A

SYSTEM

OF

ANATOMY

AND

PHYSIOLOGY;

FROM THE

LATEST and BEST AUTHORS.

ARRANGED,

AS NEARLY AS THE NATURE OF THE WORK WOULD ADMIT,

IN THE

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A
SYSTEM
OF
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WITH THE
PHYSIOLOGY.

PART VI.

Containing a DESCRIPTION of the

DIFFERENT VISCERA.

CHAP IV.

Of the PELVIS.

§ 6. *Menstruation.*

THE descriptions we have hitherto given of the female parts are in common to all ages of the sex; but about the 13th year, or somewhat later, nearly at the same time when semen begins to form itself in the male, there are likewise considerable changes produced in the female. For at this time the whole mass of blood begins to circulate with an increased force, the breasts swell out, 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, there are various ſymptoms excited in the loins, heavy pains, ſometimes like colic pains, with an increaſed pulſe, headachs; and cutaneous puſtules commonly precede, and a white juice commonly flows from the uterus. 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, do 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; at which time follows the flux of blood, 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 ſeen plainly to diſtil from the open orifices: in others, in whom, when the menſes have been deficient, the uterus has appeared full of concreted blood. It alſo appears from the nature of the uterus itſelf full of ſoft ſpongy veſſels, compared with the thin, callous, by no means fleecy, and almoſt bloodleſs ſubſtance of the vagina. That this is good blood in an healthy

healthy woman, appears both from the foregoing and innumerable other obfervations. Neverthelefs nothing hinders the blood from being fent forth through the vagina, as in other cafes it is through the inteftinum rectum, and in fhort through the remoteft parts of the body.

Since none but the human fpecies are properly fubject to this menftrual flux of blood (although there are fome animals who, at the time of their vernal copulation, diftil a fmall quantity of blood from their genitals), and fince the body of the male is always free from the like difcharge, it has been a great inquiry in all ages, what fhould be the caufe of this fanguine excretion peculiar to the fair fex? To this effect the attraction of the moon, which is known to raife the tides of the fea, has been accufed in all ages; others have referred it to a fharp ftimulating humour, fecreted in the genital parts themfelves, the fame which is the caufe of the venereal difeafe. But if the moon was the parent of this effect, it would appear in all women at the fame time; which is contrary to experience, fince there is never a day in which there are not many women feized with this flux; nor are there fewer in the decreafe than the increafe of the moon. As to any fharp ferment feated in the uterus or its parts, it will be always inquired for in vain; where there are none but mild mucous juices, and where venery, which expels all thofe juices, neither increafes nor leffens the menftrual flux: and women deny that, during the time of their menfes, they have any increafed defire of venery; feeing at that time moft of the parts are rather pained and languid; and the feat of veneral pleafure is rather in the entrance of the pudendum than in the uterus, from which laft the menfes flow. But, laftly, that the menftrual blood is forced out by fome caufe exciting the motion of the blood againft the veffels, appears from hence, that, by a retention, the courfes 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 that 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 betwixt them and their fibres; the bones too are ſlenderer, and their ſurfaces have fewer proceſſes and aſperities. 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 the great anatomiſts; and from neceſſity itſelf, which requires a greater ſpace for a greater number of viſcera in the pelvis. Moreover, the uterine arteries are conſiderably large, more ſo than in men; and have a greater proportion of light, with reſpect to the thickneſs of their coats: but the uterine veins are, in proportion, leſs than in men; and of a more firm reſiſting texture, than in other parts of the body. From hence it follows, that the blood, brought by the arterial trunk to the womb, by paſſing from a weaker artery into a narrow and more reſiſting vein, will meet with a more difficult return, and conſequently diſtend the uterine veſſels.

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 rim of the pelvis. But when the fœtus is born, and

and the umbilical artery is tied, all the blood of the iliac artery defcends to the pelvis and lower limbs, which of courfe grow larger, and the pelvis fpreads wider and deeper: fo that, by degrees, the womb and bladder are received into its cavity, without being any longer compreffed by the inteftines and peritonæum, when the abdominal mufcles prefs upon the lower parts of the abdomen. When now the increafe is perfect, or next to it, then in general we find thofe arteries of the uterus largeft, which in the fœtus were leaft, and eafily injected with wax; and all things are changed in fuch a manner, that the hemorrhoidal artery is now in place of the hypogaftric, 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 ufed to do.

At the fame time, when the growth of the body begins confiderably to diminifh, and the blood, finding eafy admittance into the completed vifcera, is prepared in a greater quantity, the appetite being now very fharp, in both fexes, a plethora confequently follows. In the male, it vents itfelf frequently by the nofe, from the exhaling veffels of the pituitary membrane being dilated to fo great a degree without a rupture, as to let the red blood diftil through them; and now the femen firft begins to be fecreted, and the beard to grow. But in the female, the fame plethora finds a more eafy vent downward; being that way directed partly by the weight of the blood itfelf, to the uterine veffels now much enlarged, of a foft fleecy fabric, feated in a loofe hollow part, with a great deal of cellular fabric interfperfed, which is very yielding and fucculent, as we obferve in the womb: for thefe caufes, the veffels being eafily diftendible, the blood finds a more eafy paffage through the very foft fleecy exhaling veffels, which open into the cavity of the uterus, as being there lefs refifted than in its return by the veins, or in taking a courfe through any other part; becaufe, in females, we obſerve the arteries of the head are both ſmaller in proportion, and of a more firm reſiſting texture. The return of the ſame is therefore more ſlow, 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, by repeated diſſections, are obſerved to be ſwelled; next it is 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, which at firſt tranſmit an increaſed quantity of warm mucus, afterward a reddiſh coloured ſerum; and by ſuffering a greater diſtention, 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 which direct 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 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, contract themſelves by degrees 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

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. Therefore this critical diſcharge of blood 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 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, which, with the difference of their poſture, never permit 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 in the lower limbs is turned away, whoſe veſſels in men are larger, as thoſe of the pelvis are ſmaller.

It will, perhaps, be demanded, why the breaſts ſwell out at the ſame time with the approach of the menſes? We are to obſerve, that the breaſts have many particulars in their fabric, common to that of 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, like whey, found in the uterus, ſo as to reſemble milk, in thoſe who do not ſuckle their children, being of a thin and white conſiſtence, appearing very evidently in 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. Therefore, the ſame cauſes 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 the breaſts.

§ 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

ginally compofed 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 *falfe* or *fpongy chorion.* But it is fuppofed to derive an extraordinary lamella immediately from the uterus, which conftitutes the external covering of the ovum. This production, which is fuppofed to be entirely formed by a continuation of the internal membrane of the uterus, is at firft loofely fpread over the ovum, and afterwards comes in contact with the falfe chorion. Thefe two lamellæ, which form the external vafcular furface 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 fo great, that, in early conception, the mafs of the ovum is chiefly compofed of them. Dr Ruyfch called this exterior coat the *tunica filamentofa;* more modern authors, the *falfe* or *fpongy chorion.* But Dr Hunter has found the fpongy chorion to confift of two diftinct layers: that which lines the uterus he ftyles *membrana caduca* or *decidua*, becaufe it is caft off after delivery; the portion which covers the ovum, *decidua reflexa*, becaufe it is reflected from the uterus upon the ovum. The membrana decidua is perforated with three foramina, viz. two fmall ones, correfponding with the infertion of the tubes at the fundus uteri; and a larger ragged perforation oppofite to the orificium uteri.

Thus, according to Dr Hunter, the embryo, on its firft formation in the ovum, and the fœtus during the whole time of geftation, is inclofed in four membranes, viz. the double, falfe, or fpongy chorion, called *membrana decidua*, and *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 tranfparent membranes. The decidua, and decidua reflexa, differ in appearance, and feem to refemble thofe inorganic fubftances which connect inflamed vifcera, and have been confidered by fome late writers as being compofed of infpiffated coagulated lymph.

Between the amnios and chorion, a quantity of gelatinous fluid is contained in the early months; and a fmall bag, or white fpeck, is then obferved on the amnion, near the infertion of the umbilical cord. It is filled with a white liquor, of a thick milky confiftence; and is called *veficula umbilicalis*, *veficula alba* or *lactea*: it communicates with the umbilical cord by a fmall funis, which is made up of an artery and vein. This veficle, and duct or tube leading from it, are only confpicuous in the early months; and afterwards become tranfparent, and of confequence invifible. Their ufe is not yet underftood.

Though the bag, or external parts of the conception, at firft form a large proportion of the ovum in comparifon of the embryo or fœtus, in advanced geftation the proportions are reverfed. Thus an ovum between the eighth and ninth week after conception, is nearly about the fize of a hen's egg, while the embryo fcarcely exceeds the weight of a fcruple: at three months, the former increafes beyond the magnitude of a goofe's egg, the weight above eight ounces; but the fœtus does not then amount to three ounces: at fix months, the fœtus weighs twelve or thirteen ounces, and the placenta and membranes only feven or eight: at eight months, the fœtus weighs between four and five pounds, the fecundines 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 obfervation of Dr Wrifberg: but the placenta feldom increafes much in bulk from between the feventh and eighth month.

Having defcribed the ovum in early geftation, we fhall next take a view of the germ; trace the progrefs of the embryo and fœtus; then refume the fubject of the ovum, to explain the ftructure of the membranes, placenta,

centa, &c. in advanced geftation, and point out the moft remarkable changes which the uterus fuffers during impregnation.

ART. II. EVOLUTION of the FOETUS.

THERE can be little doubt that all the parts of an animal exift completely in the germ, though their extreme minutenefs and fluidity for fome time conceal them from our fight. In a ftate of progreffion, fome of them are much earlier confpicuous than others.

The embryo, in its original ftate, feems to contain, in a fmall fcale, all the other parts which are afterwards to be progreffively evolved. Firft the heart and liver, then the brain and fpinal medulla, become confpicuous: for the fpine or carina of the embryo is formed fome time before any veftige of extremities begin to fprout. The encephalon, or head, and it's appendages, firft appear; then the thoracic vifcera; next, the abdominal: at length the extremities gradually fhoot out; the fuperior firft, then the inferior; till the whole is evolved.

As foon as the embryo has acquired fufficient confiftence to be the fubject of any obfervation, a little moving point, which is the heart, difcovers itfelf. Nothing, however, but general circumftances relating to the particular order and progrefs of the fucceffive germination or evolution of the vifcera, extremities, vafcular fyftem, and other parts of the human fœtus, can be afcertained, as it is beyond the power of anatomical inveftigation.

It is alfo exceedingly difficult to determine the age or proportional growth of the fœtus. The judgment we form will be liable to confiderable variation: 1ft, From the uncertainty of fixing the period of pregnancy; 2dly, From the difference of a fœtus of the fame age in different women, and in the fame woman in different pregnancies; and, laftly, Becaufe 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 this, among other reaſons, that 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 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 in length about eight, or between eight and nine inches; 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

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 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 is ſomewhat weaker and more ſlender next the placenta, according to its place of inſertion; which, though commonly not far from the centre, is ſometimes towards the very 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

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 hæmorrhagies frequently enſue.

The internal concave ſurface of the placenta is in contact with the chorion, and that with the amnion. 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 adheres 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 amnion. They are commonly joined together, either by an intervening membrane, or by the ſurfaces being contiguous

guous 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 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 amnion. They form a pretty ſtrong bag, commencing at the edge of the cake, going round the whole circumference, and lining the internal ſurface of the womb. When ſeparated from the uterus, this membranous bag is ſlender and yielding, and its texture readily deſtroyed by the impulſe of the contained fluid, the preſſure of the child, or of the finger in touching; but in its natural ſtate, while it lines the womb, and is in cloſe contact with its ſurface, the membranous bag is ſo tough and ſtrong as to give a conſiderable degree of reſiſtance. It is alſo ſtrengthened in proportion to the different layers of which it is compoſed, whoſe ſtructure we ſhall proceed to explain more particularly.

1. The *membrana decidua*, or that lamella of the ſpongy falſe chorion which is in immediate contact with the uterus, is originally very thick and ſpongy, and exceedingly vaſcular, particularly where it approaches the placenta. At firſt, there is a ſmall intervening ſpace between it and the ovum, which is filled with a quantity of gelatinous ſubſtance. It gradually becomes more and more attenuated by ſtretching, and

approaches nearer to the decidua reflexa; and about the fifth month the two layers come in contact, and adhere ſo as to become apparently one membrane.

2. *Decidua reflexa.* In its ſtructure and appearance it is ſimilar to the former, being rough, fleecy, and vaſcular, on its external ſurface. In advanced geſtation, it adheres intimately to the former membrane, and is with difficulty ſeparated from it.

The decidua reflexa becomes thicker and more vaſcular as it approaches the placenta, and is then blended with its ſubſtance, conſtituting the cellular or maternal part of the cake, as it is termed by Dr Hunter.[1] The other or more internal part belongs to the fœtus, and is ſtyled the *fœtal* part of the placenta.

The double decidua is opaque in compariſon of the other membrane; the blood-veſſels are derived from the uterus, and can be readily traced into it. Dr Hunter ſuppoſes that the double decidua lines the uterus nearly in the ſame manner as the peritonæum does the cavity of the abdomen, and that the ovum is incloſed within its duplicature as within a double night-cap. On this ſuppoſition the ovum muſt be placed on the outſide of this membrane, which is not very readily to be comprehended; unleſs we adopt Signior Scarpa's opinion already mentioned, and ſuppoſe it to be originally entirely compoſed of an inſpiſſated coagulable lymph.

3. The *true chorion*, or that connected with the amnion, is the firmeſt, ſmootheſt, and moſt tranſparent of all the membranes, except the amnios; and, when ſeparated from it, has a conſiderable degree of tranſparency. It adheres pretty cloſely to the internal ſurface of the cake, which it covers immediately under the amnios, and gives alſo a coat to the umbilical cord. It is connected to the amnion by means of a gelatinous ſubſtance, and is eaſily ſeparated from it.

4. The *amnion*, or internal membrane, forms the external coat of the umbilical cord. This internal la-

mella of the membranous bag is the moſt thin, attenuated, and tranſparent of the whole; and its veſſels are ſo delicate, that they can hardly be diſcovered; their diameters are ſo ſmall as to be incapable in their natural ſtate of admitting globules of red blood. It is, however, firmer and ſtronger than the chorion, and gives the greateſt reſiſtance in the breaking of the membranes.

The ſmall bag, called *veſicula umbilicalis*, formerly deſcribed, and only conſpicuous in the early months from its ſituation, is placed between the amnion and chorion, near the attachment of the cord; and, from the colour of its contents, has been miſtaken for the urachus: but there is no allantois in the human ſubject.

The allantois in quadrupeds is an oblong membranous ſac, or pouch, placed between the chorion and amnion. This membrane communicates with the urachus, which in brutes is open, and tranſmits the urine from the bladder to the allantois.

5. The *waters* are contained within the amnion, and are called the *liquor amnii.* They are pureſt, cleareſt, and moſt limpid in the firſt months; acquiring a colour, and becoming ſomewhat ropy, towards the latter end. They vary in different ſubjects, both in regard to conſiſtence and quantity; and, after a certain period, they proportionally diminiſh as the woman advances in her pregnancy. This liquor does not, in any reſpect, reſemble the white of an egg; it is generally ſaltiſh, and therefore unfit for the nutrition of the child; ſome of it may perhaps be abſorbed by the fœtus, but the child is chiefly nouriſhed by the navel-ſtring. In the early months, the organs are not fit for ſwallowing; and monſters are ſometimes born alive, where ſuch organs are altogether wanting.

Water is ſometimes collected between the chorion and amnion, or between the lamellæ of the chorion. This is called the *falſe water.* It is generally in much

 ſmaller

ſmaller quantity than the true water; and, without detriment to the woman, may flow at any time of pregnancy.

Having deſcribed the contents of the gravid uterus, let us conſider the changes which that organ ſuffers during the progreſs of geſtation, and explain the manner of circulation between the parent and fœtus, and within the body of the fœtus; after which we ſhall enumerate the moſt remarkable peculiarities of the *nonnatus*.

ART. IV. CHANGES of the UTERINE SYSTEM from IMPREGNATION.

THOUGH the uterus gradually increaſes in ſize from the moment of conception till full time, and although its diſtention is proportioned to that of the ovum, with regard to its contents, it is, ſtrictly ſpeaking, never completely diſtended; for in early geſtation, they are entirely confined to the fundus; and, at full time, the finger can be paſſed for ſome way within the orificium uteri without touching any part of the membranes. Again, though the capacity of the uterus increaſes, yet it is not mechanically ſtretched, for the thickneſs of its ſides does not diminiſh. The increaſed ſize ſeems, therefore, to depend on a proportionable quantity of fluids ſent to that part, nearly in the ſame way the ſkin of a child, though it ſuffers ſo great diſtention, does not become thinner, but preſerves its uſual thickneſs.

This is proved from ſeveral inſtances of extra-uterine fœtuſes, where the uterus, though there were no contents, was nearly of the ſame ſize, from the additional quantity of fluids tranſmitted, as if the ovum had been contained within its cavity. Boehmerus relates the ſame circumſtance, without attempting to explain it, in the hiſtory of a caſe of extra-uterine conception in the fifth month. The uterus is painted of a conſiderable ſize, though the fœtus was contained in the ovarium.

The

The gravid uterus is of different ſize in different women; and will vary according to the bulk of the fœtus and involucra. The ſituation alſo varies according to the increaſe of its contents, and the poſition of the body. For the firſt two or three months, the cavity of the fundus is triangular as before impregnation; but as the uterus ſtretches, it gradually acquires a more rounded form. In general, the uterus never riſes directly upwards, but inclines a little obliquely; moſt commonly to the right ſide: its poſition is never, however, ſo oblique as to prove the ſole cauſe either of preventing or retarding delivery.

Though conſiderable changes are occaſioned by the gradual diſtention of the uterus, it is difficult to judge of pregnancy from appearances in the early months. For the firſt three months, the os tincæ feels ſmooth and even, and its orifice is 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, 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

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 mufcular ftructure of the gravid uterus is extremely difficult to be traced with any exactnefs in the unimpregnated ftate; but in the gravid uterus they appear more diftinctly. In the wombs of women who die in labour, or foon after delivery, fibres running in various directions are obfervable more or lefs circular. Thefe feem to arife from three diftinct origins, viz. from the place where the placenta adheres, and from the aperture or orifice of each of the tubes: but it is almoft impoffible to demonftrate regular plans of fibres continued any length without interruption.

The appendages of the uterus fuffer alfo confiderable changes; for the tubes, ovaries, and ligaments, gradually go off below the fundus as it ftretches, and at full time are almoft entirely obliterated. At full time, efpecially in a firft pregnancy, when the womb rifes higher than in fubfequent impregnations, the ligamenta rotunda are confiderably ftretched; and to this caufe thofe pains are probably owing which ftrike from the belly downwards in the direction of thefe vafcular ropes, which are often very painful and diftreffing towards the latter end of geftation. Again, as the uterus, which is chiefly enlarged towards the fundus, at full time ftretches into the cavity of the abdomen without any fupport, leaving the broad ligaments below the moft bulky part, we can readily fee, that by pulling at the umbilical cord to deliver the placenta, before the uterus is fufficiently contracted, the fundus may be pulled down through the mouth of the womb, even though no great violence be employed. This is ftyled the *inverfion* of the uterus; and is a very dreadful, and generally fatal, accident. It is the confequence only of ignorance or temerity; and can fcarcely happen but from violence, or from an officious intrufion 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, the force of labour which propels the child where the cord is ſhort naturally, or rendered ſo by circumvolutions round the body of 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. 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; from which it is, with ſome reaſon, ſuſpected 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 of one thing we are certain, that the blood paſſes directly from the placenta

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 thefe branches, called the *ductus venofus*, 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 reft to the vena portarum; where, after circulating through the liver, it alfo gets into the vena cava, and fo to the heart: but the circulation here is carried on without any neceffity for the lungs being dilated. For fœtufes have an oval hole open between the two auricles of the heart, and a large communicating canal, called *canalis arteriofus*, going between the pulmonary artery and aorta; which two paffages allow the reft of this circulating fluid, that returns by the cava fuperior, to be tranfmitted to the aorta, without paffing through the lungs.

The blood is returned from the fœtus by the *arteriæ umbilicales*, which take their rife 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 alleged, 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 in proportion than the inferior. When other parts present, it seems owing to the motion of the child altering its figure when the waters are much diminished in quantity, or to circumvolutions of the cord: when the position is once altered, it becomes confined or locked in the uterus, and cannot easily resume its original posture.

As the figure of the fœtus is oval, and the head naturally falls to the most depending part of the uterus, the vertex generally points to the os tincæ, with the ears diagonally in the pelvis between the pubes and sacrum. The fœtus is mechanically disposed to assume this position from its peculiar figure and construction, particularly by the bulk of the head and articulation with the neck, by the action of its muscles, and by the shape and construction of the cavity in which it is contained.

ART. VII. PECULIARITIES of the FOETUS.

THE fœtus, both in external figure and internal structure, differs materially, in many striking circumstances, from the adult. It is sufficient for our present purpose to mention a few particulars.

The head is very large in proportion to the rest of the body: the cranial bones are soft and yielding, and the sutures not yet united, so that the bulk of the head may be diminished in every direction, and its passage consequently be rendered more commodious. The bones of the trunk and extremities, and all the articulations, are also remarkably flexible. All the apophyses are epiphyses; even the heads and condyles and brims of cavities, instead of bone, are of a soft cartilaginous consistence.

The brain, spinal marrow, and whole glandular as well as nervous and sanguiferous systems, are considerably larger in proportion in the fœtus than in the adult. It has a gland situated in the fore-part of the chest be-

tween

tween the laminæ of the mediaſtinum, called the *thymus*. The liver and kidneys are much larger in proportion; and the latter are divided into a number of ſmall lobes, as in the brute.

The fœtus alſo differs in ſeveral circumſtances from a child who has breathed.

The cavity of the thorax is leſs in proportion than after reſpiration. The lungs are ſmaller, more compact, of a red colour like the liver, and will ſink in water; but putrefaction, and a particular emphyſema, as in diſeaſes of cattle, and blowing into them, will make them ſwim: which ſhould prevent us from haſtily determining, from this circumſtance, whether a child has breathed or not; which we are often called on to do. Neither does their ſinking prove that the child never breathed; for a child may die, or be ſtrangled in the birth, or immediately after, before the lungs are fully inflated.

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

§ 8. *Of Conception.*

This is a very arduous inveſtigation, as we propoſe to diſcover the changes which take place in the inward parts of woman, when a new creature begins to germinate, who is, in proper time, to be expoſed to light. We ſhall relate, in the firſt place, therefore, thoſe things which experience ſhows to be true; and then add thoſe hypotheſes by which learned men have endeavoured to ſupply ſuch things as are not evident from the ſubject itſelf. How few things are aſcertained on this ſubject, and how difficultly they are aſcertained, daily experience ſhows.

That ſome light may be thrown on ſuch a dark ſubject, we ſhall begin with the moſt ſimple animals, and afterwards take notice of what nature has added in others

thers whofe fabric is more compounded. The fmalleft animals, then, which have very few or no limbs, the leaft diftinction of parts, the fhorteft life, the vital functions both few and very fimilar to one another; thefe animals bring forth young ones like themfelves, with no diftinction of fexes, as all of them are fruitful, and none imparts fecundity to the reft. Some of them exclude their young whom they have conceived in their body, through a certain cleft; from others, fome limbs fall off, which are completed into animals of a kind fimilar to thofe from which they have fallen off. This kind of generation is extended very wide, and comprehends the greater part of animal life.

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

The animals which follow are not indeed numerous, but have both eggs, and male femen befides; fo that both fexes are joined in the fame animal. But we call it *male femen*, becaufe it is neceffary for fprinkling the eggs in order to render them prolific, although it never grows alone into a new animal. In this clafs, therefore, a juice is prepared by its own proper organs, which is likewife poured on the eggs through organs proper to itfelf, but different from the former, in order to generation.

Thofe animals are much more numerous which have both a male juice and female eggs; yet fuch as cannot fecundate themfelves, but require true coition. For two animals of this kind agree in the work of fecundation, in fuch a manner, that each impregnates the other with its male organs, and again fuffers itfelf to

be

be impregnated in its female ones by the male parts of the other.

And now the nature of animals approaches nearer and nearer to that of the human race; of which, namely, ſome individuals of a ſimilar kind have only male organs, and the ſame males ſprinkle their ſeed on the female eggs of others. Very many cold ones 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. But now, if eggs are generated within the body of the female, they are brought forth covered with ſhells or membranes; but if the female has a live fœtus in its uterus, it is born quite free of any involucrum: but the difference between theſe oviparous and viviparous animals is but ſmall; ſo 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 from others ſimilar to themſelves; many from a part of it ſimilar to the whole; others from an egg of a peculiar ſtructure; but that all theſe do not ſtand in 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 certain 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, becauſe the female is at all times ready to ſuffer the venereal congreſs; and thence it behoves the male to be animated with a deſire of venery, when he has plenty of good ſeed, and ſuch as is of a prolific nature. Therefore this is the greateſt cauſe of venereal deſire in him; but in females, of the brute kind eſpecially, ſome

ſome kind of inflammation in the vagina, which excites an intolerable itching.

But nature has firſt 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; from whence it deſcends obliquely forward under the bladder, and 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 remarkable wrinkled valve, formed as a production of the ſkin and cuticle, under the denomination of *hymen*, which ſerves to exclude the air or water; not perhaps without ſome kind of moral uſe, ſeeing this membrane, as far as we know, is given to women alone. This membrane 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, and laſtly the valves of the mucous lacunæ hardened into a kind of fleſh.

At the entrance of the vagina are prefixed two cautaneous productions or appendages, called *nymphæ*, continued from the cutis of the clitoris, and from the glans itſelf of that part; and theſe, being full of cellular ſubſtance in their middle, are of a turgeſcent or diſtenſible fabric, jagged and repleniſhed with ſebaceous glandules on each ſide, ſuch as are alſo found in the folds of the prepuce belonging to the clitoris. Their uſe is principally to direct the urine, which flows betwixt them both from the urethra, that in its deſcent it may be turned off from clinging to the body, in which office the nymphæ are drawn together with a ſort of erection. Theſe membranous productions deſcend from the cutaneous arch ſurrounding the clitoris, which is a part extremely ſenſible, and wonderfully influenced by titillation; for which it is made up, like the penis, of two cavernous bodies, ariſing in like manner

ner from the ſame bones, and afterwards conjoining together in one body, but without including any urethra. It is furniſhed with blood-veſſels, nerves, and levator muſcles, and a ligament ſent down from the ſynchondroſis of the os pubis, like thoſe in men, like unto which the clitoris grows turgid and erect in the time of coition, but leſs in thoſe who are very modeſt; but from friction, the clitoris always ſwells up and is erected.

The muſcle, termed *oſtii vaginæ conſtrictor*, ſeems to compreſs the lateral venal plexuſes of the vagina, whence it every way conduces to retard the return of the venal blood. The tranſverſe muſcle of the urethra, and the bundle from the ſphincter inſerted into it, have the ſame ſituation as in men.

When a woman is invited either by moral love, or a luſtful deſire of pleaſure, and admits the embraces of the male, the penis, entering the vagina, rubs againſt its ſides, until the male ſeed breaks out and is poured into the uterus. In like manner the attrition of the very ſenſible and tender parts, which lie within the vagina, excites a convulſive conſtriction, as we obſerved before of the male. By theſe means the return of the venous blood being ſuppreſſed, the clitoris grows turgid and erect, more eſpecially in luſtful women; the nymphæ ſwell on each ſide, as well as the venal plexus, which almoſt ſurrounds the whole vagina, ſo as to raiſe the pleaſure to the higheſt pitch: in conſequence of which there is expelled, by the muſcular force of the conſtrictor, but not perpetually, nor in all women, a quantity of lubricating mucous liquor, of various kinds. The principal fountains of this are ſeated at the firſt beginning or opening of the urethra, where there are large mucous ſinuſes placed in the protuberant margin of this uriniferous canal. Moreover, there are two or three large mucous ſinuſes, which open themſelves into the cavity of the vagina itſelf, at the ſides of the urethra, in the bottom of the ſinuſes which are formed by the membranous valves fulcated upward. Laftly, at the fides of the vagina, betwixt the bottoms of the nymphæ and the hymen, there is one opening, on each fide, from a very long duct; which, defcending towards the anus, receives its mucus from a number of very fmall follicles.

But the fame action which, by increafing the pleafure to the higheft degree, caufes a greater conflux of blood to the whole genital fyftem of the female, occafions a much more important alteration in the interior parts. For the hot male femen, penetrating the tender and fenfible cavity of the uterus, which is itfelf now turgid with influent blood, does there excite, at the fame time, a turgefcence and diftention of the lateral tubes, which are very full of veffels, creeping betwixt their two coats, and now ftiff with the great quantity of blood they contain; and thefe tubes, thus copioufly filled and florid with the red blood, become erect, and afcend, fo as to apply the ruffle or fingered opening of the tube to the ovary. In the truth of all thefe particular changes, we are confirmed by diffections of gravid or pregnant women, under various circumftances; alfo from the comparative anatomy of 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 fluid, which will harden like the white of an egg, and with which little bladders are diftended. In a prolific copulation, fome one of the more ripe veficles is burft, a cleft manifeftly appears, and 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, remains a cleft, or a veftige of one. This is the *corpus luteum*, and the

 number

number of thefe, for the moft part, correfponds with that of the fœtufes; and they are common to all warm quadrupeds, in which fome late anatomifts have found a fort of juice before copulation; which, however, experience does not admit, feeing there is no corpus luteum at that age. Nor is the veficle, which is the human ovum, contained in a body like a cup.

The extremity of the tube, therefore, furrounding and compreffing the ovarium in a prolific congrefs, is thought to prefs out and fwallow 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 firft point of contact with the ovum, and urges the ovum downward fucceffively to the opening into the fundus uteri, which is very manifeft in brute animals. The truth of this appears from the conftant obfervation of a fcar or fiffure in the ovarium, which is produced there after conception; from a fœtus being certainly found in quadrupeds, both in the ovarium of the female and in the tube; 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 fluid, very foft and pellucid, and cannot be diftinguifhed from the mucus with which the tube is filled; likewife, that it is very fmall, on account of the narrownefs of the tube. The veficle itfelf which was in the ovary remains in it fixed, and becomes the covering of the corpus luteum. But the accounts of ova faid to have fallen from women during the firft days are not certain, and are contradicted by the fmallnefs of the fœtus obferved many days after conception; by the fhape in which it is firft obferved, which is always oblong, and in brutes even cylindrical; and likewife by the fmallnefs of the tube.

Thefe things are performed, not without pleafure 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, to which certain experience ſhows 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, or its ſluggiſh nature, any objection to this, which by eminent anatomiſts has been thought to render it leſs fit for performing ſuch a journey. For it is certain that the male ſemen fills the tubes themſelves at the firſt impregnation, both in women and brute animals.

The uterus indeed, in animals certainly, and in women probably, is cloſed, 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 a rotten egg. Fleſh is at this ſame time chiefly nauſeated; a vomiting alſo occurs; ſome puſtules break out, and the teeth ach. The moſt of theſe complaints we reckon to be owing to the ſwelling of the uterus, and the retention of the menſes.

Theſe changes, hitherto, which are proved at leaſt by the teſtimony of our ſenſes, may be either confirmed or corrected. Thoſe which follow are more conjectural; and the more difficult on account of the paucity of experiments, and their diſagreement with one another. And in the firſt place, it is a difficult queſtion, From whence proceed the firſt ſtamina of the new animal? Whether are they from both parents, and mixed into one animal by a conjunction of ſeminal matter coming from the whole body; as indeed there is a resemblance of the fœtus to both parents in animals, but especially in plants, as confirmed by very many experiments: the ſame thing alſo ſeems confirmed by the faults of parents being conveyed to their children. But no ſeed has ever certainly been obſerved in females; and innumerable examples ſhow, that the ſpecies of animals may be propagated without any mixture of ſeeds. Laſtly, the reſemblance of the young animal to its father ſeems only to ſhow, that in the male ſeed there is ſome power, which alone can form the ſoft matter of the embryo in its leaſt ſtate; juſt in the ſame manner as that power adds length to the pelvis in certain bodies, dilates the larynx, and cauſes the horns appear.

To the father ſome have attributed every thing; chiefly ſince the ſeminal worms, now ſo well known, were firſt obſerved in the male ſeed by the help of the microſcope, which are obſerved with truth to agree in figure with the firſt embryos of all animals. But in theſe animals there is a proportion wanting betwixt their number and that of the fœtuſes; they are alſo not to be conſtantly obſerved through all the different tribes of animals; they have too great a reſemblance to thoſe animalcules that are every where ſpontaneouſly produced in other juices, which yet are always tenacious of their own genus, and are never found to grow in the moſt diſſimilar kinds of animals that have limbs.

Again, other anatomiſts, not leſs celebrated or leſs worthy of credit, have taught that the fœtus exiſted in the mother and maternal ovary; which the male ſemen excites into a more active life, and likewiſe forms it variouſly, ſo as to ſhow it juſt brought into life, and make its preſence manifeſt. That yolks are alſo manifeſtly found in the female ovaries, even although they have not been impregnated with any male ſemen. But a yolk is known to be an appendix to the inteſtine

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of fowls; and to have its arteries from the meſenteric artery, and the covering of the yolk to be continued with the nervous membrane of the inteſtine, which is continuous with the ſkin of the animal. That along with the yolk, therefore, the fœtus ſeems to be preſent in the mother hen, of whom the yolk is a part, and which gives veſſels to the yolk. Laſtly, that the analogy of nature ſhows that many animals generate eggs without any connection with a male of the ſame ſpecies, but that a male animal never becomes prolific without a female. That the progreſſions are continued from a female quadruped to an oviparous animal, and from that to one which is not oviparous; but that the new animal proceeds from a part of the old one. Certainly, therefore, the males muſt give ſome addition to that ſex which produces the fœtus from its own body; which addition is neceſſary in ſome tribes of animals, but in others, even the moſt fruitful, may be wanted. And that it is not poſſible with any kind of truth to admit of any inſertion, by which the open navel of the male animal, when conceived, ſhould adhere to the veſſels of the female. For this navel would be by far too ſmall at the time when the yolk is of a conſiderable bigneſs; neither could the very ſmall umbilical arteries be applied to the very large yolk with any hope of a continuance of the circulation.

Thus much concerning the materials: but we are again at a loſs concerning the formation, 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 fortuitious concourſe of atoms, the blind attractions between the particles of the nutritious juices and the ſtrength of ferments, inconſcious of the reaſons why they operate; the ſoul is certainly an architect unequal to the taſk of producing ſuch a beautiful fabric; as for internal models, we ſhall refer them to thoſe hypotheſes which the desire of explaining those things, of which we are unwillingly ignorant, has given rise to.

To Haller, indeed, experience seems to agree with those things which the mind foresees will follow from their own causes. 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 is 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 things which are observed in the more perfect fœtus have been present in the tender embryo, although the situation, figure, and composition seem at first to have been exceedingly different from what they show themselves to be 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 added a little after does not generate, but renders conspicuous to the eye. And it sufficiently appears that those parts which eminent anatomists have supposed in aftertimes to be generated, and to be added to the primeval ones, have been all cotemporary with the primeval parts, only small, soft, and colourless.

It is highly probable, that for a long time the latent embryo neither increases nor is agitated, except by a very gentle motion of the humours, which we may suppose to librate from the heart into the neighbouring arteries,

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; that it is more quick in fome parts, and more flow in others; and that from thence it happens that fome parts of the body of the animal feem to be produced very early, and others to fupervene afterwards; and laftly, that fome do not fhow themfelves 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 origins, it is the fole inftrument of bringing it to perfection.

Of the objections which are ufually brought, 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 fome 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 produced, or to be occafioned 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 truly, and fhown by experience to be, prefent in the egg, thofe difficulties which are moved cannot overturn fuch things as have been truly demonftrated, although perhaps fome things may remain, to which, in fo great an infancy of human knowledge, we cannot yet give a full anfwer.

When the human ovum is brought down into the uterus, we become more fenfible of its change of fhape after the interval of a few days. The ovum itfelf fends 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. But before this adheſion, it is either nouriſhed by the matter it already contains, or elſe by ſuch juices as it abſorbs from the ſurrounding humours, if indeed there is any time when it does not adhere.

At this time, in the ovum, there is a great proportion of a limpid watery liquor, which, like the white of an egg, hardens by the heat of fire, or a mixture with alcohol; and now the fœtus, for a long time inviſible, as Haller has never obſerved it before the 17th day, makes its appearance at firſt a ſhapeleſs maſs, conſiſting of mere mucus, and as yet ſeemingly of a cylindrical ſhape. When ſome diſtinction of parts is next to be ſeen, it has a very great head, a ſmall ſlender body, no limbs, fixed by a very broad flat navel to the obtuſe end of the ovum.

From 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 ſmaller veſſels of the ovum, the fœtus itſelf grows the faſteſt; becauſe now the greateſt part of its nouriſhment ſeems to paſs through the very large umbilical vein. At the ſame time the ovum itſelf alſo grows, but leſs in proportion; and the waters, which it includes, gradually diminiſh from their firſt proportion, in reſpect of the bulk of the fœtus. The fleecy productions of the veſſels from the ovum are gradually ſpread over with a continued membrane, and only thoſe which ſprout out from the obtuſe end of the ovum take root, or increafe fo as to form a round circumfcribed placenta or cake.

Such is the appearance of the ovum, as we have here defcribed it, commonly in the fecond month; from which time it changes only by increafing in bulk. That part of the ovum next the fundus uteri is commonly uppermoft, making about a third of its whole furface, in form of a flat round difh or plate; fucculent, fibrous, full of protuberances, but throughout perfectly vafcular; changing into other tubercles of the fame kind, for the moft part accurately, and often infeparably, connected with the uppermoft part of the uterus, remarkable for its large veffels, of a thin cellular texture, collecting the veffels every where, but chiefly in the circumference of the greateft circle, as well the exhaling arteries anfwering to fuch as come from the uterus into the veins of the placenta, as the arteries of the placenta opening into the large veins of the uterus. There, in the common furface of the uterus and placenta, a communication is made, by which the uterus fends to the fœtus, firft that white ferous liquor not unlike milk, and laftly, as it feems, red blood itfelf. This communication of the humours feems to be demonftrated by the fuppreffion of the menfes in women with child, whofe blood muft be turned into another channel; from the lofs of blood which follows from a feparation of the placenta in a mifcarriage; and from the blood of the fœtus being exhaufted from an hemorrhagy in the mother; from hemorrhagies that enfue from the navel-ftring, fo as to kill the mother when the placenta has been left adhering to the uterus; and, laftly, from the paffage of water, quickfilver, tallow, or wax, injected from the uterine arteries of the mother into the veffels of the placenta, as is confirmed by the moft faithful obfervations. But that it is blood which is fent into the fœtus, is evinced by the magnitude of the finufes of the uterus and placenta; the diameter of the ferpentine arteries of the uterus; the hemorrhagy

morrhagy that follows, even when the placenta is very ſlight 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, reſorption, or the immediate anaſtomoſis of the blood-veſſels, the laſt has always had the moſt partiſans. I am ſorry that various arguments, ſufficiently weighty, prevent me from ſo eaſily embracing the ſame ſide; which arguments my celebrated pupils, Balthaſer 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. Anaſtomoſis between veſſels of ſo great magnitude and importance, the abſtraction of which ſo large a hemorrhagy frequently follows, ought not to be formed and ſupported by veſſels ſo very ſmall and imperceptible to the naked eye, but by larger ones; the number of which, however, in the natural abſtraction of the ſecundines, we find neither in the uterus nor placenta to be great.

" 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, once into the uterus of a pregnant woman who died in the seventh month of gestation of a wound, several times into the wombs of mares, cows, goats, rabbits, dogs, and cats, &c. preparations of which I possess, I never could convey the smallest quantity of the most subtile liquor into the uterus from the vessels of the cord, nor from the vessels 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 sometimes filled the recent secundines of women, and several brutes, that have come away spontaneously immediately after birth; but I never saw the mercury rushing forward, as we should have observed in the rupture of anastomosing vessels, which nevertheless penetrates the most subtile vessels.

"6. I have met with a few dogs just before birth killed by cutting through the carotids; which being almost half alive, I have filled through the uterine vessels with a very subtile liquor. The preparations which I possess are proofs of the most happy and successful injection. However, I have done nothing more in these than to push the fluid and coloured matter into the cells of the fungous chorion; but there are not the smallest traces of its entering the vessels of the placenta. As to the other side of the question, the arguments there are not of less weight: for,

"1. The suppression of the menses in pregnancy cannot so much prove it, since (*a*) several animals have no menses; (*b*) they are not suppressed in all women; (*c*) the mass of menstrual blood suppressed after conception, amounting to twelve, sixteen, or even twenty ounces, can in no ways be expended upon the small mass 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; but is fometimes feveral pounds, fometimes a few ounces and drachms: (*b*) and the fame flux is the more gentle the more carefully the abftraction has been performed, and *vice verfa;* and in very profufe fluxes the uterus is, for the moft part, more or lefs injured. (*c*) I have feen abortions of two or three months attended with a very fmall profufion; and I now remember five in which fcarce an ounce was loft. (*d*) In the birth of brutes, fo large effufions never happen, or do not laft fo long.

" 3. It would truly be a weighty argument, which would eafily determine me to embrace the doctrine of anaftomofis, if I could reconcile it with my own obfervations, that the fœtus is deprived of great part of its blood if the mother has died of an hemorrhagy. But I have feen (*a*) a human fœtus whofe mother had died in the feventh month of geftation of a very bloody wound, and had fuffered a great effufion, which had loft no blood out of the heart nor larger veffels; nay, not even in the placenta itfelf did the ftate of the blood-veffels exhibit any mark of hemorrhagy. (*b*) Next, I have killed pregnant dogs and cats, juft 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 fhowing the leaft defect of blood.

" 4. That mothers may fuffer fatal hemorrhagies from cutting and not tying the cord, neither my own obfervations, nor thofe of Roederer, will allow; and no perfon at prefent directs midwives to begin the tying of the cord towards the placenta.

" 5. The

" 5. The venous ſinuſes, ſo called, in the uterus, except the cellular ſubſtance of the fungous chorion, ſeem to afford no proof. I have obſerved ſuch ſinuſes, ſo called, 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 demonſtrate the continuation of veſſels: it only ſhows, that a certain ſtore is prepared, from which the abſorbent veſſels of the placenta may receive their nouriſhing matter, which contains a mixture of the blood itſelf tranſmitted through the increaſing veins, whoſe reſiduum is reabſorbed by the veins of the uterus, and at length mixed with the blood. Does not the like happen in other ſpongy parts?

