe on the right fide pafs behind the vena azygos; and afterwards they all run to the intercoftal mufcles, along the lower edge of the ribs, all the way to the fternum, or near it.

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They fend branches to the pleura, to the vertebral mufcles, to thofe mufcles which lie on the outfides of the ribs, and to the upper portions of the mufcles of the abdomen; and they communicate with the arteriæ epigaftricæ and lumbares.

Sometimes, inftead of going out from the aorta in pairs, they arife by fmall common trunks, which afterwards divide, and fend an artery to each neighbouring rib.

Before they take their courfe along the ribs, each of them detaches one branch between the tranfverfe apophyfes on both fides, to the vertebral mufcles, and another which enters the great canal of the fpina dorfi. Each of thefe latter branches divides at leaft into two fmall arteries; one of which runs tranfverfely on the anterior fide of the canal, the other on the pofterior fide. Both of them communicate with the like arteries from the other fide of the fpine, in fuch a manner as to form a kind of arterial rings, which likewife communicate with each other by other fmall ramifications. The fame is to be obferved in the arteriæ lumbares.

Afterwards each intercoftal artery having reached the middle of the rib, or a little more, divides into two principal branches, one internal, the other external. Soon after this divifion, the arteries that run upon the falfe ribs feparate a little from them, being gradually bent downward one after another, and are fpread upon the abdominal mufcles. They are likewife diftributed to other neighbouring mufcles, and particularly to thofe of the diaphragm, almoft in the fame manner with the arteriæ phrenicæ; they alfo communicate with the lumbares, and fometimes with branches of the hypogaftricæ.

*Arteriæ axillares.* The fubclavian artery having left the thorax immediately above the firft rib, in the interftice left between the portions of the fcalenus, there receives the name of *axillaris*, becaufe it paffes under the axilla.

In this courfe it gives off, from its infide, a fmall branch to the infide of the firft rib; and afterwards four feveral principal

pal branches, viz. the thoracica ſuperior, mammaria externa, thoracica humeralis, and axillaris ſcapularis.

*Arteria thoracica ſuperior.* The ſuperior thoracica gives branches to the two pectoral muſcles, to the muſculus ſubclavius, ſerratus major, and intercoſtales externi. It likewiſe communicates with the thoracica longa and intercoſtales. Thoracica longa of Sabatier, or mammaria externa of others, ſends branches to the axillary glands, to the two pectoral muſcles, to the ſerratus major, intercoſtales externi, to the mamma, and at laſt to the integuments. Arteria thoracica humeralis gives firſt a branch to the ſerratus major, another runs up to the ſterno-maſtoid muſcle; one ſupplies the ſubſtance of the clavicle and the parts over it; one branch, in particular, runs between the clavicle and ſmall pectoral muſcle, to which it ſends branches, and communicates with the internal mammaria: but the principal part of the thoracica humeralis deſcends between the great pectoral and deltoid muſcles, and is diſtributed about the parts ſurrounding the articulation at the top of the humerus. Another artery, called *thoracica axillaris*, ſometimes goes off from the former, to be diſpoſed upon the glands, &c. in the axilla.

*Scapularis inferior.* The inferior thoracic artery runs along the inferior coſta of the ſcapula, to the muſculus ſubſcapularis, teres major and minor, infra-ſpinatus, latiſſimus dorſi, ſerratus major, and the neighbouring intercoſtal muſcles, communicating with the arteriæ ſcapularis.

*Arteria ſcapularis externa.* The external ſcapulary artery paſſes through the notch in the ſuperior coſta of the ſcapula, to the muſculus ſupra-ſpinatus and infra-ſpinatus, teres major and minor, and to the articulation of the ſcapula with the os humeri.

*Arteria ſcapularis interna.* The internal ſcapularis ariſes from the axillary artery near the axilla, and runs backward, to be diſtributed to the ſubſcapularis, giving branches to the ſerratus major, to the axillary glands, and to the teres major, upon which it is ramified in different manners. It likewiſe ſends rami to the infra-ſpinatus and upper portion of the triceps.

*Arteria articularis.* The articular artery ariſes from the lower and fore part of the axillaris, and runs backward between the head of the os humeri and teres major, ſurrounding the articulation till it reaches the poſterior part of the deltoides, to which it is diſtributed.

During this courſe, it gives ſeveral branches to the ſuperior portions of the anconæi, to the capſular ligament of the joint of the ſhoulder, and to the os humeri itſelf through ſeveral holes immediately below the great tuberoſity of the head of that bone. It likewiſe communicates with the ſcapulary artery.

Oppoſite to the origin of this articular artery, the axillaris ſends off another ſmall branch, which runs in a contrary direction between the head of the os humeri and the common upper part of the biceps and coraco-brachialis; and having given branches to the vagina and channel of the biceps, and to the perioſteum, afterwards joins the principal humeralis.

*Arteria brachialis.* The axillary having given off theſe branches, paſſes immediately behind the tendon of the pectoralis major, where it changes its former name for that of *arteria brachialis.* It runs down on the inſide of the arm over the muſculus coraco-brachialis and anconæus internus, and along the inner edge of the biceps behind the vena baſilica, giving ſmall branches on both ſides to the neighbouring muſcles, to the perioſteum, and to the bone.

Between the axilla and middle of the arm, it is covered only by the ſkin and fat; but afterwards it is hid under the biceps, and runs obliquely forward as it deſcends; being at ſome diſtance from the internal condyle, but it does not reach the middle of the fold of the arm.

Between the axilla and this place, it ſends off many branches to to the infra-ſpinatus, teres major and minor, ſubſcapularis, latiſſimus dorſi, ſerratus major, and other neighbouring muſcles, to the common integuments, and even to the nerves. Below the fold of the arm, it divides into two principal branches, one called *arteria cubitalis*, the other *radialis*.

From its upper and inner part, it ſends off a particular branch, which runs obliquely downward and backward over the triceps, and then turns forward again near the external condyle, where it communicates with a branch of the arteria radialis.

Immediately below the inſertion of the teres major, it gives off another branch, which runs from within outwards, and from behind forward, round the os humeri; and deſcends obliquely forward, between the muſculus brachialis and triceps, to both which it is diſtributed in its paſſage. Having afterwards reached the external condyle, it unites with the branch laſt mentioned, and likewiſe communicates with a branch of the arteries of the fore-arm, ſo that there is here a triple anaſtomoſis.

About the breadth of a finger below this ſecond branch, the brachial artery ſends off a third, which runs down toward the internal condyle, and communicates with other branches of the arteries of the fore-arm.

About the middle of the arm, or a little lower, much about the place where the brachial artery begins to be covered by the biceps, it ſends off a branch, which is diſtributed to the perioſteum, and penetrates the bone between the brachialis and inner ſide of the triceps.

About an inch lower, it gives off another branch, which having furniſhed ramifications to the inner ſide of the triceps, runs over the inner condyle, and likewiſe communicates with the branches of the arteries of the fore-arm.

Having got below the middle of the arm, the brachial artery detaches another branch, which runs behind the inner condyle in company with the ulnar nerve; and having paſſed over the muſcles inſerted in this condyle, it communicates with that branch of the cubital artery which encompaſſes the fold of the arm.

A little lower it ſometimes ſends out another branch, which paſſes on the foreſide of the inner condyle, and then communicates with a branch which runs up from the cubital artery. Theſe three communicating branches are termed *collateral arteries*.

The common trunk of the brachial artery having reached the fold of the arm, runs, together with a vein and the radial nerve, immediately under the aponeuroſis of the biceps, and paſſes under the vena mediana, detaching branches on each ſide to the neighbouring muſcles.

A little more than a finger's breadth beyond the fold of the arm, this artery divides into the two principal branches called *cubitalis* and *radialis*.

From this bifurcation, the brachial artery ſends branches on each ſide, to the ſupinator longus, pronator teres, fat, and ſkin. It ſometimes, though very rarely, happens, that this artery is divided from its origin into two large branches, which run down on the arm, and afterwards on the fore-arm, where they have the names of *cubitalis* and *radialis*.

*Arteria cubitalis.* The cubital or ulnar artery, which lies at the inner ſide, and is the largeſt of the two, ſinks in between the brachialis internus and pronator teres; then between the ſublimus and profundus, and afterwards runs down between the ſublimus and flexor carpi ulnaris, all the way to the carpus and great tranſverſe ligament. In this courſe it winds and turns ſeveral ways, and ſends out ſeveral branches.

The firſt is a ſmall artery, which runs inward to the inner condyle, and then turns upward like a kind of recurrent, to communicate by ſeveral branches with the collateral arteries of the arm already mentioned, and particularly with the third.

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A little lower down, another ſmall branch goes off; which, having run upward a ſhort way, and almoſt ſurrounded the articulation, communicates with the ſecond collateral artery of the arm, between the olecranum and inner condyle.

Afterwards, the cubital artery having, in its courſe between the heads of the ulna and radius, reached the interoſſeous ligament, ſends off two principal branches, one internal, the other external; called the *interoſſeous arteries* of the fore-arm.

The external artery pierces the ligament about three fingers breadth below the articulation; and preſently afterwards gives off a recurrent branch, which runs up toward the external condyle of the os humeri, under the extenſor carpi ulnaris and anconæus, to which it is diſtributed, as alſo to the ſupinator brevis; and it communicates with the collateral arteries of the arm on the ſame ſide.

Afterward this external interoſſeous artery runs down on the outſide of the ligament, and is diſtributed to the extenſor carpi ulnaris, extenſor digitorum communis, and to the extenſores pollicis indicis and minimi digiti; communicating with ſome branches of the internal interoſſeous artery.

Having reached the lower extremity of the ulna, it unites with a branch of the internal interoſſeous artery, which at this place runs from within outward, and is diſtributed together with it on the convex ſide of the carpus and back of the hand, communicating with the arteria radialis, and with a branch of the cubitalis; which ſhall be mentioned hereafter.

By theſe communications, this artery forms a ſort of irregular arch, from whence branches are detached to the external interoſſeous muſcles, and to the external lateral parts of the fingers.

The internal interoſſeous artery runs down very cloſe to the ligament, till it reaches below the pronator teres; between which and the pronator quadratus it perforates the ligament, and goes to the convex ſide of the carpus and back of the hand, where it communicates with the external interoſſeous artery, with the radialis and internal branches of the cubitalis.

From the origin of the two interoſſeæ, the cubital artery deſcends, ſending branches to the neighbouring parts. Below the internal interoſſea, it ſometimes ſends off a branch which runs down between the flexor pollicis, flexor carpi radialis, and perforatus; to which it is diſtributed all the way to the carpus, where it runs under the internal annular ligament, and communicates on the hand with branches of the arteria radialis.

Afterward the cubital artery paſſes over the internal tranſverſe ligament of the carpus, by the ſide of the os piſiforme; and having furniſhed the ſkin, palmaris brevis, and metacarpus, it ſlips under the aponeuroſis palmaris, giving off one branch to the abductor minimi digiti, and another which runs towards the thumb between the tendons of the flexors of the fingers and the baſes of the metacarpal bones.

It likewiſe ſends off a branch, which running between the third and fourth bones of the metacarpus, reaches to the back of the hand, where it communicates with the external interoſſeous artery. Afterwards, having ſupplied the interoſſeous muſcles, it communicates with the radialis; and they both form an arterial arch in the hollow of the hand, in the following manner.

The cubitalis having got about two fingers breadth beyond the internal annular ligament of the carpus, forms an arch; the convex ſide of which is turned to the fingers, and commonly ſends off three or four branches. The firſt goes to the inner and back part of the little finger; and is ſometimes a continuation or production of that branch which goes to the muſcles on the foreſide of the little finger.

The other three branches run in the interſtices of the four metacarpal bones; near the heads of which each of them is divided into two branches, which paſs along the two internal lateral

teral parts of each finger, from the forefide of the little finger to the pofterior fide of the index inclufively; and at the ends of the fingers thefe digital arteries communicate and unite with each other.

Sometimes the arch of the cubital artery terminates by a particular branch in the middle finger; and in that cafe it communicates with the radial artery, which makes up what the other wants.

This arch fends likewife from its concave fide, towards the fecond phalanx of the thumb, a branch for the lateral internal part thereof; and then ends near the head of the firft metacarpal bone, by a communication with the radialis, having firft given a branch to the forefide of the index, and another to the fide of the thumb next the former. Thefe communicate at the ends of the fingers with the neighbouring branches as in the other fingers.

This arch fends likewife fmall twigs to the interoffeous mufcles, to the lumbricales, palmaris, and to other neighbouring parts; and, laftly, to the integuments.

*Arteria radialis.* The radial artery begins by detaching a fmall recurrent branch, which runs upwards toward the fold of the arm, and turns backward round the external condyle, communicating with the neighbouring branches from the trunk of the brachial artery, efpecially with the firft collateral branch on that fide.

It runs down along the infide of the radius, between the fupinator longus, pronator teres, and the integuments, giving branches to thefe mufcles, and likewife to the perforatus, perforans, and fupinator brevis. From thence it runs in a winding courfe toward the extremity of the radius, fupplying the flexors of the thumb and pronator quadratus.

Having reached the extremity of the radius, it runs nearer the fkin, efpecially toward the anterior edge of the bone, being

being the artery which we there feel when we examine the pulſe.

At the end of the radius, it gives off a branch to the abductor pollicis; and after having communicated with the arch of the cubital artery in the palm of the hand, and ſent off ſome cutaneous branches at that place, it detaches one along the whole internal lateral part of the thumb.

Afterwards it runs between the firſt phalanx and tendons of the thumb, to the interſtice between the baſis of this firſt phalanx and of the firſt metacarpal bone, where it turns toward the hollow of the hand.

At this turning, it ſends off a branch to the external lateral part of the thumb, which, having reached the end thereof, communicates by a ſmall arch with the branch that goes to the internal lateral part.

It likewiſe ſends branches outward, which run more or leſs tranſverſely between the firſt two bones of the metacarpus and the two tendons of the extenſores carpi radiales; and it communicates with an oppoſite branch of the cubitalis; together with which it furniſhes the external interoſſeous muſcles and integuments of the back of the hand and convex ſide of the carpus.

Laſtly, the radial artery terminates, in paſſing over the abductor muſcle of the index, near the baſis of the firſt metacarpal bone, and in running under the tendons of the flexor muſcles of the fingers, where it is joined to the arch of the cubitalis.

It ſends off another branch, which runs along the fore part of the firſt bone of the metacarpus to the convex ſide of the index, where it is loſt among the integuments.

It gives likewiſe a branch to the internal lateral part of the index; which, at the end of that finger, joins an oppoſite branch that comes from the arch of the cubitalis. It alſo ſends off a ſmall branch acroſs the internal interoſſeous muſcles,

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where it forms a kind of ſmall irregular arch, which communicates with the great arch by ſeveral ſmall arterial rami.

When the arch of the cubitalis ends at the middle finger, the radialis runs along the inner or concave part of the firſt metacarpal bone; at the head of which it terminates by two branches.

One of theſe branches runs along the inner and anterior lateral part of the index; the other paſſes between the flexor tendons of this finger and the metacarpal bone; and having communicated with the cubital branch of the middle finger, it advances on the poſterior lateral part of the index all the way to the end of that finger, where it unites again with the firſt branch.

*Arteria diaphragmatica.* The left diaphragmatic artery goes out commonly from the aorta deſcendens as it paſſes between the crura of the ſmall muſcle of the diaphragm. The right diaphragmatic comes ſometimes from the neareſt lumbar artery, but frequently from the cæliaca. Sometimes both theſe arteries ariſe by a ſmall common trunk immediately from the aorta. They likewiſe have the name of *arteriæ phrenicæ.*

They appear almoſt always in ſeveral ramifications on the concave or lower ſide of the diaphragm, and ſeldom on the upper or convex ſide. They give ſmall branches to the glandulæ renales, and fat upon the kidneys, to the liver, and to the ſuperior orifice of the ſtomach.

Beſides theſe capital diaphragmatic arteries, there are others of a ſubordinate claſs, which come from the intercoſtales, mammariæ internæ, mediaſtinæ, pericardiæ, and cæliaca, all of which communicate freely with the large diaphragmatics, as thoſe on the right and left ſides of the diaphragm do with each other.

*Arteria cæliaca.* The cæliac artery riſes anteriorly and a little to the left ſide, from the aorta deſcendens, immediately after its paſſage through the ſmall muſcle of the diaphragm,

nearly

nearly oppofite to the cartilage between the laft vertebra of the back and firft of the loins. The trunk of this artery is very fhort; and near its origin it fends frequently off the right diaphragmatica.

Immediately after this, the cæliaca divides into three branches; one runs upwards, termed *arteria ventriculi coronaria;* one toward the right hand, named *arteria hepatica;* the other to the left, called *fplenica,* which is larger than the former.

This artery is divided into thefe three branches at the fame place, very near its origin; the trunk going out from the aorta almoft in a ftraight line, and the branches from the trunk almoft at right angles, like radii from an axis; whence this trunk has been called *axis arteriæ cæliacæ.* Frequently, however, the ventriculi coronaria comes off firft, then the cæliaca divides into two parts.

*Arteria ventriculi coronaria,* or *gaftrica,* or *gaftrica fuperior.* The coronary artery of the ftomach goes firft to the left fide of that organ, a little beyond the fuperior orifice; round which orifice it throws branches, and alfo to every part of the ftomach near it; and thefe branches communicate with thofe which run along the bottom of the ftomach to the pylorus.

Afterwards it runs on the right fide of the fuperior orifice, along the fmall curvature of the ftomach, almoft to the pylorus, where it communicates with the arteria pylorica; and turning towards the fmall lobe of the liver, it gives off fome branches to it.

Then it advances, under the ductus venofus, to the left lobe of the liver, in which it lofes itfelf near the beginning of the juft-mentioned duct, having firft given off fome fmall branches to the neighbouring parts of the diaphragm and omentum.

*Arteria hepatica.* As foon as the hepatic artery leaves the cæliaca, it runs to the upper and inner part of the pylorus, in company with the vena portæ, fending off two branches; a fmall ſmall one called *arteria pylorica*, and a large one named *gaſtrica dextra*, or *gaſtrica major*.

The pylorica is ramified on the pylorus, from whence it has its name; and having diſtributed branches to the neighbouring parts of the ſtomach, which communicate with thoſe of the right gaſtrica, it terminates on the pylorus, by an anaſtomoſis, with the coronary artery of the ſtomach.

The right gaſtric artery having paſſed behind and beyond the pylorus, ſends out a conſiderable branch, named *arteria duodenalis*, or *inteſtinalis;* which ſometimes comes from the trunk of the hepatica, as we ſhall ſee hereafter. Afterwards this gaſtric artery runs along the right ſide of the great curvature of the ſtomach; to the neighbouring parts of which, on both ſides, it diſtributes branches.

Theſe branches communicate with thoſe of the arteria pylorica, and of the coronaria ventriculi, and with the right gaſtro-epiploicæ, which furniſh the neareſt parts of the omentum, and communicate with the meſenterica ſuperior. After this, the right gaſtric artery ends in the left, which is a branch of the ſplenica.

The duodenal or inteſtinal artery runs along the duodenum on the ſide next the pancreas; to both which it furniſhes branches, and alſo to the neighbouring part of the ſtomach. Sometimes this artery goes out from the meſenterica ſuperior, and ſometimes it is double.

The hepatic artery having ſent out the pylorica and right gaſtrica, advances behind the ductus hepaticus, toward the veſicula fellis, to which it gives two principal branches, called *arteriæ cyſticæ*; and another named *bilaria*, which is loſt in the great lobe of the liver.

Afterwards this artery enters the fiſſure of the liver, and joins the vena portæ, with which it runs within a membranous vagina, called *capſula gliſſoni*; and accompanies it through the whole ſubſtance of the liver by numerous ramifications, which may be termed *arteriæ hepaticæ propriæ*.

Before it enters the liver, it gives ſmall branches to the external membrane of this viſcus, and to the capſula gliſſoni. The gaſtric and proper hepatic arteries ſometimes come from the meſenterica ſuperior, when the ordinary ramifications are wanting.

*Arteria ſplenica.* Immediately after the origin of the ſplenic artery from the cæliaca, it runs toward the left, under the ſtomach and pancreas, to the ſpleen. It adheres cloſely to the poſterior part of the lower ſide of the pancreas, to which it gives ſeveral branches, named *arteriæ pancreaticæ*.

Near the extremity of the pancreas, under the left portion of the ſtomach, the ſplenic artery gives off a principal branch, called *gaſtrica ſiniſtra* or *minor*, which runs from left to right along the left portion of the great curvature of the ſtomach, giving branches to both ſides of this portion, which communicate with thoſe of the coronaria ventriculi.

This gaſtric artery ſends likewiſe another branch at leaſt to the extremity of the pancreas, which communicates with the other pancreatic arteries. It alſo ſupplies the omentum with branches, termed *gaſtro epiploicæ ſiniſtræ;* and then it communicates with the right gaſtrica; and from this union the gaſtro epiploicæ mediæ are produced.

From this detail we learn, that the arteria coronaria ventriculi, pylorica, inteſtinalis, both gaſtricæ, gaſtro epiploicæ, and conſequently the hepatica, ſplenica, and meſenterica, communicate all together.

Afterwards the ſplenic artery advances towards the ſpleen, in a courſe more or leſs contorted; but before it arrives at that viſcus, it gives two or three branches to the large extremity of the ſtomach, commonly called *vaſa brevia*; and one to the omentum, named *epiploica*.

At the ſpleen, this artery divides into four or five branches which

which enter that viſcus, after having given ſome ſmall twigs to the neighbouring parts of the ſtomach and omentum.

*Arteria meſenterica ſuperior.* The ſuperior meſenteric artery ariſes anteriorly from the lower portion of the deſcending aorta, a very little way beyond the cæliaca, going out a little towards the right ſide, but bending immediately afterwards to the left.

Near its origin, it gives off a ſmall branch, which dividing into two, goes to the lower ſide of the head of the pancreas, and neighbouring part of the duodenum, communicating with the inteſtinalis by ſmall arches, and areolæ or maſhes.

Afterwards it paſſes over the duodenum, between this inteſtine and the meſeraic vein, between the two laminæ of the meſentery; and then bending in an oblique direction from left to right, and from above downward, by very ſmall degrees, it advances toward the extremity of the ilium. By this incurvation, it forms a kind of long arch, from the convex ſide of which a great many branches go out.

Theſe branches are ſixteen or eighteen in number, or thereabouts; and almoſt all of them are beſtowed on the ſmall inteſtines, from the lower third part of the duodenum to the cæcum and colon. The firſt branches are very ſhort; and from thence they increaſe gradually in length all the way to the middle of the arch; the reſt diminiſhing again by ſmall degrees.

As they approach the inteſtines, all theſe branches communicate, firſt by reciprocal arches, then by areolæ and maſhes of all kinds of figures; from which is detached an infinite number of ſmall ramifications, which ſurround the inteſtinal canal like a cylindrical piece of net-work.

Theſe arches and maſhes increaſe in number proportionally to the length of the branches; and their ſize diminiſhes gradually as they approach the inteſtines.

The firſt branches from the convex ſide of the meſenteric arch, which are very ſhort, ſupply the pancreas and meſocolon, and communicate with the duodenal artery. The laſt branches go to the appendicula vermiformis, and ſend a portion of an arch to the beginning of the colon.

The conſiderable branches from the concave ſide of the meſenteric arch are ſeldom above two or three in number; but before they ariſe, a ſmall ramus goes out to the duodenum, and gives ſome very ſmall arteries to the pancreas.

The firſt conſiderable branch from the concave ſide of the arch goes into the meſocolon towards the right portion of the colon, being firſt divided into two rami; the firſt of which runs along the whole ſuperior part of the colon, where it forms the famous communication with the meſenterica inferior, and might be named *arteria colica ſuperior*. The other ramus of this branch runs down on the right portion of the colon.

The ſecond principal branch having run for ſome ſpace through the meſentery, divides into three rami; the firſt of which goes to the lower part of the right portion of the colon, where it communicates with the ſecond ramus of the firſt branch; the ſecond goes to the beginning of the colon, where it communicates with the firſt and to the inteſtinum cæcum.

The third ramus of this ſecond branch having communicated with the ſecond, gives ſmall twigs to the cæcum, appendicula vermiformis, and extremity of the ileum. Afterwards it communicates with the extremity of the arch, or curve trunk of the ſuperior meſenteric.

All theſe communications are by arches and maſhes, as in thoſe branches that come from the convex ſide of the arch; and it is to be obſerved in general, that all the branches of the meſenterica ſuperior are diſpoſed according to the folds of the meſentery and circumvolutions of the inteſtines; giving off branches through their whole courſe, to the laminæ of the meſentery, its cellular ſubſtance, and to the meſenteric glands.

*Arteria meſenterica inferior.* The lower meſenteric artery goes out anteriorly from the aorta deſcendens inferior, about a finger's breadth or more above the bifurcation, and below the ſpermatic arteries; and having run about the length of an inch, or ſomething more, it is divided into three or four branches, which gradually ſeparate from each other.

The firſt or ſuperior branch, about an inch from its origin, divides into two rami; the firſt of which runs along the left portion of the colon, and forms the communication of the two meſenteric arteries already mentioned. It may be named *arteria colica ſiniſtra*. The ſecond ramus having communicated with the firſt, runs down upon the ſame portion of the colon.

The middle branch having run the ſame length with the firſt, divides into two rami; one of which paſſes upward on the extremity of the colon, communicating by arches with the ſecond ramus of the ſuperior branch; the other runs down on the extremity of the ſame inteſtine.

When there is another middle branch, it goes to the firſt part of the double curvature of the colon by a like diſtribution and communication from above downward.

The lower branch goes to the ſecond portion of the colon, or to both, when the ſecond middle branch is wanting, and ſends up a ramus, which communicates with the foregoing.

It ſends another conſiderable branch downward, called *arteria hæmorrhoidalis interna*, which runs down behind the inteſtinum rectum, to which it is diſtributed by ſeveral ramifications; and it communicates with the arteriæ hypogaſtricæ.

*Arteriæ renales*. The renal arteries, called commonly *emulgents*, are ordinarily two in number, and go out laterally from the inferior deſcending aorta, immediately under the meſenterica ſuperior; one to the right hand, the other to the left. The right is ſituated more backward, and is longer than the left, becauſe of the vena cava, which lies on the right ſide between the aorta and the kidney.

They run commonly without diviſion, and almoſt horizontally

tally to the kidneys, into the depreffions of which they enter by feveral branches, which form arches in the inner fubftance of thefe vifcera.

From thefe arches, numerous fmall rami go out toward the circumference or outer furface of the kidneys. Sometimes there is more than one artery on each fide ; fometimes this augmentation is only on one fide, and thefe fupernumerary arteries come fometimes immediately from the aorta, and enter at the upper or lower part of the kidneys. It is not uncommon to find two, three, or four on each fide; fome, or all of which come from the iliac arteries.

Ordinarily, the right renal artery paffes behind the vena cava and renal vein on the other fide; and the left artery, firft behind and then before the vein. Sometimes they fend branches to the glandulæ renales, membrana adipofa of the kidneys, and even to the diaphragm.

*Arteriæ capfulares.* The arteries of the renal glands, which may be termed *arteriæ capfulares*, arife from the aorta above the arteria renalis, and give out the arteriæ adipofæ, which go to the fat of the kidneys. Sometimes they come from the trunk of the cæliaca. The right capfular artery comes moft commonly from the arteria renalis of the fame fide, near its origin; the left from the aorta above the renalis. They fend branches to the parts which furround them, and communicate there with branches of other arteries.

*Arteriæ fpermaticæ.* The fpermatic arteries are commonly two in number, fometimes more. They are very fmall; and go out anteriorly from the aorta defcendens inferior, near each other, about a finger's breadth below the arteriæ renales, more or lefs, between the two mefentericæ, or between the renales and mefentericæ inferiores. Sometimes one is higher, or placed more laterally than the other; and fometimes there are two on each fide.

They fend off to the common membrane of the kidneys fmall ſmall branches named *arteriæ adipoſæ;* and afterwards they run down upon the pſoas muſcles, on the foreſide of the ureters, behind the peritonæum.

They give ſeveral conſiderable branches to the peritonæum, chiefly to thoſe parts of it which are next the meſentery, and they communicate both with the meſentericæ and adipoſæ. They likewiſe ſend ſmall arteries to the ureters.

Afterwards they paſs, in men, through the tendinous openings of the abdominal muſcles in the vagina of the peritonæum, and are diſtributed to the teſticles and epidydimis, where they communicate with a branch of the iliaca externa.

In women they do not go out of the abdomen, but are diſtributed to the ovaria and uterus, and communicate with branches of the hypogaſtrica, at the jagged extremities of the tubæ Fallopianæ.

*Arteriæ lumbares.* The lumbar arteries go out poſteriorly from the inferior deſcending aorta, in five or ſix pairs, much in the ſame manner with the intercoſtals.

They may be divided into ſuperior and inferior. The ſuperior ſend ſmall branches to the neighbouring parts of the diaphragm and intercoſtal muſcles, and ſupply the place of ſemi-intercoſtal arteries. Sometimes thoſe pairs go out by a ſmall common trunk, and not ſeparately.

They are diſtributed on each ſide to the pſoas muſcles, to the quadrati lumborum, and to the oblique and tranſverſe muſcles of the abdomen; and by perforating the oblique muſcles, they become external hypogaſtric arteries. They go likewiſe to the vertebral muſcles, and to the bodies of the vertebræ, and enter the ſpinal canal through the lateral notches, to go to the membranes, &c. forming rings much in the ſame manner with the intercoſtals; and they likewiſe give ſmall twigs to the nerves.

*Arteriæ ſacræ.* The arteria ſacra media goes out commonly from the back part of the inferior deſcending aorta, at the bifurcation,

bifurcation. Sometimes it arifes higher from the lumbares, and fometimes lower from the iliacæ. Sometimes there are two, three, or four, in number. The branches of this artery are ramified on the os facrum, and on the neighbouring parts of the peritonæum, inteftinum rectum, fat, &c.; and enter the canal of that bone through the anterior holes, being there diftributed toward each fide. They likewife fend fmall arteries to the large fafciculi of nerves which go out through the holes of the os facrum, and they penetrate the inner fubftance of that bone. The os facrum has alfo branches fpread out upon its furface, and fome running through its anterior holes from the hypogaftric artery.

*Arteriæ iliacæ.* The inferior defcending aorta ends at the laft vertebra of the loins, and fometimes higher, in two large lateral branches, one on the right hand, the other on the left, called *arteriæ iliacæ;* each of which is a common trunk to two other arteries of the fame name. This bifurcation lies on the anterior and left fide of that of the vena cava.

The primitive iliac arteries divaricate gradually as they defcend, advancing obliquely toward the anterior and lower part of the offa ilium, without any confiderable ramification, for about the breadth of three fingers, except a few very fmall arteries that go to the os facrum; fome of which enter by the upper holes, and are diftributed like the arteriæ facræ, while others emerge again through the pofterior holes, and go to the neighbouring mufcles, &c. They likewife give fmall arteries to the peritonæum, to the coats of the veins, and to the fat and ureters, behind which the iliac trunks pafs.

The right iliac trunk paffes firft on the forefide of the origin of the left iliac vein, and runs down on the forefide of the right vein, almoft to the place where it goes out of the abdomen, its courfe being there directed more inwardly. The left trunk goes down likewife before the left vein, but lies a little toward the infide as it leaves the abdomen.

About three fingers breadth from their origin, and oppo-

fite

ſite to the union of the os ſacrum with the poſterior part of the os ilium, each iliac trunk is divided into two ſecondary arteries, one external, the other internal. The external artery has no particular name; the internal is termed *hypogaſtrica*, which often appears to be no more than a branch of the other, in adults; but in young children, and eſpecially in the fœtus, the hypogaſtric artery looks like the trunk, and the other like a branch.

The external iliac on each ſide runs down on the iliac muſcle to the ligamentum Fallopii, under which it goes out of the abdomen. In this courſe, it gives off only a few ſmall arteries to the peritonæum and other parts near it; but as it paſſes out of the abdomen under the ligament, it detaches two conſiderable branches, one internal, the other external.

The internal branch is named *arteria epigaſtrica*, and goes out anteriorly from the external iliaca. From thence it runs obliquely upward on the tendon of the tranſverſe muſcle toward the poſterior part of the rectus, which it reaches about two or three fingers breadth above the os pubis.

Afterwards the epigaſtric artery runs up along the poſterior or inner ſide of this muſcle, ſending ramifications to the tendons of the neighbouring muſcles, &c.; and then loſes itſelf by a true anaſtomoſis of ſeveral ramifications, with the mammaria interna. It likewiſe communicates with the inferior intercoſtals, which are ſpread on the abdomen.

It ſometimes gives out two particular branches; one of which accompanied by a nerve, goes through the foramen ovale of the pelvis to the triceps muſcles, &c.; the other runs down to the teſticles along with the ſpermatic artery, and there communicates with it.

The external branch of the outer iliac, or iliaca anterior of Sabatier, goes off laterally from the outſide of that artery under the ligamentum Fallopii, and from thence to the internal labium of the os ilium, where it divides into two, and is ramified on the oblique and tranfverfe mufcles of the abdomen, communicating with the arteria lumbaris.

Befides thefe two branches, the external iliaca gives off a fmall ramus internally under the ligament, which runs to the vagina of the fpermatic rope; and fometimes another fmall twig goes from the outfide to the os ilium.

The internal iliaca or hypogaftrica, having run a little more than a finger's breadth inward and backward, bends by fmall degrees obliquely forward, and toward the outfide; and, afterwards contracting in its dimenfions, it ends in the umbilical artery, which ought to be looked upon as a true continuation of the trunk of the hypogaftrica.

This arteria umbilicalis afcends on the fide of the bladder, and having detached fmall rami to that vifcus and to the neighbouring parts of the peritonæum, &c. it contracts, and in adults is quite clofed up, above the middle of the bladder. It likewife gives branches to the uterus in the female, and to the neighbouring parts in both fexes. Afterwards it afcends in form of a ligament to the umbilicus, where it lies contiguous to the umbilical artery on the other fide; its name being taken from its ufe in the fœtus.

From the convex fide of the curvature of the hypogaftric, feveral principal branches go out very near each other. Sometimes they all arife feparately, fometimes by fmall common trunks, and what is the firft branch in fome fubjects, is only a ramus of another principal branch in others; fo much does the number, difpofition, origin, and diftribution of thefe branches vary in different fubjects. For this reafon we think it proper to diftinguifh them by the following proper names: *iliaca minor*, *facræ laterales*, *glutæa*, *fciatica*, *pudica communis*, *five pudica hypogaftrica*, *hæmorrhoidalis media*, and *obturatrix*.

The iliaca minor, or ilio-lumbaris, the moft pofterior of thefe branches, and which is often no more than a ramus of the glutæa, or of the facræ lateralis, paffes behind the mufculus

lus pſoas, to which it gives twigs, and behind the crural nerve; being afterwards diſtributed to the iliac muſcle, and to the middle part of the inſide of the os ilium, penetrating into the ſubſtance of the bone, ſometimes by one hole, ſometimes by more.

Arteriæ ſacræ laterales are moſt commonly two in number, though ſometimes only one. They come from the trunk of the hypogaſtric artery, or from ſome of its largeſt branches, and are diſtributed upon the fore part of the os ſacrum; and then, by means of the anterior holes, they go to the nerves, membranes, &c. lying within that bone.

The arteria glutæa, or iliaca poſterior, is commonly very conſiderable, and ſometimes the largeſt of all the hypogaſtric branches. Near its beginning it ſometimes ſends out the iliaca minor, and ſometimes the ſacræ laterales. Afterwards this artery goes out of the pelvis in company with the ſciatic nerve, through the upper part of the great ſinus of the os innominatum, below the muſculus pyriformis, and is diſtributed in a radiated manner to the glutæus maximus and medius.

In its paſſage, it gives ſome branches to the os ſacrum, os coccygis, muſculus pyriformis, the muſcles of the anus, and to the neighbouring parts of the inteſtinum rectum, forming a particular hæmorrhoidalis interna. It likewiſe ſends twigs to the bladder and parts near it; and detaches a long branch which runs down with the ſciatic nerve.

The arteria ſciatica gives, firſt of all, ſome branches to the muſculus pyriformis, the quadrigemini, the os ſacrum, &c. and even to the inner ſide of the os iſchium. It likewiſe detaches a branch which runs under the muſculus quadratus, to the articulation of the os femoris.

It paſſes obliquely over the ſciatic nerve; and as it goes through the great poſterior ſinus of the os ilium, it detaches ſmall arteries, which are diſtributed to the inner ſubſtance of that nerve. Afterwards it runs up in a radiated manner on the outſide of the os ilium, and is diſtributed to the inner ſubſtance of that bone, and to the muſculi glutæi, eſpecially to the medius and minimus.

The pudica communis, called commonly *pudica interna*, ariſes ſometimes by a trunk common to it and to the glutæa, and gives out two principal branches; the firſt of which paſſes through the great ſinus of the os ilium in company with the glutæa and ſciatica, and then divides into two rami.

The firſt ramus goes behind the ſpine of the iſchium, between the two ligaments which lie between that bone and the os ſacrum; and runs on the inſide of the tuberculum iſchii, all the way to the origin of the corpus cavernoſum penis. There it divides into ſeveral arteries, one of which goes to the ſphincter ani, under the name of *hæmorrhoidalis externa*.

The reſt are diſtributed to the neighbouring integuments, to the bulb of the urethra, and to the corpus cavernoſum penis; but the laſt of theſe arteries, or rather the extremity of this firſt ramus, runs from behind forward, over the neck of the os femoris, and communicates with a branch of the arteria cruralis.

The ſecond principal ramus, called commonly *arteria pudica externa*, runs between the bladder and inteſtinum rectum, and is diſtributed, in men, to the veſiculæ ſeminales, neck of the bladder, proſtate gland, and neighbouring parts of the rectum.

Afterwards it runs under the os pubis on the ſide of a conſiderable vein, which lies directly under the ſymphyſis; and it runs along the penis between this vein and a nerve, being diſtributed in its paſſage to the corpus cavernoſum, and communicating with the pudica minor, which comes from the cruralis. In the female a branch of the pudica communis, after having ſupplied the tranſverſe and ſphincter muſcles with the integuments, is diſtributed upon the muſcles and ſubſtance of the clitoris and outer end of the vagina. A deeper artery belongs

longs to the clitoris, and fupplies it fomewhat in a fimilar way as a correfponding artery does the penis.

Hæmorrhoidalis media comes from the pudica interna, or from fome of the other large branches. It goes to the lower part of the rectum, which it embraces from behind forwards. It is more frequent in women than in men: in the former, it fends branches likewife to the vagina and bladder; in the latter, it fends branches to the bladder, veficulæ feminales, and proftate gland.

*Arteriæ veficales.* The bladder is fupplied with arteries from the hæmorrhoidalis media, from the uterina, and from the umbilicalis; but befides thefe, another artery commonly goes off from the trunk of the hypogaftrica, and runs to the inferior parts of the bladder, where it divides into branches, which run to the veficulæ feminales, vafa deferentia, proftate gland, and beginning of the urethra

Uterina comes from the under end of the hypogaftrica; it firft fends branches to the bottom of the bladder and urethra; then it goes to the lower part of the uterus, where it divides into numerous ferpentine branches, which are diftributed upon the uterus, and which communicate freely with the fpermatic arteries. It fends likewife a branch to the vagina, which extends alfo to the bladder, urethra, and rectum.

*Arteria vaginalis.* The arteries of the vagina come from the hæmorrhoidalis media, from the veficales and uterina: fometimes a branch arifes likewife from the trunk common to the ifchiatica and pudica interna. It goes to the under part of the vagina, and communicates with branches which run upon the external parts of generation.

The arteria obturatrix perforates the obturator mufcles, from whence it has its name, and goes out of the pelvis at the upper part of the ligament of the foramen ovale, having firft fent a fmall branch over the fymphyfis of the os ilium and os pubis, to the inguinal glands and integuments.

As it paffes by the mufcles, it divides, and is diftributed to the pectineus and triceps. It likewife fends out another branch which communicates with that branch of the fciatica that goes to the articulation of the os femoris, and gives fmall arteries to the holes of the neck of that bone. According to Sabatier, this artery comes fometimes from the epigaftric; and Lieutaud has feen it fent off from the external iliac artery.

Afterwards the hypogaftric artery ends in the umbilicalis, as has been already faid.

*Arteriæ crurales.* The iliac artery goes out of the abdomen, between the ligamentum Fallopii and tendon of the pfoas, at the union of the os ilium and os pubis; and there it takes the name of *arteria cruralis.*

It fends off, firft of all, three fmall branches; one of which, called *pudica externa*, goes over the crural vein to the fkin and ligament of the penis, and to the inguinal glands, communicating with the pudica interna. The fecond goes to the mufculus pectineus; and the third to the upper part of the fartorius. All thefe branches furnifh likewife the neighbouring anterior integuments.

Afterwards the crural artery runs down on the head of the os femoris; and by taking a particular turn, gets on the infide of the crural vein, about three fingers breadth from where it goes out of the abdomen. From its origin to this place, it is covered only by the fkin and fat, and lies on the pectineus and triceps primus.

In changing its fituation it fends out three confiderable branches, one external, one middle, and one internal. They all go out more or lefs pofteriorly, fometimes by a fhort common trunk, fometimes by two, &c.

The external branch, called *circumflexa externa*, runs on the upper fide of the thigh to the cruræus, vaftus externus, rectus anterior, mufculus fafciæ latæ, and glutæus medius; fending up a ramus to the apex of the trochanter, which communicates

municates with the firſt principal ramus of the pudica major and ſciatica, as has been already ſaid.

The middle branch, named *profunda*, runs down on the inſide of the thigh between the triceps muſcles; to which it gives ſeveral rami, one whereof perforates the ſecond muſcle, and is diſtributed to the glutæus maximus, ſemi-nervoſus, ſemi-membranoſus, biceps, and to the neighbouring integuments.

The internal branch, termed *circumflexa interna*, runs backward on the quadrigemini, towards the great trochanter; and having detached a ramus which goes into the joint of the os femoris, it runs downward, and gives rami to all the muſcles that lie on the back ſide of that bone, one of which enters the bone itſelf on one ſide of the linea aſpera.

Having ſent off all theſe branches, the arteria cruralis runs down between the ſartorius, vaſtus internus, and triceps, giving branches to all the parts near it. It is covered by the ſartorius all the way to the lower part of the thigh; and it paſſes through the tendon of the adductor magnus, a little above the internal condyle of the os femoris. Afterwards continuing its courſe through the hollow of the ham, it is called *arteria poplitea*, being accompanied by the vein of the ſame name.

The poplitea, while in the ham, is covered only by the integument, ſending off branches toward each ſide, which run up upon the condyles, and communicate with the lower ramifications of the arteria cruralis.

It ſends rami to the joint of the knee, called *articulares*; and theſe are diſtinguiſhed into ſuperior, middle, and inferior; one branch at leaſt paſſes between the crucial ligaments. As it runs down, it ſends branches to the gaſtrocnemii and popliteus; and having reached the back ſide of the head of the tibia, it gives off two branches, one to each ſide.

The firſt or internal branch ſurrounds the forepart of the head of the tibia, paſſing between the bone and internal lateral ligament;

ligament; and, befides feveral other ramifications, fends up a fmall branch which communicates with the arteries that lie round the condyles of the os femoris.

The fecond or external branch runs over the head of the fibula, and between the head of the tibia and external lateral ligament of the knee, furrounding the articulation all the way to the ligaments of the patella, and communicating with the branches which lie round the condyles of the os femoris, together with a branch of the firft or internal ramus.

Immediately after the origin of thefe two rami, and before the poplitea ends, it fends a fmall artery down on the backfide of the interoffeous ligament, very near the tibia, into which it enters by a particular hole, a little above the middle portion of the bone.

As the poplitea ends, it divides into two principal branches: one of which runs between the heads of the tibia and fibula, paffing from behind forwards on the interoffeous ligament, where it takes the name of *arteria tibialis anterior*. The fecond branch divides into two others; one internal and largeft, called *arteria tibialis pofterior*; the other pofterior and fmalleft, named *arteria peronæa pofterior*.

The tibialis anterior having paffed between the heads of the tibia and fibula, fends fmall branches upward and laterally. The fuperior branches communicate with thofe rami of the poplitea which lie round the articulation; and the lateral branches go to the neighbouring parts. Afterwards this tibial artery runs down on the forefide of the interoffeous ligament, toward the outfide of the tibia, between the mufculus tibialis anticus and extenfor pollicis.

Having run laterally on the tibia for about two thirds of the length of that bone, it paffes on the forefide under the common annular ligament and extenfor pollicis, to the articulation of the foot; giving off feveral rami both to the right and left, which communicate laterally with the tibialis pofte-

rior

rior and peronæa pofterior, fo that thefe two bones are in a manner furrounded by arteries.

At the joint of the foot it fends out branches which run between the aftragalus and os calcis, being diftributed to the articulation and to the bones of the tarfus. The communications are here very numerous on all fides.

Having paffed the fold of the foot, it fends off toward both fides other rami, which communicate with the pofterior tibialis and peronæa; all thefe branches making a kind of circles round the tarfus.

Afterwards the anterior tibial artery advances on the convex fide of the foot, as far as the interftice between the firft and fecond metatarfal bones; between the heads of which it fends a large branch, which perforates the fuperior interoffeous mufcles, and, joining the tibialis pofterior, forms an arch on the fide of the foot.

It likewife fends two or three confiderable branches over the other metatarfal bones, which go to the reft of the interoffeous mufcles, integuments, &c. and communicate with each other.

Laftly, this artery terminates by two principal branches, one of which goes to the abductor pollicis and infide of the great toe; the other is fpent upon the outfide of the great toe, and the infide of the fecond toe.

The tibialis pofterior, called likewife *furalis*, runs down between the foleus, tibialis pofticus, flexor digitorum communis, and flexor pollicis; giving branches to thefe mufcles, to the tibia, and to the marrow of that bone, through a particular canal in its pofterior and upper part.

Afterwards it runs behind the inner ankle, communicating with the tibialis anterior, and being furrounded by the neighbouring veins; it then paffes to the fole of the foot between the concave fide of the os calcis and thenar mufcle, where it divides into two branches, one large or external, the other ſmall or internal.

The great branch, or arteria plantaris externa, paſſes on the concave ſide of the os calcis obliquely under the ſole of the foot, to the baſis of the fifth metatarſal bone, and from thence runs in a kind of arch toward the great toe, communicating there with the tibialis anterior, which perforates the interoſſeous muſcles in the manner already ſaid.

The convex ſide of this arch ſupplies both ſides of the three laſt toes, and the outſide of the ſecond toe, forming ſmall communicating arches at the end, and ſometimes at the middle of each toe, as in the hand. The concave ſide of the arch furniſhes the neighbouring parts.

The ſmall branch, or arteria plantaris interna, having reached beyond the middle of the ſole of the foot, is divided into two; one of which goes to the great toe communicating with the ramus of the tibialis anterior; the other is diſtributed to the firſt phalanges of the other toes, communicating with the ramifications from the arch already mentioned.

The arteria peronæa runs down on the back-ſide of the fibula, between the ſoleus and flexor pollicis, to which and to the neighbouring parts it gives rami in its paſſage.

Having reached to the lower third part of the fibula, it ſends off a conſiderable branch, which runs in between the tibia and that bone, paſſing between their extremities from behind forward, below the interoſſeous ligament, and is diſtributed to the integuments of the tarſus.

Laſtly, the peronæa continuing its courſe downward, on the backſide of the fibula, as far as the os calcis, forms an arch with the tibialis poſterior, between the aſtragalus and the tendo Achillis.

From thence it runs outward, and a little above the outer ankle it communicates with the tibialis anterior by an arch, which

which ſends ſeveral ſmall ramifications to the neighbouring parts.

In this deſcription of the arteries, we have ſaid nothing of the cutaneous anaſtomoſes, which are exceedingly beautiful in the fœtus; nor of the frequent and conſiderable communications of ſmall arteries upon the perioſteum, which form a delicate kind of net-work, or rete mirabile.

## CHAP. VI.

### *Of the* VEINS *in general.*

THE veins in many particulars reſemble the arteries. There are ſix; of which two anſwer to the aorta, and the remaining four to the pulmonary artery. Some count a ſeventh trunk, by taking in the venæ hepaticæ. Their baſis is in the auricles of the heart, and their apices in the extremities of each branch through all parts of the body, excepting one inſtance in the liver; or we may reverſe this order, and ſay the veins terminate in the heart. They often run parallel with, and accompany, the arteries.

The fabric of the veins is tender, every where ſmooth, difficultly ſeparable into diſtinct coats or membranes, like the arteries; and the cellular texture ſurrounding them is very eaſily diſtended. The veins both above and below the heart are ſurrounded, except in one place, with muſcular fibres; everywhere, however, their ſubſtance is lax, like the cellular texture which joins the arteries to the adjacent parts; the veins are, nevertheleſs, every where ſufficiently firm, and do not eaſily burſt with inflated air; being in moſt inſtances ſtronger than the arteries themſelves. But they burſt much more eaſily in living than in dead animals, as appears from morbid inſtances in the arm, face, leg, thigh, &c. They do not preferve their cylindrical form after having been cut, but collapfe together, fo as to make their capacity appear like a flit; except they are fuftained, and hindered from thus collapfing, by fome ftronger cellular fubftance placed round them, as we fee in the liver and womb. They are only flightly irritable, unlefs the ftimulus be of the chemical or more acrid clafs; for, in that cafe, they contract themfelves with a convulfive force greater than that of the arteries. They have no pulfation, unlefs the venous channel is fomewhere obftructed; or when, in dying people, the blood is thrown back again from the right auricle into the defcending and afcending cava, or when falling back from the brain.

The veins are much larger than their correfponding arteries, having the fquare of their diameter often double or triple, or almoft quadruple; as may be feen near the emulgents and veffels of the kidneys. In general, however, the diameter of the veins is to that of the arteries as nine to four; yet the capacity of the capillary veins but little exceeds that of the arteries which accompany them. They differ likewife from the arteries in their divifion, having more numerous trunks and branches; for to one artery in the limbs, we ufually meet with two veins: and there are many veins, as the external jugular, vena portarum, azygos, cephalic, bafilic, and faphena, with which there are no correfponding arteries. The larger veins are alfo branched in a more net-like difpofition, by forming more frequent anaftomofes with one another than the arteries do. Many of the veins run near the furface of the body, efpecially in the limbs, neck, and head: they run a long way covered with little more than the bare fkin, which is a circumftance we very rarely obferve in arteries; and, for the fame reafon, they often feparate from the arteries; following the furface of the parts next the fkin, without their correfponding artery, which defcends to a confiderable depth, attended in its courfe by fome fmaller venous branch.

In

In the ſmaller branches of the veſſels, where they make net-like diſpoſitions in the membranes and the internal fabric of the viſcera, the veins and arteries commonly run contiguous one to the other; but here the veins have generally a leſs ſerpentine or inflected courſe than the arteries.

In the larger ſanguineous veins, valves are found in great plenty. The innermoſt membrane of the vein being doubled, riſes into the cavity of the veſſel like a curtain, ſtretching itſelf farther along the vein every way, ſo as to form what may be called a kind of creſcent; but the baſis, which is the part that ſuſtains the weight of the blood, is ſtrongeſt, and grows out of the vein in the ſhape of a circular ſegment. The valve intercepts a ſpace, of which the outer ſide is the vein itſelf, and the inner the valve; which, by its convexity, projects within the bore of the vein, ſo the parabolic ſpace or hollow mouth of the valve always looks towards the heart. They are found in all the ſubcutaneous veins of the limbs, in thoſe of the neck, face, tongue, and penis: at the origin of the larger branches, there are two, three, four, and ſometimes five of them together, while in the ſmaller branches they are only ſingle. Theſe valves are wanting in the veins of the deep-ſeated viſcera; namely the brain, lungs, heart, and liver, and through the whole ſyſtem of the vena portarum *. They are alſo wanting in the kidneys and womb (except one or two valves in the ſpermatic vein); and, laſtly, in thoſe ſmall blood-veins which are leſs than the twelfth part of an inch in diameter. Sometimes, though rarely, they are found in the branches of the vena azygos, and at the mouths of the hepatic and renal veins; where Dr Haller has ſometimes obſerved a ſort of wrinkles in the place of valves. In the ſmaller venous branches there are a ſet of long, ſharp-pointed or parabolical valves, of a more extended figure as the vein i

* Wriſberg has found them in the vena portarum of many quadrupeds.

ſmaller,

er, which ſeem to reſiſt the return of the blood more powerfully than the larger valves.

The veins have their origin, as we ſaid before, from the terminations of the arteries. They ſometimes ariſe by a continuation from the inſerted branches, or from a reflection of recurved trunks of the ſmalleſt arteries. Others, again, are continued from veins leſs than thoſe which carry blood; and alſo, in Dr Haller's opinion, from the abſorbing veins; but as abſorption by the red veins is now denied, that opinion muſt be rejected.

That there are veins of a ſmaller claſs, but reſembling thoſe which convey blood, appears from the ſame experiments which demonſtrate the pellucid arteries; thus there are ſmall veins in the iris, and in the adnata tunica of the eye; nor is it to be doubted, that, in a healthy body, ſmall pellucid veins may be found in the vitreous body of the eye itſelf. Such have been ſometimes ſeen by Wriſberg and others, after a fine injection or inflammation in the capſules of the lens and vitreous humour.

### §. 1. *Of the particular Veins.*

*Introduction.* THE blood diſtributed to all parts of the body by two kinds of arteries, the aorta and arteria pulmonaris, returns by three kinds of veins, called by anatomiſts *vena cava*, *vena portæ*, and *vena pulmonaris*.

The vena cava carries back to the right auricle of the heart the blood conveyed by the aorta to all the parts of the body, except what goes by the arteriæ coronariæ cordis. It receives all this blood from the arterial ramifications in part directly, and in part indirectly.

The vena portæ receives the blood carried to the floating viſcera of the abdomen by the arteria cæliaca and the two meſentericæ; and conveys it to the vena hepatica, and from thence to the vena cava.

The

The venæ pulmonares convey to the pulmonary ſinus, or left auricle of the heart, the blood carried to the lungs by the arteria pulmonaris.

To theſe three veins two others might be added, viz. thoſe which belong particularly to the heart, and to its auricles, and the ſinuſes of the dura mater.

In deſcribing the general courſe of the veins, we may either begin by their extremities in all the parts of the body, and end by the trunks carried all the way to the heart, according to the courſe of the blood; or we may begin by the great trunks, and end by the ramifications and capillary extremities, according to their ſeveral diviſions and ſubdiviſions.

This laſt method has been choſen by Winſlow; and may be conveniently followed in giving a general deſcription. But in purſuing the particular rami and ramifications, the other method ſeems to be the moſt natural, and is that to which the preference is given by the profeſſor of anatomy in this univerſity. We ſhall, therefore, in deſcribing the branches, adopt the firſt method, and, reverſing Winſlow's, trace them, according to the courſe of the blood, from their extremities to the trunks and heart.

*General diviſion of the vena cava.* We commonly talk of the vena cava in general, as if it were but one vein at its origin, or had but one common trunk; whereas it goes out from the right auricle of the heart by two large ſeparate trunks, in a direction almoſt directly oppoſite to each other, one running upward, called *vena cava ſuperior;* the other downward, called *vena cava inferior.*

It may, however, be ſaid, that theſe two veins have a ſort of continuity, or a ſmall portion of a common trunk, fixed to the edges of the right auricle; as if three quarters of the circumference of a large ſtraight tube were cut off, and the edges of a ſmall bladder applied to the edges of the opening thus made in the tube.

The

The right auricle may be alfo looked upon as a mufcular trunk common to thefe two large veins, and may be called the *finus* of the vena cava; but, in this refpect, the name of *finus pulmonaris* agrees ftill better to the left auricle.

The vena cava fuperior is diftributed chiefly to the thorax, head, and upper extremities, and but very little to the parts below the diaphragm.

The vena cava inferior is diftributed chiefly to the abdomen and lower extremities, and but very little to the parts above the diaphragm.

The ancients called the fuperior vena cava, *afcendens;* and the inferior, *defcendens;* having regard only to the great tubes, and to their divifion into trunks and branches. Several moderns have retained thefe names, but in a contrary fignification, to accommodate them to the motion of the blood, which defcends by the cava fuperior, and afcends by the cava inferior.

But, to fhun the miftakes that may happen in reports made of wounds or other difeafes, and of what is obferved in opening dead bodies, and in other cafes of thefe kinds, it is beft to retain the diftinction of the vena cava fuperior and inferior.

The trunk of each of thefe two veins fends off, much in the fame manner with the arteries, a certain number of principal or capital branches, which are afterwards ramified in different manners. Each trunk terminates afterwards by a bifurcation or a divifion into two fubordinate trunks, each of which gives off other principal branches, ending in a great number of fmall trunks, rami, and ramifications.

They have likewife this in common to them with the arteries, that the greateft part of the capital branches are in pairs; as well as the fubordinate trunks. The ramifications of each fubaltern trunk, taken by itfelf, are in uneven numbers; but they make even numbers, with thofe of the other like trunk.

The

The vena azygos and ſome other ſmall veins, of which hereafter, are exceptions to this rule.

Before we proceed to the particular deſcription of each of theſe veins, many of which have proper names, we ſhall give a general idea of their diſtribution, and an enumeration of their principal ramifications, in the ſame manner as we did in the deſcription of the arteries, and for the ſame reaſon. But we ſhall ſay nothing of the venæ coronariæ cordis, becauſe they are not immediately joined to any other vein, as we ſhall ſee in deſcribing the parts of the thorax. We begin by the vena cava ſuperior.

*Vena cava ſuperior.* The ſuperior vena cava runs up from the right auricle of the heart, almoſt in a direct courſe for about two fingers breadth, lying within the pericardium, in the right ſide of the trunk of the aorta, but a little more anteriorly.

As it goes out of the pericardium, it is inclined a little to the left hand, and then runs up about an inch, that is, as high as the cartilage of the firſt true rib, and a little higher than the curvature of the aorta. At this place it terminates by a bifurcation or diviſion into two large branches or ſubordinate trunks, one of which runs toward the left ſide, the other toward the right.

Theſe two branches are named *ſubclaviæ*, as lying behind, and, in ſome meaſure, under the claviculæ, both in the ſame manner. They are of unequal lengths, becauſe the trunk of the vena cava does not lie in the middle of the thorax, but toward the right ſide, where the left ſubclavian ariſes as well as the right; and conſequently the left is the longeſt.

The trunk of the ſuperior cava, from where it leaves the pericardium to the bifurcation, ſends out anteriorly ſeveral ſmall branches, which ſometimes ariſe ſeparately, and ſometimes by ſmall common trunks. Theſe branches are the vena mediaſtina, pericardia, diaphragmatica ſuperior, thymica, mammaria interna, and trachealis; the laſt of which go out ſometimes behind the bifurcation.

All theſe ſmall branches from the trunk of the cava ſuperior are termed *dextræ ;* and their fellows on the other ſide, called *ſiniſtræ*, do not ariſe from the trunk, becauſe of its lateral ſituation, but from the left ſubclavia.

Poſteriorly, a little above the pericardium, the trunk of the ſuperior cava ſends out a capital branch, called *vena azygos*, or *vena ſine pari*, which runs down on the right ſide of the bodies of the vertebræ dorſi, almoſt to the diaphragm; giving off the greateſt part of the venæ intercoſtales and lumbares ſuperiores.

The two ſubclaviæ run laterally or toward each ſide; and terminate as they go out of the thorax, between the firſt rib and clavicula, immediately before the anterior inſertion of the muſculus ſcalenus.

The right ſubclavian, which is the ſhorteſt of the two, commonly ſends out four capital branches; the jugularis externa, jugularis interna, vertebralis, and axillaris; which laſt is rather a continuation than a branch of the ſubclavia.

The left ſubclavian being longer than the right, for the reaſon already given, gives off, firſt of all, the ſmall veins on the left ſide, anſwering thoſe on the right ſide that come from the trunk of the ſuperior cava, viz. the mediaſtina, pericardia diaphragmatica ſuperior, thymica, mammaria interna, and trachealis.

Next to theſe ſmall veins called *ſiniſtræ*, it detaches another ſmall branch called *intercoſtalis ſuperior ſiniſtra ;* and then four large branches like thoſe from the right ſubclavian, viz. the jugularis externa, jugularis interna, vertebralis, and axillaris; which are all termed *ſiniſtræ*.

The external jugular veins are diſtributed chiefly to the outer parts of the throat, neck, and head; and ſend a ſmall vein to the arm, named *cephalica*, which aſſiſts in forming a large one of the ſame name.

The

The internal jugular veins go to the internal parts of the neck and head, communicating with the finufes of the dura mater, and in feveral places with the external jugular veins.

The vertebral veins pafs through the holes in the tranfverfe apophyfes of the vertebræ of the neck, fending branches to the neck and occiput. They form the finus venales of thefe vertebræ, and communicate with the finufes of the dura mater.

The axillary veins are continuations of the fubclaviæ, from where thefe leave the thorax to the axillæ. They produce the mammariæ internæ, thoracicæ, fcapulares or humerales, and a branch to each arm; which, together with that from the external jugularis, forms the vena cephalica.

Afterwards the axillary vein terminates in the principal vein of the arm, called *bafilica*; which, together with the cephalica, is diftributed by numerous ramifications to all the parts of the arm, fore-arm, and hand.

*Vena cava inferior.* The portion of the inferior vena cava, contained in the pericardium, is very fmall, being fcarcely the twelfth part of an inch on the fore-part, and not above a quarter of an inch on the back-part. From thence it immediately perforates the diaphragm, to which it gives the venæ diaphragmaticæ inferiores or phrenicæ.

It paffes next behind the liver, through the great finus of that vifcus, to which it furnifhes feveral branches, termed *venæ hepaticæ.*

In this courfe it inclines a little toward the fpina dorfi and aorta inferior; the trunk and ramifications of which it afterwards accompanies in the abdomen, all the way to the os facrum; the arteria cæliaca and the two mefentericæ only excepted.

Thus the inferior cava fends out on each fide, in the fame manner with the aorta, the venæ adipofæ, renales, fpermaticæ, lumbares, and facræ. Having reached to the os facrum, it it loſes the name of cava; and, terminating by a bifurcation, like that of the deſcending aorta, it forms the two venæ iliacæ.

Theſe iliac veins having given off the hypogaſtricæ, with all their ramifications, to the viſcera of the pelvis, and to ſome other external and internal neighbouring parts, go out of the abdomen, under the ligamentum Fallopii, and there take the name of *venæ crurales*.

Each crural vein ſends off numerous ramifications to all the lower extremity; beſides the vena ſaphena, which goes out near the origin of the cruralis, and, running along this whole extremity, detaches many ramifications all the way to the foot, as we ſhall ſee more particularly hereafter.

We ſhall now trace the veins in the courſe the blood takes to the heart.

## § 2. *Veins of the Head and Neck.*

*Vena jugularis externa anterior.* THE firſt branch belonging to this vein is formed of branches from each ſide, and runs down upon the forehead, by the name of *vena frontalis*, anciently *præparata*, communicating with its fellow, when any ſuch vein is found.

The ſecond branch comes along the muſculus corrugator ſupercilii and the upper part of the orbicularis, from the ſmall or external angle of the eye, after communicating with the vena temporalis, and with that vein which runs along the lower part of the orbicular muſcle, with which it forms a kind of circle.

The third branch comes from the orbit in a winding courſe, on one ſide of the cartilaginous pulley, having communicated with the vein of the eye.

The fourth comes from the root of the noſe; and communicating with its fellow from the other ſide, receives ſeveral ſmall veins from the holes of the oſſa naſi.

At

At the great or inner angle of the eye, theſe branches unite to form a trunk, called *vena angularis ;* which, running down near the ſide of the noſe, receives a branch through the lateral cartilage of the noſe from the internal nares, and another which aſcends in a winding courſe from the upper lip.

Afterwards the vena angularis runs down upon the face in a winding manner, receiving branches on each ſide from the muſcles and integuments. It paſſes next over the lower jaw, near the angle of that bone, and forms the anterior external jugular vein.

While this vein lies upon the face, the branches running into it communicate with each other, eſpecially one which paſſes under the zygoma, behind the os malæ, from the inferior orbitary or ſpheno-maxillary fiſſure ; and another ſmall branch, which runs along the inferior portion of the orbitary muſcle, from the ſmall or external angle of the eye, where it communicates with the rami temporales and frontales.

It runs next down over part of the lower jaw, between the angle and the chin, like a vena maxillaris ; and afterwards receives ſeveral branches from the anterior, poſterior, and internal parts.

Interiorly, it receives a large branch, which communicates with ſome branches of the jugularis interna, and receives ſeveral ſmall rami from the tongue, called *vena raninæ.* The blood from the glandulæ ſublinguales is likewiſe poured into it. It receives likewiſe a ſmall branch from the muſculus depreſſor anguli oris, the commiſſure of the lips, and the neighbouring parts.

The ſame branch which receives the venæ raninæ takes in another from the lateral parts of the ſeptum palati, the amygdalæ, and the uvula, and receives rami forward from the membrane which lines the arch of the palate. Another branch comes into it from the pterygoidæus internus, and muſcles about the palatum molle.

It

It is here to be obferved, that, under the angle of the lower jaw, there is a great variety of communications between the external and internal jugular veins, and alfo a great variety in their diftribution.

Almoft all the ramifications, which at this place go into the external jugular vein, from the upper part of the throat and face in fome fubjects, terminate in other fubjects in the internal jugular; and fometimes one part of them goes to the external jugular, the reft into the internal.

The trunk of the vein, after receiving thefe branches, admits another large branch anteriorly from the fymphyfis of the lower jaw, from the maxillary glands, the digaftric mufcle, the chin and upper-lip.

Oppofite to the cartilago-thyroides, it receives a tranfverfe branch, which runs on the anterior or lower part of the mufculi fterno-maftoidæi, and communicates, though not always, with the jugularis of the other fide.

The fuperior and inferior tranfverfe branches communicate on each fide by branches more or lefs perpendicular, and receive a fmall branch from the mufculus depreffor labii inferioris, and platyfma myoides, and integuments.

Anteriorly, it receives feveral branches from the mufcles of the larynx, fterno-hyoidæi, thyro-hyoidæi, and from the integuments; and below the larynx, it receives communicating branches from the jugularis externa anterior of the other fide.

Pofteriorly, it receives, 1. A large branch on the fide of the upper part of the larynx, which communicates with the jugularis interna; and likewife with a large fhort branch of the jugularis externa pofterior. 2. A fmall branch, which has the fame communication, but which is not always to be found. 3. Another fmall branch a little below the lower jaw, which communicates with the jugularis externa pofterior. The trunk of the vein thus formed fometimes runs down to open into the fubclavian

fubclavian vein; but moft commonly it opens into the communication of the temporal vein, a little below the jaw.

*Vena jugularis externa, five fuperior.* The pofterior or fuperior external jugular vein runs down from the fide of the head, &c. receiving large branches from the neighbouring parts.

This vein is at firft formed by a branch called *vena temporalis*, which receives the blood from the temples and lateral parts of the head, and likewife from fome part of the occiput and forehead. The temporal vein has fometimes two infertions, one into the jugularis interna, and the other into the jugularis externa.

The temporal vein of one fide communicates above, with its fellow on the other fide; before, with the vena frontalis; and behind, with the vena occipitalis. Oppofite to the ear, it receives a large branch; one ramus of which runs under the lower edge of the zygoma, and then returning, communicates with another ramus from the fame jugularis, a little below the condyle of the lower jaw, forming a kind of areola of a roundifh form.

Behind this condyle, it receives branches from the temporal mufcle, from the neighbouring parts of the upper jaw, and from the infide of the lower jaw, almoft in the fame manner as the arteries are fent out.

Only one of thefe branches comes from the mufculus temporalis and pterygoidæi; communicating with a branch from the maffeter in its paffage.

Having reached a little lower, it paffes through the parotid gland, receiving a large branch, which communicates with another branch common to the internal and anterior external jugular veins. Sometimes areolæ are formed, through which the nerves pafs. Thefe open into the trunk by feveral branches. Under the angle of the lower jaw it forms communications with the anterior external jugular.

The trunk of the external jugular vein, now formed of the external,

external, maxillary, or facial, and of the temporal vein, runs down between the mufculus platyfma myoides and fterno-maftoideus, being covered by the former, and croffing over the latter. In this courfe it receives pofteriorly the vena occipitalis, which comes from the different parts of the occiput, and fometimes runs into the vena vertebralis or axillaris, &c. It likewife receives a fmall vein, which comes out of the cranium by the pofterior maftoid hole from one of the lateral finufes. This branch goes fometimes into another vein.

After receiving a branch from the fcapula, called *mufcularis* or *fuper-humeralis*, it ends in the fubclavian on the fame fide, fometimes in the axillaris, and fometimes in the union of thefe two veins. The right and left do not always end in the fame manner; for fometimes the right goes into the fubclavian, and the left into the internal jugular, on the fame fide.

At the lower part of the neck it receives the vena cervicalis, which comes from the vertebral mufcles of the neck. This vein communicates with the humeralis by feveral areolæ, or venal mafhes; and they are both ramified in different manners.

Thefe ramifications and communications are in part covered by the mufculus trapezius, and communicate likewife with fome branches of the vena occipitalis, and with a branch of the fuperior intercoftal vein, which perforates the firft intercoftal mufcle.

At its termination, it receives, pofteriorly, a principal branch from the mufcles which cover the fcapula and joint of the humerus, commonly called *vena mufcularis*, and which might be named *fuper-humeralis*.

*Vena jugularis interna.* The internal jugular vein is the largeft of all thofe that come from the head; though not fo large as it feems to be when injected.

It is a continuation of the lateral finus, which, after getting through the foramen lacerum of the bafis crani, bends a little, and forms a fort of varix, which fills a thimble-like cavity in the

the temporal bone. From this it runs along the fides of the vertebræ of the neck, by the edges of the longus colli, and paffes behind the fterno-maftoidæus and omo-hyoidæus, which it croffes, and ends in the fubclavian vein. At the top of the neck it receives fmall twigs from the pharynx and neighbouring mufcles.

Farther down it receives another branch, which comes from the occiput. This branch communicates with another of the vertebralis, and, through the pofterior maftoid hole, with the lateral finus of the dura mater. This communication is fometimes by anaftomofis with a branch of the external jugular, or of the cervicalis.

Nearly oppofite to the os hyoides, the internal jugular receives another branch, which comes from the parotid gland and angle of the lower jaw, where it communicates by other branches with the two external jugulars. This firft branch receives others from the mufcles of the os hyoides and neighbouring parts.

About two fingers breadth lower than the former, it receives a middle-fized branch, which comes laterally from the larynx, and may be named *vena gutturalis*.

This guttural vein is formed chiefly of three branches; the loweft of which comes from the thyroid gland and neighbouring mufcles; the middle branch from the larynx, mufculi thyroidæi, &c.; and the third runs downward from the great communication between the two jugulares already mentioned. In this, however, there is fome variety; and fometimes the left guttural vein goes into the axillaris.

The laft branches which it receives are fmall, and come from the thyroid glands.

*Vena vertebralis*. The vertebral vein accompanies the artery of the fame name, fometimes in one trunk, fometimes in feveral ftems, through all the holes of the tranfverfe apophyfes of the vertebræ colli, all the way from the great foramen

 occipitale,

occipitale, after communicating with the occipital veins and ſmall occipital ſinuſes of the dura mater.

At firſt it receives the veins from the vertebral ſinuſes, which are rather numerous, and placed one above another, all the way from the occiput downwards, communicating freely with each other and with thoſe on the oppoſite ſide; and at the foramen magnum occipitis, there is a communication between them and the occipital ſinuſes of the dura mater.

At the top of the neck it receives a branch, which comes through the poſterior condyloid hole of the os occipitis from the lateral ſinus of the dura mater; but we cannot always diſcover it.

As this vein runs through the holes in the tranſverſe apophyſes, it receives branches anteriorly from the anterior muſcles of the neck, and from the ſmall anterior muſcles of the head.

Other branches come likewiſe from the muſculi tranſverſales and vertebrales colli at the back part of the neck.

About the third or fourth vertebra of the neck, the vertebral vein ſends off a branch, which paſſes out between the vertebræ, and carries down part of the blood from the neck: this communicates again with the trunk of the vertebral vein, or with the ſubclavian.

The trunk of the vein afterwards runs down through the holes in the tranſverſe proceſſes of the vertebræ colli, receiving branches in its paſſage from the neighbouring muſcles. At the under part of the neck it leaves the vertebræ, and ends in the upper and back part of the ſubclavian vein.

## § 3. *Veins of the Superior Extremities.*

The veins of the extremities run in two ſets, one following the arteries, the other running immediately under the ſkin; we ſhall trace them from their origins to their terminations in the ſubclavian vein.

In general, the external or ſuperficial veins of the fore-arm are larger than the internal; but they are accompanied only by ſmall arteries: Whereas the deep veins accompany large arteries.

*Vena baſilica.* This vein takes its origin by ſeveral branches which come from the convex ſide of the carpus; one of which named by the ancients *ſalvatella*, comes from the ſide of the little finger next the ring-finger, having firſt communicated with the cephalica, by means of the venal areolæ conſpicuous on the back of the hand. In the other fingers this vein follows nearly the ſame courſe with the artery.

After receiving theſe branches, it runs along the ulna, between the integuments and muſcles, a little towards the outſide, by the name of *cubitalis externa*, communicating with the veins called *profunda*, *ſatellites*, and *cephalica*. Near the inner condyle, it receives a branch which runs up along the inſide of the fore-arm, near the ulna, communicating with the mediana major. Having reached the inner condyle, it receives a vein called *mediana baſilica*, which opens into it obliquely.

Afterwards the baſilica runs up along the inſide of the os humeri, between the muſcles and integuments, forming many communications with the vena profunda, ſatellites, and cephalica, and receiving branches from the muſcles and integuments.

Below the neck of the os humeri, near the hollow of the axilla, the baſilica receives two or three conſiderable veins which come up from the ſides of the brachial artery.

Theſe veins, which often terminate in the profunda ſuperior, communicate with the baſilica and cephalica. They follow the courſe of the trunks of the arteries, and have the ſame names. At that part of the elbow where the artery divides they unite, but afterwards ſeparate and reunite ſeveral times, ſurrounding the trunk of the brachial artery at different diſtances, and communicating freely with each other. Theſe veins might be called *venæ ſatellites arteriæ brachialis.*

Behind the tendon of the pectoralis major, the baſilica receives a conſiderable branch, which runs up in company with the trunk of the brachial artery from the neighbouring muſcles on both ſides. This vein is named *profunda brachii*, or *profunda ſuperior.*

It receives at laſt, under the head of the os humeri, a large branch, which paſſes almoſt tranſverſely round the neck of that bone, from behind inward, and from within forward, coming from the muſcles on the outſide of the ſcapula, particularly the deltoides, and communicating with the venæ ſcapulares externæ. This branch may be named *vena ſub-humeralis* or *articularis*, as the artery is which lies in the ſame place; both of them having much the ſame courſe.

This articular vein receives two principal branches; one of which runs along the inſide of the bone, from which, and from the perioſteum, it gets ſmall veins. The other lies at the middle of the arm between the bone and the biceps, and communicates with the cephalica.

The baſilic vein having reached the ſide of the head of the os humeri, terminates in the trunk of the vena axillaris, which may be conſidered as a continuation of it.

The ancients termed the baſilic vein of the right arm the *vein of the liver*, or *vena hepatica brachii*; and that of the left arm, the *vein of the ſpleen*, or *vena ſplenica brachii.* It has ſometimes a double termination, by a branch of communication with the trunk of the axillaris.

*Vena cephalica.* The vena cephalica receives, at the extremity of the radius, branches which correſpond with thoſe of the radial artery. Theſe branches form numerous areolæ, which communicate freely with each other.

A particular branch comes into it, which runs more or leſs ſuperficially between the thumb and metacarpus, by the name of of *cephalica pollicis*. The areolæ receive branches from the interoſſeous muſcles and integuments, and communicate with the vena ſalvatella.

From the under part of the fore-arm the trunk of the vein runs along the radius between the muſcles and integuments, receiving branches from both ſides, which communicate with other branches of the ſame vein, and with ſome of the baſilica, forming areolæ much in the ſame manner as we ſhall afterwards find the ſaphena does in the lower extremity. That part of the vein which lies on the fore-arm may be looked upon as a radialis externa.

Having reached a little below the fold of the arm, it receives a large branch, which may be called *mediana cephalica*. This comes up obliquely from the middle of the fold of the arm, under the integuments, and over the tendon of the biceps. Theſe two medianæ are ſent off in an angle, the apex of which is turned downward. The mediana cephalica ſometimes receives a long branch called *radialis interna*, which lies almoſt parallel to the radialis externa.

The two median veins are ſent off from a trunk which may be called *mediana major*, or *longa*, to diſtinguiſh it from the other two. This trunk runs up from the fore-arm between the cephalic and baſilic veins, communicating with both in its paſſage by many branches. At the part where it ſplits into the two branches already named, a branch opens into it called *vena cubiti profunda*. This comes from the neighbouring muſcles, after having communicated with the other veins of the fore-arm.

A little below the external condyle of the os humeri, it receives a branch poſteriorly, which comes down between the muſculus brachialis and the upper portion of the ſupinator longus, after bending between the os humeri and anconæus externus, and communicating with ſome branches of the baſilica.

The cephalica runs next up along the outer edge of the

external

external portion of the biceps; communicating ſeveral times with the vena baſilica, and receiving ſmall rami on each ſide, from the neighbouring muſcles, fat, and ſkin. Some branches go into its upper part, which lower down were ſent off from its trunk.

It runs afterwards between the deltoid and large pectoral muſcles, communicating in its paſſage with a branch called *ſmall cephalic*, and terminates in the vena axillaris.

*Vena axillaris.* This vein, formed by all the veins from the ſuperior extremity, receives, above the axilla, the venæ thoracicæ; one of which is ſuperior, called alſo *mammaria externa;* and the other inferior. It likewiſe receives rami from the muſculus ſubſcapularis, teres major, teres minor, ſupra-ſpinatus, latiſſimus dorſi, ſerratus major, pectorales minor et major, and from the glands of the axilla; and ſometimes communicates by a ſmall branch with the vena baſilica.

Afterward, the laſt veins which it receives are the muſculares, which come from the middle portion of the muſculus trapezius, from the angularis, infra-ſpinatus, and ſubſcapularis; and as ſome of theſe branches came from the ſhoulder exteriorly, others interiorly, the venæ ſcapulares are diſtinguiſhed into external and internal.

The axillary vein, having received the branches mentioned above, paſſes between the firſt rib and the clavicle, where it gets the name of *ſubclavian;* it then paſſes before the anterior portion of the muſculus ſcalenus; while it lies in the neck, it receives the branches already deſcribed, from the head, neck, and upper part of the thorax; and at laſt meets with its fellow on the oppoſite ſide, to form the vena cava ſuperior.

### § 4. *Veins of the Thorax.*

*Venæ pectorales internæ.* The pectorales internæ, are ſmall veins diſpoſed in pairs toward the right and left ſide, behind the

the ſternum and parts near it, including the diaphragmaticæ ſuperiores, or pericardio-diaphragmaticæ, mediaſtinæ, mammariæ internæ, thymicæ, pericardiæ, and gutturales or tracheales.

All theſe ſmall veins are divided into right and left; and theſe are both diſtributed much in the ſame manner; but they differ in their terminations, becauſe of the inequality in the bifurcation of the cava ſuperior.

The right vena mediaſtina opens anteriorly into the trunk of the ſuperior cava, a little above the termination of the azygos; the left goes into the ſubclavian.

The right ſuperior diaphragmatica, or pericardio-diaphragmatica, goes anteriorly to the union of the two ſubclavian veins, or beginning of the ſuperior cava; and is formed by ſeveral branches from the upper, fore, and back parts of the pericardium, communicating with thoſe of the left diaphragmatica, and accompanying the nerve of the ſame name. The left ſuperior diaphragmatica goes into the left ſubclavian a little below the termination of the mammaria.

The right internal mammaria ariſes from the upper and back part of the recti muſcles of the abdomen; here it communicates with the epigaſtric vein by ſeveral ſmall branches. It paſſes afterwards into the thorax under the cartilage of the laſt true rib, and receives ſmall branches from the mediaſtinum, while others come through the integuments from between the ribs. At the upper ſurface of the diaphragm it receives a branch which communicates with the diaphragmatic veins. The trunk thus formed, runs up within the thorax, behind the cartilages of the ribs, near the edge of the ſternum, in company with the artery of the ſame name; and terminates at laſt in the beginning of the vena cava ſuperior, but frequently in the ſubclavian vein.

The left internal mammaria terminates anteriorly in the left

left ſubclavian, oppoſite to the cartilage or anterior extremity of the firſt true rib.

The right vena thymica, when it terminates ſeparately, goes into the union of the two ſubclaviæ; and when it is wanting, the thymus, from whence it takes its name, ſends branches to the gutturalis or ſome other neighbouring vein. The left vein of the ſame name goes to the left ſubclavian, almoſt oppoſite to the ſternum.

The right pericardia ſeems to go rather into the termination of the right ſubclavian, than to the trunk of the ſuperior cava; but in this there are many varieties. It comes from the upper ſide of the pericardium, and other neighbouring parts. The left pericardia goes ſometimes into the left ſubclavian, before the mammaria; and ſometimes into the mammaria or diaphragmatica ſuperior on the ſame ſide.

The right gutturalis or trachealis goes into the upper part of the union of the ſubclaviæ, above the mammaria of the ſame ſide, ſometimes more backward, and ſometimes into the ſubclavia. It comes from the glandulæ thyroidææ, trachea arteria, muſculi ſterno-hyoidæi, thymus, and glandulæ bronchiales. It communicates by lateral branches, more or leſs contorted, with the internal jugular vein; and ſometimes, by another branch, with a ſmall vein, which the internal jugular receives from the glandula thyroides. The left gutturalis goes into the upper or poſterior part of the left ſubclavian near its termination.

The ſmalleſt internal pectoral veins do not always terminate ſeparately, but have ſometimes a ſmall common trunk, eſpecially on the right ſide; and of all theſe ſmall veins, the mammaria interna is the moſt conſiderable.

*Vena azygos, and venæ intercoſtales.* The vena azygos, or ſine pari, is very conſiderable, and ariſes from the lower ſide of the thorax internally.

For at the back part of the diaphragm, it communicates, by

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a very ſenſible anaſtomoſis, ſometimes with the vena renalis, ſometimes with a neighbouring lumbar vein, ſometimes immediately with the trunk of the cava inferior, and ſometimes otherwiſe.

Winſlow has ſeen this vein extremely large, reſembling the trunk of the inferior cava, from the origin of the renales to the diaphragm; the true cava being through all this ſpace very narrow, or of the ſize of an ordinary azygos.

From the left ſide of the thorax it runs acroſs the ſpine, and afterwards aſcends on the right ſide of the vertebra dorſi and aorta, and before the intercoſtal arteries.

At the top of the thorax it is bent forward over the origin of the right lung; forming an arch which ſurrounds the great pulmonary veſſels on that ſide, as the arch of the aorta does thoſe of the left ſide, with this difference only, that the curvature of the azygos is almoſt directly forward, whereas that of the aorta is oblique. It opens poſteriorly, a little above the pericardium, into the top of the ſuperior cava.

To the above deſcription of this vein we may add the following:

The azygos begins at the under part of the thorax, receives a large branch, which perforates the muſcles of the abdomen: after having been ramified between their different planes, it communicates with the like ramifications of the laſt or two laſt intercoſtal veins.

Sometimes it receives the vena diaphragmatica inferior, and alſo a branch formed by the firſt venæ lumbares dextræ.

Theſe communications between the laſt intercoſtal and firſt lumbar veins are very irregular, being ſometimes by a ſeries of oppoſite angles, ſometimes by areolæ, ſometimes by a reticular texture, &c. Sometimes the extremity of the vena azygos communicates either mediately or immediately with the vena adipoſa, and even with the vena ſpermatica.

The azygos receives likewiſe the left intercoſtal veins, but ſeldom the whole number; for the ſuperior veins go commonly into the left ſubclavian, by a vein ſomewhat ſimilar to the azygos, but much ſmaller. The inferior intercoſtal veins, to the number of ſix or ſeven, more or leſs, run over between the aorta and vertebræ; from the ſubſtance of which, and from the œſophagus, they receive capillary twigs in their way to the azygos.

Sometimes the lower left intercoſtals paſs into a common trunk, which runs up along the left ſide of the vertebræ, and then croſſes over behind the aorta to open into the azygos. Sabbatier calls this trunk the *demi azygos*.

There is ſometimes an entire azygos on the left ſide, which opens into the arch of the ordinary azygos.

As the azygos runs up in the right ſide of the thorax, it receives the inferior intercoſtal veins on that ſide, one coming from each ſeries of intercoſtal muſcles. Theſe veins run along the lower edges of the ribs, after having perforated the muſcles by branches which come from the poſterior and external part of the thorax.

They communicate with the venæ thoracicæ, and moſt commonly with the mammaria interna; and laſtly, more or leſs with each other, by perpendicular branches, near the poſterior extremities of the ribs.

Afterwards the azygos admits into the extremity of the arch which it forms before it terminates, a trunk common to two or three ſmall veins, called *intercoſtales ſuperiores dextræ*, which bring back the blood from the firſt three ſeries of intercoſtal muſcles, and from the neighbouring part of the pleura.

Theſe intercoſtal veins communicate with other branches which come through the intercoſtal muſcles from the ſerratus ſuperior poſticus, ſerratus major, &c. and they run along the interſtices between the ribs, communicating with the venæ mammariæ.

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They likewiſe take in branches from the vertebral muſcles and canal of the ſpine, where they communicate with the venal circles or ſinuſes, which bring back the blood from the medulla ſpinalis.

Laſtly, the vena azygos receives two or three ſmall veins into the top of the arch, one of which comes from the aſpera arteria; the others partly from the aſpera arteria, and partly from the bronchia, by the name of *venæ bronchiales*, accompanying the ramifications of the bronchial artery. It opens at laſt into the back part of the ſuperior cava, a little above the pericardium.

*Vena ſubclaviana.* The ſubclavian vein is formed chiefly by veins from the head, neck, and arms. It paſſes over the inſertion of the anterior ſcalenous muſcle, between the clavicle and firſt rib.

The right ſubclavian, which is the ſhorteſt of the two, commonly receives four capital branches, viz. the jugularis externa, jugularis interna, vertebralis, and axillaris, of which laſt the ſubclavian may be looked upon as a continuation.

The left ſubclavian being longer than the right, becauſe the vena cava, into which both open, lies in the right ſide of the thorax, receives firſt the four capital branches correſponding with thoſe already mentioned, as going into the right ſubclavian. Next to theſe, it receives a vein, ſomewhat ſimilar to the vena azygos, called *intercoſtalis ſuperior*, which is formed of branches coming ſometimes from five or ſix of the ſuperior intercoſtal muſcles, &c. theſe communicate with the other intercoſtals. The intercoſtalis ſuperior receives the left bronchial vein. The ſubclavian receives alſo the ſmall veins correſponding with thoſe of the right ſide, going into the trunk of the ſuperior cava, viz. the mediaſtina, pericardia, diaphragmatica ſuperior, thymica, mammaria interna, and trachealis. And beſides all theſe, it receives the termination of the thoracic duct, to be afterwards deſcribed.

After admitting the branches mentioned above, the two venæ fubclavianæ unite at the upper end of the thorax, near the cartilage of the firft rib, and form the vena cava fuperior, which receives the vena azygos, and runs down about an inch, fomewhat inclining to the right fide; at this part it enters the pericardium, and defcends nearly in a direct courfe for about two fingers breadth in an ordinary fized perfon, being fituated on the right fide of the aorta, but a little more anteriorly. It opens at laft in the upper part of the right auricle.

## §. 5. *Veins of the Chylopoietic and affiftant Chylopoietic Vifcera.*

*Vena mefaraica minor*, or *hæmorrhoidalis interna.* The blood fent out by the cæliac and two mefenteric arteries is returned by veins, which, as in other parts of the body, are much larger than the arteries.

A branch runs up from the rectum and left portion of the colon. The beginning of this branch communicates with other hæmorrhoidal veins at the end of the rectum. The ramifications of this vein are very numerous, furrounding the inteftines, and forming arches like thofe of the arteries. It feems likewife to communicate by fome capillary twigs with the left fpermatic vein.

This vein has been named *hæmorrhoidalis*, from the tumours called *hæmorrhoides*, which are often found at its beginning next the anus. The word *interna* is added to diftinguifh it from the hæmorrhoidalis externa, which goes to the vena hypogaftrica, but communicates with the interna by capillary ramifications. The name of *mefaraica minor* agrees to it very well, becaufe of its fituation with refpect to the inferior mefenteric artery, which is alfo lefs than the fuperior.

After

After returning the blood from the parts already mentioned, it unites with a part of the branch defcending from the left part of the arch of the colon. This is formed by many ramifications which communicate with a branch of the great mefaraica, with the ramifications of the gaftro-epiploica finiftra, and with thofe of the neighbouring epiploica.

At a fmall diftance from its termination, it receives from the duodenum a vena duodenalis, which is fometimes more confiderable than one which paffes into the great trunk of the vena portæ.

The fmall mefaraic vein is one of the three principal branches of the vena portæ, opening commonly into the termination of the vena fplenica, and fometimes into the beginning of the great trunk of the vena portæ.

*Vena fplenica.* The fplenic vein is one of the three great branches of the vena portæ, and may be faid in fome meafure to be a fubordinate trunk of that vein. It runs tranfverfely from the left to the right fide, firft along the lower fide of the pancreas, near the pofterior edge, and then under the duodenum.

In this courfe it receives feveral veins, viz. the vena coronaria ventriculi, pancreaticæ, gaftrica, or gaftro-epiploica finiftra, and epiploica finiftra. It likewife often receives the hæmorrhoidalis interna, already defcribed.

The vena fplenica begins by branches which run in a winding courfe, after running through the whole length of the fpleen, almoft in the fame manner as the fplenetic artery. It is into the moft pofterior of thefe branches that the veins are received from the great extremity of the ftomach, formerly known by the name of *vafa brevia,* which communicate with the coronaria ventriculi and gaftrica finiftra.

In its paffage it receives, at the fmall extremity of the pancreas, a vein called *epiploica finiftra*, becaufe it comes from the left fide of the omentum, where it communicates with the hæ-

morrhoidalis

morrhoidalis interna. When this vein is wanting, the branch of the left gaſtrica ſupplies its place. It ſometimes goes to the moſt anterior branch, which the ſplenica receives from the ſpleen.

The left gaſtric or gaſtro-epiploic vein, coming from the convex ſide of the great extremity of the ſtomach, goes into the left extremity of the pancreas.

In its paſſage, it receives ſeveral branches from both ſides of the ſtomach, which are diſtributed by numerous ramifications, forming many areolæ, and communicating with the branches of the coronaria ventriculi.

The venæ pancreaticæ are ſeveral ſmall branches ſent into the ſplenica from the under edge of the pancreas. There are other ſmall pancreatic veins which do not open into the ſplenica, as will be found in the deſcription of the gaſtro-colica; one of the branches of the great meſaraic trunk.

The coronaria ventriculi, ſo called becauſe it ſurrounds more or leſs the upper orifice of the ſtomach, runs along the ſmall arch of that viſcus from the pylorus, where it joins and becomes continuous with the vena pylorica. In its paſſage, it receives ſeveral rami from the ſides of the ſtomach, which there form numerous areolæ, and communicate with the veins of the great arch.

It terminates very often in the beginning of the ſplenica, and ſometimes in the left ſide of the beginning of the great trunk of the vena portæ, behind the hepatic artery; and in that caſe it is the moſt conſiderable of all the ſmall veins that go into the great trunk.

*Vena meſaraica major.* The blood is returned from moſt of the branches of the ſuperior meſenteric artery by a vein called *meſaraica* or *meſaraica major*, which runs up to the inferior vena portæ, and appears in ſome meaſure to form it. As it runs along it forms an arch almoſt like that of the artery, which is likewiſe ramified on both the concave and convex

ſides;

ſides; but not ſo regularly: returning the blood from the ſmall inteſtines, the cæcum, and right portion of the colon.

Into the concave ſide of the meſaraic vein, paſſes a branch called by Riolan *vena cæcalis*, which runs from the beginning of the colon, croſſing one of the branches of the ſuperior meſenteric artery.

This cæcal vein is formed by two arches, the uppermoſt of which communicates with the lower branch of the vena gaſtro-colica; the other receives ramifications from the inteſtinum cæcum and appendicula vermiformis, and communicates below with other branches of the great meſaraic vein.

Afterwards the trunk of the meſaraica paſſes over the ſuperior meſenteric artery, to which it adheres very cloſely; but previous to this it receives ſeveral branches into the convex ſide of its arch almoſt in the ſame manner with the artery; but with this difference, that frequently the branches do not end immediately in the vein in ſo great numbers; and each of them is formed by many more ramifications.

The trunk of the great meſaraic vein receives ſometimes oppoſite to the gaſtrica, a particular branch from the omentum, called *epiploica dextra*. But almoſt immediately after it deſcends over the meſenteric artery, it gets the addition of two large branches very near each other, which paſs behind and under the artery, coming from the jejunum and part of the ilium by numerous ramifications, which form arches and areolæ like thoſe of the artery.

The trunk of the great meſaraic vein running farther, receives a vein which may be called *gaſtro-colica*; this is formed of two branches, one ſuperior, the other inferior.

The ſuperior branch of the vena gaſtro-colica receives the gaſtrica, or gaſtro-epiploica dextra, which comes from the great curvature of the ſtomach, communicating with the gaſtrica ſiniſtra. It alſo admits ſmall veins from the head of the pancreas. In its paſſage, it gets likewiſe branches from the ſtomach

ſtomach and omentum, and communicates with the pylorica, coronaria ventriculi, &c. and ſometimes it receives the pylorica.

The inferior branch of the vena gaſtro-colica, which may be called *colica dextra*, comes from the upper part of the colon, and then from the right portion of that inteſtine, where it is divided archwiſe, and communicates with the great branch of the colica anterior, and with a branch of the vena cæli-calis.

The laſt particular branch running into this trunk is called by Riolan *vena colica*. It opens into the anterior part of the trunk, before it joins the artery, and comes directly from the middle of the colon; and here it is formed of branches from the right and left, which communicate with others by arches. On the left ſide it communicates with the ſuperior or deſcending branch of the hæmorrhoidalis, and on the right, with the former branch of the meſeraica.

The vein, after having been diſtributed like the artery, runs through thoſe parts of the meſentery and meſocolon which belong to the ſmall inteſtines, the cæcum, and right portion of the colon; it paſſes next over the trunk of the arteries, receiving in its way the ſplenic vein, and terminates at laſt in the vena portæ.

The vena portæ inferior appears to be a continuation of the trunk of the vena meſeraica major. The ſplenica is a capital branch of that trunk; and the hæmorrhoidalis interna has ſometimes a common termination with the ſplenica, and ſometimes is no more than a branch of that vein. In ſome ſubjects the meſeraica major and ſplenica appear to end by an equal union in the trunk of the inferior vena portæ, and in others the hæmorrhoidalis ends in the very angle of that union.

*Vena portæ.* The inferior vena portæ, after being formed of the ſplenic and meſenteric veins, receives into its trunk ſeveral ſmall rami, which are commonly the venæ cyſticæ, he-

patica

patica minor, pylorica, duodenalis, and ſometimes the gaſtrica dextra, and coronaria ventriculi.

All theſe ſmall veins ſometimes end ſeparately; and ſometimes part of them go into the vena portæ by ſmall common trunks. It ſometimes happens that ſeveral of them do not go immediately into the trunk of the vena portæ, but into one of the branches which form it.

The trunk compoſed of the two meſenterics and ſplenic veins, paſſing on, receives the vena gaſtrica, or gaſtro-epiploica dextra, and the coronaria ventriculi, but theſe often go into ſome of the larger branches.

The duodenal vein, commonly called *vena inteſtinalis*, goes into the great trunk near the cyſticæ, and ſometimes into the ſmall common trunk of theſe veins. It comes chiefly from the inteſtinum duodenum, and receives likewiſe ſome rami from the pancreas. There is another vein called alſo *duodenalis*, which terminates in the gaſtrica of the ſame ſide.

The vena pylorica terminates in the great trunk, almoſt oppoſite to the end of the cyſticæ, and ſometimes goes into the right gaſtrica. It paſſes over the pylorus from the ſhort arch of the ſtomach, where it is joined by anaſtomoſis with the coronaria ventriculi.

The cyſtic veins run along the veſicula fellis from its bottom to its neck; and as they are commonly no more than two in number, they are called *cyſticæ gemellæ*, a name given likewiſe to the arteries which accompany them. They go into the right ſide of the great trunk near its end, ſometimes ſeparately, ſometimes by a ſmall and very ſhort common trunk.

The ſmall hepatic vein is commonly a branch of one of the cyſticæ, or of their common trunk.

The large trunk of the vena portæ inferior or ventralis, is ſituated under the lower or concave ſide of the liver, and joined by an anaſtomoſis to the ſinus of the vena portæ hepatica, between the middle and right extremity of that ſinus, and con-

 ſequently

ſequently at a good diſtance from the left extremity. From thence it runs up a little obliquely from left to right, behind or under the trunk of the arteria hepatica, its length being about five fingers breadth.

At the head of the pancreas, this trunk may be ſaid to begin by the three branches already deſcribed.

The laſt portion of this vein may be termed *vena portæ hepatica*, ſuperior or minor, the trunk of which is commonly known by the name of *ſinus venæ portarum*. The other portion may be called *vena portæ ventralis*, inferior or major.

The vena portæ may be conſidered as made up of two large veins, joined almoſt endwiſe by their trunks, from each of which the branches and ramifications go out in contrary or oppoſite directions. One of theſe parts comes from the ſtomach and inteſtines, with the ſpleen and pancreas, and has been already deſcribed; the other goes to the liver.

## § 6. *Veins of the inferior Extremities.*

THE blood is returned from the inferior extremities by a ſuperficial and deep ſet of veins, in a manner ſomewhat ſimilar to that which we have deſcribed in the ſuperior extremities. Of the ſuperficial veins we find one called *ſaphena major*, and another called *ſaphena minor*. The deep veins have the ſame names with the arteries which they accompany.

*Vena ſaphena major.* This begins at the great toe, then runs between the firſt two metatarſal bones, irregularly under the ſkin towards the inner ankle.

At the great toe it receives a kind of tranſverſe arch over the metatarſus, which communicates by ſeveral branches with an arch lying on the joint of the tarſus, and gets others from the toes. This arch receives likewiſe another branch, which runs down behind the outer ankle, having communicated with the vena tibialis externa.

Under

Under the inner ankle it receives a branch inward and forward, which runs under, and in ſome meaſure accompanies, the anterior tibial artery. Interiorly, it receives another branch at the ſame place, which paſſes up from the ſole of the foot, communicating with the external tibial vein by irregular arches. This in its paſſage receives branches from the toes.

At the lower part of the tibia, the ſaphena receives a conſiderable branch, which runs obliquely from the outer ankle, being formed of ſeveral rami, which communicate with each other, and with the trunk of the ſaphena.

A little higher, it likewiſe receives from the fore-part of the tibia ſome branches coming from the perioſteum and bone, and communicating with other branches to be deſcribed.

Afterwards the trunk of the great ſaphena runs upon the inſide of the tibia, lying always near the ſkin; at the middle of the tibia, a vein forms an arch which communicates at both ends with the trunk of the large vein. A branch running up from the outer ankle along the integuments of the tibia, and communicating with the ſaphena, paſſes into this arch. At the upper part of the bone, it receives branches forward, outward, and backward.

The anterior branches come from the integuments on the upper part of the leg; the poſterior, from thoſe which cover the gaſtrocnemii, and communicate with the little ſaphena; and the external branches come from the fat and integuments.

From the leg the ſaphena paſſes along the inſide of the knee, and afterwards along the thigh, as far as the middle of the ſartorius muſcle; and here it receives from the ſame ſide ſeveral branches, which in their paſſage communicate with each other.

The vena ſaphena paſſes afterward to the fore-part of the thigh, having been covered in all its paſſage by ſkin and fat only.

only. At the groin it receives branches from the inguinal glands and neighbouring parts: theſe form free communications with each other. It opens at laſt into the top of the femoral vein.

*Vena ſaphena minor.* The vena ſaphena minor returns the blood from the outer ſide of the foot by many ſmall branches, which communicate freely with each other. From this part it runs up on the outſide of the tendo Achillis; and next between the gaſtrocnemius externus and ſkin.

Immediately above and below the ham, this vein receives branches, which likewiſe communicate with each other, and with the ſaphena major.

At the ham, a branch forms a communication between it and the crural vein, receiving ſmall anaſtomoſing branches in its aſcent. It terminates at laſt a little above the ham in the trunk of the vena poplitea.

*Vena tibialis anterior.* From the extremities of the anterior tibial artery, the correſponding vein returns, firſt by a number of origins: but theſe, at the bottom of the leg, unite into one trunk; which, however, ſoon ſplits again into two or three branches, that ſurround the artery at different diſtances by ſmall communicating circles. A particular branch which communicates with the vena tibialis poſterior, perforates the interoſſeous ligament from behind forward, and opens into the trunk of the vein at the bottom of the leg.

At the upper end of the leg the vein receives ſmall ſuperficial branches from the head of the tibia and fibula, which come from the joint of the knee, communicating there with lateral branches of the vena poplitea. It then perforates the head of the interoſſeous ligament, and terminates in the vena poplitea.

*Vena tibialis poſterior.* From the ſole of the foot the venæ plantares return after being formed of ſeveral tranſverſe arches, which communicate with each other and with the ſaphena,

and

and receive ramifications from the toes, nearly in the fame manner as the arteria plantaris.

The venæ plantares form a trunk, which paffes on the infide of the os calcis, and then behind the inner ankle as high as the ham. At the lower part of the leg, it communicates with a tranfverfe branch of the faphena, and with the anterior tibial vein, in the manner already defcribed; then receives branches from the mufculus tibialis pofticus and the long flexors of the toes.

Afterward the pofterior tibial vein runs up between the foleus and tibialis pofticus, receiving branches from each of them. It is formed fomewhat in the fame manner as the tibialis anterior, of two or three branches, which, as they run, furround the correfponding artery, by fmall communicating circles formed at different diftances.

It receives near its termination a branch, called *furalis*, from the gaftrocnemii and foleus; and opens at laft into the vena poplitea, a little lower than the tibialis anterior.

*Vena peronæa.* The vena peronæa is likewife double, and fometimes triple. It runs up on the infide of the fibula, almoft in the fame direction with the arteria peronæa, which it likewife furrounds at different diftances, by communicating branches after the manner of the tibialis pofterior, and like it, ends in the vena poplitea.

It runs up from the foot to near the joint of the knee, communicating feveral times with the tibialis pofterior, and receiving ramifications from the neighbouring portions of the mufculi peronæi and long flexors of the toes.

The firft of thefe communications make the venæ plantares, in fome fubjects, to appear rather to go into this vein, than into the tibialis pofterior, where they commonly terminate.

*Vena poplitea.* The vena poplitea, formed of the three large veins laft defcribed, but appearing to be a continuation of the tibialis pofterior, runs up immediately behind the mufcle of the

the ſame name; at the lower part of which it receives ſeveral ramifications from each ſide, which divide and unite again in different ways and degrees before they terminate.

Near the internal condyle of the os femoris, the poplitea receives ſome lateral branches from the extremities of the neighbouring muſcles, eſpecially thoſe of the ſemi-nervoſus, ſemi-membranoſus, &c. A branch which comes off from the trunk a little way below, and runs along the peroneus longus, likewiſe goes into it.

It alſo receives ſeveral other branches; one of which comes laterally between the outer condyle and the biceps, having been ramified in the ſame manner with the artery. Another branch runs up on the back-ſide of the gaſtrocnemii muſcles from the tendo Achillis; then it goes forward, receiving ramifications from the beginning of theſe muſcles. And now running up between the two condyles, it receives branches from the flexor muſcles of the leg, from the lower and poſterior parts of both vaſti, and from the fat which lies above the interſtice of the two condyles. A little above the ham, it gets the name of *crural vein*.

The crural vein runs up between the biceps and other flexors of the leg, cloſely accompanied by the crural artery; between which and the inner condyle of the os femoris it is ſituated. A little above the ham it receives the vena ſaphena minor from the back part of the leg. Near about the ſame place the crural vein ſends out a branch which runs up on the ſide of the trunk covering the crural artery, as high as the upper extremity of the vaſtus internus, where it is again united to the trunk by anaſtomoſes; but ſometimes this trunk takes its origin in the upper part of the leg.

It has the name of *vena ſciatica* from the ſciatic nerve which it accompanies. The trunk of the vein runs now up on the thigh behind the crural artery, till it gets oppoſite to the trochanter minor, where it receives the circumflexa externa, circumflexa

cumflexa interna, and profunda femoris ; the diftribution of which is fimilar to that of the correfponding arteries. In this courfe other fmall veins run in from different parts of the thigh; but thefe have no particular names.

About an inch below Poupart's ligament, the crural vein receives the faphena major; and then gets branches from the inguinal glands, the mufculus pectineus, and parts of generation. Thefe are termed *pudicæ externæ*, and evidently communicate with internal veins of the fame name. After this the trunk of the vein goes into the abdomen under Poupart's ligament, on the infide of the correfponding artery.

### § 7. *Veins of the Pelvis.*

*Vena iliaca externa.* After the crural vein gets from under Poupart's ligamentum, it is called *vena iliaca externa ;* this receives feveral fmall rami from the neighbouring lymphatic glands.

On the infide, after it gets into the abdomen, it receives the vena epigaftrica; which runs down along the back part of the mufculi recti, from which it chiefly comes; but receives alfo branches from the broad mufcles of the abdomen, which penetrate from without inwards : near its termination, it gets fmall branches from the conglobate glands.

The beginning of the vena epigaftrica runs downward, from the ramifications of the mammaria, with which it communicates, accompanying the epigaftric artery. At the infide of the epigaftric vein, a branch is fometimes received from the mufculus obturator internus, where a communication is alfo made with the vena obturatrix.

Near the end of the former vein, the iliaca externa receives a branch which comes down along the infide of the crifta of the

the os ilium; and admits others on each ſide, from the lateral and poſterior and lower portions of the muſculi abdominis, from the muſculus iliacus, &c. So that the external iliac vein, lying on the pſoas and iliac muſcles, receives almoſt the ſame branches with the artery of the ſame name, and follows the ſame courſe.

After admitting the branches already mentioned, the trunk of the vein joins a large vein from the cavity of the pelvis called *vena iliaca interna*, or *hypogaſtrica*.

*Vena iliaca interna.* The hypogaſtric or internal iliac vein, runs behind the artery of the ſame name, making the ſame kind of arch, into which the following branches open.

Of the branches which form the hypogaſtric vein, we find firſt a large branch running from the lower part of the os ſacrum, and two or more which come upward through the notch of the os ilium from the buttocks, anus, neighbouring portion of the muſculus pectineus, and from the external parts of generation, nearly in the ſame manner with the artery which accompanies them.

The veins that come from the anus, are termed *hæmorrhoidales externa*; and thoſe that come from the parts of generation, *pudicæ internæ*. The external hæmorrhoidales communicate with the internal veins of the ſame name, which go to the vena meſaraica, one of the branches of the vena portæ.

The hypogaſtric vein receives branches which come into the pelvis, above the ſuperior ſacro-ſciatic ligament; and before they come in, they are ramified chiefly upward and downward.

Within the pelvis it receives a large branch called *vena obturatrix*, which comes through the foramen thyroideum from the obturator muſcles, adductores femoris, and neighbouring parts.

The vena obturatrix, after it perforates the muſcles, receives branches exteriorly from the muſculus iliacus, the ſuperior part of the obturator internus, and from the os ilium, near its ſymphyſis with the os iſchium.

Interiorly, the ſame obturator vein receives another branch, which comes from the ureters, bladder, and internal parts of generation in both ſexes. It communicates with the ſpermatic veins, and is more conſiderable in women than in men.

Into the poſterior or convex part of the arch, the iliac vein receives a branch from the ſuperior lateral part of the os ſacrum, which comes from the muſculus ſacer, or lower part of the multifidus ſpinæ, and other muſcles near it, and from the cavity of the bone, paſſing through the firſt great hole.

A little lower, on the ſame ſide, it receives another, which comes much in the ſame manner with the former, through the ſecond hole.

Into the external lateral part of the ſame arch, a little anteriorly, it receives a large branch, which runs behind the great ſciatic ſinus, and comes from the muſculi glutæi, pyriformis, and gemelli. After receiving theſe different branches, it joins the external iliac vein.

*Vena iliaca communis.* The hypogaſtric vein, running up in the pelvis, joins the external iliac to form the common iliac vein, in the ſame manner that the iliac arteries are connected with the aorta; but the union is about a finger's breadth lower than the bifurcation of the aorta.

The external vein in adults ſeems to be in a line with the common iliac, and the hypogaſtrica only a branch; but in the fœtus there is a conſiderable variation.

Theſe veins follow nearly the courſe and diſtribution of the iliac arteries, except that the hypogaſtric vein does not receive the vena umbilicalis. The external iliac veins lie more or leſs on the inſide of the arteries, in the manner already ſaid; but the hypogaſtric veins, in the bottom of the pelvis, lie almoſt behind the arteries on the ſame ſide.

To the common trunk of the iliac veins, and ſometimes to the origin of the iliaca externa, a particular branch comes in from the muſculus pſoas, iliacus, and quadratus lumborum; ſome of which communicate with the laſt lumbar vein.

§ 8. *Veins on the Back-part of the Abdomen and Loins.*

The two common iliac veins unite to form the vena cava. Into this union, and often into the end of the left iliaca, the vena ſacra goes in, having accompanied the artery of the ſame name in its diſtribution to the os ſacrum, to the nerves which lie there, and to the membranes which cover both ſides of that bone.

The extremity of the trunk of the vena cava, lies in ſome ſubjects behind the origin of the right iliac artery; in others, it is the left iliac vein which paſſes there, and conſequently croſſes the right iliac artery. The cava paſſes up through the abdomen on the fore-part of the lumbar vertebræ, and on the right ſide of the aorta.

It receives poſteriorly the venæ lumbares; which commonly end in pairs, in the ſame manner as the correſponding arteries go out from the aorta. Theſe may be divided into ſuperior and inferior veins.

Their terminations vary in different manners. Sometimes the cava receives a branch from each ſide below the firſt vertebra of the loins, which, like a common trunk, receives the lumbar veins. This branch communicates with the azygos.

Sometimes a conſiderable branch comes into the lower extremity of the cava, near the union, chiefly on the right ſide; which, having run down between the bodies and tranſverſe apophyſes of the vertebræ, receives the venæ lumbares, and communicates with the azygos.

Sometimes a like branch goes to the beginning of the left vena iliaca; and having run down on that ſide in the ſame

manner,

manner, admits the lumbares. This branch likewife communicates with the azygos, and with the fuperior or defcending ramus lumbaris.

The venæ lumbares on one fide communicate by tranfverfe branches with thofe of the other fide, and likewife with each other by branches more or lefs longitudinal. The firft and fecond often go to the azygos, and thereby they communicate with the intercoftal veins.

The lumbar veins come from the mufcles of the abdomen, quadratus lumborum, pfoas, iliacus, &c. and they receive fmall branches in their paffage from the fubftance of the bodies of the vertebræ. They get branches forward from the neighbouring vertebral mufcles, and from the canal of the fpine, and communicate with the venal finufes in the fame manner as the intercoftals do.

Having got as high as the arteriæ renales, the vena cava receives the veins of the fame name, termed formerly *venæ emulgentes*, and which are the largeft of all the veins that go to the cava inferior, from the beginning to the part where it runs behind the liver.

The right renal vein is the fhorteft, and runs up a little obliquely, becaufe of the fituation of the kidney. The left vein, which is the longeft, croffes on the forefide of the trunk of the aorta, immediately above the fuperior mefenteric artery, and both veins accompany the renal arteries.

They receive the venæ capfulares which come from the glandulæ renales, and branches from the venæ adipofæ which come from the fatty covering of the kidneys; and ordinarily the left renal vein receives the left fpermatic vein.

A little below the renal veins, the trunk of the cava receives anteriorly the right vena fpermatica. The left fpermatic vein goes commonly, though not always, to the left renales. Both veins accompany the correfponding arteries.

In their paſſage, they receive ſeveral ſmall branches on each ſide, from the peritonæum and meſentery; where they ſeem to be joined by anaſtomoſes with the venæ meſeraicæ, and conſequently with the vena portæ.

They ſometimes bring a conſiderable branch over the iliac muſcle, which is formed of two others; one ramus runs down from the membrana adipoſa of the kidneys, the other runs up on the laſt mentioned muſcle.

About the ſame height with the ſpermatic vein, the inferior cava receives poſteriorly, in ſome ſubjects, a branch which runs downward, after communicating with the vena azygos. Sometimes this branch goes into one or other of the renales, and appears to be a true continuation of the extremity of the azygos.

Behind the liver the vena cava receives the venæ diaphragmaticæ or phrenicæ, which come from the diaphragm, and appear chiefly on its lower ſide, one towards the right hand, the other towards the left. The right vein is more backward and lower than the left. The left comes partly from the pericardium, and partly from the diaphragm; and ſometimes they receive rami from the capſulæ renales, which correſpond with branches ſent out by the arteriæ phrenicæ.

The inferior cava paſſes next through the poſterior part of the great fiſſure of the liver, penetrating a little into the ſubſtance of that viſcus, between the great lobe and the lobulus Spigelii; being, however, covered but very little, on the backſide, by the ſubſtance of the liver, after it reaches the lobulus.

In its paſſage, it receives commonly three large branches, called *Venæ hepaticæ*, which are ramified in the liver. Sometimes there are only two, and ſometimes four.

Beſides theſe large branches, it receives ſome other ſmall ones, either before, or immediately after it enters the liver; which,

TAB. XV.


D. Lizars Sculp.t

which, according to ſome anatomiſts, anſwer to the branches of the hepatic artery, as the large branches do to thoſe of the vena portæ.

In the fœtus, as the vena cava paſſes by the liver, it receives the ductus venoſus, which communicates with the ſinus of the vena portæ, and in adults is changed to a flat ligament.

The vena cava having received theſe branches, perforates the tendinous portion of the diaphragm and the pericardium; and, running about a quarter of an inch within the pericardium, opens into the under part of the right auricle.

## EXPLANATIONS of TAB. XV. and XVI.

### TAB. XV. *Repreſents the Heart and Blood-veſſels.*

*A*, The heart.

*B*, The aorta aſcendens.

*C*, A trunk from which the right ſubclavian and right carotid arteries are ſent off. (Thoſe on the left ſide come off ſeparately.) The ſubclavian artery paſſes over to the arm behind the ſubclavian vein. The carotid artery runs up to the head, partly covered by the internal jugular vein.

*D*, The facial artery, which ſends off the coronary arteries of the lips.

*E*, The deep temporal artery.

*F*, The deſcending aorta.

*G*, The right common iliac artery, which divides into the external and internal iliacs.

*H*, The femoral artery, which is a continuation of the external iliac artery.

*I*, The anterior tibial artery, ſending branches to the forepart of the leg and upper part of the foot.

1. The

1, The frontal vein running down to form
2, The facial vein.
3, Deep temporal vein.
4, Occipital vein.
5, The external jugular vein.
6, The internal jugular vein, lying on the outer and fore part of the common carotid artery.
7, An arch on the palm of the hand, which runs partly to
8, The radial vein, and partly to
9, The ulnar vein. The two laſt veins run cloſe by the ſides of their correſponding arteries.
10, The cephalic vein.
11, The baſilic vein cut. On the left ſide it is entire.
12, Branches running up to form
13, The humeral vein.
14, The external thoracic veins running along with their arteries. [N. B. In many parts, the veſſels are ſo ſmall, that one trunk muſt repreſent both artery and vein.]
15, The axillary vein.
16, The ſubclavian vein, receiving the jugular and other veins from the head and neck.
17, The vena cava ſuperior.
18, Veins from the upper part of the foot, forming
19, The anterior tibial vein, which lies cloſe by the ſide of the correſponding artery.
20, The venæ profundæ femoris.
21, The upper part of the vena ſaphena.
22, The femoral vein.
23, The common iliac veins, formed of the external and internal iliacs.
24, Vena cava inferior.
25, The renal veins covering the arteries.
26, The diaphragmatic veins.

TAB.

TAB. XVI.


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TAB. XVI. *Exhibits a Back-view of the Blood-veſſels.*

*A*, The occipital veſſels.
*B*, The deep temporal veſſels.
*C*, The cervical veſſels.
*D*, The ſcapulary veſſels.
*E*, *F*, Deep humeral branches communicating with others at the elbow.
*G*, The poſterior interoſſeous veſſels.
*H*, Intercoſtal veſſels.
*I*, Arteriæ and venæ gluteæ.
*K*, Sciatic veſſels.
*L*, Arteria et vena poplitea.
*M*, Poſterior tibial veſſels.
*N*, Fibular veſſels.

N. B. The veſſels being ſo ſmall, both vein and artery are repreſented by one trunk.

## CHAP. VII.

### *Of the* ABSORBENT SYSTEM.

FOR the diſcovery of the principal parts of this ſyſtem, we are chiefly indebted to Aſellius, Pecquet, Rudbeck, Jolyffe, and Bartholine. Some of the veſſels of which it conſiſts had indeed been ſeen and mentioned by their predeceſſors, but it was in too curſory a manner to give them any title to the diſcovery. Thus the lacteals had been ſeen in kids by Eraſiſtratus, who calls them *arteries*, as we are informed by Galen: And

And the thoracic duct had been feen by Euftachius, who fpeaks of it as a vein of a particular kind; (fee Euftachius *de Vena fine Pari.*)

In 1622, Afellius difcovered thofe veffels on the mefentery, which, from their carrying a milk-like fluid, he denominated *lacteals*. This difcovery being made by opening a living dog, anatomifts were thence encouraged to make experiments on living animals; and Pecquet, on opening a dog in the year 1651, found a white fluid mixed with the blood in the right auricle of the heart. Sufpecting this fluid to be chyle, he endeavoured to determine how it got from the lacteals into the heart: this he found was by means of the ductus thoracicus, which he traced from the lacteals to the fubclavian vein; and thus he clearly proved the exiftence of that duct which we now confider as the trunk of the fyftem. Juft before this time the lacteals had been fuppofed to terminate in the liver; conformably to the idea which the phyfiologifts of that period had adopted about the ufe of this organ, which from the authority of the older anatomifts, they believed was the vifcus hæmato-poeticum.

In the years 1651 and 1652, Rudbeck, Jolyffe, and Bartholine, difcovered the other parts of this fyftem, which, from their carrying a tranfparent and colourlefs fluid, are called the *lymphatic veffels*.

After this period, Nuck, by his injections of the lymphatic glands; Ruyfch, by his defcription of the valves of the lymphatic veffels; and Dr Meckel, by his accurate account of the whole fyftem, and by tracing thofe veffels in many parts where they had not before been defcribed, greatly increafed our knowledge of this fyftem.

Befides thefe authors, Drs Monro and Hunter have called the attention of the public to this part of anatomy, in their controverfy concerning the difcovery of the office of the lymphatics.

When

When the lymphatic veſſels were firſt ſeen and traced into the thoracic duct, it was natural for anatomiſts to ſuſpect, that as the lacteals abſorbed from the cavity of the inteſtines, the lymphatics, which are ſimilar in figure and ſtructure, might poſſibly do the ſame office with reſpect to other parts of the body: and accordingly, Dr Gliſſon, who wrote in 1654, ſuppoſed theſe veſſels aroſe from cavities, and that they were abſorbents; and Frederic Hoffman has very explicitly confirmed the doctrine. But anatomiſts in general were of a contrary opinion; for from experiments, particularly ſuch as were made by injections, they thought, that the lymphatic veſſels did not ariſe from cavities, and did not abſorb, but were merely continuations from ſmall arteries. The doctrine, therefore, that the lymphatics, like the lacteals, were abſorbents, as had been ſuggeſted by Gliſſon and by Hoffman, has been revived by Drs Monro and Hunter, who have controverted the experiments of their predeceſſors in anatomy, and have endeavoured to prove that the lymphatic veſſels are not continued from arteries, but are abſorbents.

To this doctrine, however, ſeveral objections have been ſtarted, particularly by Haller, (Elem. Phyſ. l. 24. § 2, 3.); and it has been found, that before the doctrine of the lymphatics being a ſyſtem of abſorbents can be eſtabliſhed, it muſt firſt be determined, whether this ſyſtem is to be found in other animals, beſides man and quadrupeds. Dr Monro and Mr Hewſon claim the merit of having proved the affirmative of this queſtion, by diſcovering the lymphatic ſyſtem of birds, fiſh, and amphibious animals. See Phil. Tr. v. 58. and 59. See alſo Monro on Fiſhes.

## Section I. *Of the Abſorbent Syſtem in general.*

The abſorbent ſyſtem conſiſts of the lacteals, the lymphatic veſſels, the thoracic duct, which is their common trunk, and the glands called *conglobate*.

The lacteals begin from the inteftinal tube, and can for the moft part be feen in a dog or other large quadruped that is killed two or three hours after eating, when they appear filled with a white chyle: but they do not always convey a fluid of this colour; for, even in a dog, if opened long after a meal, they are found diftended with a liquor that is tranfparent and colourlefs like the lymph; and in birds the chyle is never found white, but always tranfparent; thefe veffels, therefore, might, with as much propriety, be called the *lymphatics of the inteftines.*

The lymphatic veffels are fmall pellucid tubes that have now been difcovered in moft parts of the human body: the fluid they contain is generally as colourlefs as water; a circumftance which procured them at firft the name of *ductus aquofi*, and afterwards that of *vafa lymphatica.* The courfe of the lymph, like that of the chyle, is from the extreme parts of the body towards the centre, and many of the lymphatic veffels lie clofe to the large blood-veffels. If therefore a ligature be made on the blood-veffels of the extremities of a living animal, or of one juft dead, that ligature, by embracing the lymphatics, will ftop the courfe of the lymph, which by diftending the veffels will make them vifible below the ligature.

All the lacteals, and moft of the lymphatic veffels, open into the thoracic duct, which lies upon the fpine, and runs up towards the neck of the animal, where it commonly opens into the angle between the internal jugular and fubclavian veins of the left fide; and thus both the chyle and lymph are mixed with the blood. If therefore a ligature be made on the thoracic duct immediately after killing an animal, not only the lacteal, but alfo the lymphatic veffels, in the abdomen and lower extremities, become diftended with their natural fluids, the courfe of thofe fluids being ftopped by the ligature.

The lacteals, the lymphatics, and the thoracic duct, have their coats thinner and more pellucid than thofe of the blood-

veffels.

veſſels. But although their coats are ſo thin, they are very ſtrong, as we daily ſee on injecting them with mercury, ſince they reſiſt a column of that fluid, the weight of which would burſt the blood veſſels.

The thinneſs of the coats prevents our dividing them from one another, and thereby aſcertaining their number, as we do thoſe of the blood-veſſels. But as the blood-veſſels have a denſe internal coat to prevent tranſudation, we have reaſon to believe the lymphatics have the ſame. And as the blood-veſſels have a muſcular coat, which aſſiſts in the circulation; ſo may the lymphatics. This is rendered probable from what Dr Haller ſays of his having found them irritable in his experiments, and alſo from what is obſerved on ſeeing them in living animals diſtended with their lymph, in which caſe they appear of a conſiderable ſize; but upon emptying them, they contract ſo much as not to be eaſily diſtinguiſhed. This experiment, Mr Hewſon informs us, he frequently made in the trunk of the lacteals in a gooſe, and on the lymphatic veſſels on its neck; both of which, when diſtended with their natural fluids, are as large as a crow-quill; but, upon emptying them in the living animal, he has ſeen them contract ſo much that it was with the greateſt difficulty he could diſtinguiſh them from the fibres.

The coats of the lymphatic veſſels have, in common with all other parts of the body, arteries and veins, for their nouriſhment. This is rendered probable by their being ſuſceptible of inflammation; for they are frequently found in the form of a cord, painful to the touch, and extending from an ulcer to the next lymphatic gland. Theſe painful ſwellings of lymphatic veſſels likewiſe ſhow that their coats have ſenſibility, and therefore that they have nerves as well as arteries and veins. Beſides, we can clearly trace, in different parts of the body, blood-veſſels running along their ſurfaces.

The lymphatic ſyſtem in moſt animals, but particularly in man and quadrupeds, is full of valves. Thefe valves have been painted by the celebrated Nuck, Ruyfch, and others, and are much more frequent than in the common veins, and thence thefe lymphatics have fometimes been diftinguifhed by the name of *valvular lymphatic veffels*. Thefe valves are generally two in number, are of a femilunar fhape, and the one is fometimes much larger than the other. In moft parts of the body thefe valves are fo numerous, that there are three or four pair in an inch, but fometimes there is no more than one pair, and fometimes feveral inches appear without a valve. They are lefs numerous in the thoracic duct than in the branches of the fyftem; thence it might be fuppofed, that in proportion as we go from the trunk to the branches, we fhould find them in greater number: but this is not always true, for Mr Hewfon obferved them more numerous in the lymphatic veffels of the thigh than on thofe of the leg. When the veffels are diftended with lymph, they appear larger on that fide of the valves next the heart; which fometimes gives a lymphatic veffel an appearance of being made of a chain of veficles: as fuch they are reprefented by fome authors; but it is an appearance that very feldom occurs in the human body. In quadrupeds, however, this appearance is very remarkable. Wherever a lymphatic veffel enters the thoracic duct or a red vein, we find either one or two valves which prevent the return of the lymph, or hinder the blood from getting into the lymphatic.

Laftly, the lymphatic fyftem, in different parts of its courfe, has the glands called *conglobate* or *lymphatic*. Thefe glands are fo placed, that the veffels come in on one fide, and pafs out on the other, in their way to the thoracic duct. They are commonly of an oval, though fometimes of a round form, and frequently fomewhat flattened, and of various fizes, fome being no larger than a millet feed, while others are almoft an inch in diameter. They vary in colour in different parts of the body, and at different times of life. In young people they

they are generally of a reddifh or brown colour; but become paler with age: They have a fhining external furface, which is owing to a fmooth denfe coat that covers them. Like other glands, they have arteries, veins, and nerves, which enter into their compofition: but with refpect to the reft of their ftructure, anatomifts are much divided in opinion; fome endeavouring to prove that they are formed of cells, while others of equal credit confider them as a collection of veffels. Before the difcovery of the lymphatic veffels in birds, fifh, and turtle, fome anatomifts have confidered thefe glands as fo effentially neceffary to the lymphatic fyftem, that they have generally fet about difcovering the veffels by firft looking for the glands: and wherever they found glands, they pronounced that there muft be veffels; and when no glands could be feen, they thought it as certain a proof of there being no veffels. But that the glands are wanting in fome animals, is now generally known.

## Section II. *A particular Defcription of the Abforbent Syftem in the Human Body.*

The abforbent fyftem, befides the glands, is divided into three parts, viz. The lacteals, the lymphatic veffels, and the thoracic duct. The lacteals belong to the inteftinal tube; the lymphatics, to all the other parts of the body; and the thoracic duct is the common trunk which receives both the lacteals and lymphatics. We fhall give a particular defcription of thefe, chiefly from Hewfon, Mafcagni, and Cruikfhank, by whofe induftry this part of anatomy has been fo greatly illuftrated.

### § 1. *Lymphatic Veffels of the Lower Extremities.*

These may be divided into two kinds, viz. a fuperficial, and a deep-feated.

The fuperficial lymphatics confift of numerous veffels that lie between the fkin and the mufcles, and belong to the furface

face of the body or the ſkin, and to the cellular membrane which lies immediately under it. Numerous large branches of them can be readily enough diſcovered in the limbs of dropſical ſubjects. Many of them run upon the top of the foot; one of them is repreſented Plate XVII. fig. 1. (10); others are generally to be found juſt under the inner ankle; tubes have been introduced into two of them, whereby they have been filled the whole length of the lower extremity, as is ſeen in this figure.

The greater number of ſuperficial lymphatics accompany the vena ſaphena major. They can be firſt traced from the toes, where they run ſomewhat like the arteries and veins. A plexus, conſiſting of ſeveral veſſels, runs over the top of the foot with the ſaphena to the inner ankle, and from thence upwards to the inner ſide of the knee. Here they are joined by another plexus which ariſes from the ſole, and paſſes up on the inner and back part of the leg. A third plexus ariſes from the outer-ſide of the foot, and runs by the outer ankle. Upon the outer part of the leg, theſe ſplit into two diviſions; one of which croſſes obliquely over the fore-part of the leg to the lymphatics, at the inner ſide of the knee, while the remaining part accompanies the vena ſaphena minor, and runs to the glandulæ popliteæ. From the inſide of the knee a plexus runs up, conſiſting of from a dozen to twenty trunks, which paſs afterwards on the anterior and inner ſide of the thigh to the inguinal glands. In their paſſage they receive branches from the outer and back parts of the thigh; but theſe are few in number when compared with the reſt.

The lymphatic glands of the groin are ſix, ſeven, eight, or upwards; they vary much in number: Of theſe, ſome lie in the very angle between the thigh and the abdomen, and others lie a few inches down on the fore-part of the thigh. The lymphatic veſſels, above-deſcribed, enter the lowermoſt of theſe glands, which in the ſubject of this figure are four in number,

number, viz. (15, 15; 16, 16.) One or more of thefe branches, however, frequently avoids the glan ds, as at 17); which afterwards bends over it at (18) to the gland (19); from which veffels go to the other lymphatic glands (20, 20) that lie in the angle between the thigh and the abdomen, and fometimes a few enter no glands till they reach thofe on the infide of Poupart's ligament.

Numerous lymphatics alfo pafs into the inguinal glands from the fuperficial parts of the abdomen and pelvis. See Mafcagni, Tab. iii.

It is into thefe upper glands alone that the lymphatic veffels of the genitals enter, fo that the venereal bubo, which arifes in confequence of an abforption of matter from the organs of generation, is always feated in thofe upper glands, and the lower glands (15, 15; 16, 16), are never affected, except by the regurgitation of the matter, or from their vicinity to the glands firft difeafed, which very feldom happens. And, as the upper glands are affected by the abforption of matter from the genitals, fo the lower are commonly firft affected from the abforption of the acrid matter of an ulcer, difeafed joint, or carious bone, in the parts below thefe glands; a circumftance that may affift us in the diagnofis of thefe two kinds of buboes: Remembering, however, that this rule may be liable to an exception from one or more of the lymphatic veffels paffing the lower glands, and only entering at the upper, as is feen at (17) in the fame figure.

In the penis three principal veffels commonly take their origin from the prepuce. Thefe foon unite, but afterwards feparate upon the middle of the dorfum penis into two parts; one of which goes to the inguinal glands on the right fide, the other to thofe of the left.

The deap-feated lymphatics arife from the glands and body of the penis, and accompany the arteries into the lower part of the pelvis. Hence if venereal matter be abforbed by thefe

veffels,

veſſels, the conſtitution may be affected without our being aware of it.

The lymphatic veſſels of the teſticle are numerous and very large for the ſize of this organ. They ariſe from its coats, from the body of the teſticle, and from the epididymis; and after running along the ſpermatic cord, they terminate in the lumbar glands. In their courſe they have few communications with each other.

The lymphatics of the ſcrotum, which are alſo numerous, go chiefly to the glands of the groin, though ſome paſs along with thoſe of the teſticle to the lumbar glands.

The lymphatic veſſels of the penis and ſcrotum having joined thoſe of the thigh, a net-work is formed, which enters the abdomen under the edge of the tendon of the external oblique muſcle, called *Poupart's ligament:* one of theſe veſſels is ſeen in Tab. XVIII. (24). This plexus on the inſide of Poupart's ligament conſiſts of many branches; ſome of which embrace the iliac artery, of which one is ſeen in (27) *ibid.* but the greateſt number of them paſs up on the inſide of the artery, as is ſeen at (21, 22) Tab. XVII. fig. i. and at (27) Tab. XVIII.

The ſuperficial lymphatics of the inferior extremity are the trunks of thoſe veſſels which abſorb from the ſkin and the cellular membrane immediately under it; but they likewiſe communicate with the deep-ſeated abſorbents: and the ſame thing is to be obſerved with reſpect to the lymphatics on all the other parts of the ſurface of the body.

Upon theſe veſſels, from the foot to the groin, there are commonly no other lymphatic glands than thoſe of the ham. But this rule has likewiſe ſome exceptions: For, even at the lower part of the leg, there is a very ſmall one in the ſubject from which this plate was taken, as repreſented at (13), Tab. XVII. fig. i. and in another ſubject Mr Hewſon ſaw a ſmall lymphatic gland near (14); from which it may be concluded,

that

that the lymphatic glands, even in the human body, are in number and ſituation different in different ſubjects.

Beſides theſe ſuperficial lymphatic veſſels which lie above all the muſcles, or in the cellular membrane under the ſkin, there are others deeper ſeated, that lie among the muſcles and accompany the arteries; and like the veins, one lies on each ſide of the artery. Of theſe the principal trunks can be diſcovered by cutting down to the poſterior tibial artery, near the inner ankle. By introducing tubes into theſe parts they may be injected; as has been done in ſeveral ſubjects, one of which is repreſented Tab. XVII. fig. ii.