" 6. As to examples of fœtuſes wanting the heart, whoſe circulation therefore ſhould have depended upon the mother alone, although I am not ſo certain of the truth of them, I could oppoſe as many other obſervations of a ſimilar monſtrous mechaniſm in birds."

The remaining part of the ovum, and likewiſe the ſurface of the placenta, are covered by an external villous and fleecy membrane, full of pores and ſmall veſſels, of a reticular fabric, eaſily lacerable, ſo as to reſemble a fine placenta, and is called the *ſpongy chorion*: (this is elegantly delineated by Dr Hunter). But even this is connected to the flocculent ſurface of the uterus, which is very like to itſelf, but ſofter, by veſſels ſmaller than thoſe of the placenta, but manifeſtly inoſculated from the chorion into the veſſels of the uterus.

Under the ſpongy chorion lies a continuous, white, opaque, and firm membrane, not vaſcular, which 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 ſpongy chorion and amnios. The moſt ſimple name we can give it, is the *læve chorion*.

The innermoſt coat of the fœtus, which is called *amnios*,

amnios, is a watery pellucid membrane, very rarely ſpread with any conſpicuous veſſels, extremely ſmooth, and in all parts alike; alſo extended under the placenta with the former, the ſurface of which is every way in contact with the waters. If there are more fœtuſes than one, either in man or beaſt, each of them has their 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 gathers its roots from the ſubſtance of the placenta, and it has manifeſt communications by ſome roots with the umbilical artery, from whence it in part riſes, and, meeting together in a large trunk, is twiſted in a circular manner through a number of folds to a ſufficient length, that may allow of a free motion; and in this courſe it is ſurrounded with a cellular ſubſtance full of mucus, diſtinguiſhed by three partitions, and the membrane which is continued to the amnios, but known by the name of the *umbilical rope;* and after forming ſome protuberances, it enters through the navel, in an arch made by a parting of the ſkin and abdominal muſcles, and goes on through a 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 thro' the large hepatic branches, which conſtantly ariſe from its ſulcus, and remain even in the adult; but it 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 again into the ſubſtance thereof, by two large *umbilical arteries*, which are

are continued on in the direction of the aorta; and after giving some slender twigs to the femorals, with still smaller arteries into the pelvis, they ascend reflected back with the bladder on each side of it, surrounded with the cellular plate of the peritonæum, with some fibres spreading to them from the bladder and urachus, in which manner they 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 or windings, somewhat sharper than those of the vein which they play around; in which manner they at last 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: for 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 demanded, Whether the fœtus is not nourished by the mouth likewise? Whether it does not drink of the lymphatic liquor contained in the cavity of the amnios, which is coagulable, unless putrefied, 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 decreafe 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 ftomach of the fœtus; the true feces found in the ftomach of the fœtus of quadrupeds; the open mouth of the fœtus, which we have certainly obferved; the gaping of a chicken fwimming in this liquor, and its attempts as it were to drink it up? Again, what are the fountains or fprings from whence this lymph of the amnios flows? whether it tranfudes thro' the invifible veffels of the amnios, or through certain pores from the fucculent chorion, which is itfelf fupplied from the uterus? It muft be confeffed, that thefe inquiries labour under obfcurities on all fides; notwithftanding which, fays Haller, there feems more probability for them than otherwife, fince the liquor is of a nutritious kind, at leaft in the firft beginnings of the fœtus, and derived from the uterus.

All the excremental feces, which are collected in the fœtus during the whole time of its refidence in the womb, amount to no great quantity, as they are the remains of fuch thin nutritious juices, percolated thro' the fmalleft veffels of the uterus. Haller frequently obferved, that the bladder was almoft empty in the fœtus. However, there is generally fome quantity of urine, collected in a very long conical bladder. But in the cavity of the inteftines, there is collected together a large quantity of a dark green pulp, which appears to be a mixture of the bile and the remains of the exhaling juices.

It may then be demanded, Whether there is any allantois? fince it is certain that there paffes out from the top of the bladder a duct called the *urachus*, which is a tender canal, firft broad, covered by the longitudinal fibres of the bladder as with a capfule; and afterwards, when thofe fibres have departed from each other, it is continued thin, but hollow, for a confiderable way over the umbilical cord, yet fo that it vanifhes

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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 who have obſerved a fourth kind of veſſel to be continued along the umbilical rope into its proper veſicle, will not allow that veſſel to be called the urachus, and very lately have referred it to the omphalo-meſenteric genus. Wriſberg has ſeen two fœtuſes with a ſimilar filament. He injected a third one with wax, and that filament which might impoſe upon us for the urachus was likewiſe filled. The artery ran from the veſſels of the omentum to the cord, and was diſtributed in very ſmall branches through the cellular texture of the cord, and upon the bladder; and in the human fœtus, the urine is ſeparated in a very ſmall quantity: but it perhaps may be no improbable conjecture, that ſome portion of the urine is conveyed to a certain extent into the funiculus umbilicalis, and there is transfuſed into the ſpongy cellular fabric that ſurrounds it; and therefore, that, of all animals, man has the longeſt umbilical cord, becauſe he alone has no allantois. But then this can take up but a ſmall ſpace, terminating in the funis, and hardly ever ſeems to reach as far as the placenta. Sometimes, even in an adult perſon, this open duct has brought the urine to the navel.

In the mean time, the fœtus continues to advance in growth; the limbs by degrees ſprout from the trunk, under the form of tubercles; and the other outworks of the human fabric are by degrees beautifully finiſhed, and added to the reſt, in the following manner:

The embryo which we firſt obſerved in the uterus of the mother was a gelatinous matter, having ſcarce any proper ſhape, and of which one part could not be diſtinguiſhed from another. There was, however, in that gluten a heart, which was the cauſe of life and motion; there were veſſels which generated the humour of the amnios; there were therefore veſſels of the umbilicus and yolk, the little trunks of which, being received from the fœtus, are at that time very large, ſeeing they have lately begun to be obſerved. There was both a head and ſpinal column, both parts very large, and larger in proportion to the reſt than ever. There were likewiſe, without doubt, all the reſt of the viſcera, but pellucid and of a mucous nature; for which reaſon, they may be obſerved ſome days ſooner than can be hoped for from nature alone, if you render them opaque.

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

In birds there is added to this the vivifying gluten or white of the egg, which is of the nature of lymph; and the yolk, which is of an oily nature: in man, ſomething of a milky nature, not altogether unlike the yolk of an egg, and 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, void of taſte, colour and ſmell, and of a glutinous nature. The proper nature of every one of them approaches to that of ſerum; but 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,

terwards 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 comprehend one another, and form a cellular texture, even in diseases, and intercept little spaces, in which there is a kind of humour. From this cellular substance are formed the membranes and vessels, and almost the whole body.

The vessels are the oldest parts of the body, and are prepared in the first delineation of the embryo. What first appears in an egg during the time of incubation, having any distinct form, are venous circles: but these veins fabricate the arteries, by which they both receive their juice, and the motion of that juice. They are not generated mechanically from an obstacle, as the arterial blood is found at that time. At first the trunks of the veins are conspicuous, afterwards the branches which convey the humours to the trunks. If they were produced from the arteries reflected, the branches would first be seen, and the trunks formed in the last place. Neither could the arterial blood, driven back by an obstacle, form those most beautiful circles, and bring back the vessels into the heart. It would rather flow irregularly through the cellular texture. And the primeval heart would soon lose its life, unless as much of the humours returned to the heart as was sufficient to keep up its pulsations.

There are, therefore, in the primeval fœtus, such as we first observe it, some things more perfect and conspicuous; others involved, invisible, and very small. The heart is the most perfect; it is the only moveable and irritable part; although it is in many respects different from what it is in an adult person. The brain is large and fluid; the vessels formed which appear in the back next to the heart. The viscera, muscles, nerves, and limbs, are not yet to be seen; the bones

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themſelves are preſent, of which the firſt appearance is a mucus, as are the veſſels of the reſt of the body. The other portion is that of the abdomen, the umbilical capſule of which is an immenſe hernia.

To this embryo is ſuperadded motion, in man almoſt of the heart alone; as alſo in birds, whoſe formation does not take place without heat rather greater than that of the human body: yet, without the heart, heat deſtroys, inſtead of forming the fœtus. It is the largeſt in proportion to the reſt in theſe beginnings; afterwards its proportion to the other parts of the body grows gradually leſs and leſs. Its pulſations are alſo at this time the moſt frequent, and in the ſofteſt fœtus the moſt powerful for impelling the humours, and diſtending and producing the veſſels.

To the force of the heart is oppoſed what is of ſervice however in forming the fœtus, namely, the viſcidity of the vital humours which collect the earthy elements. There is therefore in the embryo both an impelling force, which increaſes the parts longitudinally; and a reſiſting force, which moderates the increaſe, and increaſes the lateral preſſure, and thus the diſtention. By the force of the heart all the arteries, but for eaſineſs of expreſſion we ſhall ſay only one artery, which repreſents all the reſt, with all its ſurrounding cellular texture, is lengthened out; its folds are ſtretched out, and the ſame artery is dilated. And the blood by its lateral preſſure makes an effort againſt the almoſt blind branches of the arteries, fills and evolves them, and ſets them off at more obtuſe angles: thus are produced ſpaces which make very little reſiſtance, in which the gluten is depoſited. In the very ſubſtance of the artery itſelf, while it is every where dilated, between its imaginable ſolid threads are prepared little reticulated ſpaces like a ſtretched-out net, which are equally fit for receiving humours. The largeſt of theſe are farmed round the heart and in the head, whither the impulſe of the heart drives the humours in a ſtraight direction, and in the placenta: the leſſer ones are in the inferior part of the body, from which the umbilical arteries ſubtract the greateſt part of the blood.

The fœtus increaſes very quickly, as is moſt evident in the example of a chicken, whoſe length the twenty-ſecond day is to its length the firſt day at leaſt as 1,000,000 to 1; and the whole increaſe of bulk in the bird during the remainder of its life does not exceed the fifth part of the increaſe of the egg the firſt day. For the fœtus has a larger and more irritable heart, veſſels larger in proportion, and likewiſe more numerous and relaxed, and the ſolid parts are mucous and diſtenſible. The breaſt is later of coming to perfection, ſurrounded with membranes ſo ſoft, that they cannot be ſeen.

The embryo does not only increaſe in bulk, but is ſo remarkably altered in ſhape, that it comes forth into the light totally diſſimilar from any thing that could be obſerved in it at its firſt formation. And firſt it is probable, that the articulations of the limbs are produced from the elongated arteries, that they are laterally knit together by a certain gluten, ſeparately evolved, and at firſt that they ſprout out very ſhort, but afterwards increaſe by inſenſible degrees, and appear divided into diſtinct articulations, as the wings of a bat are formed from an open vaſcular net-work, Thus likewiſe tne 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 which earthy particles are continually brought to it, becomes 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

ties into large cells: the fame likewife incurvate the bones, and varioufly figure them.

Preffure can do a great deal: to it we muft attribute the defcent of the tefticles into the fcrotum, after the irritable force of the abdominal mufcles has taken place: to this alfo we muft afcribe the repulfion of the heart into the breaft, when the integuments of the breaft are larger: to it we are to afcribe the length of the breaft and the fhortnefs of the abdomen, and the fmaller fize of the vifcera of the latter; becaufe the air received into the lungs dilates the cavity of the thorax. But even the bones are varioufly hollowed out by the preffure of the mufcles, blood-veffels, and even of the very foft brain itfelf; and by the fame means flefh is changed into a tendinous fubftance.

The power of derivation brings the blood into the pelvis and lower extremities from the clofed umbilical arteries: the fame, when the foramen ovale is contracted by the auricles 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 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. The head grows lefs after the lower limbs have begun to increafe in bulk.

A membrane may be formed from a humour of which the thinneft part is exhaled, as we have an example in the epidermis: from the fame 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 jelly; this afterwards be-

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comes a cartilage; without any change made on the parts, as far as can be obferved.

A cartilage, however, is not afterwards fecretely changed into a bone. That never happens, unlefs lines and furrows have at firft run along the cartilage: nay, the red blood has made a paffage to itfelf through the veffels of the bones; but 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, which they remove farther and farther from its middle. Round thefe veffels is formed a cellular texture and laminæ, which feem to prefs the veffels themfelves towards the medullary tube. Laftly, in the epiphyfis, which both remains much longer cartilaginous, and denies entrance to the blood, the red veffels penetrate through the cruft which covers the extremity, as well as the others which come from the exterior veffels of the limbs. Thus alfo in the epiphyfis is produced a red nucleus of a vafcular texture, which, being gradually increafed by veffels fent out from its furface, changes the reft of the cartilage into a bony nature.

In thefe long bones it feems evident, that the increafe is owing to the arteries elongated by the force of the heart, and gradually extended to the extremities of the bones: but that the hardnefs is owing to grofs particles at laft depofited in the cartilage when its veffels admit the red blood. But even a bony callus never becomes found till the newly formed red veffels have penetrated its fubftance.

The flat bones originate from fomething of a membranaceous nature. Over this the fibres fpread themfelves, at firft in a loofe net-work, but afterwards they become more denfe, having the membrane for their bafis; the pores and clefts between thefe fibres being gradually contracted and filled with a bony juice, at laft perfect the nature of the bones.

That a heavy bony juice, confifting of groffer particles,

ticles, is depofited between the primeval fibres, is proved by the phenomena of the growing callus, which exfudes in fmall drops, not from the periofteum, but from the inmoft fubftance of the bone, and is hardened by degrees. But even a chymical analyfis extracts that gluten from the bones; and in an anchylofis it appears poured round the joint in a fluid, and manifeftly fills up the chinks of the bones and intervals of the futures. It contains grofs earthy particles, which have been difcovered by various experiments; and the juice of madder which adheres to it, manifeftly diftinguifhes it by its colour.

The periofteum covers the bones, as a membrane does any of the vifcera; and from its cellular productions follow the interior veffels of the bones: but, in the periofteum, 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 it has affumed a bony nature in the middle; and it is thinneft when the bone is in a cartilaginous ftate, but every where complete. In the flat bones it every where affords a bafis for the bony fibres.

Therefore the head is large, every where membranaceous, in a few places cartilaginous on thefe firft days of geftation, with a mouth deeply cut, and 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, with a very large liver: the bile is innocent and mucous: the inteftines are at laft irritable, and full of foft, green, excrement, when the fœtus has now arrived at its ftate of maturity:

the kidneys are divided into lobes, are large, and have very big capſules: the pelvis is very ſmall, ſo that the bladder, ovaries, and tubes, project from it: the genital ſyſtem is denſe, not yet evolved, nor preparing its juices: all the glands are large, particularly the conglobate ones, and full of a ſerous juice: the ſkin is at firſt pellucid, then gelatinous, and at laſt covered with a ſoft cuticle and ſebaceous ointment: the fat is firſt gelatinous, and then grumous: the tendons ſoft, ſucculent, and not yet ſhining.

There is a great difference betwixt the circulation of the blood in the fœtus and in the adult: that this may be underſtood, it is neceſſary to deſcribe the organs by which it is performed. The firſt is the *thymus*, a ſoft looſe gland, conſiſting of very many lobes, collected into two large upper horns, and two inferior ſhorter ones, which are however joined together 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 its liquid, 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 juſt now obſerved.

The cavity of the breaſt is ſhort in the fœtus, and greatly depreſſed 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 through the

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unactive 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 ſuch a large 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 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 right part of the auricle into the left is narrower, ſeeing the auricular canal is now taken into the heart, and the auricles themſelves are become much ſhorter. But yet the ſeptum betwixt the right and left auricle, conjoining them together, is perforated with a broad oval foramen; through which the blood coming from the abdomen, 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. But it is by degrees that the membranes of each ſinus depart from each other, upward and backward, above the oval foramen into the pulmonary ſinus, where they are connected on each ſide above, by ſeveral orders of fibres, which below are palmated or like fingers, ſo as to cloſe up at firſt a ſmall part, and afterwards a greater part, of this foramen, ſo as to leave only a ſmall oval portion of it at liberty; which lies free betwixt the round margin of the ſaid oval foramen and the increaſing valve, making in the mature fœtus about a fifteenth part of the area or capacity of the mouth of the vena cava.

That the blood takes this courſe in the fœtus, and that it does not on the contrary flow from the ſinus of the left to that of the right auricle, is evident, from all manner of experiments and obſervation. For, firſt, the column of blood in the right ſinus, is of all the largeſt; and, as it is the returning one from the whole

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body, cannot be exceeded by any other: but the left auricle has ſo much leſs blood in proportion than that of the right, inſomuch as part of it flows through the duct or canalis arterioſus into the aorta, whence its contents will be much leſs than that of the right auricle: moreover the valve of the oval foramen, in a mature fœtus, is ſo large, and placed ſo much to the left of the muſcular arch or iſtmus, 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 readily gives way ſo as eaſily to tranſmit either blood or flatus, but it will retain even flatus itſelf when injected from the right, nor will it ſuffer it to paſs back again to the right ſide.

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 light of both the pulmonary branches together, and greatly larger than the opening of the foramen ovale, and enters that part of the aorta which comes firſt in contact with the ſpine, under its left ſubclavian branch: by which means it transfers more than half the blood to the deſcending aorta, which muſt otherwiſe have paſſed through the left auricle and ventricle into the aſcending branches of the aorta; and this is the reaſon why the aorta in the fœtus is ſo ſmall at its coming out from the heart. By this mechaniſm an overcharge of blood is turned off from the lungs, by directing a great part of that fluid in a ſtraight courſe to the umbilical arteries, and the powers of both ſides of the heart are united in propelling the blood.

Thoſe who have aſſerted that the fœtus reſpires in the uterus, having made very few experiments, have neglected that moſt eaſy one which is made by water, in which the fœtus will ſwim; and likewiſe by the

lungs,

lungs, which in a fœtus are conftantly heavy, and fink in water: laftly, they do not attend to the evident fhortnefs of the breaft, and fmallnefs of the lungs. Whether or not it can take in air through the vagina of the mother, is very difficult to be determined: and 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 fticks by a part of its body, between the parts of its mother.

As the fœtus grows larger, fo the uterus increafes proportionably; the ferpentine arteries of which it is compofed being extended by the impelled blood, and ftretched into a more direct courfe; while 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, from the menftrual blood retained in the uterus, and not yet quite fpent on the fœtus. Thus its thicknefs continues the fame, becaufe the greater quantity of blood and dilatation of the arteries and veins make up for the extenuation of its folid parts. But more efpecially the fundus, or upper part of the womb, increafes beyond the reft; fo that, by dilating the above tubes, thefe laft feem thus to defcend from the middle of the uterus, which now by degrees goes out of the pelvis, even as high as the colon and ftomach itfelf, fo as to compafs all the abdominal vifcera, more efpecially the bladder and rectum. The os uteri in the firft months of geftation is drawn upwards with the uterus itfelf, and recedes from the entrance of the vagina: after the third month, according to Haller, but not till the beginning of the fixth month, according to Wrifberg, it again defcends, and ftretches into the vagina. The fame becoming perpetually fhorter, projects upon the clofe extremity of the vagina: it is, however, conftantly tender; and, from that cartilaginous hardnefs which is obferved in the virgin womb, is relaxed into a mucous foftnefs. It is never perfectly clofed or fhut together,
but

but only ſtopped up and defended from the air by thick mucus from the ſinuſes, and perhaps from the veſicles which are ſeated in the cervix uteri. Moreover, the cervix or neck of the womb itſelf, which has long remained unchanged during the laſt months of geſtation, becomes likewiſe ſhort, and forms a broad flat opening, of no length; which towards the time of delivery, is always more or leſs relaxed and gaping. 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, in ſuch a manner that the head lies betwixt the knees; and being the heavier part, it 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; for nothing is more diſagreeable to a human creature 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 greater uneaſineſs, becauſe, the waters being now taken away, the limbs which are fully formed, and the head, preſs much more vehemently on the uterus. It is thought alſo that the placenta itſelf, now very large, diſtracts the internal and naked ſurface of the uterus. From theſe cauſes ariſe at firſt ſlight endeavours of the uterus to free itſelf; and at laſt, when theſe cauſes are now got to their utmoſt height, ſuch an uneaſy ſenſation is occaſioned by the impacted head of the fœtus as ariſes from a collection of feces in the rectum; by which pain, therefore, the mother is conſtrained to attempt the birth of the child. The time of delivery comes on after the expiration of nine ſolar months, and

and is kept pretty exactly in every ſpecies of animals, although by ſome cauſes it may be accelerated or retarded for ſome weeks, according to the nature of theſe cauſes; whoſe power, however, we muſt not extend too far.

The teneſmus thus increaſing till it is no longer tolerable, the mother uſes all her efforts by very deep inſpirations, which preſs downwards the uterus and viſcera of the abdomen; and at the ſame time the womb itſelf, by its contractile vital force, conſtringes itſelf ſo powerfully about the fœtus, as ſometimes to exclude it, without further efforts 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 ſoft, ſuffers itſelf to be diſtended by the head of the fœtus. Now the amnios, filled with the water, is firſt protruded vertically, before the head of the fœtus, ſo as to dilate the os internum uteri: in which, the membranes being by degrees extenuated and dilated, eaſily break, and pour out their waters, which lubricate the paſſages, and relax all the parts of the vagina. The naked head of the fœtus now preſents naturally with the face to the os ſacrum, 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 looſen the bones of the pubes in young women, the head is thruſt out through the dilatable vagina, with intolerable pain to the mother, and an univerſal tremor of body; and if none of the bones of the pelvis happen to preſs unequally, the infant eaſily advances, and is delivered into the world. This happens difficultly even in quadrupeds; but moſt of all in the human race, whoſe fœtus has the largeſt head in proportion to its body.

It is natural for women to have but one child at a birth; which law they have in common with all the larger

larger animals, unlefs they are of the carnivorous kind. Frequently, however, they have two, more rarely three, and fcarce ever five. It is not to be doubted, however, that a fecond fœtus may be conceived while the firft remains in the uterus; feeing women have frequently born 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 uteri, 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 extracting force of the deliverer; by which the fleecy or villous furface of the placenta being withdrawn from that of the womb, is immediately followed with a confiderable flow of blood; and thus is the mother delivered from the fecundines or after-birth. 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. Thus 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 imagination, 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 foon loofened and withdrawn. By this contraction of the womb, the bleeding veffels are compreffed, no lefs than by the contraction of their own coats; whence the large quantity of blood that was collected in the uterine fubftance abundantly flows out, under the denomination of the *lochia;* at firft a mere gore, but afterwards, as the openings of the veffels more contract themfelves, they firft become yellow, at length become of a whitifh or wheyifh complexion; and then the ample wound of the

the uterus is ſoon healed, and ſhrinks up to a bulk not much exceeding that of the virgin uterus.

But after two or three days are elapſed from 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 from the nipple, 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. For *milk* very much reſembles chyle, but human milk leſs than that of other animals. It is white, thickiſh, ſweet, and replete with a very ſweet eſſential ſalt, which 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 brackiſh, alkaleſcent, and diſpleaſing to the infant. As the chyle, ſo the milk frequently retains the nature of the aliments and medicines taken into the ſtomach. The cauſe of this increaſed ſecretion in the breaſts, ſeems owing to the revulſion, in conſequence of the plentiful uterine ſecretion being ſuppreſſed, by which the fœtus was nouriſhed; 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 beſides the breaſts, and even eſcape through wounds. And there is otherwiſe between the uterus and breaſts ſome kind of nervous ſympathy, and a ſimilar fitneſs for generating a white liquor. For the uterus in infancy, and during the time of pregnancy, manifeſtly generates it. But the inoſculations betwixt the mammary and epigaſtric arteries, though true, are ſo ſmall, that they can have but a very little ſhare in this account.

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The *breasts* are made up with a very large quantity of soft surrounding cellular fat, of a white colour; and conglomerate glandules, of a convex figure, assembled into bunches somewhat round and hard, of a reddish blue colour, outwardly surrounded and connected by a firm web of the cellular substance, separating off into lesser kernels, which are common both to men and women. To these glandules a great number of blood-vessels are distributed from the internal mammaries, from the external vessels of the thorax, and sometimes from those of the shoulders, all which inosculate together around the nipple. The trunks of the mammary arteries, but not the *mammales*, inosculate with the epigastric vessels, but the veins more evidently. The nerves are both large and numerous, like those of the more sensible cutaneous parts, being derived from the superior intercostals.

From the middle of this gland of the breast, and likewise from the surrounding fat, an infinite number of small ducts or roots arise, very slender, soft, white, and dilatable, which come from all sides to the middle of the nipple, and likewise into the circle which subtends its basis, and then run together on the area of that circle, and emerge at the root of the nipple, which they perforate round its margin, in a circular figure, after emerging through the root of the said *papilla* or nipple; for by this denomination we call a cavernous or spongy cellular body, into which the blood may pass out from its vessels, so as to cause a kind of erection, as in the penis. Through this papilla open about twenty or more of the excretory ducts from the breast, called *lactiferous;* none of which inosculate or join with the others, but are greatly contracted at their opening in the nipple to what they were in the breast: and these, in a loose or flaccid state of the nipple, are compressed, wrinkled, and collapsed together; but when the nipple is erected by any kind of titillation, they become straight and open, with patulent mouths, lurking betwixt the cutaneous wrinkles. This papilla or nipple is ſurrounded by a circle, planted with ſebaceous ſmall glandules, which defend the tender ſkin againſt the repeated attrition and perpetual moiſture.

Thus the infant is naturally provided with its firſt food, which is otherwiſe exceedingly ſalutary to man. This the infant by inſtinct knows how to receive, although it is as yet a ſtranger to all the other offices of human life. Taking the nipple in its mouth, it cauſes it to ſwell by gentle vellications; the lips are preſſed cloſe to the breaſt, that no air may enter betwixt; at the ſame time the inſpiration is deep, and a ſpace formed in the back part of the mouth, in which the air is more dilated or rarefied; and thus, by the preſſure of the external air, joined with that from the lips of the infant, the milk is urged from the breaſt through the nipple, in which it would otherwiſe be collected in ſo great a quantity, as ſometimes to diſtil ſpontaneouſly and be very ready to flow out; and thus the infant ſucks, and is nouriſhed. The firſt milk, which is like whey, termed *coloſtra*, looſens the tender bowels of the infant, and purges out the meconium, to the great advantage of the infant. Yet it is alſo obſervable, the lactiferous ducts are ſo open, that when the nipples of the breaſt are diſtended by titillation, and a greater quantity of blood ſent into the breaſts, they have yielded milk, even from virgins, ſometimes from old women, or even from men. Milk is only generated after puberty; before that time a ſerous humour flows from the breaſt; and for the moſt part it is generated only about the middle of pregnancy. After the menſes have ceaſed, the breaſts, as well as the uterus, become decayed, and ceaſe to perform their office.

But great changes now happen to the little new-born infant; and the firſt is *reſpiration*, which it endeavours to exert, even before it is well ſet at liberty from the vagina of the mother; being probably excited, from the pain or anguiſh it feels, to thoſe cries with which it it ſalutes the light, and perhaps from the deſire of food which it had hitherto taken in from the liquor of the amnios. At firſt, therefore, a portion of the air is admitted into the lungs, which are as yet ſmall and full of moiſt vapours; but being dilated from the air, change from a ſmall denſe body, ſinking even in ſalt water, into a light ſpongy floating fabric, extended to a conſiderable bulk with air, and of a white colour. Now, therefore, the blood paſſes more eaſily into the enlarged and looſe fabric of the lungs; in conſequence of which, a large portion of the blood that went before from the pulmonary artery, through the canalis arterioſus, into the aorta, goes now into and through the lungs themſelves, by the other branches of the ſaid pulmonary artery. And ſo much the more is the arterial duct or canal deſerted, inaſmuch as there is made a new obſtacle to the deſcent of the blood into the abdomen; for the umbilical arteries being now very ſtraitly tied, the blood of the deſcending aorta cannot now find its way but by the ſame force with which it dilates all the arteries of the pelvis and lower extremities. Finally, as the lungs now receive more blood, ſo the aorta itſelf receives a greater quantity, and with greater force likewiſe from the heart; whereupon the intermediate canal, betwixt the protuberant part of the aorta and pulmonary artery, cloſes up or ſhrinks to ſuch a degree, that, in adults, it is not only an empty ligament, but likewiſe of very little length; and otherwiſe it is ſingularly red in the inner part, ſoft, and very fit for concreting with the ſtagnating blood. This courſe of the blood, therefore, is ſoon aboliſhed, commonly in about the compaſs of a year.

In the like manner alſo, 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, as it is invited by the more lax pulmonary artery, into which it will rather move than through the paſſage through the ſeptum of the ſinuſes. Again, the umbilical vein, being now almoſt deſtitute of any ſupply with blood from the ligature of the navel, leſs blood will from thence flow into the lower cava, and conſequently the preſſure againſt the oval mouth will be diminiſhed; by which means the blood of the upper cava, being turned off by the iſthmus, will be ſcarce 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 ſaid 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 none of this 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 rignt ſide is always greater than its reſiſtance on the left, or certainly not leſs, even in the advance of life.

The *umbilical vein*, being deprived of blood, ſoon cloſes up. The blood of the vena portarum, having no oppoſition from that which formerly flowed through the umbilical vein, occupies the left ſinus and curve of the umbilical foſſa, and ſends 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, when 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. Nor do we overlook the force of the abdominal mufcles towards this effect, by which thofe arteries are compreffed againft the full abdomen in each refpiration; and, again, the very acute angle in which the umbilicalis goes off from the iliac artery, now becomes a curve, by defcending with the fides of the bladder, and is then directly extended into an acute fold, which the thighs make with the body of the fœtus. 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 likewife 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.

From the like caufes the bulk of the liver itfelf is leffened, and by degrees contracts itfelf within the capacity of the ribs; in the mean time the inteftina craffa, from the flender condition in which they are obferved in the fœtus, dilate to a confiderable diameter, and the ftomach itfelf is gradually elongated; the large con-

convexity of the cæcum forms itſelf by the force of the feces preſſing perpendicularly downward to the right ſide of the vermicular appendix; and the lower limbs are likewiſe conſiderably enlarged by the return of the blood, ſent back from the umbilical arteries now tied; and by degrees all the other changes are made, by which a fœtus inſenſibly advances to the nature and perfection of an adult perſon.

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

After birth the child continues to grow, but always more ſlowly the older it is. There are many concurring cauſes, why the growth is continually rendered leſs and leſs. Many veſſels ſeem to be ſtopped up, both becauſe they are compreſſed by the neighbouring torrent of blood flowing through the great arterious tube, and becauſe the blood being now become more viſcid runs into clots. But the harder kind of food that is now made uſe of, throws into the blood more terreſtrial parts; which being carried through the whole body along with the nutritious parts, renders them all harder, as the bones, teeth, cartilages, tendons, ligaments, veſſels, muſcles, membranes, and cellular texture; ſo that an increaſe of hardneſs may be perceived in them, even by touching them with the finger. Wherefore, ſeeing the blood flows from the heart through fewer canals, and ſeeing all parts are grown harder, which ſhould be lengthened or diſtended, it neceſſarily follows, that thoſe which ought to increaſe in bulk, will yield leſs and leſs to the impulſe of the heart.

But the heart likewiſe, which is the part that is firſt conſolidated 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 lefs than what it was in the new-born infant. At the fame time, from that very denfity which it has fo quickly acquired, it becomes lefs irritable, and is contracted lefs frequently within a given time. Thus, while the refifting forces are augmented, the diftending ones are at the fame time diminifhed.

There will therefore, fooner or later, be an end of the increafe of bulk; and that will happen fo much the fooner as the heart has had the more frequent and vivid contractions: but this ceffation of growth will take place when the cartilaginous crufts of all the bones are now become fo thin, that they cannot yield to the increafe of the bony part. In women, the menfes feem to put a ftop to the growth fooner than in men. In cartaliginous fifhes, there is perpetual growth.

There is no ftate in which nature by a perennial progrefs induces a continual decreafe from the firft conception. It is faid however to take place, when there is neither any increafe of bulk, nor yet does any vifible decreafe take place.

For we are all perpetually confuming. Nor do we only lofe the fluid parts of our bodies, but in fhort even thofe which are reckoned to be the moft folid. For even the bones are changed; and the teeth, which are harder than the bones, increafe in bulk when the attrition of the oppofite teeth has ceafed to wear them away, and therefore their elements are changed: even the fibres of ivory in the elephant's teeth have quitted their places, and furrounded on each fide in curve lines like a leaden fhot: the bony juice likewife is changed; feeing in fome cafes the bones grow foft, in others they fwell out in bony tumors: 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 proved by fome difeafes.

The

The cause of the destruction of the solid parts lies in their perpetual extension and retraction, which happens at every pulse of the heart: this occurs an hundred thousand times every day; and by this motion even metals themselves are worn. Other causes are from the friction of the fluid against the solid parts; from the wearing away of all the membranes, which terminate with a moveable extremity, either on the surface or in the internal cavities of the body, the firmness of which only belongs to the rest of the canal; in the alternate swelling and decrease of the muscles; and in the attraction and pressure which at first form our fleshy parts. But all parts of our body are the sooner worn away, that they consist of a great deal of gluten combined with a small quantity of earth; and that gluten when it is extended, if the extension has been a little superior to the force of its cohesion, must of necessity fall away and be carried off from the earthy parts. Thus wrinkles or furrows are generated; such as are visible in the arteries of old men. The cellular texture, which otherwise would be dissolved into water or gelly, is worn away by the impetus of the blood pressing against the neighbouring blood-vessels and muscles, by friction, and by perpetual flexion and extension.

The decrease would be very quick, and indeed there would be no great distance between the end of our life and its beginning, unless these losses were repaired. The fluid parts are restored by the aliments, and that pretty quickly; 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 shown elsewhere; the lymphatic juice from jelly; the mucus from mucus; and the rest of the humours from these and water. The solid parts are repaired almost by 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 exſudes 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 will not be wanting while there is a ſufficient quantity of aliment; while there is more reſt, and leſs reſiſtance, in the bottom of the furrow than elſewhere; which always muſt be the caſe, becauſe the bottom is farther removed from the motion of the blood by the depth of its cavity. There ſeem to be certain powers in the air, by which the aliment is attached to the ſolid parts, although 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 preſſed 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.

At that time when the growth of the body can proceed no farther, fatneſs 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 entering the ſmalleſt veſſels with more difficulty, is carried to the

the ſides of the veſſels; enters the lateral ones and the inorganic pores of the arteries; exſudes into the cellular texture; and there, the power of conquaſſation of the blood being now diminiſhed, and likewiſe the abſorption by the veins, the fat is conſequently collected.

We feel the beginnings of decay even in youth itſelf. Even in that blooming ſeaſon, the ſolid elements of the body are augmented, the chinks through which the humours flow are leſſened, ſmall veſſels filled up, and the greater attraction of the cellular texture has added a denſity to the whole body. Throughout the whole body, that hardneſs occaſioned by age is very conſpicuous, in the bones now wholly brittle, in the ſkin, in the tendons, in the conglobate glands, in the arteries, and likewiſe in the weight of all the parts, and of the brain itſelf. But thoſe parts grow ſtiff ſooneſt which are moſt exerciſed by motion; as thoſe in every mechanic, which he chiefly makes uſe of in his buſineſs.

Moreover, the arteries alſo continue to become more denſe, more narrow, and even to be quite filled up, as well by the internal preſſure of the blood flowing thro' the large arterial tube, as from the attraction of the cellular texture of which the greateſt part of the artery is made up. An infinite number of parts of the cellular texture thereof ceaſe to be nouriſhed; to which the ſmalleſt arteries hitherto brought their nouriſhment, but now when ſtopped up can bring none. The extending force being removed, the cellular fleeces draw themſelves together, contract the little ſpaces intercepted between them, degenerate into membranes, or ſubſtances of a hard texture, which intercept and as it were choak up other veſſels. But the gelatinous vapour likewiſe concretes in the ſmall hollows of the cellular texture, and unites into a hard ſolid with its ſides. The muſcles, having expelled the blood they

 contained,

contained, and condenſed their fibres, degenerate into hard denſe tendons deſtitute of all irritable power.

At the ſame time the nerves become more and more callous to the impreſſions of the ſenſes, and the muſcles grow leſs ſenſible to the ſolicitations of the animal powers; thus the contractile force of the heart, and the frequency of its pulſations, is diminiſhed, and therefore the whole force which drives the blood into the ſmalleſt veſſels.

The quantity of humours is diminiſhed in a denſe body, as is evident in the perſpiration, ſemen, humours of the eye, and of the conglobate glands; the vapour alſo which bedews the ſolid parts of the body every where decreaſes. For this reaſon nutrition now languiſhes, becauſe there are more parts of the body which require nouriſhment, and leſs nutritious juice.

Nor is the quantity of humours only diminiſhed: they themſelves are likewiſe corrupted. They were mild and viſcid in children: but theſe ſame humours are now acrid, ſalt, fetid, with a great quantity of earth, in old men. This happens through the uſe of ſalt or putrid aliments, the fault of which grows ſtronger by being collected through a great length of time; alſo through the fault of a leſs perſpirable ſkin, a coſtive belly on account of the diminiſhed irritability, and thus the increaſed reſorption of the putrid liquamen. Hence the fetor of the urine, of the breath, and the difficult healing of wounds.

But the greateſt fault of the humours is, that they abound with earthy particles, as well thoſe collected inſenſibly from the aliments after the ſecretions have become leſs free, as from thoſe which are carried off from the ſolid parts and returned into the blood: of this conſiſts the earth collected in ſome diſeaſes, and which is of the nature of the gouty earth. By this quantity of earth, the portion of that element through the whole body is augmented, becauſe the nutritious liquor brings too much of that along with it; whence the

the brittlenefs of the bones, and the hardnefs of all the other parts, increafes: the fame is likewife every where depofited in the cellular texture, and produces crufts, which are firft callous, then of a bony or ftony nature, and that chiefly in the coats of the arteries.

The hardnefs or rigidity of the whole body, the decreafe of the mufcular powers, and the weakening of the fenfes, conftitute *old age;* which happens to mankind fometimes fooner, and fometimes later: fooner if they have been fubjected to violent labour, or given themfelves up to pleafure, or lived upon unwholefome diet; but more flowly if they have followed a moderate way of life, and ufed temperance in their diet, or if they have removed from a cold to a warm country.

But when thofe caufes continue to operate by rendering the matter of the body more denfe, by diminifhing its irritability, and augmenting the quantity of earth, it is not poffible but decrepid old age muft fucceed. In it the fenfes are almoft deftroyed, the natural power of the mufcles is exceedingly weak, the limbs lofe their ftrength, the feet efpecially are not fufficient for fupporting and directing the body. Thus the callous infenfibility of the nerves cannot be incited to perform the office of generation: thus the very inteftines becoming inactive, refufe to anfwer to the accuftomed folicitations: thus alfo, by the induration of the cartilages interpofed betwixt the vertebræ, the body bends forward; by the falling out of the teeth, the jaws now rendered fhorter cannot fupport the lips as ufual; and laftly, the heart lofes one half of the frequency of its pulfation which it had in the infant ftate.

Thus at laft natural death neceffarily follows; but very many people are carried off before this time by difeafes. Scarce one in a thoufand exceeds the age of 90; but one or two perhaps may be found in a century that live to the age of 150. Man is long lived when

when compared with other animals; he is alſo more tender than any of them, has looſer fleſh, and leſs hard bones. Among the long-lived people, it is not eaſy to ſay what was the cauſe of that privilege. England ſeems to excel all other nations in the long-lived people; and generally the temperate countries are remarkable in this reſpect. Among all the different profeſſions, the commonalty has almoſt ſolely afforded theſe rare examples of longevity already mentioned; although from the more numerous claſs, we might expect a greater number of examples. Some prerogatives of long life ſeem to be ſobriety, at leaſt a moderate and not very rich diet; a mild behaviour; a mind not endowed with very great vivacity, but cheerful, and little ſubject to care. Among animals, fowls are longer lived than many others, but fiſhes the moſt of all; the latter have the ſmalleſt heart, and the ſloweſt growth, and their bones are never hardened.

Death happens ſometimes, but rarely, from mere old age. This we ſay happens when the powers are gradually loſt, firſt of the muſcles ſubject to the will, then of thoſe that are ſubſervient to the vital functions, and laſtly of the heart itſelf; ſo that old men ceaſe to live through mere weakneſs, rather than through the oppreſſion of any diſeaſe. We have often obſerved the ſame kind of death in brutes. The heart becomes unable to propel the blood to the extremities, the pulſe and heat deſert the feet and hands; yet the blood continues to be ſent forth from the heart into thoſe arteries that are next to it, and to be carried back from thence: thus the flame of life is ſupported for a little while; which we ſoon perceive to be extinguiſhed, when now the heart itſelf 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. Thus the utmoſt force of reſpiration is exerted in order to open a paſſage to the blood through the lungs, until even the

powers

powers given by nature for performing the action of inſpiration, become unequal to their taſk, and ceaſe altogether. Thus the left ſide of the heart neither receives blood nor is irritated, and therefore remains at reſt; while yet for a little time the right ventricle, and laſtly the auricle of the ſame ſide, receive the blood brought by the veins from the cold and contracted limbs, and by this means being irritated they continue to beat weakly. But laſtly, when the reſt of the body has become perfectly cold, and the fat itſelf congealed, even this motion ceaſes, and death becomes complete.

We would call that death, when the whole irritable nature has left the heart. For the mere reſting of the heart is not without hope of a revival of motion: neither does the putrefaction of any part of the animal body demonſtrate the death of the whole animal; nor does its inſenſibility or coldneſs do ſo: but all theſe things when joined together, and perpetually increaſing, with the ſtiffneſs which follows the coagulation of the fat by reſt and cold, preſent the ſigns of death in any doubtful caſe.

The dead body now haſtens to putrefaction. The fat, water, and gluten, in conſequence of ſeparation and diſſolution, conſume: the earth, deprived of its bonds of union, inſenſibly moulders away, and mixes itſelf with the duſt: the ſpirit departs whither God hath deſtined it. By death it is indeſtructible; which is manifeſt from the common and frequent obſervation of phthiſical people, who, while their bodily powers are waſting by diſeaſe, evidently poſſeſs a moſt ſerene, lively, and joyful mind.

CHAP.

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 length they are cylindrical, or very imperceptibly diminifhed, when they are called capillaries, and wherever they admit only a fingle globule; the fection being every where without exception circular in a diftended artery. Where they fend off large branches, the cavity is there fuddenly diminifhed, infomuch that they 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 bafis 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 veffel, unlefs it is cylindrical. In fome places they feem to diverge or dilate; at leaft they become there of a large diameter, after they have been filled or diftended with wax; which poffibly may arife from fome ftoppage of the wax, by whofe impulfe that part of the length of the artery becomes more diftended than the reft. Examples of this kind we have in the bafilar artery, at the bafis of the fkull, in the fplenetic artery, in the flexure of the carotid artery, according to Mr Cowper's injections; in the humeral artery near its divifion; and, laftly, unlefs thefe experiments deceive us, in the fpermatic arteries in all places, likewife, where the ramifications between the diameter of the artery is a little increafed.