From the inner ankle at (13) *ibid*, theſe veſſels paſs up along with the poſterior tibial artery, being hid among the muſcles on the back part of the tibia. About the middle of the leg they ſometimes, though rarely, enter a ſmall gland at (15), which has been ſuppoſed to exiſt more frequently than it really does. Afterwards they are ſeen in the back-part of the ham, ſtill lying cloſe to the artery, and in the ham they paſs through two or three glands which are commonly found there, viz. (18, 19, 20). But after they have paſſed theſe glands, they commonly divide into two or three branches, which accompany the crural artery, and paſs with it through the perforation in the triceps muſcle. Beſides theſe, ſimilar, though ſmaller lymphatics, accompany the anterior tibial and the fibular artery; theſe run likewiſe to the glands of the ham The muſcle is divided in the preparation from which this figure was taken, in order to give a better view of the lymphatics; and the cut ends of the muſcle appear at (6, 6), though not very diſtinctly, from their being ſhrunk by drying. The lymphatic veſſels having perforated the triceps, paſs up with the artery, as is ſeen at (22, 23), and ſometimes enter a gland (24), which is deeper ſeated than thoſe that appear in the groin: From this gland they paſs into the ſuperficial glands, repreſented at (15, 15; 16, 16), where the lymph of the deep-ſeated and of



the

the ſuperficial lymphatics is mixed, and is conveyed into the body by the veſſels ſeen juſt above in the ſame figure. At this part likewiſe the lymph from the penis and ſcrotum is mixed with that brought by the two ſets of lymphatics from the lower extremities; and the whole enters the abdomen, under Poupart's ligament, by the plêxus of veſſels repreſented fig. i. at (21), and in a part of it at Tab. XVIII. (24).

Tab. XVII. fig. i. repreſents the lower extremity, with its more ſuperficial lymphatic veſſels, N° (1) is the ſpine of the os ilium, (2) the os pubis, (3) the iliac artery, (4) the knee. The other references have been explained in the courſe of the deſcription.

Fig. ii. gives a back view of the lower extremity, diſſected ſo as to ſhew the deeper-ſeated lymphatic veſſels which accompany the arteries. (1) The os pubis. (2) The tuberoſity of the iſchium. (3) That part of the os ilium which was articulated with the os ſacrum. (4) The extremity of the iliac artery appearing above the groin. (5) The knee. (6, 6) The two cut ſurfaces of the triceps muſcle, which was divided to ſhew the lymphatic veſſels that paſs through its perforation along with the crural artery. (7) The edge of the muſculus gracilis. (8) The gaſtrocnemius and ſoleus, much ſhrunk by being dried, and by the ſoleus being ſeparated from the tibia to expoſe the veſſels. (9) The heel. (10) The ſole of the foot. (11) The ſuperficial lymphatic veſſels paſſing over the knee to the thigh. (12) The poſterior tibial artery. (13) A lymphatic veſſel accompanying the poſterior tibial artery. (14) The ſame veſſel croſſing the artery. (15) A ſmall lymphatic gland through which this deep-ſeated lymphatic veſſel paſſes. (16) The lymphatic veſſel paſſing under a ſmall part to the ſoleus, which is left attached to the bone, the reſt being removed. (17) The lymphatic veſſel croſſing the popliteal artery. (18, 19, 20) Lymphatic glands in the ham, through which the lymphatic veſſel paſſes. (21) The lymphatic veſſel paſſing with the crural

TAB. XVII.

FIG. I.

FIG. II.

FIG. III.

FIG. IV.

D. Lizars Sculp.t

ral artery through the perforation of the triceps muſcle. (22) The lymphatic veſſel, after it has paſſed the perforation of the triceps, dividing into branches which embrace the artery (26). (24) A lymphatic gland belonging to the deep-ſeated lymphatic veſſel. At this place thoſe veſſels paſs to the fore-part of the groin, where they communicate with the ſuperficial lymphatic veſſels. (25) A part of the ſuperficial lymphatic veſſels appearing on the brim of the pelvis.

## 2. *Abſorbent Veſſels of the Trunk.*

The lymphatics of the lower extremities having now reached the trunk of the body, and having paſſed under Poupart's ligament, appear upon the ſides of the oſſa pubis near the pelvis at (24, 24) Tab. XVIII. A part of them paſſes up along with the iliac artery upon the brim of the pelvis; and another part dips down into the cavity of the pelvis, and joins the internal iliac artery near the ſciatic notch. At this place they are joined by the lymphatics from the contents of the pelvis, particularly from the bladder and the veſiculæ ſeminales in the male, and from the uterus in the female; and there are likewiſe ſeveral branches which paſs through the ſciatic notch from the neighbourhood of the glutæi muſcles. The lymphatic veſſels of the uterus, like its blood-veſſels, are much enlarged, and therefore eaſily diſtinguiſhed, in the pregnant ſtate of that organ. They are in two ſets; one runs along with the hypogaſtric arteries and veins; the other with the ſpermatic veſſels. The lymphatics of the external parts of generation in the female go partly to the inguinal glands of each ſide, and partly through the rings of the external oblique muſcles to terminate in the glands of the loins or pelvis. At this part, where ſo many lymphatic veſſels join, there are commonly one or two glands.

Befides thofe lymphatic veffels which dip down into the cavity of the pelvis on the infide of the external iliac artery at (27, 27), there are others which keep on the outfide of that artery upon the pfoas mufcle, fome of which are feen on the left fide in the fame plate at (28.) Of thefe, one part paffes up to the loins at (32), and goes under the aorta in different branches, getting from the left fide to the right, and joining the thoracic duct. Another part paffes under the iliac arteries, and appears upon the os facrum at (30) making a beautiful net-work, joining the lymphatics of the right fide, and paffing under the iliac artery, to form the net-work (31) upon the upper part of the right pfoas mufcle. In different parts of this courfe from Poupart's ligament to the loins, and alfo in the loins themfelves, there are, in moft fubjects, many lymphatic glands; none of which were filled in the fubject from which this plate was made.

The lymphatic veffels of the right fide, joined by fome from the left, having now reached the right lumbar region, appear there in the form of a plexus of large veffels, and pafs through feveral glands, which occupied the fpaces (33, 33, 33), but not being injected in the fubject, they are not reprefented. At this part likewife they receive large branches, under the aorta, from the plexus on the left fide of the loins, as is mentioned before; and having at laft got up as high as the fecond, or more frequently the third, lumbar vertebra, they all join, and form a fingle trunk called the *thoracic duct*, which is feen at (36). At this part they are likewife joined by the lacteals, which fhall be next defcribed.

The lacteal veffels, fo called from their commonly conveying a fluid that is of the colour of milk, are found in two fets which communicate with each other; the internal begin from the inner furface of the inteftines, where each lacteal is at firft formed upon the furface of the villi by numerous fmall radiated branches, with orifices deftined to imbibe the nutritious fluid

fluid or chyle: From the cavity of the inteftines thefe veffels pafs obliquely through their coats, uniting as they go, fo as to form larger branches. They follow the courfe of the arteries and the veins, and are double their number; one being fituated on each fide. Thefe branches run on the outfide of the gut to get to that part which is next the mefentery; and, whilft they are yet upon the gut, they are fometimes of a fize fufficient to admit a fmall pipe, fo that they have been frequently injected with mercury in the human fubject. And in man, as well as in different animals, the external fet appear between the peritonæal and mufcular coat, and commonly run for a confiderable way in the fame direction with the inteftine.

From the inteftines they run along the mefentery and mefocolon, towards the fpine; paffing through the lacteals in their way to the conglobate or mefenteric glands. Thefe glands divide the lacteals into two regions: from the inteftines to the glands thefe veffels are called *lactea primi generis;* and from the glands to the thoracic duct, *lactea fecundi generis.* (*See* Sheldon on the Abforbent Syftem).

The lacteals of the *jejunum* are larger and more numerous than thofe of the *ilium.* Thofe of the fmall inteftines, as they run upon the mefentery, commonly accompany the fuperior mefenteric artery, and unite, as they proceed, into larger branches; fo that by the time they arrive at the root of the mefentery, they are of a confiderable fize, as may be feen at (34) From the mefenteric artery they defcend by the fides of the aorta, and open at laft into the thoracic duct (36): the lacteals, or rather the lymphatics of the large inteftines, run fomewhat differently. Thofe from the cæcum, and from the right part and great arch of the colon, join the trunks of the lacteals of the fmall inteftines about the root of the mefentery, whilft thofe from the reft of the colon terminate in the lumbar glands, or lower part of the thoracic duct, accompany the inferior mefenteric artery, and communicate with the large lymphatic veffels near its root.

Into the thoracic duct at (36), likewife enters the lymph of the other abdominal vifcera. This is brought by a number of veffels, which in all the vifcera run in a fuperficial, and in a deep fet, a plexus of them may be traced from each kidney, lying principally behind the emulgent artery, and opening into large lymphatic veffels near the aorta. The lymphatics of the kidney are feldom feen in the found ftate of that vifcus; but when it is enlarged or ulcerated, they are fometimes diftinctly obferved: they run from its outer towards its inner edge, and immediately afterwards they pafs through the glands of the loins. The lymphatics of the glandulæ renales, or renal capfulæ, likewife terminate in the renal plexus.

The lymphatic veffels of the fpleen pafs from the concave fide of that vifcus, along with the fplenic artery in the finuofity of the pancreas, by the lymphatic veffels of which they are joined. The deep-feated lymphatics of the fpleen are very confiderable, and can be readily feen at its concave edge, but thofe on its furface are fmall and few in number; in quadrupeds, however, as in the bullock, they are remarkably numerous and large.

Two fets of lymphatic veffels belong to the ftomach, the one running upon its leffer, and the other upon its greater curvature. Of thefe, the former accompanies the coronary artery, and paffes through fome lymphatic glands that lie by its fides. The other fet paffes from the great curvature of the ftomach, partly to the left and partly to the right fide. Thofe on the left fide receive the lymphatics of the left half of the great omentum, and run with the lymphatics of the fpleen and pancreas to the thoracic duct. Thofe on the right fide, receive the lymphatics from the right half of the great omentum, and pafs through fome lymphatic glands that lie clofe to the arteria gaftrica dextra. Defcending by the pylorus, they meet the plexus that accompanied the coronary artery; and near the leffer curvature of the duodenum, form a confiderable net-work. Into this not only the lymphatics from

from the ſpleen enter, but likewiſe thoſe from the gall-bladder, together with the deep-ſeated lymphatics of the liver. Several branches proceed from this net-work; ſome running under the duodenum, and others over it; which all open into the thoracic duct, near the termination of the large trunk of the lacteals, as ſeen at (36). The thoracic duct is therefore the common trunk which receives the abſorbent veſſels of the lower extremities, the lacteals, and the lymphatics of the abdominal viſcera.

The lymphatics of the liver, like thoſe of the other viſcera, are in two ſets; one which lies upon the ſurface of the organ, and the other which accompanies the large blood-veſſels in its centre. Here theſe two ſets are found to communicate with each other very freely; ſo that, by injecting mercury into the lymphatic veſſels which lie upon its convex ſurface, we may fill thoſe which accompany the pori bilarii and vena portarum in its centre. Moſt of the lymphatic veſſels which lie upon the convex ſurface of the liver, run toward its falciform ligament, and paſs through the diaphragm into glands which are ſituated on the anterior part of the pericardium. But others of them run towards the lateral ligaments of the liver, where they paſs alſo through the diaphragm, and afterwards run on its upper ſurface, to join thoſe from the ligamentum latum. This is the common courſe of the abſorbents on the convex ſide of the liver; but there is great variety.

From the glands above mentioned, a large trunk runs up behind the ſternum, between the laminæ of the anterior mediaſtinum, and commonly joins the thoracic duct near its termination. Sometimes, however, inſtead of finding one trunk behind the ſternum, we meet with two or more on each ſide of the thorax, accompanying the internal mammary veſſels; thoſe of the left ſide ending in the thoracic duct; thoſe in the right going into the lymphatic trunk in that ſide of the neck.

The lymphatics on the concave ſurface run towards the portæ, where they join thoſe which come from the centre of the

the liver along with its large blood-veſſels. After they get from the liver, they are found to be very numerous. They paſs into glands on the vena portarum; and afterwards end in the thoracic duct, near the root of the ſuperior meſenteric artery. It is remarkable, that the valves of thoſe lymphatic veſſels which run upon the ſurface of the liver, can readily be made to give way, ſo that they may be injected from their trunks to their branches, with great minuteneſs.

It has been ſuggeſted by Dr Meckel, that the lymphatics of the ſtomach do not open into the thoracic duct like thoſe of the other viſcera, but into the ſanguiferous veins of the ſtomach. From repeated diſſections of the human ſubject, Mr Hewſon has, however, been convinced of the contrary, and likewiſe from analogy with other animals, particularly fiſh, whoſe lymphatic veſſels either have no valves, or the valves readily give way; ſo that he has repeatedly puſhed injections from the thoracic duct into the lymphatics of their ſtomachs, as he has alſo done into the lymphatics of the other viſcera contained in the cavity of their abdomen.

The thoracic duct, which receives all the veſſels that we have yet deſcribed, differs in its ſize in different ſubjects; but it is always ſmaller in its middle than at its beginning, as is ſeen in the plate. Sometimes its lower part (36) is ſtill larger in proportion than is there repreſented: and that enlargement has been called *receptaculum chyli;* it is conſiderable in ſome quadrupeds, in turtle, and in fiſh: but many anatomiſts have denied that there is any part of the thoracic duct in the human ſubject that deſerves the name of *receptaculum,* having never ſeen any thing like a pyriform bag, as it has been deſcribed, but merely an enlargement not unlike a varix, and that only in few ſubjects; it generally appears only a little larger at its middle than at its ends. This lower extremity of the thoracic duct is formed by the union of two or three very large trunks of lymphatic veſſels. The firſt and ſecond are formed by the

lymphatics

lymphatics of the inferior extremities, and other parts already defcribed; the third belongs chiefly to the lacteals. Thefe large veffels unite fo as to form the duct over the third vertebra lumborum, reckoning from above downwards. Upon the fecond vertebra of the loins, the union of thefe veffels is fometimes twice or thrice as large in diameter as the duct is higher up; at other times little or no enlargement can be obferved.

Thefe large lymphatic trunks which form the thoracic duct are fpread out upon the fpine, thofe of the right fide lying below the right crus diaphragmatis, and thofe of the left paffing between the aorta and the fpine; whilft the thoracic duct itfelf lies at firft behind the aorta; but afterwards paffes from that upwards, and a little to the right fide, till it gets before the firft vertebra of the loins. Here it is fituated behind the right crus of the diaphragm, where it enlarges again; and fometimes forms a pyriform bag, which has been confidered by authors as the beginning of the duct. From this part it paffes upwards, being at firft covered by the crus diaphragmatis, and afterwards appears at (38) in the thorax, upon the fpine between the aorta and the vena azygos. In the thorax it receives fome lymphatics from the intercoftal fpaces; a few of which are feen at (39), and afterwards it receives veffels from the lungs.

The fuperficial lymphatics of the lungs form a beautiful net-work, the larger branches running chiefly between the lobules, the fmaller paffing over them; and here, as well as on the liver, and other parts, there are numerous valves, the exiftence of which has been denied by fome authors. From the furface they pafs to the root of the lungs, and there they go through the bronchial glands. At this place they are joined by the deep-feated abforbents, which creep along the branches of the trachea, and likewife on thofe of the pulmonary artery and vein. Having left the glands, the principal part of thofe from the left lung form a trunk which terminates in the thoracic duct, behind the division of the trachea into its right and left branches. The rest of the absorbents of the left lobe pass through glands behind the arch of the aorta, and which are likewise common to those of the heart. They run at last into the thoracic duct near its termination in the red veins.

After leaving the bronchial glands, the absorbents of the right lung form three or four principal trunks; one of which commonly ascends on the forepart of the vena cava superior, and opens into the lymphatic trunk, that terminates in the veins of the right side of the neck. The rest of these trunks go into the thoracic duct at the root of the lungs; and near this place the absorbents of the right and left lungs communicate pretty freely together.

At the root of the lungs, where the large blood-vessels enter, are many glands called *bronchial*. They are generally of a blackish colour in the human subject, and have been suspected to secrete the mucus which is spit up from the trachea; but latter anatomists having frequently distinctly filled them with mercury, by injecting the lymphatic vessels of the lungs, think it evident that they are not mucous but lymphatic glands.

The absorbents of the heart, which have been known only by the latest anatomists, come from its superficial and deep parts. These afterwards form principal trunks which accompany the coronary arteries and veins, and like them the largest belong to the left ventricle. From the side of the right coronary artery an absorbent passes over the arch of the aorta to a gland commonly found behind the origin of the carotid arteries. The lymphatic accompanying the left coronary artery is formed of two principal branches; one of which runs up in the groove between the ventricles, and on the superior surface of the heart; the other runs in a corresponding groove on the under side of the heart: and having reached the space between the auricles and ventricles, turns round to join the former branch near the origin of its corresponding artery. Frequently, a third branch comes in between the other two. The trunk runs next to a gland on the other ſide of the aorta and the under end of the trachea; and at this place, as was formerly mentioned, the glands are common to the abſorbents both of the heart and lungs. The abſorbent accompanying the right coronary artery paſſes into the trunk, which terminates in the right ſubclavian vein; while the other, accompanying the left artery, goes to the upper end of the thoracic duct.

The thoracic duct, after receiving the veſſels before mentioned, paſſes behind the aſcending aorta, and goes to the left ſide, terminating in the angle between the jugular and ſubclavian vein. But, juſt before its termination, it generally goes higher up than the angle, and then bends down towards it; ſee Tab. XVIII. nº 42, 43. Sometimes, though rarely, there are two thoracic ducts inſtead of one. Sometimes the duct ſplits near the upper part of the thorax; and the two branches, after ſpreading out from one another, commonly unite again at their termination in the angle between the jugular vein and the ſubclavian veins.

To the preceding account, it may not be improper to add the deſcription given of the *Lacteal Sac and Duct* by the late Dr Alexander Monro.

" The receptaculum chyli of Pecquet, or ſaccus lacteus of Van Horne, is a membranous ſomewhat pyriform bag, two-thirds of an inch long, one-third of an inch over in its largeſt part when collapſed; ſituated on the firſt vertebra of the loins to the right of the aorta, a little higher than the right emulgent artery, behind the right inferior muſcle of the diaphragm; it is formed by the union of three tubes; one from under the aorta, the ſecond from the interſtice of the aorta and cava, the third from under the emulgents of the right ſide.

" The lacteal ſac, becoming gradually ſmaller towards its upper part, is contracted into a ſlender membranous pipe, of

 about

about a line diameter, which is generally named the *thoracic duct*. This paſſes between the muſcular appendices or inferior muſcles of the diaphragm, on the right of, and ſomewhat behind the aorta: then, being lodged in the cellular ſubſtance behind the pleura, it mounts between the aorta and the vena azygos as far as the fifth vertebra of the thorax, where it is hid by the azygos, as this vein riſes forwards to join the deſcending or ſuperior cava; after which the duct paſſes obliquely over to the left ſide behind the œſophagus, aorta deſcendens, and the great curvature of the aorta, until it reaches the left carotid artery; behind which, on the left ſide of the œſophagus, it runs to the interſtice of the firſt and ſecond vertebræ of the thorax, where it begins to ſeparate from the carotid, ſtretching farther towards the left internal jugular vein by a circular turn, whoſe convex part is uppermoſt. At the top of this arch it ſplits into two branches for a line and an half; the ſuperior branch receiving into it a large lymphatic veſſel from the cervical glands. This lymphatic appears, by blowing air and injecting liquors into it, to have few valves. When the two branches are again united, the duct continues its courſe towards the internal jugular vein, behind which it deſcends, and, immediately at the left ſide of the inſertion of this vein, enters the ſuperior poſterior part of the left ſubclavian vein, whoſe internal membrane being duplicated, forms a ſemilunar valve that is convex externally, and covers two-thirds of the orifice of the duct; immediately below this orifice, a cervical vein from the muſculi ſcaleni enters the ſubclavian.

" The coats of the ſac and duct are thin tranſparent membranes; from the inſide of which, in the duct, ſmall ſemilunar valves are produced, moſt commonly in pairs; which are ſo ſituated as to allow the paſſage of liquors upwards, but oppoſe their return in an oppoſite courſe. The number of theſe is generally ten or twelve.

" This

" This is the moſt ſimple and common courſe, ſituation, and ſtructure of the receptaculum chyli and thoracic duct; but having had occaſion to obſerve a variety in theſe parts, of different ſubjects, I ſhall ſet down the moſt remarkable of them.

" The ſac is ſometimes ſituated lower down than in the former deſcription; is not always of the ſame dimenſions; is not compoſed of the ſame number of ducts; and frequently appears to conſiſt of ſeveral ſmall cells or ducts, inſtead of being one ſimple cavity.

" The diameter of the duct is various in moſt bodies, and is ſeldom uniform in the ſame ſubject; but frequently ſudden enlargements or ſacculi of it are obſervable.—The diviſions which authors mention of this duct are very uncertain. I have ſeen it divided into two, whereof one branch climbed over the forepart of the aorta at the eighth vertebra of the thorax, and at the fifth ſlipped behind that artery, to join the other branch which continued in the ordinary courſe.—The preciſe vertebra, where it begins to turn to the left ſide, is alſo uncertain. —Frequently it does not ſplit at its ſuperior arch; in which caſe a large ſac is found near its aperture into the ſubclavian vein.—Generally it has but one orifice; though I have ſeen two in one body, and three in another: Nay, ſometimes it divides into two, under the curvature of the great artery; one goes to the right, another to the left ſubclavian vein; and I have found this duct diſcharging itſelf entirely into the right ſubclavian.—The lymphatic veſſel which enters its ſuperior arch, is often ſent from the thyroid gland.

" Whether is not the ſituation of the receptaculum chyli, ſo much nearer the muſcular appendices of the diaphragm in men than in brutes, deſigned to ſupply the diſadvantageous courſe the chyle muſt otherwiſe have in our erect poſture?

" Does not the deſcent of the end of the duct to the ſubclavian vein, and the opening of the lymphatic into the top of the arch,

arch, contribute to the ready admiſſion of the chyle into that vein ?"

In the deſcription of the lymphatic veſſels which lie near the trunk of the body, only a few glands have been mentioned; and in the figure where thoſe veſſels are exhibited no glands are repreſented. For the lymphatic glands not being conſtant either in number or ſituation, the deſcribing them particularly in any one ſubject appeared leſs neceſſary, ſince we cannot be ſure of finding them exactly the ſame in any other. It may, however, be neceſſary to mention where they are commonly ſeen.

The meſentery of the human ſubject is well known to contain a conſiderable number of them, from 100 to 150 or upwards; they are likewiſe found in the meſocolon, where the lymphatics of the large inteſtines paſs through them; but here they are both ſmaller and leſs numerous than in the meſentery. The ſtomach has alſo ſeveral glands which belong to its lymphatic veſſels, and lie near the arteria coronaria and the gaſtrica dextra. There are likewiſe a few upon the omentum in ſome ſubjects; and there are alſo many by the ſides of the pancreas, particularly near the leſſer lobe of that viſcus, cloſe to the duodenum.

Beſides theſe glands which belong to the inteſtinal tube, there are many more in the cavity of the abdomen, and a few in the cavity of the pelvis, which belong to the lymphatic veſſels of the other organs.

There is commonly a conſiderable gland ſeen juſt on the inſide of the edge of the tendon of the external oblique muſcle, called *Poupart's ligament*, on the outſide of the iliac artery; and there are others near that artery, where it lies upon the pſoas muſcle. There are likewiſe commonly one or two near the internal iliac artery in the cavity of the pelvis; ſome on the ſurface of the os ſacrum behind the rectum; and generally

rally a confiderable number on its fides, and upon the lumbar vertebræ.

Over the trunks of the blood-veffels of the fpleen, liver, kidneys, and renal capfulæ, there are alfo lymphatic glands which belong to the lymphatic veffels of thefe organs. In the thorax, a few glands are found on the fore-part of the pericardium and upper furface of the diaphragm, and belong to the liver or diaphragm. Others are fituated between the laminæ of the anterior mediaftinum.

There are likewife lymphatic glands fometimes obferved by the fides of the thoracic duct, particularly about the middle of the thorax; which glands belong principally to the veffels of the lungs.

There are alfo many lymphatic glands (called *bronchial*) near the root of the lungs: thefe glands are placed upon the lymphatic veffels, juft where they quit the lungs. But no lymphatic glands have yet been obferved in the fubftance of the lungs; and the tubercles, which fome fufpect to be obftructed lymphatic glands, feem to have a different origin. There are likewife fome glands feen on the lymphatic veffels which lie near the fubclavian veins at the upper part of the thorax, and which belong to the lungs.

Befides thefe there are fome lymphatic glands upon the aorta near the œfophagus, and there are alfo others occafionally met with in the intercoftal fpaces, and there are generally two or three contiguous to the thoracic duct at the lower part of the neck and upper part of the thorax, near the termination of that duct in the angle between the left jugular and the left fubclavian vein; and a few are found over the internal mammary veffels where the abforbents of the liver pafs up within the thorax.

§ 3. *Lymphatics*

### § 3. *Lymphatics of the Head and Neck.*

The lymphatics of the head, like thofe in many other parts of the body, are in two fets; one belonging to the outer, the other to the inner, parts of the head Thofe on the outfide of the head accompany the blood-veffels, and pafs through glands in their way to the neck. Thofe accompanying the temporal artery go through fmall glands at the root of the zygomatic procefs, while the abforbents of the occiput pafs through others behind the maftoid procefs of the temporal bone.

Several anatomifts have feen an appearance of lymphatics both on the brain and its membranes, but none, even of the lateft authors, have been certain about them. That the brain, however, has its abforbents, there can be little doubt; as is in fome meafure proved from the exiftence of lymphatics and glands, in, or on the outfide of, the paffages of the arteries and veins of the brain; from fwellings in the lymphatic glands of the neck, arifing from the difeafes of the brain; from the abforption of water which has fometimes happened in cafes of hydrocephalus; and from feveral other circumftances.

From the fuperficial and deep parts of the head, the lymphatics pafs through the glands fituated near the carotid arteries and internal jugular veins, where they are joined by others, to be immediately defcribed.

From the different parts of the face, the lymphatics chiefly accompany the branches and trunk of the facial artery. They come from the inner angle of the eye, from the nofe, lips, and cheeks. Some of thefe pafs through fmall glands on the outfide of the buccinator mufcle, while the principal branches go through larger glands on the outer and under fide of the lower jaw, near the correfponding blood-veffels, and the inferior maxillary

maxillary gland. Others run through the glands on the upper and under end of the parotid gland. The lymphatics of the inner fide of the nofe run principally with the internal maxillary artery, and pafs through the glands behind the angle of the lower jaw, where they are joined by others from the inner part of the mouth. Deeper than this, and near the internal jugular vein, the lymphatics of the tongue, and parts about the os hyoides, pafs through the glands which belong likewife to thofe of the deep parts of the head.

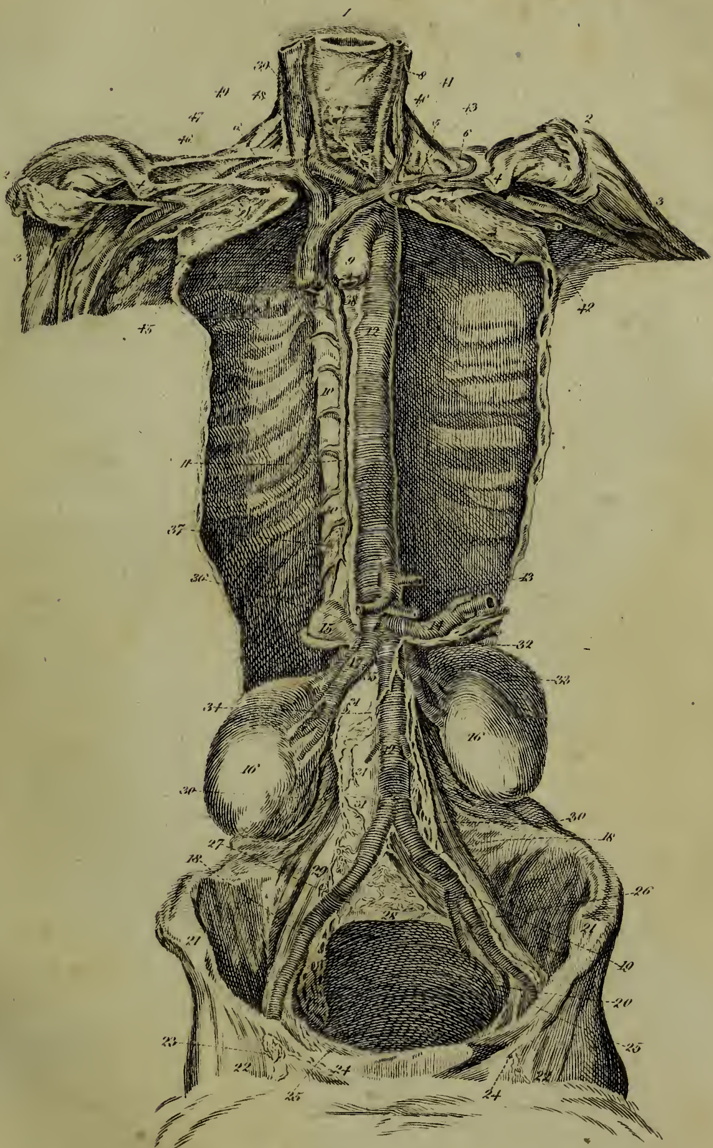
The glands which accompany the lower part of the artery that runs upon the face, are fometimes fwelled in confequence of abforption from the lips, and alfo from gum boils; and thofe which accompany the occipital artery, are frequently enlarged in confequence of abforption of matter from wounds of the fcalp; from which facts we are led to trace the courfe of the lymph even in the living body. In quadrupeds thofe veffels may be diftinctly feen, particularly in a dog or an afs, by paffing a ligature round the large blood-veffels of their necks immediately after killing them. Mr. Hewfon made fome experiments of this kind, with a view to determine whether the brain had lymphatic veffels; but he informs us he was never able to fee any on that organ; neither when he tied up the lymphatics on the necks of thofe animals, nor when he diffected the human brain, with a view to difcover thofe veffels; although he particularly fought for them in the plexus choroides, where they have been fufpected to be feen, and near the glandular pituitaria: but that although lymphatic veffels have not been demonftrated in the brain, it is probable from analogy that this organ is not deftitute of them.

The lymphatics already defcribed from the different parts which belong to the head, accompany the external and internal jugular veins, though chiefly the latter, where they form a large and beautiful plexus, paffing through numerous glands in the whole length of the neck. At the under end of the neck they join the lymphatics of the ſuperior extremities, and then form a common trunk to be afterwards mentioned.

The glandula thyroidea has many lymphatic veſſels, which can be inflated by blowing air into the cells of the gland: theſe veſſels paſs on each ſide of the trachea, one part going into the trunk, which terminates in the right ſubclavian and jugular, and the other joining the thoracic duct upon the left ſide near its termination.

In Tab. XVIII. which exhibits the trunk ſo prepared as to ſhew the lymphatics and the thoracic duct, (1) is the neck. (2) The ſhoulder. (3) The arm. (4) The out end of the clavicle. (5) The extremity of the firſt rib. (6) The ſubclavian muſcle. (7) The rib. (8) The trachea. (9) The aorta aſcendens. (10) The ſpine. (11) Vena azygos. (12) The aorta deſcendens. (13) The cæliac artery. (14) The ſuperior meſenteric artery. (15) The right crus diaphragmatis. (16) The kidney. (17) The right emulgent artery. (18) The common iliac artery. (19) The diviſion of the common iliac into the external and internal iliac arteries. (20) The cavity of the pelvis. (21) The ſpine of the os ilium. (22) The groin. (23) A lymphatic gland in the groin, into which lymphatic veſſels from the lower extremity are ſeen to enter. (26) The pſoas muſcle with lymphatic veſſels lying upon its inſide. (27) A plexus of lymphatics which having paſſed over the brim of the pelvis at (25), having entered the cavity of the pelvis, and received the lymphatic veſſels belonging to the viſcera contained in that cavity, next aſcends, and paſſes behind the iliac artery to (29, 29) The right pſoas, with a large plexus of lymphatics lying on its inſide. (30, 30,) The plexus lying on each ſide of the ſpine. (31, 31, 31,) Spaces occupied by the lymphatic glands; which are not here repreſented, not having been injected in the ſubject. (32) The trunk of the lacteals lying on the under ſide of the ſuperior meſenteric artery. (33) The ſame dividing into two branches;

TAB.XVIII.



D. Lizars Sculpt

branches; one of which paffes on each fide of the aorta; that of the right fide being feen to enter the thoracic duct at (34.) (34) The thoracic duct beginning from the large lymphatics. (38) The thoracic duct paffing under the curvature of the aorta to get to the left fubclavian vein. (39) A plexus of lymphatic veffels paffing upon the trachea from the thyroid gland to the thoracic duct. (40) The upper part of the thoracic duct lying between the left carotid and the left jugular vein, and paffing behind that vein downwards and outwards towards the angle between the left jugular and the left fubclavian. (41) The extremity of the thoracic duct entering the angle between the left jugular and the left fubclavian vein. (46) That net-work paffing under the right fubclavian vein, and under the fubclavian mufcle, the clavicle being removed.

N. B. The other N$^{os}$ are explained in the courfe of the defcriptions.

### § 4. *Lymphatics of the upper Extremities.*

Like the leg, each arm has two fets of lymphatic veffels. One fet, which lies immediately under the integuments, belongs to the fkin and the cellular membrane, connecting it to the mufcles; the other accompanies the large arteries, and belongs to the parts deeper feated.

The fuperficial fet of lymphatic veffels are numerous, and may be difcovered in emaciated dropfical fubjects, by a careful diffection on the fore and back part of the arm. They arife firft from the fore-part of the fingers and palm of the hand, and run fomewhat like the veins. They go to the fore-arm, where they meet with others from the outer and inner edges of the hand. After running a little further, they receive many branches from the back-part of the hand and fingers, and then form a plexus which furrounds the greater part of the fore-arm. Having got above the elbow, moſt of them run near the baſilic vein, and commonly paſs through one or two ſmall glands, a little above the internal condyle of the humerus, and over the brachial artery; but the lymphatics on that ſide of the arm next the thumb appear to paſs through no glands till they reach the axilla. The reſt of the lymphatics accompany the cephalic vein, and are but few in number: they paſs between the deltoid and pectoral muſcles, and then go through glands at the inſide of the clavicle. Of the deep-ſeated lymphatics of the arm, two commonly accompany each artery, in the ſame manner as the veins do: Having reached the upper end of the arm, they go through the axillary glands, where they are joined by the lymphatics from the mamma and ſide of the thorax, and alſo by thoſe from the ſhoulder. From theſe glands larger branches run under the clavicle, and form a trunk, which receives thoſe from the head and neck already deſcribed. In Tab. XVII. fig. 3. ſome of the lymphatics are ſeen running on the back part of the fore-arm at (6, 6) moſt of them paſſing on its outſide, and twiſting to the fore-part, near the head of the radius, as at (7). But in this repreſentation, there is a veſſel which paſſes toward the inſide, under the inner condyle of the os humeri at (8), and ſends a branch amongſt the muſcles; which branch perforates the interoſſeous ligament, getting between the radius and ulna to the fore-part, where it joins a deep-ſeated one that had accompanied the radial artery.

In this figure, which exhibits a back view of the fore-arm and hand, (1) Is the hand. (2) The lower extremity of the radius. (3) The lower extremity of the ulna. (4) The muſcles on the back of the fore-arm turned aſide to exhibit a deep-ſeated lymphatic veſſel which perforates the interoſſeous ligament to get to the fore-part. (5) The olecranon.—The veſſels have been already referred to.

In

In Tab. XVII. fig. iv. the lymphatic veſſels are ſeen on the fore-part of the upper extremity; thoſe ſuperficial branches which paſſed on the outſide of the back of the fore-arm appearing now on the fore-part at (8); and aſcending under the ſkin that covers the ſupinator longus, and the biceps, they enter ſome glands in the axilla at (12, 12), whilſt that veſſel which paſſed on the inſide of the back of the fore-arm under the internal condyle, appears on the fore-part at (9), and juſt above the condyle enters a gland (10), and then paſſes up on the inſide of the arm, communicating with a lymphatic from the fore-part of the wriſt, and paſſing to the axillary glands.

A ſuperficial lymphatic is ſeen under the ſkin, on the fore-part of this extremity juſt above the wriſt; a pipe was introduced at (7), and the veſſel thereby injected with mercury. Paſſing under the integuments over all the muſcles, this veſſel joins the lymphatic from the back part of the fore-arm at (11), and there forms a plexus which paſſes under the integuments, on the inſide of the arm, to the axillary glands at (12).

Beſides theſe ſuperficial lymphatics upon the upper extremity, others lie near the radial artery; one is injected with a pipe fixed at (13.) This veſſel accompanies the radial artery, and paſſes (14) firſt under the interoſſeous, and then under the ulnar artery, which in this ſubject runs over the muſcles. Near the part where it paſſes under the interoſſeous artery, it receives the branch from the back of the fore-arm. After paſſing under theſe arteries, this lymphatic appears on the inſide of the brachial artery at (15), where it is deep-ſeated. Aſcending cloſe to that artery, and near the middle of the arm, it paſſes through the two glands (16, 16); after which it appears conſiderably enlarged, goes under one of the arteriæ anaſtomaticæ at (17, 18), and then aſcends to the lymphatic glands in the axilla (19, 19).

In the above figure, which exhibits a fore view of the upper extremity, (1) is the ſcapula, (2) the clavicle, (3) the ex-

tremity

tremity of the brachial artery, (4) the mufcles lying on the infide of the arm, (5) the inner condyle of the os humeri, (6) the lower extremity of the radius. The fubfequent Nos denoting the veffels have been explained in the defcription.

Thefe veffels, however, as they here appear, although reprefented from a fuccefsful injection, are only a part of the large lymphatic veffels of the arm; and there are fome accompanying the ulnar and interoffeous arteries, that are not here injected. They fhould moreover be confidered as only trunks of the lymphatics; fince it is probable, that every (even the fmalleft) part of this, as well as all other parts of the body, has fome of thefe veffels adapted to abforption. That this is the cafe feems to be proved by the experiments made with the variolous matter; for at what part foever of the arm that matter is inferted, the lymphatic veffels take it up and carry it into the body, as can be traced by its inflaming the conglobate glands through which thefe veffels pafs.

In Tab. XVIII. the termination of all the lymphatic veffels is exhibited. Two of the trunks of thofe of the left arm are feen at (42, 42). They pafs under the clavicle, whofe cut end is feen at (4); and under the fubclavian vein. Here, having joined, they form the large trunk (43), which appears juft above the left fubclavian vein, and joins the extremity of the thoracic duct at its entrance into the angle between that vein and the jugular.

The thoracic duct is not only joined by this trunk of the lymphatics of the left arm, but alfo by the lymphatic veffels of the left fide of the thyroid gland, and by the trunk of the lymphatics of the left fide of the head and neck, and alfo by fome from the lungs of the fame fide.

The lymphatic veffels of the right fide are commonly feen to terminate in the angle between the jugular vein and the fub-

clavian.

clavian. When they enter the ſubclavian vein at any other part, it appears to be only an accidental variety.

Theſe lymphatic veſſels of the right ſide form four conſiderable trunks, which join near their termination. Theſe trunks are, 1. One from the upper extremity, which appears at (47), lying above the clavicle between the ſubclavian artery and vein: This trunk is formed by the lymphatics (44), which come up with the brachial artery, and the plexus (45), which likewiſe belongs to the arm, and paſſes under the ſubclavian vein. 2. The trunk of the lymphatic veſſels of the right ſide of the head and neck, which paſſes down on the outſide of the jugular vein, as is ſhewn at (48). 3. A lymphatic from the thyroid gland. This veſſel is ſeen at (49), paſſing under the right jugular vein to get to the others. 4. A trunk from the lungs of the right ſide: This trunk is diſtinctly traced under the ſubclavian vein to its termination, in common with the others, at the union of the jugular and ſubclavian veins.

## § 5. *Of the Chyle.*

The chyle is a white juice extracted from the aliments, and afterwards mixed with the blood. That its principal compoſition is of water and oil, ſeems evident from the ſweetneſs of its taſte, from the whiteneſs of its colour, from its aceſcent and coagulable nature, and from its lightneſs, by which it ſwims on the blood; in all which properties it very much reſembles an emulſion. It is compoſed of a vegetable farina, with animal lymph and oil. It every where retains the properties of the volatile and oily aliments. It changes into milk with very little alteration. But afterwards it becomes more manifeſtly glutinous; ſince the pellucid ſerum it contains, either by exhaling the watery part, or by applying an intenſe heat, coagulates into a kind of jelly.

Haller

Haller has attributed the firſt cauſe of motion in the chyle, and of its abſorption, chiefly to the attraction of the capillary veſſels, which obſerve alternate pulſes with the periſtaltic contraction of the inteſtine. The attractile force fills the villoſity; the periſtaltic force empties the villoſity, and moves the chyle farther forward. The reſt of its motions ſeem to depend on the ſtrength of the membrane of the lacteal veſſel itſelf, which, even after the death of the animal, expels the chyle, ſo that the veſſels become pellucid which before were milky. The alternate compreſſing force of the diaphragm is alſo of ſome efficacy in this caſe.

The chyle, mixed with the blood, does not immediately change its nature, as we learn from the milk which is afterwards made of it; but after it has circulated through the body, fomented with heat, and mixed with a variety of animal juices, it is at length ſo changed, that a part of it is depoſited in the cellular ſubſtance under the denomination of fat; a part of it is configured into the red globules; another part changes into ſerum; and the watery parts go off, in ſome meaſure, by urine, in ſome meaſure by perſpiration; while a ſmall part is retained in the habit to dilute the blood.

## CHAP. VIII.

### *Of the* PROPERTIES *of the* LYMPH, *as obſerved by Mr Hewſon**, *&c.*

AS the fluid contained in the lymphatic veſſels reſembles water in the circumſtances of tranſparency and want of colour, thence their firſt diſcoverers denominated theſe veſſels *ductus*

* The publiſher has here to acknowledge the very polite manner in which Mrs Hewſon gave him liberty to make uſe of ſuch of her huſband's diſcoveries and obſervations on the Lymphatic Syſtem as might be uſeful to this Work.

*ductus aquoſi*, and ſeem to have concluded that the lymph was nothing but water.

This opinion ſome of the ſucceeding phyſiologiſts, particularly the learned Boerhaave, rendered more probable, by ſuppoſing that there were three ſeries of arteries; the ſanguiferous, the ſeriferous, and the lymphatic; and that thoſe lymphatic veſſels we are now deſcribing, were only veins correſponding to the lymphatic arteries, to reſtore their lymph to the heart. Thence the lymph ſeems to have been concluded the thinneſt part of our fluids; in which opinion phyſiologiſts were confirmed by Leeuwenhoeck's theory, that the globules of lymph were ſmaller than thoſe of the ſerum, or of the red part of the blood.

The fluids that moiſten the different cavities of the body, viz. that of the peritoneum, pleura, pericardium, &c. being ſuſpected to be formed ſolely from the condenſation of that ſteam which appears on opening an animal juſt killed, have thence been alſo conſidered as mere water by ſome anatomiſts and phyſiologiſts; who were confirmed in this opinion by obſerving, that in dropſies, where a great quantity of fluid is let out from ſuch cavities, it is commonly a mere water, ſeldom coagulating either when expoſed to the air or to heat. And, agreeably to this opinion, theſe dropſies are ſaid to be occaſioned by an increaſed ſecretion, or an impeded abſorption; which ſuppoſes that the fluids, naturally moiſtening theſe cavities, are the ſame as thoſe let out from them in dropſical caſes.

But notwithſtanding the plauſibility of all the arguments from which ſuch concluſions were made, with reſpect to theſe fluids, it appears from experiment, that although they be ſo tranſparent in living animals, and ſo watery in dropſies, yet in animals in health they differ ſo much from water, that they not only coagulate when expoſed to heat, but alſo when merely expoſed to the air; in which circumſtance they agree moſt with that part of the blood called the *coagulable lymph*, as is evident by collecting this fluid from the furface of the abdomen, thorax, or pericardium of an animal that has been recently killed; for if the fluid thus collected be fuffered to reft, and expofed to the air, it will jelly as the coagulable lymph of the blood does. This is an experiment which Mr Hewfon made on a confiderable number of animals, viz. on bullocks, dogs, geefe, and rabbits, and the refult of all the experiments was the fame. From among thofe who concluded thefe fluids a mere water, fhould be excepted Drs Haller and Monro, who are of a different opinion.

If immediately after killing an animal in health, a lymphatic veffel be tied up properly, and then cut out of the body and opened, fo as to let out the lymph into a cup and expofe it to the air, it will jelly as the coagulable lymph of the blood does in the fame circumftances; this experiment Mr Hewfon has likewife made feveral times on dogs, affes, and geefe. But with refpect to that fluid which moiftens the cellular fubftance or cellular membrane, as it is called, he cannot fpeak with fo much precifion, fince it cannot be collected in animals in health; but when we confider how great a probability there is of the lymphatic veffels abforbing that fluid, we may fufpect that it is fimilar to what moiftens the pericardium, thorax, abdomen, &c. efpecially as Mr Hewfon has repeatedly obferved, that the lymph returning from the extremities by their lymphatic veffels, coagulates when expofed to the air, as well as the lymph nearer the centre of the body.

Since, then, thofe fluids in healthy animals coagulate fpontaneoufly on being expofed to the air, may we not conclude that they refemble the coagulable lymph of the blood, at leaft more than they do the water, or even than they do the ferum, which does not jelly on being expofed to the air? And is it not an argument in favour of this inference, that fuch a fluid appears fitter for the office of lubrication than mere water, and

and more ſimilar to the ſynovia, which of all fluids is the beſt adapted to that purpoſe?

But although, from theſe experiments, it appears ſufficiently evident, that the lymph in theſe cavities and veſſels of an healthy animal, will always jelly on being expoſed to the air, yet it has been likewiſe obſerved, that the ſtrength of that jelly is different in different animals. In geeſe theſe fluids jelly ſooner than in dogs; and in the ſame animals the jelly differs in the different circumſtances of health: in moſt of the dogs which Mr Hewſon examined, the contents of the lymphatics formed a ſtrong jelly; but in a dog which he had fed eight days with bread and water, and that rather ſparingly, the lymph formed a very weak jelly; and in young geeſe theſe fluids are later in jellying than in ſuch as are full grown. The ſame thing is true with reſpect to the fluid contained in the pericardium and abdomen of other animals; which fluid, when in a ſmall quantity, always formed a ſtrong jelly, but when more copious, and the animal more feeble, the jelly is thinner; and in dropſical caſes, it is well known that the fluid let out of theſe cavities is not obſerved to jelly on being expoſed to the air, as it does in animals in health; but in ſome caſes it is found to coagulate by heat, like the ſerum of the blood, and in others it only becomes a little turbid when boiled, owing to the coagulable matter being in very ſmall proportion to the water.

Although this lymph becomes more watery in a weak ſtate of the animal, it is leſs watery, and more coagulable in ſome diſeaſes.

But what is a more curious fact, in thoſe caſes where the fluid contained in the abdomen and pericardium has been compared with that contained in their lymphatic veſſels, of animals in different ſtates of health, they were found to agree with one another in the degree of coherence of the jelly which they formed. For when the animal was in perfect health, the lymph from the cavity of the pericardium, abdomen, and pleura, formed a ſtrong jelly, and that in the lymphatics of the neck and extremities was equally firm: When the animal was reduced, as in the dog fed eight days on bread and water, or when the gooſe was very young, then the jelly, formed by the fluid collected in theſe cavities, was weak, and that formed by the lymph in the lymphatic veſſels was likewiſe in the ſame proportion. So that although theſe fluids vary in the different circumſtances of health, yet they always agree with each other.

Theſe fluids likewiſe, as we have before obſerved, beſides agreeing with one another, approach to the nature of the coagulable lymph of the blood, in the circumſtance of coagulating when expoſed to the air, but they differ from it in the time neceſſary for that coagulation. In dogs that were ſeemingly in perfect health, whoſe blood and whoſe lymph were let out of their veſſels at the ſame time, the lymph was found to be much later in coagulating than the blood. The time which the blood requires for its coagulation is about ſeven minutes after being expoſed to the air; but the lymph let out from the lymphatic veſſels of the ſame animals, was found to require half an hour or more for its coagulation. And although the blood coagulates ſooneſt in the weak animals, yet the contents of the lymphatic veſſels, or the fluids in theſe cavities, ſeem later in jellying in proportion as the animal is reduced, or as the fluids become more watery.

Moreover the coagulable lymph of the blood, and the lymph of the lymphatic veſſels, not only differ from one another in the time which they require for their coagulation when expoſed to the air, but they alſo differ more evidently in the time required for their coagulation in the body when merely at reſt, without being expoſed to air. As, for inſtance, in a dog killed whilſt in health, and whoſe veins and lymphatic veſſels were tied up immediately after his death, the blood in the veins was completely jellied in ſix hours, but the lymph in the lympha-

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tic veſſels of his neck was perfectly fluid twenty hours after his death; but it jellied, after being for ſome time expoſed to the air.

There is another change of the lymph very evident, beſides thoſe already mentioned; for it not only is varied from the natural ſtate to the more watery, but alſo from the natural to the more viſcid or coagulable; inſtances of which occur in thoſe inflammatory cruſts that are found, in ſome diſeaſes, to cover the different parts of the body. Thus, the outſide of the heart, and the inſide of the pericardium, are ſometimes covered with a cruſt as tough as the ſize in pleuritic blood; and the ſurface underneath has marks of inflammation, but is not ulcerated. Probably, therefore, it is the inflammation which produces that change, or which makes the exhalant arteries ſecrete a lymph with ſuch an increaſed diſpoſition to coagulate. Add to this, that the change which inflammation thus ſeems to produce, is juſt the oppoſite to that produced by the dropſy; for, in the dropſy, the fluid is ſecreted with an extraordinary quantity of water and too little coagulable matter: but in inflammations the fluid is ſecreted with a greater proportion of coagulable matter, and with leſs water; and in ſome inſtances it ſeems to be a pure coagulable lymph, either unchanged by the exhalants, and then coagulating gradually on being at reſt, as the coagulable lymph is found to do in the veins that are tied; or elſe the exhalent veſſels have the power of changing its properties ſo as to make it coagulate in an inſtant after being ſecreted. And this ſuppoſition of the exhalants having a power of changing the properties of the lymph, is rendered probable from the following conſideration, viz. that it is ſometimes found coagulated in the inner ſurface of the heart, forming a cruſt ſimilar to what we ſo often ſee on the outſide. Now as there is a conſtant current of blood through the heart, unleſs the lymph forming that cruſt had coagulated inſtantly on being ſecreted, it muſt have been waſhed off by the blood. One of the cleareſt inſtances of this

this was obſerved by Sir John Pringle, in the caſe of a perſon who had for ſome time been ſubject to palpitation of the heart, but afterwards died apoplectic; when there was found marks of inflammation on the ſurface of the heart; an abſceſs on the left ventricle, which muſt have burſt had not an opening from it been covered and ſhut up by a ſmall cruſt or polypus which occupied a ſpace in the ventricle.

Now this cruſt or polypus, lying over an inflamed ſurface, had probably been formed by a ſecretion of the lymph from the inflamed veſſels; and being formed in the cavity of the heart where there was a conſtant current of blood, the lymph of which it was compoſed muſt have coagulated inſtantly on being ſecreted from the veſſels, otherwiſe it would have been waſhed off with the current; and as the coagulable lymph is not naturally diſpoſed to coagulate ſo inſtantaneouſly, it is probable that the diſeaſed veſſels here poſſeſſed the power of producing the change: and therefore, that as in dropſical habits, where the veſſels act weakly, the fluids exhaled are of a watery nature, ſo in inflammatory caſes, where the veſſels act ſtrongly, thoſe ſecreted fluids, in conſequence of that ſtrong action, acquire a more viſcid and a more coagulable nature.

And moreover, as it appears that the properties of the lymph exhaled upon ſurfaces and into cavities, differ ſo widely in different circumſtances, and as we find that pus is often met with in ſuch cavities without ulceration, is it not probable that pus itſelf is merely that lymph changed in its properties by paſſing through inflamed veſſels? The cavities of the pleura, pericardium, &c. are ſometimes obſerved to contain conſiderable quantities of pus without the leaſt mark of ulceration: Inſtances of which have been not unfrequently ſeen. In one patient Mr Hewſon found three pints of pure pus in the pericardium, without any ulcer either on that membrane or on the heart. In another, the cavity of the pleura of the right ſide was diſtended with a pus that ſmelt more

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like whey than a putrid fluid, and the lungs were compreſſed into a very ſmall compaſs ; but there was no appearance of ulcer or eroſion, either on theſe organs, or on the pleura, but only under the pus was a thin cruſt of coagulable lymph. In ſuch caſes it is manifeſt the pus muſt have been formed from the fluids ; and as the exhalant veſſels at one time appear to ſecrete a mere water, at another a coagulable lymph, and in a third (when a little inflamed) they ſecrete that lymph ſo viſcid, and change its properties ſo much as to make it coagulate inſtantly on being ſecreted ; ſo in like manner they may ſometimes, when more inflamed, have the power of converting the lymph into pus : and, according to the kind and degree of inflammation, the pus may vary from the bland, viſcid, and inodorous nature, to that of the moſt thin and fetid ſanies found in phagedenic and cancerous ulcers. And if pus in theſe caſes is produced merely by a ſecretion, ſo likewiſe it would ſeem probable, that even in abſceſſes where there is a loſs of ſubſtance, it is not the melting down of the ſolids that gives riſe to the pus, but the pus being ſecreted into the cellular membrane, from its preſſure, and from other cauſes, deadens the ſolids and then diſſolves them ; which is confirmed by obſerving, that even a piece of freſh meat, if put into an ulcer and covered up, is ſoon deſtroyed or melted down by the pus, which is thereby rendered more fetid. And this opinion, that pus is made by a ſecretion, is ſtrengthened by obſerving, that in its pure ſtate it is full of globules ; in which circumſtance it agrees with milk, which is produced by a ſecretion, and not by a fermentation.

Upon the whole, then, it appears, that the lymph contained in the lymphatic veſſels, and the fluids which moiſten the different cavities of the body, as the pleura, peritonæum, &c. inſtead of being a mere water, in healthy animals, are coagulable fluids, approaching to the nature of the coagulable lymph of the blood, of which probably they are a ſpecies, or are compoſed of a mixture of that lymph with water ;

that

that the proportions of that mixture vary from the dropſical habit, where the coagulable lymph is in a ſmall, and the water in a great proportion, up to the rheumatic or inflammatory habit, where the lymph abounds, and the water is in leſs proportion; and that in ſome caſes the lymph, in paſſing through inflamed veſſels, is even converted into pus.

### § 1. *Of the Secretion of the Lymph.*

Having already ſpoken of the properties of the lymph moiſtening the different cavities of the body, we ſhall next conſider the manner in which that lymph is formed or ſecreted from the maſs of blood.

The moſt generally received opinions concerning this ſecretion have been, that it was performed, either by ſmall exhalant arteries, or elſe by pores on the ſides of the veſſels, which pores were believed to be organized.

But theſe opinions have been controverted by Dr Hunter in his medical commentaries, who has endeavoured to prove that this ſecretion was not performed by exhalant arteries, or an effect of what is properly called *organization*, but merely by the thinner or more watery parts of the blood, filtrating or tranſuding through the inorganized interſtices between the fibres of our veſſels and membranes; ſo that, according to this idea, the fibres of our veſſels were cloſe enough to retain the ſerum or the red globules, but not cloſe enough to prevent the water oozing out as through a ſieve; and the arguments with which this doctrine is ſupported are as follow.

Firſt, The ready tranſudation of watery and other injections after death.

Secondly, The tranſudation of blood after death, but not during life; for during life he ſuppoſes the blood to be thickened by the coagulable lymph; but when that lymph is jellied, he concludes the blood is thereby made thinner, and therefore

more

more capable of oozing through the inorganized interftices, by which it could not pafs before.

Thirdly, The tranfudation of bile, which he thinks takes place in the living body, becaufe on opening a dead one we fee all the neighbourhood of the gall-bladder tinged with this fluid.

Such are the arguments brought in favour of tranfudation; but on a careful examination, they are not fo fatisfactory as thofe which may be produced in defence of the opinion, that thefe fecretions are by organized paffages, as perhaps will appear from the following obfervations.

Firft, Although fluids tranfude on being injected into the veffels of the dead body, yet we muft not thence conclude that a fimilar effect would certainly take place in the living; for it is probable, that our fibres and veffels have a degree of tenfion which they may lofe with life. Befides, if tranfudation took place in the living body, it would feem to defeat the principal purpofe for which the blood-veffels were made, that is, the containing and conveying the fluids; and upon drinking a greater quantity than ordinary of watery liquors, inftead of the liquors being carried to the kidneys or other emunctories, and thereby thrown out of the body as a redundancy, they would efcape into the cellular membrane, and occafion an anafarca. That this would be the cafe will appear the more probable, when it is confidered how fmall the fibres of our blood-veffels muft be, and therefore what millions of pores (did they exift) the water would be expofed to, from its entrance into the ftomach, and its paffage through the lacteals, the thoracic duct, the veins, the heart, the lungs, and the arteries, before it reached the kidneys. So that were we in imagination to follow a drop of thefe liquors, according to the idea of tranfudation, we fhould find it, firft leaking through the ftomach or through a lacteal, then being abforbed, then efcaping a fecond time, and being again abforbed, &c. an idea by no means conſiſtent with what we know of the works of nature. It is more probable, therefore, that as the blood-veſſels are made to contain and convey the fluids, nature has taken care to conſtruct them properly to prevent this purpoſe being defeated.

Secondly, To ſuppoſe that the fluids which moiſten the different cavities of the body, as the pericardium, pleura, peritonæum, tunica vaginalis, &c. get into theſe cavities merely by tranſudation, is to ſuppoſe not only that the ſmall veſſels in contact with theſe membranes have inorganized pores, but alſo that the membranes themſelves have the ſame juſt oppoſite to thoſe of the veſſels. Now if we admit inorganized pores at one part of thoſe membranes, we muſt admit them in all parts, and in the ſame degree: But as the blood-veſſels are circular, and touch thoſe membranes, only by a ſmall part of the circle, the parts touched by the veſſels muſt be ſmaller than the interſtices between the veſſels, and the lymph muſt have fewer chances in favour of its leaking from the veſſels into the cavities, than of its oozing again from theſe cavities into the interſtices between the veſſels or into the cellular membrane; ſo that, if theſe membranes admitted of tranſudation, there would be no ſuch thing as a partial dropſy, for the water would run out at one part of the pleura, pericardium, peritonæum, &c. as faſt as it ran in by the other, and an anaſarca would always accompany an aſcites; which not being a fact leads us to believe, that thoſe membranes do not admit of tranſudation in living bodies, and that the fluids get into them not by inorganical, but by organized paſſages.

Thirdly, To prove more ſatisfactorily that theſe fluids are not filtrated from the blood merely by inorganical tranſudation, let us recollect the experiments already related, concerning the properties of thoſe fluids, which we found varied in different circumſtances of health. For, in inflammatory affections of the parts from which they were ſecreted, they aſſumed the appearance of the coagulable lymph of the blood,

and

and formed a tough jelly; in animals in health they formed a jelly of a weaker nature; and in dropfical cafes they were almoft a mere water, without the property of coagulation. Now if thefe fluids be fo variable in their properties, it is manifeft that the paffages fecreting them cannot be always unalterably the fame, or inorganized; fince at one time we find them fecreting one fluid, and at another time fecreting another; efpecially as we fometimes find them fecreting a fluid very different from the blood, viz. pus. Which pus being found in cavities without any ulcer or erofion, we muft conclude it formed by fomething more than a mere filtration; for we cannot fuppofe there fhould be filtrated from the blood a fluid that was not in it. And if pus, which paffes from the fame pores, can only be accounted for by fuppofing thefe pores to be organical, in like manner is it not probable, that the fecretion of the natural lymph is not a ftraining through inorganical, but through organized paffages?

Laftly, It has been brought as an argument in favour of tranfudation in the living body, that blood tranfudes after death; and this has been explained on the fuppofition, that the blood was thicker before the coagulation of the lymph: Which fuppofition appears ill-founded, when we fpeak of the living body; for in former experiments we have obferved, that this lymph frequently at leaft, rather thins than thickens the blood. If, therefore, the blood tranfudes in the dead and not in the living body, we fhould rather attribute it to a change in the veffels than in the blood; as is probable from a careful examination of that very fact which has been brought as the principal argument in favour of tranfudation, viz. the parts adjacent to the gall-bladder being tinged with bile: for any one who will take the trouble of ftanding by a butcher whilft he kills a fheep, will find, contrary to that gentleman's conclufion, that upon opening the animal immediately, there is no appearance of the gall having tranfuded, for none of the parts furrounding the gall-bladder are tinged. But let the animal continue a day or two unopened, and then the gall will be found to have tranfuded, and to have tinged the neighbouring parts; as is the cafe with the human body by the time that we infpect it.

Since, then, the gall-bladder fo readily allows of tranfudation after death, and not during life, is it not probable that there is in our membranes, and in our blood-veffels, a degree of tenfion, or a power of preventing the fluids from oozing out of them, which power is loft with life?

Upon the whole, then, it appears, that the interfticial lymph, or the fluid which moiftens the different cavities of the body, being different from mere water, cannot be produced fimply by tranfudation through inorganical interftices; but that there are fmall exhalant arteries, or organized paffages, which not only tranfmit it from the blood, but change its properties, and adapt it to the office of lubrication, and likewife make it affume very different appearances in different circumftances of health.

§ 2. *Of the fuppofed Abforption of the Lymph by the red Veins.*

As there is a fecretion upon the different furfaces, and into the different cavities of the body, for the purpofes of the conftitution, fo there is likewife an inhalation or an abforption. For example; If food be taken into the ftomach and inteftines, it is there digefted, and being converted into chyle, it is in that form taken into the blood-veffels. If garlic be applied to the fkin, it gets into the body, and is fmelt in the breath with as much certainty as when taken into the ftomach, where its juices are abforbed by the lacteals. So, likewife, terebinthinate medicines applied to the fkin are foon fmelt in the urine; and cantharides in a blifter affect the urinary paffages.

In the fame manner fluids are taken from different cavities of the body into the vafcular fyftem. Thus the water of an

*afcites*

*afcites* and an *anafarca* are occafionally taken up and carried by the blood-veffels to the inteftines and kidneys, and evacuated by ftool or by urine. And the *pus* of an abfcefs is fometimes abforbed and carried to different parts of the body and there depofited, or is evacuated by the inteftines or urinary paffages. So alfo fluids injected into cavities, as that of the cheft or belly of living animals, foon find their way into the blood-veffels. Thefe circumftances are admitted by anatomifts amongft the unqueftionable facts of phyfiology.

Nor do anatomifts differ in their opinions about the mode in which thefe fluids are taken up; for it is univerfally allowed to be by abforption, or that there are fmall orifices adapted to imbibe them: the only queftion is, what the veffels are to which thefe orifices belong, whether to the lymphatic fyftem, or to the common veins?

That the common veins did the office of abforbing both the chyle and the lymph, was the opinion of anatomifts before *Afellius* difcovered the lacteals; but after his time few doubts were entertained of the lacteals abforbing, at leaft a part of that fluid. But moft anatomifts have been fo tenacious of the old opinion, as ftill to believe that the veins partly performed that office, or abforbed fome of the chyle, and carried it to the liver.

As to the abforption of the lymph, they have been ftill more pofitive of its being performed by the common veins; nay, even after the difcovery of the lymphatic veffels, it occurred but to a few, that thefe veffels contributed in the leaft to this abforption. And no wonder, fince befides the refpect for the contrary opinion, becaufe it was tranfmitted from antiquity, anatomifts thought themfelves poffeffed of many ftrong arguments in favour of the common veins performing abforption; and as thefe arguments ftill continue to have weight with fome modern phyfiologifts, we fhall take a particular examination of them in this place.

*Firft,*

*Firſt*, That the common veins ariſe from cavities, eſpecially in the inteſtines, and to do the office of abſorption, is thought probable from injections into theſe veins in dead bodies having ſometimes paſſed into thoſe cavities, even in caſes where but little force was uſed. This is a circumſtance which has occurred in the experiments of the moſt eminent anatomiſts, both of the paſt and of the preſent age, ſo that there is no fact in anatomy in favour of which more reſpectable authorities might be produced. And yet whoever has made numerous experiments with injections, muſt be convinced how eaſy it is to be deceived by them in this matter. For the veins in dead bodies being eaſily ruptured, whenever we ſee injections get from them into cavities, we have reaſon to doubt whether theſe injections had paſſed by natural paſſages or by laceration of the ſmall veſſels; and whoever will examine the authorities that have been quoted in defence of this fact, will find, that an equal degree of credit has been given to experiments, made with ſuch coarſe materials as no experienced injector will now believe could paſs through ſuch ſmall orifices, as to thoſe injections which from their ſubtility leave the point more doubtful. Beſides, as we have already found, ſuch changes are produced upon animal bodies by death, that membranes, which during life had been ſo tenſe as to prevent tranſudation, after death were ſo much altered, that in the gall-bladder, for example, they allowed the viſcid bile to paſs; does it not therefore become doubtful, when an anatomiſt injects a cavity from a vein, whether (although he cauſe no rupture) he may not ſeparate the fibres already relaxed by death, in ſuch a manner as to imitate this tranſudation? And if one anatomiſt has been miſled when he concluded tranſudation took place in the living body, becauſe he found it in the dead body, ſo may they likewiſe, who have concluded veins aroſe from cavities in the living, becauſe they had been able to puſh injections into ſuch cavities in the dead body. It muſt therefore be allowed that ſuch

experiments

experiments are at the beſt equivocal. Beſides, from the experiments upon living animals, made long ago by Bartholin, and much later by Hunter, &c. (ſee Dr Hunter's Medical Commentaries), it appears evident, that no abſorption by red veins takes place in the living body.

Another argument uſed in favour of veins ariſing from cavities, particularly from the inteſtines, is, that ſome anatomiſts have affirmed that they have ſeen white chyle in the blood taken from the meſenteric veins. But this argument will appear very inconcluſive, when the reader recollects, that the *ſerum* of the blood let out from the veins of the arm is ſometimes white, which muſt ariſe from ſome other cauſe than theſe veins abſorbing chyle. And, therefore, if that appearance in the brachial veins can be otherwiſe accounted for than by abſorption, we are left in doubt, whether, in thoſe inſtances where anatomiſts obſerved ſuch a fluid in the veins of the meſentery, it had been owing, not to thoſe veins abſorbing it, but to their receiving it from the arteries, all the *ſerum* of the body being ſometimes white as milk.

A third argument produced in ſupport of abſorption by the common veins, is taken from the ſtructure of the penis, whoſe veins ariſe from its cells; which cells, however, are now allowed to be particular organizations, and very different from thoſe of the cellular membrane, and the blood is believed not to be abſorbed, but to be impelled from theſe cells into thoſe veins; and the argument is now given up even by ſome of thoſe who were once the moſt ſtrenuous in its favour. (See Dr Monro's State of Facts.) It need not therefore be here dwelt upon.

Ligatures, or compreſſion on the large veins, have been conſidered as furniſhing a fourth argument in favour of theſe veins ariſing from cavities, and doing the office of abſorption. Thus the ſwelling of the legs in pregnant women, and in caſes where tumors have been ſeen near the veins, has been explained

plained from the uterus in the one caſe, and the tumors in the other, occaſioning ſuch compreſſion as to prevent the return of the venous blood. But there are two circumſtances which make this argument far from being ſatisfactory. *Firſt*, The lymphatic veſſels run near ſuch veins, and it is doubtful whether the lymph may not be retained in the limbs more by the compreſſion of theſe veſſels than by that of the veins. *Secondly*, The compreſſion of a vein may, by ſtopping the return of the blood, not only diſtend the ſmall veins, but the ſmall arteries, and the exhalants may be ſo dilated, or ſo ſtimulated, as to ſecrete more fluid than they did naturally. In this way perhaps the ligature which Dr Lower made on the *cava inferior* of a dog occaſioned the *aſcites*: An experiment which Mr Hewſon has repeated, but his ſubject did not live ſo long as Dr Lower's did, as it died in half an hour, and had only a very little water in the abdomen.

Dr Lower has related another experiment which has frequently been quoted by writers on the dropſy; that is, where he tied the jugular veins of a dog, and the dog's head became dropſical. Were this an experiment which always ſucceeded, it would be more deciſive; for when the whole cava was tied, no part of the blood being able to return, all the veſſels below, not only the ſmall veins, but the ſmall arteries, muſt have been extremely diſtended; whereas, in this experiment, no ſuch thing would take place, becauſe the jugular veins ſo frequently communicate with other veſſels, that there would ſtill be a regreſs allowed the blood. If the neck therefore became œdematous, it would appear more likely to have been occaſioned by the ligature on the veins. But what ſhews that there muſt have been ſome fallacy in Lower's experiment is, that theſe veins have ſince been frequently tied without an œdema being produced, or any ſigns of extravaſated lymph. Thus, in not one of the experiments which Mr Hewſon made on theſe veins in living dogs (as related in the firſt part of his

Experimental

Experimental inquiries) was this effect ever produced: Baron Van Swieten tied both the jugular veins, and though he kept the dog four days afterwards, he did not obferve him any way incommoded. In one dog Mr Hewfon even cut out both the external jugulars, and kept him near a twelvemonth without obferving the leaft fymptom of dropfy. It appears, therefore, that in Lower's experiment, not only the veins, but the lymphatic veffels which lie near them, had been tied; in which cafe the lymphatics would burft, and occafion thefe fymptoms. But in Mr Hewfon's experiment he took care to feparate the vein from the lymphatics.

Thefe arguments therefore in favour of abforption being performed by the common veins, which are brought from experiments where ligatures were made on large veffels, feem likewife to be liable to fallacy.

A fifth argument is taken from the ftructure of the placenta, where it has been concluded there are no lymphatics; and yet there muft be abforption, and not a communication of the veffels; neither of which arguments are decifive. For there may be lymphatics in the placenta though not yet difcovered; or there may be fmall veffels paffing from the mother to the fœtus, though not yet injected.

A fixth argument is furnifhed by the experiments of fome authors; in which experiments, it is affirmed, that fluids injected into the inteftines were foon afterwards difcovered in the mefenteric veins. The experiment related by the ingenious Kauw Boerhaave, has been the moft depended upon in this matter. In which experiment water was injected into the inteftines, and thofe inteftines being compreffed, the water was afterwards obferved to run from the veins; but that fome fallacy had crept into this experiment is now probable, from its having been repeated feveral times by Mr Hunter in a very fatisfactory manner, without being attended with the like ſuccefs *. In theſe experiments the inteſtines were not only filled with water, but the experiment was alſo repeated with milk, ſtearch diſſolved in water and coloured with indigo, a ſolution of muſk in water; yet nothing was abſorbed by the veins: and this was readily diſcovered; for the veins had been previouſly emptied of their blood, by punctures made into their trunks, and prevented from receiving more by ligatures thrown round their correſponding arteries. It may be obſerved, at the ſame time, that in the above experiments, though the veins were found empty, the lacteals had filled themſelves freely. The learned Haller, indeed, in comparing theſe arguments, ſays, that in ſuch caſes where authority ſeems to balance authority, he chooſes rather to adopt the opinions of thoſe who affirm, than thoſe who deny the fact. For as he obſerves, this experiment may eaſily fail of ſucceſs; but if it has ever ſucceeded, we ſhall not eaſily find another way of accounting for it, except by allowing that theſe veins open into the inteſtines. But with due deference to the opinion of this excellent author, Kauw Boerhaave's experiment is not ſo concluſive as thoſe alluded to above: for in his, the dog was opened immediately after death, and water being injected into his ſtomach, that water was ſeen firſt to dilute the blood, then to waſh it from the vena portarum, and the experiment was continued a conſiderable time by means of preſſing the ſtomach; which preſſure furniſhes a ſtrong preſumption that the water did not get into the veins by abſorption but by a laceration, eſpecially as the experiment continued to ſucceed for ſome hours after death.

And laſtly, a ſeventh argument uſed in favour of common veins abſorbing was, that many animals were deſtitute of any other veſſels which could do that office. This was ſuppoſed to be the caſe with birds, fiſh, and amphibious animals; all of which ſome anatomiſts did not heſitate to affirm muſt want every

* See Dr Hunter's Medical Commentaries.

every part of the lymphatic fyftem, and with great appearance of reafon; fince in the fmalleft quadruped they could eafily find either lacteals or lymphatic glands upon the mefentery; but in the largeft bird, or fifh, neither lacteal veffel nor conglobate gland could be feen. And if thefe animals (faid they) be without the lymphatic fyftem, abforption in them muft be performed by other veffels, viz. the common veins; and if in them the common veins can do the office of abforption, why fhould not they likewife perform it in the human body where fuch veins equally exift? But this argument is overthrown by the lymphatic fyftem being now difcovered in all thefe animals.

Such are the arguments produced in favour of the common veins doing the office of abforption; a doctrine which has lately been efpoufed by that excellent anatomift Dr Meckel; to whofe obfervations, though agreeing with fome already mentioned, it may be neceffary to pay a particular attention.

Dr Meckel's conclufions in favour of this doctrine, are made entirely from injections in dead bodies: For having filled the common veins by injecting mercury into the lymphatic glands, into the excretory ducts of the breafts, into the veficula feminalis, into the hepatic ducts, and into the urinary bladder; he concludes, that the veins open into thefe parts in the living body to abforb from them: A conclufion which is already proved to be liable to confiderable objections, as we never can be fure whether our injections, in getting from thefe cavities into fuch veins, had gone by a natural or by a forced paffage. Dr Meckel indeed mentions, that there were no marks of an extravafation in his experiments. Perhaps it might have been too fmall for obfervation. Nay, we have even reafon to believe, that as the fmall veffels of the human body are very clofe to one another, our injection may fometimes burft from one into another lying in contact with it, without diftending the cellular membrane which lies between

 them:

them: A circumſtance which anatomiſts have ſometimes obſerved, and which Mr Hewſon has ſeen happen even on the meſentery of a turtle; where upon injecting the lacteals, he has more than once made the mercury paſs into the common veins: but in all theſe caſes, on a careful examination, we found it was by rupture, as could readily be diſtinguiſhed in this animal, whoſe meſentery is extremely thin and tranſparent. And that it was actually ſo, and not by a natural paſſage, muſt be evident to every anatomiſt who conſiders that this is an experiment which does not always ſucceed on the meſentery of the turtle; where, if there were natural paſſages, or if the lacteals opened into the veins, the mercury would probably run with great facility.

And the very ſame circumſtance which Dr Meckel has obſerved of a lymphatic gland, has happened to Mr Hewſon ſometimes on injecting theſe glands in diſeaſed caſes; that is, he has filled the common veins, and in ſome inſtances where he looked for it, he could diſtinguiſh the extravaſation very readily, and therefore concluded, that in the other caſes where the veins were filled, that it was alſo by an extravaſation, though a more obſcure one. From this he ſuſpects, that in Dr Meckel's experiment, where he filled the common veins, by injecting into the lymphatic veſſels of a diſeaſed gland, a ſimilar deception had taken place: eſpecially as the force applied was conſiderable, he having uſed a column of mercury eighteen inches high.

And the ſuppoſition of the red veins opening into a lymphatic gland, appears improbable, from an obſervation concerning the ſtructure of the glands, for which we are indebted to Dr. Meckel himſelf, viz. that they are made of a convoluted lymphatic veſſel. Now to ſuppoſe a lymphatic, which is a veſſel given to abſorb, ſhould itſelf, even when convoluted, have a common vein opening into it for abſorption from its

cavity,

cavity, does not appear confiftent with what we know of nature's operations.

Similar objections might be made to the other experiments related by this very ingenious author; but enough has been faid to fhew how cautious we fhould be in making conclufions, with refpect to the paffages of the living body, from experiments made on the dead, where, from the weaknefs of the veffels, and other circumftances, we are fo liable to be deceived.

Upon the whole, on taking a review of the doctrine that the common veins are the inftruments of abforption, that doctrine appears to have no other fupport than refpect for the authority of our predeceffors: for all the arguments in its favour are liable to confiderable objections. Let us next, therefore, inquire, whether fome other part of the human body may not do that important office?

## § 3. *Of Abforption by the Lymphatic Syftem.*

This fyftem in all animals, we have found, confifts of a trunk or a thoracic duct, and of two extremities, namely, the lacteals, and the lymphatic veffels. The lacteals can be traced from the inner furface of the inteftines, where they begin by fmall orifices, in order to abforb the chyle, and to tranfmit it through the thoracic duct to the blood-veffels. That this is their ufe, has never been queftioned fince the firft difcovery of thofe veffels, from its always admitting of eafy demonftration; that is, by giving an animal milk, and then opening him a few hours after; in which cafe the fame fluid that is feen in his inteftines can likewife be feen to have got into his lacteals.

After thus being convinced, that the ufe of one branch of the fyftem is to abforb, we cannot at firft fight but wonder that any anatomift fhould have hefitated to attribute a fimilar office to the other. Neverthelefs fome anatomifts have been led to afcribe to the lymphatics a very different ufe to what they found

found the lacteals perform; particularly ſince the time that Nuck firſt made his experiments, in which he thought he injected theſe lymphatic veſſels from the arteries; and therefore concluded, that they had no other uſe than as correſpondent veins to return the lymph from ſuch arteries as were too ſmall to admit the red blood, or the ſerum. And in this opinion anatomiſts were confirmed by the theories of Leeuwenhoek and of Boerhaave, concerning the gradation in the ſeries of the globules of our fluids, and of the ſizes of the veſſels deſtined to convey them; thence the idea of the lymphatic veſſels being ſmall veins continued from arteries became ſo general among phyſiologiſts.

But although this idea was ſo commonly received, yet there were ſome phyſiologiſts who reaſoned better on the ſubject; and amongſt the firſt of theſe was Gliſſon, who, in a book publiſhed the very year after that in which Bartholin wrote upon the lymphatics, attributes to thoſe veſſels the office of carrying back to the blood-veſſels the lymph which had lubricated the cavities of the body.

M. Noguez, likewiſe in a chapter where he mentions the name of Dr Gliſſon, ſpeaks of abſorption by the lymphatics. Hambergerus alſo ſeems to have had this idea of their office: And Frederic Hoffman has expreſſed the doctrine of the lymphatics being abſorbents very completely, in his Medic. Ration. Syſtem. lib. i. ſect. 2. cap. 3.

This opinion of the lymphatics being a ſyſtem of abſorbents, has been adopted and ſupported with additional arguments by Dr Hunter and Dr Monro; who, beſides ſhewing the fallacy of the experiments brought in favour of the common veins doing the office of abſorption, have advanced the following arguments to prove that the lymphatics perform it.

Firſt, Their great analogy with the lacteals, with which they agree in their coats, in their valves, in their manner of ramifying, in their paſſage through the lymphatic or conglobate

bate glands, and in their termination in the thoracic duct, and in ſhort in every circumſtance with regard to their ſtructure; and thence it is probable they alſo agree with them in their uſe. And as the lacteals are known to begin from the ſurface of the inteſtines, and to be the abſorbents of theſe parts, the lymphatics may begin from the other cavities of the body, and may abſorb the fluids which had lubricated thoſe cavities.

Secondly, The paſſage of the venereal, variolous, and other poiſons into the conſtitution; theſe poiſons firſt making an ulcer, and then being abſorbed along with the matter of the ulcer and infecting the whole body. That in ſuch caſes they are not abſorbed by the common veins, but by the lymphatics, appears from their inflaming theſe lymphatics in their courſe, and by their generally inflaming a conglobate gland before they enter the ſyſtem; a ſtrong argument in favour of their being taken up by the lymphatic veſſels, which paſs through theſe glands in their way to the thoracic duct.

Theſe two are the principal arguments by which the doctrine of the lymphatics being a ſyſtem of abſorbents has been ſupported. Experiments made by injections in the dead body, where ſuch injections have been forced from the arteries into the cellular membrane and from the cellular membrane into the lymphatics, have been likewiſe brought in favour of this doctrine, but improperly; and being now given up by thoſe who advanced them, they need not be dwelt upon here.

But our experiments related above furniſh another argument in favour of the lymphatics being a ſyſtem of abſorbents; for in theſe experiments, we have always found the fluids contained in the different cavities of the body, and that contained in the lymphatics exactly agreeing with one another, in their tranſparency, in their conſiſtence, &c. And in animals in health, we likewiſe found, when the one jellied on being expoſed to the air, the other did ſo too; and in the animal reduced by low diet, where the properties of the one were altered;

tered, thofe of the other were fo likewife, and exactly in the fame manner. So that we now feem to have obtained as decifive an argument in favour of abforption by lymphatics, as we before had of that by the lacteals; for the lacteals were concluded abforbents from their being found to run from the inteftines filled with a fluid fimilar to what was in the cavity of the gut: fo we feem here to have the fame reafon for believing that the lymphatics abforb from cavities, becaufe they are found to contain a fluid exactly fimilar to what is obferved in thefe cavities; a ftrong argument that the fluid had paffed from fuch cavities into thefe lymphatics by abforption.

Such, then, feems to be the purpofe for which the lymphatic veffels were provided, that is, to do the office of abforption, an office of the greateft importance to the animal; no wonder, therefore, that there fhould be a fyftem fet apart for performing it, and not only in man and quadrupeds, but alfo in birds, fifh, amphibious animals, and perhaps even in infects of the moft perfect kind.

A SYSTEM

A

# SYSTEM OF ANATOMY.

## PART VII.

## OF THE HUMAN NERVES.

BY THE LATE DR ALEX. MONRO.

## CHAP. I.

### Of the NERVES in General.

1. THE numerous turns which the carotid and vertebral arteries make before they paſs through the dura mater, theſe arteries having neither ſwelling muſcles nor preſſure of the atmoſphere to aſſiſt the courſe of the blood in them after they enter the ſkull, and their diviſion into innumerable communicating branches in the pia mater, and its proceſſes, ſhew, that the liquors muſt move more ſlowly and equally in them than in moſt other parts of the body.

2. By the aſſiſtance of injections and microſcopes, the very minute branches of theſe veſſels are diſcovered to go from the pia mater, into the cortex, cineritious, or aſhy coloured part of the cerebrum, cerebellum, and ſpinal marrow; whereas we can only ſee longitudinal veſſels, without numerous ramifications or reticular plexuſes, in the white medullary ſubſtance of theſe parts.

3. The continuity of the cortex with the medulla of the encephalon and ſpinal marrow is obſervable with the naked

eye, and is more diſtinctly ſeen with the aſſiſtance of a microſcope.

4. In diſſecting the brain and cerebellum, we ſee the ſmall beginnings of the medulla proceeding from the cortex, and we can trace its gradual increaſe by the addition of more ſuch white ſubſtance coming from the cortex.

5. Both theſe ſubſtances are very ſucculent; for being expoſed to the air to dry, they loſe more of their weight than moſt other parts of the body do.

6. In ſeveral places we can obſerve the medulla to be compoſed of fibres laid at each others ſides.

7. The medullary ſubſtance is employed in forming the white fibrous cords, which have now the name of *nerves* appropriated to them. Within the ſkull we ſee the nerves to be the medullary ſubſtance continued; and the ſpinal marrow is all employed in forming nerves.

8. The common opinion concerning the riſe of the nerves, founded on a ſuperficial inſpection of thoſe parts, is, that the nerves are propagated from that ſide of the encephalon at which they go out of the ſkull. But it having been remarked, after a more ſtrict inquiry, and preparing the parts by maceration in water, that the medullary fibres decuſſate or croſs each other in ſome parts of the medulla; as for example, at the corpus annulare, and beginning of the ſpinal marrow; and practical obſervers having related ſeveral examples, of people whoſe brain was hurt on one ſide, while the morbid ſymptom, palſy, appeared on the other ſide of the body, of which I have ſeen ſome inſtances: and experiments made on brutes having confirmed theſe obſervations, it has been thought, that the nerves had their riſe from that ſide of the encephalon which is oppoſite to their egreſs from the ſkull. It may, however, ſtill be ſaid, that this laſt opinion is not fully demonſtrated, becauſe a decuſſation in ſome parts is not a proof that it obtains univerſally; and if there are examples

of

of palfy of the fide oppofite to that on which the brain was hurt, there are alfo others, where the injury done to the brain and the palfy were both on the fame fide.

9. The nerves are compofed of a great may threads lying parallel to each other, or nearly fo, at their exit from the medulla.

This fibrous texture is evident at the origin of moft of the nerves within the fkull: and in the cauda equina of the fpinal marrow, we can divide them into fuch fmall threads, that a very good eye can fcarcely perceive them: but thefe threads, when looked at with a microfcope, appear each to be compofed of a great number of fmaller threads.

10. How fmall one of thefe fibrils of the nerves is, we know not; but when we confider that every, even the moft minute part of the body is fenfible, and that this muft depend on the nerves (which, all conjoined, would not make a cord of an inch diameter) being divided into branches or filaments to be difperfed through all thefe minute parts, we muft be convinced, that the nervous fibrils are very fmall. From the examination of the minimum vifibile, it is demonftrated, that each fibre in the retina of the eye, or expanded optic nerve, cannot exceed in diameter the 32 400th part of a hair

11. The medullary fubftance, of which the nervous fibrils are compofed, is very tender, and would not be able to refift fuch force as the nerves are expofed to within the bones, nor even the common force of the circulating fluids, were not the pia mater and tunica arachnoides continued upon them; the former giving them firmnefs and ftrength, and the latter furnifhing a cellular coat to connect the threads of the nerves, to let them lie foft and moift, and to fupport the veffels which go with them.

It is this cellular fubftance that is diftended when air is forced through a blow-pipe into a nerve, and that makes a nerve appear fpongy, after being diftended with air till it dries; the proper nervous fibrils ſhrivelling ſo in drying, that they can ſcarcely be obſerved.

12. Theſe coats (§ 11.) would not make the nerves ſtrong enough to bear the ſtretching and preſſure they are expoſed to in their courſe to the different parts of the body; and therefore, where the nerves go out at the holes in the cranium and ſpine, the dura mater is generally wrapped cloſely round them to collect their looſe fibres into tight firm cords: and that the tenſion which they may happen to be expoſed to may not injure them before they have got this additional coat, it is firmly fixed to the ſides of the holes in the bones through which they paſs.

13. The nervous cords, thus compoſed of nervous fibrils, cellular coat, pia and dura mater, have ſuch numerous blood-veſſels, that after their arteries only are injected, the whole cord is tinged with the colour of the injected liquor; and if the injection is puſhed violently, the cellular ſubſtance of the nerves is at laſt diſtended with it.

14. A nervous cord, ſuch as has been juſt now deſcribed, has very little elaſticity, compared with ſeveral other parts of the body. When cut out of the body, it does not become obſervably ſhorter, while the blood-veſſels contract three-eighths of their length.

15. Nerves are generally lodged in a cellular or fatty ſubſtance, and have their courſe in the interſtices of muſcles and other active organs, where they are guarded from preſſure; but in ſeveral parts they are ſo placed, as if it was intended that they ſhould there ſuffer the vibrating force of arteries, or the preſſure of the contracting fibres of muſcles.

16. The larger cords of the nerves divide into branches as they go off to the different parts; the branches being ſmaller than the trunk from which they come, and making generally an acute angle where they ſeparate.

17. In ſeveral places, different nerves unite into one cord, which is commonly larger than any of the nerves which form it.

18. Several nerves, particularly thoſe which are diſtributed to the bowels, after ſuch union, ſuddenly form a hard knot conſiderably larger than all the nerves of which it is made. Theſe knots were called *corpora olivaria*, and are now generally named *ganglions**.

19. The ganglions have thicker coats, more numerous, and larger blood-veſſels, than the nerves; ſo that they appear more red and muſcular. On diſſecting the ganglions, fibres are ſeen running longitudinally in their axes, and other fibres are derived from their ſides in an oblique direction to the longitudinal ones.

20. Commonly numerous ſmall nerves, which conjunctly are not equal to the ſize of the ganglion, are ſent out from it, but with a ſtructure no way different from that of other nerves.

21. The nerves ſent to the organs of the ſenſes, loſe there their firm coats, and terminate in a pulpy ſubſtance. The optic nerves are expanded into a ſoft tender web, called the retina. The auditory nerve has ſcarce the conſiſtence of mucus in the veſtibulum, cochlea, and ſemicircular canal of each ear. The papillæ of the noſe, tongue, and ſkin are very ſoft.

22. The nerves of muſcles can likewiſe be traced till they ſeem to loſe their coats by becoming very ſoft; from which, and what we obſerved of the ſenſatory nerves (§ 21.), there is reaſon to conclude, that the muſcular nerves are alſo pulpy at their terminations, which we cannot indeed proſecute by diſſection.

23. It would ſeem neceſſary that the extremities of the nerves ſhould continue in this ſoft flexible ſtate, in order to perform

* See Vol. II. p 63, and Monro on the Nervous Syſtem, Tab. xx. xxi. xxii. xxiii.

perform their functions right: for, in proportion as parts become rigid and firm by age, or any other cauſe, they loſe of their ſenſibility, and the motions are more difficultly performed.

24. Though the fibres in a nervous coat are firmly connected, and frequently different nerves join into one trunk, or into the ſame ganglion; yet the ſenſation of each part of the body is ſo very diſtinct, and we have ſo much the power of moving the muſcles ſeparately, that, if the nerves are principal agents of theſe two functions, which I ſhall endeavour to prove they are, we have reaſon to believe that there is no union, confuſion, or immediate communication of the proper nervous fibrils, but that each fibre remains diſtinct from its origin to its termination.

25. Changes produced any way upon the coats of the nerves, cannot, however, but affect the nervous fibrils. The cellular ſubſtance may be too full of liquor, or may not ſupply enough; the liquor may not be of a due conſiſtence, or it may be preternaturally obſtructed and collected. The pia or dura mater may be too tenſe, or too lax; their veſſels may be obſtructed; their proper nerves may be violently irritated, or loſe their power of acting; and a great many other ſuch changes may happen, which will not only occaſion diſorders in particular nerves, but may be a cauſe of the ſympathy ſo frequently obſerved among the nerves; which is ſo neceſſary to be attentively regarded in a great many diſeaſes, in order to diſcover their true ſtate and nature, that, without this knowledge, very dangerous miſtakes in the practice of phyſic and ſurgery may be committed.

26. Many experiments and obſervations concur in proving, that when nerves are compreſſed, cut, or any other way deſtroyed, the parts ſupplied with ſuch nerves, farther from the head or ſpine than where the injuring cauſe has been applied, have their ſenſations, motions, and nouriſhment, weakened or

or loſt; while no ſuch effects are ſeen in the parts nearer to the origin of thoſe nerves: and in ſuch experiments where the cauſe impeding the nerves to exert themſelves could be removed, and the ſtructure of the nerves was not injured, as for example, when a ligature upon a nerve, ſtopping its influence, has been taken away, the motion and ſenſation of the parts were ſoon reſtored. From which it would appear, that the nerves are principal inſtruments in our ſenſations, motions, and nouriſhment; and that this influence of the nerves is not inherent in them, unleſs the communication between theſe cords and their origin is preſerved.

This concluſion is juſt, notwithſtanding that ſometimes, upon cutting a nerve, the effects above mentioned have been felt for a ſhort time, but afterwards the perſon was ſenſible of no numbneſs or immobility: for wherever this is ſaid to have happened, the cut nerve was only one of ſeveral which were ſent to the member; the want of whoſe influence was felt no longer, than till the habit was acquired of performing the functions eaſily by the other nerves.

Nor is it of greater weight as an objection, that ſometimes when a ligature is drawn very hard upon a nerve, and then is taken away, the nerve never again recovers its influence upon the parts it is diſtributed to beyond the ligature, but is of as little effect as if it had been cut through; which is to ſay that its texture has been altered beyond recovery. The ſame thing is to be ſeen by tying a thread tight round a tender twig of any vegetable; it decays.

27. Experiments and obſervations ſhew, too, that when parts of the encephalon or ſpinal marrow have been irritated, compreſſed, or deſtroyed, the parts of the body, whoſe nerves had their origin from ſuch affected parts of the encephalon or ſpinal marrow, became convulſed, paralytic, inſenſible, or waſted; and in ſuch caſes where the injuring cauſe could be removed from the origin of the nerves, the morbid ſymptoms

obſerved

obferved in the parts to which thefe nerves were diftributed, went off upon the removal of that caufe. From which it is thought reafonable to conclude, that the nerves muft not only have a communication with their origin, but that the influence they have upon the parts they are diftributed to, depends on the influence which they derive from the medulla encephala and fpinalis.

28. Though the fpinal marrow has its own veffels and cineritious fubftance, which affifts to form its medulla; yet a very large fhare of the medullary fubftance within the fpine is derived from the encephalon, whofe medulla oblongata defcends from the head; and the influence of the fpinal marrow on its nerves depends in a great meafure on this medulla oblongata of the head. Hence an injury done to any part of the fpinal marrow, immediately affects all the parts, whofe nerves have their origin below where the injuring caufe is applied. A laxation of a vertebra in the loins makes the lower extremities foon paralytic; a tranfverfe fection of the medulla at the firft vertebra of the neck, foon puts an end to life.

29. If fuch caufes produce conftantly fuch effects (§ 26, 27, 28.) in us and other creatures living in nearly the fame circumftances as we do, the conclufions already made muft be good, notwithftanding examples of children and other creatures being born without brains or fpinal marrow; or notwithftanding that the brains of adult creatures can be much changed in their texture by difeafes; and that tortoifes, and fome other animals, continue to move a confiderable time after their heads are cut off. We may be ignorant of the particular circumftances requifite or neceffary to the being or well-being of this or that particular creature; and we may be unable to account for a great many phenomena; but we muft believe our eyes in the examination of facts; and if we fee conftantly fuch confequences from fuch actions, we cannot but conclude the one to be the caufe and the other the effect.

It

It would be as unjuft to deny the conclufions made in the three preceding articles, becaufe of the feemingly preternatural phænomena mentioned at the beginning of this, as it would be to deny the neceffity of the circulation of the blood in us and moft quadrupeds, becaufe a frog can jump about, or a tortoife can walk, long after all the contents of its thorax and abdomen are taken out, or becaufe the different parts of a worm crawl after it has been cut into a great many pieces. It is therefore almoft univerfally allowed, that the nerves are principal inftruments in our fenfations, motion, and that the influence which they have is communicated from their origin, the encephalon and medulla fpinalis. But authors are far from agreeing about the manner in which this influence is communicated, or in what way nerves act to produce thefe effects.

30. Some alledge, that the nervous fibres are all folid cords, acting by elafticity or vibration; others maintain, that thofe fibres are fmall tubes conveying liquors, by means of which their effects are produced.

31. The gentlemen, who think the nervous fibres folid, raife feveral objections to the other doctrine; which I fhall confider afterwards; and endeavour to fhew the fitnefs of their own doctrine to account for the effects commonly obferved to be produced by the nerves.

The objects of the fenfes plainly (fay they) make impulfes on the nerves of the proper organs, which muft fhake the nervous fibrils: and this vibration muft be propagated along the whole cord to its other extremity or origin, as happens in other tenfe ftrings; and thefe vibrations being differently modified, according to the difference of the object, and its different application, produce the different ideas we have of objects.

32. To this account of fenfation, it is objected, firft, That nerves are unfit for vibrations, becaufe their extremities, where objects are applied to them, are quite foft and pappy

(§21.), and therefore not fufceptible of the vibrations fuppofed; and if there could be any little tremor made here by the impulfe of objects, it could not be continued along the nervous cord, becaufe the cellular fubftance by which each particular fibre is connected to the neighbouring ones (§ 11.), and the fatty fubftance in which the nervous cord is immerfed (§ 15.), would foon ftifle any fuch vibratory motion.

A fecond objection to this doctrine is, That fuppofing the nerves capable of vibrations by the impreffions of objects, thefe vibrations would not anfwer the defign. For if what we know of other vibrating ftrings, to wit, that their tone remains the fame, unlefs their texture, length, or tenfion is altered, and that different fubftances ftriking them do no more than make the found louder or weaker; if thefe properties are to be applied to nerves, then it will follow, that the fame nerve would conftantly convey the fame idea, with no other variety than of its being weaker and ftronger, whatever different objects were applied to it; unlefs we fuppofed the nerve changed in its texture, length, or tenfion, each time a different object is applied; which, it is prefumed, no body will undertake to prove does happen.

Nay, 3dly, If ever fuch a variety of vibrations could be made, our fenfations would notwithftanding be confufed and indiftinct; becaufe the tremulous nervous fibre being firmly connected and contiguous to feveral other fibres of the fame cord, would neceffarily fhake them too, by which we fhould have the notion of the object as applied at all the different parts where the extremities of thefe fibres terminate.

33. In whatever way the favourers of the doctrine of folid nerves pleafe to apply the elafticity of nerves to the contraction of mufcles, their adverfaries infift that nerves are too weak to refift fuch weights as the mufcles fuftain; they would furely break, efpecially as they are in a great meafure, if not wholly, deprived of their ftrong coats before they come to the

the part of the mufcle they are immediately to act upon (§ 22.)—The nerves being found to have little or no elafticity to fhorten themfelves (§ 14), fhews them altogether unfit for fuch an office as this of contracting the mufcles in the way propofed of their acting by elafticity; and when a nerve is viewed with a microfcope while the mufcles it ferves are in action, no contraction or motion is obferved in it. —— ay, if they were elaftic, they would equally exert their power of contracting mufcles nearer to their origin as well as farther from it, when they were put into contraction or vibration, by irritation of any part of them. The former, however, does not happen.

34. As a further objection againft either motion or fenfation being owing to the elafticity of the nerves, it is faid, that if this doctrine was true, the fenfations would be more acute, and the contractions of mufcles would be greater and ftronger, when the parts become firmer and more rigid by age; for then their elafticity is increafed: Whereas, on the contrary, it appears (§ 23.) that then the fenfations are blunted, and mufcular contraction becomes lefs and weaker.

35. If the nerves were granted to be elaftic, and to communicate a fpringy force to all the parts they are diftributed to, they might appear neceffary in this view to affift the application of the nutritious particles of the fluids to the fides of the veffels which thefe particles were to repair; and fo far might well enough account for the fhare which nerves are thought to have in nutrition: But if we cannot make ufe of elafticity in the other two functions, fenfation and motion, we muft alfo endeavour to find out fome other way for the nerves to act in nutrition; which will be done afterwards.

36. Having thus ftated the reafons for and againft the nerves acting as folid ftrings, let us likewife relate the arguments for the nerves being tubes, and the objections to this doctrine.

A great argument of thofe who think the nerves to be tubes conveying liquors, is the ftrong analogy of the brain and nerves to other glands of the body, and their excretories, where a manifeft fecretion of liquor is made in the glands, to be conveyed by the excretories to the proper places in which it ought to be depofited; they think that the vafcular texture of the cortex of the encephalon and fpinal marrow (§ 2.) the continuation of the cortex in forming the medullary fubftance (3, 4.) the fibrous texture (§ 5.) and fucculent ftate of this medulla (§ 6.) and its being wholly employed to form the nerves (§ 7.) where the fibrous texture is evident (§ 9.); all thefe things, fay they, confpire to fhow fuch a ftrong analogy between thefe parts and the other glands of the body, as carries a conviction that there is a liquor fecreted in the encephalon and fpinal marrow, to be fent out by the nerves to the different parts of the body.

37. The following objections are raifed to this argument in favour of liquor conveyed in the nerves from the analogy of the glands. *1ft*, Other glands, it is faid, have their excretories collected into a few large tubes, and not continued in fuch a great number of feparate tubes, as far as the places where the liquors are depofited; which laft muft be the cafe, if the nerves are the excretories of the glandular brain. *2dly*, We fee the cavities, and can examine the liquors in the excretories of other glands much fmaller than the brain; which cannot be done in the nerves. *3dly*, If the nerves were tubes, they would be fo fmall, that the attraction of the liquors to their fides would prevent that celerity in the motion of the liquors, which is requifite to fenfations and motions. *4thly*, If the nerves were tubes, they would be cylindrical ones, and confequently not fubject to difeafes; or at leaft we could have no comprehenfion of the difeafes in them.

38. The anfwer to the *1ft* of thefe objections is, That there are other glands where there is a manifeft fecretion, and in which the difpofition of the excretories is in much the fame way

way as in the encephalon: the kidneys, for example, have a reticulated cortex of veſſels, from which the Euſtachian or Bellinian medulla, conſiſting of longitudinal fibres and a few blood-veſſels in the ſame direction, proceeds; and this medulla is collected into ten, twelve, or more papillæ, each of which is formed of numerous ſmall ſeparate tubes, which ſingly diſcharge the urine into the large membranous tubes; and theſe united form the pelvis. Upon comparing this texture of the kidneys with that of the encephalon (§ 2, 3, 4, 5, 6, 7, 9,) the analogy will be found very ſtrong.

39. In anſwer to the 2*d* objection, in § 37. it is granted, that microſcopes, injections, and all the other arts hitherto employed, have not ſhewn the cavities of the nervous fibrils, or the liquors contained in them; and from what was ſaid (§ 10.) of the ſmallneſs of the nervous fibrils, it is not to be expected that ever they ſhould be ſeen. But ſo long as ſuch a number of little animals can every hour be brought to the objectors, in which they can as little demonſtrate the veſſels or contained fluids, it will not be allowed to be concluſive reaſoning, that becauſe ocular demonſtration cannot be given of either the tubes or their contents, therefore they do not exiſt. For if we have any notion of an animal, it is its being an hydraulic machine, which has liquors moving in it as long as it has life. If, therefore, ſuch little animals have veſſels and liquors which we cannot ſee, why may not ſome of the veſſels and liquors of the human body be alſo inviſible to us?

To avoid this anſwer to the objection, it is further urged, That though we might not ſee the nervous tubes or the liquors they contain as they naturally flow; yet if ſuch liquors really exiſt, they ought to diſcover themſelves, either by a nerve's ſwelling when it is firmly tied; or that, however ſubtile their fluids are, they might be collected in ſome drops, at leaſt, when the cut end of a nerve of a living animal is kept ſome time in the exhauſted receiver of an air-pump. It is affirmed, that neither

neither did the tied nerve ſwell between the brain and ligature, nor was there any liquor collected in the receiver of the air pump; from which it is concluded, that there is no liquor in the nerves.

Some, who ſay they have tried theſe experiments, affirm, that in young animals the nerve does ſwell above the ligature, and that a liquor does drill out upon cutting a nerve.—— Whether ſwelling or liquor is ſeen or is not ſeen in theſe experiments, no concluſion for or againſt a nervous fluid can be made from them: for the ſwelling of the nerve after it is tied, or the efflux of liquors from its extremity, will never prove either to be the effect of the fluid in the proper nervous fibrils, ſo long as they might be occaſioned by the liquors in the larger veſſels of the cellular ſubſtance of the nerves; and if theſe ſame veſſels of the coats of the nerves do not diſcover their liquors by theſe experiments, it is far leſs to be expected that the much more ſubtile nerves will diſcover theirs.

40. The 3*d* objection to the doctrine of the brain being a gland, and the nerves its excretories, ſuppoſes a more rapid motion neceſſary in the fluid of the nerves than what moſt of the defenders of the nervous fluid will now allow; and is afterwards to be conſidered particularly in a more proper place.

41. The 4*th* objection being, That if the nerves are excretories of a gland, they muſt be cylindrical tubes, in which no obſtructions or diſeaſes would happen; but ſince we daily ſee diſeaſes in the nerves, they muſt not therefore be ſuch excretories. The anſwer is, That diſeaſes happen often in the excretories of other glands, as of the liver, kidneys, &c. notwithſtanding their cylindrical form, and their much ſhorter and leſs expoſed courſe. When we conſider the very tender ſubſtance of the brain, the vaſt complication of its veſſels, the prodigious ſmallneſs of the tubes going out from it, the many moving powers which the nerves are to undergo the ſhock of, and the many chances which the veſſels, membranes, and cellular

cellular ſubſtance accompanying the nerves, have of being diſordered, and then affecting the nervous fibrils, we have very great reaſon to be ſurpriſed, that theſe cylindrical tubes are not much more frequently put out of order, by too great or too ſmall a quantity of liquors; by too viſcid or too thin fluids; by liquors conſiſting of too mild and too ſluggiſh particles, or of too acrid pungent ones; by too great or too little motion given to the liquors; by the diameters of the tubes being too much ſtraitened or too much enlarged; and by a great many other varieties of circumſtances which might be thought capable of diſturbing the functions of the nerves, ſuppoſing them to be cylindrical excretories of the brain, as a gland.

42. The numerous veſſels of the encephalon have brought ſome of the gentlemen who aſſert the nerves to be ſolid, to acknowledge, that there is a liquor ſecreted in the brain; but then they will not allow that this liquor is ſent out by the proper nervous fibrils, but that it is poured into the cellular ſubſtance, in which the nerves lie, to keep them moiſt and ſupple, and therefore fit for exerting their elaſticity, vibration, &c. by which, in their opinion, the effects commonly aſcribed to nerves are produced.

43. Beſides the objections already mentioned (§ 32, 33.) againſt the nerves acting as elaſtic ſtrings, this opinion has ſome other difficulties which may be objected to it: for inſtance, there is not one analogous example in the whole body of liquors ſecreted in a large gland, to be poured into a cellular ſubſtance, as is here ſuppoſed; the liquors in the cells of the tela cellularis of other parts are ſeparated from the little arteries which are diſtributed to theſe cells.

Further, it cannot be imagined, how a liquor ſecreted in the cortex of the brain ſhould make its way through the medulla, to come out into the cellular membranes on the ſurface of that medulla.

*Laſtly,*

*Laſtly*, A very ſimple experiment, of injecting water by the artery of any member, and thereby filling the cellular ſubſtance of the nerves of that member, ſhews, evidently, that the liquor of the cellular ſubſtance of the nerves has the ſame fountain as the liquor has in the tela cellularis any where elſe, that is, from the little arteries diſperſed upon it.

44. The doctrine of a fluid in the nerves, is not only thus ſupported by the analogy of the brain and nerves to the other glands and their excretories, but thoſe who maintain this doctrine mention an experiment which they think directly proves a fluid in the nerves. It is this: After opening the thorax of a living dog, catch hold of and preſs both one or both of the phrenic nerves with the fingers, the diaphragm immediately ceaſes to contract; ceaſe to compreſs the nerves, and the muſcle acts again: a ſecond time, lay hold of the nerve or nerves ſome way above the diaphragm, its motion ſtops. Keep firm hold of the nerve, and with the fingers of the other hand ſtrip it down from the fingers which make the compreſſion towards the diaphragm, and it again contracts: a repetition of this part of the experiment three or four times, is always attended with the ſame effects; but it then contracts no more, ſtrip as you will, unleſs you remove the preſſure to take hold of the nerves above the place firſt pinched; when the muſcle may be again made to contract, by ſtripping the nerve down towards it. This experiment I have done with the ſucceſs here mentioned. Let any one try if he can imagine any other reaſonable account of theſe appearances, than that the preſſure by the fingers ſtopped the courſe of a fluid in the nerve; that ſo much of this fluid as remained in the nerve, between the fingers and diaphragm, was forced into that muſcle by ſtripping; and when it was all preſſed away, the fingers above preventing a ſupply, the muſcle contracted no more till the fingers were removed, and a freſh flow was by that means received from the

the ſpinal marrow, or from that part of the nerve which had not yet been ſo ſtripped.

It has been objected to the concluſions from this experiment, 1. That the diaphragm is ſet in motion by ſtripping the nerve from, as well as towards, this muſcle; and this may be well expected; for a liquor in ſuch ſmall pipes hindered to flow backwards by ligature, pinching fingers, or even the flow of their liquors from the fountain, will regurgitate forwards with velocity when preſſed backwards. We ſee it happen in the ſtalks of tender ſucculent plants.

2. It is ſaid that muſcles ceaſe to act when their veins are tied, as well as when their arteries or nerves are tied or cut, but that muſcles continue to act when their veins are cut: by which it would appear that the overloading of the veſſels is an impediment to the action of muſcles; and therefore the ceaſing of their action, when their arteries or nerves are tied or cut, may alſo be owing to the liquor in the branches of theſe pipes of muſcles ſtagnating when it is not propelled by the flow of more liquor from their trunks, and not to any influence or moving power, which now ceaſes to be conveyed to them.

It is to be obſerved, in making the experiments juſt now mentioned, that the contraction of the muſcles ceaſes ſooneſt when the nerves, and lateſt when the veins are tied.——That when veins are tied, not only are the veſſels overloaded, but all the cellular ſubſtance of the muſcles is filled with coagulated blood; whereas when the arteries and nerves are tied, the reverſe is ſeen, the muſcles are lax, and of leſs bulk. So that in theſe caſes, the ceaſing of the contraction of the muſcles ſeems to depend on very different cauſes, to wit, a deprivation of neceſſary liquors in the one, and a redundancy of ſuperfluous blood in the other. An elaſtic ſtick may be deprived of its elaſticity, by being made either too dry or too wet.

45. Some gentlemen, convinced of the reaſonableneſs of the ſecretion of a liquor in the brain to be ſent out by the nerves,

but not comprehending how a fluid could have ſuch a rapid retrograde motion as they imagined was neceſſary for conveying the impreſſions of objects made on the extremities of nerves to the ſenſorium, ſuppoſed two ſorts of nerves; one that conveyed a liquor for muſcular motion and nutrition; the other compoſed of ſolid nerves, that were to ſerve for organs of the ſenſes, to convey the vibrations communicated from objects to the ſenſorium.

46. To this opinion (§ 45.) the objection againſt the ſenſatory nerves acting by vibration (§ 32.) may be made; and there is ſo little reaſon to ſuſpect any difference in the texture of the different parts of the brain or nerves, that, on the contrary, the ſtructure is every where ſimilar, and branches of the ſame nerve often ſerve both for ſenſation and motion.

How little neceſſity there is for ſuppoſing extremely rapid motions of the nervous fluid, is to be examined ſoon.

47. The hypotheſis of great celerity in the motion of the fluid of the nerves being neceſſary, gave alſo riſe to another diviſion of the nerves, into arterious or effluent, and venous or refluent. It was ſaid that muſcular motion or nutrition depended on the arterious nerves; and that the ſenſations depended on an accelerated motion of the nervous fluid towards the brain, by the impreſſions which the objects of the ſenſes make upon the venous nerves. By this ſuppoſition, the abſurdity of rapid fluxes and refluxes in the ſame canal was prevented; and an advantage was thought to be gained by it, of ſaving too great a waſte of the fluid of the nerves, which otherwiſe the encephalon and ſpinal marrow could not ſupply in ſufficient quantity to anſwer all the exigencies of life.

48. To this opinion (§ 47.) it has been objected, *1ſt*, That there is no example in the body, of a ſecreted liquor being turned immediately and unmixed to the gland by which it was originally ſeparated from the maſs of blood; which would be the caſe were there venous nerves. *2dly*, There is no occaſion for

for faving the fluid of the nerves in the way propofed; the organs for fecreting that fluid being large enough to fupply all that is neceffary of it in the common functions of life. 3*dly*, If the fluid of the nerves was to be thus kept in a perpetual circulation, it would foon become too acrid for continuing with fafety in fuch fenfible tender veffels as the brain and nerves are compofed of. 4*thly*, This hypothefis will not anfwer the defign forwhich it was propofed: for though the momentary application of an object might caufe an acceleration in the fluid of venous nerves, yet if the object was kept applied to the nerves, it would ftop their fluid, fo that it could not go forward to the brain; and therefore, according to this doctrine, we fhould be fenfible of no objects, except thofe whofe application to the organs of the fenfes was momentary.

49. Let us now fuppofe it probable, that the encephalon and fpinal marrow fecern a liquor from the blood which is fent into all the nerves, and that by the means of this liquor the nerves perform the offices commonly affigned to them; it is next neceffary to enquire what kind of liquor this is, and how it moves, in order to determine how well its nature and motion are fitted for performing what is expected from it.

50. The liquor of the nerves has been fancied by fome to be of a very ftrong acid or alkaline nature: But fince none of our juices appear to be of this fort, and fince fuch liquors irritate and deftroy the parts of the body to which they are applied, we cannot conceive how the brain can feparate, or the nerves could bear any thing of fuch an acrid nature. This tendernefs and fenfibility of thefe organs muft hinder us abfolutely from fuppofing that the liquor of the nerves can be acrid or pungent, or of the nature of fpirit of wine, hartfhorn, &c.

51. Some have imagined the liquor of the nerves to be capable of vaft explofion like gun-powder, or of violent fudden rarefaction like air, or of ftrong ebullition like boiling-water,

or of effervefcence like the mixture of acids with alkaline liquors. But as the mafs of blood from which this fluid is derived, is not poffeffed of any fuch properties, we cannot fuppofe the blood to furnifh what it has not in itfelf. Befides, all thefe operations are too violent for the brain or nerves to bear; and when once they are begun, they are not fo quickly controlled or reftrained, as experience teaches us the nerves can, which may be fuddenly made to ceafe from acting.

52. We are not fufficiently acquainted with the properties of an æther, or electrical effluvia, pervading every thing, to apply them juftly in the animal œconomy; and it is as difficult to conceive how they fhould be retained or conducted in a long nervous cord. Thefe are difficulties not to be furmounted.

53. The fureft way of judging what kind of liquor this of the nerves muft be, is to examine the liquors of fimilar parts of the body. All the glands feparate liquors from the blood much thinner than the compound mafs itfelf; fuch is the liquor poured into the cavity of the abdomen, thorax, ventricles of the brain, the faliva, pancreatic juice, lymph, &c. Wherever there is occafion for fecreted liquors being thick and vifcid, in order to anfwer better the ufes they are intended for, nature has provided refervoirs for them to ftagnate in, where their thinner parts may be carried off by the numerous abforbent veins difperfed on the fides of thofe cavities; or they may exhale where they are expofed to the open air. The mucus of the nofe becomes vifcid by ftagnation; for when it is immediately fecreted, it is thin and watery, as appears from the application of fternutatories, &c. The cerumen of the ears is of a watery confiftence when juft fqueezing out. The mucus of the alimentary canal grows thick in the lacunæ. The bile in the hepatic duct has little more confiftence than lymph; that in the gall-bladder is vifcid and ftrong. The urine is much more watery as it flows from the kidneys, than when it is

is excreted from the bladder. The feed is thin in the tefticles, and is concocted in the veficulæ feminales, &c.

54. Hence (§ 53.) we may fafely conclude, that a thin liquor is fecreted in the cortex encephali or fpinal marrow; and feeing the thinnefs of the fecreted liquors is generally, as the divifions of the veffels, into fmall fubtile branches, and that the ramifications within the fkull are almoft infinitely fubtile, the liquor fecreted in the encephalon may be determined to be among the fineft or thinneft fluids.

55. Seeing alfo that we can obferve no larger refervoir, where the liquor fecerned in the cortical fubftance is depofited, to have its finer parts taken off, we have reafon to think that it goes forward into the nerves in the fame condition in which it is fecerned.

56. By fine or fubtile animal liquors, is meant no more than thofe which are very fluid, and which feem to confift of a large proportion of watery particles, and a leffer one of the oily, faline, and terreftrious particles. Some of the liquors which we can have in fufficient quantity to make experiments with, are fluid, and have fo little vifcidity or cohefion of parts, that when laid upon a piece of clean mirror, they evaporate without leaving a ftain. Such is the liquor oozing out from the furface of the pleura, the lymph, and feveral others.

If then thefe liquors, which are fubject to our examination, the fecerning veffels of which are fo large that we can fee them, have fuch a fmall cohefion of parts, it might not be unreafonable to fay, that the liquor of the nerves is as much more fine and fluid than lymph, as the veffels feparating it are fmaller; and therefore that the fluid of the nerves is a defecated water, with a very fmall proportion of the other principles extremely fubtilized.

57. Two experiments are faid to contradict this opinion of the liquor of the nerves being fo fluid and fubtile. One is, that

upon

upon cutting the cauda equina of a living animal, a liquor as vifcid as the white of an egg drops out. The other is, that a wounded nerve yields a glairy fanies. But thefe do not appear to be the proper fluid of the nerves; fince it is evident, that what is difcharged in both thefe cafes comes out of the cellular fubftance involving the nervous fibrils.

58. Confidering how many experiments make it evident, that there is a conftant uninterrupted ftream of liquors flowing through all the canals of animals, which convey liquors compofed of particles fmaller than the diameter of their canal, which is always the cafe of the nerves in a natural ftate, it is furprifing how it ever could be thought that the liquid of the nerves fhould be obliged to flow from the brain to each mufcle the moment we will; or that this liquor fhould flow back with the like fwiftnefs from the extremity of each nerve, to which an object of fenfation is applied. The nerves, as well as the other excretories of the glands, are always full of liquor; the degree of diftention of the canals not being at all times alike even in a found ftate. But this happens without inconvenience, as the fides of the canals have a power to accommodate themfelves to the prefent quantity, unlefs it is very much above or below the natural ftandard; in both which cafes difeafes enfue.

59. The motion of the fluid in the nerves is therefore not only conftant, but it is alfo equal, or nearly fo: for though the blood in the larger arteries is moved unequally by the unequal forces, the contraction of the ventricle of the heart, and the weaker power, the fyftole of the arteries; yet the difference between thefe two moving powers becomes lefs and lefs perceptible as the arteries divide into fmaller branches; becaufe of the numerous refiftances which the liquors meet with, and becaufe the canals they move in become larger, till in the very fmall arterious branches there is no fenfible difference in the velocity of the liquors from the effect of the heart

or

or arteries. The motion of the fluids muſt ſtill be more equal in the excretories of glands, and particularly in thoſe where the veſſels are divided into very minute branches, and the liquors have no other propelling force but the heart and arteries, (ſee § 1.); therefore the nervous fluid moves conſtantly, equally, and ſlowly, unleſs when its courſe is altered by the influence of the mind, or by the preſſure of ſome neighbouring active organ.

60. As there is neither proof nor probability of the valves ſuppoſed by ſome authors in nerves, we are not to aſſume them in accounting for any phenomena.

61. We have not, and perhaps cannot have, any idea of the manner in which the mind and body act upon each other: but if we allow that the one is affected by the other, which none deny, and that the fluid of the nerves (whatever name people pleaſe to give it) is a principal inſtrument which the mind makes uſe of to influence the actions of the body, or to inform itſelf of the impreſſions made on the body, we muſt allow that the mind can direct this inſtrument differently, particularly as to quantity and celerity, though we muſt remain ignorant of the manner how many phenomena, depending on this connection of mind and body, are produced. Thus we would in vain attempt to account for animals continuing, after their heads were ſtruck off or their hearts were cut out, to perform actions begun before they ſuffered any injury.

62. Let us now ſuppoſe the nervous fluid ſuch as has been argued for, to wit, a very fluid ſaponaceous water, moving in a conſtant, equal, ſlow ſtream, from the encephalon and ſpinal marrow, in each of the proper nervous fibres, except when the motion is changed by ſome acceſſory cauſe, ſuch as the mind, preſſure of other parts, &c.; and let us examine how well ſuch a ſuppoſition will agree with the phenomena of the three great functions, nutrition, ſenſation, and muſcular motion, of which the nerves are principal inſtruments.

63. In

63. In general, we may fay, that nerves can carry fluids to the moft minute part of the body, to fupply what is wafted in any of the folids * ; that the impreffion made by the objects of the fenfes on the very foft pulpy extremities of the nerves of the organs of the fenfes, muft make fuch a ftop in the equal flowing nervous fluid, as muft inftantaneoufly be perceptible at the fountain-head from which the tubes affected arife; that the conftant flow of the liquor of the nerves into the cavities of the mufcular fibrillæ, occafions the natural contraction of the mufcles, by the as conftant nifus it makes to increafe the tranfverfe and to fhorten the longitudinal diameter of each fibre; and that it is only to allow the mind a power of determining a greater quantity of this fame fluid with a greater velocity into what mufcular fibres it pleafes, to account for the voluntary ftrong action of the mufcles.

64. But fince fuch a fuperficial account would not be fatisfactory, it will be expected, that the principal phenomena of thefe three functions fhould be explained by the means of fuch a fluid as has been fuppofed, and that the feveral objections againft this doctrine fhould be anfwered: let us attempt this; and where we cannot extricate ourfelves from difficulties which

* However plaufible the above doctrine might appear to the Author and fome of his contemporaries, it is not agreeable to the opinion of many of the later phyfiologifts, particularly to the prefent Profeffor Monro, who appears to prove beyond a doubt, that nutrition is performed by means of the arteries. After giving his arguments in favour of this doctrine, he concludes thus: " Upon the whole, I apprehend there are few points in phyfiology fo clear as,

1. That the arteries prepare and directly fecrete the nourifhment in all our organs.

2. That the nerves do not contain nor conduct the nourifhment; but that, by enabling the arteries to act properly, they contribute indirectly to nutrition." See Obfervations on the Nervous Syftem, p. 78.

which may be thrown in, let us honeftly acknowledge ignorance.

65, α. If water, with a very fmall proportion of oils and falts from the earth, proves a fit nourifhment for vegetables, fuch a liquor as the fluid of the nerves has been defcribed (§ 56.) may not be unfit for repairing the wafte in animals.

β. The flow continual motion of this nervous fluid (§ 58, 59.) to the moft minute parts of the body (§ 10.) is well enough calculated to fupply the particles that are conftantly worn off from the folids by the circulation of the liquors and neceffary actions of life.

γ. The greater proportional fize of the encephalon in young creatures than in adults, feems calculated for their greater proportional growth: for the younger the animal is, the larger encephalon and fpeedier growth it has.

δ. A palfy and atrophy of the limbs generally accompanying each other, fhew, that nourifhment, fenfation, and motion, depend on the fame caufe.

ε. It was faid (§ 26.), that the nerves were principal inftruments in nutrition: it was not affirmed, that they were the fole inftruments; and therefore an atrophy may proceed from the compreffion or other injury of an artery, without being an objection to the doctrine here laid down.

66. *a* All objects of fenfe, when applied to their proper organs, act by impulfe; and this action is capable of being increafed by increafing the impelling force. In tangible objects, it is clearly evident, that the clofer they are preffed to a certain degree, the more diftinct does the perception become. Odorous particles need the affiftance of air moved rapidly to affect our nofe: fapid fubftances, that are fcarcely fufficient to give us an idea of their tafte by their own weight, are affifted by the preffure of the tongue upon the palate: the rays of light collected drive light bodies before them: found commu-

nicates a vibration to all bodies in harmonic proportion with it.

The impulfes made thus by any of thefe objects on the foft pulpy nerves (§ 21.), which are full of liquor, prefs their fides or extremities, and their liquor is prevented from flowing fo freely as it did. The canals being all full (§ 58.) this refiftance muft inftantaneoufly affect the whole column of fluids in the canals that are preffed, and their origins, and have the fame effect as if the impulfe had been made upon the origin itfelf. To illuftrate this by a grofs comparifon: Let any one pufh water out of a fyringe, through a long flexible pipe fixed to the fyringe; and he is fenfible of refiftance or a pufh backwards, the moment any one ftops the orifice of the pipe, or clofes the fides of it with his fingers. This impulfe made on the nerves, and thus communicated to their origin, varies according to the ftrength or weaknefs, the quicknefs or flownefs, the continuance or fpeedy removal, the uniformity or irregularity, the conftancy or alteration, &c. with which objects are applied to the nerves.

*b*. Whenever any object is regularly applied with due force to a nerve rightly difpofed to be impreffed by it, and is communicated, as juft now explained, to the fenforium, it gives a true and juft idea of the object to the mind.

*c*. The various kinds of impulfes which the different claffes of objects make, occafion in animals, which ought to have accurate perceptions of each object, a neceffity of having the different organs of the fenfes varioufly modified, fo that the ferveral impulfes may be regularly applied to the nerves in each organ; or, in other words, we muft have different organs of the fenfes fitted to the different claffes of objects.

*d*. As the objects have one common property of impulfe, fo all the organs have moft of the properties of the organ of touching in common with the papillæ of the fkin. This is evident in the nofe and tongue: we can alfo perceive it in

fome

ſome operations of the eyes, as we may likewiſe do in ſome caſes where matter is collected in the internal ear.

*e.* Theſe properties common to the different objects and organs, occaſion frequently uncommon effects in the application of an object to an organ proper to another object of ſenſation; for ſometimes we have the ſame idea as if the object had been applied to its own proper organ; at other times the object is as it were changed, and we have the idea as if the organ had had its own proper object applied to it. Thus, for example, light is the proper object to be applied to the eye, to give us an idea of colours; yet when all light is excluded from the eyes, an idea of light and colours may be excited in us by coughing, ſneezing, rubbing or ſtriking the eye-ball.——A cane vibrating, ſo as not to excite ſound perceptible to the ear, applied to the teeth, raiſes a ſtrong idea of ſound; as a little inſect creeping in the meatus auditorius alſo does. The fingers applied to two rough ſurfaces, rubbing on each other, are ſenſible of the ſound they make; ſurgeons of any practice in the cure of fractured bones can bear witneſs to the truth of this.——The fingers dipped in acid and ſeveral other acrid liquors, have a ſenſation very like to taſting.——Smelling and taſting, every body knows, are ſubſervient and aſſiſting to each other. From ſuch examples we have further proof of one general cauſe of our ſenſations, to wit, impulſe from the objects; and of ſuch a ſimilarity and relation in the organs, as might give reaſon for imagining that any one of them would be capable of producing the effect of another, if the impulſes of the different objects could be regularly applied to each.——Hence light and ſound may affect inſects and other animals that have not eyes or ears.

*f.* If the impulſe of an object is applied with due force, but irregularly, a confuſed idea of the object is raiſed. Diſtant objects are confuſed to myopes, as very near ones are to preſbytæ.

*g*. If the application of the impulſe is regular, but the force with which it is applied too weak, our perception of the object is too faint. One may whiſper ſo low as not to be heard.

*h*. If the application of objects is too violent, and there is any danger of the tender organs of our ſenſes being hurt or deſtroyed, an uneaſy ſenſation we call *pain* is raiſed, whatever may be the organ thus injured. The object of feeling affects every organ: thus preſſure, ſtretching, cutting, pricking, acrid ſalts, pungent oils, great heat, violent cold, &c. occaſion pain, where-ever they are applied. Beſides, every particular organ can be affected with pain by the too violent application of its own proper object. Too much light pains the eyes; very loud ſound ſtuns the ears; very odorous bodies and too ſapid objects hurt the noſe and tongue. This is a ſure proof that the objects of our ſenſes all act, and that the organs are all impreſſed, in nearly the ſame way.

*i*. Since a middle impulſe, neither too ſmall nor too great, is neceſſary for a clear perception of objects, we would often be in danger of not diſtinguiſhing them, if we were not ſubjected to another law, to wit, that numerous impulſes made at once, or in a quick ſucceſſion to each other, increaſe our perceptions of objects. Thus, ſuch ſound as would not be heard on a mountain-top, will be diſtinctly heard in a wainſcotted chamber.——We feel much more clearly a tangible object when our finger is drawn along it, than when applied with the ſame force, but by a ſingle preſſure upon it.——We make repeated applications of odorous and ſapid objects, when we wiſh to ſmell or taſte accurately.——The end of a burning ſtick appears much more luminous when quickly whirled in a circle than when at reſt.

*k*. Whenever the uneaſy ſenſation, pain, is raiſed by the too ſtrong application of objects, a ſort of neceſſity is as it were impoſed upon the mind, to endeavour to get free of the injuring cauſe, by either withdrawing the grieved part of the body

body from it, as one draws back his hand when his finger is pricked or burnt; or the injuring caufe is endeavoured to be forced from the body, as a tenefmus excites the contraction which pufhes acrid fæces out of the rectum. In both thefe operations, a convulfive contraction is immediately made in the part hurt, or in the neighbourhood of it; and if the irritation is very ftrong or permanent, the greater part of the nervous fyftem becomes affected in that fpafmodic or convulfive way.——Is it this neceffity which obliges the mind to exert herfelf in refpiration, or in the action of the heart, when the lungs or heart are gorged with blood? or the iris to contract the pupil, when the eye is expofed to a ftrong light? or fneezing to be performed when the nofe is tickled? &c.——Will not a ftimulus of any nerve more readily affect thofe with which it is any where connected, than the other nerves of the body?——May not this fympathy ferve as a monitor of the mind to employ the organs furnifhed with nerves thus connected, to affift in freeing her of any uneafy fenfation, rather than to make ufe of any other organs?——Will not this in fome meafure account for many falutary operations performed in the body, before experience has taught us the functions of the organs performing them?

This nifus of the mind to free the body from what is in danger of being hurtful, may ferve to explain the phenomena of a great many difeafes, when we are acquainted with the diftribution of the particular nerves; and from this we can underftand the operation of medicines that ftimulate; and may learn how, by exciting a fharp but momentary pain, we may free the body of another pain, that would be more durable; and that, by having it thus in our power to determine a flow of the liquor of the nerves to any particular part, for the benefit of that part, or the relief of any other difeafed part, we can do confiderable fervice by a right application of the proper medicines.

*l.* If

*l.* If a pain-giving caufe is very violent or long continued, it deftroys the organs either irrecoverably, or puts them fo much out of order, that they only gradually recover. People have been made blind or deaf for all their lives after a violent effect of light on their eyes, or of found on their ears; and we are frequently expofed to as much light and found as to make us unfit to fee or hear for a confiderable time. I would explain this by a ligature put round the tender branch of an herb. This ligature drawn to a certain degree, may weaken the canals fo as to be unfit for the circulation of the juices a good while, till they are gradually explicated and made firm by thefe juices: A ftricter ligature would diforder the ftructure of the fibres fo much, that the liquors could not recover them. The analogy is fo plain that it needs no commentary. ——Thus the influence of a nerve tied with an artery in the operation of an aneurifm, may ceafe for fome time, but be afterwards recovered.

67. (1.) In applying the fluid of the nerves to the action of mufcles, it was faid, that the natural or involuntary contraction of mufcles was the nifus which the nervous fluid, flowing conftantly into the mufcular fibres, makes to diftend thefe fibrils, by enlarging their tranfverfe diameters and fhortening their axes; and that voluntary contraction was owing to a greater quantity of that nervous liquor determined towards the mufcle to be put in action, and poured with greater momentum into the mufcular fibrils, by the power of the mind willing to make fuch a mufcle to act, or obliged to do it by an irritating pain-giving caufe (§ 66. *k.*)

(2.) Some object to this account of mufcular motion, that if there is no outlet for the liquor fuppofed to be poured into mufcular fibres, mufcles would always be in a ftate of contraction, which they are not; and if there is a paffage from the fibrils, the liquor would flow out as faft as it was thrown in;

and

and therefore no diftention of the fibres, or contraction of the mufcles could be made.

(3.) In anfwer to this objection, it is obferved, that notwithftanding the evident outlet from the arteries into the veins, yet the arteries are diftended by the fyftole of the heart, or any other caufe increafing the momentum of the blood.

(4.) It has been alfo objected to § 1. that, if it was true, the volume of the mufcle in contraction neceffarily would be confiderably increafed by fo much liquor poured into its fibrils; whereas it does not appear, by any experiment, that the volume of a mufcle is increafed by its being put into action.

(5.) To this it has been anfwered, 1. That when the axes of mufcular fibres are fhortened, and their tranfverfe diameters are enlarged; the capacities of their fibres, and confequently their volume, may not be changed, the diminution one way balancing the increafe in the other. 2. That the fpaces between the mufcular fibres are fufficient to lodge thefe fibres when they fwell during the contraction of a mufcle, without any addition to its bulk; and that it plainly appears that thefe fpaces between the fibrils are thus occupied, by the compreffion which the larger veffels of mufcles, which run in thofe fpaces, fuffer during the action of the mufcle; it is fo great as to drive the blood in the veins with a remarkable accelerated velocity.

(6.) Another objection to the action of mufcles being owing to the influx of fluids into their fibrils is, That mufcular fibrils are diftractile, or capable of being ftretched; and therefore, when a fluid is poured into their hollow fibrils, they would be ftretched longitudinally, as well as have their tranfverfe diameters increafed; that is, a mufcle would become longer as well as thicker, when it is put into action; whereas it is certainly known that a mufcle is fhortened while it acts.

(7.) In

(7.) In anſwer to this it has been remarked, That though muſcular fibrils are diſtractile, yet they will not yield to, or be ſtretched by, every force, however ſmall, that might be applied to them. A cord that can be ſtretched in length by the weight of a pound or two, would not yield in the leaſt to an ounce or two; and it muſt likewiſe be obſerved, that, as any body is ſtretched, its reſiſtance to the ſtretching force gradually increaſes. A rope may be ſtretched to a certain length by a pound weight appended to it, which would require two pounds to ſtretch it a very little further; and therefore the general obſervation of animal fibres being diſtractile, cannot be a reaſonable objection to the account of muſcular motion above-mentioned, unleſs a proof is brought, that the force which the liquid of the nerves muſt exert upon each fibre of a muſcle, in order to make it act, is capable of diſtracting or ſtretching the fibres; which has not yet been attempted to be proved.——It would appear from the pain cauſed by too great an effort of muſcles, eſpecially in weak people, that muſcular fibres can bear very little diſtraction without danger of a ſolution of continuity.

(8.) Muſcles ceaſing to act when their arteries are tied or cut, and being brought into motion by injecting liquors into the arteries even of a dead animal, has been mentioned as objections to the nervous influence cauſing their contractions.

To the firſt of theſe experiments it may be anſwered, That the tying or cutting of the nerves ſooner produces the effect of making the contraction ceaſe, than ſtopping the influx of the arterious blood does; and it will be univerſally allowed, that the influx of the blood into the muſcles is neceſſary for performing their functions right.

Whoever obſerves the motion which injecting water, or any other liquor, into the arteries of a dead animal, cauſes in its muſcles, will not compare it to what contraction, whether voluntary or excited by irritation, he may ſee in a living one.