There is no external coat proper and perpetual to all the arteries; 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 external membrane common to the arterial tube in all parts of the body, is the cellular ſubſtance, which in ſome parts (as in the thorax) we ſee repleniſhed with fat.

This cellular coat is, in its external ſurface, of a more lax texture, painted with a great many ſmall arteries and veins; and it has nerves running through its ſubſtance, which are none of the ſmalleſt. There is ſometimes ſo much of this cellular ſubſtance about the artery, as might occaſion one to think it hardly belonged to it as an external coat or lamella, but rather as ſome foreign net-work added to this veſſel. Thus we find it in the arteries of the neck, groins, and ſubclavians; in the meſenteric, cæliac, and hepatic arteries; where it is chiefly interwoven with long fibres. And theſe are the vaginæ or capſules of the arteries, formerly obſerved by ſome eminent anatomiſts, and which, according to Wriſberg, are beſt ſeen in young animals, or in ſuch as have laboured under a congeſtion or kind of ſuffocation.

As this cellular coat advances more inward, it becomes more denſe, ſolid, and is tied more cloſely together by a kind of wool, and may be called the *proper coat* of the artery. That there is no tendinous coat of the arteries diſtinct from this laſt part of the cellular ſubſtance, is evident from maceration, whereby the inner ſtratum of this arterious tunic changes into

into a cellular fabric, which may be divided into several layers.

Within the former, there is a coat of muscular fibres, which are in general imperfect circles: that is to say, no fibre any where makes a complete circle round the vessel; but a number of segments conjoined together, with their extremities turned off sidewise, seem to form one ring round the artery. These fibres, in the larger arterial trunks, form many strata, appear of a reddish colour, and are remarkably firm and solid; but in the smaller arteries they are by degrees more difficult to demonstrate, and seem to be wanting in the arteries of small animals. Dr Haller has never observed them to run along the vessel lengthwise. Under these membranes, but pretty 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 influent blood; so as to form a single incrustation that every where lines the fleshy fibres, which are not very continuous one to the other, and prevents the blood from insinuating into the spaces betwixt them. It is every where smooth and without valves; although, from a sort of mechanical necessity, sometimes certain folds, raised into a semicircle at the origination of branches, form a projecting eminence; as we see at the branches produced by the arch of the aorta. Yet, in arteries of the viscera, the innermost coat is softer, 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; and, springing on all sides from the next adjacent small arterial trunks, form numerous branchy net-works, which are all of them indeed very minute, but plainly appear, even in the fœtus, without injection, to be very numerous. There are also *nerves* which descend

 for

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 arch of the aorta; and Dr Walter has ſhown them in numerous arteries in the thorax and abdomen. And from theſe, do not the arteries ſeem to derive a muſcular and convulſive force, very different from that of their ſimple elaſticity? Does not this force ſhow itſelf plainly enough in fevers, faintings, palſy, conſumption, 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, ſays he, it has this in common with the dead ſkin. This, however, is not agreeable to the opinions of the preſent phyſiologiſts.

The *ſections*, or diviſions, of arteries ſhow themſelves with a round cavity, 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 in 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 naturally; and 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

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, almoſt eaſier than the coats of the veins; and from thence ariſe aneuriſms. 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 thoſe of the limbs. From hence it is, that aneuriſms are moſt frequently formed near the heart; for, in the lower extremities, the ſtrength of the arteries, and of the veins too, is much increaſed, as well as in the ſecreting organs.

With regard to the courſe and general diſtribution of the arteries, nature has every where diſperſed them through the whole animal body, except in a few membranes. But ſhe hath diſpoſed of the trunks every where in places of ſafety; becauſe wounds cannot happen to the ſmaller of them without danger, nor to the larger without loſs of life. The ſkin is ſpread with numerous ſhort and ſmall arterial trunks; but the larger ones, 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 creature, whofe blood hath a feeble motion.

From the trunks of all the arteries branches are fent forth, and from thefe again proceed leffer twigs by a numerous divifion, of which you can fcarce find the end, though you may perhaps count twenty fubdivifions of this kind. Here the fections of any two branches taken together, always exceed that of the trunk from whence they come, in the proportion of three to two, or fomewhat lefs. Alfo every trunk juft above its divifion is fomewhat broader or more expanded. The angles, at which the branches go out from their trunks, are generally acute, either half right angles or nearly fo; to the forming of which angles, as we fee in mechanics, there is required the longeft projection. Inftances of their going off at right angles, or nearly fo, we have in the lumbal or intercoftal arteries; of their going off in a retrogade or reflected courfe, we have one inftance in the coronaries of the heart, and another inftance in the fpinal arteries, which are produced by the vertebrals. But, generally fpeaking, thofe which are efteemed retrogade or reflexed, 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 ones of the large bones. Laftly, we often obferve large branches arifing under leffer angles, and fmaller ones under greater angles: but it is rarely that we obferve two arteries of a large diameter run together into one trunk. An example of this, however, we have in that artery which is formed out of the vertebrals: in the fmaller ones it is frequent, as in both the fpinal arteries, and that of the fincipital foramen. In many parts, the arteries have repeated alternate undulations or flexures, as they run on in a fpiral courfe, wherein we fee their diameter often confiderably enlarged, as in the large inteftines, womb, face, fpleen, lips, and iris.

Even the ſtraight arteries in other places, if too much diſtended, fall into ſerpentine flexures. Sometimes they are ſuddenly twiſted into a kind of circles, as the carotids under the mamillary proceſs.

The arteries are frequently conjoined by intermediate branches, in ſuch a manner, that the twig of ſome certain artery ſhall run to meet one of the ſame kind from another neighbouring artery, and, by joining together with that, form one trunk. Inſtances of this kind we have among the large trunks in the inteſtines, among the middling ones in the kidneys, womb, &c. and among the ſmaller in all parts of the body; inſomuch that there is no part of the human body, wherein the neighbouring arterial trunks, whether of the ſame or of different denominations, do not form anaſtomoſes or joinings one to the other by intermediate branches. Of rings diverging laterally from the arteries, and returning into themſelves, we have inſtances in the eye and brain. The extremities of the arteries, which are either cylindrical or nearly ſo, ſend off ſmaller branches, which, for their extent, are more numerous and generally diſpoſed like a net; ſo that each branch, by its ſmaller twigs, forms anaſtomoſes with thoſe of its neighbouring branches: and thus we find it in all membranes. By this means it happens, that, though the paſſage from the heart to any part of an artery is obſtructed, the blood may nevertheleſs flow through the neighbouring arteries into all the branches of 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 ſurpaſſed the angle of its reflection, becomes now a ſmall vein; or elſe a branch, ſent out at right angles from the artery, is inſerted under a like

angle

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. And theſe vaſcules we ſee ſometimes 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-works as in a different fabricature, wherein the ſmall branches deſcend very thick, or in cluſters, parallel to the trunk, ſo as to reſemble bruſh-pencils, 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. Theſe are ſometimes continuous to the arteries and real arterial trunks, as may be obſerved in the ophthalmic artery, upon 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, is evident from inflammations, and the redneſs of the parts when relaxed by vapour or by cupping; from repletion, and the microſcopical experiments of Lieberkuhn upon frogs, in which colourleſs globules were ſeen to paſs from a red artery into a lateral veſſel. In a fabric of this kind the red blood is eaſily forced into the ſmaller veſſels.

In other places the ſmaller veſſels ſeem to proceed laterally as branches from the trunks of the leaſt ſanguineous arteries, and are drawn out into trunks ſtill ſmaller. Theſe are called *excretory ducts*. It is with difficulty that theſe veſſels are filled with red blood; of this, however, we have examples in the kidneys, the liver, and breaſts. Indeed the blood, when vitiated, penetrates the excretory ducts of the whole body, even without hurting the veſſels; nor is that aberration found to be productive of any evil consequence after the disorder of the blood is cured.

Another termination of the arterial extremities is into the exhaling vessels; and this is a manner of their ending very frequently to be observed in all parts of the body. The whole skin, all membranes of the human body, which form any close cavity, all the ventricles of the brain, the anterior and posterior chambers of the eyes, all the adipose cells and pulmonary vesicles, the whole cavity of the stomach and intestinal tube, through which the air has a passage, are all of them replenished with exhaling arteries of this kind. These emit a thin, watery, gelatinous humour, which, being collected together by standing, sometimes makes no inconsiderable quantity; and, particularly by disease or death, is converted into a watery, but coagulable lymph. The truth of this is easily demonstrable from the watery sweat that ensues after injecting the arteries with that liquor warm. In some places, indeed, they exhale not a thin vapour, but blood itself, as we see in the heart, the cellular fabric of the penis, urethra, clitoris, and nipple of the female breast; in all which the blood itself is naturally poured out. Does not every secretion, that is made in true glands or hollow cryptæ, bear some analogy to this exhaling fabric?

Whether or no, in all parts of the human body, do the pellucid vessels, arising from the sanguine ones, and carrying a humour thinner than blood, again send out smaller vessels, to be subdivided into still lesser orders? We seem, indeed, not to want examples of this in the manner proposed to us by the most celebrated professors. Different anatomists have seen, in various parts of the body, a new rise of blood-vessels, after the course of the blood to the heart had been obstructed. That the aqueous humour is separated by very fine vessels, generated from the colourless arteries of the iris, is very probable. That the red-coloured vessels in the cortical

cortical ſubſtance of the brain, ſeparate a juice pervading the medullary ſubſtance, by the intermedium of another order of veſſels, we are almoſt certain. And the like we are perſuaded from an eryſipelas or yellow inflammation, ariſing from the yellow or ſerous globules impacted into ſmaller veſſels.

It may then be aſked, if there are not yellow arterious veſſels of a ſecond order, which ſend off lymphatic ones of a third order, from whence by degrees ſtill leſſer kinds of veſſels branch out? Such a fabric does not ſeem agreeable to the very eaſy tranſition that is made by the blood, mercury, or wax, into the exhaling and perſpiratory veſſels, or into the uriniferous tubuli, with the adipoſe and pulmonary cells; nor is it very difficult for the blood to ſtray into the lactiferous, lymphatic and lachrymal ducts, whither it ſhould ſeem not able to penetrate, if it went through any other intermediate vaſcular ſyſtem ſmaller than the blood globules, which make the ſame journey. Nor can it be admitted, from the great retardation, which the humours muſt, in a third order of veſſels, meet with from this mechaniſm, and which is continually to increaſe in proportion to their diminiſhed ſize.

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

The blood is driven from the left ventricle of the heart into the aorta; and here the maſs of this purple fluid ſtrikes firſt againſt the right ſide, and is then reflected to the left ſide of the aorta; whence flowing in a vortical or whirling motion as much as that full veſſel will permit, it goes on through the arteries, with an alternate colliſion againſt, and repercuſſion from, their ſides.

The arteries are, in a living perſon, always full of blood; ſince the jet or ſtream ſtarts from an artery, is not interrupted by alternate ſtops, while the heart reſts or relaxes itſelf, but it flows on in a continued thread:

add to this, that the microſcope ſhows the arteries, in living animals, to be full, both in their ſyſtole and diaſtole; nor can the circular fibres of the arteries ſo far contract themſelves as entirely to evacuate theſe tubes. Since, therefore, a new wave or column of blood is ſent into the arteries, already full, although it bear a ſmall proportion to the whole maſs contained in the arterial ſyſtem throughout the body, hardly ever exceeding two ounces; yet, by its immediate contact with the precedent wave or column, which moves ſlower as it gets farther from the heart, it conſequently drives the ſame forwards, lengthens the artery, and makes it aſſume a cylindric form, augments its diameter, preſſes the membranes cloſer to one another, urges the convex parts of the arterial flexures outwards, and cauſes their ſpiral waves to be more ſerpentine, as injections demonſtrate to us. This dilatation of the artery, whereby its light or capacity is changed from a leſs to a greater circle, is called the *pulſe;* the diaſtole of which is an expanſion of the artery beyond its natural diameter. This being the proper or characteriſtic action of life, reſults from the heart only, and is in nowiſe natural to the arteries left to themſelves. Hence when the motion of the heart is intercepted, whether by aneuriſm, ligature, or otherwiſe, there is no pulſation of the arteries to be felt; and hence there is a ſudden ceſſation of the pulſe, by a wound through the heart, in a living animal. But the arterty is proportionally more dilated, as the wave of blood flows on before more ſlowly, and 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 ſtate of relaxation and reſt. But the artery, at this ſame time, by its innate elaſticity and contractile power reſiding in its circular fibres, irritated likewiſe by the ſtimulus of the blood, contracts itſelf, and expels as

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much blood as ſerved to dilate it beyond its mean or middle 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 in the part of that veſſel through which it has juſt now paſſed. So 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.

That the arteries thus contract, and, by that force, propel their contained blood, is proved evidently from their ſtrongly contractile nature; from the apparent diminution of the diameter or dilatation they receive from the heart; from the evacuation that follows, by the proper force of the artery itſelf, driving out all the blood that is contained in the lateral branches betwixt two ligatures; from the return of the blood to the heart through veins whoſe artery is tied, which therefore the heart has no ſhare in propelling; 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 from the tied aorta below the ligature; 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; and, laſtly, from the conſiderable ſaltus of blood that iſſues from a large artery in an animal even after death, mounting to the height of two feet: to which add, the convulſive contractions of the animal in which the artery is thus wounded, and the remarkable cloſings of the mouths of divided arteries in wounds, and a ſphacelation of the limbs from an oſſification of the artery; whence the veins become diſtended.

The mean ſwiftneſs of the blood's motion being di-

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minifhed in the time of the heart's fyftole, but increafed during its diaftole, is fuch as carries it through a fpace fomewhat lefs than one foot in the fpace of a fecond of time; and the conftant plenitude of the arteries renders it impoffible for us to perceive any fucceffion in the pulfes of different arteries; whence all the arteries of the body feem to beat at one and the fame inftant, whilft the heart ftrikes againft the breaft: and yet there is certainly a fucceffion in the fyftole of the arteries, by which the aorta feems to contract in the fame order fucceffively, as it is filled by the blood expelled from the heart; fo that the part of the artery next the heart is firft conftringed, and thence gradually, the arterial contracting force proceeds to the extremities. An inftance of this we have in the inteftines; and the fame is evident to the eye in infects, who have a long fiftulous and knotted heart, manifeftly contracting in a fucceffion from the beginning to the end. But the mind cannot diftinguifh the leaft points of time, which are the meafures of this fucceffion, and amount only to a few thirds of a fecond.

If it be afked, Where this pulfation ends? we anfwer, In the leaft arteries, and cylindrical originations of the veins. We have already mentioned the velocity with which the blood comes from the heart. But that velocity continually decreafes. Certain we are, (1.) That the fections of the arteries, compofed by the aggregation or fum of their tranfverfe fections, as they divide farther in their courfe from the heart, greatly exceed that of the aorta; fo that fince the ratio, or lefs proportion of the trunks to their branches, continually diminifhes as they make lefs ramifications, and this in a variable or uncertain proportion; the difference of that ratio or proportion will be the greateft betwixt the light of the aorta at the heart, and the fum of the fections of all the fmall arteries, where they are leaft, in the extreme parts of the body. Again, (2.) The proportion of the arterial membranes or coats in thicknefs,

thicknefs, with refpect to their bores or capacities, is greater as the arteries grow lefs; and is largeft in the leaft of them, which tranfmit only one globule at a time. The truth of this is proved from anatomy, and the forcing of air into the arteries, by which they burft always more difficultly as they are lefs; and from the calculation itfelf, by which the magnitude of the leaft arteries is determined from the globules diftending their two femicylindric membranes. Add to this, (3.) The friction of the juices through the leaft veffels, inflected and meeting together in angles; which friction, even in the moft fluid water, running through long pipes that are fingle, and in a direct courfe, greatly diminifhes the velocity, and more in proportion as the tube is of a lefs bore; while again, as the artery is lefs, there are a great number of globules rubbing and grating againft its membranous converging fides. And by the conical figure of the artery, it happens, that the broader wave of blood, coming from the trunk, is refifted in its paffage through the narrower branch, and fo muft diftend it by force. But moreover, (4.) The inflections and folds, or plates of the veffels, greatly flacken the blood's motion; fince always fome part of the impelling force is fpent and loft in removing the convex parts of the folds, and changing the figure of the inflected veffel. The angles likewife take off more from this force in proportion to their acutenefs, or the more they recede from a ftraight line. Laftly, (5.) A confiderable allowance muft be made for the great vifcidity or tenacity of the blood itfelf; fince, by reft only, it directly hardens into clots; and fince it is from the circulatory motion only of the blood, that this mutual attraction of parts is overcome, fo as to hinder it from adhering to the fides of the arteries; for fo we find it adhere in anuerifms and wounds of the arteries, or elfe the globules clot together, as we fee ufually after death. From all which confiderations, you will obferve, that the blood meets with the greateſt retardation in its courſe in the leaſt veſſels. And the oppoſition it meets with in the branches leſſens the velocity of the blood alſo in the trunk: the oppoſition of torrents of blood to one another in the anaſtomoſes of veſſels alſo deſtroys ſome parts of its motion. We may eaſily perceive the amounts 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; ſo that in theſe it begins to put on a ſtate of coagulation. It is alſo well known to ſurgeons, that a ſmall branch of an artery near the heart or aorta bleeds more dangerouſly than a much larger one that lies 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, make a reſiſtance indeed to the heart; but do not leſſen the velocity of the blood, ſeeing 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 by which this power, deſtructive of the blood's motion, is leſſened. And, in the firſt place, it is certain, that the lights of the branches do not bear ſuch a proportion to the trunk in the ſmalleſt veſſels; their great ſmoothneſs diminiſhes the friction. The facility likewiſe with which the blood flows through the veins, expedites its paſſage through the little arteries, which immediately communicate with theſe veins. No great help is to be expected from conſidering the effect of ligatures or the weight of the blood, which is capable both of diminiſhing and accelerating the motion; nor can we ſuppoſe that in live animals a great effect depends upon the force of the nerves. The power of derivation, whatever that is, and the motion of the mufcles, are capable of producing a new velocity.

The pulfe therefore enfues, becaufe the anterior wave or column of blood moves on flower, while the fubfequent or pofterior wave comes fafter; fo that the preceding is an obftacle to the confequent blood. But fince the force of the heart weakens as the blood goes on, and the contractile power of the arteries increafes, therefore the difproportion of celerity betwixt the antecedent and confequent waves or columns of blood coming from the heart, will be continually leffening with refpect to the blood that is urged on by the contraction of the fmaller veffels, till arriving at a part where there is no excefs or difference, it will there ceafe to make any pulfation of the artery; becaufe here the anterior and confequent blood flow evenly, or with the fame celerity. But this place of equality in motion cannot be in the larger and more confpicuous arterial branches: for in them the wave, laft coming from the heart, moves quicker than what went before; as is evident from the inflammatory pulfation of them, efpecially in the fmall arteries of the eye. But, in the leaft red arteries, the pulfe at length begins to vanifh. This is evident from the equable motion of the blood, often feen by a microfcope through the arteries of a frog. In the larger veffels, however, fuch as may be about the fixth part of a line in diameter, the pulfe is perceptible. But in the leaft veins vifible to the eye, there is no fenfible pulfation or accelerated motion of the blood, whilft the heart contracts, demonftrable either by the microfcope or any other experiment.

Even in the veins, the blood preffes againft their fides, as appears from the furrows hollowed out of the bones, and the fwelling of the veins on being tied. If it be afked, Why the veins do not beat? (for we do not allow that to be a pulfe which happens from refpiration, from the rejection of the blood from the right auricle, or from the mufcular part of the vena cava); the reafon of this feems to be, that the blood, immediately on its leaving the heart, is more retarded in its motion than when it paffes into the fmalleft veffels. Hence, the fhort fpace of time by which the velocity of the laft wave exceeds the foregoing, is greateft at the heart, and grows gradually lefs, till it at laft totally vanifhes. This is illuftrated by the experiment, in which a pipe, fixed in a leathern tube, and driving forth water in a continual, but ftarting ftream, does, by a fponge fixed round the mouth of the faid tube, caufe the water to iffue forth in an even ftream, without leaping through the fponge; and the fame is evident from another experiment, in which the fame thing happens, by injecting the mefenteric arteries with an alternate impulfion of water; for then the water flows out through the veins in one continued even ftream.

The pulfe is therefore the meafure of the powers which the heart fpends on the blood; becaufe it is the immediate and full effect of thofe powers. Hence, all things confidered as alike, the pulfe is flow in the moft healthy people, where there is no ftimulus, nor any unnatural refiftance to caufe the effect of a ftimulus, but the heart is at liberty to fend forwards the blood with eafe. You muft except thofe cafes where there is fome obftacle, by which the blood is prevented from entering the aorta. For this reafon the pulfe in afthmatic people is flow: the fame thing alfo happens from a debility or infenfibility of the heart, which the ufual ftimulus is not capable of exciting to contraction. A large pulfe is caufed by fulnefs of the artery, joined with a ftrong force of the heart; a fmall pulfe by the emptinefs of the artery, and a leffer wave of blood fent from the heart. A hard pulfe denotes fome obftacle or ftimulus; or elfe that the heart's force is increafed with a greater thicknefs of blood, or a greater rigidity of the artery. A quick pulfe denotes fome ftimulus, obftacle, or greater fenfibility or irritability

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of the heart. It 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 the heart is proportionably bigger in the fmaller than in the larger animals, and, as well as the other parts of the body, is more irritable in the former than in the latter; and becaufe the heart is obliged to drive the blood to a greater diftance; whence the refiftances or frictions in the more bulky feem to be increafed more than the force of the heart. Hence, fmall animals are more voracious; and large ones, as the whale and elephant, eat lefs. The pulfe of a healththy perfon rifing in the morning, beats 65 in a minute; but, after the fatigue of the day, it will beat 80 in that time; 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 taken into the ftomach, urge the venal blood on to the heart, which being thereby oftener ftimulated, makes more frequent contractions. This is the caufe of thofe paroxyfms or fits of increafe obfervable in all fevers towards the evening. For fleep not only retards the motion of the blood, but of all the other humours and actions in the body whatever.

A frequent pulfe is different from a fwift one; and it is poffible for the pulfe to be at the fame time fwift and unfrequent. But it is difficult to obferve a fwift pulfe. The frequent pulfe is what is commonly called a fwift one. It takes place in children, and becomes afterwards flower in perfons as they grow older. The falient point beats 134 in a minute: new-born infants have their pulfe 120 in that time; and from thence down to old age it grows flower, to 60 in a minute.

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A feverish pulse begins from 96 per minute; and we count the pulse has but a moderate celerity in fevers, or laborious exercises of adult persons, if it does not exceed above 110 or 120 in a minute: but it is excessive at 130 or 140, with which number people seldom recover; nor have we ever observed it exceed that number. The pulse beats slower in winter, and quicker in summer, by about 10 strokes per minute; and under the torrid zone, it grows quicker 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 only the heart, being with more difficulty freed from the stimulating, contracts itself more strongly, and at shorter intervals. An irritation from an acrid blood is the cause of the frequent pulse in fevers.

Through the least veins the blood moves on very slowly, partly by force of the heart, and partly by the contractile force of the arteries. The first is proved by 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. But the contractile force of the artery is proved by what has been said above. But after death the blood continues to move, in part, also by its own gravity, and by the elasticity of the air generated or extricated by putrefaction.

But the blood moves on faster in the larger veins. For whenever the impelling powers remain sufficient, and the conveying 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. Therefore if the motion

tion of the venal blood loſes nothing in its way, the proportion of its celerity in the vena cava, to its celerity in the veins of the thirtieth diviſion, will be thirty times greater in the former, in proportion as the conjunct ſections of all the ſmall veins exceed the ſection of the cava. In like manner, too, the friction or attrition of the blood in the veins, and its contact with their ſides, diminiſh.

But 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 wonderfully hinders its return to the heart, while, at the ſame time, the very thin coats of the veins have but little contractile power to be expected from them; therefore nature has 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 ſhe probably ſent by the arteries, if we conſider the great exhalation that is made from the arterial blood in the lungs.

She has, therefore, likewiſe placed the veins near the muſcles, that by the turgeſcence or contractions of the latter the veins may be preſſed; and ſince any preſſure upon the veins muſt be determined towards the heart, therefore all this force muſt be entirely employed in accelerating the return of the blood to the heart. From hence proceeds that wonderful quickneſs of the pulſe, heat, and redneſs of the body, with a ſhort and laborious breathing, that attend muſcular motions or violent exerciſes.

Moreover, thoſe muſcles which conſtantly urge or preſs violently the contiguous viſcera on all ſides that are contained in any of the common cavities, do all of them powerfully promote the return of the venal blood to the heart. Such an effect has the conjunct preſſure of the diaphragm with the abdominal muſcles, in reſpect to the abdomen. Laſtly, the pulſations of the arteries, which run every where contiguous and parallel to the ſides of the veins, have no inconſiderable effect in promoting the return of the venal blood; ſince, as we have before ſhown, 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 place where it is more compreſſed to one more lax, and where it meets with leſs reſiſtance. 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 power of derivation from all parts of the body: and again, in exſpiration, it is driven into the trunks of the veins in the head and abdomen. Hence the ſwelling of the veins, and likewiſe of the brain, in the time of exſpiration. 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 render the paſſage of the blood more eaſy from thoſe places where it is obſtructed to ſuch as are more free.

By theſe means, the blood in a healthy perſon, uſing ſufficient exerciſe of body, moves on with ſuch a velocity, as ſuffices to deliver as much of the purple fluid in every pulſe by the vena cava to the heart, as is equal to what is ſent out by that great artery 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 and the piles in women with child; which latter is much occaſioned from the deficiency of valves in the vena portarum. And from hence ſpring even the menſes themſelves. And when the veins too ſlowly return their blood to the heart, the ſubtile vapours, being thus unable to return to the heart, are obliged to ſtagnate; whence proceeds that frequency of œdematous and pitting ſwellings of weak people.

The time in which an ounce of blood, ſent out from the

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, and different in every different portion of the body. If, however, you want to know about the ounce of blood propelled in that quantity, which we have mentioned, the amount of it will be about $7\frac{1}{2}$ ounces in an hour with 4500 pulfes; and the amount of the perfect circulations will be about $23\frac{1}{2}$.

The effects which follow from the motion of the heart and arteries upon the blood are various; which may be deduced and eftimated from the caufes themfelves of thofe effects, if we compare the blood of a living and of a dead animal, that which is healthy with that which is difeafed, and that which is inert or too little moved with that which circulates too fwiftly. For we obferve that, in the living, the blood is, (1.) Confiderably warm or hot. (2.) It looks red, with a fort of purple florid hue. (3.) It feems to be homogeneous or uniform, and alike in its parts; though they are really mixed and of different principles. (4.) It is made up almoft entirely of particles, commonly called globules. (5.) It flows very readily through the leaft veffels: From whence being drawn, (6.) It exhales a volatile vapour, which we have already defcribed particularly. In the dead animal which has not yet begun to corrupt or putrefy, we obferve, (1.) That it has loft a great deal of its rednefs. (2.) That it feparates into a more denfe and a more thin fubftance. (3.) That it exhales no vapour. (4.) Being drawn out from the veins, it congeals all or the greateft part. But even in the living animal, when very weak, where there is fome pulfe or refpiration, though fmall, we find the blood cold, even to a confiderable degree. If, again, you compare the blood of a human perfon, unactive both in body and mind, with the blood of one that is addicted to violent exercife, you will obferve the latter has, (1.) A greater heat. (2.) A more intenfe rednefs.

(3.) A ſubſtance more compact, and ſpecifically heavier. And, (4.) The volatile parts more abundant. All which appearances ſeem manifeſtly the effects of the motion of the heart and arteries, ſince they proportionably increaſe and diminiſh with that motion, and diſappear when that 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 the ſame, and of the arteries alternately compreſſing and urging it forward. And firſt we ſee, that the heart drives the blood into the arteries with a very great celerity. With a confuſed or vortical motion, the heart thus throws the blood into the crooked or inflected arteries, in ſuch a manner that the right globules, expelled through 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 or diſtends them into a greater convexity; and, laſtly, in the ſmaller veſſels, capable of receiving only one or a few of the blood-particles, all the ſaid particles come ſo intimately into contact with, and grate againſt, the ſides of the ſaid artery in all their points, that they are even obliged to change their figure in gaining a paſſage into the veins.

But the arteries, by their elaſtic force, reacting upon the impinging blood, repel the ſame from their ſides towards the axis of the light or capacity; 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 moſt prodigious 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

tion 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, and from the ſtrong impulſe of the heart, joined with the powerful reaction of the arteries; to which add, the weight of the incumbent parts raiſed by the force of the arterial blood. This friction generates a fluidity in the blood, by perpetually removing the points of contact in its particles, reſiſting their attraction of coheſion, mixing together particles of different kinds; which become more fluid upon mixture; as we have an inſtance in oil when triturated with water. It alſo augments the roundneſs of the particles, by breaking off their protuberances and little branchings. 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 deficiency in theſe particulars the blood coagulates in the veſſels before death; and hence 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 a queſtion, whether this motion of the blood, and the denſity proceeding from it, is the cauſe of the red colour of the blood, ſeeing the redneſs is in proportion to the denſity, and increaſes or decreaſes from the ſame cauſes. This ſeems to ariſe from a mixture of the ferruginous with the oily part of the blood.

We may alſo aſk, whether the heat of the blood does not alſo proceed from its motion? ſeeing we obſerve heat to ariſe from the motion of all kinds of fluids, even of air itſelf, in our experiments; but much more does this attrition produce heat in the inflammable animal juices, which are denſer than water, and compreſſed with a conſiderable force by contractile and converging tubes. Is not the truth of this sufficiently evinced, by the blood's being warm in those fish which have a large heart, and cold in such as have a small one? the generation of heat being in proportion to the size of their bodies: from the more intense heat of birds that have a larger heart, and more frequent or quick pulsations? from the increase of animal heat, that ensues from exercise of all kinds, and even from 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 stiff, tho' he yet retains some warm blood and is alive? and from the coldness of such people as have their pulse weak and obscure? Nor does the heat at all arise at first from any degree of putrefaction in the blood, seeing the humours themselves, when left at rest, generate no heat. Nor must we explain an evident appearance from the action of such an obscure being as the *vital power*; and though sometimes the heat may be greater when the pulse is slow, and less when it is more frequent, the difference may arise from the different disposition of the blood, from the different densities of the vessels, or the increase or diminution of perspiration.

The same cause also hinders putrefaction, by not suffering the intestine motion to be diminished, and by dissipating such particles as have already begun to be corrupted.

But the different natures of the several particles themselves, which conjunctly make up the mass of blood, are the causes by which, from one and the same impetus of the heart, different effects or consequences are produced in different particles of the blood; namely, those particles move quicker, whose greater density makes them receive a greater impetus, and whose apt figure or less extended surface makes them meet with less resistance in the fluid in which they move. Those also are driven along more swiftly

which

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

The ſyſtole of the arteries renders the parts of their contained fluids more denſe or compact, while they contract round the blood as round a ſolid obſtacle; which being in ſome parts viſcid and compreſſible, they drive and expel the more liquid parts into the lateral mouths or ducts, at the ſame time increaſing the points of contact betwixt the particles themſelves, combining their more large and denſe particles, and compacting the flat particles into denſer bodies. But the denſity of the blood is partly as the number of particles, and partly as the denſity of the materials whereof theſe particles are compoſed.

Moreover, the mouths of the leaſt veſſels pervious to only one particle at a time, ſeem to be a ſort of moulds to figure and break off the angular eminences of the particles in the blood, and bring them to a circular figure; which at length they put on, and change into perfect circles, which, according to the obſervations of Mr Hewſon, are 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 cohering begins to form an obſtruction, a contrary flux is admitted, by which the obſtructing matter is repelled to a larger part of the trunk; and thus betwixt the reflux and the direct torrent of the blood, the ſaid matter is broken and attenuated. This mechaniſm alſo ſupplies the deficiency from an irremovable obſtruction or the loſs of a veſſel, by cauſing a greater diſtenſion or enlargement of the next adjoining or anaſtomoſing veſſel; as is proved by experience in ſurgery, after tying and cutting a great artery. The colliſion of theſe oppoſite torrents of blood take ſomething from its velocity; and the reticular diſtribution augments the friction of the particles.

As the quicker motions of the blood in the trunks conduce to ſanguification, ſo the ſlower motions of it, in the leaſt veſſels, have their effects towards the ſecretions. In the larger arteries we ſee the different particles of the blood are whirled about amongſt each other with a rapid and confuſed motion; but, in the leſſer ramifications, the progreſſive motion of the blood being diminiſhed, the more looſe colourleſs particles depart laterally from the more denſe and red particles; while the latter, keeping on their courſe more firmly along the axis of the veſſel, expel the former laterally, and to the circumference. Thus the attractive powers of the particles of the blood increaſe as their progreſſive 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 ſubſtance; which particles we know are both groſs and ſluggiſh: and again, other thinner juices are ſent off through lateral branches of a much ſmaller orifice, till at length little more than the red blood alone remains to paſs through the coaleſcent artery into the incipient vein: But all theſe particulars, by which the blood is diſpoſed for the ſecretions, we ſhall conſider in another place.

§ 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 diſtributes the blood to all the parts of the body,

body, for the nouriſhment of the parts, and for the ſecretion of different fluids.

The arteria pulmonalis carries the venal blood thro' all the capillary veſſels 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 from whence the blood paſſes into the left ventricle. From this the aorta goes out in a direct courſe, 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 hand, and from before, backward.

Soon after this, it bends obliquely from the right hand 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 hand; 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 both are but one and the ſame trunk. It is termed *aſcendens*, 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 ſacrum or bifurcation already mentioned, is named *deſcendens*.

The aorta deſcendens is further divided into the ſuperior and inferior portions; the firſt taking in all that lies above the diaphragm; the other, all that lies between the diaphragm and the bifurcation.

The aorta aſcendens is chiefly diſtributed to part of the thorax, to the head and upper extremities. The ſuperior portion of the aorta deſcendens furniſhes the reſt of the thorax; the inferior portion furniſhes the abdomen and lower extremities.

The great trunk of the aorta, thro' its whole length, ſends off immediately ſeveral branches, which are afterwards differently ramified; and theſe arterial branches may be looked upon as ſo many trunks with reſpect to the other ramifications, which again may be conſidered as ſmall trunks with regard to the ramifications that they ſend off.

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

The large capital branches of the aorta are theſe: two arteriæ ſubclaviæ; two carotides, one cæliaca, one meſenterica ſuperior, two renales, formerly termed *emulgentes*, one meſenterica inferior, and two iliacæ.

The ſmall capital branches are chiefly the arteriæ coronariæ cordis, bronchiales, œſophagææ, intercoſtales, dia-

diaphragmaticæ inferiores, ſpermaticæ, lumbares, and ſacræ.

These capital branches or arteries are for the moſt part diſpoſed in pairs; there being none in odd numbers but the cæliaca, the two meſentericæ, ſome of the œſophagææ, the bronchialis, and ſometimes the ſacræ.

The ramifications of each capital branch are in uneven numbers with reſpect to their particular trunks; but with reſpect to the ramifications of the like capital trunks on the other ſide, they are diſpoſed in pairs. Among the branches there are in odd numbers, none but the arteria ſacra when it is ſingle, and the œſophagææ, the ramifications of which are ſometimes found in pairs.

Before we enter upon the detail of each of theſe particular arteries, many of which have proper names; it will be convenient to give a ſhort view of the diſpoſition and diſtribution of the principal arterial branches, as a general plan to which all the particularities of each diſtribution may afterwards be referred: for we have found by experience, that the common method of deſcribing the courſe of all the ramifications of theſe veſſels, without having firſt given a general idea of the principal branches, is very troubleſome to beginners.

From the upper part of the arch or curvature, the aorta ſends out commonly three, ſometimes 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, *ſubclaviæ*; and both are diſtinguiſhed into right and left.

When there are but three branches, which is ofteneſt the caſe, the firſt is a ſhort trunk, common to the right ſubclavian and carotid; the ſecond is the left ſubclavian; and the third the left carotid. Sometimes, though very rarely, theſe four arteries unite in two trunks.

The origin of the left ſubclavian terminates the aorta aſcendens; but we have ſometimes obſerved four branches,

branches, the firſt three of which were thoſe already mentioned, and the fourth a diſtinct trunk of the left vertebral artery.

It muſt be obſerved, that theſe large branches which ariſe from the curvature of the aorta, are ſituated obliquely; the firſt, or that which is moſt on the right hand, lying more forward than the reſt, and the laſt, which is moſt on the left hand, 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 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

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 where it goes out of the thorax to the axilla, detaches chiefly the mammaria externa or thoracica ſuperior, thoracica inferior, ſcapulares externæ, ſcapularis interna, humeralis or muſcularis, &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 ſuperior portion of the aorta deſcendens gives off the arteriæ bronchiales, which ariſe ſometimes by a ſmall common trunk, ſometimes ſeparate, and ſometimes do not come immediately from the aorta. It next ſends off the œſophagææ, which may be looked upon as mediaſtinæ poſteriores; and then the intercoſtales from its poſterior part, which in ſome ſubjects come all from this portion of the aorta, in others only the loweſt eight or nine.

The ſmall anterior arteries here mentioned are generally, at their origins, ſingle and in uneven numbers, but they divide ſoon after toward the right and left.

The inferior portion of the deſcending aorta, as it paſſes through the diaphragm, gives off the diaphragmaticæ inferiores or phrenicæ, which however do not always come immediately from the aorta. Afterwards it ſends off ſeveral branches anteriorly, poſteriorly, and laterally.

The anterior branches are cæliaca, which ſupply the ſtomach, liver, ſpleen, pancreas, &c.; the meſenterica ſuperior, which goes chiefly to the meſentery, to the ſmall inteſtines, and to that part of the great inteſtines which lies on the right ſide of the abdomen; the meſenterica inferior, which goes to the great inteſtines on the

the left ſide, and produces the hæmorrhoidalis interna; and laſtly, the right and left arteriæ ſpermaticæ.

The poſterior branches are the arteriæ lumbares, of which there are ſeveral pairs, and the ſacræ, which do not always come from the trunk of the aorta.

The lateral branches are the capſulares and adipoſæ, the origin of which often varies; the renales, formerly termed *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 commences 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

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, 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-maſtoides, 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

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 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 thyroidææ, and to the muſcles and other parts of the larynx; for which reaſon it may be called *laryngææ*, 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

called *arteria ſublingualis ;* and it is the ſame artery which others 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 ſtyloide and maſtoide 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, amygdala, 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 angulioris, 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 muſculis 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.

confiderable. It paffes behind the condyle, and runs between the jaws, where it gives off numerous branches to the parts which lie near it. The moft confiderable of thefe are, (1.) The fpheno-fpinalis, or media duræ matris, which runs between the internal and external carotids: this paffes through the foramen fpinale of the fphenoidal bone, and is diftributed to the dura mater by feveral ramifications, which run forward, upward, and backward; the uppermoft communicating with thofe on the other fide above the longitudinal finus of the dura mater. This artery of the dura mater may be termed *fpheno fpinalis*, or *medica duræ matris*, to diftinguifh it from thofe that go to the fame part by another courfe. (2.) The maxillaris inferior, which runs through the canal of the lower jaw; and being diftributed to the alveoli and teeth, goes out at the hole near the chin, and lofes itfelf in the neighbouring mufcles, communicating with the branches of the arteria maxillaris externa. (3.) The pterygoideæ, and temporales profundæ, to the pterygoid and temporal mufcles. (4.) The arteria buccalis, to the buccinator mufcle, and other foft parts of the cheek. (5.) The alveolaris, to the teeth and fubftance of the upper jaw, and to feveral of the foft parts furrounding it. (6.) The infra-orbitaria, which, after fending a branch to the nofe, paffes through the pofterior opening of the orbitar canal; and having fent branches to the orbit, antrum maxillaris, and teeth, goes out by the infra orbitar hole, and on the cheek communicates with the angular artery. (7.) Palatina fuperior, which goes through the palato-maxillary canal to the palate and bones furrounding it. Another fmall branch terminates on the parts at the upper end of the pharynx.

The fixth anterior or internal branch, which is very fmall, is fpent on the mufcle mafleter.

The firft external or pofterior branch is named *arteria occipitalis*. It paffes obliquely before the internal jugular vein; and having given twigs to the mufculus

ftyloſtylo-hyoidæus, ſtylo-gloſſus, and digaſtricus, it runs between the ſtyloide and maſtoide apophyſes, along the maſtoide 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, 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 clinoide apophyſis 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: afterwards the artery covered with the levator muſcles of the eye and upper eye-lid 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 of anterior ciliary branches; afterwards two go off to the levator of the eye and upper eye-lid; then the poſterior æthmoidal and the arteria centralis retinæ are ſent off. While it paſſes over the nerve, it gives off the muſculares ſuperior, inferior, and other ciliary nerves. 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

and optic nerve, receive branches from it; then it produces the æthmoidal anterior; its trunk next defcends under the cartilaginous pulley of the fuperior oblique: here it frequently gives a branch to the lacrymal fac; the arteries of the eye-lids alfo grow from it; at laft it divides into four branches, which are the fuperciliary, the nafal, the fuperficial, and deep frontals; which laft go through the foramen fupra orbitarium to be diftributed to the forehead. At the inner angle of the eye, it communicates with the angular artery; and within the orbit it fends one or two fmall branches to the nofe. This artery was by the ancients miftaken for a vein. Ingraffius was the firft who confidered it in its proper light; but Haller was the firft who defcribed it with accuracy. For a more minute defcription, fee Zinn and Sabatier.

Afterwards the internal carotid runs under the bafis of the brain to the fide of the infundibulum, where it is at a fmall diftance from the internal carotid of the other fide, and there it commonly divides into two principal branches, one anterior and one pofterior.

The anterior branch runs forward under the brain, firft feparating from that on the other fide, then coming nearer again, it unites with it by an anaftomofis or communciation in the interftice between the olfactory nerves. Afterwards, having fent of fmall arteries, which accompany thefe nerves, it leaves its fellow, and divides into two, but, according to Winflow, two or three branches. The firft of thefe is the fmalleft of the two, but it is a very conftant one; it runs forwards at the inner fide of the anterior lobe, which it fupplies in its paffage. The fecond, after it has got beyond the corpus callofum, to which it fends branches, is reflected back over that fubftance upon the inner fide of the hemifphere, and may be traced back as far as the pofterior lobe: in all this courfe it fends off innumerable branches, which are at firft fpread 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 in the inner ſubſtance of the brain. The anterior and middle branches produce the ſame kind of ramifications, and the anterior, in particular, ſupplies the corpus calloſum.