(9.) If

(9.) If muſcular motion depends on the influx of the nervous liquid, the inſtantaneous contraction of a muſcle, when the mind wills to make it act, will be eaſily underſtood from the nerves being always full of their liquor (§ 58, *66, a.*)

(10.) If either the nerves of any muſcle do not furniſh a ſufficient quantity of their liquor, or if the fibres of a muſcle become too eaſily diſtractile, ſuch a muſcle will be unactive or paralytic.

(11.) If too great a quantity of the liquor of the nerves is determined to a muſcle or muſcles, by any cauſe which the mind cannot command, ſuch muſcle or muſcles will be convulſed.

(12.) If the motion of the liquid of the nerves is not uniform, but by diſeaſe becomes irregular, an alternate relaxation and contraction of muſcles may be the conſequence. Hence trembling palſies, chorea Sancti Viti, &c. Hence alſo the convulſive tremors which animals have when they loſe much blood.

(13.) Though the nerves may not furniſh ſo much liquor as may be ſufficient to make muſcles contract, with ſtrength enough to overcome the reſiſtances to their actions, yet there may be a ſufficient quantity of liquor in the nerves to allow the impreſſions of objects to be conveyed to the ſenſorium. This may be one cauſe of a limb being ſometimes ſenſible after it cannot be moved.

(14.) Unleſs the liquor of the nerves acquires ſome energy in the brain, which we have no reaſon to think the circulation of the fluids in the veſſels can give it, or unleſs it has other properties than what we can diſcover in it, or unleſs there is an agent regulating its momentum and courſe to different parts which we are not conſcious of; if ſome of theſe, I ſay, do not obtain, the action of the heart continuing of equal force to propel our liquors, notwithſtanding all the reſiſtances that are made againſt it, is not to be explained.

(15.) All mufcles, but efpecially the heart, continue to contract in an irregular way, after they are cut away from the animal to whom they belonged; which may be owing to the liquors continuing to flow in the fmall veffels, and being poured irregularly into the mufcular fibrillæ.

(16.) It is faid, that a mufcle cut out of the body continues fome time to be capable of contraction; whereas by tying its arteries or nerves, while it is otherwife entire in the body, it lofes its contracting power, which therefore does not depend on thefe organs, the arteries or nerves.

The lofs of the power of acting when the arteries or nerves are tied while the mufcle is in the body, is denied by fome who made the trial; and it might be expected that the motion of a mufcle would be more confpicuous where there is no refiftance to it, as is the cafe when it is cut away from all the parts it is connected with, than when its connection remains with parts refifting its contractile efforts.

(17.) After the heart, or any other mufcle cut away from an animal, has ceafed to contract, its contraction may again be reftored, by breathing upon it, or pricking it with any fharp inftrument. That heat or pricking fhould, by their ftimulus (§ 66, *k.*), occafion contraction in a living creature, may be underftood; but how they fhould have the fame effect in a mufcle feparated from an animal, I know not.

68. Some have thought the ganglions of nerves (§ 18, 19, 20.) to be glandular, and to perform a fecretion.——Others, from their firm texture, fuppofe them to be mufcular, and to ferve to accelerate the motion of the liquor in the nerves which proceed from them; but as no proof is offered of either of thefe opinions, they cannot be maintained.——Others would make them ferve, 1. To divide a fmall nerve into many nerves, and by thefe means to increafe the number of nervous branches. 2. To make nerves come conveniently by different directions

to

to the parts to which they belong. To re-unite feveral fmall nervous fibres into one large nerve.——Since no proof is brought that thefe three things cannot be done without the interpofition of a ganglion, but on the contrary we fee them performed where there are no ganglions, we muft continue to acknowledge ignorance concerning the ufes of thefe knots, the ganglions.

## CHAP. II.

### *Of the* Particular Nerves.

IT is generally faid, that there are 40 pair of nerves in all, of which 10 come from the encephalon, and the other 30 have their origin from the fpinal marrow.

Of the ten pair of nerves which come from the encephalon *, the firft is the *olfactory*, which long had the name of the *mamillary proceffes* of the brain, becaufe in brutes, cows and fheep, which were moft commonly diffected by the ancients, the anterior ventricles of the brain are extended forwards upon thefe nerves, and adhere fo firmly to them, that they feem to make the upper fide of the nerves. Each of them being large where it begins to be ftretched out, and gradually becoming fmaller as it approaches the cribriform bone, was imagined to refemble a nipple. Thofe who miftook the ventricles for part of the nerves, obferving the cavity in them full of liquor, concluded, that thefe olfactory nerves ferved to convey the fuperfluous moifture of the brain to the holes of the ethmoid bone through which it paffed into the nofe. But in man, the ventricles of whofe brain are not thus extended forwards, thefe nerves are fmall, long, and without any cavity,

 having

* For a fuller defcription with figures of the origin of the nerves, fee Soemmerring de orig. nervor, and Dr Monro on the Nerves.

having their origin from the corpora ſtriata, near the part where the internal carotid arteries are about to ſend off their branches to the different parts of the brain; and in their courſe under the anterior lobes of the brain; which have each a depreſſion made for lodging them, the human olfactory, nerves become larger, till they are extended to the cribriform bone, where they ſplit into a great number of ſmall filaments, to paſs through the little holes in that bone; and being joined by a branch of the fifth pair of nerves, are ſpread on the membrane of the noſe *.

The tender ſtructure and ſudden expanſion of theſe nerves on ſuch a large ſurface, render it impoſſible to trace them far; which has made ſome authors deny them to be nerves: but when we break the circumference of the cribriform lamella, and then gently raiſe it, we may ſee the diſtribution of the nerves ſome way on the membrane of the noſe where they form a beautiful net-work.

The contrivance of defending theſe long ſoft nerves from being too much preſſed by the anterior lobes of the brain under which they lie, is ſingular; becauſe they have not only the prominent orbitar proceſſes of the frontal bone to ſupport the brain on each ſide, with the veins going into the longitudinal ſinus, and other attachments bearing it up, but there is a groove formed in each lobe of the brain itſelf for them to lodge in—Their ſplitting into ſo many ſmall branches before they enter the bones of the ſkull, is likewiſe peculiar to them; for generally the nerves come from the brain in ſeparated filaments, and unite into cords, as they are going out at the holes of the bones. This contrivance is the beſt for anſwering the purpoſe they are deſigned for, of being the organ of ſmelling; for had they been expanded upon the membrane of the noſe into a medullary web, ſuch as the optic nerve forms, it would have been

* See Obſ. on the Nervous Syſtem, Tab. xxiv.

been too fenfible to bear the impreffions of fuch objects as are applied to the nofe ; and a diftribution in the more common way, of a cord fending off branches, would not have been equal enough for fuch an organ of fenfation.

The *fecond* pair of nerves, the *optic*, rifing from the thalami nervorum opticorum, make a large curve outwards, and then run obliquely inwards and forwards, till they unite at the fore-part of the fella turcica; they then foon divide, and each runs obliquely forwards and outwards to go out at its proper hole in the fphenoid bone, accompanied with the ocular artery, to be extended to the globe of the eye, within which each is expanded into a very fine cup-like web, that lines all the infide of the eye, to within a little diftance of the edge of the cryftalline lens, and is univerfally known by the name of *retina*.

Though the fubftance of this pair of nerves feems to be blended at the place where they are joined ; yet obfervations of people whofe optic nerves were not joined, and of others who were blind of one eye from a fault in the optic nerve, or in thofe who had one of their eyes taken out, make it appear that there is no fuch intimate union of fubftance*; the optic nerve of the affected fide only being wafted, while the other was large and plump. And the fame obfervations are contradictory to the doctrine of a decuffation of all the nerves (§ 8.): for the difeafe could be traced from the affected eye to the origin of the nerve on the fame fide. In many fifhes, indeed, the doctrine of decuffation is favoured; for their optic nerves plainly crofs each other, without any union at the part where they are joined in men and moft quadrupeds.

Thofe people whofe optic nerves were not joined, having neither feen objects double, nor turned their eyes different ways,

* The decuffation of the fibres, and intimate union of the fubftance of the optic nerves, appear to be greater than is here fuppofed. See Obf. on Nervous Syftem, Tab. v.

ways, is alſo a plain proof, that the conjunction of the optic nerves will not ſerve to account for either the uniform motions of our eyes, or our ſeeing objects ſingle with two eyes, though it may be one cauſe of the remarkable ſympathy of the one eye with the other in many diſeaſes.

The retina of a recent eye, without any preparation, appears a very fine web, with ſome blood-veſſels coming from its centre to be diſtributed on it; but, after a good injection of the arteries that run in the ſubſtance of this nerve, as is common to other nerves, it is with difficulty that we can obſerve its nervous medullary ſubſtance.——The ſituation of theſe veſſels in the central part of the optic nerve, the want of medullary fibres here, and the firmneſs of this nerve before it is expanded at its entry into the ball of the eye, may be the reaſon why we do not ſee ſuch bodies, or parts of bodies, whoſe picture falls on this central part of the retina.—An inflammation in thoſe arteries of the retina, which ſeveral fevers and an ophthalmia are generally attended with, may well account for the tenderneſs of the eyes, and inability to bear the light, which people have in theſe diſeaſes.——The over-diſtention of theſe veſſels may likewiſe ſerve to account for the black ſpots obſerved on bright-coloured bodies eſpecially, and for that ſmoky fog through which all objects are ſeen by people in ſome fevers.——If theſe veſſels loſe their tone, and remain preternaturally diſtended, no object affects our retina, though the eye externally appears ſound: or this may be one cauſe of an amauroſis or gutta ſerena.—From a partial diſtention of theſe veſſels, or paralyſis of a part of the retina, the central part, or the circumference, or any other part of objects, may be loſt to one or both eyes.

The *third* pair riſe from the anterior part of the proceſſus annularis; and piercing the dura mater a little before and to a ſide of the ends of the poſterior clinoid proceſs of the ſphenoid bone, run along the receptacula, or cavernous ſinuſes, at the

the ſide of the ephippium, to get out at the foramina lacera: after which each of them divides into branches; of which one, after forming a little ganglion, is diſtributed to the globe of the eye; the others are ſent to the muſculus rectus of the palpebra, and to the attollens, adductor, deprimens, and obliquus minor, muſcles of the eye-ball. Theſe muſcles being principal inſtruments in the motions of the eye-lid and eye-ball, this nerve has therefore got the name of the *motor oculi.*——I have frequently obſerved in convulſions the eye-lids widely opened, the cornea turned upwards and outwards, and the eye-balls ſunk in the orbit; which well deſcribed the conjunct action of the muſcles which this pair of nerves ſerves. ——The diſtention of a conſiderable branch of the carotid, which paſſes over this nerve near its origin on each ſide, may poſſibly be the reaſon of the heavineſs in the eye-lids and eyes, after drinking hard or eating much.

The *fourth* pair, which are the ſmalleſt nerves of any, derive their origin from the back-part of the baſe of the teſtes; and then making a long courſe on the ſide of the annular protuberance, enter the dura mater a little farther back and more externally than the third pair, to run alſo along the receptacula, to paſs out at the foramina lacera, and to be entirely ſpent on the muſculi trochleares, or ſuperior oblique muſcles of the eyes. Theſe muſcles being employed in performing the rotatory motions, and the advancement of the eye-balls forward, by which ſeveral of our paſſions are expreſſed, the nerves that ſerve them have got the name of *pathetici.*—Why theſe ſmall nerves ſhould be brought ſo far to this muſcle, when it could have been ſupplied eaſily by the motor oculi, I know not.

The *fifth* pair are large nerves, riſing from the annular proceſſes, where the medullary proceſſes of the cerebellum join in the formation of that tuber, to enter the dura mater near the point of the petrous proceſſes of the temporal bones; and then

then finking clofe by the receptacula at the fides of the fella turcica, each becomes in appearance thicker, forms a diftinct ganglion, and goes out of the fkull in three great branches.

The firft branch of the fifth is the *ophthalmic*, which runs through the foramen lacerum to the orbit, having in its paffage thither a connection with the fixth pair. It is afterwards diftributed to the ball of the eye with the third; to the nofe, along with the olfactory, which the branch of the fifth that paffes through the foramen orbitarium internum joins, as was already mentioned in the defcription of the firft pair. This ophthalmic branch likewife fupplies the parts at the internal canthus of the orbit, the glandula lachrymalis, fat, membranes, mufcles, and integuments of the eye-lids; its longeft and fartheft extended branch paffing through the foramen fuperciliare of the os frontis, to be diftributed to the forehead.

The fmall fibres which this firft branch of the fifth and third pair of nerves fend to the eye-ball, being fituated on the optic nerve, and, after piercing the fclerotic coat, running along the choroid coat on the outfide of the retina in their courfe to the uvea or iris, may be a caufe of the fympathy between the optic nerve and the uvea; by which we more readily acquire the habit of contracting the iris, and thereby leffen the pupil, when too ftrong a light is excluded; and, on the contrary, enlarge the pupil when the light is too faint.—This, with the fympathy which muft arife from fome of the nerves of the membrane of the noftrils, being derived from this firft branch of the fifth pair of nerves, may alfo be the caufe, why an irritation of the retina, by too ftrong light, may produce fneezing, as if a ftimulus had been applied to the membrane of the nofe itfelf;—why preffing the internal canthus of the orbit fometimes ftops fneezing;—why irritation of the nofe or of the eye caufes the eye-lids to fhut convulfively, and make the tears to flow plentifully; and why medicines put into the

nofe

nofe, do often great fervice in difeafes of the eyes.——In the megrim, all the branches of the nerves difcover themfelves to be affected: for the forehead is racked with pain; the eye-ball is pained, and feels as if it was fqueezed; the eye-lids fhut convulfively, and make the tears trickle down, and an uneafy heat is felt in the nofe. Hence we can underftand, where external medicines will have the beft effect when applied to remove this difeafe, to wit, to the membrane of the nofe, and to the forehead:——why alternate preffure near the fuperciliary hole of the frontal bone, or fneezing, fometimes gives immediate relief in the megrim;—why the fight may be loft by an injury done to the fupra-orbitar branch;——how it may be reftored by agitation of that branch of this nerve.

The fecond branch of the fifth pair of nerves may be called *maxillaris fuperior*, from its ferving principally the parts of the upper jaw. It goes out at the round hole of the fphenoid bone, and fends immediately one branch into the channel on the top of the antrum maxillare; the membrane of which and the upper teeth are fupplied by it in its paffage. As this branch is about to go out at the foramen orbitarium externum, it fends a nerve through the fubftance of the os maxillare to come out at Steno's duct, to be diftributed to the fore-part of the palate; and what remains of it, efcaping at the external orbitar hole, divides into a great many branches, that fupply the cheek, upper lip, and noftril.—The next confiderable branch of the fuperior maxillary nerve, after giving branches which are reflected through the fixth hole of the fphenoid bone, to join the intercoftal where it is paffing through the fkull with the carotid artery, and the portio dura of the feventh pair as it paffes through the os petrofum, is fent into the nofe by the hole common to the palate and fphenoidal bone; and the remaining part of this nerve runs in the palato-maxillaris canal, giving off branches to the temples and pteregoid mufcles, and comes at laft into the palate to be loft.——Hence a pain in the teeth of the upper jaw occafions a gnawing pain deep-feated in the bones of the face, with fwelling in the eye-lids, cheek, nofe, and upper lip; and on the other hand, an inflammation in thefe parts, or a megrim, is often attended with a fharp pain in the teeth.——Hence, an obftruction in the duct of the maxillary finus, which obliges the liquor fecreted there to find out a preternatural rout for itfelf, may be occafioned by the pain of the teeth.—Hence, the upper lip often fuffers when the palate or nofe is ulcerated.

The third, or *maxillaris inferior*, branch of the fifth pair going out of the oval hole of the fphenoid bone, ferves the mufcles of the lower jaw, and the mufcles fituated between the os hyoides and jaw: All the falivary glands, the amygdalæ, and the external ear, have branches from it: It has a large branch loft in the tongue, and fends another through the canal in the fubftance of the lower jaw, to ferve all the teeth there, and to come out at the hole in the fore-part of the jaw, to be loft in the chin and under-lip.——Hence a convulfive contraction of the mufcles of the lower jaw, or the mouth's being involuntarily fhut, a great flow of fpittle or falivation, a pain in the ear, efpecially in deglutition, and a fwelling all about the throat, are natural confequences of a violent irritation of the nerves of the lower teeth in the toothach; and pain in the teeth and ear is as natural a confequence of an angina.——Hence alternate preffure on the chin may fometimes relieve the violence of a toothach.——Hence deftroying the nerves of a tooth by actual or potential cauteries, or pulling a carious tooth, fo often removes immediately all thefe fymptoms.——Hence no cure is to be found for fome ulcers in the upper or lower jaw, but by drawing a tooth.—Hence in cancers of the upper-lip, the falivary glands are in danger of being affected, or the difeafe may be occafioned in the lip by its beginning in the glands.—Perhaps the fympathy of the organs

of

of tafting and fmelling may in fome meafure depend on their both receiving nerves from the fifth pair.

The *fixth pair*, which is the fmalleft except the fourth, rifes from the fore-part of the corpora pyramidalia; and each, entering the dura mater fome way behind the pofterior clinoid procefs of the fphenoid bone, has a long courfe below that membrane, and within the receptaculum at the fide of the tcella turcica, where it is immerfed in the blood of the receptacle; but for what purpofe, I am ignorant. It goes afterwards out at the foramen lacerum into the orbit, to ferve the abductor mufcle of the eye.——A defect in this nerve may therefore be one caufe of ftrabifmus.——In the paffage of this nerve below the dura mater, it lies very contiguous to the internal carotid artery, and to the ophthalmic branch of the fifth pair of nerves. At the place where the fixth pair is contiguous to the carotid, a nerve either goes from each of them in an uncommon way, to wit, with the angle beyond where it rifes obtufe, to defcend with the artery, and to form the beginning of the intercoftal nerve, according to the common defcription; or, according to other authors, this nerve comes up from the great ganglion of the intercoftal, to be joined to the fixth here.

The arguments for this later opinion are, That, according to the common doctrine, this beginning of the intercoftal nerve, as it is called, would rife in a manner not fo ordinary in nerves. Befides, it is obferved, that the next pair is larger nearer to the orbit, than it is before it comes to the place where this nerve is faid to go off; and therefore it is more probable, that it receives an addition there, rather than gives off a branch. Laftly, it is found, that upon cutting the intercoftal nerves of living animals, the eyes were plainly affected; they loft their bright water; the gum or gore, as we call it, was feparated in greater quantity; the pupil was more contracted; the cartilaginous membrane, at the internal canthus, came more over the eye; and the eye-ball itſelf was diminiſhed.

To this it is anſwered, in defence of the more common doctrine, 1ſt, That other branches of nerves go off in a reflected way, as well as this does, ſuppoſing it to be the beginning of the intercoſtal; and that the reflection would rather be greater, if it is thought to come up from the intercoſtal to the ſixth. 2dly, It is denied that this nerve is ordinarily thicker at its fore than at its back part; and if it was ſuppoſed to be thickeſt nearer to the orbit, the concluſion made above could be drawn from this appearance, becauſe other nerves enlarge ſometimes where there is no addition made to them, as in the inſtance already mentioned of the trunk of the fifth pair while below the dura mater. 3dly, The experiments on living animals ſhew indeed, that the eyes are affected upon cutting the intercoſtal nerve; but not in the way which might have been expected, if the intercoſtal had furniſhed ſuch a ſhare of the nerve that goes to the abductor muſcle of the eye: for it might have been ſo much weakened immediately upon cutting the intercoſtal, that its antagoniſt the adductor would have greatly prevailed over it, and have turned the eye ſtrongly in towards the noſe; which is not ſaid to be a conſequence of this experiment. So that the arguments are ſtill equivocal; and more obſervations and experiments muſt be made, before it can be determined with certainty whether the ſixth pair gives or receives a branch here. In the mean time, I ſhall continue to ſpeak about the origin of the intercoſtal with the generality of anatomiſts.

At this place where the intercoſtal begins, the fifth pair is contiguous and adherent to the ſixth; and it is generally ſaid that the ophthalmic branch of the fifth gives a branch or two to the beginning of the intercoſtal, or receives ſuch from it. Others deny any ſuch communication between them: and thoſe who affirm the communication confeſs, that in ſome

ſubjects

ſubjects they could ſee it. After examining the nerves here in a great many ſubjects, I cannot determine whether or not there are nervous filaments going from the one to the other. Sometimes I have thought that I traced them evidently; at other times I obſerved, that what I diſſected for nervous filaments, was collapſed cellular ſubſtance; and in all the ſubjects where I had puſhed an injection ſucceſsfully into the very ſmall arteries, I could only obſerve a plexus of veſſels connecting the one to the other. In any of theſe ways, however, there is as much connection as, we are aſſured from many experiments and obſervations on other nerves, is ſufficient to make a very great ſympathy among the nerves here.—Poſſibly the appearances in the eyes of dogs, whoſe intercoſtal nerves were cut, might be owing to this ſympathy.

The *ſeventh* pair comes out from the lateral part of the annular proceſs, behind where the medullary proceſſes of the cerebellum is joined to that tuber; and each being accompanied with a larger artery than moſt other nerves, enters the internal meatus auditorius, where the two large bundles of fibres, of which it appeared to conſiſt within the ſkull, ſoon ſeparate from each other: one of them entering by ſeveral ſmall holes into the veſtibule, cochlea, and ſemicircular canals, is ſtretched on this inner camera of the ear in a very ſoft pulpy ſubſtance; and being never ſeen in the form of a firm cord, ſuch as the other parcel of this and moſt other nerves become, is called the *portio mollis* of the auditory nerve *.

The other part of this ſeventh pair paſſes through Galen's foramen cæcum, or Fallopius's aquæduct, in its crooked paſſage by the ſide of the tympanum; in which paſſage, a nerve ſent to the lingual branch of the inferior maxillary nerve, along the outſide of the tuba Euſtachiana, and croſs the cavity of the tympanum, where it has the name of *chorda tympani*, is

* See Obſ. on the Nervous Syſtem, Tab. xxvii.—xxxi.

is commonly ſaid to be joined to it. The very acute angle which this nerve makes with the fifth, or the ſudden violent reflection it would ſuffer on the ſuppoſition of its coming from the fifth to the ſeventh, appears unuſual; whereas, if we ſuppoſe that it comes from the ſeventh to the fifth, its courſe would be more in the ordinary way, and the chorda tympani would be eſteemed a branch of the ſeventh pair going to join the fifth, the ſize of which is increaſed by this acquiſition. This ſmaller bundle of the ſeventh gives branches to the muſcles of the malleus, and to the dura mater, while it paſſes through the bony crooked canal, and at laſt comes out in a firm chord named *portio dura*, at the end of this canal, between the ſtyloid and maſtoid proceſſes of the temporal bone, giving immediately filaments to the little oblique muſcles of the head and to thoſe that riſe from the ſtyloid proceſs. It then pierces through the parotid gland, and divides into a great many branches, which are diſperſed in the muſcles and teguments that cover all the ſide of the upper part of the neck, the whole face and cranium, as far back as the temples, including a conſiderable part of the external ear. Its branches having thus a conſiderable connection with all the three branches of the fifth pair, and with the ſecond cervical, occaſion a conſiderable ſympathy of theſe nerves with it.——Hence in the toothach, the pain is ſometimes very little in the affected tooth, compared to what it is all along the ſide of the head and in the ear.———Hence probably the relief of the toothach from bliſters applied behind or before the ear, or by a hot iron touching the antihelix of the ear.——By this communication or connection poſſibly too it is, that a vibrating ſtring held between one's teeth, gives a ſtrong idea of ſound to the perſon who holds it, which no body elſe can perceive.——Perhaps too the diſtribution of this nerve occaſions the head to be ſo quickly turned upon the impreſſion of ſound on our ears.

The

The *eighth* pair * of nerves rife from the lateral bafes of the corpora olivaria in feparated fibres; and as they are entering the anterior internal part of the holes common to the os occipitis and temporum, each is joined by a nerve which afcends within the dura mater from the tenth of the head, the firft, fecond, and inferior cervical nerves: this has the name of the *nervus acceffòrius*. When the two get out of the fkull, the acceffòrius feparates from the eighth, and, defcending obliquely outwards, paffes through the fterno-maftoideus mufcle, to which it gives branches, and afterwards terminates in the trapezius mufcle of the fcapula. In this courfe it is generally more or lefs joined by the fecond cervical nerve.——Why this nerve, and feveral others which are diftributed to mufcles, are made to pierce through mufcles which they might have only paffed near to, I do not know.

The large eighth pair, foon after its exit, gives nerves to the tongue, larynx, pharynx, and ganglion of the intercoftal nerve; and being disjoined from the ninth and intercoftal, to which it adheres clofely fome way, runs ftraight down the neck behind the internal jugular vein, and at the external fide of the carotid artery. As it is about to enter the thorax, a large nerve goes off from the eighth of each fide: this branch of the right fide turns round from the fore to the back part of the fubclavian artery, while the branch of the left fide turns round the great curve of the aorta; and both of them mounting up again at the fide of the œfophagus, to which they give branches, are loft at laft in the larynx †. Thefe are called the

*recurrent*

* For a beautiful and accurate figure of this nerve, fee Walter's Tab. Nervorum thoracis et abdominis.

† The recurrent and fuperior laryngeal nerves are joined together by their appices, to form a plexus refembling that of the nerves of the face; fo that from both thefe nerves each mufcle of the larynx receives branches. See Obf. on the Nervous Syftem, Tab. xxv.

*recurrent nerves*, which we are defired to fhun in the operation of bronchotomy, though their deep fituation protects them fufficiently.——The mufcles of the layrnx being in a good meafure fupplied with nerves from the recurrents, it is to be expected, that the cutting of them will greatly weaken the voice, though it will not be entirely loft fo long as the fuperior branches of the eighth pair are entire.——Why the recurrent nerves rife fo low from the eighth pair to go round a large artery, and to have fuch a long courfe upwards, I know not.

The eighth pair, above, and at or near the place where the recurrent nerves go off from it, or frequently the recurrents themfelves, fend off fmall nerves to the pericardium, and to join with the branches of the intercoftal that are diftributed to the heart; but their fize and fituation are uncertain.

After thefe branches are fent off, the par vagum on each fide defcends behind the great branch of the trachea, and gives numerous filaments to the lungs, and fome to the heart in going to the œfophagus. The one of the left fide running on the fore-part of the œfophagus, communicates by feveral branches with the right one in its defcent to be diftributed to the ftomach: the right one gets behind the œfophagus, where it fplits and rejoins feveral times before it arrives at the ftomach, to which it fends nerves; and then being joined by one or more branches from the left trunk, they run towards the cæliac artery, there to join into the great femilunar ganglion formed by the two intercoftals.

From the diftribution of this par vagum, we may learn, how tickling the fauces with a feather or any fuch fubftance, excites a naufea and inclination to vomit;—why coughing occafions vomiting, or vomiting raifes a cough.——Hence we fee how the nervous afthma, the tuffis convulfiva, and chincough, are attended with a ftraitening of the glottis;—why food difficult to digeft occafions the afthma to weakly people; and why emetics have frequently cured the afthma very fpeedily;

—why

why an attempt to vomit is ſometimes in danger of ſuffocating aſthmatic people;—why the ſuperior orifice of the ſtomach is ſo ſenſible as to be looked on as the ſeat of the ſou by ſome anatomiſts;—why people ſubject to diſtentions of the ſtomach, have ſo often the ſenſation of balls in their breaſt and throat;—why the globus hyſtericus is ſo often attended with a violent ſtrangulation at the glottis.

The *ninth* pair of nerves comes from the inferior part of the corpora pyramidalia, to go out of the ſkull at their proper holes of the occipital bone. After their egreſs they adhere for ſome way firmly to the eighth and intercoſtal; and then ſending a branch, that in many ſubjects is joined with branches of the firſt and ſecond cervical nerves, to be diſtributed to the thyroid gland, and muſcles on the fore-part of the trachea arteria, the ninth is loſt in the muſcles and ſubſtance of the tongue. Some authors have thought this nerve, and others have eſteemed the third branch of the fifth pair of nerves, to be the proper guſtatory nerve. I know no obſervation or experiments to prove either opinion, or to aſſure us that both nerves do not ſerve for taſting and for the motion of the tongue.——May not the diſtribution of this nerve to the muſcles below as well as above the os hyoides, contribute to their acting more uniformly in depreſſing the lower jaw or head?

The *tenth* pair riſes in ſeparate threads from the ſides of the ſpinal marrow, to go out between the os occipitis and firſt vertebra of the neck. After each of them has given branches to the great ganglion of the intercoſtal, 8th, 9th, and 1ſt cervical nerves, it is diſtributed to the ſtraight oblique, and ſome of the extenſor muſcles of the head. Whether the name of the tenth of the head, or of the firſt vertebral, ought to be given to this pair of nerves, is of no ſuch conſequence as to deſerve a debate, though it has ſome of the marks of the ſpinal nerves, to wit, its being formed of filaments proceeding from both the fore and back part of the medulla, and a little ganglion being formed where theſe filaments meet.

In the deſcription of the ſixth pair, I followed the uſual way of ſpeaking among anatomiſts, and called that the beginning of the intercoſtal nerve which comes out of the ſkull; and therefore ſhall here ſubjoin a curſory deſcription of this nerve, notwithſtanding its much larger part is compoſed of nerves coming out from the ſpinal marrow. There is no greater incongruity in point of method to ſay, that the nerve we are deſcribing receives additions from others that have not been deſcribed, than it is to repeat in the deſcription of a great many nerves, that each of them gives branches to form a nerve of which we are ignorant; which is all the difference between deſcribing the intercoſtal before or after the ſpinal nerves.

The branch reflected from the ſixth pair, joined poſſibly by ſome filaments of the ophthalmic branch of the fifth, runs along with the internal carotid artery, through the crooked canal formed for it in the temporal bone, where the little nerve is very ſoft and pappy, and in ſeveral ſubjects divides and unites again, and is joined by one or more branches from the fifth, particularly of its ſuperior maxillary branch before it comes out of the ſkull. May not the compreſſion of this nerve by the carotid artery, when ſtretched during the ſyſtole, contribute to the diaſtole of the heart? As ſoon as the nerve eſcapes out of this bony canal, it is connected a little way with the eighth and ninth; then ſeparating from theſe, after ſeeming to receive additional nerves from them, it forms a large ganglion, into which branches, from the tenth of the head, and from the firſt and ſecond cervical, enter. From this ganglion the nerves come out again ſmall, to run down the neck along with the carotid artery, communicating by branches with the cervical nerves, and giving nerves to the muſcles that bend the head and neck. As the intercoſtal is about to enter the thorax, it forms another ganglion, from which nerves are ſent to the trachea and to the heart; thoſe deſigned for the heart joining with the branches of the eighth, and moſt of them paſſing between the two great arteries and the auricles to the ſubſtance of that muſcle. The intercoſtal * after this conſiſting of two branches, one going behind, and the other running over the fore-part of the ſubclavian artery, forms a new ganglion, where the two branches unite below that artery; and then deſcending along the ſides of the vertebræ of the thorax, receives branches from each of the dorſal nerves; which branches appearing to come out between the ribs, have given the name of *intercoſtal* to the whole nerve. Where the addition is made to it from the fifth dorſal nerve, a branch goes off obliquely forwards; which being joined by ſuch branches from the ſixth, ſeventh, eighth, and ninth dorſal, an anterior trunk is formed, and paſſes between the fibres of the appendix muſculoſa of the diaphragm, to form, along with the other intercoſtal and the branches of the eighth pair, a large ſemilunar ganglion, ſituated between the cæliac and ſuperior meſenteric arteries: the roots of which ſeem to be involved in a ſort of nervous net-work of this ganglion, from which a great number of very ſmall nervous threads runs out to be extended on the ſurface of all the branches of theſe two arteries, ſo as to be eaſily ſeen when any of the arteries are ſtretched, but not to be raiſed from them by diſſection; and thus the liver, gall-bladder, duodenum, pancreas, ſpleen, jejunum, ileum, and a large ſhare of the colon, have their nerves ſent from this great ganglion or plexus. — May not the periſtaltic motion of the inteſtines depend in ſome meaſure on the paſſage of the intercoſtal nerves through the diaphragm?

Several fibres of this ganglion, running down upon the aorta, meet with other nerves ſent from the poſterior trunk of the intercoſtal, which continues its courſe along the ſides of the vertebræ: they ſupply the glandulæ renales, kidneys, and teſtes



* See Walter's Tab. Nervor. thor. et abd.

in men, or ovaria in women; and then they form a net-work upon the inferior meſenteric artery where the nerves of the two ſides meet, and accompany the branches of this artery to the part of the colon that lies in the left ſide of the belly, and to the rectum as far down as to the lower part of the pelvis.

The intercoſtal continuing down by the ſide of the vertebræ of the loins, is joined by nerves coming from between theſe vertebræ, and ſends nerves to the organs of generation and others in the pelvis, being even joined with thoſe that are ſent to the inferior extremities.

The almoſt univerſal connection and communication which this nerve has with the other nerves of the body, may lead us to underſtand the following and a great many more phenomena: Why tickling the noſe cauſes ſneezing:—Why the too great quantity of bile in the cholera occaſions vomiting as well as purging: Why people vomit in cholics, in inflammations, or other irritations of the liver, or of the ducts going from it and the gall-bladder: Why a ſtone in the kidneys, or ureters, or any other cauſe irritating thoſe organs, ſhould ſo much more frequently bring on vomiting and other diſorders of the ſtomach, than the ſtone or any other ſtimulating cauſe in the bladder does:—Why vomiting is a ſymptom of danger after child-birth, lithotomy, and other operations on the parts in the pelvis:—Why the obſtructions of the menſes are capable of occaſioning ſtrangulations, belching, cholics, ſtomach-aches, and even convulſions in the extremities: Why veſicatories, applied from the ears to the clavicles of children labouring under the tuſſis convulſiva, are frequently of great ſervice:—Why worms in the ſtomach or guts excite an itching in the noſe, or grinding of the teeth:—Why irritations in the bowels or the belly occaſion ſometimes univerſal convulſions of the body.

The Spinal Nerves riſe generally by a number of ſeparated fibres from both the fore and back part of the medulla ſpinalis; and ſoon after form a little knot or ganglion, where they acquire ſtrong coats, and are extended into firm cords; but the ganglion is entirely formed by the poſterior bundle. They are diſtinguiſhed by numbers, according to the vertebræ from between which they come out; the ſuperior of the two bones forming the hole through which they paſs, being the one from which the number is applied to each nerve. There are generally ſaid to be thirty pair of them: ſeven of which come out between the vertebræ of the neck, twelve between thoſe of the back, five between thoſe of the loins, and ſix from the falſe vertebræ.

The *firſt* cervical pair of the nerves comes out between the firſt and ſecond vertebræ of the neck; and having given branches to join with the tenth pair of the head, the ſecond cervical and intercoſtal, and to ſerve the muſcles that bend the neck, it ſends its largeſt branches backwards to the extenſor muſcles of the head and neck; ſome of which piercing thro' theſe muſcles, run up on the occiput to be loſt in the integuments there; and many fibres of it advance ſo far forward as to be connected with the fibrils of the firſt branch of the fifth pair of the head, and of the portio dura of the auditory nerve. —Hence poſſibly it is, that a clavus hyſtericus changes ſuddenly ſometimes from the forehead to a violent pain and ſpaſm in the back-part of the head and neck.

The *ſecond* cervical is ſoon joined by ſome branches to the ninth of the head and intercoſtal, and to the firſt and third of the neck; then has a large branch that comes out at the exterior edge of the ſterno-maſtoideus muſcle, where it joins with the acceſſorius of the eighth pair; and is afterwards diſtributed to the platyſma myoides, integuments of the ſide of the neck and head, parotid gland, and external ear, being connected to the portio dura of the auditory nerve, and to the firſt cervical. The remainder of this ſecond cervical is ſpent on the levator ſcapulæ and the extenſors of the neck and head. Generally

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a large branch is here ſent off to join the acceſſorius of the eighth pair, near the ſuperior angle of the ſcapula.

The irritation of the branches of this nerve in an inflammation of the parotid gland, is probably the cauſe why the neck is pained ſo far down as the clavicle, the head is drawn towards the ſhoulder of the affected ſide, and the chin is turned to the other ſide.—In opening the external jugular vein, no operator can promiſe not to touch ſome of the cutaneous branches of this nerve with the lancet; which occaſions a ſharp-pricking pain in the mean time, and a numbneſs of the ſkin near the orifice for ſome time after.

The *third* pair of the neck paſſes out between the third and fourth cervical vertebræ; having immediately a communication with the ſecond, and ſending down a branch, which, being joined by a branch from the fourth cervical, forms the *phrenic* nerve. This nerve enters the thorax between the ſubclavian vein and artery; and then being received into a groove formed for it in the pericardium, it has its courſe along this capſula of the heart, till it is loſt in the middle part of the diaphragm. The right phrenic has a ſtraight courſe; but the left one is obliged to make a conſiderable turn outwards to go over the prominent part of the pericardium, where the point of the heart is lodged. Hence, in violent palpitations of the heart, a pungent acute pain is felt near the left orifice of the ſtomach.—The middle of the diaphragm ſcarce could have been ſupplied by any other nerve which could have had ſuch a ſtraight courſe as the phrenic has. If the ſubclavian artery and vein have any effect upon this nerve, I do not know it.

The other branches of the third cervical nerve are diſtributed to the muſcles and integuments at the lower part of the neck and top of the ſhoulder. No wonder then that an inflammation of the liver or ſpleen, an abſceſs in the lungs adhering to the diaphragm, or any other cauſe capable of irritating the diaphragm, ſhould be attended with a ſharp pain on

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the top of the ſhoulder, as well as wounds, ulcers, &c. of this muſcle itſelf.—If the irritation of this muſcle is very violent, it may occaſion that convulſive contraction of the diaphragm which is called an *hiccough;* and therefore an hiccough in an inflammation of the liver has been juſtly declared to be an ill ſymptom.

An irritation of the thoracic nerves which produces ſneezing may ſometimes free the phrenic nerves from any ſpaſm they occaſion: ſo that ſneezing ſometimes takes away the hiccough; and a derivation of the fluid of the nerves any other way may do the ſame thing; or the hiccough may alſo be ſometimes cured, by drawing up into the noſe the ſmoke of burning paper or other acrid fumes, ſwallowing pungent or aromatic medicines, and by a ſurpriſe, or any other ſtrong application, of the mind in thinking, or in diſtinguiſhing objects: or, when all theſe have failed, it has been put away by the briſk ſtimulus of a bliſtering plaſter applied to the back.

The *fourth* cervical nerve, after ſending off that branch which joins with the third to form the phrenic, and beſtowing twigs on the muſcles and glands of the neck, runs to the arm-pit, where it meets with the *fifth*, *ſixth*, and *ſeventh* cervicals, and *firſt* dorſal, that eſcape in the interſtices of the muſculi ſcaleni, to come at the arm-pit, when they join, ſeparate, and rejoin, in a way ſcarcely to be rightly expreſſed in words; and, after giving ſeveral conſiderable nerves to the muſcles and integuments which cover the thorax, they divide into ſeveral branches, to be diſtributed to all the parts of the ſuperior extremity. Seven of theſe branches I ſhall deſcribe under particular names.

1. *Scapularis* runs ſtraight to the cavitas ſemilunata of the upper coſta of the ſcapula, which is a hole in the recent ſubject, by a ligament being extended from one angle of the bone to the other, giving nerves in its way to the muſcles of the ſcapula. When it has paſſed this hole, it ſupplies the ſu-

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pra-ſpinatus muſcle; and then deſcending at the anterior root of the ſpine of the ſcapula, it is loſt in the other muſcles that lie on the dorſum of that bone.

2. *Articularis* ſinks downwards at the axilla, to get below the neck of the head of the os humeri, and to mount again at the back part of it; ſo that it almoſt ſurrounds the articulation, and is diſtributed to the muſcles that draw the arm back, and to thoſe that raiſe it up.

3. *Cutaneus* runs down the fore part of the arm near the ſkin, to which it gives off branches; and then divides on the inſide of the fore-arm into ſeveral nerves, which ſupply the integuments there, and on the palm of the hand.——In opening the baſilic vein of the arm at the ordinary place, the ſame ſymptoms are ſometimes produced as in opening the external jugular vein, and from a like cauſe, to wit, from hurting a branch of this cutaneous nerve with the lancet.

4. *Muſculo-cutaneus*, or perforans Caſſeri, paſſes thro' the coraco brachialis muſcle; and after ſupplying the biceps flexor cubiti and brachiæus internus, paſſes behind the tendon of the biceps, and over the cephalic vein, to be beſtowed on the integuments on the outſide of the fore-arm and back of the hand. ——This nerve is ſometimes hurt in opening the cephalic vein, and cauſes pain and numbneſs for a ſhort time.

5. *Muſcularis* has a ſpiral courſe from the axilla, under the os humeri, and backward to the external part of that bone, ſupplying by the way the extenſor muſcles of the fore-arm, to which it runs between the two brachiæi muſcles, and within the ſupinator radii longus.—At the upper part of the fore-arm, it ſends off a branch which accompanies the ſupinator longus till it comes near the wriſt, where it paſſes obliquely over the radius, and is loſt in the back of the hand and fingers.—The principal part of this nerve pierces through the ſupinator radii brevis, to ſerve the muſcles that extend the hand and fingers, whoſe actions are not injured when the ſupinator acts. Part

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of this nerve ſeems to be loſt upon the ligament of the wriſt *.

6. *Ulnaris* is extended along the inſide of the arm, to give nerves to the muſcles that extend the fore-arm and to the integuments of the elbow: towards the lower part of the arm, it ſlants a little backward to come at the groove behind the internal condyle of the os humeri, through which it runs to the ulna: in its courſe along this bone, it ſerves the neighbouring muſcles and integuments; and as it comes near the wriſt, it detaches a branch obliquely over the ulna to the back of the hand, to be loſt in the convex part of ſeveral fingers. The larger part of the nerve goes ſtraight forward to the internal ſide of the os piſiforme of the wriſt; where it ſends off a branch, which ſinks under the large tendons in the palm, to go croſs to the other ſide of the wriſt, ſerving the muſculi lumbricales and interoſſei, and at laſt terminating in the ſhort muſcles of the thumb and fore-finger. What remains of the ulnar nerve after ſupplying the ſhort muſcles of the little-finger, divides into three branches; whereof two are extended along the ſides of the ſheath of the tendons of the flexors of the little finger, to furniſh the concave ſide of that finger; the third branch is diſpoſed in the ſame way upon the ſide of the ring-finger next to the little-finger.

When we lean or preſs on the internal condyle of the os humeri, the numbneſs and prickling we frequently feel, point out the courſe of this nerve. I have ſeen a weakneſs and atrophy in the parts to which this nerve is ſent after a wound in the internal lower part of the arm.

7. *Radialis* accompanies the humeral artery to the bending of the elbow, ſerving the flexors of the cubit in its way; then paſſing through the pronator radii teres muſcle, it gives nerves to the muſcles on the fore-part of the fore-arm, and continues



* See Obſ. on the Nervous Syſtem, Tab. xxvi.

its courfe near to the radius, beftowing branches on the circumjacent mufcles. Near the wrift, it fometimes gives off a nerve which is diftributed to the back of the hand, and the convex part of the thumb and feveral of the fingers, inftead of the branch of the mufcular. The larger part of this nerve, paffing behind the annular ligament of the wrift, gives nerves to the fhort mufcles of the thumb; and afterwards fends a branch along each fide of the fheath of the tendons of the flexors of the thumb, fore-finger, middle-finger, and one branch to the fide of the ring-finger, next to the middle one, to be loft on the concave fide of thofe fingers.

Though the radial nerve paffes through the pronator mufcle, and the mufcular nerve feems to be ftill more unfavourably placed within the fupinator brevis; yet the action of thefe mufcles does not feem to have any effect in hindering the influence of thefe nerves; for the fingers or hand can be bent while pronation is performing vigoroufly, and they can be extended while fupination is exercifed.

The manner in which thefe nerves of the fingers go off, both from the ulnar and radial, is, that a fingle branch is fent from the trunk to the fide of the thumb and little finger fartheft from the other fingers; and all the reft are fupplied by a trunk of a nerve, which fplits into two fome way before it comes as far as the end of the metacarpus, to run along the fides of different fingers that are neareft to each other.

It might have been obferved, that, in defcribing the pofterior branches of the ulnar and mufcular nerve, I did not mention the particular fingers, to the convex part of which they are diftributed. My reafon for this omiffion is, the uncertainty of their diftribution; for though fometimes thefe pofterior branches go to the fame fingers, to the concave part of which the anterior branches of the ulnar and radial are fent, yet frequently they are diftributed otherwife.

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The ſituation of theſe brachial nerves in the axilla, may let us ſee how a weakneſs and atrophy may be brought on the arms by long-continued preſſure of crutches, or ſuch other hard ſubſtances on this part; and the courſe of them from the neck to the arm may teach us how much better effects veſicatories, or ſtimulating nervous medicines, would have, when applied to the ſkin covering the tranſverſe proceſſes of the vertebræ of the neck, or at the axilla, than when they are put between the ſhoulders, or upon the ſpinal proceſſes, in convulſions or palſies of the ſuperior extremities, where a ſtimulus is required.

The *twelve dorſal* nerves of each ſide, as ſoon as they eſcape from between the vertebræ, ſend a branch forward to join the intercoſtal, by which a communication is made among them all; and they ſoon likewiſe give branches backward to the muſcles that raiſe the trunk of the body, their principal trunk being extended outwards to come at the furrow in the lower edge of each rib, in which they run toward the anterior part of the thorax, between the internal and external intercoſtal muſcles, giving off branches in their courſe to the muſcles and integuments of the thorax.

The *firſt* dorſal, as was already obſerved, is particular in this, that it contributes to form the brachial nerves; and that the two branches of the intercoſtal, which come down to the thorax, form a conſiderable ganglion with it.

The *ſix* lower dorſal nerves give branches to the diaphragm and abdominal muſcles.

The *twelfth* joins with the firſt lumbar, and beſtows nerves on the muſculus quadratus lumborum and iliacus internus.

May not the communications of all theſe nerves be one reaſon, why the parts they ſerve act ſo uniformly and conjunctly in reſpiration, and conſpire together in the convulſive motions of coughing, fneezing, &c.——The twitching fpafms that happen fometimes in different parts of the mufcles of the abdomen, by an irritation on the branches of the lower dorfal nerves, are in danger of occafioning a miftake in practice, by their refemblance to the cholic, nephritis, &c.——The communications of thefe lower ones with the intercoftals, may ferve to explain the violent effort of the abdominal mufcles in a tenefmus, and in child-bearing.

As the intercoftal is larger in the thorax than any where elfe, and feems to diminifh gradually as it afcends and defcends, there is caufe to fufpect that this is the trunk from which the fuperior and inferior pairs are fent as branches.

The *five lumbar* nerves on each fide communicate with the intercoftal and with each other, and give branches backwards to the loins.

The *firft* communicates with the laft dorfal, fends branches to the abdominal mufcles, to the pfoas and iliacus, and to the integuments and mufcles on the fore-part of the thigh; while its principal branch joins with the other nerves to form the crural nerve.

The *fecond lumbar* nerve paffes through the pfoas mufcle, and is diftributed nearly in the fame way as the former; as is alfo the *third.*

Branches of the fecond, third, and fourth, make up one trunk, which runs along the fore-part of the pelvis; and paffing in the notch at the fore-part of the great hole common to the os pubis and ifchium, is fpent on the adductor mufcles, and on the integuments on the infide of the thigh. This nerve is called the *obturator*, or *pofterior crural nerve.*

By united branches from the firft, fecond, third, and fourth lumbar nerves, a nerve is formed that runs along the pfoas mufcle, to efcape with the external iliac veffels out of the abdomen below the tendinous arcade of the external oblique

lique mufcle. This nerve, which is named the *anterior crural* is diftributed principally to the mufcles and integuments on the fore-part of the thigh. A branch, however, of this nerve runs down the infide of the leg to the upper part of the foot, keeping near to the vena faphena; in opening of which with a lancet at the ankle, the nerve is fometimes hurt, and occafions fharp pain at the time of the operation, and numbnefs afterwards.

The remainder of the fourth lumbar and the fifth join in compofing the largeft nerve of the body, which is foon to be defcribed.

Whoever attends to the courfe of thefe lumbar nerves, and of the fpermatic veffels and nerves upon the pfoas mufcle, with the oblique paffage of the ureter over that mufcle, will not be furprifed, that when a ftone is paffing in this canal, or even when it is inflamed, the trunk of the body cannot be raifed erect, without great pain; or that the fkin of the thigh becomes lefs fenfible, and the thigh is drawn forward, and that the tefticle often fwells and is drawn convulfively towards the ring of the abdominal mufcles.

The *fix pair* of the falfe *vertebræ* confift each of fmall pofterior branches fent to the hips, and of large anterior branches.

The firft, fecond, and third, after coming through the three upper holes in the fore-part of the os facrum, join together with the fourth and fifth of the loins, to form the largeft nerve of the body, which is well known by the name of *fciatic* or *ifchiatic* nerve: This, after fending large nerves to the different parts of the pelvis, and to the external parts of generation and the podex, as alfo to the mufcles of the hips, paffes behind the great tuber of the os ifchium, and then over the quadrigemini mufcles to run down near to the bone of the thigh at its back part, giving off nerves to the neighbouring mufcles and integuments. A little above the ham, where it has the name of *poplitæus nervus*, it fends off a large branch that

that paſſes over the fibula, and ſinking among the muſcles on the anterior external part of the leg, runs down to the foot, to be loſt in the upper part of the larger toes, ſupplying the neighbouring muſcles and integuments every where in its paſſage. The larger branch of the ſciatic, after giving branches to the muſcles and integuments about the ham and knee, and ſending a large cutaneous nerve down the calf of the leg, to be loſt at laſt on the outſide of the foot, and upper part of the leſſer toes, ſinks below the gemellus muſcle, and diſtributes nerves to the muſcles on the back of the leg; among which it continues its courſe, till, paſſing behind the internal malleolus, and in the internal hollow of the os calcis, it divides into the two plantar nerves: The internal of which is diſtributed to the toes in the ſame manner that the radial nerve of the hand ſerves the concave ſide of the thumb and fingers; and the external plantar is divided and diſtributed to the ſole of the foot and toes, nearly as the ulnar nerve is in the palm of the hand, and in the concave part of the fingers.

Several branches of theſe nerves, that ſerve the inferior extremities, pierce through muſcles.

By applying what was ſaid of the nerves in general to the particular diſtribution of the nerves of the inferior extremities, we may ſee why people with fractured legs, eſpecially where there are ſplinters, ſhould be ſubject to convulſive ſtartings of the fractured member:—Why, upon tying the blood-veſſels in an amputation of the leg, the patients ſhould ſometimes complain of violent pain in their toes;—why ſuch patients ſhould alſo be troubled with ſtartings;—why, for a conſiderable time after the amputation of the diſeaſed limb, when the ſuppuration is well advanced, they ſhould complain of pain in the ſore which occaſioned the amputation.

The *fourth*, which, with the two following, is much ſmaller than the three ſuperior, is ſoon loſt in the veſica urinaria and inteſtinum rectum.

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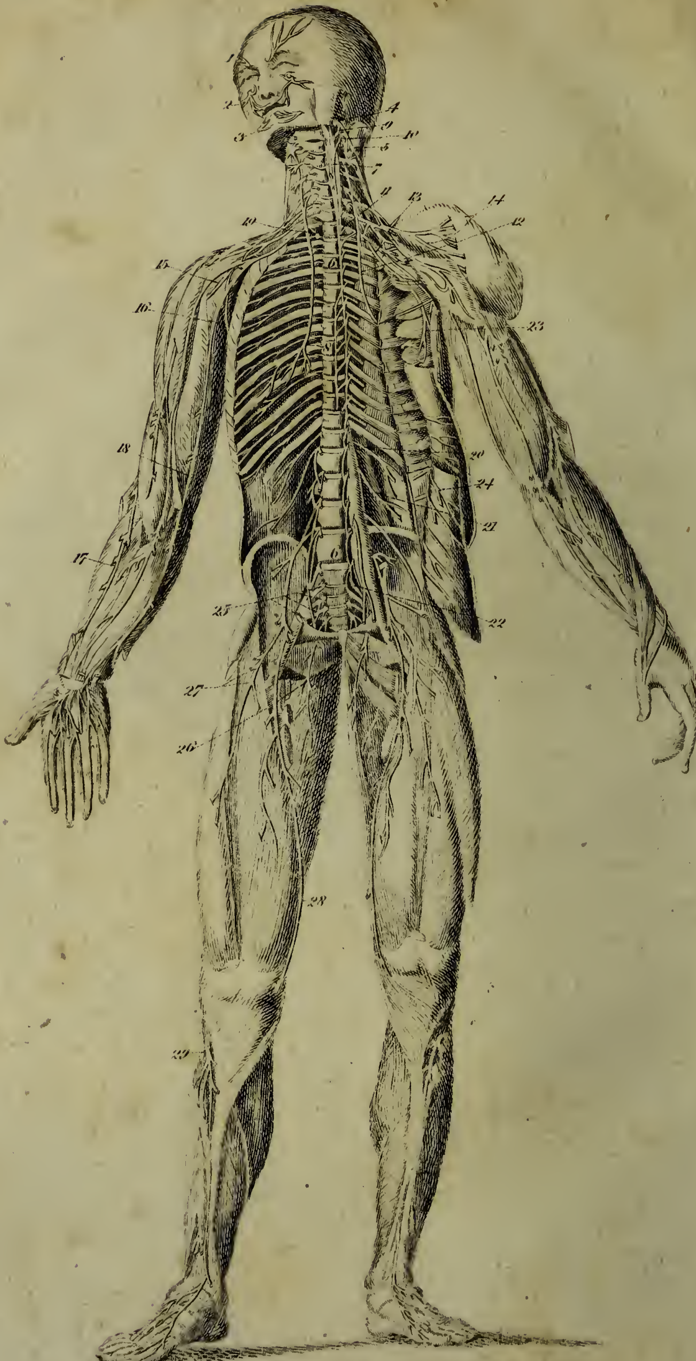
TAB. XIX.




D. Lizars Sculpt

The *fifth* comes forward between the extremity of the os facrum and coccygis, to be diftributed principally to the levatores ani.

The *fixth*, which may be confidered as the termination of a fubftance called *ligamentum denticulatum*, advances forward below the broad fhoulders of the firft bone of the os coccygis, and is loft in the fphincter ani and integuments covering it.

The branches of the four laft cervical nerves, and of the firft dorfal, which are beftowed on the fuperior extremities, and the two crurals, with the fciatic, which are diftributed to the inferior extremities, are much larger proportionally to the parts they ferve, than the nerves of the trunk of the body, and efpecially of the vifcera; and for a very good reafon, that in the moft common neceffary actions of life, a fufficient quantity of fluid, on which the influence of nerves feems to depend, may be fupplied to the mufcles there, which are obliged to perform more frequent and violent contractions than thofe of any other parts.—The fize of the nerves of the inferior extremities feems larger proportionally than in the fuperior extremities; the inferior extremities having the weight of the whole body to fuftain, and that frequently at a great difadvantage.--What the effect of the nerves here being injured is, we fee daily: When people happen, by fitting wrong, to comprefs the fciatic nerve, they are incapable for fome time after to fupport themfelves on the affected extremity; and this is ftill more remarkable in the fciatica or hip-gout, in which the member is not only weakened, but gradually fhrivels and waftes.

## Explanation of Tables XIX. and XX.

Tab. XIX.—(1) The firft branch of the fifth pair of nerves. (2) The fecond branch of the fifth pair. (3) The third branch of the fifth pair. (4) The trunk of the eighth pair cut. (5) The recurrent

recurrent nerve. (6) The great ſympathetic nerve. (7) The uppermoſt ganglion of the great ſympathetic nerve. (8) The ramus ſplanchnicus of the great ſympathetic nerve. (9) A branch of the ſub-occipital, or tenth pair of the head, joining with the great ſympathetic nerve. (10) The firſt cervical nerve. (11) The ſeventh cervical nerve. The intermediate cervicals come out in a ſimilar manner. (12) The phrenic nerve. (13) The axillary plexus. (14) The muſcular nerve of the arm. (15) The articular nerve. (16) The ſpiral nerve. (17) The radial nerve. (18) The ulnar nerve. (19) The firſt intercoſtal nerve. (20) The laſt intercoſtal nerve. The other ten come out in the ſame manner. (21) The firſt lumbar nerve. (22) The laſt lumbar nerve. The three intermediate lumbar nerves come out in a ſimilar way. (23) Branches from the external thoracic nerves running down upon the ſide of the thorax. (24) Branches ſent off from the intercoſtal and lumbar nerves to ſupply the outer part of the thorax and abdomen. (25) Nerves of the os ſacrum. (26) The obturator nerve. (27) The anterior crural nerve. (28) A branch of the anterior crural nerve, which runs near the vena ſaphena major. (29) The anterior tibial nerve running down to the foot.

Tab. XX.—(1) The recurrent nerve. (2) A branch of the 4th cervical nerve, joining the recurrent one before it terminates on the muſculus trapezius. (3) Branches of the fifth pair, perforating the ſcalenus medius to be ſpent upon the rhomboid muſcles. (4) Branches of the ſub-occipital nerve, running to the ſmall muſcles at the under and back part of the head. (5) Poſterior branches of the cervical nerves. (6) Poſterior branches of the dorſal nerves. (7) Poſterior branches of the dorſal and lumbar nerves running to the erector muſcles of the back. (8) Poſterior branches of the dorſal nerves, penetrating the intercoſtal muſcles. (9) Branches from the laſt dorſal, and from the lumbar nerves, ſupplying the lumbar and abdominal muſcles. (10) Branches from ſome of the

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lower cervical nerves, running to the muſcles on the back-part of the ſcapula. (11) The articular nerve. (12) A branch from the axillary plexus running to the muſculus latiſſimus dorſi. (13) Another branch from the axillary plexus running to the latiſſimus dorſi and ſerratus magnus. (14) The ſpiral nerve. (15) The ulnar nerve. (16) Small branches coming through the holes in the back-part of the os ſacrum running to the muſcles, &c. there. (17) A ſmall branch running out between the os ſacrum and os coccygis. (18) The end of the cauda equina running through the canal at the back part of the os ſacrum. (19) The ſciatic nerve. (20) Branches from the ſciatic nerve to the muſcles on the back part of the pelvis. (21) Branches from the ſciatic nerve to the muſcles, &c. about the anus. (22) Branches from the ſciatic nerve to the glutæus maximus and muſcles, at the upper and back part of the thigh. (23) Trunk of the ſciatic nerve, ſending off branches to the muſcles on the back part of the thigh. (24) The fibular nerve ſent off from the ſciatic one. (25) The poſterior tibial nerve, which is a continuation of the ſciatic nerve.

A

# TREATISE

ON

# COMPARATIVE ANATOMY.

BY

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PUBLISHED BY HIS SON,

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WITH

Conſiderable IMPROVEMENTS and ADDITIONS.

# PREFACE.

WHAT is called *Comparative Anatomy*, was certainly the firſt branch of the ſcience that was cultivated; and from it the earlieſt anatomiſts formed their notions of the human body. The natural prejudices of mankind, and, in ſome ſenſe, common humanity, oppoſed any attempts to be made in the other way. As the firſt phyſicians were philoſophers, and this part of natural knowledge more immediately related to medicine, they particularly applied to it. Democritus, who, according to ſome authors, was the maſter of Hippocrates, ſpent much time in diſſecting brutes and examining their ſeveral parts. He applied himſelf with ſuch eagerneſs to this ſtudy, as to incur the cenſure of madneſs. His deſign was to examine the nature of the bile, and learn the ſeat and cauſes of diſeaſes. That this ſcience was much improved by the time of Hippocrates, is apparent from his writings, which are intermixed with reaſonings drawn from it; and ſome parts of his phyſiology are only applicable to brutes. Theſe paſſages appear to us exceedingly obſcure, often falſe and contradictory; and have for that reaſon been rejected by ſome very great critics. But is not this owing to our own ignorance? We do not well underſtand the then received

received fyftem of anatomy; and his terms and names do not correfpond to ours. The fmall tract *De Vulneribus Capitis*, is as great a mafter-piece in its kind as the *Coacæ Predictiones*. Yet the firft has been efteemed by fome critics, as lame and imperfect, and has afforded occafion for many difputes and wranglings; becaufe it was not underftood. Anatomifts, however, have done with Hippocrates in moft cafes as the critics have done with Homer; they have made him the mafter of all human and divine fcience. Not a new divifion of a bone, or difpute about a procefs or articulation, but has been referred to his judgement; and he has often been made to explain what he never dreamt of. Galen, the father of anatomifts, is, for the fame reafon, in many places, become an obfcure writer. He is accufed and defended by the greateft fucceeding mafters. Vefalius, the great reftorer of anatomy, will not allow accuracy or truth in many of his defcriptions; they are, according to him, taken from brutes, and obtruded on the world for human.

The other anatomifts treat Vefalius much in the fame manner; and, with uncommon fagacity and unwearied application, have found out variations and *lufus naturæ* in particular parts, that they may eftablifh Galen's defcriptions, and condemn thofe of Vefalius. This is particularly the cafe with Euftachius in his Treatife on the Kidneys. How fhall we now underftand Galen, and judge between thefe great anatomifts? It is Comparative Anatomy alone can extricate us from this confufion; as it will teach us when Galen and others defcribed and reafoned from

brutes,

brutes, and when not. We ſhall find, that the greateſt part of his deſcriptions was taken from brutes, which he transferred by analogy to the human body, and ſo are inaccurate; that a few were taken from the human ſubject, and are not capable of being otherwiſe applied. This ſtudy he himſelf recommends with great earneſtneſs to his ſcholars; and it is obſervable, that the moſt eminent anatomiſts firſt diſcovered their genius by an early attachment to it. This was particularly the caſe with Veſalius and Valſalva *.

As the firſt knowledge the ancients gained in anatomy was from the diſſection of brutes, ſo they formed the names and terms of art from the moſt natural appearance the part afforded, and that in different animals. Thoſe names were applied to the correſponding parts in the human body, and retained by ſucceeding anatomiſts to avoid a multiplicity of words. This, however, produces one bad effect, that it muſt miſlead us in our conceptions, as thoſe names are often very improper epithets in the human ſubject. The author has elegantly remarked ſeveral of theſe. The name of *right* and *left* ventricle is apt to give a wrong idea of the poſition of the heart; and the aorta *aſcendens* and *deſcendens* has impoſed on ſome of the maſters in anatomy, who, it is plain, have taken their figures from the name. Diſputes have ariſen about

* Gaudebat enim avicularum, aliorumque animalculorum diſſectionibus; eorumque exta curioſus, quam pro illa ætate, rimabatur: quam ego præſignificationem, non in Veſalio tantum, ſed in aliis quoque pueris fuiſſe ſcio, qui cum adoleviſſent, anatomiæ penitus ſe dediderunt. *Morgagni Comment. de vita Valſalvæ.*

bout the *appendix vermiformis*, &c. which are all cleared up when we once view the part in the animal whence the name was taken.

The intention of nature in the formation of the different parts, can no where be ſo well learned as from this ſcience; that is, if we would underſtand phyſiology, and reaſon on the functions in the animal-economy, we muſt ſee how the ſame end is brought about in other ſpecies. We muſt contemplate the part or organ in different animals, its ſhape, poſition, connection with the other parts, &c. and obſerve what thence ariſes. If we find one common effect conſtantly produced, though in a very different way, then we may ſafely conclude that this is the uſe or function of the part: this reaſoning can never betray us, if we are but ſure of the facts. The writers in phyſiology have generally taken another method, and one favourite theſis or other ſerves to explain the whole or moſt of the ſyſtem. An innate and concocting heat, acids, menſtruums, &c. have all had their ſucceſſive reigns and patrons: and in truth, phyſicians ſeem not to have ſufficiently conſidered the importance of this ſtudy to form a complete phyſiology, which muſt ever be the great baſis of their art. They have beſtowed pains in examining the human body, diſſected minutely its ſeveral parts, traced out (perhaps often invented) a new diviſion of a muſcle: But how little has phyſic been promoted by all this? The moſt accurate deſcription of the human ſtomach, with all its veins, arteries, nerves, &c. will never rightly explain digeſtion. What muſt we then do? Examine it in the other ſpecies of animals, mark there its differences and the effects, compare theſe with the human; and then we ſhall be able, in ſome meaſure, to judge what are the principal inſtruments, and how they are employed in this compound action. Any other way of reaſoning (as the author well obſerves) will never bring us to the ſolution of a philoſophical or medical problem. It muſt indeed be confeſſed, that this method is tedious and ſlow; many obſervations muſt firſt be made, and the labour of ſearching and examining gone through, before we can have proper materials to build on. Yet theſe are the hard conditions on which the knowledge of natural cauſes is to be obtained; which, as a great genius ſays, *Tam facile ſolertia vinci poſſunt, quam ſolent conatibus vulgaribus difficulter cedere.*

Of this kind of reaſoning we have many beautiful inſtances in the following papers. Such is the account of the poſition of the Duodenum; of the cauſe of our preferring the Right Arm; of the circulation of the blood in the Fœtus; the hiſtory of the Thymus and Thyreoid Glands, their uſe and mutual proportion; the uſe of the ſpleen, &c. This laſt he explains in ſo ſhort and maſterly a manner, that more argument will be found in the few lines upon it, than is to be collected from whole treatiſes on the ſubject. But as his deſign was to give a deſcription of the ſeveral ſpecies, or rather their principal differences, he chiefly confines himſelf to this. So in the anatomy of the dog he compares the different poſition, ſhape, length, &c. of the ſeveral parts with the correſponding

reſponding parts in man; and from that one circumſtance, the difference of an erect and horizontal poſture, explains all the variations. This reaſoning then gives ſolution to many difficulties in the human anatomy; why the Spleen is ſo firmly attached to the Diaphragm; why the Omentum reaches only ſo far; why the poſterior part of the Bladder is only covered by the Peritoneum, &c. There have been diſputes about the fiſſure in the human liver, and different accounts given. Theſe all vaniſh, when we conſider this viſcus in different animals. We then find, that there are more or fewer diviſions, according to the greater or leſſer flexibility of the ſpine. The ſame rule holds with regard to the diviſions of the lungs. This reaſoning likewiſe excludes the pretended uſe of the ligament in the human liver. And, in ſhort, we can underſtand but little of our own ſtructure unleſs we ſtudy that of other animals: we ſhall then find, that the ſeveral variations are relative, and depend on the different ways of life; that is, one leading ſpecialty draws after it a great many more, in which nature is always an economiſt, and takes the ſhorteſt means to accompliſh her ends.

The beautiful gradation of nature in the different orders of beings is very remarkable, and ſtrikes the mind firſt as being moſt obvious; but when we take any one ſpecies, the caſe there is ſtill the ſame, and we obſerve as ſurpriſing a difference. Thus, in the animal kingdom, ſome are provided with lungs, when others are deprived of theſe organs of reſpiration; ſome have a ſtrong muſcular diaphragm and ſtrong abdominal mufcles, others a mere membrane. It muft be very entertaining to learn how thefe differences and deficiencies are adjufted and fupplied : it is then from this fcience alone we can underftand that fimplicity of nature which is fo much talked of, and but little underftood. Hence likewife we may perceive the reafons why fome animals are more perfect than others.