Arteria ſubclavia. The ſubclavian arteries are named from their ſituation near the claviculæ, in the tranſverſe direction of which they run. They are two in number, one right, the other left; and they ariſe from the arch of the aorta, on each ſide of the left carotid, which commonly lies in the middle between them; but when both carotids go out ſeparately, they both lie between the ſubclaviæ. Theſe arteries terminate, or rather change their name, above the middle of the two firſt ribs, between the anterior inſertions of the muſculi ſcaleni.

The right ſubclavian is larger at the beginning than the left, when it produces the right carotid; its origin is likewiſe more anterior and higher, becauſe of the obliquity of the arch of the aorta; for which reaſon alſo the left is ſhorter than the right, and runs more obliquely. Both of them are diſtributed much in the ſame manner; and therefore the deſcription of one may likewiſe be applied to the other.

The right ſubclavian, the longeſt of the two, gives off,

off, firſt of all, ſmall arteries to the mediaſtinum, thymus, pericardium, aſpera arteria, &c. which are named *mediaſtinæ*, *thymicæ*, *pericardiæ*, and *tracheales*. Theſe ſmall arteries ſometimes go out from the ſubclavian itſelf, either ſeparately or by ſmall common trunks; ſometimes they are branches of the mammaria interna, eſpecially the mediaſtina.

Afterward this right ſubclavian, at about a finger's breadth from its origin, commonly produces the common carotid of the ſame ſide; and at a ſmall finger's breadth from the carotid, it gives of commonly three conſiderable branches, viz. the mammaria interna, cervicalis, and vertebralis, and ſometimes an intercoſtal artery, which goes to the firſt ribs called *intercoſtalis ſuperior*.

Arteria thymica. The arteria thymica communicates with 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; and, in its courſe, it gives branches to the peritonæum, and to the anterior part of the oblique and tranſverſe muſcles of the abdomen.

Arteria cervicalis. The cervical artery ariſes from the upper ſide of the ſubclavian, and is preſently afterwards divided into two, which come out ſometimes ſeparately, ſometimes by a ſmall common trunk. The largeſt of theſe two arteries is anterior, the other poſterior.

The anterior cervicalis, running behind the carotid of the ſame ſide, is diſtributed to the muſculus coraco-hyoidæus, maſtoidæus, cutaneus, ſterno-hyoidæus, and ſterno-thyroidæus, to the jugular glands, the aſpera arteria, the muſcles of the pharynx, bronchia, œſophagus, and to the anterior muſcles which move the neck and head. This artery has been obſerved to ſend out the intercoſtalis ſuperior.

The poſterior cervicalis ariſes ſometimes a little after the vertebralis, and ſometimes from that artery. It paſſes under the tranſverſe apophyſis of the laſt vertebra

bra of the neck; and ſometimes through a particular hole in that apophyſis; and from thence runs up backward in a winding courſe, on the vertebral muſcles of the neck, and then returns in the ſame manner.

It communicates with a deſcending branch of the occipital artery, and with another of the vertebral artery above the ſecond vertebra. It is diſtributed to the muſculi ſcaleni, angularis ſcapulæ, and trapezius, and to the jugular glands and integuments.

Arteria vertebralis. The vertebral artery goes out from the poſterior and upper ſide of the ſubclavian, almoſt oppoſite to the mammaria interna and cervicalis. It runs up through all the holes in the tranſverſe apophyſis of the vertebræ of the neck, and in its paſſage ſends off little twigs through the lateral notches of theſe vertebræ, to the medulla ſpinalis and its coverings. It alſo gives arteries to the vertebral muſcles, and to other muſcles near them.

As it paſſes through the tranſverſe hole of the ſecond vertebra, it is generally incurvated, to accommodate itſelf to the particular obliquity of this foramen. And between this hole and that in the firſt vertebra, it takes another larger turn in a contrary direction to the former. Having paſſed the tranſverſe hole of the firſt vertebra, it is conſiderably incurvated a third time, from before backwards, as it goes through the ſuperior and poſterior notch in this vertebra.

At this third curvature, it ſends off a ſmall branch, which is ramified on the outer and poſterior 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 theſe accounts it may be named *arteria occipitalis poſterior*, to diſtinguiſh it from the other which is lateral.

As ſoon as it enters the cranium, it ſends ſeveral ſmall ramifications to the back-part of the medulla oblongata, and to the corpora olivaria and pyramidalia, which are likewiſe ſpread on the back-ſides of the fourth ventricle of the brain, and form the plexus choroides of the cerebellum.

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

Arteria baſilaris. The arteria baſilaris runs forward under the great tranſverſe protuberance of the medulla oblongata, to which it gives ramifications, as well as to the neighbouring parts of the medulla. Commonly this artery divides again near the extremity of the apophyſis baſilaris into four lateral branches, which communicate with the poſterior branches of the two internal carotides, and are loſt in the poſterior lobe of the brain. The firſt and ſmalleſt of each ſide forms the artery ſuperior cerebelli, which goes to the upper part of this viſcus, and to the nates, teſtes, &c. and at laſt is loſt in the inner ſubſtance of the cerebellum. The other branch on each ſide is much more conſiderable: this forms the arteria poſterior, or profunda cerebri, which ſupplies the poſterior lobe of the brain, and parts lying near the third ventricle. The arteria poſterior cerebri, on each ſide, likewiſe communicate with the trunk of the internal carotid, by a branch ſomething ſimilar to that between the anterior branches of the carotids: theſe aſſiſt in forming the circle of Willis.

Arteriæ ſpinales. The ſpinal arteries are two in number, one anterior, and one poſterior; both produced by both vertebrales; each of which, as ſoon as it enters the cranium, ſends out a ſmall branch, by the union of which the poſterior ſpinalis is formed. Afterwards

wards the vertebrales advancing on the apophyſis baſilaris, or production of the occipital bone, detach backward two other ſmall branches, which likewiſe meet, and by their union form the ſpinalis anterior. Theſe ſpinal arteries run down on the fore and back ſides of the medulla ſpinalis, and, by ſmall tranſverſe ramifications, communicate with thoſe which the intercoſtal and lumbar arteries ſend to the ſame part.

Arteria auditoria interna. The internal auditory artery goes off from each ſide of the arteria baſilaris to the organ of hearing, accompanying the auditory nerve, having firſt furniſhed ſeveral ſmall twigs to the membrana arachnoides.

Arteria meningæa poſterior. The poſterior meningæa ariſes from the ſame trunk with the auditoria interna, and goes to the back-part of the dura mater, on the occipital and temporal bones, and likewiſe ſupplies the neighbouring lobes of the brain.

Arteria intercoſtalis ſuperior. When the ſuperior intercoſtal artery does not go out from the trunk of the aorta deſcendens, it commonly ariſes from the lower ſide of the ſubclavian, and runs down on the inſide of the two, three, or four, uppermoſt true ribs, near their heads, and ſends off under each rib a branch which runs along the lower edge, and ſupplies the intercoſtal muſcles and neigbouring parts of the pleura.

Theſe branches or particular intercoſtal arteries communicate with each other at different diſtances by ſmall rami, which run upward and downward from one to the other, on the intercoſtal muſcles.

They likewiſe give branches to the muſculi ſterno-hyoidæi, ſubclavius, vertebrales, and bodies of the vertebræ; and alſo to the pectoralis major and minor, piercing the intercoſtal notch; and laſtly, they ſend branches through the muſcles of the firſt four vertebræ to the medulla ſpinalis and its coverings.

Sometimes the ſuperior common intercoſtal artery comes

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 comes commonly from the fuperior intercoftal, the left from the aorta, and fometimes from the arteria œfophagæa. 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.

Sometimes there are free communications obferved between the branches of the bronchial artery and thofe of the pulmonary artery: thefe have been mifta-

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ken for direct communications between the bronchial artery and pulmonary vein, vena azygos, &c.

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

Arteriæ œſophagææ. The œſophagææ are generally two or three in number, ſometimes but one. They ariſe anteriorly from the aorta deſcendens, and are diſtributed to the œſophagus, &c. Sometimes the uppermoſt œſophagæa produces a bronchial artery.

Arteriæ intercoſtales inferiores. The inferior intercoſtals are commonly ſeven or eight on each ſide, and ſometimes ten, when the ſuperior intercoſtals ariſe likewiſe from the aorta deſcendens; in which caſe theſe run obliquely upward, as has been already ſaid.

They ariſe along the backſide of the deſcending aorta in pairs, all the way to the diaphragm, and run tranſverſely towards each ſide, on the bodies of the vertebræ. Thoſe on the right ſide paſs behind the vena azygos; and afterwards they all run to the intercoſtal muſcles, along the lower edge of the ribs, all the way to the ſternum, or near it.

They ſend branches to the pleura, to the vertebral muſcles, to thoſe muſcles which lie on the outſides of the ribs, and to the upper portions of the muſcles of the abdomen; and they communicate with the arteriæ epigaſtricæ and lumbares.

Sometimes, inſtead of going out from the aorta in pairs, they ariſe by ſmall common trunks, which afterwards divide, and ſend an artery to each neighbouring rib.

Before they take their courſe along the ribs, each of them detaches one branch between the tranſverſe apophyſes on both ſides, to the vertebral muſcles, and another which enters the great canal of the ſpina dorſi. Each of theſe latter branches divides at leaſt into two ſmall arteries; one of which runs tranſverſely on the

anterior

anterior ſide of the canal, the other on the poſterior ſide. Both of them communicate with the like arteries from the other ſide of the ſpine, in ſuch a manner as to form a kind of arterial rings, which likewiſe communicate with each other by other ſmall ramifications. The ſame is to be obſerved in the arteriæ lumbares.

Afterwards each intercoſtal 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 diviſion, the arteries that run upon the falſe ribs ſeparate a little from them, being gradually bent downward one after another, and are ſpread upon the abdominal muſcles. They are likewiſe diſtributed to other neighbouring muſcles, and particularly to thoſe of the diaphragm, almoſt in the ſame manner with the arteriæ phrænicæ; they alſo communicate with the lumbares, and ſometimes with branches of the hypogaſtricæ.

Arteriæ axillares. The ſubclavian artery having left the thorax immediately above the firſt rib, in the interſtice left between the portions of the ſcalenus, there receives the name of *axillaris*, becauſe it paſſes under the axilla.

In this courſe it gives off, from its inſide, a ſmall branch to the inſide of the firſt rib; and afterwards four ſeveral principal branches, viz. the thoracica ſuperior, mammaria externa, thoracica humeralis, and axillaris ſcapulares.

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 mammari; 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 ſcapulares.

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

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 artery 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 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 infertion of the teres major, it gives off another branch, which runs from within outwards, and from behind forward, round the os humeri; and defcends obliquely forward, between the mufculus brachialis and triceps, to both which it is diftributed in its paffage. Having afterwards reached the external condyle, it unites with the branch laft mentioned, and likewife communicates with a branch of the arteries of the fore-arm, fo that there is here a triple anaftomofes.

About the breadth of a finger below this fecond branch, the brachial artery fends 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 fends off a branch, which is diftributed to the periofteum, and penetrates the bone between the brachialis and inner fide of the triceps.

About an inch lower, it gives off another branch, which having furnifhed ramifications to the inner fide of the triceps, runs over the inner condyle, and likewife communicates with 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 paffed over the mufcles inferted in this condyle, it communicates with that branch of the cubital artery which encompaffes the fold of the arm.

A little lower it fometimes fends out another branch, which paffes on the forefide of the inner condyle, and then communicates with a branch which runs up from the

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.

About a large 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. 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 inter-

interoffeous ligament, fends off two principal branches, one internal, the other external; called the *interoffeous arteries* of the fore-arm.

The external artery pierces the ligament about three fingers breadth below the articulation; and prefently afterwards gives off a recurrent branch, which runs up toward the external condyle of the os humeri, under the extenfor carpi ulnaris and anconæus, to which it is diftributed, as alfo to the fupinator brevis; and it communicates with the collateral arteries of the arm on the fame fide.

Afterward this external interoffeous artery runs down on the outfide of the ligament, and is diftributed to the extenfor carpi ulnaris, extenfor digitorum communis, and to the extenfores pollicis indicis and minimi digiti; communicating with fome branches of the internal interoffeous artery.

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

By thefe communications, this artery forms a fort of irregular arch, from whence branches are detached to the external interoffeous mufcles, and to the external lateral parts of the fingers.

The internal interoffeous artery runs down very clofe 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 fide of the carpus and back of the hand, where it communicates with the external interoffeous artery, with the radialis and internal branches of the cubitalis.

From the origin of the two interoffeæ, the cubital artery defcends, fending branches to the neighbouring parts. Below the internal interoffea, it fometimes fends off a branch which runs down between the flexor pollicis, flexor carpi radialis, and perforatus; to which it is diftributed 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 paffes over the internal tranfverfe ligament of the carpus, by the fide of the os pififorme; and having furnifhed the fkin, palmaris brevis, and metacarpus, it flips under the aponeurofis 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 bafes of the metacarpal bones.

It likewife fends 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 interoffeous artery. Afterwards, having fupplied the interoffeous mufcles, 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 fide of which is turned to the fingers, and commonly fends off three or four branches. The firft goes to the inner and back part of the little finger; and is fometimes a continuation or production of that branch which goes to the mufcles on the forefide of the little finger.

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

Some-

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

This arch ſends likewiſe from its concave ſide, towards the ſecond phalanx of the thumb, a branch for the lateral internal part thereof; and then ends near the head of the firſt metacarpal bone, by a communication with the radialis, having firſt given a branch to the foreſide of the index, and another to the ſide of the thumb next the former. Theſe communicate at the ends of the fingers with the neighbouring branches as in the other fingers.

This arch ſends likewiſe ſmall twigs to the interoſſeous muſcles, to the lumbricales, palmaris, and to other neighbouring parts; and, laſtly, to the integuments.

Arteria radialis. The radial artery begins by detaching a ſmall 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, eſpecially with the firſt collateral branch on that ſide.

It runs down along the inſide of the radius, between the ſupinator longus, pronator teres, and the integuments, giving branches to theſe muſcles, and likewiſe to the perforatus, perforans, and ſupinator brevis. From thence it runs in a winding courſe toward the extremity of the radius, ſupplying the flexors of the thumb and pronator quadratus.

Having reached the extremity of the radius, it runs nearer the ſkin, eſpecially toward the anterior edge of the bone, 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 which 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 its passage over the abductor muscle of the index, near the basis of the first metacarpal bone, and as it runs 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 forepart of the first bone of the metacarpus to the convex side of the index, where it is lost in 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 which comes from the arch of the cubitalis. It also sends off a small branch across the internal interosseous muscles, 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

One of thefe branches runs along the inner and anerior lateral part of the index; the other paffes 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 pofterior lateral part of the index all the way to the end of that finger, where it unites again with the firft branch.

Arteria diaphragmatica. The left diaphragmatic artery goes out commonly from the aorta defcendens as it paffes between the crura of the fmall mufcle of the diaphragm. The right diaphragmatic comes fometimes from the neareft lumbar artery, but frequently from the cæliaca. Sometimes both thefe arteries arife by a fmall common trunk immediately from the aorta. They likewife have the name of *arteriæ phrenicæ.*

They appear almoft always in feveral ramifications on the concave or lower fide of the diaphragm, and feldom on the upper or convex fide. They give fmall branches to the glandulæ renales, and fat upon the kidneys, to the liver, and to the fuperior orifice of the ftomach.

Befides thefe capital diaphragmatic arteries, there are others of a fubordinate clafs, which come from the intercoftales, mammariæ internæ, mediaftinæ, pericardiæ, and cæliaca, all of which communicate freely with the large diaphragmatics, as thofe on the right and left fides of the diaphragm do with each other.

Arteria cæliaca. The cæliac artery rifes anteriorly and a little to the left fide, from the aorta defcendens, immediately after its paffage through the fmall mufcle of the diaphragm, 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 hepa-*

hepatica; the other to the left, called *ſplenica*, which is larger than the former.

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

Arteria ventriculi coronaria, or *gaſtrica*, or *gaſtrica ſuperior*. The coronary artery of the ſtomach goes firſt to the left ſide of that organ, a little beyond the ſuperior orifice; round which orifice it throws branches, and alſo to every part of the ſtomach near it: and theſe branches communicate with thoſe which run along the bottom of the ſtomach to the pylorus.

Afterwards it runs on the right ſide of the ſuperior orifice, along the ſmall curvature of the ſtomach, almoſt to the pylorus, where it communicates with the arteria pylorica; and turning towards the ſmall lobe of the liver, it gives off ſome branches to it.

Then it advances, under the ductus venoſus, to the left lobe of the liver, in which it loſes itſelf near the beginning of the juſt-mentioned duct, having firſt given off ſome ſmall branches to the neighbouring parts of the diaphragm and omentum.

Arteria hepatica. As ſoon as the hepatic artery leaves the cæliaca, it runs to the upper and inner part of the pylorus, in company with the vena portæ, ſending off two branches; a 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

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 coronoria 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 come ſometimes 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 hand, 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 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 hand, but bending immediately afterwards to the left.

Near

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 an annular piece of net-work.

Theſe arches and maſhes increaſe in number proportionably 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,

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 to the kidneys, into the depreſſions of which they enter by ſeveral branches, which form arches in the inner ſubſtance of theſe viſcera.

From theſe arches, numerous ſmall rami go out toward

ward the circumference or outer ſurface of the kidneys. Sometimes there is more than one artery on each ſide; ſometimes this augmentation is only on one ſide, and theſe ſupernumerary arteries come ſometimes 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 ſide, and ſome, or all of theſe, from the iliac arteries.

Ordinarily, the right renal artery paſſes behind the vena cava and renal vein on the other ſide; and the left artery, firſt behind and then before the vein. Sometimes they ſend branches to the glandulæ renales, membrana adipoſa of the kidneys, and even to the diaphragm.

Arteriæ capſulares. The arteries of the renal glands, which may be termed *arteriæ capſulares*, ariſe from the aorta above the arteria renalis, and give out the arteriæ adipoſæ, which go to the fat of the kidneys. Sometimes they come from the trunk of the cæliaca. The right capſular artery comes moſt commonly from the arteria renalis of the ſame ſide, near its origin; the left from the aorta above the renalis. They ſend branches to the parts which ſurround them, and communicate there with branches of other arteries.

Arteriæ ſpermaticæ. The ſpermatic arteries are commonly two in number, ſometimes more. They are very ſmall; and go out anteriorly from the aorta deſcendens inferior, near each other, about a finger's breadth below the arteriæ renales, more or leſs, between the two meſentericæ, or between the renales and meſentericæ inferiores. Sometimes one is higher, or placed more laterally than the other; and ſometimes there are two on each ſide.

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

I They

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. Sometimes it ariſes higher from the lumbares, and ſometimes lower from the

iliacæ.

iliacæ. Sometimes there are two, three, or four, in number. The branches of this artery are ramified on the os ſacrum, and on the neighbouring parts of the peritonæum, inteſtinum rectum, fat, &c.; and enter the canal of that bone through the anterior holes, being there diſtributed toward each ſide. They likewiſe ſend ſmall arteries to the large faſciculi of nerves which go out through the holes of the os ſacrum, and they penetrate the inner ſubſtance of that bone. The os ſacrum has alſo branches ſpread out upon its ſurface, and ſome running through its anterior holes from the hypogaſtric artery.

Arteriæ iliacæ. The inferior deſcending aorta ends at the laſt vertebra of the loins, and ſometimes 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 ſame name. This bifurcation lies on the anterior and left ſide of that of the vena cava.

The primitive iliac arteries divaricate gradually as they deſcend, advancing obliquely toward the anterior and lower part of the oſſa ilium, without any conſiderable ramification, for about the breadth of three fingers, except a few very ſmall arteries that go to the os ſacrum; ſome of which enter by the upper holes, and are diſtributed like the arteriæ ſacræ, while others emerge again through the poſterior holes, and go to the neighbouring muſcles, &c. They likewiſe give ſmall arteries to the peritonæum, to the coats of the veins, and to the fat and ureters, behind which the iliac trunks paſs.

The right iliac trunk paſſes firſt on the foreſide of the origin of the left iliac vein, and runs down on the foreſide of the right vein, almoſt to the place where it goes out of the abdomen, its courſe being there directed more inwardly. The left trunk goes down likewiſe before the left vein, but lies a little toward the inſide as it leaves the abdomen.

About three fingers breadth from their origin, and oppoſite 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

thence to the internal labium of the os ilium, where it divides into two, and is ramified on the oblique and tranſverſe muſcles of the abdomen, communicating with the arteria lumbaris.

Beſides theſe two branches, the external iliaca gives off a ſmall ramus internally under the ligament, which runs to the vagina of the ſpermatic rope; and ſometimes another ſmall twig goes from the outſide to the os ilium.

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

This arteria umbilicalis aſcends on the ſide of the bladder, and having detached ſmall rami to that viſcus and to the neighbouring parts of the peritonæum, &c. it contracts, and in adults is quite cloſed up, above the middle of the bladder. It likewiſe gives branches to the uterus in the female, and to the neighbouring parts in both ſexes. Afterwards it aſcends in form of a ligament to the umbilicus, where it lies contiguous to the umbilical artery on the other ſide; its name being taken from its uſe in the fœtus.

From the convex ſide of the curvature of the hypogaſtric, ſeveral principal branches go out very near each other. Sometimes they all ariſe ſeparately, ſometimes by ſmall common trunks, and what is the firſt branch in ſome ſubjects, is only a ramus of another principal branch in others; ſo much does the number, diſpoſition, origin, and diſtribution of theſe branches vary in different ſubjects. For this reaſon we think it proper to diſtinguiſh them by the following proper names: *iliaca minor*, *ſacræ laterales*, *glutæa*, *ſciatica*, *pudica communis ſive pudica hypogaſtrica*, *hæmorrhoidalis media*, and *obturatrix*.

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The iliaca minor, or ileo-lumbaris, the moſt poſterior of theſe branches, and which is often no more than a ramus of the glutæa, or of the ſacræ laterales, paſſes behind the muſculus 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 pretty 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 they both go 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

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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 to the clitoris, and ſupplies it ſomewhat in a ſimilar way as a correſponding artery does the penis.

Hæmorrhoidalis media comes from the pudica interna, or from ſome 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 ſends branches likewiſe to the vagina and bladder; in the latter, it ſends branches to the bladder, veſiculæ ſeminales, and proſtate.

Ateriæ veſicales. The bladder is ſupplied with arteries from the hæmorrhoidalis media, from the uterina, and from the umbilicalis: but beſides theſe, another artery goes commonly off from the trunk of the hypogaſtrica, and runs to the inferior part of the bladder, where it divides into branches which run to the veſiculæ ſeminales, vaſa deferentia, proſtate gland, and beginning of the urethra.

Uterina comes from the under end of the hypogaſtrica; it ſends firſt branches to the bottom of the bladder and urethra; then it goes to the lower part of the uterus, where it divides into numerous ſerpentine branches, which are diſtributed upon the uterus, and which communicate freely with the ſpermatic arteries. It ſends likewiſe a branch to the vagina, which extends alſo to the bladder, urethra, and rectum.

Arteria vaginalis. The arteries of the vagina come from the hæmorrhoidalis media, from the veſicales and uterina: ſometimes a branch ariſes likewiſe from the trunk common to the iſchiatica and pudica interna. This 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 ſometimes by a ſhort common trunk, ſometimes by two, &c.

The external branch, called *circumflexa externa*, runs on the upper ſide of the thigh to the crureus, vaſtus externus, rectus anterior, muſculus faſciæ latæ, and glutæus medius; ſending up a ramus to the apex of the great trochanter, which communicates 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 backſide 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 *articu-*

lares, 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 backſide 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; and, beſides ſeveral other ramifications, ſends up a ſmall branch which communicates with the arteries that lie round the condyles of the os femoris.

The ſecond or external branch runs over the head of the fibula, and between the head of the tibia and external lateral ligament of the knee, ſurrounding 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 firſt or internal ramus.

Immediately after the origin of theſe two rami, and before the poplitea ends, it ſends a ſmall artery down on the backſide of the interoſſeus 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, paſſing from behind forwards on the interoſſeous ligament, where it takes the name of *arteria tibialis anterior*. The ſecond branch divides into two others; one internal and largeſt, called *arteria tibialis poſterior*; the other poſterior and ſmalleſt, named *arteria peronæa poſterior*.

The tibialis anterior having paſſed between the heads of the tibia and fibula, ſends ſmall branches upward and laterally. The ſuperior branches communicate with thoſe rami of the popliteus which lie round the articulation; and the lateral branches go to the neighbouring parts. Afterwards this tibial artery runs

down

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 hand, which communicate laterally with the tibialis pofterior 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 matatarfal bones; between the heads of which it fends a large branch, which perforates the fuperior interoffeus 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 theſe muſcles, to the tibia, and to the marrow of that bone, through a particular canal in its poſterior and upper part.

Afterwards it runs behind the inner ankle, communicating with the tibialis anterior, and ſurrounded by the neighbouring veins; and paſſes to the ſole of the foot between the concave ſide of the os calcis and thenar muſcle, 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 laſt three 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,

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 communicates with the tibialis anterior by an arch, 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 ventricles 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. In a great number of parts they run parallel with the arteries, one by the ſide of the other; but yet they differ from the arteries in various reſpects.

The fabric of the veins is ſlender, every where ſmooth, difficultly ſeparable into diſtinct coats or membranes, like the arteries; and the cellular texture ſur-round-

rounding this fabric is very eaſily diſtended. This fabric, both above and below the heart, is ſurrounded, except in one place, with muſcular fibres. Every where, however, it is lax like the cellular texture of the arteries by which they are joined to the other parts of the body. Notwithſtanding this ſlender fabric, the veins are 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. Nor do they ſupport themſelves like cylinders after being divided, but they collapſe together, ſo as to make their capacity appear like a ſlit; except they are ſuſtained and hindered from thus collapſing by ſome ſtronger cellular ſubſtance placed round them, as we ſee in the liver and womb. They are but ſlightly irritable, unleſs the ſtimulus be of the chemical or more acrid claſſes; for, in that caſe, they contract themſelves with a convulſive force greater than that of the arteries. They have no pulſation, if we may truſt all accounts, unleſs the venous channel is ſomewhere obſtructed; or when, in dying people, the blood is thrown back again from the right auricle into the deſcending and aſcending cava, or when falling back from the brain.

The veins are much larger than their correſponding arteries, having the ſquare of their diameter often double or triple, and almoſt quadruple; as near as the emulgents and veſſels 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 likewiſe from the arteries in their diviſion, having more numerous trunks and branches; for to one artery in the limbs, we uſually meet with two veins: and there are many veins, as the external jugular, vena portarum, azygos, cephalic,

phalic, basilic, and saphena, with which no arteries correspond. The larger veins are also branched in a more net-like disposition, by forming more frequent anastomoses one with another; for not only the smaller branches, but even the larger trunks, of the veins, are conjoined one to the other within its neighbourhood, upper with lower, and right with left, by apparent inlets or inosculations. Many of the veins, especially some of those mentioned above, affect to run near the surface of the body, and through the limbs, neck, and head: they run a long way covered with little more than the bare skin, which is a circumstance we very rarely observe in arteries; and, for the same reason, they often go out in their course to a considerable distance from the arteries. For, in this case, the veins follow the surface of the parts next the skin, without their corresponding artery, which, in the mean time, descends to a considerable depth, attended in its course by some smaller venous branch. 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.

In the larger sanguineous veins, valves are found in great plenty. The innermost membrane of the vein being double, 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. These, joined with the side of the preceding vein, intercept a space, of which the outer side is the vein itself, and the inner the valve; which, by its convexity, stands out within the bore of the vein: so that the parabolic space or hollow mouth of the valves always looks toward the heart. They are found in all the subcutaneous veins

of

of the limbs, in theſe of the neck, face, tongue, and in the veins of the penis: at the origin of the larger branches there are two, three, four, and ſometimes five of them together, while in their ſmaller branches they are only ſingle. There are none of theſe valves in the deep-running veins of the viſcera; and, therefore, none in thoſe of the brain, lungs, heart or liver, or through the whole ſyſtem of the vena portarum, though Wriſberg has found them in the vena portarum of many quadrupeds; nor in the kidneys or womb (except one or two valves in the ſpermatic vein); nor, laſtly, are there any in thoſe ſmaller blood-veins which are of a leſs diameter than the twelfth part of an inch. Sometimes, though rarely, they are found in the branches of the vena azygos, and at the mouths of the hepatic and renal veins: there Dr Haller has ſeveral times 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 is ſmaller: and theſe make a greater reſiſtance than the larger valves, to hinder the blood from returning back upon the parts.

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 beſides theſe, Dr Haller takes into account abſorbing veins; but as abſorption by red veins is now denied, we lay theſe aſide.

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 in the iris of the eye there are ſmall veins, and not a few in the adnata tunica of that organ; 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

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 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 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 perpendicularly 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 right auricle may alſo be looked upon as a muſcular trunk common to theſe two large veins, and may be called the *ſinus* of the vena cava; but in this reſpect, the name of *ſinus pulmonaris* agrees ſtill better to the left auricle.

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

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

The ancients called the ſuperior vena cava, *aſcendens;* and the inferior, *deſcendens;* having regard only to the great tubes, and to their diviſion into trunks and branches. Several moderns have retained theſe names, but in a contrary ſignification, to accommodate them to the motion of the blood, which deſcends by the cava ſuperior, and aſcends by the cava inferior.

But,

But, to ſhun the miſtakes that may happen in reports made of wounds or other diſeaſes, and of what is obſerved in opening dead bodies, and in other caſes of theſe kinds, it is beſt to retain the diſtinction of the vena cava ſuperior and inferior.

The trunk of each of theſe two veins ſends off, much in the ſame manner with the arteries, a certain number of principal or capital branches, which are afterward ramified in different manners. Each trunk terminates afterwards by a bifurcation or a diviſion into two ſubordinate trunks, each of which gives off other principal branches, ending in a great number of ſmall trunks, rami, and ramifications.

They have likewiſe this common to them with the arteries, that the greateſt part of the capital branches are in pairs; as well as the ſubordinate trunks. The ramifications of each ſubaltern trunk, taken by itſelf, are in uneven numbers; but they make even numbers, with thoſe of the other like trunk. The vena azygos and ſome other ſmall veins, of which hereafter, are exceptions from this rule.

Before we go on 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 finger's 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 hand, 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 is conſequently 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 ſuperioris.

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

The vertebral veins paſs through the holes in the tranſverſe apophyſes of the vertebræ of the neck, ſending branches to the neck and occiput. They form the ſinus venales of theſe vertebræ, and communicate with the ſinuſes of the dura mater.

The axillary veins are continuations of the ſubclaviæ, from where theſe leave the thorax to the axillæ. They produce the mammariæ internæ, thoracicæ, ſcapulares 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 *baſilica;* which, together with the cephalica, is diſtributed 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 ſmall, being ſcarcely 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 paſſes next behind the liver, through the great ſinus of that viſcus, to which it furniſhes ſeveral branches termed *venæ hepaticæ*.

In this courſe it inclines a little toward the ſpina dorſi and aorta inferior; the trunk and ramifications of which it afterwards accompanies in the abdomen, all the way to the os ſacrum; the arteria cæliaca and the two meſentericæ only excepted.

Thus the inferior cava ſends out on each ſide, in the ſame manner with the aorta, the venæ adipoſæ, renales, ſpermaticæ, lumbares, and ſacræ. Having reached to the os ſacrum, 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,

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 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, after which, it 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 rami from the tongue, called *venæ 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 is here to be obſerved, that, under the angle of the lower jaw, there is a great variety of communications between the external and internal jugular veins, and alſo a great variety in the diſtribution of theſe veins.

Almoſt all the ramifications, which at this place go into the external jugular vein, from the upper part of the throat and face in ſome ſubjects, terminate in other ſubjects in the internal jugular; and ſometimes, one part of them goes to the external jugular, the reſt into the internal.

The trunk of the vein, after receiving theſe branches, admits another large branch anteriorly from the ſymphyſis of the lower jaw, from the maxillary glands, the digaſtric muſcle, the chin and under-lip.

Oppoſite to the cartilago thyroides, it receives a tranſverſe branch, which runs on the anterior or lower part of the muſculi ſterno-maſtoidæi, and communicates with the jugularis of the other ſide, though not always by a vein of the ſame kind.

The ſuperior and inferior tranſverſe branches communicate on each ſide by branches more or leſs perpendicular, and receive a ſmall branch from the muſculus

culus depreſſor labii inferioris and platyſma myoides, and integuments.

Anteriorly, it receives ſeveral branches from the muſcles of the larynx, ſterno-hyoidæi, thyro-hyoidæi, and from the integuments; and below the larynx it receives communicating branches from the jugularis externa anterior of the other ſide.

Poſteriorly, it receives, 1. A large branch on the ſide of the upper part of the larynx, which communicates with the jugularis interna; and likewiſe with a large ſhort branch of the jugularis externa poſterior. 2. A ſmall branch, which has the ſame communication, but which is not always to be found. 3. Another ſmall branch a little below the lower jaw, which communicates with the jugularis externa poſterior. The trunk of the vein thus formed ſometimes runs down to open into the ſubclavian vein; but moſt commonly it opens into the communication of the temporal vein, a little below the jaw.

Vena jugularis externa poſterior, ſive ſuperior. The poſterior or ſuperior external jugular vein runs down from the ſide of the head, &c. receiving conſiderable branches from neighbouring parts.

This vein is at firſt formed by a branch called *vena temporalis*, which receives the blood from the temples and lateral parts of the head, likewiſe from ſome part of the occiput and forehead. Sometimes the temporal vein has two inſertions, whereof one is into the jugularis interna.

The temporal vein of one ſide communicates above, with its fellow on the other ſide; before, with the vena frontalis; and behind, with the vena occipitalis. Oppoſite 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 ſame jugularis, a little below the condyle of the lower jaw, forming a kind of areola of a roundiſh form.

Behind this condyle, it receives branches from the temporal muſcle, from the neighbouring parts of the upper jaw, and from the inſide of the lower jaw, almoſt in the ſame manner as the arteries are ſent out.

Only one of theſe branches comes from the muſculus temporalis and pterygoidæi; communicating with a branch from the maſſeter in its paſſage.

Having reached a little lower, it paſſes through the parotid gland, receiving a large branch, which communicates with another branch common to the interternal and anterior external jugular veins. Sometimes areolæ are formed through which the nerves paſs. Theſe open into the trunk by ſeveral 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, maxillary, or facial, and of the temporal vein, runs down between the muſculus platyſma myoides and ſterno-maſtoideus, being covered by the former, and croſſing over the latter. In this courſe it receives poſteriorly the vena occipitalis, which comes from the different parts of the occiput, and ſometimes runs into the vena vertebralis or axillaris, &c. It likewiſe receives a ſmall vein, which comes out of the cranium by the poſterior maſtoide hole from one of the lateral ſinuſes. This branch goes ſometimes into another vein.

After receiving a branch from the ſcapula, called *muſcularis* or *ſuper-humeralis*, it ends in the ſubclavian on the ſame ſide, ſometimes in the axillaris, and ſometimes in the union of theſe two veins. The right and left do not always end in the ſame manner; for ſometimes the right goes into the ſubclavian, and the left into the internal jugular, on the ſame ſide.

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

Theſe ramifications and communications are in part covered by the muſculus trapezius, and communicate likewiſe with ſome branches of the vena occipitalis, and with a branch of the ſuperior intercoſtal vein, which perforates the firſt intercoſtal muſcle.

At its termination, it receives, poſteriorly, a principal branch from the muſcles which cover the ſcapula and joint of the humerus, commonly called *vena muſcularis*, and which might be named *ſuper-humeralis*.

Vena jugularis interna. The internal jugular vein is the largeſt of all thoſe that come from the head; tho' not ſo large as it ſeems to be when injected.

It is a continuation of the lateral ſinus, which, after getting through the foramen lacerum of the baſis crani, bends a little, and forms a ſort of varix, which fills a thimble-like cavity in the temporal bone. From this it runs along the ſides of the vertebræ of the neck, by the edges of the longus colli, and paſſes behind the ſterno-maſtoidæus and omo-hyoidæus, which it croſſes, and ends in the ſubclavian vein. At the top of the neck it receives ſmall twigs from the pharynx and neighbouring muſcles.

Farther down it receives another branch, which comes from the occiput. This branch communicates with another of the vertebralis, and, through the poſterior maſtoide hole, with the lateral ſinus of the dura mater. This communication is ſometimes by an anaſtomoſis with a branch of the external jugular, or of the cervicalis.

Nearly oppoſite 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 firſt branch receives others from the muſcles 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 thyroide 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 thyroide 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, after communicating with the occipital veins and fmall occipital finufes of the dura mater.

At firft, it receives the veins from the vertebral finufes, which are pretty numerous, and placed one above another, all the way from the occiput downwards, communicating freely with each other and with thofe on the oppofite fide; and at the foramen magnum occipitis, there is a communication between them and the occipital finufes of the dura mater.

At the top of the neck it receives a branch, which comes through the pofterior condyloide hole of the os occipitis from the lateral finus of the dura mater; but it is not always to be met with.

As this vein runs through the holes in the tranfverfe apophyfes, it receives branches anteriorly from the anterior mufcles of the neck, and from the fmall anterior mufcles of the head.

Other branches come likewife from the mufculi tranfverfales and vertebralis colli at the back part of the neck.

About the third or fourth vertebra of the neck, the vertebral

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

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 pretty large branch, which paſſes almoſt tranſverſely round the neck of that bone, from behind inward, and from within foreward, coming from the muſcles on the outſide of the ſcapula, particularly the deltoides, and communicating with the venæ ſcapularis externæ. This branch may be named *vena ſub-humeralis* or *articularis*, as the artery which lies in the ſame place; they both 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

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 *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

ceives 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 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, pectoralis minor, pectoralis 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 muſcu-

musculares, which come from the middle portion of the musculus trapezius, from the angularis, infra-spinatus, and subscapularis; and as some of these branches come 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;* then before the anterior portion of the musculus scalenus; while it lies in the neck, 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 sternum and parts near it, including the diaphragmaticæ superiores, or pericardia 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 supe-

rior

rior 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 from the integuments through 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 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 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 vertebræ 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:

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

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

Thefe communications between the laft intercoftal and firft lumbar veins are very irregular, being fometimes by a feries of oppofite angles, fometimes by areolæ, fometimes by a reticular texture, &c. Sometimes the extremity of the vena azygos communicates either mediately or immediately with the vena adipofa, and even with the vena fpermatica.

The azygos receives likewife the left intercoftal veins, but feldom the whole number; for the fuperior veins go commonly into the left fubclavian, by a vein fomewhat fimilar to the azygos, but much fmaller. The inferior intercoftal veins, to the number of fix or feven, fometimes more, fometimes fewer, run over between the aorta and vertebræ; from the fubftance of which, and from the œfophagus, they receive capillary twigs in their way to the azygos.

Sometimes the lower left intercoftals pafs into a common trunk, which runs up along the left fide of the vertebræ, and then croffes over behind the aorta to open into the azygos. Sabbatier calls this trunk the *demi-azygos*.

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

As the azygos runs up in the right fide of the thorax, it receives the inferior intercoftal veins on that fide, one coming from each feries of intercoftal mufcles. Thefe veins run along the lower edges of the ribs, after having perforated the mufcles by branches which come from the pofterior 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.

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 ſcalenus 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,

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 ſubclavianæ unite at the upper end of the thorax, near the cartilage of the firſt rib, and form the vena cava ſuperior, which receives the vena azygos, and runs down about an inch, ſomewhat inclining to the right ſide; at this part it enters the pericardium, and deſcends nearly in a direct courſe for about two fingers breadth in an ordinary ſized perſon, being ſituated on the right ſide of the aorta, but a little more anteriorly. It opens at laſt in the upper part of the right auricle.

§ 5. *Veins of the Chylopoietic and aſſiſtant Chylopoietic Viſcera.*

Vena meſaraica minor, or hæmorrhoidalis interna. The blood ſent out by the cæliac and two meſenteric 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, ſurrounding the inteſtines, and forming arches like thoſe of the arteries, It ſeems likewiſe to communicate

communicate by ſome capillary twigs with the left ſpermatic 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 diſtinguiſh it from the hæmorrhoidalis externa, which goes to the vena hypogaſtrica, but communicates with the interna by capillary ramifications. The name of *meſaraica minor* agrees to it very well, becauſe of its ſituation with reſpect to the inferior meſenteric artery, which is alſo leſs than the ſuperior.

After returning the blood from the parts already mentioned, it unites with a branch deſcending from the left part of the arch of the colon. This is formed by many ramifications which communicate with a branch of the great meſaraica, with the ramifications of the gaſtro-epiploica ſiniſtra, and with thoſe of the neighbouring epiploica.

At a ſmall diſtance from its termination, it receives from the duodenum a vena duodenalis, which is ſometimes more conſiderable than one which paſſes into the great trunk of the vena portæ.

The ſmall meſaraic vein is one of the three principal branches of the vena portæ, opening commonly into the termination of the vena ſplenica, and ſometimes into the beginning of the great trunk of the vena portæ.

Vena ſplenica. The ſplenic vein is one of the three great branches of the vena portæ, and may be ſaid in ſome meaſure to be a ſubordinate trunk of that vein. It runs tranſverſely from the left to the right ſide, firſt along the lower ſide of the pancreas, near the poſterior edge, and then under the duodenum,

In this courſe it receives ſeveral veins, viz. the vena coronaria ventriculi, pancreaticæ, gaſtrica, or gaſtro-epiploica ſiniſtra, and epiploica ſiniſtra. It likewiſe often receives the hæmorrhoidalis interna, already deſcribed.

The vena ſplenica begins by branches which run in a winding courſe, after having run through the whole length of the ſpleen, almoſt in the ſame manner as the ſplenetic artery. It is into the moſt poſterior of theſe branches that the veins are received from the great extremity of the ſtomach, formerly known by the name of *vaſa brevia*, which communicate with the coronaria ventriculi and gaſtrica ſiniſtra.

In its paſſage it receives, at the ſmall extremity of the pancreas, a vein called *epiploica ſiniſtra*, becauſe it comes from the left ſide of the omentum, where it communicates with the hæmorrhoidalis 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 ſplenica at 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

merous areolæ, and communicate with the veins of the great arch.

It terminates pretty 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; 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 wirh 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

mediately after it defcends over the mefenteric artery, it gets the addition of two large branches very near each other, which pafs behind and under the artery, coming from the jejunum and part of the ilium by numerous ramifications, which form arches and areolæ like thofe of the artery.

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

The fuperior branch of the vena gaftro-colica receives the gaftrica, or gaftro-epiploica dextra, which comes from the great curvature of the ftomach, communicating with the gaftrica finiftra. It alfo admits fmall veins from the head of the pancreas. In its paffage it gets likewife branches from the ftomach and omentum, and communicates with the pylorica, coronaria ventriculi, &c. and fometimes it receives the pylorica.

The inferior branch of the vena gaftro-colica, which may be called *colica dextra*, comes from the upper part of the colon, and then from the right portion of that inteftine, where it is divided archwife, and communicates with the great branch of the colica anterior, and with a branch of the vena cæcalis.

The laft 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 hand, it communicates with the fuperior or defcending branch of the hæmorrhoidalis; and on the right, with the former branch of the mefaraica.

The vein, after having been diftributed like the artery, runs through thofe parts of the mefentery and mefocolon which belong to the fmall inteftines, the cæcum, and right portion of the colon; it paffes next over

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

All theſe ſmall veins ſometimes end ſeparately; and in other ſubjects, ſome of them go into it 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 go ſometimes 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 conſequently 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*

§ 6. *Veins of the Inferior Extremities.*

THE blood is returned from the inferior extremities by a fuperficial and deep fet of veins, fomewhat in a fimilar manner to what we have defcribed in the fuperior extremities. Of the fuperficial veins we find one called *faphena major*, and another called *faphena minor*. The deep veins have the fame names with the arteries which they accompany.

Vena faphena major. This begins at the great toe, then runs between the firft two metatarfal bones irregularly under the fkin towards the inner ankle.

At the great toe it receives a kind of tranfverfe arch over the metatarfus, which communicates by feveral branches with an arch which lies on the joint of the tarfus, and gets others from the toes. This arch receives likewife another branch, which runs down behind the outer ankle, having communicated with the vena tibialis externa.

Under the inner ankle, it receives a branch inward and forward, which runs under, and in fome meafure accompanies, the anterior tibial artery. Interiorly, it receives another branch at the fame place, which paffes up from the fole of the foot, communicating with the external tibial vein by irregular arches. This in its paffage receives branches from the toes.

At the lower part of the tibia, the faphena receives a confiderable branch, which runs obliquely from the outer ankle, being formed of feveral rami, which communicate with each other and with the trunk of the faphena.

A little higher, it likewife receives from the fore-part of the tibia fome branches coming from the periofteum and bone, and communicating with other branches to be defcribed.

Afterwards the trunk of the great faphena runs upon the infide of the tibia, lying always near the fkin; at the

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 forepart of the thigh, having been covered in all its paſſage by ſkin and fat 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 at 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

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 receive ramifications from the toes, nearly in the ſame manner as the arteria plantaris.

The venæ plantares form a trunk, which paſſes on the inſide 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 tranſverſe branch of the ſaphena, and with the anterior tibial vein, in the manner already ſaid; then receives branches from the muſculus tibialis poſticus and the long flexores of the toes.

Afterward the poſterior tibial vein runs up between the ſoleus and tibialis poſticus, receiving branches from each of them. It is formed, ſomewhat in the ſame manner as the tibialis anterior, of two or three branches, which, as they run, ſurround the correſponding artery, by ſmall communicating circles formed at different diſtances.

It receives near its termination a branch, called *ſuralis*, from the gaſtrocnemii and ſoleus; and opens at laſt into the vena poplitæa, a little lower than the tibialis anterior.

Vena peronæa. The vena peronæa is likewiſe double, and

and ſometimes triple. It runs up on the inſide of the fibula, almoſt in the ſame direction with the arteria peronæa, which it likewiſe ſurrounds at different diſtances, by communicating branches, after the manner of the tibialis poſterior, and like it ends in the vena poplitea.

It runs up from the foot to near the joint of the knee, communicating ſeveral times with the tibialis poſterior, and receiving ramifications from the neighbouring portions of the muſculi peronæi and long flexors of the toes.

The firſt of theſe communications make the venæ plantares, in ſome ſubjects, to appear rather to go into this vein, than into the tibialis poſterior, where they commonly terminate.

Vena poplitea. The vena poplitea, formed of the three large veins laſt deſcribed, but appearing to be a continuation of the tibialis poſterior, runs up immediately behind the muſcle of 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 peronæus 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 betwixt 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

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 circumflex externa, circumflexa interna, and profunda femoris; the diſtribution of which is ſimilar to that of the correſponding arteries. In this courſe, other ſmall veins run in from different parts of the thigh; but theſe have no particular names.

About an inch below Poupart's ligament, the crural vein receives the ſaphena major; and then branches from the inguinal glands, the muſculus pectineus, and parts of generation. Theſe are termed *pudicæ externæ*, and evidently communicate with internal veins of the ſame name. After this the trunk of the vein goes into the abdomen under Paupert's ligament, on the inſide of the correſonding artery.

§ 7. *Veins of the Pelvis.*

Vena iliaca externa. After the crural vein gets from under the ligamentum Fallopii, it is called *vena iliaca externa;* this receives ſeveral ſmall rami from the neighbouring lymphatic glands.

To the inſide, after it gets into the abdomen, it receives the vena epigaſtrica; which runs down along the back part of the muſculi recti, from which it chiefly comes; but receives alſo branches from the broad muſcles of the abdomen, which penetrate from without inwards: near its termination, it gets ſmall branches from the conglobate glands.

The beginning of the vena epigaſtrica runs downward, from the ramifications of the mammaria, with which it communicates, accompanying the epigaſtric artery. At the inſide of the epigaſtric vein, a branch is ſometimes received from the muſculus obturator internus, where a communication is alſo made with the vena obturatrix.

Near the end of the former vein, the iliaca externa receives a branch which comes down along the inſide of the criſta of the os ilium; and admits others on each ſide, from the lateral and poſterior 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 iliac 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 *hæ-*

morrhoidales

morrhoidales externæ; and thoſe that come from the parts of generation, *pudicæ internæ*. The external hemorrhoidales communicate with the internal veins of the ſame name, which go to the ſmall vena meſariaca, 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 multi fidus 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

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 forepart 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, admits the lumbares. This branch likewise communicates with the azygos, and with the superior or descending ramus lumbaris.

The venæ lumbares on one side communicate by transverse branches with those of the other side, and likewise with each other by branches more or less longitudinal. The first and second often go to the azygos, and thereby they communicate with the intercostal veins.

The lumbar veins come from the muscles of the abdomen, quadratus lumborum, psoas, iliacus, &c. and they receive small branches in their passage from the substance of the bodies of the vertebræ. They get branches forward from the neighbouring vertebral muscles, and from the canal of the spine, and communicate with the venal sinuses in the same manner as the intercostals do.

Having got as high as the arteriæ renales, the vena cava receives the veins of the same name, termed formerly *venæ emulgentes*, and which are the largest 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 shortest, and runs up a little obliquely becaufe of the fituation of the kidney. The left vein, which is the longeft, croffes on the fore-fide 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 paffage, they receive feveral fmall branches on each fide, from the peritonæum and mefentery; where they feem to be joined by anaftomofes with the venæ mefaraicæ, and confequently with the vena portæ.

They fometimes bring a confiderable branch over the iliac mufcle, which is formed of two others; one ramus runs down from the membrana adipofa of the kidneys, the other runs up on the laft mentioned mufcle.

About the fame height with the fpermatic vein, the inferior cava receives pofteriorly, in fome fubjects, 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 fide, 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 fometimes 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, 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 upon running a quarter of an inch or ſo within the pericardium, opens into the under part of the right auricle.

EXPLANATIONS of TABLES XI. and XII.

TAB. XI. *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 fubclavian vein. The carotid artery runs up to the head, partly covered by the internal jugular vein.

D, The facial artery, which fends off the coronary arteries of the lips.

E, The deep temporal artery.

F, The defcending 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, fending branches to the forepart of the leg and upper part of the foot.

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 laft veins run clofe by the fides of their correfponding arteries.

10, The cephalic vein.

11, The bafilic vein cut. On the left fide 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 veffels are fo fmall, that one trunk muft reprefent both artery and vein.]

15, The axillary vein.

16, The fubclavian vein, receiving the jugular and other veins from the head and neck.

17, The vena cava fuperior.

18, Veins

TAB. XI

D. Lizars Sculp.

TAB. XII.

D. Lizars Sculpt

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. XII. *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.

C H A P. 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 been indeed 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 the thoracic duct had been ſeen by Euſtachius, who ſpeaks of it as a vein of a particular kind; (ſee Euſtachius *de Vena ſine Pari.*)

In 1622, Aſellius diſcovered thoſe veſſels on the meſentery, which, from their carrying a milk-like fluid, he denominated *lacteals*. This diſcovery being made by opening a living dog, anatomiſts 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. Suſpecting 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 ſubclavian vein; and thus he clearly proved the exiſtence of that duct which we now conſider as the trunk of the ſyſtem. Juſt before this time the lacteals had been ſuppoſed to terminate in the liver; conformably to the idea which the phyſiologiſts of that period had adopted about the uſe of this organ, which, from the authority of the older anatomiſts, they believed

was

was the viſcus hæmatopoeticum, or received the chyle from the inteſtines to convert it into blood.

In the years 1651 and 1652, Rudbeck, Jolyffe, and Bartholin, diſcovered the other parts of this ſyſtem, which, from their carrying a tranſparent and colourleſs fluid, are called the *lymphatic veſſels.* Thus there was proved to exiſt in an animal body a ſyſtem of ſmall veſſels containing fluids very different from the blood, and opening into the ſanguiferous veſſels at the left ſubclavian vein.

After this period, Nuck added to our knowledge of this ſyſtem, by his injections of the lymphatic glands; Ruyſch, by his deſcription of the valves of the lymphatic veſſels; and Dr Meckel, by his accurate account of the whole ſyſtem, and by tracing thoſe veſſels in many parts where they had not before been deſcribed.

Beſides theſe authors, Drs Hunter and Monro have called the attention of the public to this part of anatomy, in their controverſy concerning the diſcovery of the office of the lymphatics.

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, ſuppoſes theſe veſſels aroſe from cavities, and that their uſe was to abſorb; and Frederic Hoffman has very explicitly laid down the doctrine of the lymphatic veſſels being a ſyſtem of abſorbents. But anatomiſts in general have been of a contrary opinion; for from experiments, particularly ſuch as were made by injections, they have been perſuaded, 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 Dr Hunter and Dr Monro, 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. Mr Hewſon claims the merit of having proved the affirmative of this queſtion, by diſcovering the lymphatic ſyſtem in birds, fiſh, and amphibious animals. See Phil. Tranſ. vol. 58. and 59.

Section I. *Of the Abſorbent Syſtem in general.*

The abſorbent ſyſtem conſiſts of the lacteals, the lymphatic veſſels, their common trunk, the thoracic duct, and the glands called *conglobate*.

The lacteals begin from the inteſtinal tube, and can for the moſt part be ſeen 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 diſtended with a liquor that is tranſparent and colourleſs like the lymph; and in birds the chyle is never found white, but always tranſparent: theſe veſſels, therefore, might, with as much propriety, be called the *lymphatics of the inteſtines*.

The lymphatic veſſels are ſmall pellucid tubes that have now been diſcovered in moſt parts of the human body; the fluid they contain is generally as colour-

leſs

lefs 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 thrown round the large 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 thrown round 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, all agree in having their coats thinner and more pellucid than thofe of the blood-veffels. But although their coats are fo thin, they are very ftrong, as we daily fee on injecting them with mercury, fince they refift a column of that fluid, whofe weight would make it burft through blood-veffels, the coats of which are many times thicker than thofe of the lymphatic fyftem.

The thinnefs of the coats prevents our dividing them from one another, and thereby afcertaining their number as we do thofe of the blood-veffels. But as the blood-veffels have a denfe internal coat to prevent tranfudation, we have reafon to believe the lymphatics have the fame. And as the blood-veffels have a mufcular

coat,

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 of their contents, 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 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. Theſe valves have been painted by the celebrated Nuck, Ruyſch, and others, and are much more frequent than in the common veins, and thence theſe lymphatics have ſometimes been diſtinguiſhed by the name of *valvular lymphatic veſſels*. Thoſe valves are generally two in number, are of a ſemilunar ſhape, and the one is ſometimes much larger than the other. In moſt

parts

parts of the body theſe valves are ſo numerous, that there are three or four pair in an inch of ſpace, but ſometimes there is no more than one pair, and ſometimes ſeveral inches of a lymphatic appear without a valve. They are leſs numerous in the thoracic duct than in the branches of the ſyſtem; thence it might be ſuppoſed, that in proportion as we go from the trunk to the branches, we ſhould find them thicker ſet: but this is not always true, for Mr Hewſon obſerved them more numerous in the lymphatic veſſels of the thigh than on thoſe of the leg. When the veſſels are diſtended with lymph, they appear larger on that ſide of the valves next the heart; which ſometimes gives a lymphatic veſſel an appearance of being made of a chain of veſicles: as ſuch they are repreſented by ſome authors; but it is an appearance that very ſeldom occurs in the human body. In quadrupeds, however, this appearance is very remarkable. Wherever a lymphatic veſſels 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.

Laſtly, the lymphatic ſyſtem, in different parts of its courſe, has the glands called *conglobate* or *lymphatic.* Theſe glands are ſo placed, that the veſſels come in on one ſide, and paſs out on the other, in their way to the thoracic duct. They are commonly of an oval, though ſometimes of a round ſhape, and frequently ſomewhat flattened, and of various ſizes; ſome being no larger than a millet ſeed, while others are almoſt an inch in diameter. They vary in colour in different parts of the body, and at different times of life. In young people they are generally of a reddiſh or brown colour; but become paler with age: They have a ſhining external ſurface, which is owing to a ſmooth denſe coat that covers them. Like other glands, they have arteries, veins, and nerves, which enter into their compoſition: but with reſpect to the

reſt

reſt of their ſtructure, anatomiſts are much divided in opinion; ſome endeavouring to prove that they are formed of cells, while others of equal credit conſider them as a collection of veſſels. Before the diſcovery of the lymphatic veſſels in birds, fiſh, and turtle, ſome anatomiſts have conſidered theſe glands as ſo eſſentially neceſſary to the lymphatic ſyſtem, that they have generally ſet about diſcovering the veſſels by firſt looking for thoſe glands: and wherever they found glands, they pronounced that there muſt be veſſels; and when no glands could be ſeen, they thought it as certain a proof of their being no veſſels. But that they are wanting in ſome animals, is now generally known.

Section II. *A particular Deſcription of the Abſorbent Syſtem in the Human Body.*

The abſorbent ſyſtem, beſides the glands, is divided into three parts, viz. The lacteals, the lymphatic veſſels, and the thoracic duct. The lacteals belong to the inteſtinal 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 the lymphatics. We ſhall give a particular deſcription of theſe, chiefly from Hewſon, Maſcagni, and Cruikſhank, by whoſe attention this part of anatomy has been ſo greatly illuſtrated.

§ 1. *Lymphatic Veſſels of the Lower Extremities.*

These may be divided into two ſets, viz. a ſuperficial, and a deep-ſeated.

The ſuperficial ſet of lymphatics conſiſts of numerous veſſels that lie between the ſkin and the muſcles, and belong to the ſurface of the body or the ſkin, and to the cellular membrane which lies immediately under it. Of theſe there are numerous large branches that

that can be readily enough difcovered in the limbs of dropfical fubjects. Many of thefe run upon the top of the foot; one of them is reprefented Plate XIII. fig. i. (10); others are generally to be found juft under the inner ankle; pipes have been introduced into two of them, whereby they have been filled the whole length of the lower extremity, as is feen in this figure.

The greater number of fuperficial lymphatics accompany the vena faphena major. They can be firft traced from the toes; and there they run fomewhat like the arteries and veins. A plexus, confifting of feveral veffels, runs over the top of the foot with the faphena to the inner ankle; and from thence upwards to the inner fide of the knee. Here they are joined by another fet which arifes from the fole, and paffes up on the inner and back part of the leg. A third fet arifes from the outer-fide of the foot, and runs by the outer ancle. Upon the outer part of the leg, thefe fplit into two divifions; one of which croffes obliquely over the fore-part of the leg to the lymphatics, at the inner fide of the knee, while the remaining part accompanies the vena faphena minor, and runs to the glandulæ popliteæ. From the infide of the knee a plexus runs up, confifting of from a dozen to twenty trunks, which pafs afterwards on the anterior and inner fide of the thigh to the inguinal glands. In their paffage they receive branches from the outer and back parts of the thigh; but thefe are few in number when compared with the reft.

The lymphatic glands of the groin are fix, feven, eight, or upwards; they vary much in number: of thefe, fome 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 veffels, above defcribed, enter the lowermoft of thefe glands, which in the fubject of this figure, are four in number, viz. (15 15, 16 16. One or more of thefe branches, however, frequently avoids the glands, as at (17); which afterwards bends bend over at (18) to the gland (19); from which go veſſels to the other lymphatic glands (20, 20) that lie in the angle between the thigh and the abdomen, and ſometimes a few enter no glands till they reach thoſe on the inſide of Poupart's ligament.

Into the inguinal glands alſo numerous lymphatics paſs from the ſuperficial parts of the abdomen and pelvis. See Maſcagni, Tab. iii.

It is into theſe upper glands alone that the lymphatic veſſels of the genitals enter, ſo that the venereal bubo which ariſes in conſequence of an abſorption of matter from theſe organs, is always ſeated in thoſe 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 firſt diſeaſed, which very ſeldom happens. And, as it is the upper glands that are affected by the abſorption of matter from the genitals, ſo it is the lower which are commonly firſt affected from the abſorption of the acrid matter of an ulcer, diſeaſed joint, or carious bone, (in the parts below theſe glands); a circumſtance that may aſſiſt us in the diagnoſis of thoſe two kinds of buboes: Remembering, however, that this rule may be liable to an exception from one or more of the lymphatic veſſels paſſing the lower glands, and only entering the upper, as is ſeen at (17) in the ſame figure.

In the penis three principal veſſels commonly take their origin from the prepuce. Theſe ſoon unite, and afterwards ſeparate upon the middle of the dorſum penis into two parts; one of which goes to the inguinal glands on the right ſide, the other to thoſe on the left, and which are ſituated at the upper and anterior part of the groin.

The deep ſeated lymphatics ariſe from the glands and body of the penis, and accompany the arteries into the lower part of the pelvis. Hence if venereal matter be abſorbed by theſe veſſels the conſtitution may be affected without our being aware of it.

The

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, 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 network 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. XIV. (26). 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. XIII. fig. i. and at (27) Tab. XIV.

The ſuperficial lymphatics of the inferior extremity are the trunks of thoſe veſſels which aſorb 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 is commonly not one lymphatic gland, beſides 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. XIII. fig. i. and in another ſubject Mr Hewſon ſaw a ſmall lymphatic gland near (14); from which it may be concluded, that the lymphatic glands, even in the human body, are in number and ſituation a little different in different ſubjects.

Besides these superficial lymphatic vessels which lie above all the muscles, or in the cellular membrane under the skin, there is a set deeper seated that lie amongst the muscles, and accompany the arteries, and like the veins, one lies on each side. Of these the principal trunks can be discovered by cutting down to the posterior tibial artery, near the inner ankle. By introducing pipes into these parts, they may be injected; as has been done in several subjects, one of which is represented Tab. XIII. fig. ii.

From the inner ankle at (13) *ibid.* these vessels pass up along with the posterior tibial artery, being hid amongst 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 which 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 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 Paupert's ligament, by the plexus of veſſels repreſented fig. i. at (21), and a part of it at Tab. XIV. (27).

Tab. XIII. 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 ſhow 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 ſhow 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 get 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 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 (23). (24) A lymphatic gland belonging to the deep-feated lymphatic veffel. At this place thofe veffels pafs to the fore-part of the groin, where they communicate with the fuperficial lymphatic veffels. (25) A part of the fuperficial lymphatic veffels appearing on the brim of the pelvis.

2. *Abforbent Veffels of the Trunk.*

The lymphatics of the lower extremities having now reached the trunk of the body, and having paffed under Poupart's ligament, appear upon the fides of the offa pubis near the pelvis at (27, 27) Tab. XIV. A part of them paffes 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 fciatic notch. At this place they are joined by the lymphatics from the contents of the pelvis, particularly from the bladder and the veficulæ feminales in the male, and from the uterus in the female; and there are likewife feveral branches which pafs thro' the fciatic notch from the neighbourhood of the glutei mufcles. The lymphatic veffels of the uterus, like its blood-veffels, are much enlarged, and therefore eafily diftinguifhed, in the pregnant ftate of that organ. They are in two fets; one runs along with the hypogaftric arteries and veins; the other with the fpermatic veffels. The lymphatics of the external parts of generation in the female go partly to the inguinal glands of each fide, and partly through the rings of the external oblique mufcles to terminate in the glands of the loins or pelvis. At this part, where fo many lymphatics veffels join, there is 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 of which are ſeen on the left ſide in the ſame plate at (28.) Of theſe, one part paſſes up to the loins at (32), and goes under the aorta in different branches, getting from the left ſide to the right, and joining the thoracic duct. Another part paſſes under the iliac arteries, and appears upon the os ſacrum at (30), making a beautiful network, joining the lymphatics of the right ſide, and paſſing under the iliac artery, to form the network (31) upon the upper part of the right pſoas muſcle. In different parts of this courſe from Poupart's ligament to the loins, and alſo in the loins themſelves, there are, in moſt ſubjects, many lymphatic glands; none of which were filled in the ſubject from which this plate was made.

The lymphatic veſſels of the right ſide, joined by ſome from the left, having now reached the right lumbar region, appear there in the form of a plexus of large veſſels, and paſs through ſeveral glands, which occupied the ſpaces (33, 33, 33), but not being injected in the ſubject are not repreſented. At this part likewiſe they receive large branches, under the aorta, from the plexus on the left ſide of the loins, as is mentioned before; and having at laſt got up as high as the ſecond or more frequently the third lumbar vertebra, they all join, and form a ſingle trunk called the *thoracic duct*, which is ſeen at (36). At this part they are likewiſe joined by the lacteals, which ſhall be next deſcribed.

The lacteal veſſels, ſo called from their commonly conveying a fluid that is of the colour of milk, are found in two ſets which communicate with each other; the internal begin from the inner ſurface of the inteſtines, where each lacteal is at firſt formed upon the ſurface of the villi by numerous ſmall radiated branches, with orifices deſtined to imbibe the nutritious fluid or chyle: From the cavity of the inteſtines theſe veſſels paſs obliquely through their coats, uniting as they go, ſo as to form larger branches. They follow the courſe of the arteries and veins, and are double their number; one being ſituated on each ſide. Theſe branches run on the outſide of the gut to get to that part which is next the meſentery; and, whilſt they are yet upon the gut, they are ſometimes of a ſize ſufficient to admit a ſmall pipe, ſo that they have been frequently injected with mercury in the human ſubject. And in man as well as in different animals the external ſet appear between the peritonæal and muſcular coat, and commonly run for a conſiderable way in the ſame direction with the inteſtine.

From the inteſtines they run along the meſentery and meſocolon, towards the ſpine; paſſing thro' the lacteals in their way to the conglobate or meſenteric glands. Theſe glands divide the lacteals into two regions: from the inteſtines to the glands theſe veſſels are called *lactea primi generis;* and from the glands to the thoracic duct, *lactea ſecundi generis.* (*See* Sheldon on the Abſorbent Syſtem).

The lacteals of the *jejunum* are larger and more numerous than thoſe of the *ilium.* Thoſe of the ſmall inteſtines, as they run upon the meſentery, commonly accompany the ſuperior meſenteric artery, and unite, as they proceed into larger branches; ſo that by the time they arrive at the root of the meſentery, they are of a conſiderable ſize, as may be ſeen at (34). From the meſenteric artery they deſcend by the ſides of the aorta, and open at laſt into the thoracic duct (36): the lacteals, or rather the lymphatics of the large inteſtines, run ſomewhat differently. Thoſe from the cæcum, and from the right part and great arch of the colon, join the trunks of the lacteals of the ſmall inteſtines about the root of the meſentery, whilſt thoſe from the reſt of the colon terminate in the lumbar glands, or lower part of the thoracic duct, accompany the inferior meſenteric artery, and communicate with the large lymphatic veſſels near its root.

Into the thoracic duct at (36), likewiſe enters the lymph of the other abdominal viſcera. This is brought by a number of veſſels, which in all the viſcera run in a ſuperficial and deep ſet; a plexus of theſe may be traced from each kidney, lying principally behind the emulgent artery, and opening into large lymphatic veſſels near the aorta. The lymphatics of the kidney are ſeldom ſeen in the ſound ſtate of that viſcus; but when it is enlarged or ulcerated, they are ſometimes obſerved diſtinctly: they run from its outer towards its inner edge, and immediately afterwards paſs thro' the glands of the loins. The lymphatics of the glandulæ renales, or renal capſulæ, likewiſe terminate in the renal plexus.

The lymphatic veſſels of the ſpleen paſs from the concave ſide of that viſcus, along with the ſplenic artery in the ſinuoſity of the pancreas, by the lymphatic veſſels of which they are joined. The deep ſeated lymphatics of the ſpleen are very conſiderable, and can be readily ſeen at its concave edge, but thoſe on its ſurface are ſmall and few in number in quadrupeds; however, as in the bullock, they are remarkably numerous and large.

To the ſtomach belong two ſets of lymphatic veſſels, the one running upon its leſſer, and the other upon its greater curvature. Of theſe, the former accompanies the coronary artery, and paſſes through ſome lymphatic glands that lie by its ſides. The other ſet paſſes from the great curvature of the ſtomach, partly to the left and partly to the right ſide. Thoſe on the left ſide receive the lymphatics of the left half of the great omentum, and run with the lymphatics of the ſpleen and pancreas to the thoracic duct. Thoſe on the right ſide, receive the lymphatics from the right half of the great omentum, and paſs through ſome lymphatic glands that lie cloſe to the arteria gaſtrica dextra. Deſcending by the pylorus, they meet the plexus that accompanied the coronary artery; and near the leſſer curvature of the duodenum, form a conſiderable network. Into this not only the lymphatics 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 network; 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 therefore is 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 towards 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 in 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 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

and afterwards end in the thoracic duct, near the root of the superior mesenteric artery. It is remarkable of those lymphatic vessels which run upon the surface of the liver, that their valves can readily be made to give way, so that they may be injected from their trunks to their branches, and to 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 only open into the sanguiferous veins of the stomach: but from repeated dissections of the human subject, Mr Hewson has been convinced of the contrary; and likewise from the 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 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 the *receptaculum chyli*, and 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; for that commonly it appears only a little larger than at its middle. 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, and other parts already described, formed by the lymphatics of the inferior extremities; the third belongs chiefly to the lacteals. These large vessels unite so as to form the duct over the third vertebra lumborum, reckoning from above downwards.

 Upon

Upon the ſecond vertebra of the loins, the union of theſe veſſels is ſometimes twice or thrice as large in diameter as the duct is higher up; at other times little or no enlargement can be obſerved.

Theſe large lymphatic trunks which form the thoracic duct are ſpread out upon the ſpine, thoſe of the right ſide lying below the right crus diaphragmatis, and thoſe of the left paſſing between the aorta and the ſpine; whilſt the thoracic duct itſelf lies at firſt behind the aorta; but afterwards paſſes from that upwards, and a little to the right ſide, till it gets before the firſt vertebra of the loins. Here it is ſituated behind the right crus of the diaphragm, where it enlarges again; and ſometimes forms a pyriform bag, which has been conſidered by authors as the beginning of the duct. From this part it paſſes upwards, being at firſt covered by the crus diaphragmatis, and afterwards appears at (38) in the thorax, upon the ſpine between the aorta and the vena azygos. In the thorax it receives ſome lymphatics from the intercoſtal ſpaces; a few of which are ſeen at (39), and afterwards it receives veſſels from the lungs.

The ſuperficial lymphatics of the lungs form a beautiful network, the larger branches running chiefly between the lobules, the ſmaller paſſing over them; and here, as well as on the liver, and other parts, there are numerous valves; the exiſtence of which has by ſome been denied. From the ſurface they paſs to the root of the lungs, and there they go through the bronchial glands. At this place they are joined by the deep-ſeated abſorbents which creep along the branches of the trachea, and likewiſe on thoſe of the pulmonary artery and vein. Having left the glands, the principal part of thoſe 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

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 later 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 correſpondent 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 between the arch 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 the ſubclavian vein. But, juſt before its termination, it generally goes higher up than the angle, and then bends down towards it; ſee Tab. XIV. n° 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 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 a line diameter, which is generally named the *thoracic duct*. This paſſes betwixt 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

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 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 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 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;

menſions; 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 ſubclavin 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, 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

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 pretty 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 there is a conſiderable number generally met with by the ſides, and upon the lumbar vertebræ.

Over the trunks of the blood-veſſels of the ſpleen, liver, kidneys, and renal capſulæ, there are alſo lymphatic glands which belong to the lymphatic veſſels of theſe organs. In the thorax, a few glands are found on the fore-part of the pericardium and upper ſurface of the diaphragm, and belong to the liver or diaphragm,

phragm. Others are ſituated between the laminæ of the anterior mediaſtinum.

There are likewiſe lymphatic glands ſometimes obſerved by the ſides of the thoracic duct, particularly about the middle of the thorax; which glands belong principally to the veſſels of the lungs.

There are alſo many lymphatic glands (called *bronchial*) near the root of the lungs: theſe glands are placed upon the lymphatic veſſels, juſt where they quit the lungs. But no lymphatic glands have yet been obſerved in the ſubſtance of the lungs; and the tubercles, which ſome ſuſpect to be obſtructed lymphatic glands, ſeem to have a different origin. There are likewiſe ſome glands ſeen on the lymphatic veſſels which lie near the ſubclavian veins at the upper part of the thorax, and which belong to the lungs.

Beſides theſe there are ſome lymphatic glands upon the aorta near the œſophagus, and there are alſo others occaſionally met with in the intercoſtal ſpaces, 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 ſubclavian vein; and a few are found over the internal mammary veſſels where the abſorbents of the liver paſs up within the thorax.

§ 3. *Lymphatics of the Head and Neck.*

The lymphatics of the head, like thoſe in many other parts of the body, are in two ſets; one belonging to the outer, the other to the inner, parts of the head. Thoſe on the outſide of the head accompany the blood-veſſels, and paſs through glands in their way to the neck. Thoſe accompanying the temporal artery go through ſmall glands at the root of the zygomatic proceſs, while the abſorbents of the occiput paſs through others behind the maſtoid proceſs of the temporal bone.

Several anatomiſts have ſeen an appearance of lymphatics both on the brain and its membranes; but none even of the lateſt authors have been certain about theſe. That the brain, however, has its abſorbents, there can be little doubt; as is in ſome meaſure proved from the exiſtence of lymphatics and glands, in or on the outſide of the paſſages of the arteries and veins of the brain, from ſwellings in the lymphatic glands of the neck, ariſing from diſeaſes of the brain, from the abſorption of water which has ſometimes happened in caſes of hydrocephalus, and from ſeveral other circumſtances.

From the ſuperficial and deep parts of the head, the lymphatics paſs through the glands ſituated near the carotid arteries and internal jugular veins, where they are joined by others, to be immediately deſcribed.

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 noſe, lips, and cheeks. Some of theſe paſs through ſmall glands on the outſide of the buccinator muſcle, while the principal branches go through larger glands on the outer and under ſide of the lower jaw, near the correſponding blood-veſſels, and the inferior maxillary gland. Others run through the glands on the upper and under end of the parotid gland. The lymphatics of the inner ſide of the noſe run principally with the internal maxillary artery, and paſs 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, paſs through the glands which belong likewiſe to thoſe of the deep parts of the head.

The glands which accompany the lower part of the artery that runs upon the face, are ſometimes ſwelled in conſequence of abſorption from the lips, and alſo from gum boils; and thoſe which accompany the occipital artery, are frequently enlarged in conſequence of abſorption of matter from wounds of the ſcalp; from which facts we are led to trace the courſe of the lymph even in the living body. In quadrupeds thoſe veſſels may be diſtinctly ſeen, particularly in a dog or an aſs, by paſſing a ligature round the large blood-veſſels of their necks immediately after killing them. Mr Hewſon made ſome experiments of this kind, with a view to determine whether the brain had lymphatic veſſels; but he informs us he was never able to ſee any on that organ; neither when he tied up the lymphatics on the necks of thoſe animals, nor when he diſſected the human brain, with a view to diſcover thoſe veſſels, although he particularly ſought for them in the plexus choroides, where they have been ſuſpected to be ſeen, and near the glandular pituitaria: but that although lymphatic veſſels have not been demonſtrated in the brain, it is probable from analogy that this organ is not deſtitute of them.

The lymphatics already deſcribed 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, paſſing 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. XIV. which exhibits the trunk ſo prepared as to ſhow the lymphatics and the thoracic duct, (1) is

TAB. XIII.

. Lazars Sculp.t

TAB. XIV.

D. Lizars Sculpt.

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; one of which paſſes on each ſide of the aorta, that of the right ſide being ſeen to enter the thoracic duct at (34.) (34) The thoracic duct beginning from the large lymphatics. (38) The thoracic duct paſſing under the curvature of the aorta to get to the left ſubclavian vein. (39) A plexus of lymphatic veſſels paſſing 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 paſſing behind that vein downwards and outwards towards the angle between the left jugular and the left ſubclavian.

 (41)

(41) The extremity of the thoracic duct entering the angle between the left jugular and the left fubclavian vein. (46) That network paffing under the right fubclavian vein, and under the fubclavian mufcle, the clavicle being removed.

N. B. The other Nos 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, moft of them run near the bafilic vein, and commonly pafs through one or two fmall glands, a little above the internal condyle of the humerus, and over the brachial artery; but the lymphatics on that fide of the arm next the thumb appear to pafs through no glands till they reach the axilla. The reft of the lymphatics accompany the cephalic vein, and are but few in number: they pafs between the deltoid and pectoral mufcles, and then go thro' glands at the infide of the clavicle. Of the deep-

deep-feated lymphatics of the arm two commonly accompany each artery, in the fame 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 fide of the thorax, and alfo by thofe from the fhoulder. From thefe glands larger branches run under the clavicle, and form a trunk, which receives thofe from the head and neck already defcribed. In Tab. XIII. fig. iii. fome of the lymphatics are feen running on the back part of the fore-arm at (6, 6) moft of them paffing on its outfide, and twifting to the fore-part, near the head of the radius, as at (7). But in this reprefentation, there is a veffel which paffes towards the infide, under the inner condyle of the os humeri at (8), and fends a branch amongft the mufcles; which branch perforates the interoffeous ligament, getting between the radius and ulna to the fore-part, where it joins a deep-feated 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 mufcles on the back of the fore-arm turned afide to exhibit a deep-feated lymphatic veffel, which perforates the interoffeous ligament to get to the fore-part. (5) The olecranon.—The veffels have been already referred to.

In Tab. XIII. fig. iv. the lymphatic veffels are feen on the fore-part of the upper extremity; thofe fuperficial branches which paffed on the outfide of the back of the fore-arm appearing now on the fore-part at (8); and afcending under the fkin that covers the fupinator longus and the biceps, they enter fome glands in the axilla at (12, 12), whilft that veffel which paffed on the infide of the back of the fore-arm under the internal condyle, appears on the fore-part at (9), and juft above the condyle enters a gland (10), and then paffes up on the infide of the arm, communicating with a lymphatic from the fore-part of the wrift, and paffing to the axillary glands.

A fuperficial lymphatic is feen under the fkin, on the fore part of this extremity juft above the wrift; a pipe was introduced at (7), and the veffel thereby injected with mercury. Paffing under the integuments over all the mufcles, this veffel joins the lymphatic from the back part of the fore-arm at (11), and there forms a plexus which paffes under the integuments, on the infide of the arm, to the axillary glands at (12).

Befides thefe fuperficial lymphatics upon the upper extremity, others lie near the radial artery; one is injected from a pipe fixed at (13). This veffel accompanies the radial artery, and paffes (14) firft under the interoffeous, and then under the ulnar artery, which in this fubject runs over the mufcles. Near the part where it paffes under the interoffeous artery, it receives the branch from the back of the fore arm. After paffing under thefe arteries, this lymphatic appears on the infide of the bracheal artery at (15), where it is deep-feated. Afcending clofe to that artery, and near the middle of the arm, it paffes through the two glands (16, 16); after which it appears confiderably enlarged, goes under one of the arteriæ anaftomaticæ at (17, 18), and then afcends 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 fcapula, (2) the clavicle, (3) the extremity 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. N. B. The fubfequent N^{os} 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 larger lymphatic veffels of the arm; and there are fome accompanying the ulnar and interoffeous interosseous arteries, although not here injected. They should moreover be considered as only trunks of the lymphatics; since it is probable, that every (even the smallest) part of this, as well as all other parts of the body, has some of these vessels adapted to absorption. That this is the case, seems to be proved by the experiments made with the variolous matter; for at what part soever of the arm that matter is inserted, the lymphatic vessels take it up and carry it into the body, as can be traced by its inflaming the conglobate glands through which these vessels pass.

In Tab. XIV. the termination of all these lymphatic vessels is exhibited. Two of the trunks of those of the left arm are seen at (42, 42). They pass under the clavicle, whose cut end is seen at (4); and under the subclavian vein. Here, having joined, they form the large trunk (43), which appears just above the left subclavian 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 also by the lymphatic vessels of the left side of the thyroid gland, and by the trunk of the lymphatics of the left side of the head and neck, and also by some from the lungs of the same side.

The lymphatic vessels of the right side are commonly seen to terminate in the angle between the jugular vein and the subclavian. When seen to 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

chial artery, and the plexus (45), which likewife belongs to the arm, and paffes under the fubclavian vein. 2. The trunk of the lymphatic veffels of the right fide of the head and neck, which paffes down on the outfide of the jugular vein, as is fhown at (48). 3. A lymphatic from the thyroid gland. This veffel is feen at (49), paffing under the right jugular vein to get tothe others. 4. A trunk from the lungs of the right fide: This trunk is diftinctly traced under the fubclavian vein to its termination, in common with the others, at the union of the jugular and fubclavian veins.

§ 5 *Of the Chyle.*

THE chyle is a white juice extracted from the aliments, which is afterwards mixed with the blood. That its principal compofition is of water and oil, feems evident, from the fweetnefs of its tafte, from the whitenefs of its colour, from its acefcent and coagulable nature, and from its lightnefs by which it fwims on the blood; in all which properties it very much refembles an emulfion. It is compofed 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 manifeftly glutinous; fince the pellucid ferum it contains, either by exhaling the watery part, or by applying an intenfe heat, coagulates into a kind of jelly.

That the chyle is abforbed into the lacteal veffels, by the adhering villous coat, has been a long time known, by experiments of injecting tinctured liquors, which readily defcribe the fame courfe; from the white liquor of the lacteals, let out from blood-veffels; and from the venous nature of them. But late experiments have taught us this in a much better manner. The chyle is abforbed by fmall openings in the extremity of of each of the villi, by the ſame force which is common to all capillary tubes, and perhaps alſo by a living power in theſe tubes, by which it is taken up into the cavity of the abſorbing duct at the time when the inteſtine is relaxed; but the parts, by which the abſorbing duct begins in the inteſtine, being preſſed by the ſucceeding conſtriction of the muſcular fibres in the periſtaltic motion, urges the contents further on into the duct, which begins to appear within the ſecond cellular ſtratum. But there is a two-fold ſtratum of theſe abſorbing veſſels, one anterior, the other poſterior, as we obſerved before of the blood-veſſels. From thence, uniting into a larger canal in the firſt cellular ſtratum, the abſorbed liquor enters into the lacteal veſſel, which, in general, follows the courſe of the arteries, and likewiſe accompanies their arches, but conjoined with others ſimilar to it into a very obliquely angled net-work. Very many ariſe from the firſt part of the ſmall inteſtines under the meſocolon; ſome from the duodenum, and ſome from the large inteſtines themſelves.

The lacteal veſſels are furniſhed with valves in the very firſt cellular texture of the inteſtine, like thoſe of the lymphatics, joined together by pairs, of a ſemilunar figure, which admit the chyle paſſing from the inteſtines, but prevent its return, and ſuſtain its weight. Through this whole courſe, the chyle is urged on by the periſtaltic motion of the inteſtines, as well as by the contractile force of the veſſels themſelves, which, even after death, is ſtrong enough to propel the chyle; to which add, the conſiderable preſſure of the abdominal muſcles, and other parts, determined by the valves.

But betwixt the plates of the meſentery, at the diviſions of the veſſels, are found an infinite number of ſmall conglobate glandules. Some lacteal veſſels are ſeen to paſs theſe glands: moſt part enter them; and, being divided and ſubdivided through their cellular fabric, compoſe the greateſt part of the gland. And, again, other lacteal veſſels are produced out of every gland; and, being mutually joined among themſelves, go off in little trunks, of which the ultimate and largeſt ones go out from the gland. In the ſame manner the chyle enters other glandules twice, thrice, or four times; nor does any lacteal veſſel arrive at the thoracic duct without meeting ſome of theſe glandules, although it may paſs by ſome without entering them. But that this is the true courſe of the chyle, by which it paſſes from the inteſtines to the meſenteric glands, appears from a ligature, by the veſſel growing turgid betwixt the ſaid ligature and the inteſtine; and from ſcirrhoſities in the glands, by which they are rendered more conſpicuous; and from the nature of the valves themſelves hindering any return back to the inteſtines.

What alteration the chyle undergoes within the cellular fabric of theſe glands is not yet ſufficiently known; but it appears, in general, that ſome thin liquor diſtils from the arteries in this part, ſerving to dilute the chyle, into which it is poured. For it is obſerved, that after the chyle has ſurmounted all the glands, it appears more watery; and thin liquors, injected through the arteries, paſs out into the cellular fabric of the glands, and mix with the chyle. Laſtly, that a kind of cream appears manifeſtly in the glandules of infants.

From the laſt glandules, which are collected together in the centre of the meſentery, the lacteal veſſels go out very large, and few, to the number of four, five, or more, which aſcend together with the meſenteric artery, and intermix with the lymphatic plexus, that aſcends from all the lower parts of the body, creeps over the renal vein, and then goes along with that which takes its courſe behind the aorta from the lumbar glandules, and with the hepatics. Here the lymphatics take a variable courſe, but moſt frequently terminate in the receptacle of the chyle. In this the gelatinous lymph of the lower limbs, and of the abdominal viſcera, mixes with the chyle, and dilutes its white colour; thus ſome-

times

times it appears filled with a pellucid or reddifh humour, but frequently alfo with a white milk. The receptacle of the chyle muft fuffer a confiderable alternate preffure from the diaphragm and aorta, by which the chyle is moved fafter through it, in proportion as the light of the capacity of the receptacle is greater than that of the thoracic duct, into which it empties itfelf.

That the chyle comes from the inteftines into this duct, is fhown from injections, by which quickfilver may be driven from the firft lacteal veffels to the thoracic duct; from ligatures made on the duct itfelf, or the red veins which receive it, and by which the firft and fecond lacteal veffels fwell; and from the manifeft flux of the chyle into the thoracic duct, when the ligatures are removed.