Anatomifts have made a noife about the different ftructures of the fame part in the human body, and have been at great pains to make collections of thofe *Lufus Naturæ*, as they call them ; which becaufe they are rare, are for that very reafon of no great confequence to be known. The epithet, however, is extremely proper ; for the moft remarkable of them are tranfitions from the order or law of nature that obtains in one fpecies to that of another. Thus it has been obferved, (though very rarely), that the liver was fituated in the left hypochondrium : but, as our author remarks, it is not peculiar to it to lie on the right fide of animals ; for in fowls it lies equally in both, and in fifhes moftly on the left.

It is furprifing that we have no tolerable treatife on this fubject, which is in itfelf fo entertaining and fo conducive to promote medical knowledge. Thofe who have made attempts this way, have only collected and arranged fome particular fpecies, fuch as Birds or Fifhes. They have likewife with great labour given us figures and defcriptions of them ; but all this is little elfe than mere amufement. It is the ftructure of their internal organs we feek after, and the

manner

manner how the different functions of the animal-economy are performed. Their hiftories of thefe are every way defective, and erroneous. There are indeed noble hints to be found in the writings of fome of our modern anatomifts, particularly thofe of the immortal Dr Harvey. That great man well underftood the importance of this fcience to advance medicine; and accordingly he employed the moft of his time in diffecting animals of different tribes, and making experiments on them: by which means he made the greateft difcovery that ever was made in the fcience, and he laid the foundation of the prefent fyftem. He had certainly left us other treatifes on this fubject, had he not been interrupted by the civil wars. The phyficians who lived then, imitating his example, made many new experiments on the bodies of brutes, changing their juices by transfufing of new liquors, accurately marking the effects, &c. that all this might be transferred to the human body: And indeed, from the application of thefe reafonings to the obfervations they made on morbid bodies, the fcience feemed faft advancing to that phyfical certainty which can be attained from experiment and obfervation. But alas! this fpirit died with thofe great men, and theory and calculation came in its place. Mathematics, it was faid, could alone bring the fcience to certainty, and throw out conjecture. The quantity and velocity of the blood, the force of the heart, diameters of the veffels, &c. were fubjected to meafure and number, and difeafes next were to be accounted for, all in a mathematical manner.—This method, however, did not fucceed according to wifh: For, firft, thofe great geniufes difagreed widely in their calculations, and differed from one another; whence, in place of certain conclufions, we had only wranglings and difputes: not to mention, that fome of them made fuch eftimates as muft plainly appear ridiculous at firft fight *. This, fome may fay, proves nothing; it was the fault of the artifts, who affumed wrong hypothefes for their calculations, or who were not perhaps accurate enough in their obfervations. True; but whofe fault was it to adapt figure and number to a fubject which refufes them, through its numberlefs deviations from fixed laws and conditions?—Is an animate body a mere bundle of hard conical elaftic tubes, and the heart a pump forcing the liquors through them? Are then all the veffels exact cones, or have two anatomifts agreed in their meafures of them? Do they not yield every way? and are they not continually obftructed in different places? Are there not many different attractions prevailing for the feveral fecretions, and many different forces acting on

* The ingenious Dr Pitcairn was the chief man here, who applied mathematics to anatomy. He fuppofes the force of the mufcles to be in a compound ratio of their length, breadth, and depth; that is, as they are homogeneous folids in their ratio of their weights. Whence, knowing the force of any one mufcle, we can by the rule of proportion (from their weights) determine that of another. This he applies to the ftomach; and by the computation, its mufcular force is at leaft equal to 117,088lb. weight.—That mufcles are in that proportion, is a mere hypothefis, for which the Doctor does not offer the fmalleft proof; and had he affigned five ounces as the force of the ftomach, he had been nearer the truth. This is one glaring inftance how much theory and whim may prevail with the greateft of men over common fenfe.

on the veſſels at the ſame time, which can never be determined? &c. Theſe and ſuch like conſiderations will ſoon convince us how little the practice of medicine is to be promoted by thoſe ſpeculations *. If theſe gentlemen meant by mathematical reaſoning, phyſical experiments; then no one would doubt their uſe in medicine more than the uſe of mathematics in natural philoſophy itſelf. But as this ſeems not to be their ſenſe of the matter, they ſhould point out a few diſeaſes which this ſcience has explained, and wherein it has corrected the received practice.—But we are now got from the ſubject to what is foreign. To return then: Comparative anatomy has hitherto only been treated in its detached parts. Thus ſome, writing on the human eye, have examined the eyes of other animals; and ſo with regard to the heart, &c. Some have given us the deſcription of one particular animal, others of another. But no one author that we know of, has given us a ſyſtem of this ſcience, where we might have a ſummary view of the moſt material differences in the ſtructure of animals. There are indeed compendiums of this ſcience which

* The authority of Hippocrates is often adduced in this argument; for which they cite two paſſages. In the one he recommends the ſtudy of Aſtronomy as neceſſary to a phyſician; and in the other, that of Arithmetic and Geometry.—The firſt he did from his belief in the influence of the ſtars; and the ſecond, from his veneration for the Pythagoric numbers, in the myſteries of which he founded his theory of the criſes in acute diſeaſes: Both theſe conſiderations then are foreign to the purpoſe; nor is there in any of his genuine writings the ſmalleſt veſtige of this kind of reaſoning. On the contrary, Celſus ſays of him "Primus a ſtudio ſapientiæ medicinam ſeparavit."

which are much efteemed, and which were written with the noble defign of illuftrating the wifdom and goodnefs of our Maker. But thofe who compofed them not being anatomifts, only collected from others, and often without judgement: for how voluminous fo-ever their works may be, yet if we ftrip them of their repeated exclamations, citations of authors and books, the many ftrange and furprifing ftories, all told, however, by creditable vouchers, we fhall have little left behind, except an indigefted chaos of hiftories and defcriptions, fome true and many falfe. The argument, however, was popular, and they could not fail of pleafing.

The following Treatife, by the late celebrated Dr Monro, is executed upon a more ufeful plan, and in a more fyftematic manner. The defcriptions are all taken from life, and the reafoning employed is plain and conclufive. Thefe are intermixed with many practical obfervations in medicine and furgery, which muft equally inftruct and entertain the reader.

The fubftance of this work appeared about forty years ago, under the title of *An Effay on Comparative Anatomy;* but without any author's name, being only compofed from Notes taken by a ftudent at the Clafs Lectures. As it was of courfe exceedingly defective and erroneous, the prefent Profeffor of Anatomy, in preparing for the prefs the Collection of his father's Works lately publifhed, corrected this piece amongft the reft; and alfo made fome additions to it, from obfervations that had been collected by the

the author with a view to a larger work upon the ſubject, but which various avocations prevented him from proſecuting. The Profeſſor's deſign, however, being only to correct his father's works, not to enlarge them by additions of his own, the preſent performance ſtill remained leſs complete than might be wiſhed, and unimproved by later diſcoveries. It having been, therefore, ſuggeſted to the preſent publiſher, as proprietor of the late Doctor's Works, that a ſeparate Edition of this Treatiſe, improved and enlarged, could not fail of being acceptable, he readily adopted the deſign; and was fortunate enough to prevail with ſome gentlemen verſed in the ſubject to undertake the taſk of making the neceſſary additions and improvements. This has been accordigly accompliſhed, as far as the limits of a compendium would admit, or as ſeemed to be ſuitable to the limits of the preſent undertaking. Some of the principal ſubjects, particularly the Dog, Fowls, and Fiſhes, have received conſiderable augmentation: Others have been entirely added; as Amphibious Animals, Serpents, Inſects, &c. And leſſer additions in great number have been made in various parts of the work,—either inſerted into the body, or thrown to the bottom of the page in the form of notes. Of the additions in general, a few are drawn from the experience of the gentlemen themſelves who had the care of the edition, ſome from different parts of the late author's other works, and the greateſt number from the lectures of the illuſtrious Profeſſor who now fills the anatomical chair.

AN

# ESSAY

ON

# COMPARATIVE ANATOMY.

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## THE INTRODUCTION.

THE principal advantages of Comparative Anatomy are the following: Firft, It furnifhes us with a fufficient knowledge of the different parts of animals, to prevent our being impofed upon by fuch authors as have delineated and defcribed feveral parts from brutes as belonging to the human body. Secondly, It helps us to underftand feveral paffages in the ancient medical writers, who have taken many of their defcriptions from brutes, and reafoned from them: their reafonings have often been mifapplied (and confequently wrong explained) by the moderns, through a foolifh fondnefs to fupport their own inventions, or give an air of antiquity to a favourite hypothefis. The third and great ufe we reap from this fcience, is the light it cafts on feveral functions in the human oeconomy, about which there have been fo many difputes among anatomifts: Thefe differences of opinion, by exhibiting the ftructure of the fame parts in different animals, and by comparing the

the ſeveral organs employed in performing the ſame action, which in the human body is brought about by one more complex, will be in a great meaſure done away.

In this view, it is altogether needleſs to inſiſt on thoſe parts whoſe uſe is eaſily underſtood when their ſtructure is unravelled. Thus, for inſtance, if we be acquainted with the action of the muſcles in general, it will not be difficult to determine the uſe of any particular muſcle whoſe origin and inſertion is known, if we at the ſame time conſider the various connections of the bones to which it is fixed, and the different degrees of mobility they have in reſpect to each other. In the ſame manner, if we know the uſe of the nerves in general, we can eaſily aſſign the uſe of thoſe nerves which are diſtributed to any particular part. There is then no occaſion for a complete Oſteology, Myology, &c. of the ſeveral animals we ſhall deſcribe; nor need we trouble ourſelves about the ſtructure of any of the parts, unleſs when it ſerves to illuſtrate ſome of the fore-mentioned purpoſes. *

That the firſt uſe we propoſed from examining the ſtructure of the parts in brutes is real and of conſequence, is evident from looking into the works of ſome of the earlieſt and greateſt maſters of anatomy, who, for want of human ſubjects, have often borrowed their deſcriptions from other animals. The great Veſalius, although he juſtly reproves Galen for this fault, is guilty of the ſame himſelf, as is plain from his delineations of the kidneys, uterus, the muſcles of the eye, and ſome other parts. Nor is antiquity only to be charged with

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* Notwithſtanding this aſſertion of the learned author, we muſt obſerve, that the myology of animals ſeems exceedingly neceſſary for young anatomiſts, who generally begin with diſſecting brutes before they have acceſs to human bodies. For this reaſon, we have added, not indeed a complete canine myology, but an account of the particulars wherein the muſcles of a dog differ from thoſe of a man; this being the animal moſt frequently choſen for diſſections, and one whoſe ſtructure bears no ſmall reſemblance to that of the human ſpecies.

this fault: ſince, in Willis's *Anatomia Cerebri* (the plates of which were reviſed by that accurate anatomiſt Dr Lower) ſeveral of the pictures beſides thoſe he owns to be ſuch, are taken from different brutes, eſpecially the dog.

We ſhall give ſeveral examples of the ſecondary uſe in the ſequel of this work.

The animal kingdom, as well as the vegetable, contains the moſt ſurpriſing variety; and the deſcent in each is ſo gradual, that the little tranſitions and deviations are almoſt imperceptible. The bat and flying-ſquirrel, though quadrupeds, have wings to buoy themſelves up in the air. Some birds inhabit the waters; and there are fiſhes that have wings, and are not ſtrangers to the airy regions; the amphibious animals blend the terreſtrial and aquatic together.

The animal and vegetable kingdoms are likewiſe ſo nearly connected, that if you take the higheſt of the one, and the loweſt of the other, there will ſcarce be perceived any difference. For inſtance, what difference is there between an oyſter, one of the moſt inorganiſed of the animal tribe, and the ſenſitive plant, the moſt exalted of the vegetable kingdom? They both remain fixed to one ſpot, where they receive their nouriſhment, having no proper motion of their own, ſave the ſhrinking from the approach of external injuries. Thus we obſerve a ſurpriſing chain in nature.

As there is then ſuch a vaſt variety, it is not only needleſs, but impoſſible, to conſider all of them particularly. We ſhall take only ſome of the moſt remarkable genera; and hope, from what will be ſaid of them, any of the intermediate degrees may be underſtood.

In treating of Quadrupeds, we ſhall divide them into the carnivorous and herbivorous. As an inſtance of theſe laſt, we ſhall take the ruminant kind. The Fowls we ſhall divide into thoſe that feed on grain, and thoſe that feed on fleſh. The diſtinction we ſhall make in treating of Fiſhes, ſhall be of thoſe that

that have lungs, and thofe that have them not. The firft indeed are with difficulty procured, and at the fame time differ very little from quadrupeds.

As the ftructure of infects and worms is fo very minute, and lends us but little affiftance for the ends propofed, we purpofely omit them *.

In inquiring into the ftructure of different animals, we ought to be previoufly acquainted with the form of their body, manner of life, kind of food, or in fhort with their natural hiftory; which will lead us to account for the reafon of their different ftructure, and thence explain the actions of the human body.

* Though the anatomy of infects is very difficult, and little known, yet as they conftitute one of the great claffes into which animals are divided, and as many of them are very ufeful to man, we have thought proper to add a few circumftances concerning them, which at leaft may be confidered as matters of curiofity highly worthy of the attention of every anatomift; not to mention, that every advance in knowledge, with refpect to the ftructure of any one animal, muft either directly or indirectly caft fome light on the ftructure of fome part of every other.

## Of QUADRUPEDS in general.

ALL quadrupeds have a covering of hair, wool, &c. to defend them from the injuries of the weather; which varies in thicknefs according to the feafon of the year, and difference of the climate. Thus in Ruffia and the northern countries the furs are very thick and warm; while the little Spanifh lap-dogs, and Barbary cows, have little or no hair at all.

The *cutis* and *cuticula* in quadrupeds are difpofed much in the fame way as the human, but they are more elaftic. Immediately under this there is a very thin cutaneous mufcular fubftance, called *panniculus carnofus*, which is common to all quadrupeds, the porcine kind excepted; this principally covers the trunk, ferving to fhrivel the fkin, in order to drive off infects, their tails and heads not being fufficient for this purpofe, while their extremities are employed in their fupport and progreffion.

It has probably been from obferving fome mufcles of the human body, fuch as the platyfma myoides, cremafter, and frontales, and the collapfed tunica cellulofa of the emaciated fubjects, to refemble this thin mufcle, that fome of the older anatomifts reckoned fuch a panniculus among the common integuments of the human body. This Carolus Stephanus has well obferved.

Moft of the quadrupeds want clavicles, whereby their anterior extremities fall upon their cheft, fo as to make their thorax proportionally narrower than the human. This fmall diftance of their anterior extremities is very neceffary for their uniform progreffion: Apes indeed, and fquirrels, have clavicles, to allow them a more full ufe of their extremities in climbing; but they walk ill on all fours.

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## The ANATOMY of a DOG.

WE may firſt obſerve of this animal, as indeed of moſt quadrupeds, that its legs are much ſhorter in proportion to its trunk than in man, the length of whoſe ſteps depends entirely on the length of his inferior extremities: however, to balance this, the trunk of the animal is proportionally longer and ſmaller, and his ſpine more flexible, by which he is able at each ſtep to bring his poſterior extremities nearer to his anterior. His common integuments are much like thoſe of other quadrupeds; only they allow little or no paſſage for ſweat; but when he is over heated, the noxious and ſuperfluous matter finds an exit by the ſalivary glands; for he lolls out his tongue, and ſlavers plentifully *.

The pyramidal muſcles are wanting; to ſupply which, the rectus is inſerted fleſhy into the os pubis.

The *omentum* reaches down to the os pubis: which conſidering the poſture of the animal, we will find to be a wiſe proviſion, ſince its uſe is to ſeparate an oily liquor for lubicrating the guts, and facilitating their periſtaltic motion. So in our erect poſture, the natural gravity of the oil will determine it downward; but in the horizontal poſition of theſe creatures, if all the inteſtines were not covered, there would be no favourable derivation of the fluid to the guts lying in the poſterior

* We are not, however, to ſuppoſe, that becauſe a dog does not ſweat, he has no inſenſible perſpiration. That a dog perſpires is evident, becauſe one of theſe animals can trace another by the ſcent of his footſteps; which could not happen, if a large quantity of perſpirable matter was not conſtantly going off. We may alſo obſerve, that the Rabies Canina is a diſeaſe peculiar to dogs, foxes, wolves, and others of that genus; for though the bite of other mad animals, ſuch as cats, or hogs, and even poultry, will produce the diſeaſe, no fair inſtance has ever been brought of any of theſe animals being originally ſeized with this malady.

rior part of the abdomen, which is the higheſt; and beſides, had the omentum reached much farther down in us, it would not only have ſupplied too great a quantity of oil to the lower part of the abdomen, but we ſhould have been in continual danger of herniæ; and even at preſent the omentum frequently paſſes down with ſome of the other viſcera, and forms part of theſe tumors. To theſe, however, the dog is not ſubject, as his viſcera do not preſs ſo much on the rings of the abdominal muſcles, and beſides are prevented from paſſing through by a pendulous flap of fat mentioned, p. 344. The inferior and anterior lamella of the omentum is fixed to the ſpleen, fundus of the ſtomach, pylorus, liver, &c. in the ſame way as the human; but the ſuperior having no colon to paſs over, goes directly to the back-bone. This ſerves to explain the formation of the ſmall omentum in the human body; which is nothing but the large omentum, having loſt its fat, paſſing over the ſtomach and colon, where it reaſſumes its pinguedo, ſo proceeds, and is firmly attached to the liver, ſpine, &c.

The ſtriæ of fat are regularly diſpoſed through it, accompanying the diſtribution of the blood-veſſels to guard them from the preſſure of the ſuperincumbent viſcera.

This animal's ſtomach, though reſembling the human in its ſhape, is ſomewhat differently ſituated. It lies more longitudinal, as indeed all the other viſcera do, to accommodate themſelves to the ſhape of the cavity in which they are contained; that is, its inferior orifice is much farther down with reſpect to the ſuperior than the human: by this means the groſs food has an eaſier paſſage into the duodenum. Again, the fundus of the human ſtomach, when diſtended, ſtands almoſt directly forwards, which is occaſioned by the little omentum, tying it ſo cloſe down to the back-bone, &c. at its two orifices; but it not being fixed in that manner in the dog, the fundus remains always poſterior: this alſo anſwers very well the ſhape of the different cavities, the diſtance between the cardia and

fundus

fundus being greater than that between the two fides. It feems to be much larger in proportion to the bulk of the animal than the human, that it might contain a greater quantity of food at once; which was very neceffary, fince this animal cannot at any time get its fuftenance as men do. The turbilion is not fo large, nor is there any coarction forming the *antrum Willefii*, as in the ftomach of man. It is confiderably thicker and more mufcular than ours, for breaking the cohefion of their food, which they fwallow without fufficient chewing. Hence it is evident the force of the ftomach is not fo great as fome anatomifts would have it, nor its contraction fo violent: otherwife that of dogs would be undoubtedly wounded by the fharp bones, &c. which they frequently fwallow; for the contraction here is ftill greater than in the human ftomach, which is much thinner. The rugæ of the tunica villofa, are neither fo large, nor fituated tranfverfely, as in the human, but go from one orifice to the other: the reafon of which difference is, perhaps, that they might be in lefs danger of being hurt by the hard fubftances this creature frequently feeds on; and for the fame reafon there is not the like coarction at their pylorus.

The inteftines of this animal are proportionally much fhorter than ours; for the food which thefe creatures moftly ufe, foon diffolves, and then putrifies; on which account there was no occafion for a long tract of inteftines; the food being required to be quickly thrown out of the body. The fame is to be obferved of all the carnivorous animals. The mufcular coat of the inteftines is alfo thicker and ftronger than the human, to protrude the contents quickly and accurately.

The valvulæ conniventes are lefs numerous, and in a longitudinal direction; and the whole tract of the alimentary canal is covered with a flime, which lubricates the inteftines, faves them from the acrimony of the excrementitious part, and facilitates its paffage.

The

The *duodenum* differs confiderably in its fituation from the human. For in man it firft mounts from the pylorus upwards, backwards, and to the right fide; then paffes down by the gall-bladder; and, going over the right kidney and fuperior part of the pfoas mufcles, makes a curvature upwards; and paffes over the back-bone and vena cava inferior, to the left hypochondrium, where it gets through the omentum, mefentery, and mefocolon, to commence *jejunum*, being firmly tied down all the way, the biliary and pancreatic ducts entering at its moft depending part: Whereas in the dog, the duodenum is fixed at the pylorus to the concave furface of the liver, and hangs loofe and pendulous with the mefentery backwards into the cavity of the abdomen; then turning up again, is fixed to the back-bone, where it ends in the jejunum; the bile and pancreatic juice are poured into it at the moft depending part. Therefore the fame intention feems to have been had in view in the formation of this part in both, viz. the giving the chyle, after the liquors of the liver and pancreas are poured into it, a difadvantageous courfe, that fo it might be the more intimately blended with the humours before its entry into the jejunum, where the lacteals are very numerous: And thus, by reafon of their different pofture, the fame defign (though by a very different order of the parts) is brought about in both.

The other fmall guts are much the fame with ours, only fhorter. The great guts are alfo fhorter and lefs capacious than in the human body; and we take it for a general rule, that all animals that live on vegetable food, have not only their fmall guts confiderably longer, but alfo their great guts more capacious, than fuch creatures as feed on other animals. Hence man, from this form of his inteftines, and that of the teeth, feems to have been originally defigned for feeding on vegetables chiefly; and ftill the moft of his food, and all his drink, is of that clafs.

The

The reaſon of this difference ſeems to be, that as animal-food is not only much more eaſily reduced into chyle, but alſo more prone to putrefaction, too long a remora of the juices might occaſion the worſt conſequences. So it was neceſſary that their receptacles ſhould not be too capacious; but on the contrary, being ſhort and narrow, might conduce to the ſeaſonable diſcharge of their contents. Whereas vegetable food being more difficultly diſſolved and converted into an animal nature, there was a neceſſity for ſuch creatures as fed on it to be provided with a long inteſtinal canal, that this food in its paſſage might be conſiderably retarded, and have time to change its indoles into one more agreeable to our nature. There is another advantage which accrues to man in particular, from having his great guts very capacious: for as he is a rational being, and moſtly employed in the functions of ſocial life, it would have been very inconvenient as well as unbecoming for him to be too frequently employed in performing his excretions; ſo that, having this large reſervoir for his fæces alvinæ, he can retain them for a conſiderable time without trouble.

The *appendix vermiformis* juſtly enough deſerves the name of an *inteſtinum cæcum* in this ſubject, though in the human body it does not; and it has probably been from the largeneſs of this part, in this and ſome other animals, that the oldeſt anatomiſts came to reckon that ſmall appendicle in man one of the great guts. On its internal ſurface we obſerve a great number of mucous glands*.



* As all theſe throw out ſlime, their principal office would ſeem to be the procuring a ſufficient quantity of that matter for the purpoſes above mentioned. Still, however, there ſeems to be ſome unknown uſe for this organ in other animals; for the appendicula vermiformis in them is either of great ſize or of great length. In a rat, it is rather larger than the ſtomach; in others, as ſwine, and ſome of the animals

The *colon* has no longitudinal ligaments; and confequently this gut is not purfed up in different bags or cells as the human: nor does this inteftine make any circular turn round the abdomen; but paffes directly acrofs it to the top of the os facrum, where it gets the name of *rectum*.

At the extremity of the *inteftinum rectum*, or verge of the anus, there are found two bags or pouches, which contain a moft abominable fetid mucus of a yellow colour, for which I know no ufe, unlefs it ferves to lubricate the ftrained extremity of the rectum, and defend it againft the afperity of the fæces, or to feparate fome liquor that might otherwife prove hurtful to their bodies. There is nothing analogous to thofe facs in the human fubject, unlefs we reckon the mucilaginous glands that are found moft frequent and largeft about the lower part of the rectum.

The *mefentery* is confiderably longer than in the human body; that, in his horizontal fituation, the inteftines may reft fecurely on the foft cufhion of the abdominal mufcles. The fat is here difpofed in the fame way, and for the fame reafon, as in the omentum. The interftices between the fat are filled with a fine membrane. Inftead of a great number of glandulæ vagæ to be found in the human mefentery, we find the glands few in number, and thofe are clofely connected together; or there is only one large gland to be obferved in the middle of the mefentery of a dog, which, from its imagined refemblance to the pancreas and the name of its difcoverers, is called *pancreas Afellii;* but the refemblance, if there is any, depends chiefly on the connection, the ftructure being entirely different. The reafon why this in man is as it were fubdivided into

which live on vegetables, it has long convolutions, fo that the food muft be lodged in it for a long time. Thus, probably, fome change takes place in the food, which requires a confiderable time to effectuate, and, though unknown to us, may anfwer very ufeful purpofes to the animal.

to many fmaller ones, may poffibly be, that as the guts of a human body are proportionally much longer than thofe of this creature, it would have been inconvenient to have gathered all the *lacteals primi generis* into one place; whereas, by collecting a few of thefe veffels into a neighbouring gland, the fame effect is procured much more eafily. Whether the food in this animal needs lefs preparation in its paffage through thefe glands, is a matter very much unknown to us; though it is certain that fome changes really take place.

The *pancreas* in man lies acrofs the abdomen, tied down by the peritonæum; but the capacity of this creature's abdomen not allowing of that fituation, it is difpofed more longitudinally, being tied to the duodenum, which it accompanies for fome way. Its duct enters the duodenum about an inch and a half below the ductus communis.

The *fpleen* of this animal differs very much from ours both in figure and fituation. It is much more oblong and thin, and lies more according to the length of the abdomen, like the pancreas. Though the fpleen of this creature is not firmly tied to the diaphragm (which was neceffary in our erect pofture to hinder it from falling dowwards), yet by the animal's prone pofition, its pofterior parts being rather higher than the anterior, it comes to be always contiguous to this mufcle, and is as effectually fubjected to an alternate preffure from its action as the human fpleen is.

The human *liver* has no fiffures or divifions, unlefs you pleafe to reckon that fmall one between the two *pylæ*, where the large veffels enter: Whereas in a dog, and all other creatures that have a large flexion in their fpine, as lions, leopards, cats, &c. the liver and lungs are divided into a great many lobes by deep fections, reaching the large blood-veffels, which in great motions of the back-bone may eafily fhuffle over one another; and fo are in much lefs danger of being torn or bruifed, than if they were formed of one entire piece, as we really fee it is in horfes, cows, and fuch creatures as have their back-bone ftiff and immoveable. There is here no *ligamentum latum* connecting the liver to the diaphragm, which in our fituation was neceffary to keep the vifcus in its place: Whereas in this creature, it naturally gravitates forwards, and by the horizontal pofition of the animal is in no danger of preffing againft the vena cava; the preventing of which is one ufe generally affigned to this ligament in man. Had the liver of the dog been thus connected to the diaphragm, the refpiration muft neceffarily have fuffered; for, as we fhall fee afterwards, this mufcle is here moveable at the centre as well as at the fides: But in man the liver is fixed to the diaphragm, moftly at its tendinous part; that is, where the pericardium is fixed to it on the other fide; fo that it is in no danger of impeding the refpiration, being fufpended by the mediaftinum and bones of the thorax. In confequence of this vifcus being divided into fo many lobes, it follows, that the hepatic ducts cannot poffibly join into one common trunk till they are quite out of the fubftance of the liver; becaufe a branch comes out from every lobe of the liver; all of which, by their union, form the hepatic duct; whence we are led to conclude, that the hepato-cyftic ducts, mentioned by former authors, do not exift. The gall-bladder itfelf is wanting in feveral animals, fuch as the deer, the horfe, the afs, &c.; but in place of it, in fuch animals, the hepatic duct, at its beginning, is widened into a refervoir of confiderable fize, which may anfwer the fame purpofe in them that the gall-bladder does in others.

We come next, after having examined the chylopoietic vifcera, to difcourfe of thofe organs that ferve for the fecretion and excretion of urine. And firft of the kidneys: Which in this animal are fituated much in the fame way as in the human fubject; but have no fat on their inferior furface, where they face the abdomen, and are of a more globular form than the human. The reafon of thefe differences will eafily appear, if if you compare their fituation and pofture in this animal with thofe in a man, who walks erect. They are placed in this fubject in the inferior part of the body, fo are not fubject to the preffure of the vifcera, which feems to be the principal caufe of the fatnefs of thofe organs in us, and perhaps may likewife be the caufe of our being more fubject to the ftone than other animals. Hence there is no need of any cellular fubftance to ward off this preffure where there would neceffarily be fat collected; but the fuperior part of their kidneys is fomewhat covered with fat, left they fhould fuffer any compreffion from the action of the ribs and fpine.

In the internal ftructure there is ftill a more confiderable difference: For the *papillæ* do not here fend out fingle the feveral *tubuli uriniferi*; but being all united, they hang down in form of a loofe pendulous flap in the middle of the pelvis, and form a kind of feptum medium; fo that a dog has a pelvis formed within the fubftance of the kidney. The only thing that is properly analogous to a pelvis in man, is that fac or dilatation of the ureters formed at the union of the *ductus uriniferi*. The external part of the kidney of a dog fomewhat refembles one of the lobes of the kidney of a human fœtus: but in a human adult the appearance is very different; becaufe in man, from the continual preffure of the furrounding vifcera, the lobes, (which in the fœtus are quite diftinct and feparated,) concrete, but the original cortical fubftance is ftill preferved in the internal parts of the kidney. The reafon of thefe particularities may probably be, that the liquors of this animal, as of all thofe of the carnivorous kind, being much more acrid than thofe of fuch as live on vegetable food, its urine muft incline much to an alkalefcency, as indeed the fmell and tafte of that liquor in dogs, cats, leopards, &c. evidently fhew, being fetid and pungent, and therefore not convenient to be long retained in the body. For this end it was proper, that the fecerning organs fhould have as little impediment as poffible by preffure,

&c

&c. in the performing their functions; and for that design the mechanism of their kidneys seems to be excellently adapted: We have most elegant pictures in Eustachius of the kidneys of brutes, delineated as such, with a view to shew Vesalius's error in painting and describing them for the human.

The *glandulæ* or *capsulæ atrabiliariæ* are thicker and rounder than the human, for the same reason as the kidneys.

The *ureters* are more muscular than the human, because of the unfavourable passage the urine has through them; they enter the bladder near its fundus.

The bladder of urine differs considerably from the human; and first in its form, which is pretty much pyramidal or pyriform. This shape of the dog's bladder is likewise common to all quadrupeds, except the ape and those of an erect posture. In men it is by no means pyriform, but has a large sac at its posterior and inferior part: this form depends entirely on the urine gravitating in our erect posture to its bottom, which it will endeavour to protrude; but as it cannot yield before, being contiguous to the os pubis, it will naturally stretch out where there is the least resistance, that is, at the posterior and lateral parts; and were it not for this sac, we could not so readily come at the bladder to extract the stone either by the lesser or lateral operation of lithotomy. Most anatomists have delineated this wrong; so much, that I know of none who have justly painted it, excepting Mr Cowper in his *Myotomia*, and Mr Batty. It has certainly been from observing it in brutes and young children, that they have been led into this mistake. The same cause, *viz.* the gravity of the urine, makes the bladder of a different form in brutes: In their horizontal position the cervix, from which the urethra is continued, is higher than its fundus; the urine must therefore distend and dilate the most depending part by its weight.

As to its *connection*, it is fastened to the abdominal muscles by a process of the peritoneum, and that membrane is extend-

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ed quite over it: whereas in us its ſuperior and poſterior parts are only covered by it: hence in man alone the high operation of lithotomy can be performed without hazard of opening the cavity of the abdomen. Had the peritoneum been ſpread over the bladder in its whole extent, the weight of the viſcera in our erect poſture would have ſo borne upon it, that they would not have allowed any conſiderable quantity of urine to be collected there; but we muſt have been obliged to diſcharge its contents too frequently to be conſiſtent with the functions of ſocial life: Whereas, by means of the peritoneum, the urine is now collected in ſufficient quantity, the viſcera not gravitating this way.

We may take it for a general rule, that thoſe creatures that feed upon animal food have their bladder more muſcular and conſiderably ſtronger, and leſs capacious, than thoſe that live on vegetables, ſuch as horſes, cows, ſwine, &c. whoſe bladder of urine is perfectly membraneous, and very large. This is wiſely adapted to the nature of their food: For in theſe firſt, as all their juices are more acrid, ſo in a particular manner their urine becomes exalted; which, as its remora might be of very ill conſequence, muſt neceſſarily be quickly expelled. This is chiefly effected by its ſtimulating this viſcus more ſtrongly to contract, and ſo to diſcharge its contents, though the irritation does not altogether depend upon the ſtretching, but likewiſe ariſes from the quality of the liquor. That a ſtimulus is one of the principal cauſes of the excretion of urine, we learn from the common ſaline diuretic medicines that are given, which are diſſolved into the ſerum of the blood, and carried down by the kidneys to the bladder: The ſame appears likewiſe from the application of cantharides: or, without any of theſe, when the parts are made more ſenſible, as in an excoriation of the bladder, there is a frequent deſire to make water. Accordingly we find theſe animals evacuate their urine much more frequently than man, or any other creature

that

that lives on vegetable food. And if theſe creatures, whoſe fluids have already a tendency to putrefaction, are expoſed to heat or hunger, the liquids muſt for a conſiderable time undergo the actions of the containing veſſels, and frequently perform the courſe of the circulation, without any new ſupplies of food; by which the fluids becoming more and more acrid, the creature is apt to fall into feveriſh and putrid diſeaſes: And in fact, we find that fatal and melancholy diſtemper the *rabies canina*, *vulpina*, &c. frequent in theſe animals; whereas thoſe that feed on vegetable food ſeldom or never contract theſe diſeaſes but by infection.

Their *ſpermatic veſſels* are within the peritoneum, which is ſpread over them, and from which they have a membrane like a meſentery; ſo that they hang looſe and pendulous in the abdomen: whereas, in us, they are contained in the cellular part of the peritoneum, which is tenſely ſtretched over them. At their paſſage out of the lower belly, there appears a plain perforation, or holes; hence the adult quadruped, in this reſpect, reſembles the human fœtus. And from obſerving this in quadrupeds, has ariſen the falſe notion of *hernia* or *rupture* among authors. This opening, which leads down to the teſticle, is of no diſadvantage to them, but evidently would have been to us; for, from the weight of our viſcera continually gravitating upon theſe holes, we muſt have perpetually laboured under enteroceles, which they are in no hazard of; as in them this paſſage is at the higheſt part of their belly, and, in their horizontal poſture, the viſcera cannot bear upon it: And, to prevent even the ſmalleſt hazard, there is a looſe pendulous ſemilunar flap of fat, which ſerves two uſes, as it both hinders the inteſtines from getting into the paſſage, and alſo the courſe of the fluids from being ſtopped in the veſſels, which is ſecure to us by the cellular ſubſtance and tenſe peritoneum: And it may be worth while to obſerve, that this

proceſs

procefs remains almoft unaltered, even after the animal has been nearly exhaufted of fat.

There is next a paffage quite down into the cavity, where the tefticles lie. Had the fame ftructure obtained in man, by the conftant drilling down of the liquor which is fecerned for the lubricating of the guts, we fhould always have laboured under an hydrocele; but their pofture fecures them from any hazard of this kind. Indeed, very fat lap-dogs, who confequently have an overgrown omentum, are fometimes troubled with an epiplocele.

The *fcrotum* is fhorter and not fo pendulous as the human in all the dog kind that want the *veficulæ feminales*, that the feed at each copulation might the fooner be brought from the teftes, thus in fome meafure fupplying the place of the *veficulæ feminales*; for the courfe of the feed through the *vafa deferentia* is thus fhortened, by placing the fecerning veffels nearer the excretory organs *. The want of *veficulæ feminales* at the fame time explains the reafon why this creature is fo tedious in copulation. But why thefe bodies are abfent in the dog kind more than in other animals, is a circumftance we know nothing of.

The ftructure of the *tefticles* is much the fame with the human, as are likewife the *corpus pyramidale*, *varicofum*, or *pampiniforme*, and the *epididymis* or excretory veffel of the tefticle. The *vafa deferentia* enter the abdomen where the blood-veffels come out; and paffing along the upper part of the bladder, are inferted a little below the bulbous part of the urethra.

The præputium has two mufcles fixed to it; one that arifes from the fphincter ani, and is inferted all along the *penis*; and this is called *retractor præputii*: But the other, whofe office is directly contrary to this, is cutaneous; and feems to



* Perhaps its paffage is likewife quickened by the mufcular power of the vafa deferentia, which is ftronger in this creature than in man.

take its origin from the muſcles of the abdomen, or rather to be a production of their tunica carnoſa. The *corpora cavernoſa* riſe much in the ſame way as the human: but theſe ſoon terminate; and the reſt is ſupplied by a triangular bone, in the inferior part of which there is a groove excavated for lodging the urethra. There are upon the penis two protuberant bulbous fleſhy ſubſtances, reſembling the glans penis in man, at the back of which are two veins, which, by the *erectores penis* and other parts, are compreſſed in the time of coition; and the circulation being ſtopped, the blood diſtends the large cavernous bodies. After the penis is thus ſwelled, the vagina, by its contraction and ſwelling of its corpus cavernoſum, which is conſiderably greater than in other animals, grips it cloſely; and ſo the male is kept in action ſome time contrary to his will, till an opportunity be given for bringing a quantity of ſeed ſufficient to impregnate the female: and thus, by that *orgaſmus veneris* of the female organs, the want of the *veſiculæ ſeminales* are in ſome meaſure ſupplied. But as it would be a very uneaſy poſture for the dog to ſupport himſelf ſolely upon his hinder feet, and for the bitch to ſupport the weight of the dog for ſo long a time; therefore, as ſoon as the bulbous bodies are ſufficiently filled, he gets off and turns averſe to her. Had, then, the penis been pliable as in other animals, the urethra muſt of neceſſity have been compreſſed by this twiſting, and conſequently the courſe of the ſeed intercepted; but this is wiſely provided againſt by the urethra's being formed in the hollow of the bone. After the emiſſion of the ſeed, the parts turn flaccid, the circulation is reſtored, and the bulbous parts can be eaſily extracted.

The *proſtata* ſeems here divided into two, which are proportionally larger than the human, and afford a greater quantity of that liquid.

The *uterus* of multiparous animals is little elſe but a continuation of their vagina, only ſeparated from it by a ſmall ring

or

or valve. From the *uterus* two long canals mount upon the loins, in which the fœtufes are lodged: thefe are divided into different facs, which are ftrongly conftricted between each fœtus; yet thefe coarctations give way in the time of birth. From thefe go out the *tubæ Fallopianæ*, fo that the ovaria come to lodge near the kidneys.

We ought next to examine the ftructure of the thorax and its contents. But firft it may not be amifs to remark of the *diaphragm* in its natural fituation, that it is in general more loofe and free than the human; which is owing to its connection with the neighbouring parts in a different manner from ours. The human *diaphragm* is connected to the pericardium; which again, by the intervention of the mediaftinum, is tied to the fternum, fpine, &c. but here there is fome diftance between the diaphragm and pericardium. We obferve further, that its middle part is much more moveable, and the tendinous parts not fo large. And indeed it was neceffary their *diaphragm* fhould be fomewhat loofe, they making more ufe of it in difficult refpiration than man. This we may obferve by the ftrong heaving of the flanks of an horfe or dog when out of breath; which correfponds to the rifing of the ribs in us.

The difpofition and fituation of the *mammæ* vary as they bear one or more young. Thofe of the uniparous kind have them placed between the pofterior extremities, which in them is the higheft part of their bodies, whereby their young get at them without the inconvenience of kneeling: Neverthelefs, when the creatures are of no great fize, and their breaft large as in fheep, the young ones are obliged to take this pofture. In multiparous animals, they muft have a great number of nipples, that their feveral young ones may have room at the fame time, and thefe are difpofed over both thorax and abdomen; and the creatures generally lie down when the young are to be fuckled, that they may give them the moft favourable fituation. From this it does not appear to be from any particular fitnefs of the veffels at certain places for giving a proper nourifhment to the child, that the breafts are fo placed in women as we find them, but really from that fituation being the moft convenient both for mother and infant.

The *fternum* is very narrow, and confifts of a great number of fmall bones, moveable every way; which always happens in creatures that have a great mobility in their fpine. The ribs are ftraighter, and by no means fo convex as the human; whereby in refpiration the motion forward will very little enlarge their thorax, which is compenfated by the greater mobility of their diaphragm; fo our thorax is principally enlarged according to its breadth and depth, and theirs according to its length. The want of clavicles, and the confequent falling in of the anterior extremities upon the cheft, may contribute fomewhat to the ftraitnefs of the ribs.

The *mediaftinum* in this creature is pretty broad. The pericardium is not here contiguous to the diaphragm, but there is an inch of diftance between them, in which place the fmall lobe of the lungs lodges; and by this means the liver, &c. in this animal, though continually preffing upon the diaphragm, yet cannot difturb the heart's motion.

The heart is fituated with its point almoft directly downwards, according to the creature's pofture, and is but very little inclined to the left fide. Its point is much fharper, and its fhape more conoidal, than the human. Here the names of *right* and *left* ventricles are proper enough, though not fo in the human; which ought rather to be called *anterior* and *pofterior*, or *fuperior* and *inferior*. The animal has the *vena cava* of a confiderable length within the thorax, having near the whole length of the heart to run over ere it gets at the *finus Lowerianus dexter*. In men it enters the pericardium as foon as it pierces the diaphragm, which is firmly attached to it, and immediately gets into the *finus Lowerianus;* which finus, in the

the human ſubject, by the oblique ſituation of the heart, is almoſt contiguous to the diaphragm: and by this we diſcover, that ſeveral authors have taken their delineations of the human heart from brutes; which is eaſily detected by the ſhape and ſituation of the heart, and long vena cava, within the thorax. This was one of the faults of the curious wax-work that was ſhewn at London and Paris, which was plainly taken from a cow.

This ſituation of the heart of the creature agrees beſt with the ſhape of its thorax, which is lower than the abdomen.

The egreſs of the large blood-veſſels from the heart is ſomewhat different from the human: For here the right ſubclavian comes off firſt; and as a large trunk runs ſome way upwards before it gives off the left carotid, and ſplits into the carotid and ſubclavian of the right ſide, then the left ſubclavian is ſent off. So that, neither here, properly ſpeaking, is there an *aorta aſcendens* more than in the human; but this name has probably been impoſed upon it from obſerving this in a cow, where indeed there is an aſcending and deſcending aorta.

From this ſpecialty of the diſtribution of the veſſels of the right ſide, which happens, though not in ſo great a degree, in the human ſubject, we may perhaps in ſome meaſure account for the general greater ſtrength, readineſs, or facility of motion, which is obſervable in the right arm. I believe, upon meaſuring the ſides of the veſſels, the ſurface of the united trunk of the right ſubclavian and carotid is leſs than that of the left ſubclavian and carotid, as they are ſeparated. If ſo, the reſiſtance to the blood muſt be leſs in that common trunk than in the left ſubclavian and carotid: But if the reſiſtance be ſmaller, the abſolute force with which the blood is ſent from the heart being equal, there muſt neceſſarily be a greater quantity of blood ſent through them in a given time; and as the ſtrength of the muſcles is, *cæteris paribus*, as the quantity of blood ſent into them in a given time, thoſe of the

right

right arm will be ſtronger than thoſe of the left. Now children, being conſcious of this ſuperior ſtrength, uſe the right upon all occaſions; and thus from uſe comes that great difference which is ſo obſervable. That this is a ſufficient cauſe, ſeems evident from fact; for what a difference is there between the right and the left arm of one who has played much at tennis? View but the arms of a blackſmith and legs of a footman, and you will ſoon be convinced of this effect ariſing from uſing them. But if by any accident the right arm is kept from action for ſome time, the other from being uſed gets the better; and thoſe people are left handed: For it is not to be imagined, that the ſmall odds in the original formation of the veſſels ſhould be ſufficient to reſiſt the effect of uſe and habit, (inſtances of the contrary occur every day); it is enough for our preſent argument, that where no means are uſed to oppoſe it, the odds are ſufficient to determine the choice in favour of the right. Now becauſe it is natural to begin with the leg correſponding to the hand we have moſt power of, this is what gives alſo a ſuperiority to the right leg.

This difference is not peculiar to man, but is ſtill more obſervable in thoſe creatures in whom the ſame mechaniſm obtains in a greater degree. Obſerve a dog at a trot, how he bears forward with his right ſide; or look at him when ſcraping up any thing, and you will preſently ſee that he uſes his right much oftener than he does his left foot. Something analogous to this may be obſerved in horſes *.

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* It has been the opinion of ſome anatomiſts, that left-handed people, as well as thoſe diſtinguiſhed by the name of Ambidexter, (who uſe both hands promiſcuouſly), have the two carotid and ſubclavian arteries coming off in four diſtinct trunks from the arch of the aorta; but no appearance of this kind has ever been obſerved in ſuch bodies as have been examined for this purpoſe; though indeed theſe have been but few, and more experience might throw greater light on the ſubject.

The *thymus* of this creature is proportionally much larger than ours: whereas the glandula thyroidea is much lefs, and is divided into two diftinct parts, or there are two feparate glands; which is not the cafe in man. The reafon of this difference is unknown, as is likewife the ufe of the gland itfelf. It is generally remarked, that thefe two glands do thus fupply the place of each other; that is, in fuch animals as have a large thymus, the glandula thyroidea is fmaller, and *vice verfa*. Hence we are naturally led to afcribe the fame ufe to both, viz. the feparation of a thin lymph for diluting the chyle in the thoracic duct before it be poured into the blood; then if we confider the different formation of the thorax in both, we fhall readily account for the variety in the bulk of thefe two glands. Refpiration being chiefly performed in man by the widening of the cheft, the lungs at every infpiration muft prefs upon the thymus, and confequently diminifh it: but the diaphragm, yielding more in the dog's infpiration, this gland is not fo much preffed by the lungs, and fo will be larger; and hence the glandula thyroidea will be proportionally lefs. Again, from the pofture of this creature, we fhall fee that it was much more convenient for a dog to have the moft part of the diluting lymph fupplied by the thymus, fince the neck being frequently in a defcending pofture, the lymph of the thyroid gland would have a very difadvantageous courfe to get to the thoracic duct: whereas in the human body, the thymus is really below the lacteal canal, where it makes its curvature before it opens into the fubclavian; and confequently there is a neceffity of a confiderable fhare of the diluting liquor being furnifhed by the thyroid gland, which is fituated much higher; fo that its lymph has the advantage of a perpendicular defcent.

We may here obferve, that the *thoracic duct* in a dog has no curvature before it enters the fubclavian vein, the horizontal pofition of this animal allowing a favourable courfe to

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the chyle, ſo as not to need that turn to force its paſſage into the blood. It may likewiſe be obſerved, that ſuch animals as walk horizontally, have the valves of the thoracic duct fewer in number than others. The horſe has only a ſingle pair; while, on the contrary, the ape reſembles man in having ſeveral valves. Thus the lymph is not only forwarded in its paſſage, but the weight of the column is diminiſhed.

The lungs of this creature are divided into more numerous lobes, and deeper, than they are in man, for the ſame reaſon as the liver. The left ſide of the thorax in this animal bears a greater proportion to the right than in man; the one being nearly as three to two, the other as four to three.

In quadrupeds, as well as in man, the lungs are cloſely applied to the containing parts; although this has been denied by ſome authors.

We conſider it as a general rule, that all quadrupeds, as having occaſion to gather their food from the ground, are provided with longer necks than man: but as a long neck not only gives the advantage of too long a lever to the weight of the head, but alſo, when the animal is gathering his food, makes the brain in danger of being oppreſſed with too great a quantity of blood, by the liquor in theſe arteries having the advantage of a deſcent, while that in the veins muſt remount a conſiderable way contrary to its own gravity; it was therefore neceſſary that a part of the length of the neck ſhould be ſupplied by the length of the jaws. Thus we ſee horſes, cows, &c. who have no occaſion for opening their mouths very wide, yet have long jaws. Bull dogs indeed, and ſuch animals as have occaſion for very ſtrong jaws, muſt of neceſſity have them ſhort; becauſe the longer they are, the reſiſtance to be overcome acts with a longer lever. Another exception to this general rule, is, ſuch animals are furniſhed with ſomething analogous to hands to convey their food to their mouths, as cats, apes, &c. The teeth of this creature plainly ſhew it to be of the carnivo-

rous

rous kind; for there are none of them made for grinding the food, but only for tearing and dividing it. It has fix remarkable fharp teeth before, and two very long tufks behind; both of which the ruminating animals want. Thefe are evidently calculated for laying very firm hold of fubftances, and tearing them to pieces; and the vaft ftrength of the mufcles inferted into the lower jaw, affifts greatly in this action; while the molares have fharp cutting edges, calculated for cutting flefh, and breaking the hardeft bones.

Even its pofterior teeth are not formed with rough broad furfaces as ours are; but are made confiderably fharper, and pafs over one another when the mouth is fhut, that fo they may take the firmer hold of whatever comes between them.

The tongue, in confequence of the length of the jaws, is much longer than ours; and as this creature feeds with his head in a depending pofture, the bolus would always be in danger of falling out of the mouth, were it not for feveral prominences or papillæ placed moftly at the root of the tongue, and crooked backwards in fuch a manner, as to allow any thing to pafs eafily down to the jaws, but to hinder its return. By the papillæ alfo the furface of the tongue is increafed, and a ftronger impreffion is made on the fenfation of tafte. In fome animals who feed on living creatures, thefe tenter-hooks are ftill more confpicuous; as in feveral large fifhes, where they are almoft as large as their teeth in the forepart of their mouth, and nearly as firm and ftrong.

When we open the mouth we fee the amygdalæ very prominent in the pofterior part of it; fo that it would appear at firft view, that thefe were inconveniently placed, as being continually expofed to injuries from the hard fubftances this creature fwallows: but upon a more narrow fcrutiny, we find this inconvenience provided againft by two membranous capfulæ, into which the amygdalæ, when preffed, can efcape, and remove themfelves from fuch injuries.

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The *velum pendulum palati* is in this creature confiderably longer than in man, to prevent the food from getting into his nofe; which would happen more frequently in this animal than in man, becaufe of its fituation while feeding.

In this fubject, as well as in other quadrupeds, there is no *uvula;* but then the *epiglottis*, when preffed down, covers the whole rima entirely, and naturally continues fo: there is therefore a ligament, or rather mufcle, that comes from the os hyoides and root of the tongue, that is inferted into that part of the epiglottis where it is articulated with the cricoid cartilage, which ferves to raife it from the rima, though not fo ftrongly but that it may with a fmall force be clapped down again.

It may again be afked, however, Why the uvula is wanting here, and not in man? This feems to be, that quadrupeds, who fwallow their food in an horizontal fituation, have no occafion for an uvula, though it is neceffary in man on account of his erect fituation.

In the upper part of the pharynx, behind the cricoid cartilage, there is a confiderable gland to be found, which ferves not only for the feparation of a mucous liquor to lubricate the bolus as it paffes this way, but alfo to fupply the place of a valve, to hinder the food from regurgitating into the mouth, which it would be apt to do by reafon of the defcending fituation of the creature's head. In man, this mufcle of the epiglottis is wanting, its place being fupplied by the elafticity of the cartilage.

The *œfophagus* is formed nearly in the fame way as the human. Authors indeed generally alledge, that quadrupeds have their gullet compofed of a double row of fpiral fibres decuffating one another; but this is peculiar to ruminating animals, who have occafion for fuch a decuffation of fibres. The action of thefe may eafily be obferved in a cow chewing her cud.

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The *nofe* is generally longer than in man, and its external paffage much narrower The internal ftructure is alfo better adapted for an acute fmelling, having a larger convoluted furface on which the *membrana fcheideriana* is fpread; and this is to be obferved in moft quadrupeds, who have the offa fpongiofa commonly large, and thefe too divided into a great number of exceffively fine thin lamellæ. The fenfibility feems to be encreafed in proportion to the furface; and this will alfo be found to take place in all the other fenfes. The elephant, which has a head large in proportion to its body, has the greateft part of it taken up with the cavity of the nofe and frontal finufes; which laft extend almoft over their whole head, and leave but a fmall cavity for their brains. A very nice fenfe of fmelling was not fo abfolutely neceffary for man, who has judgment and experience to direct him in the choice of his food; whereas brutes, who have only their fenfes, muft of neceffity have thefe acute; fome having one fenfe in greater perfection than others, according to their different way of life. We not only conclude *a priori* from the large expanded *membrana fcheideriana*, that their fenfe of fmelling is very acute, but we find it fo by cows and horfes diftinguifhing fo readily between noxious and wholefome herbs, which they do principally by this fenfe.

The external *ear* in different quadrupeds is differently framed, but always calculated to the creature's manner of life. In fhape it commonly refembles the oblique fection of a cone from near the apex to the bafis. Hares, and fuch other animals as are daily expofed to infults from beafts of prey, have large ears directed backwards, their eyes warning them of any danger before; rapacious animals, on the other hand, have their ears placed directly forwards, as we fee in the lion, cat, &c. The flow hounds, and other animals that are defigned to hear moft diftinctly the founds coming from below, have their ears hanging downwards; or their ears are flexible, becaufe they move their head for the moft part with greater difficulty than man. Man again, who muft equally hear founds coming from all quarters, but efpecially fuch as are fent from about his own height, has his external ear placed in a vertical manner, fomewhat turned forward. In fhort, wherever we fee a fpecialty in the make of this organ in any creature, we fhall, with very little reflection, difcover this form to be more convenient for that creature than another. The animal alfo has the power of directing the cone of the ear to the fonorous body without moving the head. There are fome differences to be obferved in the ftructure of the internal ear in different animals; but we know fo very little of the ufe of the particular parts of that organ in the human fubject, that it is altogether impoffible to affign reafons for thefe variations in other creatures.

All quadrupeds have at the internal canthus of the eye a ftrong firm membrane with a cartilaginous edge, which may be made to cover fome part of their eye; and this is greater or lefs in different animals as their eyes are more or lefs expofed to dangers in fearching after their food. This *membrana nictitans*, as it is called, is not very large in this animal. Cows and horfes have it fo large as to cover one half of the eye like a curtain, and at the fame time it is tranfparent enough to allow abundance of the rays of light to pafs through it. Fifhes have a cuticle always over their eyes, as they are ever in danger in that inconftant element, the water. In this then we may alfo obferve a fort of gradation.

All quadrupeds have a feventh mufcle belonging to the eye, called *fufpenforius*. It furrounds almoft the whole optic nerve, and is fixed into the fclerotic coat as the others are. Its ufe is to fuftain the weight of the globe of the eye, and prevent the optic nerve from being too much ftretched, without obliging the four ftraight mufcles to be in a continual contraction, which would be inconvenient; at the fame time this mufcle

mufcle may be brought to affift any of the other four, by caufing one particular portion of it to act at a time.

The next thing to be remarked is the figure of the *pupil*, which is different in different animals, but always exactly accommodated to the creature's way of life, as well as to the different fpecies of objects that are viewed. Man has it circular, for obvious reafons: an ox has it oval, with the longeft diameter placed tranfverfely, to take in a larger view of his food: cats, again, have theirs likewife oval, but the longeft diameter placed perpendicularly; they can either exclude a bright light altogether, or admit only as much as is neceffary. The pupil of different animals varies in widenefs, according as the internal organs of vifion are more or lefs acute: Thus cats and owls, who feek their prey in the night, or in dark places, (and confequently muft have their eyes fo formed as that a few rays of light may make a lively impreffion on the retina), have their pupils in the day-time contracted into a very narrow fpace, as a great number of rays would opprefs their nice organs; while in the night, or where the light is faint, they open the pupil, and very fully admit the rays. In the fame way, when the retina is inflamed, a great number of rays of light would occafion a painful fenfation; therefore the pupil is contracted: on the contrary, in dying people, or in a beginning amaurofis, it is generally dilated, as the eyes on fuch occafions are very difficultly affected, and as it were infenfible.

The pofterior part of the choroid coat, which is called *tapetum*, is of different colours in different creatures. For oxen, feeding moftly on grafs, have this membrane of a green colour, that it may reflect upon the retina all the rays of light which come from the objects of that colour, while other rays are abforbed; Thus the animal fees its food better than it does other objects. Cats and owls have their tapetum of a whitifh colour; and for the fame reafons have the pupil very dilatable, and their organs of vifion acute; And we fhall find, that

that all animals ſee more or leſs diſtinctly in the dark, according as their tapetum approaches nearer to white or black colour. Thus dogs, who have it of a greyiſh colour, diſtinguiſh objects better in the night than man, whoſe tapetum is dark brown, and who, I believe, ſees worſt in the dark of any creature; it being originally deſigned that he ſhould reſt from all kinds of employment in the night-time. The difference then of the colour of the tapetum, as indeed the fabric of any other part in different creatures, always depends on ſome particular advantage accruing to the animal in its peculiar manner of life from this ſingularity.

We ſhall now proceed to the BRAIN, which we remark in the firſt place is proportionally much ſmaller in all quadrupeds than the human; but, as in man, it is divided into cerebrum and cerebellum, and theſe two parts bear nearly the ſame proportion to one another as in us. There was no ſuch occaſion for ſo great a quantity of brain in thoſe animals as in man: ſince in them all its energy is employed in their progreſſion, while man has a great waſte of ſpirits in the exerciſe of his reaſon and intellectual faculties. And beſides all this, a great bulky brain would be inconvenient to theſe creatures, in ſo far as it would add conſiderably to the weight of the head; which having the advantage of a long lever to act with, would require a much greater force to ſupport it than it now does; for the heads of the greateſt part of quadrupeds are not near ſo heavy as they would at firſt ſight ſeem to be, from the *ſinus frontales* being produced a great way upwards to enlarge the organs of ſmelling.

The pits in the anterior part of their ſkulls are much more conſpicuous than in the human cranium; which may be occaſioned by the depending poſture of theſe creatures heads while they gather their food: the brain at this time gravitating much on the bones while they are as yet ſoft, will gradually make impreſſions upon them at theſe places where it riſes into eminences.

nences. This is prevented in man moftly by his erect pofture.

The *falx* is not near fo large in quadrupeds as in man, as they have little occafion to lie on either fide, and the two hemifpheres of the brain are in a great meafure hindered from juftling againft one another in violent motions, by the brain's infinuating itfelf into the above-mentioned pits.

The fecond procefs of the *dura mater*, or *tentorium cerebelli fuper-expanfum*, is confiderably thicker and ftronger in moft quadrupeds than in man; efpecially in fuch of them as are very fwift of foot, as hares and rabbits, and that moft when they are old. This membrane is generally offified, or we find the place of it fupplied by a bone, that it may the more effectually keep off the fuperincumbent brain from the cerebellum in their rapid motions, which otherwife would be of bad confequence.

The olfactory nerves are very large, and juftly deferve the name of *proceffus mamillares*. They are hollow, and confift of a medullary and cineritious fubftance, and at firft fight appear to be the anterior ventricles of the brain produced; but in man they are fmall, and without any difcernible cavity. The reafon of this is fufficiently evident, if we confider how this animal's head is fituated; for the lymph continually gravitating upon the inferior part of the ventricles, may thus elongate and produce them; but from this very inferior part the olfactory nerves rife, and are fent immediately through the os ethmoides into the nofe. Hence the ancients, thinking they were continued hollow into the nofe, believed they were the emunctories of the brain. In the brain of fheep, which, by its firm texture, is the beft fubject of any for fearching into the ftructure of this part, we evidently fee, that the name of the *figmoid cavity* was very properly applied by the ancients to the lateral ventricles of the brain; which are really of a greater extent than they are ordinarily painted by the anatomifts, reaching farther backwards, and forwards again under the

fubftance

ſubſtance of the brain. The cortical and medullary parts, as well as the corpus calloſum, are ſimilar to thoſe parts in man.

The *nates* and *teſtes* deſerve this name much better here than in the human body, with reſpect to each other. They are larger in the quadruped; and hence we perceive that there is no great reaſon for aſcribing the different operations to any particular ſize or ſhape of theſe parts. They are here alſo of different colours: the *nates* being of the colour of the cortical, and the *teſtes* of the medullary ſubſtance of the brain; whereas in man they are both of one colour. The reaſon of theſe differences, and others of the like nature to be met with, I ſhall not pretend to determine; for we have hitherto ſuch an imperfect knowledge of the brain itſelf, that we are entirely ignorant of the various uſes of its different parts. We may in general conclude, that the varying in one animal from what it is in another, is fitted to the creature's particular way of living.

The *rete mirabile Galeni*, ſituated on each ſide of the *ſella turcica*, about which there has been ſo much diſpute, is very remarkable in moſt quadrupeds. This plexus of veſſels in nothing elſe than a continuation of the internal carotid arteries, which, entering the ſkull, divide into a vaſt number of minute branches running along the ſide of the ſella turcica, and, uniting afterwards, are ſpent on the brain in the common way. Galen ſeems with juſtice to ſuppoſe, that this plexus of veſſels ſerves for checking the impetuoſity of the blood deſtined for the brain. The ſtructure of the brain differing but very little in all quadrupeds, it will be needleſs to examine it in any other.

## The MUSCLES of a DOG.

IN the following deſcription, it is not intended to give a complete account of the dog, but only of the particulars wherein the muſcles differ from thoſe of the human ſpecies; at the ſame

ſame time that care has been taken to make their names agree as near as poſſible with thoſe of modern authors.

It is alſo to be underſtood, that thoſe muſcles concerning which nothing is here ſaid, in general agree with thoſe of the human ſpecies.

PANNICULUS CARNOSUS.—Immediately below the ſkin lies a thin fleſhy expanſion, covering the greateſt part of the body, and ſurrounding the other muſcles. It runs over the head, neck, and greateſt part of the thorax and abdomen, and covers the whole of the back, ilium, ſacrum, and upper part of the thighs. From the thorax a ſlip runs over the axilla, where it is collected into a thick fold that terminates in the latiſſimus dorſi. In man there is nothing ſimilar to this, excepting the platyſma myoides, or the occipito-frontalis. The uſe of this thin muſcle is to wrinkle the ſkin, in order to ſhake off duſt, inſects, &c. By this alſo the animal has a power, in ſome meaſure, of making the hair ſtand on end, particularly on the neck.

## MUSCLES of the INTEGUMENTS of the CRANIUM.

*Occipito frontalis.* In man this is a diſtinct muſcle covering all the upper part of the head, beginning at the occiput, and ending at the under part of the brow. In a dog this is only part of the panniculus carnoſus; and therefore is common to the head and reſt of the body.

*Corrugator ſupercilii* wanting.

## MUSCLES of the EAR.

The muſcles of the ear of this animal differ conſiderably from thoſe in the human ear, where little motion ſeems to have been intended. In a dog, the motions of the ear are free and extenſive; and hence a greater number of muſcles were required: But ſeveral of theſe are ſo ſmall, that perhaps it may be ſufficient to deſcribe two of the principal of them.

*Retrahens*, a large and diſtinct muſcle ariſing from the ſpinous proceſſes of the two or three firſt cervical vertebræ, and running over to be fixed to the concha at its lateral and upper part. Its name denotes its uſe.

*Erigens*, ariſes from a ridge on the occipital bone, and runs over by three diſtinct fleſhy ſlips to be fixed to the outer part of the ear, and ſerving to erect or prick it up.

There are likewiſe a number of very diſtinct muſcles belonging to the internal ear.

*Laxator tympani* is a ſhort muſcle, of an oval form and glandular appearance, lying in a particular cavity of the os petroſum, near the foramen ovale; from the bottom of which it ſprings, and is inſerted by a very ſlender tendon into the malleus. The uſe is, as in man, to relax the membrana tympani, by rendering it leſs concave.

*Muſculus meatus auditorius.* In a dog there are ſeveral ſmall muſcles which come from one of the protuberant cartilages of the concha, and end in another of them; which, by putting them nearer together or farther aſunder, may dilate or contract the meatus externus, the better to fit it for different ſounds.

## MUSCLES of the EYE.

The muſcles which belong to the eye of a dog are ſimilar to thoſe in man: but, from the difference of ſituation of the head, the dog has the addition of two others not found in the human ſpecies.

All quadrupeds have a ſeventh muſcle belonging to the eye, called *ſuſpenſorius.* It ſurrounds almoſt the whole optic nerve, and is fixed into the ſclerotic coat as others are. Its uſe is to ſuſtain the weight of the globe of the eye, and to prevent the optic

optic nerve from being too much ſtretched, without obliging the four ſtraight muſcles to be in a continual contraction, which would be inconvenient; at the ſame time this muſcle may be brought to aſſiſt any of the four, by cauſing one particular portion of it to act at a time.

*Muſculus trochleæ proprius* is by much the ſmalleſt muſcle of the eye. It ariſes fleſhy near the origin of the obliquus major; and ſoon ſends off a ſlender tendon, which is inſerted into the trochlea, to the motions of which it is ſubſervient.

## MUSCLES of the FACE.

NOSE. The noſe of a dog has no proper muſcle as in the human body; but is moved by muſcles which are common to it and to the reſt of the face.

MOUTH. The lips of a man are moved by nine pair of muſcles and a ſphincter; but a dog has only ſix pair and the ſphincter.

*Levator anguli oris* wanting.

*Levator labii ſuperioris* ariſes and is inſerted in the dog in a manner ſomewhat ſimilar to what it is in man. Its uſe is to pull up the lip, which the animal does principally in ſnarling.

*Depreſſor labii ſuperioris* as in man.

*Depreſſor anguli oris* wanting.

*Depreſſor labii inferioris* ariſes from the middle of the lower jaw, and runs up to be fixed to the under lip.

*Levator labii inferioris* as in man.

*Zygomaticus major* has many of its fibres ſpread out upon the buccinator muſcle, by which the corner of the mouth is forcibly drawn upwards.

*Buccinator* as in man.

*Zygomaticus minor* wanting.

## Muscles of the LOWER JAW.

*Temporalis* ariſes and is inſerted almoſt in the ſame manner as in man; but is much thicker and ſtronger in proportion to the ſize of the animal; as indeed might naturally be expected, when we conſider the very hard and ſtrong ſubſtances which dogs are capable of breaking and tearing aſunder with their teeth.

*Maſſeter* ariſes and is alſo inſerted ſomewhat in the ſame manner as in man; and like the temporal muſcle, is thick and ſtrong, that the jaws may be brought more forcibly together.

*Pterygoideus internus et externus*, ariſe cloſe together from the ſphenoid bone, and are inſerted as in man.

## Muscles about the NECK, THROAT, &c.

*Platyſma myoides*. A dog has no proper platyſma myoides; but the panniculus carnoſus runs over the neck, and ſerves the ſame purpoſe.

*Sterno-cleido-maſtoidæus*. As the dog has no clavicle, this muſcle ariſes by one head from the top of the ſternum, and runs half way up the neck, contiguous to its fellow on the other ſide; here it ſeparates from it, and runs up to be inſerted as in man.

*Digaſtricus*, in man, has two fleſhy bellies, with a tendon in the middle; but in the dog it ariſes by a very thick and ſtrong fleſhy belly, from between the maſtoid proceſs of the temporal bone, and condyloid proceſs of the occipital-bone, and runs forward to be fixed by a broad inſertion into the middle of the lower jaw. Its uſe is to counteract the temporal and maſſeter muſcles by bringing down the jaw.

*Sterno-hyoidæus*,

*Sterno-hyoidæus*, in man, arifes from the fternum, firft rib, and clavicle. In the dog, it arifes, in common with the fterno-thyroidæus mufcle, from the cartilaginous extremity of the firft rib. After running along the neck a fhort way, it leaves the fterno-thyroid mufcle, and runs, as in man, to the bafe of the os hyoides.

*Omo-hyoidus* wanting.

*Sterno-thyroidæus* arifes in common with the fterno-hyoidæus.

*Chondro-cerato hyoidæus* arifes from the fuperior corner of the thyroid cartilage, and is inferted into the cartilaginous appendix of the os hyoides. Its ufe is to draw thefe bodies clofer together. In man this mufcle is wanting.

*Stylo-gloffus*, in man, arifes from the ftyloid procefs. In the dog it arifes from the extremity of the long procefs of the os hyoides; and therefore ought to be called *hyo-gloffus*.

*Inio cerato-hyoidæus*, a very fhort flefhy mufcle, arifing from the head by the fide of the digaftric mufcle of the lower jaw; and is inferted near the extremity of the long procefs of the os hyoides, which it pulls backwards.

*Stylo hyoidæus alter*, wanting.

*Stylo pharyngæus* arifes from the extremity of the long procefs of the os hyoides.

*Circumflexus*, or *tenfor palati*, arifes from the beginning of the Euftachian tube; adheres firmly to the foft part, where it becomes flefhy; and afterwards fends off a tendon which runs over the inner plate of the pterygoid procefs of the fphenoid bone. It is inferted into the palatum molle, and likewife joins its fellow on the other fide. The ufe of this mufcle is to pull the foft part of the palate from the pofterior part of the noftrils, in order to comprefs the glands of the palate which lie near it. It may likewife affift in dilating the foft part of the Euftachian tube.

*Conftrictor*

*Conſtrictor iſthmi faucium* may not only ſerve the common purpoſes as in man, but likewiſe act upon a glandular body which is placed in the throat, near the amygdalæ.

*Azygos uvulæ.* Although the uvula is wanting in this animal, a bundle of muſcular fibres runs through the middle of the palatum molle, ſomewhat in the ſame manner as in man.

*Hyo-epiglottidæus.* In man, the epiglottis is raiſed by the elaſticity of its cartilage; but in the dog there is a very diſtinct muſcle, which ariſes from the body and cartilaginous proceſs of the os hyoides, and runs down to be inſerted into the middle of the upper part of the epiglottis near its top. Its uſe is to raiſe the epiglottis after ſwallowing.

## Muscles of the ABDOMEN.

*Obliquus externus deſcendens* ariſes fleſhy, by nine or ten heads, from an equal number of poſterior ribs; membranous from the ſpinous proceſſes of the four anterior lumbar vertebræ, and from the ſpine of the os ilium. From theſe different origins it runs over and downwards to the edge of the rectus muſcle. Here it aſſiſts in forming the linea ſemilunaris, and is then continued over the rectus by a thin tendinous expanſion to be inſerted into the linea alba. A thin tendinous expanſion may be traced down with the chord.

*Obliquus aſcendens internus*, at a little diſtance from the outſide of the rectus muſcle, becomes tendinous, and is continued ſo, over the fore-part of that muſcle, to be fixed to the linea alba.

*Rectus abdominis* ariſes fleſhy from the pubes, and runs up, to be fixed to the under end of the ſternum; and about the 5th or 6th rib it ſends off a tendinous expanſion, which covers the cartilages of the ribs, and is continued to the top of the ſternum.

num. It has the fame ufe as in man; but its under end being flefhy, ferves in fome meafure to make up for the

*Pyramidalis*, which is wanting.

## Muscles of the MALE PARTS of GENERATION.

The mufcles in general are thicker and ftronger than in man. The tranfverfalis perinei is wanting, but there is an addition of three or four mufcles which are not found in the human fpecies.

*Tranfverfalis penis*, a fmall but diftinct mufcle; which arifes behind the erector penis from a fmall protuberance at the under and pofterior part of the os pubis. It is inferted with its fellow into a tendon between the os pubis and penis. This mufcle may affift in keeping the penis diftended in time of copulation.

*Præputium adducens* arifes from the panniculus carnofus near the cartilago enfiformis; and runs along the fide of the linea alba, to be fixed to the lateral part of the prepuce; its ufe is to bring the prepuce forward over the glands, after an erection of the penis.

*Præputium abducens* is a fingle mufcle which arifes by a fmall flefhy belly from the fphincter ani and accelerator urinæ; at the fore-part of which it runs along the under fide of the urethra, to be inferted into the prepuce. Its ufe is to counteract the former mufcle.

*Mufculus urethræ* furrounds that part of the urethra which lies between the proftate gland and union of the crura penis. Its ufe is to comprefs that part of the mucous glands and urethra which it covers in time of coition.

Mufcles of the *Female Organs of Generation* agree in general with thofe of the human fpecies.

Muscles

## Muscles of the ANUS.

*Sphincter ani* ſurrounds the anus, as in man ; but is much narrower, leſs force being required here, from the horizontal ſituation of this animal.

*Levator ani* ariſes as in man ; but divides into three or four portions, one of which runs into the tail, and aſſiſts in compreſſing it.

## Muscles about the PELVIS, LOINS, &c.

*Muſculus parvus in articulatione femoris ſitus* ariſes near the upper edge of the acetabulum, and runs over the capſular ligament of the joint, to be fixed to the os femoris between the vaſtus internus and cruræus. Its uſe is to aſſiſt the obturator externus in the rotation of the thigh.

*Muſculi caudæ.* The tail of this animal, which conſiſts of many joints, has ſeveral muſcles fixed into it. They begin with fleſhy bellies, which ſoon ſend off long tendons ; ſome of which run as far as the extremity of the tail, and ſerve to give it its different motions upwards, downwards, and to each ſide ; or, by a ſucceſſion of theſe motions, the animal can roll its tail.

*Quadratus lumborum* is a ſmall ſlender muſcle ; the anterior and upper end of which is contiguous to the pſoas parvus ; the poſterior end to the pſoas magnus. It ariſes from the ſpine of the ilium internally ; and, aſcending, is inſerted into the tranſverſe proceſſes of all the lumbar vertebræ, and likewiſe into the 9th or 10th rib.

*Pſoas parvus*, a large diſtinct muſcle, ariſing from the four loweſt vertebræ of the back and as many of the loins, ſoon forming a fleſhy belly, which ſends off a broad expanſion that

runs

runs by the infide of the pfoas magnus; part of which it covers and conceals. At laft it is fixed, as in man, to the brim of the pelvis.

## Muscles fituated on the THORAX.

*Pectoralis major* in a dog differs from that in a man, in being divided into three diftinct parts. The firft arifes from the upper part of the fternum; and paffing over the third, is inferted under it by a ftrong broad tendon into the whole length of the external and fore-part of the os humeri. The fecond arifes from the under end of the fternum and cartilago enfiformis, and covers a confiderable fhare of the under part of the next mufcle. It is inferted partly with the next mufcle, and partly runs down upon the mufcles on the humerus. The third, and by much the broadeft part, arifes from the cartilago enfiformis and all the fternum. It is inferted into the head of the os humeri.

*Subclavius* wanting, as the dog has no clavicle.

*Pectoralis minor* wanting.

*Serratus major anticus*, arifes flefhy from the five pofterior tranfverfe proceffes of the vertebræ of the neck, tendinous and flefhy from the feven anterior ribs; from the neck it runs obliquely downwards; from the ribs it runs obliquely upwards. It is inferted into the pofterior angle of the fcapula internally. It may pull the fcapula upwards, downwards, and backwards.

*Sterno-coftalis*, in a dog, is much larger and ftronger than in man; of confequence it may act more powerfully on the thorax.

*Longus colli*, in a dog, is much more diftinct in every refpect than in a man, its flefhy bellies being divided by tendinous lines equal in number to the vertebræ of the neck.

*Rectus capitis internus major* arifes by a number of tendinous and flefhy beginnings from the tranfverfe proceffes of all the vertebræ of the neck except the firſt; over the inſide of which it is reflected in its paſſage to the head. It is inſerted in a ſmall cavity in the cuneiform proceſs of the occipital bone.

## Muscles ſituated on the POSTERIOR PART of the TRUNK.

*Trapezius* ariſes from the ligamentum nuchæ and vertebræ of the back. It is inſerted into all the ſpine of the ſcapula except its fore part, where it unites with the levator ſcapulæ major.

*Latiſſimus dorſi* is membranous as far as the under part of the thorax, and is afterwards covered as in man by the trapezius. When it arrives at the teres major, it parts with a thin fleſhy production, which, running down upon the long head of the triceps, is inſerted tendinous into the elbow. A little before this, it receives the continuation of the panniculus carnoſus.

*Serratus poſticus inferior* ariſes by a thin tendon from the poſterior part of the ligamentum nuchæ, and from the ſpinous proceſſes of the eight anterior vertebræ of the back. It is inſerted into the anterior ribs excepting the firſt, by as many fleſhy indentations. Its tendon joins with that of the ſerratus poſticus inferior; and with it makes a tendinous ſheath, which keeps the ſubjacent muſcles together, and ſtrengthens them in their action.

*Longiſſimus dorſi* and *ſacro lumbalis* are ſimilar to that in man, but much ſtronger.

*Complexus* ariſes from the tranſverſe proceſſes of the four anterior vertebræ of the back by as many ſmall tendons, from the poſterior vertebræ of the neck by as many different heads, which, uniting, form a fleſhy belly that is inſerted into the occipital bone near its ridge.

*Trachelo-maſtoidæus*, a little before it reaches the head, is firmly united to the ſplenius muſcle.

*Levator*

*Levator ſcapulæ major* ariſes fleſhy from the tranſverſe proceſs of the firſt vertebræ of the neck, and runs along the ſide of the neck to be inſerted in common with the trapezius into the ſpine of the ſcapula.

*Levator ſcapulæ minor* ariſes tendinous from the occipital bone, runs down the back part of the neck, and in its paſſage joins the long portion of the rhomboid muſcle, to be inſerted by a long tendon into the baſe of the ſcapula near its angle. The two ſerve to raiſe the ſcapula; the anterior may raiſe the fore-part and the poſterior the back part.

*Multifidus ſpinæ*, in general agrees with that in man, but the upper part of it is inſerted into the bodies of the cervical vertebræ.

*Rectus*. In the dog there are three recti muſcles.

*Rectus major* ariſes from the ſpinous proceſs of the ſecond vertebra of the neck, and runs ſtraight forward, covering the rectus medius.

*Rectus medius* ariſes from the upper part of the ſame proceſs, and is inſerted with the former.

*Rectus minor* the ſame as in man.

*Obliquus capitis ſuperior*, like the rectus major, is alſo double. One part ariſes from the extremity of the tranſverſe proceſs of the firſt vertebra of the neck, the other from its upper edge; and both are inſerted into the occipital bone.

*Scalenus*, as in man, may be divided into three muſcles; but the ſcalenus medius is broader, and is inſerted into the fifth or ſixth rib.

*Muſculus in ſummo thorace ſitus* ariſes fleſhy from the firſt rib; and afterwards turns tendinous to be inſerted into the ſternum under the tendon of the rectus abdominis.

*Intertranſverſalis colli* is much thicker and ſtronger than in man.

## Muscles of the SUPERIOR EXTREMITIES.

*Infraſpinatus* has the middle tendon and penniform appearance much more diſtinct than in man.

*Teres minor* ariſes by a ſlender tendon, which adheres forwards to the under edge of the infraſpinatus; then it forms a fleſhy belly, which paſſes obliquely over the beginning of the biceps muſcle, to be inſerted into the head of the os humeri.

*Deltoides* ariſes tendinous from almoſt all the ſpine of the ſcapula. That part which comes from the acromion ſeems to be diſtinct from its other origin, but cannot be divided from it without violence. Its action is upwards and outwards; for it has no beginning from the clavicle to move it inwards.

*Coraco-brachialis* is a ſmall muſcle ariſing from the upper part of the ſuperior coſta ſcapulæ by a very ſlender tendon; which, paſſing over the head of the humerus, grows fleſhy, and is inſerted into the inſide of that bone about an inch or more below its neck.

*Subſcapularis* poſſeſſes only about three parts of the ſurface of the ſcapula, the ſerratus magnus poſſeſſing the reſt.

Beſides the muſcles already deſcribed, the dog has two others peculiar to himſelf.

*Levator humeri proprius* ariſes from all the ſpace between the tendinous end of the maſtoid muſcle and ridge of the occiput, from the anterior part of the ligamentum nuchæ. This large beginning becomes narrower as it runs obliquely along the neck, cloſely adhering to ſome part of the levator ſcapulæ major; and, paſſing over the articulation of the humerus, goes ſtraight down to its inſertion in the fore, and near the under part of the ſame bone.

*Muſculus ad levatorem acceſſorius*, ariſes from the os occipitis near the inſertion of the maſtoid muſcle, and unites with the former a little before it reaches the ſcapula. Juſt above the head

head of the os humeri, near the termination of the muſcle, there is placed a ſmall crooked body, of a cartilaginous nature, tied to the ſcapula and top of the ſternum by two ſmall ligaments; which is all that the animal can be ſaid to have for a clavicle. In cats, this muſcle is inſerted into the whole length of the clavicle, which it ſerves to raiſe: but in this animal the uſe of the acceſſory muſcle ſeems calculated for the aſſiſtance of the levator, which ſerves to raiſe the os humeri, and to turn it a little outwards, whereby the fore-feet are kept from injuring each other in running or leaping.

*Biceps*, in this animal, ought to be diſtinguiſhed by ſome other name, as *flexor cubiti anterior*. It riſes here by one head from the cervix ſcapulæ, and runs down above the following muſcle to be inſerted by two tendons as in man.

*Brachialis internus* riſes broad and fleſhy from the back of the humerus under its neck, and runs down by the outſide of the former muſcle.

The extenſion of the cubit or fore-arm is performed by the action of five muſcles.

*Extenſor primus*, and what correſponds with the long head of the triceps in man, becomes very thick and fleſhy; but afterwards ſends off a tendon, which is inſerted into the olecranon.

*Extenſor ſecundus*, correſponding with the ſhort head of the triceps, ariſes from the ſuperior and back part of the humerus, and, deſcending under the former, ſends off a tendon through a ſulcus in the extremity of the ulna, and is inſerted below the other muſcles.

*Extenſor tertius*, ſomething analogous to the brachialis externus in man, ariſes from the upper and back part of the humerus at a protuberance near the termination of the teres minor, to be inſerted into the outſide of the olecranon.

*Extenſor quartus*, or *anconæus*, fills up a cavity or hollow between

between the heads of the radius and ulna, and has the fame origin and termination as in man.

*Extenfor quintus* arifes by a thin tendon from the infide of that protuberance into which the fupraspinatus of the fcapula is inferted; and paffing under the tendon of the teres major, ends at the infide of the olecranon.

*Palmaris longus* wanting.

——— *brevis* wanting.

*Flexor carpi ulnaris.*—Here we find two diftinct mufcles. The

*Large* arifes from the internal condyle of the os humeri near the edge of the finus that receives the head of the ulna, and is inferted into the carpus. The

*Smaller* arifes flefhy from the olecranon, and runs down by the fide of the former to terminate with it in the carpus.

*Extenfor carpi radialis longior et brevior*, fimilar to thofe in man, but more firmly united together at their origin.

*Extenfor carpi ulnaris* fends a tendon to the carpus, which pulls that part out in extenfion, and affifts the animal in running.

*Flexor fublimis perforatus.* The openings through the tendons of this mufcle for the paffage of the next, are much larger and wider than in man, and the tendons terminate without any fubdivifion.

*Flexor profundus perforans* arifes from the os humeri, radius, and ulna, by three diftinct heads, which unite; and afterwards fends off a ftrong tendon, which fplits into five fmall ones; four of which terminate as in man; the fifth is inferted into the part which correfponds with the thumb.

*Extenfor digitorum communis* runs to the laft bone of each toe between the two ligaments that go from the fecond bone of the toe to the third. The ufe of thefe ligaments is to draw the laft joint backwards and upwards, and keep it fufpended, that the extending tendon may not always be upon the ftretch.

Supinator

*Supinator radii longus* wanting.

*Pronator radii quadratus* lies upon the membrane that joins the two bones of the cubit together, to both of which it adheres; and near the under end of the ulna it ſends off a tendon obliquely to the extremity of the radius, into which it is inſerted.

*Indicator* ariſes as in man, but is inſerted into the laſt joint of what correſponds with the fore-finger.

*Abductor indicis manus* wanting.

*Flexor primi internodii* wanting.

*Extenſor tertii internodii* wanting.

*Interoſſei*— A dog has interoſſei muſcles ſomewhat ſimilar to thoſe in man, and they are ſix in number; four of which are large, and placed not between, but in the hollow of the metacarpal bones, and run ſtraight down. The other two are very ſmall, and run oblique. The large ariſe tendinous and fleſhy from the ſuperior part of the metacarpal bones, adhering to the ſame in their deſcent: at the os ſeſamoideum of the firſt joint, each divides into two tendons; which running obliquely along the ſides of the toe, unite inſeparably with the tendon of the extenſor near the lower part of the firſt bone of each toe.

The firſt of the two ſmall muſcles belongs to the fore-toe or index. It ariſes from the upper part of the os metacarpi medii digiti; and, deſcending obliquely, grows tendinous about the firſt joint, and terminates near the middle of this bone internally.

The ſecond ariſes from the os metacarpi of the third toe; and after running obliquely, ends in the inſide of the firſt bone of the little toe. The uſe of theſe two muſcles is to bring their reſpective toes nearer the middle one.

*Abductor indicis* wanting.

*Flexor primi internodii* wanting.

## Muscles of the INFERIOR EXTREMITIES.

*Psoas magnus.*

*Pectinalis*, arises from the os pubis, and terminates by a broad and thin tendon at the inner condyle of the femur.

Besides the *triceps adductor femoris*, a dog has a *musculus parvus in articulatione situs*, which arises from the side of the acetabulum, and is inserted into the upper inner part of the os femoris, after running over the capsular ligament of the joint.

*Glutæus medius* here, ought rather to be called *glutæus maximus*. The principal difference between the glutæi muscles and those of man is, that the middle glutæus is by much the largest.

*Tensor vaginæ femoris* is divided into two distinct muscles. The superior arises from the spine of the os ilium, and ends as in man. The inferior arises from below the former, and with it is inserted into the same tendon.

A dog has the addition of a *fifth extensor*, which arises from the spine and half the costa of the os ilium. In its descent it adheres to the sartorius by a membrane, and is inserted into the patella.

*Biceps flexor cruris* nearly as in man, excepting that its short head is much smaller.

*Gastrocnemius* has but two heads: whereas in man it has four.

*Plantaris* arises in common with the flexor digitorum communis.

*Tibialis anticus* sends off a tendon which runs upon the great toe, which it serves to extend.

*Tibialis posticus*, a very small muscle when compared with that in man.

*Extensor longus digitorum* arises by a round tendon from the fore-part of the external condyle of the os femoris; and descending through a sinus in the head of the tibia, grows fleshy after

after paffing under the ligament fimilar to that of the tarfus in man. Inferted into the ends of the toes.

*Extenfor brevis digitorum* may be faid to be two diftinct mufcles. The firft arifes tendinous, the other flefhy from the os calcis. The firft foon becomes flefhy, and afterwards fends off a tendon, which ends in the toe next the great one. The fecond, or outermoft, gives tendons to the reft of the toes.

*Flexor brevis digitorum* arifes from the lower part of the os femoris, and runs under the gaftrocnemius, to which it adheres. It afterwards runs over the os calcis, and fplits into four tendons, which give paffage to the following mufcle.

*Flexor longus digitorum* fplits into five tendons: one runs to the great toe: the reft run through the tendons of the former to the other toes.

*Flexor digitorum acceffiorius* wanting.

*Extenfor proprius pollicis.* Somewhat fimilar to that in man; but, befides it, there is a tendon fent off from the lower part of the tibialis pofticus, which runs along the upper part of this toe, and affifts in extending it.

*Flexor brevis pollicis*, in this animal, is a thin flip fent off from the flexor profundus.

*Abductor pollicis* wanting.

*Adductor pollicis* wanting.

*Abductor minimi digiti* wanting.

*Flexor brevis minimi digiti* wanting.

*Interoffei.* The hind-foot, like the fore-one, has fix mufcles, four of which are ftraight, the other two oblique; and the whole of them ferve the fame purpofe as the interoffei in man.

## MUSCLES peculiar to MAN.

Pyramidalis.
Corrugator fupercilli.
Compreffor naris.

Levator anguli oris.
Depreſſor anguli oris.
Zygomaticus minor.
Omo-hyoidæus.
Levator palati.
Palato pharyngæus.
Subclavius.
Pectoralis minor.
Supinator longus.
Palmaris longus.
Palmaris brevis.
Prior indicis.
Abductor indicis.
All the muſcles of the thumb, excepting one flexor and one extenſor.
All the muſcles of the little finger, excepting the extenſor.
Coccygeus.

## Muscles peculiar to the DOG.

Tranſverſalis penis.
Muſculus oculi ſuſpenſorius.
Muſculus trochleæ proprius.
Several muſcles of the ear.
Chondro-cerato-hyoidæus.
Inio-cerato-hyoidæus.
Hyo-glottis.
Tympano palatinus.
Muſculus in ſummo thorace ſitus.
Levator ſcapulæ minor.
Panniculus carnoſus.
Levator humeri proprius.
Muſculus ad levatorem acceſſorius.
Extenſor cubiti quintus.

A fecond flexor carpi ulnaris.
Mufculus parvus in articulatione fitus.
Mufculi caudæ.
Extenfor tibiæ quintus.
Præputium adducens.
Præputium abducens.
Mufculus urethræ.

## The ANATOMY of a COW.

THE next fpecies of quadrupeds we propofed to confider, was the ruminant kind, of which we have an example in a cow; and accordingly fhall take the fœtus of the animal *in utero*, that we may firft remark fome things that are peculiar to it in that ftate, and afterwards proceed to examine its vifcera as a ruminant animal. Firft, then, as a fœtus.—But before we begin our inquiry, it may be worth our obfervation, that from the ovarium fomething effentially neceffary for the production of the fœtus is derived, as well as in the human fpecies.

The form of a cow's *uterus* differs from the human, in having two large cornua. This is common to it with other brutes; for a bitch has two long *cornua uteri*: But thefe again differ (as being multiparous and uniparous) in this, that in the bitch's cornua the fœtufes are contained; whereas here there is only part of the fecundines, being moftly the allantois with the included liquor. The mufcular fibres of the uterus are more eafily difcovered; its internal furface has a great number of fpongy, oblong, protuberant, glandular bodies fixed to it. Thefe are compofed of veffels of the uterus terminating here. In an impregnated uterus, we can eafily prefs out of them a chylous mucilaginous liquor; they are compofed of a great many proceffes or digituli, and deep caverns, anfwering to as many caverns and proceffes of the placenta.

Their refemblance has occafioned the name of *papillæ* to be given them; and hence it was that Hippocrates was induced to believe that the fœtus fucked *in utero*. The papillæ are found in all the different ftages of life, in the various ftages of pregnancy, and likewife in the unimpregnated ftate. It is not eafy to determine whether the uterus grows thicker or thinner in the time of geftation. The membranes, it is plain, (by the ftretching of the parts), muft be made thinner; but then it is as evident, that the veffels are at that time enlarged, upon which principally the thicknefs of any part depends; fo there feems to be as much gained the one way as is loft the other.

The *os uteri* is entirely fhut up by a glutinous mucilaginous fubftance, that is common to the females of all creatures when with young; by this the external air is excluded, which would foon make the liquors corrupt; it alfo prevents the inflammation of the membranes and the hazard of abortion. By this means alfo the lips of the womb are kept from growing together, which they would otherwife certainly do at this time.

There are mucous glands placed here to fecern this gluten, which on the breaking of the membranes with the contained waters make a fapo that lubricates and wafhes the parts, and makes them eafily yield. The firft of the proper involucra of the fœtus is the chorion.

The *chorion* is a ftrong firm membrane, on whofe external furface are difperfed a great many red flefhy bodies of the fame number, fize, and ftructure with the papillæ, with which they are mutually indented. They have been called *cotyledones*, from κοτυλη, "cavity." This is greatly difputed by fome authors as a name very improper; but I think without reafon, fince the furface that is connected to the papillæ is concave, though when feparated it appears rather convex. To fhun all difpute, they may be called properly enough *placentulæ*, fince they ferve the fame ufe as the placenta in women. The fepa-

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ration of thefe from the papillæ without any laceration, and our not being able to inject coloured liquors from the veffels of the glands of the uterus into the placentulæ, feem to prove beyond a reply, that there can be here no anaftomofes between the veffels: on their coats run a great number of veffels that are fent to the feveral placentulæ, on the external fide next to the uterus; whereas in creatures that have but one placenta, as in the human fubject, cats, dogs, &c. the adhefion is fomewhat firmer: The placentæ are likewife joined to the papillæ in the cornua uteri. We fhall next give the hiftory of the *allantois*.

This is a fine tranfparent membrane contiguous to the former. It is not a general involucrum of the fœtus in the mother, for it covers only a fmall part of the amnios. It is moftly lodged in the cornua uteri. In mares, bitches, and cats, it furrounds the amnios, being every where interpofed between it and the chorion. In fheep and goats it is the fame as in this animal; and in fwine and rabbits it covers ftill lefs of the amnios. This fac is probably formed by the dilatation of the urachus, which is connected at its other end to the fundus of the bladder, through which it receives its contents; and a great quantity of urine is commonly found in it. The membrane is doubled at the extremity of the canal, to hinder the return of the urine back into the bladder. Its veffels are fo exceffively fine and few, that we cannot force an injected liquor farther than the beginning of this coat. This membrane is fo far analogous to the cuticula, as not to be liable to corruption, or eafily irritated by acrid liquors. The exiftence of this membrane in women has been very warmly difputed on both fides. Thofe who are againft its exiftence deny they could ever find it; and, allowing it were fo, alledge, that fince the urachus is impervious, as appears by our not being able to throw liquors from the bladder into it, or *vice verfa*, it cannot ferve

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the ufe that is agreed by all it does ferve in beafts; and therefore in the human body there is no fuch thing. But when I confidered on the other hand, firft, that there feems to be the fame neceffity for fuch a refervoir in man as in other animals: fecondly, that we actually find urine contained in the bladder of the human fœtus: thirdly, that urine has been evacuated at the navel when the urethra was ftopped, which urine without this conduit would have fallen into the cavity of the abdomen: fourthly, that midwives have pretended to remark two different forts of waters come away at the time of birth: and laftly, that Dr Littre and Dr Hale have given in this membrane of an human fubject, with all the other fecundines curioufly prepared, the one to the royal academy at Paris, the other the royal fociety of London; by which focieties their refpective accounts are attefted; not to mention Verheyen, Heifter, Keill, &c. who affirm their having feen it; and Albinus, the famous profeffor of anatomy at Leyden, fhews, as I am told, to his college every year a preparation of it: On all thefe accounts I muft own, that it feemed not improbable to me there was fuch a membrane in the human body. But in four bodies I purpofely diffected, wherein I was affifted by a very accurate anatomift, Dr Sinclair, I could not obferve any fuch thing. However, my want of fkill will more probably be doubted, than the truth of relations, fupported by fuch authentic vouchers, called in queftion.

The third proper integument of the fœtus is the *amnios*. It is thinner and firmer than the chorion; it has numerous ramifications of the umbilical veffels fpread upon it, the lateral branches of which feparate a liquor into its cavity. This is the proper liquor of the amnios: which at firft is in a fmall quantity, afterwards increafes for fome months, then again decreafes; and in a cow near her time, the quantity of this liquor is not above a pound. This membrane does not enter the *cornua uteri* in this creature, being confined to the body of the

uterus:

uterus; whereas the allantois occupies chiefly its cornua. But for what further relates to the ſtructure of the involucra, with the nature of the liquors contained in them, I muſt refer to the ſecond volume of Medical Eſſays, from page 121, where you have the ſum of all I know of this matter.

There are here two *venæ umbilicales*, and but one in the human ſubject; becauſe the extreme branches coming from the ſeveral placentulæ could not unite ſo ſoon as they would have done had they come all from one cake as in the human.

There is a ſmall round fleſhy body that ſwims in the urine of this creature, mares, &c. which is the *hippomanes* of the ancients. Several idle opinions and whims have been entertained as to its uſe; but that ſeems to be ſtill unknown, or how it is generated or nouriſhed, for it has no connection with the fœtus or placenta.

Having thus conſidered the ſeveral involucra of this animal in a fœtus ſtate, let us next obſerve the ſpecialties in its internal ſtructure peculiar to a fœtus.

The umbilical vein joins the *vena portarum* in the *capſula Gliſſoniana*, without ſending off any branches as it does in the human ſubject. This vein ſoon after birth turns to a ligament; yet there are ſome inſtances where it has remained pervious for ſeveral years after birth, and occaſioned a hæmorrhage. We may next obſerve the duct called *canalis venoſus*, going ſtraight from the *capſula Gliſſoniana* to the *vena cava;* this turns alſo afterwards to a ligament. The umbilical arteries riſe at acute angles from the internal iliacs, whatever ſome may ſay to the contrary; theſe alſo become impervious.

The pulmonary artery coming from the right ventricle of the heart divides into two, the largeſt, called *canalis arterioſus*, opens into the deſcending aorta, the other divides into two, to ſerve the lungs on each ſide. The *foramen ovale* is placed in the partition between the right and left auricles. At the edge of the hole is fixed a membrane, which when

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much ſtretched will cover it all over; but more eaſily yields to a force that acts from the right auricle to the left, than from the left to the right. After what has been ſaid, we may eaſily underſtand how the circulation is performed in a fœtus. The blood, being brought from the placenta of the mother, is thrown into the *capſula Gliſſoniana*, where it is intimately blended with the blood in the *vena portarum:* then part of this blood goes directly into the *vena cava* by the *ductus venoſus;* the reſt paſſes through the liver. Firſt, then, the whole is ſent from the *vena cava* into the right auricle, from whence part of it is ſent by the *foramen ovale* into the left auricle; the reſt paſſes into the right ventricle, then into the pulmonary artery; then the greateſt ſhare it receives is ſent immediately into the deſcending aorta by the *canalis arterioſus*, and the remainder circulates through the lungs, and is ſent back by the pulmonary veins into the left auricle; which, with the blood brought there by the *foramen ovale*, is ſent into the left ventricle, from whence it is driven by the aorta through the body. The great deſign of this mechaniſm is, that the whole maſs of blood might not paſs through the collapſed lungs of the fœtus; but that part of it might paſs through the *foramen ovale* and *canalis arterioſus*, without circulating at all through the lungs.

This was the opinion that univerſally prevailed till the end of the laſt century, when it was violently oppoſed by Monſieur Mery, who is very ſingular in ſeveral of his opinions. He will not allow that the foramen ovale tranſmits blood from the right to the left auricle, but on the contrary from the left to the right; and that for no other reaſon, but becauſe he obſerved the pulmonary artery in a fœtus larger than the aorta. Mr Winſlow endeavours to reconcile theſe two opinions, by ſaying the blood may paſs either way, and that it is here as it were blended: his reaſon is, that on putting the heart in water, the foramen ovale tranſmits it any way. Mr Rohault, profeſſor

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of anatomy at Turin, and formerly one of Mery's ſcholars, ſtrongly defends his maſter, and criticiſes Mr Winſlow. What he principally builds on, is the appearance this foramen has in ſome dried preparations: This Mr Winſlow will not allow as proof. After all I remain in the common opinion; and that for the following reaſons; Firſt, the pulmonary artery being much larger ſignifies nothing, ſince its coats are not only thinner and will be more eaſily diſtended, but alſo the reſiſtance to the blood in the pulmonary artery from the collapſed lungs is greater than the reſiſtance to the blood in the aorta. Secondly, if we ſhould allow any of theſe two uncommon opinions, we ſhould have the right ventricle vaſtly more capacious than the left: For if we ſuppoſe the *foramen ovale* to be capable of tranſmitting one third of the whole maſs of blood in any given time, and the *canalis arterioſus* as much in the ſame time, then you will find, that, according to Mr Mery's opinion, the whole maſs of blood being driven from the right ventricle into the pulmonary artery, one-third paſſes by the *canalis arterioſus* into the deſcending aorta, two-thirds paſſing through the lungs and returning into the left auricle; one-half of which portion, or one third of the whole maſs, paſſes by the *foramen ovale* into the right auricle; and the other, or the laſt third, will be ſent into the left ventricle, and thence expelled into the *aorta;* which third, with that from the pulmonary artery by the *canalis arterioſus*, circulating through the body, is returned unto the right auricle; where meeting with the other third from the *foramen ovale*, with it the whole is ſent into the right ventricle to undergo the ſame courſe. Thus the whole maſs is expelled by the right ventricle, and only one-third by the left. If this was the caſe, why is not the right ventricle three times as large and ſtrong as the left?

Then if, according to Mr. Winſlow's ſyſtem, the *foramen ovale* tranſmits equal quantities from both auricles, this comes to the ſame as if there was no *foramen ovale* at all: that is to ſay, the whole maſs going from the right auricle into the right ventricle and pulmonary artery, one-third of the whole maſs paſſes into the aorta through the *canalis arterioſus*; the other two-thirds, paſſing through the lungs, return to the left auricle and ventricle. Thus the right ventricle expels the whole maſs; the left, only two-thirds.

But if, according to the common opinion, we ſuppoſe the *foramen ovale* to convey the blood from the right to the left auricle, then one-third paſſes this way into the left ventricle; the other two-thirds are ſent by the right ventricle into the pulmonary artery: from whence one-third paſſes by the *canalis arterioſus* into the *aorta deſcendens*; the other third circulates through the lungs, and is returned into the left ventricle; where meeting with that from the *foramen ovale*, it is therewith expelled into the aorta, and with the one third tranſmitted by the *canalis arterioſus* returns into the right auricle to run the ſame courſe as before. Thus we conclude, that two-thirds are expelled by each ventricle, and the whole circulates through the body; and hence they come to be of nearly equal dimenſions. In all this calculation I have had no regard to the blood diſcharged from the umbilical veſſels: but the greater quantity returned by the veins, than ſent out by the arteries, ſtill argues for the common opinion.

The *kidneys* in the fœtus are compoſed of different lobes, which ſerve to give us an idea of the kidneys being a congeries of different glands; theſe lobes being kept contiguous by the external membrane, are preſſed by the other viſcera, till at length they unite.

We now come to conſider the creature as a ruminant animal. There are no *dentes inciſores* in the upper jaw; but the gums are ſomewhat hard, and the tongue rough. This roughneſs is occaſioned by long ſharp pointed papillæ with which the whole ſubſtance of it is covered. Theſe papillæ are turned towards the throat; ſo that by their means the food, having once got into the mouth, is not eaſily pulled back. The animals therefore ſupply the defect of teeth by wrapping their tongue round a tuft of graſs; and ſo, preſſing it againſt the upper jaw, keep it ſtretched, and cut it with the teeth of the under jaw; then without chewing, throw it down into the œſophagus, which in theſe creatures conſiſts of a double row of ſpiral fibres decuſſating one another. All animals which ruminate muſt have more ſtomachs than one; ſome have two, ſome three; our preſent ſubject has no leſs than four. The food is carried directly down into the firſt, which lies upon the left ſide, and is the largeſt of all; it is called γαστηρ, *ventriculus*, and χοιλια, by way of eminence. It is what is called by the general name of *paunch* by the vulgar. There are no rugæ upon its internal ſurface; but inſtead of theſe there are a vaſt number of ſmall blunt-pointed proceſſes, by which the whole has a general roughneſs, and the ſurface is extended to ſeveral times the ſize of the paunch itſelf. The food, by the force of its muſcular coat, and the liquors poured in here, is ſufficiently macerated; after which it is forced up hence by the œſophagus into the mouth, and there it is made very ſmall by maſtication; this is what is properly called *chewing the cud*, or *rumination*; for which purpoſe the *dentes molares* are exceedingly well fitted: for inſtead of being covered with a thin cruſt, the enamel on them conſiſts of perpendicular plates, between which the bone is bare, and conſtantly wearing faſter than the enamel, ſo that the tooth remains good to extreme old age; and by means of theſe teeth the rumination is carried on for a long time without any danger of ſpoiling them. After rumination, the food is ſent down by the gullet into the ſecond ſtomach; for the œſophagus opens indifferently into both. It ends exactly where the two ſtomachs meet; and there is a ſmooth gutter with riſing edges which leads into the ſecond ſtomach, from thence to the third, and alſo to the fourth: however, the creature has a power to direct it into which it will. Some tell us, that the drink goes to the ſecond; but that might be eaſily determined by making them drink before ſlaughter. The ſecond ſtomach, which is the anterior and ſmaller, is called κεκρυφαλος, *reticulum*, *honeycomb*, the *bonnet*, or *king's-hood*. It conſiſts of a great number of cells on its internal ſurface, of a regular pentagonal figure, like to a honeycomb. Here the food is farther macerated; from which it is protruded into the third, called εχινος, or *omaſum*, *vulgo* the *manyplies*, becauſe the internal ſurface riſes up into a great many plicæ or folds, and *ſtratum ſuper ſtratum*, according to the length of this ſtomach. Some of theſe plicæ are farther produced into the ſtomach than others; *i. e.* firſt two long ones on each ſide, and within theſe two ſhorter in the middle, &c. There are numberleſs glandular grains like millet-ſeeds diſperſed on its plicæ, from which ſome authors call the ſtomach the *millet*. From this it paſſes into the fourth, whoſe names are ηνυστρον *abomaſum*, *caille*, or the *red*, which is the name it commonly has becauſe of its colour. This much reſembles the human ſtomach, or that of a dog; only the inner folds or plicæ are longer and looſer; and it may alſo be obſerved, that in all animals there is only one digeſtive ſtomach, and that has the ſame coagulating power in the fœtus as the fourth ſtomach in this animal; whence this might not improperly be called the only true ſtomach. *Caille* ſignifies *curdled*; and hence the French have given that as a name to this fourth ſtomach, becauſe any milk that is taken down by young calves, is there curdled. It is this fourth ſtomach, with the milk curdled in it, that is commonly taken for making runnet; but after the bile and pancreatic juice enter, this coagulation is not to be found, which ſhews the uſe of theſe liquors. There are other creatures which uſe the ſame food, that have not ſuch a mechaniſm in their digeſtive organs. Horſes, aſſes, &c. have but one ſtomach, where graſs is macerated, and a liquor for their nouriſhment extracted, and the remain-

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der ſent out by the anus very little altered. From this different ſtructure of the ſtomach in theſe creatures, a ruminant animal will be ſerved with one third leſs food than another of equal bulk: graſiers are ſufficiently acquainted with this. The reaſon is, that ruminating animals have many and ſtrong digeſtive organs; all their food is fully prepared, and almoſt wholly converted into chyle: But a horſe's ſtomach is not fitted for this; ſo that he requires a much greater quantity of food to extract the ſame nouriſhment.

The guts of theſe creatures are of a conſiderable length in proportion to the bulk of the body; and this confirms what we ſaid formerly on the ſubject of the inteſtines of a dog, viz. that the length and capacity of the guts were different in different animals, according to the nature of their food.

The *duodenum* is formed here much the ſame way as in a dog, and the general intention kept in view with regard to the mixture of the bile and pancreatic lymph. The great guts here hardly deſerve that name, their diameter differing very little from that of the ſmall ones; but to compenſate this, they are much longer proportionally than a dog's are, being convoluted as the ſmall guts are. The cæcum is very large and long. The digeſtion of the cow, as well as ſome other animals, is accompanied with a peculiar kind of action called *rumination;* the intention of which ſeems to be, that the food may be ſufficiently comminuted, and thus more fully acted upon by the ſtomach: for it is not obſerved that a calf ruminates as long as it is fed only upon milk, though the action takes place as ſoon as it begins to eat ſolid food. But it is to be obſerved, that as long as a calf feeds only upon milk, the food deſcends immediately into the fourth ſtomach (which, as has been already mentioned, ſeems only capable of performing the operation of digeſtion) without ſtopping in any of the firſt three. The rumination does not take place till after the animal has eaten a conſiderable quantity: after which ſhe lies down, if ſhe can

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do it conveniently, and begins to chew; though the operation will take place in a ſtanding poſture, if ſhe cannot lie down. In this action a ball is obſerved to riſe from the ſtomach with great velocity, almoſt as if ſhot from a muſket. This ball the animal chews very accurately, and then ſwallows it again, and ſo on alternately, till all the food ſhe has eaten has undergone this operation. This is eaſily explained from the ſtructure of the œſophagus, which has one ſet of fibres calculated for bringing up the graſs, and another for taking it down again.

By means of rumination, the cow extracts a much larger proportion of nouriſhment from her food, than thoſe animals which do not ruminate; and hence ſhe is contented with much worſe fare, and ſmaller quantities of it, than a horſe; hence alſo the dung of cows, being much more exhauſted of its fine parts than horſe dung, proves much inferior to it as a manure.

The *ſpleen* differs not much either in figure or ſituation from that of a dog's: but it is a little more firmly fixed to the diaphragm, there not being here ſo much danger of this viſcus's being hurt in the flexions of the ſpine.

The *liver* is not ſplit into ſo many lobes in this creature as either in a man or dog; which depends on the ſmall motion this creature enjoys in its ſpine, which made ſuch a diviſion needleſs. This alſo confirms what I formerly advanced on this head.

Their *veſica urinaria* is of a pyramidal ſhape. It is very large, and more membranaceous; for the urine of theſe creatures not being ſo acrid as that of carnivorous animals, there was no ſuch occaſion for expelling it ſo ſoon.

The male is provided with a looſe pendulous *ſcrotum*, and conſequently with *veſiculæ ſeminales*. The female organs differ from theſe of a bitch, moſtly as to the form of the cornua uteri, which are here contorted in form of a ſnail. In this, and all uniparous animals, they contain only part of the ſecundines; but in bitches, and other multiparous animals, they run

run ſtraight up in the abdomen, and contain the fœtus themſelves.

The ſituation of the *heart* is much the ſame with that of a dog, only its point is rather ſharper: In us, the heart beating continually againſt the ribs, and both ventricles going equally far down to the conſtitution of the apex, it is very obtuſe; but here the apex is made up only of the left ventricle, ſo is more acute.

The *aorta* in this creature is juſtly divided into *aſcending* and *deſcending*, though this diviſion is ill founded either in a dog or man; and it has certainly been from this ſubject that the older anatomiſts took their deſcriptions when they made this diviſion; for here the aorta divides into two, the aſcending and deſcending.

## Of FOWLS in general.

THE next claſs of animals we come to conſider are of the feathered kind; which are divided into the *granivorous* and *carnivorous*. But before we go on to conſider the ſpecialties in the viſcera of each kind, we muſt obſerve what both ſpecies agree in.

Fowls have a particular covering of feathers different from all other creatures, but exactly well ſuited to their manner of life; for it not only protects them from the injuries of the weather, but ſerves them in their progreſſion through that thin aerial element in which they are for the moſt part employed; and as ſome fowls live much in the water, their feathers being continually beſmeared with an oily liquor, keeps the water from ſoaking into their ſkins, and ſo prevents the bad effects which it would infallibly otherwiſe produce.

Fowls

Fowls have the ſtrongeſt muſcles of their whole body inſerted into their wings; whence by the way we may obſerve, that it is altogether impoſſible for man to buoy himſelf up into the air like birds, even though he had proper machines in place of wings, unleſs he were likewiſe provided with muſcles ſtrong enough for moving them, which he has not. In the next place, their wings are not placed in the middle of their bodies, but a good deal further forwards; whence it would at firſt view appear, that their heads would be erect, and their poſterior parts moſt depending when raiſed in the air: but by ſtretching out their heads, which act upon the lever of a long neck, they alter their centre of gravity conſiderably; and alſo by filling the ſacs or bladders in the inſide of their abdomen with air, and expanding their tail, they come to make the poſterior part of their bodies conſiderably higher; and thus they fly with their bodies nearly in an horizontal ſituation. Hence we find, that if their necks are kept from being ſtretched out, or if you cut away their tails, they become incapable of flying any conſiderable way. The largeneſs of the wings in different fowls varies according to the occaſions of the creature. Thus birds of prey, who muſt fly a conſiderable way to provide their food, have large ſtrong wings; whereas domeſtic birds, who find their nouriſhment almoſt every where, have very ſhort and but ſmall wings. Their tail is of uſe in aſſiſting to raiſe them in the air; though the chief purpoſe of it is to ſerve as a rudder in guiding their flight, whilſt they uſe their wings as we do oars in putting forward a boat. The beſt account of this manner of progreſſion of fowls is given by Alfonſus Borellus, in his treatiſe *De Motu Animalium*; and in the *Religious Philoſopher* we have Borelli's doctrine ſtripped in ſome meaſure of its mathematical form. The poſterior extremities are ſituated ſo far back, as to make us at firſt think they would be in continual hazard of falling down forwards when they walk: but this is prevented by their holding up their

heads

heads and necks, fo as to make the centre of gravity fall upon the feet; and when they have occafion for climbing up a fteep place, they ftretch out their heads and necks forward, efpecially if they are fhort legged, the better to preferve properly the balance of the body. Thus we may obferve a goofe entering a barn-door, where generally there is an afcending ftep, to ftretch out its neck, which before was raifed, and incline its body forwards. This is laughed at by the common people, who afcribe it to a piece of folly in the goofe, as if afraid of knocking its head againft the top of the door.

Carnivorous animals are provided with ftrong crooked claws for catching their prey: water-fowls ufe them for fwimming; and, principally for this purpofe, have a ftrong firm membrane interpofed between the toes. There is a beautiful mechanifm to be obferved in the toes of fowls, which is of confiderable ufe to them. For their toes are naturally drawn together, or bent, when the foot is bent: this is owing to the fhortnefs of the tendons of the toes, that pafs over them, which is analogous to our heel: and that the toes are fet in the circumference of a circle, as our fingers are: Hence, when the foot is bent, the tendons muft confequently be much ftretched; and, fince they are inferted into the toes, muft of neceffity bend them when the foot is bent; and when the foot is extended, the flexors of the toes are again relaxed, and the toes therefore expanded. This is alfo of great ufe to different kinds of fowls: thus the hawk defcending with his legs and feet extended, fpreads his talons over his prey: and the weight of his body bending his feet, the toes are contracted, and the prey is feized by the talons. This is alfo of great ufe to water fowls: for had there been no fuch contrivance as this, they muft have loft as much way when they pulled their legs in, as they had gained by the former ftroke; but, as the parts are now framed, whenever the creature draws in its foot, the toes are at the fame time bent and contracted into lefs fpace, fo that the refiftance made againft the water is not near fo great as before: on the contrary, when they ftretch their foot, their toes are extended, the membrane between them expanded, and confequently a greater refiftance made to the water. Again, fuch fowls as live moftly in the air, or have occafion to fuftain themfelves on branches of trees in windy weather, and even in the night-time when afleep, while all their mufcles are fuppofed to be in a ftate of relaxation; fuch, I fay, have no more to do but lean down the weight of their bodies, and their toes continue bent without any mufcles being in action; and whenever they would difentangle themfelves, they raife up their bodies, by which their foot, and confequently their toes, are extended.

The roftrum, bill, or beak of fowls, is compofed of two mandibulæ, and, as in quadrupeds, the upper one has no motion but what it poffeffes in common with the head. But parrots are an exception to this rule; for they can move the upper mandible at pleafure: this is exceedingly convenient, as it enables them to lay hold of whatever comes in their way. Carnivorous fowls have their beaks long, fharp, and crooked; domeftic fowls, fuch as the hen kind, &c. have ftrong fhort beaks, commodioufly fitted to dig up and break their food; the water-fowls, again, have long, or very broad fcoop-like beaks, which is moft convenient for them. The fternum of fowls is much larger proportionally than the human, and has a ridge rifing in its middle for the more commodious origin of the mufcles that move the wings. It is alfo lefs moveable than ours; for had it been very moveable, a great deal of the force employed for moving the wings would at every contraction of the mufcles have been loft, or elfe fome other mufcles muft have come in play to keep the fternum firm; but this additional weight would have been inconvenient for their progreffion.

What

What other things are moſt remarkable in the ſtructure of the ſeveral viſcera, we ſhall conſider in that common domeſtic animal the cock or hen; and afterwards obſerve the difference of their viſcera chylopoietica from a carnivorous fowl.

## The ANATOMY of a COCK.

THOUGH this kind of birds lives upon food ſomewhat ſimilar to that of man, yet as they have no teeth to ſeparate or break down this food, we would expect to find ſomething to compenſate the want of teeth, ſomething remarkable in the organs of digeſtion: we ſhall therefore begin with theſe parts.

The *œſophagus* of this creature runs down its neck, ſomewhat inclined to the right ſide; and terminates in a large membranous ſac, which is the ingluvies or crop, where the food is macerated and diſſolved by a liquor ſeparated by the glands, which are eaſily obſerved every where on the internal ſurface of this bag. The effect of this maceration may be very well obſerved in pigeons, who are ſometimes in danger of being ſuffocated by the peaſe, &c. they feed upon, ſwelling to ſuch an immenſe bulk in their ingluvies, that they can neither get upwards nor downwards. If it be a favourite fowl, it might be preſerved by opening the ſac, taking out the peaſe, and ſewing up the wound.

The food getting out of this ſac, goes down by the remaining part of the œſophagus into the *ventriculus ſuccenturiatus*, or *infundibulum Peyeri*, which ſeems to be a continuation of the gullet: it has ſeveral glands, for ſeparating a liquor to dilute the food ſtill more before it comes into the true ſtomach or gizzard, *ventriculus calloſus*. The gizzard conſiſts of two very ſtrong muſcles covered externally with a tendinous aponeuroſis, and lined on the inſide by a very thick firm membrane, which we evidently diſcover to be a production of the

 cuticula.

cuticula. This might have been proved in some measure *a priori*, from observing, that this membrane, which in chicks is only a thin slight pellicle, by degrees turns thicker and stronger the more attrition it suffers: but there is no other animal-substance, so far as we know, which grows more hard and thick by being subjected to attrition, except the cuticula.—Hence may be drawn some kind of proof of what I have somtimes affirmed concerning the tunica villosa of the stomach and intestines in the human body, viz. that it was in part a continuation of the epidermis; nay, all the hollow parts of the body, even arteries, veins, &c. seem to be lined with a production of this membrane, or one analogous to it. The use of the internal coat of the stomach of fowls is to defend the more tender parts of that viscus from the hard grains and little stones these creatures swallow. The use of the gizzard is to compensate for the want of teeth; and it is well fitted for this purpose from the great strength it possesses.

The digestion of these animals is performed merely by attrition, as is evinced by many experiments; and it is further assisted by the hard bodies they swallow. We see them daily take down considerable numbers of the most solid little rugged flints they find; and these can serve for no other purpose than to help the trituration of their aliments*. After these pebbles, by becoming smooth, are unfit for this office, they are thrown up by the mouth. Hence fowls that are long confined, though ever

* Spalanzani has found, that pebbles are not at all necessary to the trituration of the food of these animals. He does not, however deny, that when put in motion by the gastric muscles, they are capable of producing some effect on the contents of the stomach; but is inclined to believe, that they are not sought for and selected by design, as many suppose, but because they frequently happen to be mixed with the food. See Dissertations relative to the natural history of animals and vegetables.

ever fo well fed, turn lean for want of thefe ftones to help their digeftion. But this was put beyond all difpute by Mr Tauvry, who gave a piece of metal to an oftrich, convex on one fide, and concave on the other, but carved on both; and opening the creature's body fome time after, it was found, that the carving on the convex fide was all obliterated, while the engraved character remained the fame as before on the concave fide, which was not fubjected to the ftomach's preffure: this circumftance could not have happened had digeftion been performed by a menftruum, or any other way whatfoever; but may be eafily folved by allowing a fimple mechanicle preffure to take place. We are, however, by no means to conclude from this, as fome have too rafhly done, that in the human body digeftion is performed by fimple attrition; otherwife we may, with equal ftrength of reafon, by as good arguments drawn from what is obferved in fifhes, prove that the aliments are diffolved in our ftomachs by the action of a menftruum. But this method of reafoning is very faulty; nor can it ever bring us to the true folution of any philofophical or medical problem. It is very plain, fince the ftructure of the parts of the human ftomach are fo very different from that of this creature, that it is foolifh and unreafonable to imagine both of them capable of producing the fame effects. At each end of the ftomach, there are as it were two particular facs of a different texture from the reft of the ftomach, not confifting of ftrong mufcular fibres; they feem to be receptacles for the ftones, (efpecially at the end which is fartheft from the orifice), while the digefted aliment is protruded into the inteftines.

The *duodenum* begins near the fame place at which the œfophagus enters; yet notwithftanding the vicinity of thefe two tubes, the aliments are in no danger of getting out before they are perfectly digefted, by reafon of a protuberance, or *feptum medium*, between the orifices; and in thofe creatures

who

who have ſuch a ſtrong muſcular ſtomach, it is a matter of great indifference whether the entry of the œſophagus or pylorus be higheſt, provided that the entry from the œſophagus does not allow the food to regurgitate, ſince the force of the ſtomach can eaſily protrude it towards the duodenum. This gut is moſtly in the right ſide, and hangs pendulous in their abdomen, having its two extremities fixed to the liver. The *ductus choledochus* enters near its termination, where it mounts up again to be fixed to the liver; and leſt, by the contraction of the inteſtines, the bile ſhould paſs over without being intimately blended with the chyle, that duct enters downwards, contrary to the courſe of the food, and contrary to what is obſerved in any of the animals we have yet mentioned. But ſtill the general intention is kept in view, in allowing theſe juices the faireſt chance of being intimately blended with the food.

The *ſmallguts* are proportionally longer than thoſe of carnivorous birds, for the general cauſe already aſſigned. At the end of the ilium they have two large *inteſtina cæca*, one on each ſide, four or five inches long, coming off from the ſide of the rectum, and aſcending; and we find them containing part of the food: Theſe ſerve as reſervoirs to the fæces; which, after ſome remora, there regurgitate into what ſoon becomes the rectum; which, together with the excretories of urine and organs of generation, empties itſelf into the common cloaca. The ſmall inteſtines are connected by a long looſe meſentery, which has little or no fat accompanying the blood veſſels, there being no hazard of the blood's being ſtopped. The *pancreas* in the creature lies between the two folds of the duodenum, and ſends two or three ducts into this gut near the biliary duct.

The *ſpleen* is here of a round globular figure, ſituated between the liver and ſtomach; and between theſe and the backbone it enjoys the ſame properties as in other animals, viz.

large

large blood-veffels, &c. All its blood is fent into the *vena portarum*, and has a perpetual conquaffation. It has no excretory, as far as we know. Their *liver* is divided into two equal lobes by a pellucid membrane, running according to the length of their body: and hence we may obferve, that it is not proper to that bowel to lie on the right fide; which is ftill more confirmed by what we obferve in fifhes, where the greateft part of it lies in the left fide.

The fhape of their *gall-bladder* is not much different from that of quadrupeds; but is thought to be longer in proportion to the fize of the animal, and is farther removed from the liver.

The principal difference to be remarked in the *heart*, is the want of the *valvulæ tricufpides*, and their place being fupplied by one flefhy flap.

The *lungs* are not loofe within the cavity of the thorax, but fixed to the bone all the way; neither are they divided into lobes, as in thofe animals that have a large motion in their fpine. They are two red fpongy bodies, covered with a membrane that is pervious, and which communicates with the large veficles or air-bags that are difperfed over their whole abdomen; which veficles ferve two very confiderable ufes. The one is to render their bodies fpecifically light, when they have a mind to afcend and buoy themfelves up when flying, by diftending their lungs with air, and alfo ftraiten their *trachea arteria*, and fo retain the air. Secondly, they fupply the place of a mufcular *diaphragm* and ftrong abdominal mufcles; producing the fame effects on the feveral contained vifcera, as thefe mufcles would have done, without the inconveniency of their additional weight; and conducing as much to the exclufion of the egg and fæces.

When we examine the upper end of the *trachea*, we obferve a *rima glottidis* with mufcular fides, which may act in preventing the food or drink from paffing into the lungs; for there is no *epiglottis*, as in man and quadrupeds.

The

The *trachea arteria*, near where it divides, is very much contracted; and their voice is principally owing to this coarctation. If you liften attentively to a cock crowing, you will be fenfible that the noife does not proceed from the throat, but deeper; nay, this very pipe, when taken out of the body, and cut off a little after its divifion, and blown into, will make a fqueaking noife, fomething like the voice of thefe creatures. On each fide, a little higher than this contraction, there is a mufcle arifing from their fternum, which dilates the trachea. The cartilages, of which the pipe is compofed in this animal, go quite round it; whereas in men and quadrupeds they are difcontinued for about one fourth on the back-part, and the intermediate fpace is filled up by a membrane. Neither is the trachea fo firmly attached to their vertebræ as in the other creatures we have examined. This ftructure we fhall find of great fervice to them, if we confider, that, had the fame ftructure obtained in them as in us, their breath would have been in hazard of being ftopped at every flexion or twifting in their neck, which they are frequently obliged to. This we may be fenfible of by bending our necks confiderably on one fide, upon which we fhall find a great ftraitnefs and difficulty of breathing; whereas their trachea is better fitted for following the flexions of the neck by its loofe connection to the vertebræ.

In place of a *mufcular diaphragm*, this creature has nothing but a thin membrane connected to the pericardium, which feparates the thorax and abdomen. But befides this, the whole abdomen and thorax are divided by a longitudinal membrane or *mediaftinum* connected to the lungs, pericardium, liver, ftomach, and to the fat lying over their ftomach and guts, which is analogous to an *omentum*, and fupplies its place.

The *lymphatic fyftem* in birds confifts, as in man, of lacteal and lymphatic veffels, with the thoracic duct.

The

The lacteals indeed, in the ſtricteſt ſenſe are the lymphatics of the inteſtines; and, like the other lymphatics, carry only a tranſparent lymph; and inſtead of one thoracic duct, there are two, which go to the jugular veins. In theſe circumſtances, it would ſeem that birds differ from the human ſubject, ſo far at leaſt as we may judge from the diſſection of a *gooſe*, the common ſubject of this inquiry, and from which the following deſcription is taken.

The lacteals run from the inteſtines upon the meſenteric veſſels: thoſe of the duodenum paſs by the ſide of the pancreas; afterward they get up the cæliac artery, of which the ſuperior meſenteric is a branch. Here they are joined by the lymphatics of the liver, and then they form a plexus which ſurrounds the cæliac artery. Here alſo they receive a lymphatic from the gizzard, and ſoon after another from the lower part of the œſophagus. At the root of the cæliac artery they are joined by the lymphatics from the glandulæ renales, and near the ſame part by the lacteals from the other ſmall inteſtines, which veſſels accompany the lower meſenteric artery; but, before they join thoſe from the duodenum, they receive from the rectum a lymphatic, which runs from the blood veſſels of that gut. Into this lymphatic ſome ſmall veſſels from the kidneys ſeem to enter at the root of the cæliac artery. The lymphatics of the lower extremities probably join thoſe from the inteſtines. At the root of the cæliac artery and contiguous part of the aorta, a net work is formed by the veſſels above deſcribed. From this net-work ariſe two thoracic ducts, of which one lies on each ſide of the ſpine, and runs obliquely over the lungs to the jugular vein, into the inſide of which it terminates, nearly oppoſite to the angle formed by the jugular and ſubclavian vein. The thoracic duct of the left ſide is joined by a large lymphatic, which runs upon the œſophagus. The thoracic ducts are joined by the lymphatics of the neck, and probably by thoſe of the wings where they open into the jugular veins. The lymphatics of the neck generally confist of two large branches, on each fide of the neck, accompanying the blood-veffels; and thefe two branches join near the lower part of the neck, and form a trunk which runs clofe to the jugular vein, and opens into a lymphatic gland; from the oppofite fide of this gland a lymphatic comes out, which ends in the jugular vein.

On the left fide, the whole of this lymphatic joins the thoracic duct of the fame fide: but, on the right fide, part of it goes into the infide of the jugular vein a little above the angle; whilft another joins the thoracic duct, and with that duct forms a common trunk, which opens into the infide of the jugular vein, a little below the angle which that vein makes with the fubclavian. This fyftem in birds differs moft from that of quadrupeds, in the chyle being tranfparent and colourlefs, and in there being no vifible lymphatic glands, neither in the courfe of the lacteals, nor in that of the lymphatics of the abdomen, nor near the thoracic ducts.

The *kidneys* lie in the hollow excavated in the fide of the back-bone, from which there is fent out a bluifh coloured canal running along by the fide of the *vas deferens*, and terminating directly into the common cloaca. This is the *ureter*, which opens by a peculiar aperture of its own, and not at the penis. Fowls having no *vefica urinaria*, fome authors thought that they never paffed any urine, but that it went to the nourifhment of the feathers: but this is falfe; for that whitifh fubftance covering their greenifh fæces, and which turns afterwards chalky, is their urine. Let us next confider the organs of generation of both fexes, and firft thofe of the male.

The *tefticles* are fituated one on each fide of the back-bone; and are proportionally very large to the creature's bulk. From thefe run out the *vafa feminiferæ*; at firft ftraight; but after they recede farther from the body of the tefticle they ac-

quire

quire an undulated or convoluted form, as the epididymis in man. Thefe convolutions partly fupply the want of *veficulæ feminales*: They terminate in the penis, of which the cock has two, one on each fide of the common cloaca pointing directly outwards. They open at a diftance from each other, and are very fmall and fhort; whence they have efcaped the notice of anatomifts, who have often denied their exiftence. In birds there is no proftate gland. This is what is chiefly remarkable in the organs of that male.

The *racemus vitellorum*, being analogous to the ovaria in the human fubject, are attached by a proper membrane to the back-bone. This is very fine and thin, and continued down to the uterus. Its orifice is averfe with refpect to the ovaria; yet notwithftanding, by the force of the *orgafmus venereus*, it turns round and grafps the *vitellus*, which in its paffage through this duct called the *infundibulum*, receives a thick gelatinous liquor fecreted by certain glands. This, with what it receives in the uterus, compofes the white of the egg. By this tube then it is carried into the uterus. The fhell is lined with a membrane; and in the large end there is a bag full of air, from which there is no outlet.

The *uterus* is a large bag, placed at the end of the *infundibulum*, full of wrinkles on its infide; here the egg is completed, receiving its laft involucrum, and is at laft pufhed out at an opening on the fide of the common cloaca. From the teftes in the male being fo very large in proportion to the body of the creature, there muft neceffarily be a great quantity of femen fecerned; hence the animal is falacious, and becomes capable of impregnating many females. The want of the *veficule feminales* is in fome meafure fupplied by the convolutions of the *vafa deferentia*, and by the fmall diftance between the fecerning and excretory organs. The two *penes* contribute alfo very much to their fhort coition; at which time the opening of the

 uterus

uterus into the cloaca is very much dilated, that the effect of the femen on the vitelli may be greater.

A hen will of herfelf indeed lay eggs; but thefe are not impregnated, and yet they appear entirely complete.

I come now to confider the nutrition of the fœtufes of oviparous animals, and fhall give a fhort hiftory of an egg, and of the changes brought on it by incubation. To fave the perpetual repetition of my being affured of the truth of each fact by repeated obfervations, I have to obferve once for all, that unlefs where I exprefsly confefs I had no opportunity, or neglected to examine them, I confider myfelf obliged to give ocular demonftration of what I affert.

1. The fhell of an egg becomes more brittle by being expofed to a dry heat.

2. The fhell is lined every where with a very thin, but fomewhat tough, membrane; which, dividing at or very near to the obtufe end of the egg, forms a fmall bag, where air only is contained.

3. In a new-laid egg, this folliculus appears very little, but becomes larger when the egg is kept.

4. The albumen, or white of an egg, is contained in concentrical membranes, but is not all of the fame confiftence; for the exterior part of it is thin, and diffufes itfelf almoft like water when the membranes are broken; whereas its anterior part is more vifcous.

5. The white of an egg can make its way through the fhell, as appears from its wafting by keeping, efpecially if expofed to gentle heat.

6. The globular vitellus or yolk would feem to be no other than a liquor inclofed in a membrane; becaufe, whenever the membrane is broke, it runs all out; and is fpecifically heavier than the white.

7. The chalazæ are two white fpongy bodies, rifing very fmall from the oppofite fides of the membrane of the yolk, but gradually

gradually become larger as they are ſtretched out from it in an oblique direction with regard to the two ends of the egg.

8. If we compare the chalazæ to the extremities of an axis paſſing through the ſpherical vitellus, this ſphere will be compoſed of two unequal portions, its axis not paſſing through its centre; conſequently, ſince it is heavier than the white, its ſmaller portion muſt always be uppermoſt in all poſitions of the egg.

9. The yellowiſh-white round ſpot, called *cicatricula*, is placed on the middle of the ſmaller portion of the yolk; and therefore muſt (by § 8.) always appear on the ſuperior part of the vitellus.

10. The cicatricula ſeems to be compoſed of ſeveral circles of different colours; and in a fecundated egg, contains the embryo or chick. See Malpighi *.

11. Eggs, whoſe obtuſe ends are all rubbed over with linſeed-oil, or ſuch other ſubſtances as block up ſmall pores, are as fit for bringing forth chickens, when incubated by a hen, as other egs are.

I did not make the experiment; but can give a voucher, whoſe ſcrupulous candour, with ſincere good wiſhes and endeavours for the improvement of phyſic in this place, numbers muſt be acquainted with: I mean my father; who beſmeared eighteen eggs in the manner mentioned; then having put a mark on them, he ſet them, with the like number of other eggs, under three hens, who brought out thirty-ſix chickens, not one egg of the whole number failing.

12. After incubation, the *folliculus aeris* is gradually extended; till, near the time of the excluſion of the chick, it occupies, as near as I could judge, more than a third of the cavity of the ſhell.

13. The

* De Ovo Incubat.

13. The extended folliculus does not collapſe, upon being expoſed to the preſſure of the atmoſphere, after incubated eggs are opened *.

14. By incubation the albumen becomes thinner and more turbid, eſpecially on its upper part near the air-bag, where it is alſo firſt conſumed : and it is afterwards diminiſhed towards the ſharp end of the egg, till at laſt nothing of it is left except a white cretaceous ſubſtance at the lower part of the ſhell.

15. As the part of the white neareſt to the cicatricula is waſted, its membrane and the cicatricula ſtill approach nearer, till they become contiguous. This membrane of the albumen is what is commonly called the *chorion.*

16. Some time before the albumen is quite conſumed, what remains of it is placed at the lower part of the egg; and therefore the yolk is interpoſed between it and the membrane which immediately contains the fœtus. See § 9. and 10.