It appears that the chyle flows through the thoracic duct into the blood; becaufe, on tying the red veins, both the thoracic duct and lacteal veffels which are inferted into it fwell up.

Haller has attributed the firft caufe of motion in the chyle, and of its abforption, efpecially to the attraction of the capillary veffels, which obferves alternate pulfes with the periftaltic contraction of the inteftine. The attractile force fills the villofity; the periftaltic force empties the villofity, and moves the chyle farther forward. The reft of its motions feem to depend on the ftrength of the membrane of the lacteal veffel itfelf, which, even after the death of the animal, expels the chyle, fo that the veffels become pellucid, which before were milky. The alternate compreffing force of the diaphragm alfo is of fome efficacy in this cafe, and the motion of the chyle through the thorax is fomewhat accelerated by the conduit itfelf; which being preffed, moves the chyle fo much the more quickly forward, as itfelf is larger than the thoracic duct.

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 five or more

hours

hours have paſſed from the meals, almoſt to the twelfth hour, during all which ſpace a woman will afford milk after it has circulated near 80,000 times 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 into the cellular ſubſtance, under the denomination of fat: a part of it is again configured into the red globules; another part, that is, of a mucous or gelatinous nature, changes into ſerum; and the watery parts go off, in ſome meaſure, by urine, in ſome meaſure exhaled by perſpiration; while a ſmall part is retained in the habit to dilute the blood. Nor is it any thing uncommon for a pellucid lymphatic liquor to fill the lacteals, in a dying animal, inſtead of chyle; or for ſome of them to appear milky in one part of the meſentery, and limpid or pellucid in another; ſince, as to their fabric and uſe, they alſo agree to anſwer the end of lymphatics. There are not, therefore, two kinds of veſſels from the inteſtines; one to carry the chyle only, and another peculiarly for the conveyance of lymph. After the digeſtion has been completed ſome time, the lacteal veſſels abſorb pellucid watery juices from the inteſtines, whence they appear themſelves diaphanous; but the thoracic duct is more eſpecially a lymphatic of the largeſt order, conveying all the lymph of the abdomen, lower extremities, and moſt parts of the body to the blood.

CHAP.

C H A P. 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 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 peritonæum, 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;

* 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.

giſts; 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 ſurface of the abdomen, thorax, or pericardium of an animal that has been recently killed; for if the fluid thus collected be ſuffered to reſt, expoſed to the air it will jelly as the coagulable lymph of the blood does. This is an experiment which Mr Hewſon made on a conſiderable number of animals, viz. on bullocks, dogs, geeſe, and rabbits, and the reſult of all the experiments was the ſame. From among thoſe who concluded theſe fluids a mere water, ſhould be excepted Drs Haller and Monro, who are of a different opinion.

If immediately after killing an animal in health, a lymphatic veſſel be tied up properly, and then cut out of the body and opened, ſo as to let out the lymph into a cup and expoſe it to the air, it will jelly as the coagulable lymph of the blood does in the ſame circumſtances; this experiment Mr Hewſon has likewiſe made ſeveral times on dogs, aſſes, and geeſe. But with reſpect to that fluid which moiſtens the cellular ſubſtance, or cellular membrane, as it is called, he cannot ſpeak with

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 equally 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 more fimilar to the fynovia, which of all fluids is the beft adapted to that purpofe?

But although from thefe experiments it appears pretty evident that the lymph in thefe cavities and veffels of an healthy animal will always jelly on being expofed to the air, yet it has been likewife obferved that the ftrength of that jelly is different in different animals. In geefe thefe fluids jelly fooner than in dogs; and in the fame animals the jelly differs in the different circumftances of health: in moft of the dogs which Mr Hewfon examined, the contents of the lymphatics formed a ftrong jelly; but in a dog which he had fed eight days with bread and water, and that rather fparingly, the lymph formed a very weak jelly; and in young geefe thefe fluids are later in jellying than in fuch as are full grown. The fame thing is true with refpect to the fluid contained in the pericardium and abdomen of other animals; which fluid, when in a fmall quantity, always formed a ftrong jelly, but when more copious, and the animal more feeble, the jelly is thinner; and in dropfical cafes, it is well known that the fluid let out of thefe cavities is not obferved to jelly on being expofed to the air, as it does in animals in health; but in fome cafes it is found to coagulate by heat, like the ferum of the blood, and in others it only becomes a little turbid when boiled, owing to the coagulable matter being in very fmall proportion to the water.

Although this lymph becomes more watery in a weak ftate of the animal, it is lefs watery and more coagulable in fome difeafes.

But, what is a more curious fact, in thofe cafes where fluid contained in the abdomen and pericardium has been compared with that contained in their lymphatic veffels, of animals in different ftates 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 ftrong 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 goofe was very young, then the jelly, formed by the fluid collected in thefe cavities, was weak, and that formed by the lymph in the lymphatic veffels was likewife in the fame proportion. So that although thefe fluids vary in the different circumftances of health, yet they always agree with each other.

Thefe fluids likewife, as we have before obferved, befides agreeing with one another, approach to the nature of the coagulable lymph of the blood in the circumftance of coagulating when expofed to the air, but they differ from it in the time neceffary for that coagulation. In dogs that were feemingly in perfect health, whofe blood and whofe lymph were let out of their veffels at the fame 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

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feven minutes after expofition to the air, but the lymph let out from the lymphatic veffels of the fame animals, was found to require half an hour or more for its coagulation. And although the blood coagulates fooneft in the weak animals, yet the contents of the lymphatic veffels, or the fluids in thefe cavities, do not, but feem later in jellying in proportion as the animal is reduced, or as they become more watery.

Moreover, the coagulable lymph of the blood and the lymph of the lymphatic veffels, not only differ from one another in the time which they require for their coagulation when expofed to the air, but alfo they differ more evidently in the time required for their coagulation in the body when merely at reft, without being expofed to air. As, for inftance, in a dog killed whilft in health, and whofe veins and lymphatic veffels were tied up immediately after his death, the blood in the veins was completely jellied in fix hours, but the lymph in the lymphatic veffels of his neck was perfectly fluid twenty hours after his death, and, being let out at this time, jellied, after being for fome time expofed to the air.

There is another change of the lymph very evident, befides thofe already mentioned; for, it not only is varied from the natural ftate to the more watery, but alfo from the natural to the more vifcid or coagulable; inftances of which occur in thofe inflammatory crufts that are found, in fome difeafes, to cover the different parts of the body. Thus, the outfide of the heart, and the infide of the pericardium, are fometimes covered with a cruft as tough as the fize in pleuritic blood; and the furface 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 fecrete a lymph with fuch an increafed difpofition to coagulate. Add to this, that the change which inflammation thus feems to produce, is juft the oppofite to that produced by the dropfy;

fy; for, in the dropfy, the fluid is fecreted with an extraordinary quantity of water and too little coagulable matter: but in inflammations the fluid is fecreted with a greater proportion of coagulable matter, and with lefs water; and in fome inftances it feems to be a pure coagulable lymph, either unchanged by the exhalants, and then coagulating gradually on being at reft, as the coagulable lymph is found to do in the veins that are tied; or elfe the exhalant veffels have the power of changing its properties, fo as to make it coagulate in an inftant after being fecreted. And this fuppofition of the exhalants having a power of changing the properties of the lymph, is rendered probable from the following confideration, viz. that it is fometimes found coagulated in the inner furface of the heart, forming a cruft fimilar to what we fo often fee on the outfide. Now as there is a conftant current of blood through the heart, unlefs the lymph forming that cruft had coagulated inftantly on being fecreted, it muft have been wafhed off by the blood. One of the cleareft inftances of this was obferved by Sir John Pringle, in the cafe of a perfon who had for fome time been fubject to palpitation of the heart, but afterwards died apoplectic; when there was found marks of inflammation on the furface of the heart; an abfcefs on the left ventricle, which muft have burft, had not an opening from it been covered and fhut up by a fmall cruft or polypus which occupied a fpace in the ventricle.

Now this cruft or polypus, lying over an inflamed furface, had probably been formed by a fecretion of the lymph from the inflamed veffels; and being formed in the cavity of the heart where there was a conftant current of blood, the lymph of which it was compofed muft have coagulated inftantly on being fecreted from the veffels, otherwife it would have been wafhed off with the current; and as the coagulable lymph is not naturally difpofed to coagulate fo inftantaneoufly, it is probable that the difeafed veffels here poffeffed the power of producing that change: and therefore, that as in dropſical habits, where the veſſels act weakly, the fluids exhaled are of a watery tenuity; 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 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 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.

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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 thro' 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 capable of oozing through the inorganized interſtices, by which it could not paſs before.

Thirdly, The tranſudation of bile, which he thinks takes place in the living body, becauſe on opening a dead one we ſee all the neighbourhood of the gall-bladder tinged with this fluid.

Such are the arguments brought in favour of tranſudation; but on a careful examination, they are not ſo ſatisfactory as thoſe which may be produced in defence of the opinion that theſe ſecretions are by organized paſſages, as perhaps will appear from the following obſervations.

Firſt, Although fluids do tranſude on being injected ed into the veſſels of the dead body, yet we muſt not thence conclude that a ſimilar effect would certainly take place in the living; for it is probable, that our fibres and veſſels have a degree of tenſion which they may loſe with life. Beſides, if tranſudation took place in the living body, it would ſeem to defeat the principal purpoſe for which the blood-veſſels were made, that is, the containing and conveying the fluids; and upon drinking a greater quantity than ordinary of watery liquors, inſtead of the liquors being carried to the kidneys or other emunctories, and thereby thrown out of the body as a redundancy, they would eſcape into the cellular membrane and occaſion an anaſarca. That this would be the caſe will appear the more probable, when it is conſidered how ſmall the fibres of our blood-veſſels muſt be, and therefore what millions of pores (did they exiſt) the water would be expoſed to from its entrance into the ſtomach, and its paſſage 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 theſe liquors, according to the idea of tranſudation, we ſhould find it, firſt leaking through the ſtomach or through a lacteal, then being abſorbed, then eſcaping a ſecond time, and being again abſorbed, &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 theſe membranes themſelves have the ſame juſt oppoſite to thoſe of the veſſels. Now if we admit inorganized pores at one part

part of thofe membranes, we muft admit them in all parts, and in the fame degree: But as the blood-veffels are circular, and touch thofe membranes only by a fmall part of the circle, the parts touched by the vef-fels muft be fmaller than the interftices between the veffels, and the lymph muft have fewer chances in favour of its leaking from the veffels into the cavities, than of its oozing again from thefe cavities into the interftices between the veffels or into the cellular membrane; fo that, if thefe membranes admitted of tranfudation, there would be no fuch thing as a partial dropfy, for the water would run out at one part of the pleura, pericardium, peritonæum, &c. as faft as it ran in by the other, and an anafarca would always accompany an afcites; which not being a fact leads us to believe, that thofe membranes do not admit of tranfudation in living bodies, and that the fluids get into them not by inorganical, but by organized paffages.

Thirdly, To prove more fatisfactorily that thefe fluids are not filtrated from the blood merely by inorganical tranfudation, let us recollect the experiments already related, concerning the properties of thofe fluids, which we found varied in different circumftances of health. For, in inflammatory affections of the parts from which they were fecreted, they affumed the appearance of the coagulable lymph of the blood, 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;

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for we cannot ſuppoſe there ſhould be filtrated from the blood a fluid that was not in it. And if pus, which paſſes from the ſame pores, can only be accounted for by ſuppoſing theſe pores to be organical, in like manner is it not probable, that the ſecretion of the natural lymph is not a ſtraining through inorganical, but thro' organized paſſages?

Laſtly, It has been brought as an argument in favour of tranſudation in the living body, that blood tranſudes after death; and this has been explained on the ſuppoſition, that the blood was thicker before the coagulation of the lymph: Which ſuppoſition appears ill-founded, when we ſpeak of the living body; for in former experiments we have obſerved, that this lymph, frequently at leaſt, rather thins than thickens the blood. If, therefore, the blood tranſudes in the dead and not in the living body, we ſhould rather attribute it to a change in the veſſels 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 tranſudation, viz. the parts adjacent to the gall-bladder being tinged with bile: for any one who will take the trouble of ſtanding by a butcher whilſt he kills a ſheep, will find, contrary to that gentleman's concluſion, that upon opening the animal immediately, there is no appearance of the gall having tranſuded, for none of the parts ſurrounding the gall-bladder are tinged. But let the animal continue a day or two unopened, and then the gall will be found to have tranſuded, and to have tinged the neighbouring parts; as is the caſe in the human body by the time that we inſpect it.

Since, then, the gall-bladder ſo readily allows of tranſudation after death, and not during life, is it not probable that there is in our membranes and our blood-veſſels a degree of tenſion, or a power of preventing the fluids oozing out of them, which power is loſt with life?

Upon the whole, then, it appears, that the interſti-

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cial lymph, or the fluid which moiſtens the different cavities of the body, being different from mere water, cannot be produced ſimply by tranſudation through inorganical interſtices; but that there are ſmall exhalant arteries, or organized paſſages, which not only tranſmit it from the blood, but change its properties, and adapt it to the office of lubrication, and likewiſe make it aſſume very different appearances in different circumſtances of health.

§ 2. *Of the ſuppoſed Abſorption of the Lymph by the red Veins.*

As there is a ſecretion upon the different ſurfaces, and into the different cavities of the body for the purpoſes of the conſtitution, ſo there is likewiſe an inhalation or an abſorption. For example; If food be taken into the ſtomach and inteſtines, it is there digeſted, and being converted into chyle, it is in that form taken into the blood-veſſels. If garlic be applied to the ſkin it gets into the body, and is ſmelt in the breath with as much certainty as when taken into the ſtomach, where its juices are abſorbed by the lacteals. So, likewiſe, terebinthinate medicines applied to the ſkin are ſoon ſmelt in the urine; and cantharides in a bliſter affect the urinary paſſages.

In the ſame manner fluids are taken from different cavities of the body into the vaſcular ſyſtem. Thus the water of an *aſcites* and an *anaſarca* are occaſionally taken up and carried by the blood-veſſels to the inteſtines and kidneys, and evacuated by ſtool or by urine. And the *pus* of an abſceſs is ſometimes abſorbed, and carried to diſtant parts of the body and there depoſited, or is evacuated by the inteſtines or urinary paſſages. So alſo fluids injected into cavities, as that of the cheſt or belly of living animals, ſoon find their way into the blood-veſſels. Theſe circumſtances are admitted by anatomiſts amongſt the unqueſtionable facts of phyſiology.

Nor do anatomiſts differ in their opinions about the mode in which theſe fluids are taken up; for it is univerſally allowed to be by abſorption, or that there are ſmall orifices adapted to imbibe them: the only queſtion is, what the veſſels are to which theſe orifices belong, whether to the lymphatic ſyſtem, or to the common veins?

That the common veins did the office of abſorbing both the chyle and the lymph, was the opinion of anatomiſts before *Aſellius* diſcovered the lacteals; but after his time few doubts were entertained of the lacteals abſorbing, at leaſt a part of that fluid. But moſt anatomiſts have been ſo tenacious of the old opinion, as ſtill to believe that the veins partly performed that office, or abſorbed ſome of the chyle, and carried it to the liver.

As to the abſorption of the lymph, they have been ſtill more poſitive of its being performed by the common veins; nay, even after the diſcovery of the lymphatic veſſels, it occurred but to few, that theſe veſſels contributed in the leaſt to this abſorption. And no wonder, ſince beſides the reſpect for the contrary opinion, becauſe it was tranſmitted from antiquity, anatomiſts thought themſelves poſſeſſed of many ſtrong arguments in favour of the common veins performing abſorption; and as theſe arguments ſtill continue to have weight with ſome modern phyſiologiſts, we ſhall make a particular examination of them in this place.

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 con-

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vinced how eafy it is to be deceived by them in this matter. For the veins in dead bodies being eafily ruptured, whenever we fee injections get from them into cavities, we have reafon to doubt whether thefe injections had paffed by natural paffages or by laceration of the fmall veffels; 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 fuch coarfe materials as no experienced injector will now believe could pafs through fuch fmall orifices, as to thofe injections which from their fubtilty leave the point more doubtful. Befides, as we have already found, fuch changes are produced upon animal bodies by death, that membranes, which during life had been fo tenfe as to prevent tranfudation, after death were fo much altered, that in the gall-bladder, for example, they allowed the vifcid bile to pafs; does it not therefore become doubtful, when an anatomift injects a cavity from a vein, whether (although he caufe no rupture) he may not feparate the fibres already relaxed by death, in fuch a manner as to imitate this tranfudation? And if one anatomift has been mifled when he concluded tranfudation took place in the living body, becaufe he found it in the dead body, fo may they likewife, who have concluded veins arofe from cavities in the living becaufe they had been able to pufh injections into fuch cavities in the dead body. It muft therefore be allowed that fuch experiments are at the beft equivocal. Befides, from the experiments upon living animals, made long ago by Bartholin, and much later by Mr Hunter, &c. (fee Dr Hunter's Medical Commentaries), it appears evident, that no abforption by red veins takes place in the living body.

Another argument ufed in favour of veins arifing from cavities, particularly from the inteftines, is that fome anatomifts have affirmed that they have feen white chyle in the blood taken from the mefenteric veins. But this argument will appear very inconclufive, when

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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 now and then as 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 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

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, as it died in half an hour, and had only a very little water in the abdomen.

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. Now 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 to the blood. If the neck therefore became œdemitous, it would appear more likely to have been occaſioned by the ligature on the veins. But what ſhows 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 Inquiries) was this effect ever produced: And Baron Van Swieten tied up both the jugular veins, and tho' he kept the dog four days afterwards, did not obſerve him any way incommoded. In one dog Mr Hewſon even cut out both the external jugulars, and kept him near a twelvemonth without obſerving the leaſt ſymptom of dropſy. It appears, therefore, that in Lower's experiment, not only the veins, but the lymphatic veſſels which lie near them, had been tied; in which caſe the lymphatics would burſt and occaſion theſe ſymptoms. But in Mr Hewſon's experiment

riment he took care to ſeparate the vein from the lymphatics.

Theſe arguments therefore in favour of abſorption being performed by the common veins, which are brought from experiments where ligatures were made on large veſſels, ſeem likewiſe to be liable to fallacy.

A fifth argument is taken from the ſtructure of the placenta, where it has been concluded there are no lymphatics; and yet there muſt be abſorption, and not a communication of the veſſels; neither of which arguments are deciſive. For there may be lymphatics in the placenta though not yet diſcovered; or there may be ſmall veſſels paſſing from the mother to the fœtus, though not yet injected.

A ſixth argument is furniſhed by the experiments of ſome authors; in which experiments, it is affirmed, that fluids injected into the inteſtines were ſoon afterwards diſcovered in their meſenteric veins. The experiment related by the ingenious Kauw Boerhaave, has been the moſt depended upon in this matter. In which experiment water was injected into the inteſtines, and thoſe inteſtines being compreſſed, the water was afterwards obſerved to run from the veins; but that ſome fallacy had crept into this experiment is now probable, from its having been repeated ſeveral times by Mr Hunter in a very ſatisfactory manner, without being attended with the like ſucceſs *. 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 lac-

* See Dr Hunter's Medical Commentaries.

lacteals had filled themfelves freely. The learned M. de Haller, indeed, in comparing thefe arguments, fays, that in fuch cafes where authority feems to balance authority, he chooses rather to adopt the opinions of thofe who affirm, than of thofe who deny the fact. For as he obferves, this experiment may eafily fail of fuccefs; but if it has ever fucceeded, we fhall not eafily find another way of accounting for it, except by allowing that thefe veins open into the inteftines. But with due deference to the opinion of this excellent author, Kauw Boerhaave's experiment is not fo conclufive as thofe alluded to above: for in his, the dog was opened immediately after death, and water being injected into his ftomach, that water was feen firft to dilute the blood, then to wafh it from the vena portarum, and the experiment was continued a confiderable time by means of preffing the ftomach; which preffure furnifhes a ftrong prefumption that the water did not get into the veins by abforption but by a laceration, efpecially as the experiment continued to fucceed for fome hours after death.

And laftly, A feventh argument ufed in favour of common veins abforbing was, that many animals were deftitute of any other veffels which could do that office. This was fuppofed to be the cafe with birds, fifh, and amphibious animals; all of which fome anatomifts did not hefitate to affirm muft want 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

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is overthrown by the lymphatic ſyſtem being now diſcovered in all theſe animals.

Such are the arguments produced in favour of the common veins doing the office of abſorption; a doctrine which has lately been eſpouſed by that excellent anatomiſt Dr Meckel; to whoſe obſervations, though agreeing with ſome already mentioned, it may be neceſſary to pay a particular attention.

Dr Meckel's concluſions 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 breaſts, into the veſicula ſeminalis, into the hepatic ducts, and into the urinary bladder; he concludes, that the veins open into theſe parts in the living body to abſorb from them. A concluſion which is already proved to be liable to conſiderable objections, as we never can be ſure whether our injection, in getting from theſe cavities into ſuch veins, had gone by a natural or by forced paſſage. Dr Meckel does indeed mention, that there were no marks of an extravaſation in his experiments. Perhaps it might have been too ſmall for obſervation. Nay, we have even reaſon to believe, that as the ſmall veſſels of the human body are very cloſe to one another, our injection may ſometimes burſt from one into another lying in contact with it, without diſtending the cellular membrane which lies between 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 al-

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ways 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, does not appear conſiſtent 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 ſaid to ſhow how cautious we ſhould be in making concluſions, with reſpect to the paſſages of the living body, from experiments made on the dead, where, from the weakneſs of the veſſels, and other circumſtances, we are ſo liable to be deceived.

Upon the whole, on taking a review of the doctrine that the common veins are the inſtruments of abſorption; that doctrine appears to have no other ſupport than

than reſpect for the authority of our predeceſſors; for all the arguments in its favour are liable to conſiderable objections. Let us next, therefore, inquire, whether ſome other part of the human body may not do that important office?

§ 3. *Of Abſorption by the Lymphatic Syſtem.*

This ſyſtem, in all animals, we have found, conſiſts of a trunk or thoracic duct, and of two extremities, namely, the lacteals and the lymphatic veſſels. The lacteals can be traced from the inner ſurface of the inteſtines, where they begin by ſmall orifices, in order to abſorb the chyle, and to tranſmit it through the thoracic duct to the blood-veſſels. That this is their uſe, has never been queſtioned ſince the firſt diſcovery of thoſe veſſels, from its always admitting of eaſy demonſtration; that is, by giving an animal milk, and then opening him a few hours after; in which caſe the ſame fluid that is ſeen in his inteſtines can likewiſe be ſeen to have got into his lacteals.

After thus being convinced, that the uſe of one branch of the ſyſtem is to abſorb, we cannot at firſt ſight but wonder that any anatomiſt ſhould have heſitated to attribute a ſimilar office to the other. Nevertheleſs ſome anatomiſts have been led to aſcribe to the lymphatics a very different uſe to what they 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 Leeuwenhoeck 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 amongſt 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. 1. 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 ſhowing the fallacy of the experiments brought in favour of the common veins doing the office of abſorption, have advanced the following 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 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, thoſe of the other were ſo likewiſe, and exactly in the ſame manner. So that we now ſeem to have obtained as deciſive an argument in favour of abſorption by lymphatics, as we before had of that by the lacteals; for the lacteals were concluded abſorbents from their being found to run from the inteſtines filled with a fluid ſimilar to what was in the cavity of the gut; ſo we ſeem here to have the ſame reaſon for believing that the lymphatics ab-

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ſorb from cavities, becauſe they are found to contain a fluid exactly ſimilar to what is obſerved in theſe cavities; a ſtrong argument that the fluid had paſſed from ſuch cavities into theſe lymphatics by abſorption.

Such, then, ſeems to be the purpoſe for which the lymphatic veſſels were provided, that is, to do the office of abſorption, an office of the greateſt importance to the animal; no wonder, therefore, that there ſhould be a ſyſtem ſet apart for performing it, and not only in man and quadrupeds, but alſo in birds, fiſh, amphibious animals, and perhaps even in inſects of the moſt perfect kind.

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 pafs thro' the dura mater, thefe arteries having neither fwelling mufcles nor preffure of the atmofphere to affift the courfe of the blood in them after they enter the fkull, and their divifion into innumerable communicating branches in the pia mater, and its proceffes, fhow, that the liquors muft move more flowly and equally in them than in moft other parts of the body.

2. By the affiftance of injections and microfcopes, the very minute branches of thefe veffels are difcovered to go from the pia mater, into the cortex, cineritious, or afhy-coloured part of the cerebrum, cerebellum, and fpinal marrow; whereas we can only fee longitudinal veffels, without numerous ramifications or reticular plexufes, in the white medullary fubftance of thefe parts.

3. The continuity of the cortex with the medulla of the

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 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 obſervators 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 pal-

fy of the fide oppofite to where the lefion of the brain was, 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 many 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 fcarce 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 vifible, it is demonftrated, that each fibre in the retina of the eye, or expanded optic nerve, cannot exceed the fize of 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 forces 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 thruft into a nerve, and that makes a nerve appear all fpongy, after being diftended with air till it dries; the proper nervous fibrils

fhrivelling

ſhrivelling ſo in drying, that they ſcarce can 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 diſgregated 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 of 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 the ſoft tender webs, the retinæ. The auditory nerve has ſcarce the conſiſtence of mucus in the veſtibulum, cochlea, and ſemi-circular canals 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 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. Tho' the fibres in a nervous coat are firmly connected,

* See Vol. II. p. 63, and Monro on the Nervous Syſtem, Tab. xx. xxi. xxii. xxiii.

nected, 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 into 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, miſs to 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 ſerved by ſuch nerves, farther from the head or ſpine than where the injuring cauſe has been applied, have their ſenſations, motions, and nouriſhment weakened 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 not injured, as for example, when a ligature made upon a nerve and ſtopping its influence has been taken away, the motion and

and ſenſation of the parts ſoon were 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 ſhow, 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 in the parts to which theſe nerves were diſtributed, went off upon the removal of that cauſe. From which it is thought reaſonable to conclude, that the nerves muſt not only have a communication with their origin, but that the influence they have upon the parts

they

they are diftributed to, depends on the influence which they derive from the medulla encephali and fpinalis.

28. Tho' 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 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

frog can jump about, or a tortoiſe can walk long after all the bowels of its thorax and abdomen are taken out, or becauſe the different parts of a worm crawl after it has been cut into a great many pieces. It is therefore almoſt univerſally allowed, that the nerves are principal inſtruments in our ſenſations, motion, and nouriſhment; and that the influence which they have is communicated from their origin, the encephalon and medulla ſpinalis. But authors are far from agreeing about the manner in which this influence is communicated, or in what way nerves act to produce theſe effects.

30. Some alledge, that the nervous fibres are all ſolid cords acting by elaſticity or vibration; others maintain, that thoſe fibres are ſmall pipes conveying liquors, by means of which their effects are produced.

31. The gentlemen, who think the nervous fibres ſolid, raiſe ſeveral objections to the other doctrine; which I ſhall conſider afterwards; and endeavour to ſhow the fitneſs of their own doctrine to account for the effects commonly obſerved to be produced by the nerves.

The objects of the ſenſes plainly (ſay they) make impulſes on the nerves of the proper organs, which muſt ſhake the nervous fibrils: and this vibration muſt be propagated along the whole cord to its other extremity or origin, as happens in other tenſe ſtrings; and theſe 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 ſenſation, it is objected, firſt, That nerves are unfit for vibrations, becauſe their extremities, where objects are applied to them, are quite ſoft and pappy (§ 21.), and therefore not ſuſceptible of the vibrations ſuppoſed; and if there could be any little tremor made here by the impulſe of objects, it could not be continued along the nervous cord, becauſe the cellular ſubſtance by which each particular fibre is connected to the neighbouring ones (§ 1 .), and

and the fatty ſubſtance in which the nervous cord is immerſed (§ 15.), would ſoon ſtifle any ſuch vibratory motion.

A ſecond objection to this doctrine is, That ſuppoſing the nerves capable of vibrations by the impreſſions of objects, theſe vibrations would not anſwer the deſign. For if what we know of other vibrating ſtrings, to wit, that their tone remains the ſame, unleſs their texture, length, or tenſion is altered, and that different ſubſtances ſtriking them do no more than make the ſound higher or lower; if theſe properties are to be applied to nerves, then it will follow, that the ſame nerve would conſtantly convey the ſame idea, with no other variety than of its being weaker and ſtronger, whatever different objects were applied to it; unleſs we ſuppoſed the nerve changed in its texture, length, or tenſion, each time a different object is applied; which, it is preſumed, nobody will undertake to prove does happen.

Nay, 3dly, If ever ſuch a variety of vibrations could be made, our ſenſations would notwithſtanding be confuſed and indiſtinct; becauſe the tremulous nervous fibre being firmly connected and contiguous to ſeveral other fibres of the ſame cord, would neceſſarily ſhake them too, by which we ſhould have the notion of the object as applied at all the different parts where the extremities of theſe fibres terminate.

33. In whatever way the favourers of the doctrine of ſolid nerves pleaſe to apply the elaſticity of nerves to the contraction of muſcles, their adverſaries inſiſt that nerves are too weak to reſiſt ſuch weights as the muſcles ſuſtain; they would ſurely break, eſpecially as they are in a great meaſure, if not wholely, deprived of their ſtrong coats before they come to the part of the muſcle they are immediately to act upon (§ 22.)—The nerves being found to have little or no elaſticity to ſhorten themſelves (§ 14.) ſhows them altogether unfit for ſuch an office as this of contracting muſcles in the way propoſed

posed of their acting by elasticity; and when a nerve is viewed with a microscope while the muscles it serves are in action, no contraction or motion is observed in it.——Nay, if they were elastic, they would equally exert their power of contracting muscles 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 against either motion or sensation being owing to the elasticity of the nerves, it is said, that if this doctrine was true, the sensations would be more acute, and the contractions of muscles would be greater and stronger, when the parts become firmer and more rigid by age; for then their elasticity is increased: Whereas, on the contrary, it appears (§ 23.) that then the sensations are blunted, and muscular contraction becomes less and weaker.

35. If the nerves were granted to be elastic, and to communicate a springy force to all the parts they are distributed to, they might appear necessary in this view to assist the application of the nutritious particles of the fluids to the sides of the vessels which these particles were to repair; and so far might well enough account for the share which nerves are thought to have in nutrition: But if we cannot make use of elasticity in the other two functions, sensation and motion, we must also endeavour to find out some other way for the nerves to act in nutrition; which will be done afterwards.

36. Having thus stated the reasons for and against the nerves acting as solid strings, let us likewise relate the arguments for nerves being pipes, and the objections to this doctrine.

A great argument of those who think the nerves to be tubes conveying liquors, is the strong analogy of the brain and nerves to other glands of the body and their excretories, where a manifest secretion of liquor is made in the glands, to be conveyed by the excretories to the proper places in which it ought to be deposited:

they

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. 1*ft*, Other glands, it is faid, have their excretories collected into a few large pipes, and not continued in fuch a great number of feparate pipes, 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. 2*dly*, 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. 3*dly*, If the nerves were pipes, 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. 4*thly*, If the nerves were pipes, 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 1*ft* 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 as in the encephalon: the kidneys, for example, have a reticulated cortex of veffels, from which the Euftachian or Bellinian medulla, confifting of longitudinal fibres and a few blood-veffels in the fame direction, proceeds; and this medulla is collected into ten, twelve, or more papillæ, each of which

is formed of numerous ſmall ſeparate pipes, 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 ſhown 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 ſubtle 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 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 ſubtle 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 nerves are excretories of a gland, they muſt be cylindrical pipes, in which no obſtructions or diſeaſes would happen; but ſince we daily ſee diſeaſes in the nerves, they muſt therefore not 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 veſſels there, the prodigious ſmallneſs of the pipes 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 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 pipes 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 confifting of too mild and fluggifh particles, or of too acrid pungent ones; by too great or too little motion given to the liquors; by the diameters of the pipes being too much ftraitened, or too much enlarged; and by a great many other varieties of circumftances which might be thought capable of difturbing the functions of the nerves, fuppofing them to be cylindrical excretories of the gland, the brain.

42. The numerous veffels of the encephalon have brought fome of the gentlemen who affert the nerves to be folid, to acknowledge, that there is a liquor fecreted in the brain: but then they will not allow that this liquor is fent out by the proper nervous fibrils, but that it is poured into the cellular fubftance in which the nerves lie, to keep them moift and fupple, and therefore fit for exerting their elafticity, vibration, &c. by which, in their opinion, the effects commonly afcribed to nerves are produced.

43. Befides the objections already mentioned (§ 32, 33.) againft the nerves acting as elaftic ftrings, this opinion has fome other difficulties which may be objected to it: for inftance, there is not one analogous example in the whole body of liquors fecreted in a large gland, to be poured into a cellular fubftance, as is here fuppofed; the liquors in the cells of the tela cellularis of other parts are feparated from the little arteries which are diftributed to thefe cells.

Further, it cannot be imagined, how a liquor fecreted in the cortex of the brain fhould make its way thro' the medulla, to come out into the cellular membranes on the furface of that medulla.

Laftly, A very fimple experiment, of injecting water by the artery of any member, and thereby filling the cellular fubftance of the nerves of that member, fhows evidently, that the liquor of the cellular fubftance of the nerves has the fame fountain as the liquor has in the tela cellularis any where elfe, that is, from the little arteries difperfed upon it.

44. The

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 one or both 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 the 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 again be 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, betwixt 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 by that means was received from 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 us 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

organs of the ſenſes, to convey the vibrations communicated from objects to the ſenſorium.

46. To this opinion (§ 45.) the objections 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 and 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, 1*ſt*, That there is no example in the body, of a ſecreted liquor being returned 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. 2*dly*, There is no occaſion for ſaving the fluid of the nerves in the way propoſed; the organs for ſecreting that fluid being large enough to ſupply all that is neceſſary 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 ſoon become too acrid

for continuing with fafety in fuch fenfible tender veffels as the brain and nerves are compofed of. *4thly*, This hypothefis will not anfwer the defign for which 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 foreward 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 inquire 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 which they are applied to, 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 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

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 be 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 excreted from the bladder. The feed is thin as it comes from 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 and fpinal

marrow; and ſeeing the thinneſs of ſecreted liquors is generally, as the diviſions of the veſſels, into ſmall ſubtle branches, and that the ramifications within the ſkull are almoſt infinitely ſubtle, the liquor ſecreted in the encephalon may be determined to be among the fineſt or thinneſt fluids.

55. Seeing alſo that we can obſerve no large reſervoir, where the liquor ſecerned in the cortical ſubſtance is depoſited, to have its finer parts taken off, we have reaſon to think that it goes forward into the nerves in the ſame condition in which it is ſecerned.

56. By fine or ſubtle animal liquors, is meant no more than thoſe which are very fluid, and which ſeem to conſiſt of a large proportion of watery particles, and a leſſer one of the oily, ſaline, and terreſtrious particles. Some of the liquors which we can have in ſufficient quantity to make experiments with, are ſo fluid, and have ſo little viſcidity or coheſion of parts, that when laid upon a piece of clean mirror, they evaporate without leaving a ſtain. Such is the liquor oozing out from the ſurface of the pleura, the lymph, and ſeveral others.

If then theſe liquors, which are ſubject to our examination, the ſecerning veſſels of which are ſo large that we can ſee them, have ſuch a ſmall coheſion of parts, it might not be unreaſonable to ſay, that the liquor of the nerves is as much more fine and fluid than lymph as the veſſels ſeparating it are ſmaller; and therefore that the fluid of the nerves is a defecated water, with a very ſmall proportion of the other principles extremely ſubtilized.

57. Two experiments are ſaid to contradict this opinion of the liquor of the nerves being ſo fluid and ſubtle. One is, that upon cutting the cauda equina of a living animal, a liquor as viſcid as the white of an egg drops out. The other is, that a wounded nerve yields a glairy ſanies. But theſe do not appear to be the proper fluid of the nerves; ſince it is evident, that what

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, always are 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 comes to be 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 arteries. The motion of the fluids muft ftill be more equal in the excretories of glands, and particularly in thofe where the veffels have divided into very minute branches, and the liquors have no other propelling force but the heart and arteries,

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(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 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 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, which the nerves are principal instruments of.

63. In general, we may say, that nerves can carry fluids to the most minute part of the body, to supply what is wasted in any of the solids*; that the impression made

* However plausible the above might appear to the Author and some

made by the objects of the senses on the very soft pulpy extremities of the nerves of the organs of the senses, must make such a stop in the equal-flowing nervous fluid, as must instantaneously be perceptible at the fountain-head from which the pipes affected arise; that the constant flow of the liquor of the nerves into the cavities of the muscular fibrillæ, occasions the natural contraction of the muscles, by the as constant nisus it makes to increase the transverse and to shorten the longitudinal diameter of each fibre; and that it is only to allow the mind a power of determining a greater quantity of this same fluid with a greater velocity into what muscular fibres it pleases, to account for the voluntary strong action of the muscles.

64. But since such a superficial account would not be satisfactory, it will be expected, that the principal phenomena of these three functions should be explained by the means of such a fluid as has been supposed, and that the several objections against this doctrine should be answered: let us attempt this; and where we cannot extricate ourselves from difficulties which may be thrown in, let us honestly acknowledge ignorance.

65. α. If water, with a very small proportion of oils and salts from the earth, proves a fit nourishment for vegetables, such a liquor as the fluid of the nerves has been described (§ 56.) may not be unfit for repairing the waste in animals.

β. The slow continual motion of this nervous fluid (§ 58,

some of his cotemporaries, it is not agreeable to the opinion of many of the later physiologists, particularly to the present Professor 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 physiology so clear as,

1. That the arteries prepare and directly secrete the nourishment in all our organs.

2. That the nerves do not contain nor conduct the nourishment, but by enabling the arteries to act properly, contribute indirectly to nutrition." See Observations on the Nervous System, p. 78.

(§ 58, 59.) to the moſt minute parts of the body (§ 10.) is well enough calculated to ſupply the particles that are conſtantly worn off from the ſolids by the circulation of the liquors and neceſſary actions of life.

γ. The greater proportional ſize of the encephalon in young creatures than in adults, ſeems calculated for their greater proportional growth: for the younger the animal is, the larger encephalon and ſpeedier growth it has.

δ. A palſy and atrophy of the members generally accompanying each other, ſhow, that nouriſhment, ſenſation, and motion, depend on the ſame cauſe.

ε. It was ſaid (§ 26.), that the nerves were principal inſtruments in nutrition: it was not affirmed, that they were the ſole inſtruments; and therefore an atrophy may proceed from the compreſſion or other leſion of an artery, without being an objection to the doctrine here laid down.

66. *a*. All objects of ſenſe, when applied to their proper organs, act by impulſe; and this action is capable of being increaſed by increaſing the impelling force. In tangible objects, that it is clearly evident; the cloſer they are preſſed to a certain degree, the more diſtinct perception enſues. Odorous particles need the aſſiſtance of air moved rapidly to affect our noſe: ſapid ſubſtances, that are ſcarce ſufficient to give us an idea of their taſte by their own weight, are aſſiſted by the preſſure of the tongue upon the palate: the rays of light collected drive light bodies before them: ſound communicates a vibration to all bodies in harmonic proportion with it.

The impulſes made thus by any of theſe objects on the ſoft pulpy nerves (§ 21.), which are full of liquor, preſs their ſides or extremities, and their liquor is hindered to flow ſo freely as it did. The canals being all full (§ 58.) this reſiſtance muſt inſtantaneouſly affect the whole column of fluids in the canals that are preſſed, and their origins, and have the ſame effect as if the impulſe

impulſe had been made upon the origin itſelf. To illuſtrate this by a groſs compariſon: Let any one puſh water out of a ſyringe, through a long flexible pipe fixed to the ſyringe; and he is ſenſible of reſiſtance or a puſh backwards, the moment any one ſtops the orifice of the pipe, or cloſes the ſides of it with his fingers. This impulſe made on the nerves, and thus communicated to their origin, varies according to the ſtrength or weakneſs, the quickneſs or ſlowneſs, the continuance or ſpeedy removal, the uniformity or irregularity, the conſtancy or alternation, &c. with which objects are applied to the nerves.

b. Whenever any object is regularly applied with due force to a nerve rightly diſpoſed to be impreſſed by it, and is communicated, as juſt now explained, to the ſenſorium, it gives a true and juſt idea of the object to the mind.

c. The various kinds of impulſes which the different claſſes of objects make, occaſion in animals, which ought to have accurate perceptions of each object, a neceſſity of having the different organs of the ſenſes variouſly modified, ſo that the ſeveral impulſes may be regularly applied to the nerves in each organ; or, in other words, we muſt have different organs of the ſenſes fitted to the different claſſes of objects.

d. As the objects have one common property of impulſe, ſo all the organs have moſt of the properties of the organ of touching in common with the papillæ of the ſkin. In the noſe and tongue this is evident: in ſome operations of the eyes, we can alſo perceive this; 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,

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 the organ thus injured is. 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. A pretty ſure proof this, 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 alongſt 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 from it, as one retires his hand when his finger is pricked or burnt; or the injuring cauſe is endeavoured to be forced from the body, as a teneſmus excites the contraction which puſhes acrid fœces out of the rectum. In both theſe operations, a convulſive contraction is immediately made in the leſed part, or in the neighbourhood of it; and if the irritation is very ſtrong or permanent, the greater

greater part of the nervous ſyſtem becomes affected in that ſpaſmodic or convulſive way.——Is it this neceſſity which obliges the mind to exert herſelf in reſpiration, 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 expoſed to ſtrong light? or ſneezing to be performed when the noſe is tickled? &c. ——Will not a ſtimulus of any nerve more readily affect thoſe with which it is any where connected than the other nerves of the body?——May not this ſympathy ſerve as a monitor of the mind rather to employ the organs furniſhed with nerves thus connected, to aſſiſt in freeing her of any uneaſy ſenſation, than to make uſe of any other organs?——Will not this in ſome meaſure account for many ſalutary operations performed in the body, before experience has taught us the functions of the organs performing them?

This niſus of the mind to free the body of what is in danger of being hurtful, may ſerve to explain the phænomena of a great many diſeaſes, when we are acquainted with the diſtribution of the particular nerves; and from this we can underſtand the operation of medicines that ſtimulate; and may learn how, by exciting a ſharp, 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 diſeaſed part, we can do conſiderable ſervice by a right application of the proper medicines.

l. If a pain giving cauſe is very violent or long continued, it deſtroys the organs either irrecoverably, or puts them ſo 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 ſound on their ears; and we are frequently expoſed to as much light and ſound as to make us unfit to ſee or hear for a conſiderable time. I would ex-

plain

plain this by a ligature put round the tender branch of an herb. This ligature drawn to a certain degree, may weaken the canals ſo as to be unfit for the circulation of the juices a good while, till they are gradually explicated and made firm by theſe juices: A ſtricter ligature would diſorder the ſtructure of the fibres ſo much, that the liquors could not recover them. The analogy is ſo plain that it needs no commentary.——Thus the influence of a nerve tied with an artery in the operation of an aneuriſm, may ceaſe for ſome time, but be afterwards recovered.