17. The white of a fecundated egg is as ſweet and free from corruption, during all the time of incubation, as it is in a new laid egg.

I taſted, ſmelled, and ſwallowed the whites of eggs during all the ſtates of incubation, both when they were raw and boiled, and conſtantly found as juſt now deſcribed; and therefore cannot imagine how Bellini † could affirm it to have a heavy, abominably ungrateful taſte, a ſtinking ſmell, and not only to occaſion, when ſwallowed, a troubleſome ſenſation in the ſtomach

* It is ſomewhat out of my ſphere to inquire how this additional air gets into the folliculus : but if any are curious enough to make this inquiry, I would recommend to them to obſerve how this folliculus diſtends and keeps ſtretched in an exhauſted receiver of an air-pump; to exhauſt the air gradually out of the ſhell, while it ſtands expoſed to the atmoſphere, both while the folliculus is entire, and after it is broke, obſerving always the riſing or falling of the mercurial gage; to conſider § 11. and 13.; and to conſult Bellini de Mot. Cord. prop. ix. and Hale's Staticks.

† De Motu Cord. prop. vi.

mach and guts, but to prove purgative. He muft unluckily have examined none but fubventaneous eggs: which is further confirmed by defcription of the fmall particles in the colliquated albumen, that reflect light fo ftrongly as the eye cannot bear it; which I faw in fome fubventaneous eggs, but could not obferve in any that were impregnated.

18. According to Bellini †, the colliquated white always becomes incapable of coagulation by heat; but in the trials I made, it frequently did coagulate, though I found the fuccefs of this experiment very uncertain: the only general rule I could fix was, that, before the 9th or 10th day of incubation, the thinner white did not coagulate; but after that, it frequently did.

19. Very foon after incubation, the volume of the yolk appears encreafed: and, by its rifing then nearer to the upper part of the egg, we may conclude that its fpecific weight decreafes.

20. The yolk becomes pale and more fluid for fome time, efpecially on the fide next to the chick, where its bulk alfo fooneft increafes; but afterwards the membranes of the yolk turn firmer and ftronger, and the liquor in them is lefs in quantity, and becomes more vifcous.

21. As the chick increafes, the yolk is depreffed in the middle; and is foon brought into a form fomething like to a horfefhoe, in the middle of which the chick is lodged.

22. The yolk remains frefh and uncorrupted all the time of incubation, and is always coagulable.

23. Not long before the exclufion of the chick, the whole yolk is taken into its abdomen.

24. The whole albumen and vitellus are not confumed by the chick: for fome part of the humours of the egg efcapes through the fhell, and is not fupplied by any thing from without; as evidently appears by an egg's becoming fo much fpecifically

† Ibid.

cifically lighter, as to ſwim in water after incubation, though it ſunk in it when recent.

25. The chalazæ remain long without being conſiderably changed, unleſs that they are brought nearer to each other by the creſcent form of the yolk; at laſt they degenerate into a dry chalky ſubſtance.

26. The cicatricula very ſoon is enlarged by incubation; and, being buoyed up on the top of the yolk to the ſuperior part of the egg, it is placed very near to the air-bag; and when both increaſe, they become contiguous.

27. The cicatricula is called *amnios*, when it becomes large, and contains the colliquamentum or liquor in which the chick is immerſed.

28. The quantity of the colliquamentum gradually increaſes till the 15th or 16th day of incubation; on the 18th, it is all conſumed; and, in the three following days, ſcarce any moiſture can be obſerved on the internal ſurface of the amnios.

29. The liquor of the amnios is more clear and tranſparent than the colliquated white; its taſte is more ſalt, and it has no obſervable ſmell. Its conſiſtence is at firſt a little viſcous, then it becomes more fluid, and afterwards turns a little ropy again. I can ſay nothing of the particular times when it does or does not coagulate by heat: for it is in ſo ſmall quantity during the greater part of the time of incubation, that one can ſcarce gather as much in a ſpoon as is fit to make any experiment with: and when all the egg is boiled hard, it adheres ſo cloſely to the white, that it is ſcarce poſſible to diſtinguiſh the one from the other. Malpighius *, ſpeaking of the egg between the 14th and 19th day, ſays, "That this thin diaphanous liquor of the amnios was ſometimes forced, by boiling, into a white taſty ſubſtance;" which my trials alſo confirmed.

The

* De Ovo Incubato.

30. The allantois and its contained urine are to be ſeen in an egg, as well as in the ſecundines of viviparous animals †.

31 Though the heart is among the firſt parts of the chick that can be diſtinguiſhed, yet the umbilical veſſels are ſeen much about the ſame time that the heart is obſerved.

I did not enquire into this fact; but have two very good vouchers for its truth, Harvey ‡ and Malpighius §.

32. The umbilical veſſels gradually diſperſe their branches upon the amnios, upon the vitellus, and upon the membranes of the albumen: The extremities of the much greater number being immerſed into the white, are extended proportionally as it is colliquated.

33. Near to the end of incubation, the umbilical veſſels begin to ſhrivel and decreaſe, till at the excluſion they are very ſmall.

34. The embryo is ſeen in an egg at firſt in the form of a ſmall worm: then its carina or ſpine, with the large prominences, that afterwards ſhew themſelves to be the brain and eyes, appear; the other bowels ſeem hanging from the ſpine; the chaſm of the mouth diſcovers itſelf; the extremities ſprout out; the viſcera are gradually covered with the integuments; and at laſt the beak, nails, and feathers are ſeen; after which all the parts become ſtronger and firmer, the proportional bulk of the head decreaſing.

For the particular times when all theſe changes are thus orderly brought about, conſult Fabricius ab Aquapendente, Harvey, and Malpighius.

35. After all the parts of the chick are formed, it is always found lying on the ſide, with its neck greatly bent forward, the head being covered with the upper wing, and the beak placed between the thighs.



† Malpig. Append. de Ovo Incub. tab. vii.

‡ De Generat. Animal. exercit. 16. and 17.

§ De Ovo Incubato.

36. When the ſhell is opened after the chick is large and ſtrong, it may be ſeen to bounce and ſpurn, ſometimes opening its mouth wide, eſpecially if it is ſtirred or pricked.

37. The mouth, œſophagus, and ingluvies, are always found moiſt; but never contain any quantity of liquor that can be collected or will run out in drops.

38. The bulbous glandular part of the œſophagus immediately above the ſtomach, or what Peyer * calls the *infundibulum*, and the ſtomach, are full of a liquor, in the youngeſt chick we can diſſect, and continue full the whole time of incubation; neither infundibulum nor ſtomach having yet got the tendinous firmneſs they have in adults; nor can we obſerve the dry pellicle which is ſo eaſily ſeparated from theſe parts in hens.

39. This liquor of the ſtomach is at firſt thin and more watery; afterwards it becomes curdy; and at laſt reſembles a greyiſh white mucus, unleſs that ſome part of it frequently is coloured yellow or green by a mixture of bile. It always coagulates, by boiling, into a firm yellowiſh white ſubſtance.

40. The quantity of fæces was not large in the great guts of any chickens I opened before excluſion.

41. A little time before the excluſion, the chick may frequently be heard making the ſame piping ſound that hatched chickens make. In three eggs, which were all I opened in this ſtate, the beak of the chick had perforated the membrane of the *folliculus aeris*.

42. The ſhell at the obtuſe end of the egg frequently appears cracked ſome time before the excluſion of the chick.

43. The chick is ſometimes obſerved to perforate the ſhell with its beak; but in thoſe I ſaw tumbling out of the ſhell, it was broke off irregularly, at the place where the membrane of the *folliculus aeris* was joined to it.

44. After the excluſion the yolk is gradually waſted, being conveyed into the ſmall guts by a ſmall duct, its membranes

* Comment. in Anat. Ventricul. Gaillin.

branes gradually contract themfelves, and the duct becomes fhorter. On the tenth day after exclufion, the vitellus was no larger than a fmall pin-head, and the duct was fcarce one-twentieth part of an inch long.

From this hiftory of the egg and of incubation, I fhall endeavour to deduce the manner in which the colliquated white is taken in by the chick.

Authors generally feem to agree, that the oviparous fœtus, while very young, receives its nourifhment by the navel; but feveral of the beft reputation have been of opinion, that afterwards it is conveyed by the mouth. I fhall examine the arguments they ufed in proof of this, and then fhall fubjoin fome negative reafons which they have not noticed.

Bellini* has defcribed the cicatricula, or *facculus amnii*, with the chalazæ firft formed in the back of the hen; to which, according to him, the vitellus is afterwards joined, and the white is acquired as they pafs down the oviduct. He fays the chalazæ are compofed of numerous canals, which open into the amnios, and fend out their roots into the cavity of the yolk, and into the white. It is eafy to conceive what confequences may be drawn from this defcription, by thofe who affert the nourifhment to be carried by the mouth, viz. That here are direct paffages into the cavity where the chick is, which can take up the liquors no other way than by the mouth.

The anfwer to this obfervation is the fame as has been made to the other facts already quoted from this author. I deny that the *facculus amnii* is formed before the vitellus; on the contrary, the vitellus is evidently to be feen before the cicatricula or chalazæ can be difcerned. Next, I deny the chalazæ (if they are canals) to have the leaft communication with the amnios, at any time, or in any ftate of the egg, otherwife than as they



* De Mot. Cord. prop. ix.

are both adhering to the membrane of the vitellus; upon which, or within which, no particular fibres, no canals, are ſtretched to the cicatricula. Every one has it in his power to examine theſe facts. If then the facts are denied, the conſequences cannot be admitted.

Since there are no canals paſſing through the yolk, that open into the *ſaccus colliquamenti*, and the cicatricula comes to be placed on the upper part of the yolk, and contiguous to the air-bag (§ 26.), it is evident, that the *liquor amnii* muſt be furniſhed by the chick, which being covered with feathers, having no mammæ, bladder of urine, or large ſalivary glands, can only ſupply it by the branches of the umbilical veſſels ſpread on the amnios.

Harvey * affirms, that a liquor is found in the mouth and ingluvies of the chick, which he concludes to be the colliquamentum or *liquor amnii*, from their reſemblance; from the quantity of the contents of the ſtomach; from the chick's being ſeen to open its mouth; and from the neceſſity creatures are in of ſwallowing, or of forcing back by vomiting, whatever is introduced to the root of their tongue.

As to the reſemblance, I do not ſee how the compariſon can be made, ſince the liquor in the mouth and crop is in ſuch a ſmall quantity, (§ 37.). But ſuppoſe that a ſufficient quantity was collected, the two liquors agreeing in ſeveral properties would not of itſelf be a ſufficient proof of their being the ſame; and if, for argument's ſake, the liquor in the crop was granted to be in a very large quantity, and to agree in every property with that in the amnios, it would certainly appear in the ſame form for ſome time in the ſtomach; whereas it is always found very different there in the larger fœtus (§ 39.); and Harvey confeſſes as much in this place: therefore it may be concluded, that it does not go down into the ſtomach.

If

* De Generat. Animal. exercit. 58.

If ever any thing like fæces has been ſeen in the crop of chickens, as has been alledged by ſome, it might be no more than the yellow or green-coloured ſubſtance brought up from the ſtomach, (§ 39.)

The quantity of the contents of the ſtomach and inteſtines may be accounted for from § 38, applied to what was ſaid on viviparous animals.

Though creatures that reſpire are under a neceſſity of either ſwallowing, or forcing back by vomiting, whatever is introduced beyond their fauces, I cannot think it ſhould be thence concluded that a fœtus is under the ſame neceſſity; for, as it does not exerciſe reſpiration, it will ſuffer no inconvenience by a liquor lodging near to the glottis; whereas creatures that breathe cannot allow any ſubſtance to remain there without danger of the glottis being ſtopped, or of ſuch ſubſtances falling down the trachea, either of which would be of bad conſequence; which the creature prevents, by forcing ſuch ſubſtances out of ſuch a dangerous ſituation.

But to enforce the negative of the colliquamentum paſſing by the mouth, obſerve, that there are only three days in which this paſſage can moſt probably be ſuppoſed to happen, which are from the 15th to the 18th day of incubation: for before the 15th, the quantity of the *liquor amnii* is encreaſing, which is no great ſign of its being ſwallowed; and after the 18th this liquor is not to be ſeen, (*vid.* § 28.) If, then, the *liquor amnii* were all ſwallowed between the 15th and 18th days, the ſtomach ought to be fuller at this time, and its contents ſhould be thinner, more pellucid, &c. like to the colliquamentum; which I am certain does not happen. Beſides, if we ſuppoſe the power of digeſtion, ſo ſtrong as to expel this liquor as faſt as it is taken down in theſe three days, it would certainly follow, that this powerful digeſtion continuing in the three ſucceeding days, while there is no liquor to be ſwallowed, the ſtomach ought to be quite emptied; which every one who

opens

opens the ftomachs of chickens at this time will fee it is not. And, laftly, as a more direct proof ftill againft Harvey, I broke the fhells of feveral incubated eggs, while the colliquamentum was in large quantity, and before the amnios was opened, I faw the chickens open their mouths very wide feveral times, but could not obferve the quantity of the liquor in which they lay at all leffened. I afterwards carefully diffected the chickens, and found no other than the common fmall quantity in the crops, and the ordinary curdy mucus in the ftomach; which feems to me a demonftration that they do not fwallow.

After fuch convincing proofs, it will be needlefs to make any application of the arguments in the former part of this effay to this fubject; and therefore I fhall only defire the reader to compare the pofture of a chick, and of a hen while fhe fwallows liquors, that they may fee the pofture of the chick's neck to be moft unfavourable to the fuppofition of deglutition being performed; and then fhall conclude with a very fhort hiftory of incubation, affigning what I imagine to be the moft probable reafons of the feveral appearances.

By the heat of the hen, or of ftoves equal to it, affifted poffibly by the action of the air contained in the *folliculus aeris* (§ 2. 3. 12.) the albumen becomes thinner, efpecially where it is moft expofed to thefe forces (§ 14.); and the vitellus in the fame manner becomes fpecifically lighter (§ 19.), and therefore readily rifes in the white. And as, by being divided into two unequal portions by its axis the chalazæ, it prefents the fmaller portion to the incubating heat at firft, (§ 8. 9.); fo the change in confequence of incubation being sooneft and moft produced here (§ 20), and the cicatricula being enlarged at the fame time, the fmaller portion of the yolk becomes much lighter; and therefore is buoyed up to the fuperior part of the egg; whereby the *folliculus aeris* and the membranes of the cicatricula become contiguous when they enlarge (§ 26.), and the vitellus can never be in hazard of com-

preffing

preffing the tender embryo; and the umbilical veffels are fituated fo as to have their extremities immerfed in the liquors that firft undergo the proper change, for being imbibed by their orifices, (§ 12.)—The incubation continuing, the white is ftill more and more colliquated, and the umbilical veffels are proportionally extended, the veins to abforb it, and the arteries to throw out any particles that are unfit for the chick till they are farther prepared, but efpecially to drive forward the liquors in the veins, as was explained in the account of the viviparous animals, (§ 20.)—When the white in the upper part of the egg is exhaufted, its membranes become contiguous to the amnios, (§ 15.); and thereby the membranes involving the fœtus, becomes fufficiently ftrong to refift the motions of the chick, when its eafe or fafety prompt it at any time to fpurn.—The powers of incubation above-mentioned, affifted by the pulfation and conquaffatory motions of the numerous umbilical veffels fpread on the yolk (§ 32.), diffolve that humour more, and render fome part of it fine enough to be taken up by the fmall extremities of the umbilical vein, fome of which penetrate its membrane: by which the liquor at laft becomes thicker (§ 20.); and the membrane, being in part emptied, will more eafily yield to the weight of the chick; and is preffed into the form of a horfe-fhoe (§ 21.), while the net-work of the veffels extended on this membrane renders it ftronger and firmer.—The *folliculus aeris* not only affifts in colliquating the albumen; but, when the humours of the egg come to occupy a lefs fpace, by efcaping through the fhell (§ 24.) and by being changed into the folid fubftance of the chick, the folliculus enlarging (§ 12.), keeps the chick and humour fteady, without danger of being difordered and broke, by the motions of the egg.——Branches of the umbilical veffels being diftributed to the amnios (§ 32.), the arteries will pour out their liquors into its cavity in greater quantity than the veins can take them up, as long as the fœtus is weak: but whenever the fœtus be-

comes

comes ſtronger, and conſequently the abſorbent power of the veins increaſes, they will take up the fluid of the amnios faſter than the arteries pour it in, and its quantity will be diminiſhed till it is quite exhauſted, (§ 28 and 29 )—This abſorption will go on more ſpeedily in proportion alſo to the umbilical veſſels being leſs diſtended with albumen, whereby there is leſs reſiſtance to the progreſſive motion of the abſorbed liquors; which probably is the reaſon of the colliquamentum being all taken up between the 15th and 18th days.—By the conſtant circulation and renewal of all theſe humours of the egg, they keep freſh and uncorrupted in a fecundated egg. (§ 17. and 22.); but corrupt ſoon in a ſubventaneous one, or in ſuch whoſe fœtus dies in the time of incubation.—Wherever veſſels are not ſufficiently filled, they contract themſelves; and therefore the albumen being exhauſted in the laſt days of incubation, the umbilical veſſels gradually ſhrivel (§ 33.), which prevents the danger of an hæmorrhage when the chick is ſeparated from its membranes. But as the white is not ſufficient at this time fully to ſupply the chick, the yolk is taken into its body (§ 23.); and being there preſſed, it is thrown gradually by the proper duct (§ 23. and 44.) into the guts to ſupply that defect.—The veſſels and glands which open into the alimentary tube ſeparate at leaſt as much liquor as will moiſten it; and the ſtomach, having no callous ſtrong cruſt on its internal ſurface (§ 38.), will ſeparate more than it can do in the adult; and in the mean time the glands of the infundibulum pour out a liquor that is always thicker as the chick increaſes, till it becomes a very thick white mucus: And therefore the contents of the ſtomach of the fœtus in the egg muſt have the appearance deſcribed (§ 39.), and will be ſlowly paſſing off into the inteſtines.—The ſhell at the obtuſe end of the egg becoming more brittle, by being ſo long expoſed to a dry heat (§ 1 ), and the membranes loſing their toughneſs when their moiſture is exhauſted, the chick very eaſily tears them, and breaks off that end of the ſhell,

ſhell, to make its way into the common atmoſphere.——The mother having no juices prepared within her body to give to the chick for food after it is hatched, and its organs for taking in and digeſting aliment being for ſome time too weak to ſupply it ſufficiently with nouriſhment, the vitellus is made to ſupply theſe deficiencies, till the chick is ſufficiently confirmed and ſtrong (§ 44. ); after which it is no longer the ſubject of my preſent inquiry.

After having obſerved the contents of the abdomen and thorax, we next proceed to examine the parts about the neck and head.

Theſe creatures, as was obſerved of fowls in general, have no teeth. Some, indeed, have an appearance of teeth; but theſe are only ſmall proceſſes or ſerræ riſing out from the mandible, without any ſocket, &c. which would have been needleſs, as they ſwallow their food entire. But their *tongue* is made ſomewhat firm, leſt it ſhould be hurt by the ſharp points of the grain on which they feed. It is of a triangular figure, and pointed before; and as by their depending poſture their meat is in hazard of falling out of their mouths, to prevent this, there are ſeveral ſmall pointed papillæ ſtanding out upon their tongue and palate, with their points inclined backwards, allowing an eaſy paſſage to the food, but hindering it to return.

We have here no *velum palatinum*, *uvula*, or *epiglottis*; and in place of two large holes opening into the noſe, there is only a long narrow rima furniſhed with ſtrong muſcles; and a ſimilar rima ſupplies the place of a glottis. The creature has a power of ſhutting both at pleaſure: the nature of their food ſeems not only to exempt them from the hazard of its getting into the noſe or trachea, but its ſharp points would hurt an uvula, or epiglottis. Hence we ſee with what difficulty they ſwallow dough or other ſort of food that can be eaſily moulded into any form. When we examine the upper end of the trachea, we obſerve a rima glottidis with muſcular ſides, which may act in preventing the food or drink from paſſing into the lungs, for there is no epiglottis, as in man and quadrupeds.

Their *cranium* is more cellular and cavernous than ours. By this means their heads are light, yet ſtrong enough to reſiſt external injuries; for the enlarging of the diameter of bones contributes to their ſtrength. By this cavernous cranium the organ of ſmelling is ſuppoſed to be conſiderably enlarged; and farther, ſinging birds, as is obſerved by Mr Ray and Mr Derham, have the cavernous ſtructure of the brain ſtill more obſervable: and we are told that the cavity of the tympanum communicates with the cells; but this, I am apt to believe, ſo far as I could find from diſſection, is rather founded on theory than matter of fact. Their brain is covered with the common membranes, but its external ſurface is not formed into ſo many gyræ or convolutions as ours. Its anterior part is quite ſolid, of a cineritious colour, and ſo far reſembles the *corpora ſtriata* as to give riſe to the olfactory nerves. The whole of it appears to us as imperfect, and we can ſcarcely determine whether there be any thing analogous to a third or fourth ventricle: neither the *corpus calloſum*, *fornix*, *nates*, or *teſtes*, &c. can be obſerved here; which parts therefore cannot be imagined as abſolutely neceſſary for the functions of life, ſince we find theſe creatures perform them ſufficiently well. We may perhaps think they ſerve a particular uſe in man, who is a rational creature; but then quadrupeds enjoy them in common with men. Theſe protuberances, &c. ſeem rather to depend on the different diſpoſition of the ſeveral parts, being variouſly connected and meeting in different directions in different places, than their being abſolutely neceſſary for any particular uſe; and the uſes that have been aſſigned to different parts of the brain by authors, ſeem to have no other foundation than the authors fancy. I have already owned my ignorance of the uſes of the particular parts of the brain, ſo I ſhall not pretend to give reaſons for their

their being different in different animals All animals ſeem to agree in this, that the cerebrum has always hollows and vacuities in it.

Their organ of *ſmelling* is very large, and well provided with nerves; hence they have this ſenſation very acute. Ravens and other birds of prey give a ſure proof of this, by their being able to find out their prey, though concealed from their ſight, and at a conſiderable diſtance.

Thoſe birds that grope for their food in the waters, mud, &c. have large nerves, which run quite to the end of their bills, by which they find out and diſtinguiſh their food.

The anterior part of their *eyes* (inſtead of having the ſclerotic coat contained, ſo as to make nearly a ſphere as in us,) turns all of a ſudden flat; ſo that here the ſclerotic makes but half a ſphere; and the cornea riſes up afterwards, being a portion of a very ſmall and diſtinct ſphere: ſo that in theſe creatures there is a much greater difference between the ſclerotic and cornua than in us. Hence their eyes do not jut out of their heads, as in man and quadrupeds. As moſt of theſe creatures are continually employed in hedges and thickets, that their eyes might be ſecured from theſe injuries, as well as from too much light when flying in the face of the ſun, there is therefore a very elegant mechaniſm in their eyes. A membrane riſes from the internal canthus, which at pleaſure, like a curtain, can be made to cover the whole eye; and this, by means of a proper muſcle that riſes from the ſclerotic coat, and paſſing round the optic nerves, runs through the *muſculus oculi attollens* (by which however the optic nerves are not compreſſed), and palpebra, to be inſerted into the edge of this membrane. Whenever this muſcle ceaſes to act, the membrane by its own elaſticity again diſcovers the eye. This covering is neither pellucid nor opaque, both which would have been equally inconvenient; but, being ſomewhat tranſparent, allows as many rays to enter as to make any object juſt viſible, and is ſufficient to direct them in their progreſſion. By means of this mem-

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brane it is that the eagle is ſaid to look at the ſun. Quadrupeds alſo, as we mentioned before, have a ſmall *membrana nictitans.*

Beſides, all fowls have another particularity, the uſe of which I think is not ſo well underſtood; and that is, a longiſh black triangular purſe, riſing from the bottom of their eye juſt at the entry of the optic nerve, and ſtretched out into their vitreous humour, and perhaps it gives ſome threads to the cryſtalline. To this the French (who, as far as I know, were the firſt who took notice of it in their diſſections before the Royal Academy) gave the name of *bourſe noire.* It may poſſibly ſerve to ſuffocate ſome of the rays of light, that they may ſee objects more diſtinctly without hurting their eyes. It has a connection with the vitreous, and ſeems to be joined alſo to the cryſtalline, humours. If we ſuppoſe it to have a power of contraction, (which may be as well allowed as that of the iris), it may ſo alter the poſition of the vitreous and cryſtalline humours, that the rays from any body may not fall perpendicularly upon the cryſtalline; and this ſeems to be neceſſary in them, ſince they cannot change the figure of the anterior part of their eye ſo much as we can do: and as this animal is expoſed often to too great a number of rays of light, ſo they have no tapetum, but have the bottom of their eye wholly black on the retina; and in conſequence of this, fowls ſee very ill in the dark.

They have no external ear; but in its place a tuft of very fine feathers covering the *meatus auditorius*, which eaſily allows the waves of ſound to paſs them, and likewiſe prevents duſt or any inſect from getting in. An external ear would have been inconvenient in their paſſage through thickets, and in flying, &c. A liquor is ſeparated in the external part of the ear, or *meatus auditorius*, to lubricate the paſſage, and farther prevent the entrance of any inſects, &c. The *membrana tympani* is convex externally; and no muſcles are fixed to the bones of their ear, which are rather of a cartilaginous conſiſt-

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ence: Any tremulous motions impreſſed on the air are communicated in theſe creatures merely by the ſpring and elaſticity of theſe bones; ſo, probably, the membrane is not ſo ſtretched as in the human ear by muſcles. The ſemicircular canals are very diſtinct, and eaſily prepared.

## The ANATOMY of a CARNIVOROUS BIRD.

WE come next to birds of prey, and for an example ſhall take a ſtannel or ſmall hawk. The principal difference to be obſerved in them, is in their chylopoietic viſcera, which may be accounted for from their different way of life.

Immediately under their clavicles, you will obſerve the œſophagus expanded into their *ingluvies*, which is proportionally leſs than in the granivorous kind, ſince their food does not ſwell ſo much by maceration: and for the ſame reaſon, there is a leſs quantity of menſtruum to be found here.

They have alſo a *ventriculus ſuccenturiatus*, plentifully ſtored with glands, ſituated immediately above their ſtomach, which we ſee here is thin and muſculo-membranous, otherwiſe than in the granivorous kind: and this difference, which is almoſt the only one we ſhall find between the two different ſpecies of fowls, is eaſily accounted for from the nature of their food, which requires leſs attrition, being eaſier of digeſtion than that of the other kind; nevertheleſs, it ſeems requiſite it ſhould be ſtronger than the human, to compenſate the want of abdominal muſcles, which are here very thin.

The ſame mechaniſm obtains in this creature's *duodenum*, that we have hitherto obſerved. As being a carnivorous animal, its guts are proportionally ſhorter than thoſe of the granivorous kind: for the reaſon firſt given, viz. its food being more liable to corrupt, therefore not proper to be long detained in the body; and for that reaſon it has no *inteſtina cæca*, of which the other fowls have a pair. The difference in their wings, beaks,

beaks, and claws, are obvious; and have been already in ſome meaſure obſerved.

## The ANATOMY of AQUEOUS ANIMALS.

### I. AMPHIBIOUS.

AQUEOUS animals are generally divided into ſuch as have lungs, and ſuch as want them. The firſt ſpecies differ ſo inconſiderably from an ox or any other quadruped, that a few obſervations may be ſufficient to give an idea of their internal ſtructure; for this purpoſe, we ſhall firſt examine that ſpecies of them which moſt reſembles man in the internal ſtructure, the tortoiſe.

TORTOISE. The covering of this animal is compoſed of a ſhell ſo remarkably hard and firm in its texture, that a loaded waggon may go over it, without hurting the ſhell or the animal within it. In the young animal, this ſhell grows harder in proportion as its contents expand; and this creature never changes its ſhell, as ſome others do: hence it was neceſſary for it to be compoſed of different pieces; and theſe are more or leſs diſtinct in different animals. Its feet are ſmall and weak; and are exceedingly ſlow in motion.

It has neither tongue nor teeth; to make up for which, its lips are ſo hard as to be able to break almoſt the hardeſt bodies.

The alimentary canal very much reſembles that of the former claſs.

The principal difference is in the circulation of the blood. The heart has two diſtinct auricles, without any communication: and under theſe, there is the appearance of two ventricles, ſimilar in ſhape to thoſe of the former claſs: but they may be conſidered as one cavity; for the ventricle ſends out not only the pulmonary artery, but likewiſe the aorta; for there is a paſſage in the

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ſeptum, by which the ventricles communicate freely, and the blood paſſes from the left into the right one From the aorta the blood returns into the right auricle, while that from the pulmonary artery returns to the left auricle, from which it is ſent to the left ventricle, &c ſo that only a part of the blood is ſent to the lungs, the reſt going immediately into the aorta; hence the animal is not under the neceſſity of breathing ſo often as otherwiſe it would be.

*Blood-veſſels* From the baſe of the right ventricle goes out the pulmonary artery and aorta. The pulmonary artery is ſpent upon the lungs. The aortæ may be ſaid to be three in number: for the aorta ſiniſtra aſcends through the pericardium in company with the pulmonary artery; and afterwards turns down, and ſends off a conſiderable branch, which ſplits into two; one of which joins the right aorta, while the other is diſtributed upon the liver, ſtomach, inteſtines, &c. What remains of this aorta runs to the kidneys and poſterior extremities of that ſide An aorta-deſcendens, &c. after piercing the pericardium, runs down and communicates with the branch already mentioned, is diſtributed upon the right kidney and inferior extremity, and alſo upon the bladder and parts of generation. An aorta aſcendens, after getting out of the pericardium, ſupplies the fore legs, neck, and head. The blood of the ſuperior part of the body returns to the right auricle by two jugular veins, which unite after perforating the pericardium. From the inferior part, it returns to the ſame auricle by two large veins; one on the right ſide receives the blood from the right lobe of the liver; the other on the left ſide receives the blood from the left lobe, and alſo a trunk which correſponds with the inferior vena cava in other animals. The pulmonary veſſels run in the left auricle in the common way.

*Abſorbents.* The abſorbent ſyſtem in the turtle, like that in the former claſs, conſiſts of lacteals and lymphatics, with their common trunks the thoracic ducts; but differs from it in having

ving no obvious lymphatic glands on any parts of its body, nor plexus formed at the termination in the red veins.

The *lacteals* accompany the blood-veſſels upon the meſentery, and form frequent net works acroſs theſe veſſels: near the root of the meſentery a plexus is formed, which communicates with the lymphatics coming from the kidneys and parts near the anus. At the root of the meſentery on the left ſide of the ſpine, the lymphatics of the ſpleen join the lacteals; and immediately above this a plexus is formed, which lies upon the right aorta. From this plexus a large branch ariſes, which paſſes behind the right aorta to the left ſide, and gets before the left aorta, where it aſſiſts in forming a very large receptaculum, which lies upon that artery.

From this receptaculum ariſe the thoracic ducts. From its right ſide goes one trunk, which is joined by that large branch that came from the plexus to the left ſide of the right aorta, and then paſſes over the ſpine. This trunk is the thoracic duct of the right ſide; for having got to the right ſide of the ſpine, it runs upwards on the inſide of the right aorta, towards the right ſubclavian vein; and when it has advanced a little above the lungs, it divides into branches, which near the ſame place are joined by a large branch, that comes up on the outſide of the aorta. From this part upwards, thoſe veſſels divide and ſubdivide, and are afterwards joined by the lymphatics of the neck, which likewiſe form branches before they join thoſe from below. So that between the thoracic duct and the lymphatics of the ſame ſide of the neck, a very intricate net-work is formed; from which a branch goes into the angle between the jugular vein and the lower part or trunk of the ſubclavian. This branch lies therefore on the inſide of the jugular vein, whilſt another gets to the outſide of it, and ſeems to terminate in it, a little above the angle between that vein and the ſubclavian.

Into

Into the above-mentioned receptaculum the lymphatics of the ſtomach and duodenum likewiſe enter. Thoſe of the duodenum run by the ſide of the pancreas, and probably receive lymphatics from it, and a part of thoſe of the liver. The lymphatics of the ſtomach and duodenum have very numerous anaſtomoſes, and form a beautiful net-work on the artery, which they accompany. From this receptaculum likewiſe (beſides the trunk already mentioned, which goes to the right ſide) two other trunks, nearly equal in ſize, ariſe; one of which runs upon the left ſide, and the other upon the right ſide of the left aorta, till they come within two or three inches of the left ſubclavian vein: where they join behind the aorta, and form a number of branches which are afterwards joined by the lymphatics of the left ſide of the neck; ſo that a plexus is here formed as well as upon the right ſide. From this plexus a branch iſſues, which opens into the angle between the jugular and ſubclavian vein.

SERPENT AND CROCODILE. The circulation in theſe is ſimilar to that of the turtle; but we find only one ventricle. The blood goes from the right auricle to the ventricle which ſends out the pulmonary artery and aorta; the blood from the pulmonary artery returns to the left auricle, that from the aorta going to the right auricle, and both the auricles opening into the ventricle.

FROG AND LIZARD. Theſe differ from the former animals, in having only one auricle and ventricle: and beſides, the ventricle ſends out a ſingle artery, which afterwards ſplits into two parts; one to ſupply the lungs, the other runs to all the reſt of the body: from the lungs and from the other parts the blood returns into the auricle.



II. FISHES.

## II. FISHES.

OF thefe we may firft obferve, that they have a very ftrong thick *cuticle*, covered with a great number of fcales, laid one on another like tiles on houfes. This among other arguments is fuppofed to prove the human epidermis to be of a fquamous ftructure; but the fcales refemble the hairs, wool, feathers, &c. of the creatures that live in air; and below thefe we obferve the proper *cuticula* and *cutis*.

The generality of fifhes, particularly thofe fhaped like the cod, haddock, &c. have a line running on each fide. Thefe lines open externally by a number of ducts, which throw out a mucous or flimy fubftance, that keeps the fkin foft and clammy, and feems to ferve the fame purpofe with the mucous glands or ducts which are placed within many of our internal organs.

In the next place, thefe creatures have neither fuperior nor inferior extremities, as quadrupeds and fowls; for their progreffion is performed in a different way from either of thofe fpecies of animals: for this purpofe they are provided with machines, properly confifting of a great number of elaftic beams, connected to one another by firm membranes, and with a tail of the fame texture; their fpine is very moveable towards the pofterior part, and the ftrongeft mufcles of their bodies are inferted there. Their tails are fo framed as to contract to a narrow fpace when drawn together to either fide, and to expand again when drawn to a ftraight line with their bodies; fo, by the affiftance of this broad tail, and the fins on their fides, they make their progreffion much in the fame way as a boat with oars on its fides and rudder at its ftern. The perpendicular fins fituated on the fuperior part of their body, keep them in *æquilibrio*, hindering the belly from turning uppermoft: which it would readily do, becaufe of the air-bag in the abdomen rendering their belly fpecifically lighter than

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their back; but by the reſiſtance theſe fins meet with when inclined to either ſide, they are always kept with their backs uppermoſt.

The beſt account of this matter, we have in the treatiſe before mentioned, viz. *Borelli de Motu Animalium, cap.* 23.

It may be next obſerved, that theſe creatures have nothing that can be called a *neck*, ſince they ſeek their food in an horizontal way, and can move their bodies either upwards or downwards, as they have occaſion, by the contraction or dilatation of the air-bag; a long neck, as it would hinder their progreſſion, would be very diſadvantageous in the element they live in.

The *abdomen* is covered on the inferior part with a black-coloured thin membrane reſembling our peritoneum. It is divided from the thorax by a thin membranous partition, which has no muſcular appearance; ſo that we have now ſeen two different ſorts of animals that have no muſcular diaphragm.

Theſe creatures are not provided with *teeth* proper for breaking their aliment into ſmall morſels, as the food they uſe is generally ſmall fiſhes, or other animals that need no trituration in the mouth, but ſpontaneouſly and gradually diſſolve into a liquid chyle. Their teeth ſerve to graſp their prey, and hinder the creatures they have once catched from eſcaping again. For the ſame purpoſe, the internal cartilaginous baſis of the branchiæ, and the two round bodies ſituated in the poſterior part of the jaws, have a great number of tenter-hooks fixed into them, in ſuch a manner as that any thing can eaſily get down, but is hindered from getting back. The water that is neceſſarily taken along with their food in too great quantities to be received into their jaws in deglutition, paſſes between the interſtices of the branchiæ and the flap that covers them. The compreſſion of the water on the branchiæ is of conſiderable uſe to the animal, as we ſhall explain by and by.



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The *œſophagus* in theſe creatures is very ſhort, and ſcarcely diſtinguiſhed from their ſtomach; and their food lies almoſt equally in both. The ſtomach is of an oblong figure. There are commonly found ſmall fiſhes ſtill retaining their natural form in the ſtomach of large ones; but when touched, they melt down into a jelly. From this, and the great quantity of liquors poured into their ſtomachs, we may conclude, that digeſtion is ſolely brought about in them by the diſſolving power of a menſtruum, and that no trituration happens here.

The *guts* of theſe animals are very ſhort, making only three turns; the laſt of which ends in the common cloaca for the fæces, urine, and ſemen, ſituated about the middle of the inferior part of their bodies.

To that ſubſtance which I call *pancreas*, ſome give the name of *inteſtinula cæca*: it conſiſts of a very great number of ſmall threads, like ſo many little worms, which all terminate at laſt in two larger canals, that open into the firſt gut, and pour into it a viſcous liquor much about the place where the biliary ducts enter. That kind of pancreas formed of *inteſtinula cæca* is peculiar to a certain kind of fiſhes; for the cartilaginous, broad, and flat kind, as the ſkate, ſole, flounder, &c. have a pancreas reſembling that of the former claſs of animals. Their inteſtines are connected to the back-bone by a membrane analogous to a meſentery.

Their *liver* is very large, of a whitiſh colour, and lies almoſt wholly in the left ſide, and contains a great deal of fat or oil.

The *gall-bladder* is ſituated a conſiderable way from their liver; and ſends out a canal, the cyſtic duct, which joins with the hepatic duct juſt at the entry into the gut. Some fibres are ſtretched from the liver to the gall-bladder; but nobody that I know of has hitherto diſcovered any cavity in theſe cords: ſo in this animal it ſhould ſeem impoſſible that the bile can be carried into the gall-bladder in the ordinary way; and conſequently

quently it muſt either be ſecreted on the ſides of that ſac, or regurgitate into it from the canalis choledochus *.

The *ſpleen* is placed near the back-bone, and at a place where it is ſubject to an alternate preſſure from the conſtriction and dilatation of the air-bag, which is ſituated in the neighbourhood. Since, in all the different animals we have diſſected, we find the ſpleen attached to ſome part that may give it a conquaſſation; as in the human ſubject and quadrupeds, it is contiguous to the diaphragm; in fowls, it is placed between the back-bone, the liver, and ſtomach; in fiſhes, it lies on the ſaccus aerius: and ſince we find it ſo well ſerved with blood-veſſels, and all its blood returning into the liver; we muſt not conclude the ſpleen to be an *inutile pondus*, only to ſerve as a balance to the animal *pro æquilibrio*, but particularly deſigned for preparing the blood for the liver.

The only *organs* of *generation* in this animal are two bags ſituated in the abdomen uniting near the podex. Theſe in the male are filled with a whitiſh firm ſubſtance called the *milt*; and in the female with an infinite number of little ova cluſtered together, of a reddiſh yellow colour, called the *roe*. Both theſe at ſpawning-time we find very much diſtended; whereas at any other time the male organ can ſcarcely be diſtinguiſhed from the female; nor is there any proper inſtrument in the male for throwing the ſeed into the organ of the female, as in other creatures. I ſhall not take upon me to determine the way whereby the female ſperm is impregnated; but we find that the ſpawn of frogs conſiſts of ſmall ſpecks wrapped up in a whitiſh glutinous liquor; theſe ſpecks are the rudiments of the young frogs, which are nouriſhed in that liquor

* Here we may make the ſame remark as upon the biliary ducts of fowls, viz. that hepato-cyſtic ducts exiſt in the one as well as the other. This, for example, is very obvious in the ſalmon, where large and diſtinct ducts run from the biliary ducts of the liver, and open into the gall-bladder.

liquor till they are able to go in fearch of their food*. In the fame way, the ova of fifhes are thrown out and depofited in the fand, the male being for the moft part ready to impregnate them, and they are hatched by the heat of the fun. It is curious enough to remark with what care they feek for a proper place to depofite their ova, by fwimming to the fhallow, where they can better enjoy the fun's rays, and fhun the jaws of other large fifhes. The river-fifhes, again, fpawn in fome creek free from the hazard of the impetuous ftream But whether this mixture be brought about in fifhes by a fimple application of the genitals to each other, or if both of them throw out their liquors at the fame time in one place, and thus bring about the defired mixture, it is not eafy to determine; the latter, I think, feems moft probable. Thefe creatures are fo fhy that we cannot eafily obferve their manner of copulation, and we are confequently but little acquainted with their natural hiftory. Frogs, it is very evident, do not copulate; at leaft no farther than to allow both fexes an opportunity of throwing their fperm. Early in the fpring the male is found for feveral days in clofe contact upon the back of the female, with his fore-legs round her body in fuch a manner that makes it very difficult to feparate them, but there is no communication. At this time the female lays her fpawn in fome place that is moft fecure, while the male emits his fperm upon the female fpawn.

After raifing up the black peritoneum in fifhes, there comes in view an oblong white membranous bag, in which there is nothing

* Spallanzani has found, that the eggs of frogs, toads, and water newts, are not fecundated in the body of the female; that the male emits his femen upon the fpawn while it is flowing from the female; and that the fœtus pre-exifts in the body of the female: but whether impregnation takes place in the fame manner in fifhes, he has not yet been able to determine, though he feems to think it probable. See Differtations relative to the Natural Hiftory of Animals and Vegetables, Vol. II.

nothing contained but a quantity of elaftic air. This is the *fwimming bladder*: it lies clofe to the back-bone; and has a ftrong mufcular coat, whereby it can contract itfelf. By contracting this bag and condenfing the air within it, fifh can make their bodies fpecifically heavier than water, and fo readily fall to the bottom; whereas the mufcular fibres ceafing to act, the air is again dilated, and they become fpecifically lighter than water, and fo fwim above. According to the different degrees of contraction and dilatation of this bladder, they can keep higher or lower in the water at pleafure. Hence flounders, foles, raia or fkate, and fuch other fifhes as want this fac, are found always groveling at the bottom of the water: it is owing to this that dead fifh (unlefs this membrane has been previoufly broken) are found fwimming on the furface with their bellies uppermoft; for the back bone cannot yield, and the diftended fac is protruded into the abdomen, and the back is confequently heavieft at its upper part, according to their pofture. There is here placed a glandular fubftance, containing a quantity of red blood; and it is very probable that the air contained in the fwimming-bladder, is derived from this fubftance. From the anterior part of the bag go out two *proceffes* or *appendices*, which, according to the gentlemen of the French academy, terminate in their fauces: In a variety of other fifhes we find communications with fome parts of the alimentary canal, particularly the œfophagus and ftomach. The falmon has an opening from the fore-end of the air-bag into the œfophagus, which is furrounded by a kind of mufcular fibres. The herring has a funnel-like paffage leading from the bottom of the ftomach into the air-bag, but it is not determined whether the air enters the air-bag by this opening, or comes out by it: the latter, however, feems to be the more probable opinion, as the glandular body is found in all fifhes, whereas there are feveral without this paffage of communication. But in fome fifhes, as the cod and haddock, I never could

could find out this communication, either by tracing them, pouring in mercury or water, &c. I put, it is true, a probe through them : but then with the ſame ſtrength I could have put it through the ſides of the proceſſes.

At the ſuperior part of this bag there are other red-coloured bodies of a glandular nature, which are connected with the kidneys. From them the *ureters* go down to their inſertion in the *veſica urinaria*, which lies in the lower part of the abdomen ; and the urethra is there produced, which terminates in the podex.

Theſe laſt-mentioned parts have not hitherto been obſerved in ſome ſpecies of fiſh ; whence authors too haſtily denied them in all. Theſe creatures have a *membranous diaphragm*, that forms a ſac in which the heart is contained. It is very tenſe, and almoſt perpendicular to the vertebræ.

The *heart* is of a triangular form, with its baſe downwards and its apex uppermoſt ; which ſituation it has becauſe of the *branchiæ*. The heart has but one *auricle*, one *ventricle*, and one great artery. The ſize of the auricle and that of the ventricle are much the ſame ; the artery ſends out numerous branches to the branchiæ or gills. And what is rather curious, this artery, inſtead of ſupporting all parts as in the frog, is diſtributed entirely upon the gills, every branch terminating there, and becoming ſo extremely ſmall as at laſt to eſcape the naked eye.

The *branchiæ* lie in two large ſlits at each ſide of the head, and ſeem to be all that bears any analogy to lungs. Their form is ſemicircular ; they have a vaſt number of red fibrillæ ſtanding out on each ſide of them like a fringe, and very much reſemble the vane of a feather. Theſe branchiæ are perpetually ſubject to an alternate motion and preſſure from the water ; and we may here remark, that we have not found any red blood but in places ſubject to this alternate preſſure. This obſervation will help us in explaining the action

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of the lungs upon the blood. Over thefe gills there is a large flap allowing a communication externally; by which the water they are obliged to take into their mouths with their food finds an exit without paffing into their ftomach: it is owing to thefe flaps coming fo far down, that the heart is faid commonly to be fituated in their heads. The blood is collected again from the gills by a vaft number of fmall veins, fomewhat in the fame manner as in our pulmonary vein; but inftead of going back to the heart a fecond time, they immediately unite and form an aorta defcendens without the intervention of an auricle and ventricle. Hence a young anatomift may be puzzled to find out the power by which the blood is propelled from the gills to the different parts of the body; but the difficulty will be confiderably leffened when we confider the manner in which the blood is carried through the liver from the inteftines in man and quadrpueds. The aorta in fifhes fends off branches which fupply all the parts of the body excepting the gills. From the extremity of thofe branches the blood returns to the heart fomewhat in the fame manner as in the former clafs of animals; only there are two inferior venæ cavæ, whereas the former has but one.

*Abforbent fyftem in Fifhes.* We fhall take the Haddock as a general example: for the other fifhes, particularly thofe of the fame fhape, will be found in general to agree with it.

On the middle of the belly of a haddock, immediately below the outer fkin, a lymphatic veffel runs upwards from the anus, and receives branches from the parietes of the belly, and from the fin below the anus: near the head this lymphatic paffes between the two pectoral fins; and having got above them, it receives their lymphatics. It then goes under the fymphyfis of the two bones which form the thorax, where it opens into a net-work of very large lymphatics, which lie clofe to the pericardium, and almoft entirely furrounds the heart. This net-work, befides that part of it behind the heart, has a large lymphatic on each fide, which receives lymphatics from the kidney, runs upon the bone of the thorax backwards, and when it has got as far as the middle of that bone, it fends off a large branch from its infide to join the thoracic duct. After detaching this branch, it is joined by the lymphatics of the thoracic fins, and foon after by a lymphatic which runs upon the fide of the fifh. It is formed of branches, which give it a beautiful penniform appearance.

Befides thefe branches, there is another deeper fet which accompanies the ribs. After the large lymphatic has been joined by the above-mentioned veffels, it receives lymphatics from the gills, orbit, nofe, and mouth. A little below the orbit, another net-work appears, confifting in part of the veffels above defcribed, and of the thoracic duct. This net-work is very complete; fome of its veffels lie on each fide of the mufcles of the gills; and from its internal part, a trunk is fent out which terminates in the jugular vein.

The lacteals run on each fide of the mefenteric arteries, anaftomofing frequently acrofs thofe veffels. The receptaculum into which they enter is very large, in proportion to them; and confifts at its lower part of two branches, of which one lies between the duodenum and ftomach, and runs a little way upon the pancreas, receiving the lymphatics of the liver, pancreas, thofe of the lower part of the ftomach, and the lacteals from the greateft part of the fmall inteftines. The other branch of the receptaculum receives the lymphatics from the reft of the alimentary canal. The receptaculum formed by thefe two branches lies on the right fide of the upper part of the ftomach, and is joined by fome lymphatics in that part, and alfo by fome from the found and gall bladder, which in this fifh adheres to the receptaculum. This thoracic duct takes its rife from the receptaculum, and lies on the right fide of the œfophagus, receiving lymphatics from that part; and running up about half an inch, it divides into two ducts, one

of

of which paſſes over the œſophagus to the left ſide, and the other goes ſtraight upon the right ſide, paſſes by the upper part of the kidney, from which it receives ſome ſmall branches, and ſoon afterwards is joined by a branch from the large lymphatic that lies above the bone of the thorax, as formerly mentioned: near this part it likewiſe ſends off a branch to join the duct of the oppoſite ſide; and then, a little higher, is joined by thoſe large lymphatics from the upper part of the gills, and from the fauces.

The thoracic duct, after being joined by theſe veſſels, communicates with the net-work near the orbit, where its lymph is mixed with that of the lymphatics from the poſterior part of the gills, and from the ſuperior fins, belly, &c. and then from this net-work, a veſſel goes into the jugular vein juſt below the orbit. This laſt veſſel, which may be called the termination of the whole ſyſtem, is very ſmall in proportion to the net-work from which it riſes; and indeed the lymphatics of the part are ſo large, as to exceed by far the ſize of the ſanguiferous veſſels.

The thoracic duct having paſſed under the œſophagus from the right, runs on the inſide of the vena cava of the left ſide, receives a branch from its fellow of the oppoſite ſide, and joins the large lymphatics which lie on the left ſide of the pericardium, and a part of thoſe which lie behind the heart; and afterwards makes, together with the lymphatics from the gills, upper fins, and ſide of the fiſh, a net-work, from which a veſſel paſſes into the jugular vein of this ſide. In a word, the lymphatics of the left ſide agree exactly with thoſe of the right ſide above deſcribed. Another part of the ſyſtem is deeper-ſeated, lying between the roots of the ſpinal proceſſes of the back-bone. This part conſiſts of a large trunk that begins from the lower part of the fiſh, and as it aſcends, receives branches from the dorſal fins and adjacent parts of the body. It goes up near the head, and fends a branch to each thoracic duct, near its origin.

The brain in fifhes is formed nearly in the fame way as that of fowls; only we may obferve, that the pofterior lobes bear a greater proportion to the anterior.

Their organ of *fmelling* is large; and they have a power of contracting and dilating the entry into their nofe as they have occafion. It feems to be moftly by their acute fmell that they difcover their food: for their tongue feems not to have been defigned for a very nice fenfation, being of a firm cartilaginous fubftance; and common experience evinces, that their fight is not of fo much ufe to them as their fmell in fearching for their nourifhment. If you throw a frefh worm into the water, a fifh will diftinguifh it at a confiderable diftance; and that this is not done by the eye, is plain from obferving, that after the fame worm has been a confiderable time in the water, and loft its odour, no fifhes will come near it: but if you take out the bait, and make feveral little incifions into it, fo as to let out more of the odoriferous effluvia, it will have the fame effect as formerly. Now it is certain, had the creatures difcovered this bait with their eyes, they would have come equally to it in both cafes. In confequence of their fmell being the principal means of difcovering their food, we may frequently obferve their allowing themfelves to be carried down with the ftream, that they may afcend again leifurely againft the current of the water; thus the odoriferous particles fwimming in that medium, being applied more forcibly to their fmelling organs, produce a ftronger fenfation.

The *optic nerves* in thefe animals are not confounded with one another in their middle progrefs between their origin and the orbit, but the one paffes over the other without any communication; fo that the nerve that comes from the left fide of the brain goes diftinctly to the right eye, and *vice verfa*.

Indeed

Indeed it would ſeem not to be neceſſary for the optic nerves of fiſhes to have the ſame kind of connection with each other as thoſe of man have: for their eyes are not placed in the fore part, but in the ſides of their head; and of conſequence, they cannot ſo conveniently look at any object with both eyes at the ſame time.

The *lens cryſtallina* is here a complete ſphere, and more denſe than in terreſtrial animals, that the rays of light coming from water might be ſufficiently refracted.

As fiſhes are continually expoſed to injuries in the uncertain element they live in, and as they are in perpetual danger of becoming a prey to the larger ones, it was neceſſary that their eyes ſhould never be ſhut; and as the cornea is ſufficiently waſhed by the element they live in, they are not provided with palpebræ: but then, as in the current the eye muſt be expoſed to ſeveral injuries, there was a neceſſity that it ſhould be ſufficiently defended; which in effect it is by a firm pellucid membrane, that ſeems to be a continuation of the cuticula, being ſtretched over here. The epidermis is very proper for this purpoſe, as being inſenſible, and deſtitute of veſſels, and conſequently not liable to obſtructions, or, by that means, of becoming opake. In the eye of the ſkate tribe, there is a digitated curtain which hangs over the pupil, and may ſhut out the light when the animal reſts, and it is ſimilar to the tunica adnata of other animals.

*Ear of Fiſhes.* Although it was formerly much doubted whether fiſhes poſſeſſed a ſenſe of hearing, yet there can be little doubt of it now; ſince it is found that they have a complete organ of hearing as well as other animals; and likewiſe, as the water in which they live is proved to be a good medium. Fiſhes, particularly thoſe of the ſkate kind, have a bag at ſome diſtance behind the eyes, which contains a fluid and a ſoft cretaceous ſubſtance, and ſupplies the place of veſtibule and cochlea. There is a nerve diſtributed upon it, ſimilar to the portio mollis

mollis in man. They have ſemicircular canals, which are filled with a fluid, and communicate with the bag: they have likewiſe, as the preſent Profeſſor of anatomy here has lately diſcovered, a meatus externus, which leads to the internal ear. The cod fiſh, and others of the ſame ſhape, have an organ of hearing ſomewhat ſimilar to the former; but inſtead of a ſoft ſubſtance contained in the bag, there is a hard cretaceous ſtone. In this kind of fiſh no meatus externus has been yet obſerved.

## The ANATOMY of INSECTS.

As inſects and worms are ſo exceedingly numerous, it would be endleſs to examine all the different kinds, nor would it ſerve any uſeful purpoſe to the anatomiſt. We ſhall therefore be content with making a few general obſervations, and theſe chiefly on the ſtructure of their body; leaving the variety of their colour, ſhape, &c. to the naturaliſt. Inſects differ from the former claſſes, by their bodies being covered with a hard cruſt or ſcale, by their having feelers or antennæ ariſing from their head, and many of them breathing the air through lateral pores. As to the ſhape of their bodies, though it ſomewhat differs from that of birds, being in general not ſo ſharp before, to cut, and make way through, the air, yet it is well adapted to their manner of life. The baſe of their bodies is not formed of bone, as in many other animals, but the hard external covering ſerves them for ſkin and bone at the ſame time. Their feelers, beſide the uſe of cleaning their eyes, are a guard to them in their walk or flight. Their legs and wings are well fitted for their intended ſervice; but the latter vary ſo much in different inſects, that from them naturaliſts have given names to the ſeveral orders of the claſs. As, firſt, the

*Coleoptera,*

*Coleoptera*, or beetle tribe, which have a cruſtaceous elytra or ſhell, that ſhuts together, and forms a longitudinal ſuture down their back.

*Hemiptera*—as in cimex, cockroach, bug, &c. which have the upper wings half cruſtaceous, and half membranaceous; not divided by a longitudinal ſuture, but incumbent on each other.

*Lepidoptera*—as the butterfly, have four wings covered with fine ſcales in the form of powder.

*Neuroptera*—as the dragon-fly, ſpring-fly, &c. have four membranaceous tranſparent naked wings, generally reticulated.

*Hymenoptera*—as waſps, bees, &c. have four membranaceous wings, and a tail furniſhed with a ſting.

*Diptera*—as the common houſe-fly, have only two wings.

*Aptera*—as the lobſter, crab, ſcorpion, ſpider, &c. have no wings.

The ſtructure of the Eye in many inſects is a moſt curious piece of mechaniſm. The outer part is remarkably hard, to guard againſt injuries; and has commonly a reticular appearance, or the whole may be conſidered as an aſſemblage of ſmaller eyes; but whether they ſee objects multiplied before them, has not yet been determined.

Linnæus, and ſeveral others following him, deny the exiſtence of a Brain in theſe creatures. But it is certain, that at leaſt a number of the larger kinds, as the lobſter, crab, &c. have a ſoft ſubſtance ſimilar to the brain, from which the optic and other nerves take their riſe; beſides, when this ſubſtance is irritated, the animal is thrown into convulſions: hence we would conclude, that inſects have a brain as well as the former claſſes, although this is ſmaller in proportion to their bodies.

Their Ear has been lately diſcovered to be placed at the root of their antennæ or feelers, and can be diſtinctly ſeen in ſome of the larger kinds, as the lobſter.

They

They have a Stomach, and other organs of digeſtion; and it is curious, that in ſome, as the lobſter, the teeth are found in the ſtomach.

They have a heart and blood-veſſels, and circulation is carried on in them ſomewhat as in the former claſs; but the blood is without red globules: or, as naturaliſts ſpeak, is colourleſs. In the lobſter, and others of the larger kind, when a piece of the ſhell is broken, the pulſation of the heart is ſeen diſtinctly, and that ſometimes for ſeveral hours after it has been laid bare.

*Lungs.* The exiſtence of theſe has been denied by ſome authors. But late experiments and obſervations ſhew, that no ſpecies want them, or at leaſt ſomething ſimilar to them; and in many inſects, they are larger in proportion than in other animals: in moſt of them, they lie on or near the ſurface of their body; and ſend out lateral pores or tracheæ, by which, if the animal is beſmeared with oil, it is inſtantly ſuffocated.

*Generation.* The ſame difference in ſex exiſts in inſects as in other animals, and they even appear more diſpoſed to increaſe their ſpecies, many of them, when become perfect, ſeeming to be created for no other purpoſe but to propagate. Thus the ſilk-worm, when it arrives at its perfect or moth ſtate, is incapable of eating, and can hardly fly; it endeavours only to propagate its ſpecies: after which the male immediately dies, as does the female as ſoon as ſhe has depoſited her eggs.

Beſides thoſe of the male and female, a third ſex exiſts in ſome inſects which we call *neuter.* As theſe have not the diſtinguiſhing parts of either ſex, they may be conſidered as eunuchs or infertile. We know of no inſtance of this kind in any other claſs of animals: and it is only found among thoſe inſects which form themſelves into ſocieties, as bees, waſps, and ants: and here theſe eunuchs are real ſlaves, as on them lies

lies the whole bufinefs of the economy. No hermaphrodites as yet have been difcovered among infects.

Many have imagined that the generality of infects were merely the production of putrefaction, becaufe they have been obferved to arife from putrified fubftances: but a contrary opinion is now more generally adopted; and it is certain, that if putrid bodies be fhut up in a clofe veffel, no infects are ever generated unlefs their ova have been originally depofited there.

They are oviparous animals, and lay their eggs in places moft convenient for the nourifhment of their young; fome in water, others in flefh; fome in fruit and leaves; while others make nefts in the earth or in wood, and fometimes even in the hardeft ftone. The eggs of all infects firft become (*larva*) caterpillar or maggot; from which they are changed into (*pupa*) chryfalis or aureliæ, fo named from their being inclofed in a cafe; and thefe dying, or feeming to die, the (*imago*) fly, or butterfly, or perfect ftate, fucceeds; and during each of thefe changes their appearance differs wonderfully.

## Of WORMS.

WITH refpect to this clafs of animals, they have characters correfponding with thofe of the former tribe, but are diftinguifhed from them by having no antennæ, and in being furnifhed with tentacula.

Many of them, particularly thofe without fhells, are remarkably tenacious of life, fometimes capable of being new formed from a part which may have been feparated. By much the greater number of them are deftitute of head, ears, nofe, eyes, and feet.

Some of thofe in the firft order, as the common round worms, have a vafcular and nervous fyftem, with the parts of generation, which can be diftinctly feen. Some, as the cuttle-fifh, form a kind of connection between fifhes and worms, in poffeffing gills but wanting fins, &c. while others, as thofe of the loweft order, or zoophyta, join the properties of the animal and vegetable kingdom together.

The clafs is divided by Linnæus, &c. into the following orders, viz.

*Inteftina*—as the earth worm, leech, &c. which are the moft fimple animals, being perfectly naked, and without limbs of any kind.

*Mollufca*—as the naked fnail, fea ftar, cuttle fifh; which are likewife fimple animals without any fhell, but they are brachiated or furnifhed with a kind of limbs.

*Teftacea*—as the fnail, oyfter, &c. which have the fame characters as the former order, but are covered with a fhell, and include the greater part of what we commonly call fhell-fifh.

*Lithophyta*—as corals, madrepores, &c, which are compound animals fixed upon a calcareous bafe, conftructed by the creatures themfelves.

*Zoophyta*—as the fponge, polypus, &c. Thefe are likewife compound animals, furnifhed with a kind of flowers, and having a vegetating root and ftem.

Some of thefe creatures inhabit the earth, others live on the reft of the animal or on the vegetable kingdom, and many are found in the hardeft ftones; while an innumerable tribe of them live in the waters. In general, they are faid to be of the hermaphrodite and oviparous kind; while the loweft clafs, as the polypi, in a great meafure refemble the vegetable kingdom in their manner of growth: but for the propagation of thefe animals, as well as of the others of this clafs, we refer the reader to the various books which have lately been written on natural hiftory.

APPENDIX.

# APPENDIX.

A

## SHORT ACCOUNT

OF THE

## BURSÆ MUCOSÆ.

AS the *Burſæ Mucoſæ* are organs which form a very curious part of our ſtructure, a perfect knowledge of them will frequently be found uſeful in practice; yet, notwithſtanding the neceſſity of being well acquainted with theſe material parts of the human frame, anatomiſts, even the lateſt and moſt accurate, have not paid that attention to the ſubject which its importance ſeems to require.

It is well known that the tendons of the muſcles, at the wriſts and ankles, and in their courſe along the fingers and toes, are conducted in ſheaths. Winſlow obſerved, that theſe ſheaths were lined with thin and ſmooth membranes; and Albinus remarked, that where theſe ligamentary ſheaths were abſent, ſacs were frequently interpoſed between the tendons and the bones over which theſe tendons moved. To theſe ſacs, he gave the name of *Burſæ Mucoſæ*; and in his admirable work, the Hiſtory of the Muſcles, he deſcribes ſeveral of them. Dr Monro thinks, and not without juſt grounds, that Winſlow had not ſufficiently examined the extent and ſtructure of the membranes lining the ligamentous ſheaths of the tendons; and he alſo makes it appear, that Albinus did not perceive, as is really the caſe, any ſimilarity between theſe membranes and the ſacs which he deſcribed under the name of *Burſæ Mucoſæ*. Some of the later anatomiſts, Profeſſor Monro thinks, have not ſufficiently attended to Albinus's diſcovery; and that others, eſpecially the learned Haller, have miſtaken the nature of the *Burſæ*, ſuppoſing them to be formed of cellular membrane, like that which covers the belly of the muſcles; while the greater number of the later writers on anatomy have contented themſelves with repeating the deſcription given by Albinus, and have never attempted to throw farther light on the ſubject.

The *Burſæ Mucoſæ* are only to be found in the extremities of the body; they are in all 140, 33 in each ſuperior, and 37 in each inferior extremity.

Many of them are placed on the inner ſides of the tendons, between theſe and the bones. Many others cover not only the inner but the outer ſides of the tendons, or are interpoſed between the tendons and external parts, as well as between thoſe and the bones.

Some are ſituated between the tendons and external parts only or chiefly; ſome between contiguous tendons, or between the tendons and the ligaments of the joints.

A few ſuch ſacs are interpoſed where the proceſſes of bones play upon the ligaments, or where one bone plays upon another.

Where two or more tendons are contiguous, and afterwards ſeparate from each other, we generally find a common burſa divided into branches, with which it communicates; and a few burſæ of contiguous tendons communicate with each other.

Some burſæ, even in young and healthy children, communicate with the cavities of the joints; and in many old perſons I have obſerved ſuch communications formed by uſe or worn by friction, although there had been no lameneſs nor complaint of pain made by the perſon on that account during life.

There is ſome little difference, in different perſons, as to the manner in which contiguous ſacs communicate with each other, or with the cavities of the joints: And, particularly, I have obſerved, that a burſa as large as a hen's egg, which is placed behind the tendon of the extenſors of the leg, in ſome perſons has no communication with the cavity of the joint of the knee; but in the greater number of children, as well as adults, although I obſerved the appearance of a *ſeptum*, or the root of one, yet I found the opening large enough to allow one or two fingers to paſs from the burſa into the joint.

We are at firſt ſight ſtruck with the reſemblance which the ſtructure of the bruſæ bears to that of the capſular ligaments of the joints; and the more attentively we purſue the compariſon, the more juſt and perfect their agreement will be found.

1. The internal membrane of the ligaments of the joints, like that of the burſæ, is thin and denſe.

2. It is connected to the external ligaments by the common cellular ſubſtance.

3. Between

3. Between it and the bones, layers of cartilage or the articular cartilages are interpoſed.

4. At the ſides of the joint, where it is not ſubjected to violent preſſure and friction, the adipoſe ſubſtance is connected with the cellular membrane.

5. Within the cavities of the joints we obſerve maſſes of fat projecting which are covered with ſimilar blood-veſſels, and with ſimilar fimbriæ or fringes hanging from their edges.

6. In the knee we may obſerve the upper part of ſuch a maſs of fat, forming what has been called *the mucilaginous gland of the joint*; and the under part of it projecting into the burſa, behind the ligament which ties the patella to the tibia.

7. The liquor which lubricates the burſæ has the ſame colour, conſiſtence, and properties, as that of the joints; and both, as I have found by experiment, are affected in the ſame manner by heat, mineral acids, and ardent ſpirits.

8. In ſome places the burſæ conſtantly communicate with the cavities of the joints; in others they generally do ſo: From which we may infer a ſameneſs of ſtructure.

As there is not room, in this place, for the whole of Dr Monro's account of the *Burſæ Mucoſæ*, it may be ſufficient to ſay, that the admiſſion of air into theſe cavities is productive of the worſt conſequences; this leads Dr Monro into many arguments which prove the abſolute neceſſity, where any operation requires an opening of theſe cavities, of preventing, as much as poſſible, any admiſſion of air; and the directions which he gives for conducting the operation ſo as to avoid this inconvenience are admirable. Among other operations on which he enlarges, is that for the reduction of the incarcerated hernia. He ſhews that the cutting of the peritonæum, or the tendons of the abdominal muſcles, contributes little to the fatal conſequences which frequently attend the operation; but

but that all, at leaſt the moſt dangerous, of the bad ſymptoms, ariſe from the opening of the hernial ſac, and the conſequent admiſſion of air. He therefore juſtly condemns the common mode, univerſally recommended, of opening the hernial ſac before cutting the tendons of the abdominal muſcles. After the integuments are cut through, and the ſac is expoſed to view, he adviſes to cut the tendon, and to reduce the hernia without opening it. His arguments for the propriety of this practice, and the anſwers which he gives to objections that may be made againſt it, are well ſupported.

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