67. (1.) In applying the fluid of the nerves to the action of muſcles, it was ſaid, that the natural or involuntary contraction of muſcles was the niſus which the nervous fluid, flowing conſtantly into the muſcular fibres, makes to diſtend theſe fibrils, by enlarging their tranſverſe diameters and ſhortening their axes; and that voluntary contraction was owing to a greater quantity of that nervous liquor determined towards the muſcle to be put in action, and poured with greater momentum into the muſcular fibrils, by the power of the mind willing to make ſuch a muſcle to act, or obliged to do it by an irritating pain-giving cauſe (§ 66. *k*.)

(2.) Some object to this account of muſcular motion, that if there is no outlet for the liquor ſuppoſed to be poured into muſcular fibres, muſcles would always be in a ſtate of contraction, which they are not; and if there is a paſſage from the fibrils, the liquor would flow out as faſt as it was thrown in; and therefore no diſtention of the fibres, or contraction of the muſcles, could be made.

(3.) In anſwer to this objection, it is obſerved, that notwithſtanding the evident outlet from the arteries into the veins, yet the arteries are diſtended by the ſyſtole of the heart, or any other cauſe increaſing the momentum of the blood.

(4.) It has been alſo 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 a fluid into their fibrils is, That mufcular fibres 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 tranfvefe 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 anfwer to this it has been remarked, That though mufcular fibrils are diftractile, yet they will not yield to or be ftretched by every force, however fmall, that might be applied to them. A cord that can be ftretched in length by the weight of a pound or two, would not yield in the leaft to an ounce or two; and it muft likewife be obferved, that gradually as any body is ftretched, its refiftance to the ftretching force increafes. A rope may be ftretched to a certain length by a pound

pound weight appended to it, which would require two pounds to ſtretch it 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 blood into 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 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

(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 member's 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 to it, is not to be explained.

(15.) All muſcles, but eſpecially 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 ſmall veſſels, and being poured irregularly into the muſcular fibrillæ.

(16.) It is ſaid, that a muſcle cut out of the body continues ſome time to be capable of contraction; whereas by tying its arteries or nerves, while it is otherwiſe entire in the body, it loſes its contracting power, which

which therefore does not depend on theſe organs, the arteries or nerves.

The loſs of the power of acting when the arteries or nerves are tied while the muſcle is in the body, is denied by ſome who made the trial; and it might be expected that the motion of a muſcle would be more conſpicuous where there is no reſiſtance to it, as is the caſe when it is cut away from all the parts it is connected with, than when its connection remains with parts reſiſting its contractile efforts.

(17.) After the heart, or any other muſcle cut away from an animal, has ceaſed to contract, its contraction may again be reſtored, by breathing upon it, or pricking it with any ſharp inſtrument. That heat or pricking ſhould, by their ſtimulus (§ 66, *k.*) occaſion contraction in a living creature, may be underſtood; but how they ſhould have the ſame effect in a muſcle ſeparated from an animal, I know not.

68. Some have thought the ganglions of nerves (§ 18, 19, 20.) to be glandular, and to perform a ſecretion.——Others, from their firm texture, ſuppoſe them to be muſcular, and to ſerve to accelerate the motion of the liquor in the nerves which proceed from them; but as no proof is offered of either of theſe opinions, they cannot be maintained.——Others would make them ſerve, 1. To divide a ſmall nerve into many nerves, and by theſe means to increaſe the number of nervous branches. 2. To make nerves come conveniently by different directions to the parts to which they belong. 3. To re-unite ſeveral ſmall nervous fibres into one large nerve.——Since no proof is brought that theſe three things cannot be done without the interpoſition of a ganglion, but on the contrary we ſee them performed where there are no ganglions, we muſt continue to acknowledge ignorance concerning the uſes of theſe knots, the ganglions.

CHAP. II.

Of the PARTICULAR NERVES.

IT is generally ſaid, that there are 40 pair of nerves in all; of which 10 come out from the encephalon, and the other 30 have their origin from the ſpinal marrow.

Of the ten pair of nerves which come from the encephalon *, the firſt is the *olfactory*, which long had the name of the *mamillary proceſſes* of the brain, becauſe in the brutes, cows and ſheep, which were moſt commonly diſſected by the ancients, the anterior ventricles of the brain are extended forwards upon theſe nerves, and adhere ſo firmly to them, that they ſeem to make the upper ſide of the nerves. Each of them being large, where it begins to be ſtretched out, and gradually becoming ſmaller as it approaches the cribriform bone, was imagined to reſemble a nipple. Thoſe who miſtook the ventricles for part of the nerves, obſerving the cavity in them full of liquor, concluded, that theſe olfactory nerves ſerved to convey the ſuperfluous moiſture of the brain to the holes of the ethmoid bone through which it paſſed into the noſe. But in man, the ventricles of whoſe brain are not thus extended forwards, theſe nerves are ſmall, long, and without any cavity, 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

* For a fuller deſcription with figures of the origin of the nerves, ſee Soemmerring de orig. nervor.

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 diſgregated 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 forms, it would have been too ſenſible to bear the impreſſions of ſuch objects as are applied to the noſe; and a diſtribution in the more common way, of a cord ſending off branches, would not have been equal enough for ſuch an organ of ſenſation.

The *ſecond* pair of nerves, the *optic*, riſing from the thalami nervorum opticorum, make a large curve outwards, and then run obliquely inwards and forwards,

† See Obſ. on the Nervous Syſtem, Tab. xxiv.

till they unite at the forepart of the ſella turcica; then ſoon divide, and each runs obliquely forwards and outwards to go out at its proper hole in the ſphenoid bone, accompanied with the occular 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 inſide of the eye, to within a little diſtance of the edge of the cryſtalline lens, and is univerſally known by the name of *retina*.

Though the ſubſtance of this pair of nerves ſeems to be blended at the place where they are joined; yet obſervations of people whoſe optic nerves were not joined, and of others who were blind of one eye from a fault in the optic nerve, or in thoſe who had one of their eyes taken out, make it appear, that there is no ſuch intimate union of ſubſtance *; the optic nerve of the affected ſide only being waſted, while the other was large and plump. And the ſame obſervations are contradictory to the doctrine of a decuſſation of all the nerves (§ 8.): for the diſeaſe could be traced from the affected eye to the origin of the nerve on the ſame ſide. In many fiſhes, indeed, the doctrine of decuſſation is favoured; for their optic nerves plainly croſs each other, without any union at the part where they are joined in men and moſt quadrupeds.

Thoſe people whoſe optic nerves were not joined, having neither ſeen objects double, nor turned their eyes different 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

* The decuſſation of the fibres, and intimate union of the ſubſtance of the optic nerves, appear to be greater than is here ſuppoſed. See Obſ. on Nervous Syſtem, Tab. v.

ter a good injection of the arteries that run in the fubftance of this nerve, as is common to other nerves, it is with difficulty that we can obferve its nervous medullary fubftance.——The fituation of thefe veffels in the central part of the optic nerve, the want of medullary fibres here, and the firmnefs of this nerve before it is expanded at its entry into the ball of the eye, may be the reafon why we do not fee fuch bodies, or parts of bodies, whofe picture falls on this central part of the retina.—An inflammation in thofe arteries of the retina, which feveral fevers and an ophthalmia are generally attended with, may well account for the tendernefs in the eyes, and inability to bear the light, which people have in thefe difeafes.——The over-diftention of thefe veffels may likewife ferve to account for the black fpots obferved on bright-coloured bodies efpecially, and for that fmoky fog through which all objects are feen by people in fome fevers.——If thefe veffels lofe their tone, and remain preternaturally diftended, no object affects our retina, though the eye externally appears found; or this may be one caufe of an amaurofis or gutta ferena.——From a partial diftention of thefe veffels, or paralyfis of a part of the retina, the central part, or the circumference, or any other part of objects, may be loft to one or both eyes.

The *third* pair rife from the anterior part of the proceffus annularis; and piercing the dura mater a little before and to a fide of the ends of the pofterior clinoid procefs of the fphenoid bone, run along the receptacula, or cavernous finufes, at the fide 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 diftributed to the globe of the eye; the others are fent to the mufculus rectus of the palpebra, and to the attollens, adductor, deprimens, and obliquus minor mufcles of the eye-ball. Thefe mufcles being principal inftruments in the motions of the eye-lid and eye-ball, this nerve has therefore got the

the name of the *motor oculi.*——I have frequently obſerved in convulſions the eye-lids widely opened, the cornea turned upward 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 proceſs of the temporal bones; and then ſinking cloſe by the receptacula at the ſides of the ſella turcica, each becomes in appearance thicker, forms a diſtinct ganglion, and goes out of the ſkull in three great branches.

The firſt branch of the fifth is the *ophthalmic*, which runs through the foramen lacerum to the orbit, having in its paſſage thither a connection with the ſixth pair. It is afterwards diſtributed to the ball of the eye with the third; to the noſe, along with the olfactory, which the

the branch of the fifth that paſſes through the foramen orbitarium internum joins, as was already mentioned in the deſcription of the firſt pair. This ophthalmic branch likewiſe ſupplies the parts at the internal canthus of the orbit, the glandula lacrymalis, fat, membranes, muſcles, and teguments of the eye-lids; its longeſt fartheſt extended branch paſſing through the foramen ſuperciliare of the os frontis, to be diſtributed to the forehead.

The ſmall fibres which this firſt branch of the fifth and third pair of nerves ſend to the eye-ball, being ſituated on the optic nerve, and, after piercing the ſclerotic coat, running along the choroid coat on the outſide of the retina in their courſe to the uvea or iris, may be a cauſe of the ſympathy between the optic nerve and the uvea; by which we more readily acquire the habit of contracting the iris, and thereby leſſen the pupil, when too ſtrong light is excluded; and, on the contrary, enlarge the pupil when the light is too faint.—This, with the ſympathy which muſt ariſe from ſome of the nerves of the membrane of the noſtrils, being derived from this firſt branch of the fifth pair of nerves, may alſo be the cauſe, why an irritation of the retina, by too ſtrong light, may produce ſneezing, as if a ſtimulus had been applied to the membrane of the noſe itſelf;——why preſſing the internal canthus of the orbit ſometimes ſtops ſneezing;——why irritation of the noſe or of the eye cauſes the eye-lids to ſhut convulſively, and makes the tears to flow plentifully; and why medicines put into the noſe, do often great ſervice in diſeaſes of the eyes.——In the megrim, all the branches of the nerves diſcover themſelves to be affected: for the forehead is racked with pain; the eye-ball is pained, and feels as if it was ſqueezed; the eye-lids ſhut convulſively, the tears trickle down, and an uneaſy heat is felt in the noſe. Hence we can underſtand where external medicines will have the beſt effect when applied to remove this diſeaſe, to wit, to the mem-

membrane of the noſe, and to the fore-head;——why alternate preſſure near the ſuperciliary hole of the frontal bone, or ſneezing, ſometimes gives immediate relief in the megrim;——why the ſight may be loſt by an injury done to the ſupra orbitar branch;——how it may be reſtored by agitation of that branch of this nerve.

The ſecond branch of the fifth pair of nerves may be called *maxillaris ſuperior*, from its ſerving principally the parts of the upper jaw. It goes out at the round hole of the ſphenoid bone, and ſends immediately one branch into the channel on the top of the antrum maxillare; the membrane of which and the upper teeth are ſupplied by it in its paſſage. As this branch is about to go out at the foramen orbitarium externum, it ſends a nerve through the ſubſtance of the os maxillare to come out at Steno's duct, to be diſtributed to the fore-part of the palate; and what remains of it eſcaping at the external orbitar hole, divides into a great many branches, that ſupply the cheek, upper lip, and noſtril.—The next conſiderable branch of the ſuperior maxillary nerve, after giving branches which are reflected through the ſixth hole of the ſphenoid bone, to join the intercoſtal where it is paſſing through the ſkull with the carotid artery, and the portio dura of the ſeventh pair as it paſſes through the os petroſum, is ſent into the noſe by the hole common to the palate and ſphenoidal bone; and the remaining part of this nerve runs in the palato-maxillaris canal, giving off branches to the temples and pterygoid muſcles, and comes at laſt into the palate to be loſt.——Hence, the ach in the teeth of the upper jaw occaſions a gnawing pain deep-ſeated in the bones of the face, with ſwelling in the eye-lids, cheek, noſe, and upper lip; and on the other hand, an inflammation in theſe parts, or a megrim, is often attended with ſharp pain in the teeth.——Hence, an obſtruction in the duct of the maxillary ſinus, which obliges the liquor ſecreted there to find out a preternatural route

for

for itſelf, may be occaſioned by the pain of the teeth. ——Hence, the upper lip often ſuffers when the palate or noſe is ulcerated.

The third, or *maxillaris inferior*, branch of the fifth pair going out of the oval hole of the ſphenoid bone, ſerves the muſcles of the lower jaw, and the muſcles ſituated between the os hyoides and jaw: All the ſalivary glands, the amygdalæ, and the external ear, have branches from it: It has a large branch loſt in the tongue, and ſends another through the canal in the ſubſtance of the lower jaw to ſerve all the teeth there, and to come out at the hole in the fore-part of the jaw, to be loſt in the chin and under-lip.—— Hence a convulſive contraction of the muſcles of the lower jaw, or the mouth's being involuntarily ſhut, a great flow of ſpittle or ſalivation, a pain in the ear, eſpecially in deglutition, and a ſwelling all about the throat, are natural conſequences 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 conſequence of an angina.——Hence alternate preſſure on the chin may ſometimes relieve the violence of a toothach.—— Hence deſtroying the nerves of a tooth by actual or potential cauteries, or pulling a carious tooth, ſo often removes immediately all theſe ſymptoms.—Hence no cure is to be found for ſome ulcers in the upper or lower jaw, but by drawing a tooth.—Hence, in cancers of the upper lip, the ſalivary glands are in danger of being affected, or the diſeaſe may be occaſioned to the lip by its beginning in the glands.—Perhaps the ſympathy of the organs of taſting and ſmelling may in ſome meaſure depend on their both receiving nerves from the fifth pair.

The *ſixth* pair, which is the ſmalleſt except the fourth, riſes from the forepart of the corpora pyramidalia; and each entering the dura mater ſome way behind the poſterior clinoid proceſs of the ſphenoid bone has a long courſe below that membrane, and within the receptaculum at the ſide of the cella turcica, where it is immerſed in the blood of the receptacle; but for what purpoſe, I am ignorant. It goes afterwards out at the foramen lacerum into the orbit, to ſerve the abductor muſcle of the eye.—A defect in this nerve may therefore be one cauſe of ſtrabiſmus.—In the paſſage 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 ſixth 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 riſes obtuſe, to deſcend with the artery, and to form the beginning of the intercoſtal nerve, according to the common deſcription; or, according to other authors, this nerve comes up from the great ganglion of the intercoſtal, to be joined to the ſixth here.

The arguments for this latter opinion are, That, according to the common doctrine, this beginning of the intercoſtal nerve, as it is called, would riſe in a manner not ſo ordinary in nerves. In the next place, it is obſerved, that the ſixth pair is larger nearer to the orbit, than it is before it comes to the place where this nerve is ſaid to go off; and therefore it is more probable, that it receives an addition there, rather than gives off a branch. Laſtly, It is found, that upon cutting the intercoſtal nerves of living animals, the eyes plainly were affected; they loſt their bright water; the gum, or gore, as we call it, was ſeparated 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

denied that this nerve is for ordinary 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 not 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 ſhow 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 thought, that this muſcle would 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 they could not 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

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 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,

* See Obſ. on the Nervous Syſtem, Tab. xxvii—xxxi.

leus, 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 nobody 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 *eighth* pair * of nerves riſe from the lateral baſes the corpora olivaria in diſgregated 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 aſcends within the dura mater from the tenth of the head, the firſt, ſecond, and inferior cervical nerves: this, every body knows, has the name of the *nervus acceſſorius*. When the two get out of the ſkull, the acceſſorius ſeparates from the eighth, and, deſcending obliquely outwards, paſſes through the ſterno-

 maſtoideus

* For a beautiful and accurate figure of this nerve, ſee Walter's Tab. Nervorum thoracis et abdominis.

maſtoideus muſcle, to which it gives branches, and afterwards terminates in the trapezius muſcle of the ſcapula. In this courſe it is generally more or leſs joined by the ſecond cervical nerve.——Why this nerve, and ſeveral others which are diſtributed to muſcles, are made to pierce through muſcles, which they might have only paſſed near to, I do not know.

The large eighth pair, ſoon after its exit, gives nerves to the tongue, larynx, pharynx, and ganglion of the intercoſtal nerve; and being disjoined from the ninth and intercoſtal, to which it adheres cloſely ſome way, runs ſtraight down the neck behind the internal jugular vein, and at the external ſide of the carotid artery. As it is about to enter the thorax, a large nerve goes off from the eighth of each ſide: this branch of the right ſide turns round from the fore to the back part of the ſubclavian artery, while the branch of the left ſide turns round the great curve of the aorta; and both of them mounting up again at the ſide of the œſophagus, to which they give branches, are loſt at laſt in the larynx *. Theſe are called the *recurrent nerves*, which we are deſired to ſhun in the operation of bronchotomy, though their deep ſituation protects them ſufficiently.——The muſcles of the larynx being in a good meaſure ſupplied 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 loſt ſo long as the ſuperior branches of the eighth pair are entire.——Why the recurrent nerves riſe ſo low from the eighth pair to go round a large artery, and to have ſuch a long courſe 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 themſelves, ſend off ſmall nerves to the pericardium, and to join with the branches of the intercoſtal

* The recurrent and ſuperior laryngeal nerves are joined together by their apices, to form a plexus reſembling that of the nerves of the face; ſo that from both theſe nerves each muſcle of the larynx receives branches. See Obſ. on the Nervous Syſtem, Tab. xxv.

coſtal that are diſtributed to the heart; but their ſize and ſituation are uncertain.

After theſe branches are ſent off, the par vagum on each ſide deſcends behind the great branch of the trachea, and gives numerous filaments to the lungs, and ſome to the heart in going to the œſophagus. The one of the left ſide running on the forepart of the œſophagus, communicates by ſeveral branches with the right one in its deſcent to be diſtributed to the ſtomach: the right one gets behind the œſophagus, where it ſplits and rejoins ſeveral times before it arrives at the ſtomach, to which it ſends 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 ſemilunar ganglion formed by the two intercoſtals.

From the diſtribution of this par vagum, we may learn, how tickling the fauces with a feather or any ſuch ſubſtance, excites a nauſea and inclination to vomit; —why coughing occaſions vomiting, or vomiting raiſes a cough.——Hence we ſee how the nervous aſthma and the tuſſis convulſiva, chincough, are attended with a ſtraitening of the glottis;—why food difficult to digeſt occaſions the aſthma to weakly people; and why emetics have frequently cured the aſthma very ſpeedily;—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 ſoul by ſome;—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 forepart of the trachea arteria, the ninth is loſt in the muſcles and ſubſtance of the tongue. Some 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 which we are ignorant of; which is all the difference between deſcribing the intercoſtal before or after the ſpinal nerves.

The branch reflected from the fixth pair, joined poffibly by fome filaments of the opthalmic branch of the fifth, runs along with the internal carotid artery, thro' the crooked canal formed for it in the temporal bone, where the little nerve is very foft and pappy, and in feveral fubjects divides and unites again, and is joined by one or more branches from the fifth, particularly of its fuperior maxillary branch, before it comes out of the fkull. May the compreffion of this nerve by the carotid artery, when ftretched during the fyftole, contribute to the diaftole of the heart? As foon as the nerve efcapes out of this bony canal, it is connected a little way with the eighth and ninth; then feparating from thefe, after feeming to receive additional nerves from them, it forms a large ganglion, into which branches, from the tenth of the head, and from the firft and fecond cervical, enter. From this ganglion the nerves come out again fmall to run down the neck along with the carotid artery, communicating by branches with the cervical nerves, and giving nerves to the mufcles that bend the head and neck. As the intercoftal is about to enter the thorax, it forms another ganglion, from which nerves are fent to the trachea and to the heart; thofe defigned for the heart joining with the branches of the eighth, and moft of them paffing between the two great arteries and the auricles to the fubftance of that mufcle. The intercoftal * after this confifting of two branches, one going behind, and the other running over the forepart of the fubclavian artery, forms a new ganglion, where the two branches unite below that artery; and then defcending along the fides of the vertebræ of the thorax, receives branches from each of the dorfal nerves; which branches appearing to come out between the ribs, have given the name of *intercoftal* to the whole nerve. Where the addition is made to it from the fifth dorfal nerve, a branch goes off obliquely forwards; which being joined by fuch branches from the fixth, feventh, eighth, and ninth

* See Walter's Tab. Nervor. thor. et abd.

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 are as it were 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 thoſe 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, ilium, and a large ſhare of the colon, have their nerves ſent from this great ſolar 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 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 cau-

ſes

fes fneezing:—Why the too great quantity of bile in the cholera occafions vomiting as well as purging:—Why people vomit in colics, in inflammations, or other irritations of the liver, or of the ducts going from it and the gall-bladder:—Why a ftone in the kidneys, or ureters, or any other caufe irritating thofe organs, fhould fo much more frequently bring on vomiting and other diforders of the ftomach, than the ftone or any other ftimulating caufe in the bladder does:—Why vomiting is a fymptom of danger after child-birth, lithotomy, and other operations on the parts in the pelvis:—Why the obftructions of the menfes are capable of occafioning ftrangulations, belching, colics, ftomach-aches, and even convulfions in the extremities:—Why veficatories, applied from the ears to the clavicles of children labouring under the tuffis convulfiva, are frequently of great fervice:—Why worms in the ftomach or guts excite an itching in the nofe, or grinding of the teeth:—Why irritations in the bowels or the belly occafion fometimes univerfal convulfions of the body.

The SPINAL NERVES rife generally by a number of difgregated fibres from both the fore and back part of the medulla fpinalis; and foon after form a little knot or ganglion, where they acquire ftrong coats, and are extended into firm cords; but the ganglion is entirely formed by the pofterior bundle. They are diftinguifhed by numbers, according to the vertebræ from between which they come out; the fuperior of the two bones forming the hole through which they pafs, being the one from which the number is applied to each nerve. There are generally faid to be thirty pair of them: feven of which come out between the vertebræ of the neck, twelve between thofe of the back, five between thofe of the loins, and fix from the falfe vertebræ.

The *firft* cervical pair of nerves comes out between the firft and fecond vertebræ of the neck; and having given branches to join with the tenth pair of the head, the fecond cervical and intercoftal, and to ferve the mufcles that bend the neck, it fends its largeft branches backwards to the extenfor mufcles of the head and neck; fome of which piercing through thefe mufcles, run up on the occiput to be loft in the teguments here; and many fibres of it advance fo far forward as to be connected with the fibrils of the firft branch of the fifth pair of the head, and of the portio dura of the auditory nerve.——Hence poffibly it is, that a clavus hyftericus changes fuddenly fometimes from the forehead to a violent pain and fpafm in the back part of the head and neck.

The *fecond* cervical is foon joined by fome branches to the ninth of the head and intercoftal, and to the firft and third of the neck; then has a large branch that comes out at the exterior edge of the fterno-maftoideus mufcle, where it joins with the acceflorius of the eighth pair; and is afterwards diftributed to the platyfma myoides, teguments of the fide of the neck and head, parotid gland, and external ear, being connected to the portio dura of the auditory nerve, and to the firft cervical. The remainder of this fecond cervical is fpent on the levator fcapulæ and the extenfors of the neck and head. Generally a large branch is here fent off to join the acceflorius of the eighth pair, near the fuperior angle of the fcapula.

To the irritation of the branches of this nerve it probably is, that in an inflammation of the parotid gland, the neck is pained fo far down as the clavicle, the head is drawn towards the fhoulder of the affected fide, and the chin is turned to the other fide.——In opening the external jugular vein, no operator can promife not to touch fome of the cutaneous branches of this nerve with the lancet; which occafions a fharp pricking pain in the mean time, and a numbnefs of the fkin near the orifice for fome time after.

The *third* pair of the neck paffes 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 deſcending 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 teguments 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 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

ing 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, where they join, ſeparate, and rejoin, in a way ſcarce to be rightly expreſſed in words; and, after giving ſeveral conſiderable nerves to the muſcles and teguments 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 ſupra-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

ſupply the teguments 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 teguments 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, to be 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 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 teguments 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, its ſerves the neighbouring muſcles and teguments; 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 ſeve-

ral

* See Obſ. on the Nervous Syſtem, Tab. xxvi.

ral fingers. The larger part of the nerve goes ftraight forward to the internal fide of the os pififorme of the wrift; where it fends off a branch, which finks under the large tendons in the palm, to go crofs to the other fide of the wrift, ferving the mufculi lumbricales and interoffei, and at laft terminating in the fhort mufcles of the thumb and fore-finger. What remains of the ulnar nerve after fupplying the fhort mufcles of the little-finger, divides into three branches; whereof two are extended along the fides of the fheath of the tendons of the flexors of the little-finger, to furnifh the concave fide of that finger; the third branch is difpofed in the fame way upon the fide of the ring-finger next to the little-finger.

When we lean or prefs on the internal condyle of the os humeri, the numbnefs and prickling we frequently feel, point out the courfe of this nerve. I have feen a weaknefs and atrophy in the parts which I mentioned this nerve to be fent to, after a wound in the internal lower part of the arm.

7. *Radialis* accompanies the humeral artery to the bending of the elbow, ferving the flexors of the cubit in its way; then paffing through the pronator radii teres mufcle, it gives nerves to the mufcles on the forepart of the fore-arm, and continues 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, mid-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,

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 bended while pronation is performing vigoroufly, and they can be extended while fupination is exercifed.

The manner of the going off of thefe nerves of the fingers, 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.

The fituation of thefe brachial nerves in the axilla, may let us fee how a weaknefs and atrophy may be brought on the arms by long-continued preffure of crutches, or fuch other hard fubftances on this part; and the courfe of them from the neck to the arm may teach us how much better effects veficatories, or ftimulating nervous medicines, would have, when applied to the fkin covering the tranfverfe proceffes of the vertebræ of the neck, or at the axilla, than when they are put between the fhoulders, or upon the fpinal proceffes, in convulfions or palfies of the fuperior extremities, where a ftimulus is required.

The *twelve dorfal* nerves of each fide, as foon as they efcape from between the vertebræ, fend a branch forward

ward 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 teguments 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, ſneezing, &c.— The twitching ſpaſms that happen ſometimes in different parts of the muſcles of the abdomen, by an irritation on the branches of the lower dorſal nerves, are in danger of occaſioning a miſtake in practice, by their reſemblance to the cholic, nephritis, &c.——The communications of theſe lower ones with the intercoſtals, may ſerve to explain the violent effort of the abdominal muſcles in a teneſmus, and in childbearing.

As the intercoſtal is larger in the thorax than any where elſe, and ſeems to diminiſh gradually as it aſcends and deſcends, there is cauſe to ſuſpect that this is the trunk from which the ſuperior and inferior pairs are ſent as branches.

The *five lumbar* nerves on each ſide communicate with

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 teguments 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 teguments 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 mufcle. This nerve, which is named the *anterior crural*, is diftributed principally to the mufcles and teguments 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

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 thro' 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 teguments. Some way above the ham, where it has the name of the *poplitæus* nerve, it fends off a large branch that paffes over the fibula, and finking in among the mufcles on the anterior external part of the leg, runs down to the foot, to be loft in the upper part of the larger toes, fupplying the neighbouring mufcles and teguments every where in its paffage. The larger branch of the fciatic, after giving branches to the mufcles and teguments about the ham and knee, and fending a large cutaneous nerve down the calf of the leg, to be loft at laft on the outfide of the foot and upper part of the leffer toes, finks below the gemellus mufcle, and diftributes nerves to the mufcles on the back of the leg; among which it continues its courfe, till, paffing 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 diftributed to the toes in the fame manner that the radial nerve of the hand ferves the concave fide of the thumb and fingers; and the external plantar is divided and diftributed to the fole 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 thefe nerves, that ferve the inferior extremities, pierce through mufcles.

By applying what was faid of the nerves in general to the particular diftribution of the nerves of the inferior extremities, we may fee how people with fractured legs, efpecially where there are fplinters, fhould be fubject to convulfive ftartings of the fractured member: ——Why, upon tying the blood-veffels in an amputation of the leg, the patients fhould fometimes complain of violent pain in their toes;——why fuch patients fhould alfo be troubled with ftartings;——why, for a confiderable time after the amputation of the difeafed limb, when the fuppuration is well advanced, they fhould complain of pain in the fore which occafioned the amputation.

The *fourth*, which, with the two following, is much fmaller than the three fuperior, foon is loft in the vefica urinaria and inteftinum rectum.

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 teguments 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, are; 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 any other parts do.——The ſize of the nerves of the inferior extremities ſeems larger proportionally than in the ſuperior extremities; the inferior extremities having the weight of the whole body to ſuſtain, and that frequently at a great diſadvantage.—— What the effect is of the nerves here being injured, we ſee daily: When people happen, by ſitting wrong, to compreſs the ſciatic nerve, they are incapable for ſome time after to ſupport themſelves on the affected extremity; and this is ſtill more remarkable in the ſciatica or hip-gout, in which the member is not only weakened, but gradually ſhrivels and waſtes.

EXPLANATION of TABLES XV. and XVI.

TAB. XV.—(1) The firſt branch of the fifth pair of nerves. (2) The ſecond branch of the fifth pair. (3) The third branch of the fifth pair. (4) The trunk of the eighth pair cut. (5) The 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 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

TAB. XV

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TAB. XVI.

(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. XVI.—(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 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 gluteus 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

ALEXANDER MONRO, M. D.

Fellow of the Royal Society, Fellow of the Royal College of Phyficians, and late Profeffor of Medicine and Anatomy in the Univerfity of Edinburgh.

PUBLISHED BY HIS SON,

ALEXANDER MONRO, M. D.

Profeffor of Medicine, and of Anatomy and Surgery in the Univerfity of Edinburgh.

WITH

Confiderable IMPROVEMENTS and ADDITIONS,
By other Hands.

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 and ſyſtem 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, 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 times of Hippocrates, is very 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 exceeding 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 ſyſtem of anatomy, and his terms and names do not correſpond to ours. The ſmall tract *De Vulneribus Capitis*, is as great a maſter-piece in its kind as the *Coacæ Prediĉtiones*. Yet the firſt has been eſteemed by ſome lame and imperfect, and afforded occaſion for many diſputes and wranglings; and all this becauſe not underſtood. Anatomiſts, however, have done by Hippocrates in moſt caſes as the critics with Homer, made him the maſter of all human and divine ſcience. Not a new diviſion of a bone, or diſpute about a proceſs or articulation, but has been referred to his judgment; and he has often been made to explain what he never dreamt of. Galen, the father of anatomiſts, is, for the ſame reaſon, in many places, become an obſcure writer. He is accuſed and defended by the greateſt ſucceeding maſters. Veſalius, the great reſtorer of anatomy, will not allow accuracy or truth in many of his deſcriptions; they are, according to him, taken from brutes, and obtruded on the world for human.

The other anatomiſts treat Veſalius much in the ſame manner; and, with uncommon ſagacity and unwearied application,

tion, have found out variations and *lusus naturæ* in particular parts, that they may eſtabliſh Galen's deſcriptions, and condemn thoſe of Veſalius. This is particularly the caſe with Euſtachius in his Treatiſe on the Kidneys. How ſhall we now underſtand Galen, and judge between theſe great anatomiſts? It is Comparative Anatomy alone can extricate us from this confuſion; as it will teach us when Galen and others deſcribed and reaſoned from brutes, and when not. We ſhall then 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 of 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 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-œconomy, 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.

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* 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.*

rifes. If we find one common effect conftantly produced, tho' in a very different way, then we may fafely conclude that this is the ufe or function of the part: this reafoning can never betray us, if we are but fure of the facts. The writers in phyfiology have generally taken another route, and one favourite thefis or other ferves to explain the whole or moft of the fyftem. An innate and concocting heat, acids, menftruums, &c. have all had their fucceffive reigns and patrons: and in truth, phyficians feem not to have fufficiently confidered the importance of this ftudy to form a complete phyfiology, which muft ever be the great bafis of their art. They have beftowed pains in examining the human body, diffected minutely its feveral parts, traced out (perhaps often invented) a new divifion of a mufcle: But how little has phyfic been promoted by all this? The moft accurate defcription of the human ftomach, with all its veins, arteries, nerves, &c. will never rightly explain digeftion. What muft we then do? Examine it in the other fpecies of animals, mark there its differences and the effects, compare thefe with the human; and then fhall we, in fome meafure, be able to judge what are the principal inftruments, and how they are employed in this compound action. Any other way of reafoning (as the author well obferves) will never bring us to the folution of a philofophical or medical problem. It muft indeed be confeffed, that this method is tedious and flow; many obfervations muft firft be made, and the labour of fearching and examining gone through, before we can have proper materials to build on. Yet thefe are the hard conditions on which the knowledge of natural caufes is to be obtained; which, as a great genius fays, *Tam facile folertia vinci poffunt, quam folent conatibus vulgaribus difficulter cedere.*

Of this kind of reafoning we have many beautiful inftances in the following papers. Such is the account of the pofition of the Duodenum; of the caufe of our preferring the Right Arm; of the circulation of the blood in the Fœtus; the hiftory of the Thymus and Thyreoid Glands, their ufe and mutual proportion; the ufe of the Spleen, &c. This laft he explains in fo fhort and mafterly a manner, that more argument will be found in the few lines upon it, than is to be collected from whole treatifes on the fubject. But as his defign was to give a defcription of the feveral fpecies, or rather their principal differences, he chiefly confines himfelf to this. So in the anatomy of the dog he compares the different pofition, fhape, ſhape, length, &c. of the ſeveral parts with the correſponding 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 flexility 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 way of life; that is, one leading ſpecialty draws after it a great many more, in which nature is always an œconomiſt, and takes the ſhorteſt route.

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 breathing organs; ſome have a muſcular diaphragm and ſtrong abdominal muſcles, others a mere membrane. It muſt be very entertaining to learn how theſe differences and deficiences are adjuſted and ſupplied: it is then from this ſcience alone we can underſtand that ſimplicity of nature which is ſo much talked of, and but little underſtood. Hence likewiſe we muſt learn what to think of animals perfect and imperfect.

Anatomiſts have made a noiſe about the different ſtructures of the ſame part in the human body, and been at great pains to make collections of thoſe *Luſus Naturæ*, as they call them; which becauſe they are rare, are for that very reaſon of no great conſequence to be known. The epithet, however, is extremely proper; for the moſt remarkable of them are tranſitions from the order or law of nature that obtains in one ſpecies to that of another. Thus it has been obſerved, (though very rarely), that the liver was ſituated in the left hypochondrium: but, as our author remarks, it is not peculiar to it to

lie

lie on the right ſide in animals; for in fowls it lies equally in both, and in fiſhes moſtly on the left.

It is ſurpriſing that we have no tolerable treatiſe on this ſubject, which is in itſelf ſo entertaining and ſo conducive to promote Medicine. Thoſe who have made attempts this way, have only collected and ranged in order ſome particular ſpecies, ſuch as Birds or Fiſhes. They have likewiſe with great labour given us figures and deſcriptions of them; but all this is little elſe than mere amuſement. It is the ſtructure of their internal organs we ſeek after, and the manner how the different functions of the animal-œconomy are performed. Their hiſtories of theſe are every way defective and erroneous. There are indeed noble hints to be found in the writings of ſome of our modern anatomiſts, particularly thoſe of the immortal Dr Harvey. That great man well underſtood the importance of this ſcience to advance medicine; and accordingly employed the moſt of his time in diſſecting animals of different tribes, and making experiments on them: by which means he made the greateſt diſcovery that ever was in the ſcience, and laid the foundation of the preſent ſyſtem. He had certainly left us other treatiſes on this ſubject, had he not been interrupted by the civil wars. The phyſicians who lived then, imitating his example, made many new experiments on the bodies of brutes, changing their juices by transfuſing of new liquors, accurately marking the effects, &c. that all this might be transferred to the human body: And indeed, from the application of theſe reaſonings to the obſervations they made on morbid bodies, the ſcience ſeemed faſt advancing to that phyſical certainty which can be attained from experiment and obſervation. But, alas! this ſpirit died with thoſe great men, and theory and calculation came in its place. Mathematics, it was ſaid, could alone bring the ſcience to certainty, and throw out conjecture. The quantity and velocity of the blood, the force of the heart, diameters of the veſſels, &c. were ſubjected to meaſure and number, and diſeaſes next were to be accounted for, all in a mathematical manner.—This method, however, did not ſucceed according to wiſh: For, firſt, thoſe great geniuſes diſagreed widely in their calculations, and differed from one another; whence, in place of certain concluſions, we had only wranglings and diſputes: not to mention, that ſome of them made ſuch eſtimates as muſt plainly appear ridiculous at firſt ſight*. This, ſome may ſay, proves

* The ingenious Dr Pitcairn was the chief man in theſe parts who gave into

proves nothing; it was the fault of the artifts, who affumed wrong hypothefes for their calculations, or 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? 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 veffels at the fame time, which can never be determined? &c. Thefe and fuch like confiderations will foon convince us how little the practice of medicine is to be promoted by thofe fpeculations *. If thefe gentlemen meant by mathematical reafoning phyfical experiments, then no one ever doubted of this, no more than they do of the ufe of mathematics in natural philofophy itfelf. But as this feems not to be their fenfe of the matter, they fhould point out a few difeafes which this fcience has explained, and wherein it has corrected the received practice.—But we are now got from the fubject to what is foreign. To return then: Comparative Anatomy has hitherto been treated but by pieces. Thus fome, writing on the human eye, have examined the eyes of other animals; and fo with regard to the heart, &c. Some have given us the defcription of one particular animal, others of another. But no one author, that we know of, has given us a fyftem of this fcience, where we might have a fummary view

into this way. 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 the 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 at leaft is equal to 117,088 lb. 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 weight 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.

* The authority of Hippocrates is often adduced in this argument; for which they cite two paffages. In the one he recommends the ftudy of Aftronomy as neceffary to a phyfician; and in the other, that of Arithmetic and Geometry. ——The firft he did from his belief in the influence of the ftars; and the fecond from his veneration for the Pythagoric numbers, in the myfteries of which he founded his theory of the crifes in acute difeafes: Both thefe confiderations then are foreign to the purpofe, nor is there in any of his genuine writings the fmalleft veftige of this kind of reafoning. On the contrary, Celfus fays of him, *Primus ab ftudio fapientiæ medicinam feparavit.*

view of the moſt material differences in the ſtructure of animals. There are indeed compends of this ſcience, if you will, which are eſteemed by many, and were wrote with the noble deſign of illuſtrating the wiſdom and goodneſs of our Maker. But thoſe who compoſed them were not anatomiſts themſelves; ſo could only collect from others, which they often do without any judgment: for how voluminous ſoever their works may be, yet if you will ſtrip them of their repeated exclamations, citations of authors and books, the many ſtrange and ſurpriſing ſtories, all told, however, by creditable vouchers, you will have little left behind beſides an indigeſted chaos of hiſtories and deſcriptions, ſome true and many falſe. The argument, however, was popular, and they could not fail of pleaſing.

The following Treatiſe, by the late celebrated Dr Monro, is executed upon a more uſeful plan, and in a more ſyſtematic manner. The deſcriptions are all taken from the life, and the reaſoning employed is plain and concluſive. Theſe are intermixed with many practical obſervations in medicine and ſurgery, which muſt equally inſtruct and entertain the reader.

This work, in ſubſtance, appeared about forty years ago, under the title of *An Eſſay on Comparative Anatomy;* but without any author's name, being only compoſed from Notes taken by a ſtudent at the Claſs Lectures. As it was of courſe exceedingly defective and erroneous, the preſent Profeſſor of Anatomy, in preparing for the preſs the Collection of his father's Works lately publiſhed, corrected this piece amongſt the reſt; and alſo made ſome additions to it, from obſervations that had been collected by 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 accordingly accompliſhed, as far as the limits of a compend would admit, or as ſeemed to comport with the original ſcale of the

the 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 and obſervation of the gentlemen themſelves who had the care of the edition, ſome from different parts of the late Author's others Works, and the greateſt number from the Lectures of the illuſtrious Profeſſor who now fills the Anatomical Chair.

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AN ESSAY ON COMPARATIVE ANATOMY.

The INTRODUCTION.

THE principal advantages of Comparative Anatomy are the following: Firſt, It furniſhes us with a ſufficient knowledge of the different parts of animals, to prevent our being impoſed upon by ſuch authors as have delineated and deſcribed ſeveral parts from brutes as belonging to the human body. Secondly, It helps us to underſtand ſeveral paſſages in the ancient writers in medicine, who have taken many of their deſcriptions from brutes, and reaſoned from them: their reaſonings have often been miſapplied (and conſequently wrong explained) by the moderns, through a fooliſh fondneſs to ſupport their own inventions, or give an air of antiquity to a favourite hypotheſis. The third and great uſe we reap from this ſcience, is the light it caſts on ſeveral functions in the human œconomy, about which there have been ſo many diſputes among

mong anatomifts: Thefe will be in a great meafure cleared up by exhibiting the ftructure of the fame parts in different animals, and comparing the feveral organs employed in performing the fame action, which in the human body is brought about by one more complex.

In this view, it is altogether needlefs to infift on thofe parts whofe ufe is eafily underftood when once their ftructure is unravelled. Thus, for inftance, if we be acquainted with the action of the mufcles in general, it will not be difficult to determine the ufe of any particular mufcle whofe origin and infertion is known, if we at the fame time confider the various connections of the bones to which it is fixed, and the different degrees of mobility they have refpect to each other. In the fame manner, if we know the ufe of the nerves in general, we can eafily affign the ufe of thofe nerves which are diftributed to any particular part. There is then no occafion for a complete Ofteology, Myology, &c. of the feveral animals we fhall treat of; nor need we trouble ourfelves about the ftructure of any of the parts, unlefs when it ferves to illuftrate fome of the fore-mentioned purpofes *.

That the firft ufe we propofed from examining the ftructure of the parts in brutes is real and of confequence, is evident from looking into the works of fome of the earlieft and greateft mafters of anatomy, who, for want of human fubjects, have often borrowed their defcriptions from other animals. The great Vefalius, although he juftly reproves Galen for this fault, is guilty of the fame himfelf, as is plain from his delineations of the kidneys, uterus, the mufcles of the eye, and fome other

* Notwithftanding this affertion of the learned author, we muft obferve, that the myology of animals feems exceedingly neceffary for young anatomifts, who generally begin with diffecting them before they have accefs to human bodies. For this reafon, we have added, not indeed a complete myology, but an account of the particulars wherein the mufcles of a dog differ from thofe of a man; this being the animal moft frequently chofen for diffections, and one of thofe whofe ftructure bears no fmall refemblance to that of the human fpecies.

other parts. Nor is antiquity only to be charged with this; ſince, in Willis's *Anatomia Cerebri* (the plates of which were reviſed by that accurate anatomiſt Dr Lower), there are ſeveral of the pictures taken from different brutes, eſpecially the dog, beſides thoſe he owns to be ſuch.

We ſhall give ſeveral examples of the ſecond uſe in the ſequel of the 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 betwixt an oyſter, one of the moſt inorganiſed of the animal tribe, and the ſenſative 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

and thofe that feed on flefh. The diftinction we fhall make in treating of Fifhes, fhall be of thofe 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, only 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 emaciated fubjects, to refemble this thin mufcle, that fome of the older anatomifts reckoned fuch a panniculus among the common teguments of the human body. This Carolus Stephanus has well obferved.

Moft part of 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 when they walk on all fours, they walk but indifferently.

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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 teguments are much a-kin to 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 lubricating 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 part of the abdomen, which is the higheſt;

 and

* 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 diſeaſe called *Rabies Canina*, is 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 thoſe being originally ſeized with this malady.

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 would 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 tumours. 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 358. 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 pretty 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 pretty much 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 betwixt the cardia

cardia and fundus being greater than that betwixt the two ſides. It ſeems 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 neceſſary, ſince this animal cannot at any time get its ſuſtenance as men do. The turbillion is not ſo large, nor is there any coarction forming the *antrum Willeſii* as in the ſtomach of man. It is conſiderably thicker and more muſcular than ours, for breaking the coheſion of their food, which they ſwallow without ſufficient chewing. Hence it is evident the force of the ſtomach is not ſo great as ſome would have it, nor its contraction ſo violent: otherwiſe that of dogs would be undoubtedly wounded by the ſharp bones, &c. they always take down; for the contraction here is ſtill greater than in the human ſtomach, which is much thinner. The rugæ of the tunica villoſa are neither ſo large, nor ſituated tranſverſely, as in the human, but go from one orifice to the other: the reaſon of which difference is, perhaps, that they might be in leſs danger of being hurt by the hard ſubſtances this creature frequently feeds upon; and for the ſame reaſon there is not the like coarction at their pylorus.

The inteſtines of this animal are proportionally much ſhorter than ours; for the food which theſe creatures moſtly uſe, ſoon diſſolves, and then putrifies; on which account there was no occaſion for a long tract of inteſtines, but on the contrary that it ſhould be quickly thrown out of the body. The ſame is to be obſerved of all the carnivorous animals. The muſcular coat of the inteſtines is alſo thicker and ſtronger than the human, to protrude the contents quickly and accurately.

The valvulæ conniventes are leſs numerous, and in a longitudinal direction; and the whole tract of the alimentary canal is covered with a ſlime, which lubricates the inteſtines, ſaves them from the acrimony of the excrementitious part, and facilitates its paſſage.

The *duodenum* differs conſiderably in its ſituation from the human. For in man it firſt mounts from the pylorus upwards, backwards, and to the right-ſide; then paſſes down by the gall-bladder; and, marching over the right kidney and ſuperior part of the pſoas muſcles, makes a curvature upwards; and paſſes over the back-bone and vena cava inferior, to the left hypochondrium, where it gets through the omentum, meſentery, and meſocolon, to commence *jejunum*, being firmly tied down all the way, the biliary and pancreatic ducts entering at its moſt depending part: Whereas, in the dog, the duodenum is fixed at the pylorus to the concave ſurface of the liver, and hangs looſe and pendulous with the meſentery 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 moſt depending part. Therefore the ſame intention ſeems 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 diſadvantageous courſe, that ſo 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 reaſon of their different poſture, the ſame deſign (tho' by a very different order of the parts) is brought about in both.

The other ſmall guts are much the ſame with ours, only ſhorter. The great guts are alſo ſhorter and leſs 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 ſmall guts conſiderably longer, but alſo their great guts more capacious, than ſuch creatures as feed on other animals. Hence man, from this form of his inteſtines, and that of the teeth, ſeems to have been originally deſigned for feeding on vegetables

tables chiefly; and ſtill the moſt of his food, and all his drink, is of that claſs.

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. Beſides which 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 ſuch ignoble exerciſes; ſo that, having this large reſervoir for his fæces alvinæ, he can retain them for a conſiderable time without any 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 as one of the great guts. On its internal ſurface we obſerve a great number of mucous glands *.

 The

* 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

The *colon* has no longitudinal ligaments; and confequently this gut is not purfed up into 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 betwixt 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 many

a rat, it is rather larger than the ftomach; in others, as fwine, and fome of the animals 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.

many ſmaller ones, may poſſibly be, that as the guts of a human body are proportionally much longer than thoſe of this creature, it would have been inconvenient to have gathered all the *lactea primi generis* into one place; whereas, by collecting a few of theſe veſſels into a neighbouring gland, the ſame effect is procured much more eaſily. Whether the food in this animal needs leſs preparation in its paſſage through theſe glands, is a matter very much unknown to us; though it is certain that ſome changes really do take place.

The *pancreas* in man lies acroſs the abdomen, tied down by the peritonæum; but the capacity of this creature's abdomen not allowing of that ſituation, it is diſpoſed more longitudinally, being tied to the duodenum, which it accompanies for ſome way. Its duct enters the duodenum about an inch and half below the ductus communis.

The *ſpleen* of this animal differs from ours very much, both in figure and ſituation. It is much more oblong and thin, and lies more according to the length of the abdomen, like the pancreas. Though the ſpleen of this creature is not firmly tied to the diaphragm (which was neceſſary in our erect poſture to hinder it from falling downwards), yet by the animal's prone poſition, its poſterior parts being rather higher than the anterior, it comes to be always contiguous to this muſcle, and is as effectually ſubjected to an alternate preſſure from its action as the human ſpleen is.

The human *liver* has no fiſſures or diviſions, unleſs you pleaſe to reckon that ſmall one betwixt the two *pylæ*, where the large veſſels enter: Whereas in a dog, and all other creatures that have a large flexion in their ſpine, as lions, leopards, cats, &c. the liver and lungs are divided into a great many lobes by deep ſections, reaching the large blood-veſſels, which in great motions of the back-bone may eaſily ſhuffle over one another; and ſo are in much leſs danger of being torn or bruiſed, than if they were formed of one entire piece, as

we

we really ſee it is in horſes, cows, and ſuch creatures as have their back-bone ſtiff and immoveable. There is here no *ligamentum latum* connecting the liver to the diaphragm, which in our ſituation was neceſſary to keep the viſcus in its place: Whereas in this creature, it naturally gravitates forwards, and by the horizontal poſition of the animal is in no danger of preſſing againſt the vena cava; the preventing of which is one uſe generally aſſigned to this ligament in man. Had the liver of the dog been thus connected to the diaphragm, the reſpiration muſt neceſſarily have ſuffered; for, as we ſhall ſee afterwards, this muſcle is here moveable at the centre as well as at the ſides: But in man the liver is fixed to the diaphragm, moſtly at its tendinous part; that is, where the pericardium is fixed to it on the other ſide; ſo that it is in no danger of impeding the reſpiration, being ſuſpended by the mediaſtinum and bones of the thorax. In conſequence of this viſcus being divided into ſo many lobes, it follows, that the hepatic ducts cannot poſſibly join into one common trunk till they are quite out of the ſubſtance of the liver; becauſe 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-cyſtic ducts, mentioned by former authors, do not exiſt. The gall-bladder itſelf is wanting in ſeveral animals, ſuch as the deer, the horſe, the aſs, &c.; but in place of it, in ſuch animals, the hepatic duct, at its beginning, is widened into a reſervoir of conſiderable ſize, which may anſwer the ſame purpoſe in them that the gall-bladder does in others.

We come next, after having examined the chylopoietic viſcera, to diſcourſe of thoſe organs that ſerve for the ſecretion and excretion of urine. And firſt of the kidneys: Which in this animal are ſituated much in the ſame way as in the human ſubject; but have no fat on their inferior ſurface, where they face the abdomen, and are of a more globular form than the hu-

 man.

man. The reafon of thefe differences will eafily appear, 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 pretty well 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 that 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 fhow, being fetid and pungent, and therefore not convenient to be long

re-

retained in the body. For this end it was proper, that the ſecerning organs ſhould have as little impediment as poſſible by preſſure, &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 ſhow 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 thro' 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 Butty. 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;

dus ; 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 extended 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 bore 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 a ſocial life : Whereas by means of the peritoneum, the urine is now collected in ſufficient quantity, the viſcera not gravitating this way.

You 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 membranous, 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

tion of cantharides; or without any of thefe, when the parts are made more fenfible, as in an excoriation of the bladder, there is a frequent defire to make water. Accordingly we find thefe animals evacuate their urine much more frequently than man, or any other creature that lives on vegetable food. And if thefe creatures, whofe fluids have already a tendency to putrefaction, are expofed to heat or hunger, the liquids muft for a confiderable time undergo the actions of the containing veffels, and frequently perform the courfe of the circulation, without any new fupplies of food; by which the fluids becoming more and more acrid, the creature is apt to fall into feverifh and putrid difeafes: And in fact, we find that fatal and melancholy diftemper the *rabies canina*, *vulpina*, &c. frequent in thefe animals; whereas thofe that feed on vegetable food feldom or never contract thefe difeafes but by infection.

Their *fpermatic veffels* are within the peritoneum, which is fpread over them, and from which they have a membrane like a mefentery, fo hang loofe and pendulous in the abdomen: whereas, in us, they are contained in the cellular part of the peritoneum, which is tenfely ftretched over them. At their paffage out of the lower belly, there appears a plain perforation, or holes; hence the adult quadruped, in this refpect, refembles the human fœtus. And from obferving this in quadrupeds, has arifen the falfe notion of *hernia* or *rupture* among authors. This opening, which leads down to the tefticle, is of no difadvantage to them, but evidently would have have been to us; for from the weight of our vifcera, and our continually gravitating upon thefe holes, we muft have perpetually laboured under enteroceles. This they are in no hazard of, fince in them this paffage is at the higheft part of their belly, and, in their horizontal pofture, the vifcera cannot bear upon it: And, to prevent even the fmalleft hazard, there is a loofe pendulous femilunar flap of fat; which ferves two ufes, as it both hinders the inteftines from getting into the paſſage, and alſo the courſe of the fluids from being ſtopped in the veſſels, which is ſecured in us by the cellular ſubſtance and tenſe peritoneum: And it may be worth while to obſerve, that this proceſs remains almoſt unaltered, even after the animal has been almoſt exhauſted of fat..

There is next a paſſage quite down into the cavity, where the teſticles lie. Had the ſame ſtructure obtained in man, by the conſtant drilling down of the liquor which is ſecerned for the lubricating of the guts, we ſhould always have laboured under an hydrocele; but their poſture ſecures them from any hazard of this kind: indeed your very fat lap-dogs, who conſequently have an overgrown omentum, are ſometimes troubled with an epiplocele.

The *ſcrotum* is ſhorter and not ſo pendulous as the human in all the dog kind that want the *veſiculæ ſeminales*, that the ſeed at each copulation might the ſooner be brought from the teſtes, thus in ſome meaſure ſupplying the place of the *veſiculæ ſeminales;* for the courſe of the ſeed through the *vaſa deferentia* is thus ſhortened, by placing the ſecerning veſſels nearer the excretory organs *. The want of *veſiculæ ſeminales* at the ſame time explains the reaſon why this creature is ſo tedious in copulation. But why theſe bodies are abſent in the dog kind more than in other animals, is a circumſtance we know nothing of.

The ſtructure of the *teſticles* is much the ſame with the human; as are likewiſe the *corpus pyramidale*, *varicoſum*, or *pampiniforme*, and the *epididymis* or excretory veſſel of the teſticle. The *vaſa deferentia* enter the abdomen where the blood-veſſels come out; and, paſſing along the upper part of the bladder, are inſerted a little below the bulbous part of the urethra.

The præputium has two muſcles fixed to it: one that

* Perhaps its paſſage is likewiſe quickened by the muſcular power of the vaſa deferentia, which is ſtronger in this creature than in man.

that ariſes from the ſphincter ani, and is inſerted all along the *penis;* and this is called *retractor præputii:* But the other, whoſe office is directly contrary to this, is cutaneous; and ſeems to 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, gripes it cloſely; and ſo the male is kept in action ſome time contrary to his will, till time 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

 proportionably

proportionably 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 valve. From the *uterus* two long canals mount upon the loins, in which the fœtuſes are lodged: theſe are divided into different ſacs, which are ſtrongly conſtricted betwixt each fœtus; yet theſe coarctions give way in the time of birth. From theſe go out the *tubæ Fallopianæ*, ſo that the ovaria come to lodge pretty near the kidneys.

We ought next to examine the ſtructure of the thorax and its contents. But firſt it may not be amiſs to remark of the *diaphragm* in its natural ſituation, that it is in general more looſe 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 mediaſtinum, is tied to the ſternum, ſpine, &c. but here there is ſome diſtance between the diaphragm and pericardium. We obſerve further, that its middle part is much more moveable, and the tendinous parts not ſo large. And indeed it was neceſſary their *diaphragm* ſhould be ſomewhat looſe, they making more uſe of it in difficult reſpiration than man. This we may obſerve by the ſtrong heaving of the flanks of an horſe or dog when out of breath; which correſponds to the riſing of the ribs in us.

The diſpoſition and ſituation of the *mammæ* vary as they bear one or more young. Thoſe of the uniparous kind have them placed between the poſterior extremities, which in them is the higheſt part of their bodies, whereby their young get at them without the inconvenience of kneeling: Nevertheleſs, when the creatures are of no great ſize, and their breaſt large, as in ſheep, the young ones are obliged to take this poſture. In multiparous animals, they muſt have a great number of nipples, that their ſeveral young ones may have room at the ſame time, and theſe diſpoſed over both thorax and abdomen; and the creatures generally lie down when the young are to be ſuckled, that they may give them the moſt favourable ſituation. From this it does not appear to be from any particular fitneſs of the veſſels at certain places for giving a proper nouriſhment to the child, that the breaſts are ſo placed in women as we find them, but really from that ſituation being the moſt convenient both for mother and infant.

The *ſternum* is very narrow, and conſiſts of a great number of ſmall bones, moveable every way; which always happens in creatures that have a great mobility in their ſpine. The ribs are ſtraighter, and by no means ſo convex as the human; whereby in reſpiration the motion forward will very little enlarge their thorax, which is compenſated by the greater mobility of their diaphragm: ſo our thorax is principally enlarged according to its breadth and depth, and theirs according to its length. The want of clavicles, and the conſequent falling in of the anterior extremities upon the cheſt, may contribute ſomewhat to the ſtraitneſs of the ribs.

The *mediaſtinum* in this creature is pretty broad. The pericardium is not here contiguous to the diaphragm, but there is an inch of diſtance betwixt them, in which place the ſmall lobe of the lungs lodges; and by this means the liver, &c. of this animal, though continually preſſing upon the diaphragm, yet cannot diſturb the heart's motion.

The heart is ſituated with its point almoſt directly downwards, according to the creature's poſture, and is but very little inclined to the left ſide. Its point is much ſharper, and its ſhape more conoidal, than the human. Here the names of *right* and *left* ventricles are proper enough, though not ſo in the human; which ought rather to be called *anterior* and *poſterior*, or *ſuperior* and *inferior*. The animal has the *vena cava* of a conſiderable 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, as foon as it pierces the diaphragm, fo foon it enters the pericardium, which is firmly attached to it, and immediately gets into the *finus Lowerianus;* which finus, in the human fubject, by the oblique fituation of the heart is almoft contiguous to the diaphragm: and by this we difcover, that feveral authors have taken their delineations of the human heart from brutes; which is eafily detected by the fhape and fituation of the heart, and long vena cava, within the thorax. This was one of the faults of the curious wax-work that were fhown at London and Paris, which were plainly taken from a cow.

This fituation of the heart of the creature agrees beft with the fhape of its thorax, which is lower than the abdomen.

The egrefs of the large blood-veffels from the heart is fomewhat different from the human: For here the right fubclavian comes off firft; and as a large trunk runs fome way upwards before it gives off the left carotid, and fplits into the carotid and fubclavian of the right fide, then the left fubclavian is fent off. So that neither here, properly fpeaking, is there an *aorta afcendens* more than in the human; but this name has probably been impofed upon it from obferving this in a cow, where indeed there is an afcending and defcending aorta.

From this fpeciality of the diftribution of the veffels of the right fide, which happens, though not in fo great a degree, in the human fubject, we may perhaps in fome meafure account for the general greater ftrength, readinefs, or facility of motion, which is obfervable in the right arm. I believe, upon meafuring the fides of the veffels, the furface of the united trunk of the right fubclavian and carotid is lefs than that of the left fubclavian and carotid, as they are feparated. If fo, the refiftance to the blood muft be lefs 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 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 betwixt 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 does obtain in a greater degree. Do but obſerve a dog at a trot, how he bears forward with his right ſide; or look at him when a-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 *.

The

* It has been the opinion of ſome anatomiſts, that left-handed people,

The *thymus* of this creature is proportionably 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 always 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 proportionably 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 fur-

 nifhed

people, as well as thofe diftinguifhed by the name of *ambidexter* (who ufe both hands promifcuoufly), have the two carotid and fubclavian arteries coming off in four diftinct trunks from the arch of the aorta: but no appearance of this kind has ever been obferved in fuch bodies as have been examined for this purpofe; though indeed thefe have been but few, and more experience might throw greater light on the fubject.

niſhed by the thyroid gland, which is ſituated much higher; ſo that its lymph has the advantage of a perpendicular deſcent.

We may here obſerve, that the *thoracic duct* in a dog has no curvature before it enters the ſubclavian vein, the horizontal poſition of this animal allowing a favourable enough courſe to 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.

We look on 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

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 as are furniſhed with ſomething analagous to hands to convey their food to their mouths, as cats, apes, &c. The teeth of this creature plainly ſhow it to be of the carnivorous kind; for there are none of them made for grinding their food, but only for tearing and dividing it. It has ſix remarkable ſharp teeth before, and two very long tuſks behind; both of which the ruminating animals want. Theſe are evidently calculated for laying very firm hold of ſubſtances, and tearing them to pieces; and the vaſt ſtrength of the muſcles inſerted into the lower jaw, aſſiſts greatly in this action; while the molares have ſharp cutting edges, calculated for cutting fleſh, and breaking the hardeſt bones.

Even its poſterior teeth are not formed with rough broad ſurfaces as ours are; but are made conſiderably ſharper, and preſs over one another when the mouth is ſhut, that ſo they may take the firmer hold of whatever comes betwixt them.

The tongue, in conſequence of the length of the jaws, is much longer than ours; and as this creature feeds with his head in a depending poſture, the bolus would always be in danger of falling out of the mouth, were it not for ſeveral prominences or papillæ placed moſtly at the root of the tongue, and crooked backwards in ſuch a manner, as to allow any thing to paſs eaſily down to the jaws, but to hinder its return. By the papillæ alſo the ſurface of the tongue is increaſed, and a ſtronger impreſſion is made on the ſenſation of taſte. In ſome animals who feed on living creatures, theſe tenter-hooks are ſtill more conſpicuous; as in ſeveral large fiſhes, where they are almoſt as large as their teeth in the forepart of their mouth, and near as firm and ſtrong.

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 provided for by two membranous capfulæ, into which the amygdalæ, when preffed, can efcape, and remove themfelves from fuch injuries.

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 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 pretty large 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 fupplies 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, the mufcle of the epiglottis is wanting, its place being fupplied by the elafticity of the cartilage.

The *œſophagus* is formed pretty much in the ſame way as the human. Authors indeed generally allege, that quadrupeds have their gullet compoſed of a double row of ſpiral fibres decuſſating one another; but this is peculiar to ruminating animals, who have occaſion for ſuch a decuſſation of fibres. The action of theſe you may eaſily obſerve in a cow chewing her cud.

The *noſe* is generally longer than in man, and its external paſſage much narrower. The internal ſtructure is alſo better adapted for an acute ſmelling, having a larger convoluted ſurface on which the *membrana ſcheideriana* is ſpread; and this is to be obſerved in moſt quadrupeds, who have the oſſa ſpongioſa commonly large, and theſe too divided into a great number of exceſſively fine thin lamellæ. The ſenſibility ſeems to be increaſed in proportion to the ſurface; and this will alſo be found to take place in all the other ſenſes. The elephant, which has a head pretty large in proportion to its body, has the greateſt part of it taken up with the cavity of the noſe and frontal ſinuſes; which laſt extend almoſt over their whole head, and leave but a ſmall cavity for their brains. A very nice ſenſe of ſmelling was not ſo abſolutely neceſſary for man, who has judgment and experience to direct him in the choice of his food; whereas brutes, who have only their ſenſes, muſt of neceſſity have theſe acute, ſome having one ſenſe in greater perfection than others, according to their different way of life. We not only conclude *à priori* from the large expanded *membrana ſcheideriana*, that their ſenſe of ſmelling is very acute, but we find it ſo by cows and horſes diſtinguiſhing ſo readily betwixt noxious and wholeſome herbs, which they do principally by this ſenſe.

The external *ear* in different quadrupeds is differently framed, but always calculated to the creature's manner of life. In ſhape it commonly reſembles the oblique ſection of a cone from near the apex to the baſis. Hares, and ſuch other animals as are daily expoſed pofed 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 fpeciality 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 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. In this then we may alfo obferve a fort of gradation.

All quadrupeds have a feventh mufcle belonging to the

the eye, called *ſuſpenſorius.* It ſurrounds almoſt the whole optic nerve, and is fixed into the ſclerotic coat as the others are. Its uſe is to ſuſtain the weight of the globe of the eye, and prevent the 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 other four, by cauſing 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 ſpecies of objects that are viewed. Man has it circular, for obvious reaſons: an ox has it oval, with the longeſt diameter placed tranſverſely, to take in a larger view of his food: cats, again, have theirs likewiſe oval, but the longeſt diameter placed perpendicularly; they can either exclude a bright light altogether, or admit only as much as is neceſſary. The pupil of different animals varies in wideneſs, according as the internal organs of viſion are more or leſs acute: Thus cats and owls, who ſeek their prey in the night, or in dark places, (and conſequently muſt have their eyes ſo formed as that a few rays of light may make a lively impreſſion on the retina), have their pupils in the day-time contracted into a very narrow ſpace, as a great number of rays would oppreſs 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 ſame way, when the retina is inflamed, a great number of rays of light would occaſion a painful ſenſation; therefore the pupil is contracted: on the contrary, in dying people, or in a beginning amauroſis, it is generally dilated, as the eyes on ſuch occaſions are very difficultly affected, and as it were inſenſible.

The poſterior part of the choroid coat, which is called *tapetum*, is of different colours in different creatures. For oxen, feeding moſtly on graſs, have this membrane

of

of a green colour, that it may reflect upon the retina all the rays of light which come from objects of that colour, while other rays are abſorbed : Thus the animal ſees its food better than it does other objects. Cats and owls have their tapetum of a whitiſh colour ; and for the ſame reaſons have the pupil very dilatable, and their organs of viſion acute: And we ſhall find, that all animals ſee more or leſs diſtinctly in the dark, according as their tapetum approaches nearer to a 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 ; ſeeing 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 now it does ; for the heads of the greateſt part of quadrupeds are not near ſo heavy as they would at 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. This is prevented in man moſtly by his erect poſture.

The *falx* is not near ſo large in quadrupeds as in man, as they have little occaſion to lie on either ſide, and the two hemiſpheres of the brain are in a great meaſure hindered from juſtling againſt one another in violent motions, by the brain's inſinuating itſelf into the above-mentioned pits.

The ſecond proceſs of the *dura mater*, or *tentorium cerebello ſuper-expanſum*, is conſiderably thicker and ſtronger in moſt quadrupeds than in man; eſpecially in ſuch of them as are very ſwift of foot, as hares and rabbits, and that moſt when they are old. This membrane is generally oſſified, or we find the place of it ſupplied by a bone, that it may the more effectually keep off the ſuperincumbent brain from the cerebellum in their rapid motions, which otherwiſe would be of bad conſequence.

The olfactory nerves are very large, and juſtly deſerve the name of *proceſſus mamillares*. They are hollow, and conſiſt of a medullary and cineritious ſubſtance, and at firſt ſight appear to be the anterior ventricles of the brain produced; but in man they are ſmall, and without any diſcernible cavity. The reaſon of this is pretty evident, if we conſider how this animal's head is ſituated; 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 riſe, and are ſent immediately through the os ethmoides into the noſe. Hence the ancients, thinking they were continued hollow

low into the noſe, believed they were the emunctories of the brain: In the brain of ſheep, which by its firm texture is the beſt ſubject of any for ſearching into the ſtructure of this part, we evidently ſee, that the name of the *ſigmoid 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 anatomiſts, reaching farther backwards, and forwards again under the 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 is 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 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 muſcles of the dog, but only of the particulars wherein they differ from thoſe of the human ſpecies; at the 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 of 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 TEGUMENTS 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

In a dog this is only part of the panniculus carnofus; and therefore is common to the head and rest of the body.

Corrugator fupercilii wanting.

Muscles of the EAR.

The mufcles of the ear of this animal differ confiderably from thofe in the human ear, where little motion feems to have been intended. In a dog, the motions of the ear are free and extenfive; and hence a greater number of mufcles were required: But feveral of thefe are fo fmall, that perhaps it may be fufficient to defcribe two of the principal of them.

Retrahens, a large and diftinct mufcle arifing from the fpinous proceffes of the two or three firft cervical vertebræ, and running over to be fixed to the concha at its lateral and upper part. Its name denotes its ufe.

Erigens, arifes from a ridge on the occipital bone, and runs over by three diftinct flefhy flips to be fixed to the outer part of the ear, and ferving to erect or prick it up.

There are likewife a number of very diftinct mufcles belonging to the internal ear.

Laxator tympani is a fhort mufcle, of an oval form and glandular appearance, lying in a particular cavity of the os petrofum, near the foramen ovale; from the bottom of which it fprings, and is inferted by a very flender tendon into the malleus. The ufe is, as in man, to relax the membrana tympani, by rendering it lefs concave.

Mufculus meatus auditorius. In a dog there are feveral fmall mufcles which come from one of the protuberating cartilages of the concha, and end in another of them; which, by putting them nearer together or farther afunder, may dilate or contract the meatus externus, the better to fit it for different founds.

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Muscles of the EYE.

The mufcles which belong to the eye of a dog are fimilar to thofe in man; but, from the difference of fituation of the head, the dog has an addition of two others not found in the human fpecies.

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 others are. Its ufe is to fuftain the weight of the globe of the eye, and to 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 may be brought to affift any of the four, by caufing one particular portion of it to act at a time.

Mufculus trochleæ proprius is by much the fmalleft mufcle of the eye. It arifes flefhy near the origin of the obliquus major; and foon fends off a flender tendon, which is inferted into the trochlea, to the motions of which it is fubfervient.

Muscles of the FACE.

Nose. The nofe of a dog has no proper mufcle as in the human body; but is moved by mufcles which are common to it and to the reft of the face.

Mouth. The lips of a man are moved by nine pair of mufcles and a fphincter; but a dog has only fix pair and the fphincter.

Levator anguli oris wanting.

Levator labii fuperioris arifes and is inferted in the dog in a manner fomewhat fimilar to what it is in man. Its ufe is to pull up the lip, which the animal does principally in fnarling.

Depreffor labii fuperioris as in man.

Depreffor 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 be naturally 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 inſerted alſo 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-C-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

maſtoid proceſs of the temporal and condyloid proceſs of the occipital bones, 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, in man, ariſes from the ſternum, firſt rib, and clavicle. In the dog, it ariſes, in common, with the ſterno-thyroidæus muſcle, from the cartilaginous extremity of the firſt rib. After running along the neck a ſhort way, it leaves the ſterno-thyroid muſcle, and runs, as in man, to the baſe of the os hyoides.

Omo hyoidæus wanting.

Sterno thyroidæus ariſes in common with the ſterno-hyoidæus.

Chondro-cerato-hyoidæus ariſes from the ſuperior corner of the thyroid cartilage, and is inſerted into the cartilaginous appendix of the os hyoides. Its uſe is to draw theſe bodies cloſer together. In man, this muſcle is wanting.

Stylo-gloſſus, in man, ariſes from the ſtyloid proceſs. In the dog it ariſes from the extremity of the long proceſs of the os hyoides; and therefore ought to be called *hyo-gloſſus.*

Inio cerato-hyoidæus, a very ſhort fleſhy muſcle, ariſing from the head by the ſide of the digaſtric muſcle of the lower jaw; and is inſerted near the extremity of the long proceſs of the os hyoides, which it pulls backwards.

Stylo hyoidæus alter, wanting.

Stylo pharyngæus ariſes from the extremity of the long proceſs of the os hyoides.

Circumflexus, or *tenſor palati*, ariſes from the beginning of the Euſtachian tube; adheres firmly to the ſoft part, where it becomes fleſhy; and afterwards ſends off a tendon which runs over the inner plate of the pterygoid proceſs of the ſphenoid bone. It is inſerted into the palatum molle, and likewiſe joins its

 fellow

fellow on the other ſide, The uſe of this muſcle is to pull the ſoft part of the palate from the poſterior part of the noſtrils, to compreſs the glands of the palate which lie near it. It may likewiſe aſſiſt in dilating the ſoft part of the Euſtachian tube.

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

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. It has the ſame uſe as in man; but its under end being fleſhy, ſerves in ſome meaſure to make up for the

Pyramidalis, which is wanting.

MUSCLES of the MALE PARTS of GENERATION.

The muſcles in general are thicker and ſtronger than in man. The tranſverſalis perinei is wanting, but there is an addition of three or four muſcles which are not found in the human ſpecies.

Tranſverſalis penis, a ſmall but diſtinct muſcle, which ariſes behind the erector penis from a ſmall protuberance at the under and poſterior part of the os pubis. It is inſerted with its fellow into a tendon between the os pubis and penis. This muſcle may aſſiſt in keeping the penis diſtended in time of copulation.

Præputium adducens ariſes from the panniculus carnoſus near the cartilago enſiformis; and runs along the ſide of the linea alba, to be fixed to the lateral part of the prepuce. Its uſe is to bring the prepuce forward over the glans, after an erection of the penis.

Preputium abducens is a ſingle muſcle which ariſes by a ſmall fleſhy belly from the ſphincter ani and accelerator urinæ; at the fore-part of which it runs along the under ſide of the urethra, to be inſerted into the prepuce. Its uſe is to counteract the former muſcle.

Muſculus urethræ ſurrounds that part of the urethra which lies between the proſtate gland and union of the crura penis. Its uſe is to compreſs that part of the mucous glands and urethra which it covers in time of coition.

Muſcles of the *Female Organs of Generation* agree in general with thoſe of the human ſpecies.

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 is made up 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 which are 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, which is conſtantly preſent, 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 by the inſide of the pſoas magnus; part of which

it

it covers and conceals. At laſt it is fixed, as in man, to the brim of the pevis.

MUSCLES ſituated on the THORAX.

Pectoralis major in a dog, differs from that in man, in being divided into three diſtinct parts. The firſt ariſes from the upper part of the ſternum; and, paſſing over the third, is inſerted under it by a ſtrong broad tendon into the whole length of the external and fore-part of the os humeri. The ſecond ariſes from the under end of the ſternum and cartilago enſiformis, and covers a conſiderable ſhare of the under part of the next muſcle. It is inſerted partly with the next muſcle, and partly runs down upon the muſcles on the humerus. The third, and by much the broadeſt part, ariſes from the cartilago enſiformis and all the ſternum. It is inſerted into the head of the os humeri.

Subclavius wanting, as the dog has no clavicle.

Pectoralis minor wanting.

Serratus major anticus, ariſes fleſhy from the five poſterior tranſverſe proceſſes of the vertebræ of the neck, tendinous and fleſhy from the ſeven anterior ribs; from the neck it runs obliquely downwards, from the ribs it runs obliquely upwards. It is inſerted into the poſterior angle of the ſcapula internally. It may pull the ſcapula upwards, downwards, and backwards.

Sterno-coſtalis, in a dog, is much larger and ſtronger than in man; of conſequence it may act more powerfully on the thorax.

Longus colli, in a dog, is much more diſtinct in every reſpect than in man, its fleſhy bellies being divided by tendinous lines equal in number to the vertebræ of the neck.

Rectus capitis internus major ariſes by a number of tendinous and fleſhy beginnings from the tranſverſe proceſſes 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.

MUSCLE 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-maſtoideus, a little before it reaches the head is firmly united to the ſplenius muſcle.

Levator ſcapulæ major ariſes fleſhy from the tranſverſe proceſs of the firſt vertebra of the neck, and runs along the

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

Teres minor arifes by a flender tendon, which adheres forwards to the under edge of the infrafpinatus; then it forms a flefhy belly, which paffes obliquely over the beginning of the biceps mufcle, to be inferted into the head of the os humeri.

Deltoides arifes tendinous from almoft all the fpine of the fcapula. That part which comes from the acromion feems to be diftinct 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 fmall mufcle arifing from the upper part of the fuperior cofta fcapulæ by a very flender tendon; which, paffing over the head of the humerus, grows flefhy, and is inferted into the infide of that bone about an inch or more below its neck.

Subfcapularis poffeffes only about three parts of the furface of the fcapula, the ferratus magnus poffeffing the reft.

Befides the mufcles already defcribed, the dog has two others peculiar to himfelf.

Levator humeri proprius arifes from all the fpace between the tendinous end of the maftoid mufcle 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, clofely adhering to fome part of the levator fcapulæ major; and, paffing over the articulation of the humerus, goes ftraight down to its infertion in the fore, and near the under part of the fame bone.

Mufculus ad levatorem acceffortus, arifes from the os occipitis near the infertion of the maftoid mufcle, and unites with the former a little before it reaches the fcapula. Juft above the head of the os humeri, near the termination of the mufcle, there is placed a fmall crooked body, of a cartilaginous nature, tied to the fcapula and top of the fternum by two fmall ligaments; which is all that the animal can be faid to have for a clavicle.

In

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 anternus 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 the heads of the radius and ulna, and has the ſame origin and termination as in man.

Extenſor quintus ariſes by a thin tendon from the inſide of that protuberance into which the ſupraſpinatus of the ſcapula is inſerted; and paſſing under the tendon of the teres major, ends at the inſide of the olecranon.

Palmaris

Palmaris longus wanting.

——— *brevis* wanting.

Flexor carpi ulnaris.—Here we find two diſtinct muſcles. The

Large ariſes from the internal condyle of the os humeri near the edge of the ſinus that receives the head of the ulna, and is inſerted into the carpus. The

Smaller ariſes fleſhy from the olecranon, and runs down by the ſide of the former to terminate with it in the carpus.

Extenſor carpi radialis longior et *brevior*, ſimilar to thoſe in man, but more firmly united together at their origin.

Extenſor carpi ulnaris ſends a tendon to the carpus, which pulls that part out in extenſion, and aſſiſts the animal in running.

Flexor ſublimis perforatus. The openings through the tendons of this muſcle for the paſſage of the next, are much larger and wider than in man, and the tendons terminate without any ſubdiviſion.

Flexor profundus perforans ariſes from the os humeri, radius, and ulna, by three diſtinct heads, which unite, and afterwards ſend off a ſtrong tendon, which ſplits into five ſmall ones; four of which terminate as in man; the fifth is inſerted into the part which correſponds with the thumb.

Extenſor digitorum communis runs to the laſt bone of each toe between the two ligaments that go from the ſecond bone of the toe to the third. The uſe of theſe ligaments is to draw the laſt joint backwards and upwards, and keep it ſuſpended, that the extending tendon may not always be upon the ſtretch.

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 ſends off a tendon obliquely to the extremity of the radius, into which it is inſerted.

Indicator arifes as in man, but is inferted into the laft joint of what correfponds with the fore-finger.

Abductor indicis manus wanting.

Flexor primi internodii wanting.

Extenfor tertii internodii wanting.

Interoffei.——A dog has interoffei mufcles fomewhat fimilar to thofe in man, and they are fix in number; four of which are large, and placed, not between, but in the hollow of the metacarpal bones, and run ftraight down. The other two are very fmall, and run oblique. The large arife tendinous and flefhy from the fuperior part of the metacarpal bones, adhering to the fame in their defcent: at the os fefamoideum of the firft joint, each divides into two tendons; which running obliquely along the fides of the toe, unite infeparably with the tendon of the extenfor near the lower part of the firft bone of each toe.

The firft of the two fmall mufcles belongs to the fore-toe or index. It arifes from the upper part of the os metacarpi medii digiti; and, defcending obliquely, grows tendinous about the firft joint, and terminates near the middle of this bone internally.

The fecond arifes from the os metacarpi of the third toe; and after running obliquely, ends in the infide of the firft bone of the little toe. The ufe of thefe two mufcles is to bring their refpective toes nearer the middle one.

Abductor indicis wanting.

Flexor primi internodii wanting.

Muscles of the INFERIOR EXTREMITIES.

Pfoas magnus.

Pectinalis, from the os pubis, and terminates by a broad and thin tendon at the inner condyle of the femur.

Befides the *triceps adductor femoris*, a dog has a *mufculus parvus in articulatione femoris fitus*, which arifes from the fide of the acetabulum, and is inferted into the

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 paſſing under the ligament ſimilar to that of the tarſus in man. Inſerted into the ends of the toes.

Extenſor brevis digitorum may be ſaid to be two diſtinct muſcles. The firſt ariſes tendinous, the other fleſhy from the os calcis. The firſt ſoon becomes fleſhy, and afterwards ſends off a tendon, which ends in the toe next the great one. The ſecond, or outermoſt, gives tendons to the reſt of the toes.

Flexor brevis digitorum ariſes from the lower part of the

the os femoris, and runs under the gaſtrocnemius, to which it adheres. It afterwards runs over the os calcis, and ſplits into four tendons, which give paſſage to the following muſcle.

Flexor longus digitorum ſplits into five tendons: one runs to the great toe; the reſt run through the tendons of the former to the other toes.

Flexor digitorum acceſſorius wanting.

Extenſor proprius pollicis. Somewhat ſimilar to that in man; but, beſides it, there is a tendon ſent off from the lower part of the tibialis poſticus, which runs along the upper part of this toe, and aſſiſts in extending it.

Flexor brevis pollicis, in this animal, is a thin ſlip ſent off from the flexor profundus.

Abductor pollicis wanting.

Adductor pollicis wanting.

Abductor minimi digiti wanting.

Flexor brevis minimi digiti wanting.

Interoſſei. The hind-foot, like the fore-one, has ſix muſcles, four of which are ſtraight, the other two oblique; and the whole of them ſerve the ſame purpoſe as the interoſſei in man.

MUSCLES peculiar to MAN.

Pyramidalis.
Corrugator ſupercilii.
Compreſſor 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 mufcles of the thumb, excepting one flexor and one extenfor.
All the mufcles of the little finger, excepting the extenfor.
Coccygæus.

Muscles peculiar to the DOG.

Tranfverfalis penis.
Mufculus oculi fufpenforius.
Mufculus trochleæ proprius.
Several mufcles of the ear.
Chondro cerato-hyoidæus.
Inio-cerato-hyoidæus.
Hyo-glottis.
Tympano-palatinus.
Mufculus in fummo thorace fitus.
Levator fcapulæ minor.
Panniculus carnofus.
Levator humeri proprius.
Mufculus ad levatorem acceflorius.
Extenfor 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 ſpecies of quadrupeds we propoſed to conſider, was the ruminant kind, of which we have an example in a cow; and accordingly ſhall take the fœtus of the animal *in utero*, that we may firſt remark ſome things that are peculiar to it in that ſtate, and afterwards proceed to examine its viſcera as a ruminant animal. Firſt, then, as a fœtus.—However, before we begin our inquiry, it may be worth our obſervation, that from the ovarium ſomething eſſentially neceſſary for the production of the fœtus is derived, as well as in the human ſpecies.

The form of a cow's *uterus* differs from the human, in having two pretty large cornua. This is common to it with other brutes; for a bitch has two long *cornua uteri:* But theſe again differ (as being multiparous and uniparous) in this, that in the bitch's cornua the fœtuſes are contained; whereas here there is only part of the ſecundines, being moſtly the allantois with the included liquor. The muſcular fibres of the uterus are more eaſily diſcovered; its internal ſurface has a great number of ſpongy, oblong, protuberant, glandular bodies fixed to it. Theſe are compoſed of veſſels of the uterus terminating here. In an impregnated uterus, we can eaſily preſs out of them a chylous mucilaginous liquor; they are compoſed of a great many proceſſes or digituli, and deep caverns, anſwering to as many caverns and proceſſes of the placenta. Their reſemblance has occaſioned the name of *papillæ* to be given them; and hence it was that Hippocrates was induced to believe that the fœtus ſucked *in utero.* The papillæ are found in all the different ſtages of life, in the various ſtages of pregnancy, and likewiſe in the unimpregnated ſtate. It is not eaſy to determine whether the uterus grows thicker or thinner in the time of geſtation.

tation. The membranes, it is plain, (by the ſtretching of the parts), muſt be made thinner; but then it is as evident, that the veſſels are at that time enlarged, upon which principally the thickneſs of any part depends; ſo there ſeems to be as much gained the one way as loſt the other.

The *os uteri* is entirely ſhut up by a glutinous mucilaginous ſubſtance, that is common to the females of all creatures when with young: by this the external air is excluded, which would ſoon make the liquors corrupt; it alſo prevents the inflammation of the membranes, and the hazard of abortion. By this means alſo the lips of the womb are kept from growing together, which otherwiſe they would certainly at this time do. There are mucous glands placed here to ſecern this gluten, which on the breaking of the membranes with the contained waters make a ſapo that lubricates and waſhes the parts, and makes them eaſily yield. The firſt of the proper involucra of the fœtus is the chorion.

The *chorion* is a pretty ſtrong firm membrane, on whoſe external ſurface are diſperſed a great many red fleſhy bodies of the ſame number, ſize and ſtructure with the papillæ, with which they are mutually indented. They have been called *cotyledones*, from Κοτυλη, "cavity." This is greatly diſputed by ſome as a name very improper; but I think without reaſon, ſince the ſurface that is connected to the papillæ is concave, though when ſeparated it appears rather convex. To ſhun all diſpute, they may be called properly enough *placentulæ*, ſince they ſerve the ſame uſe as the placenta in women. The ſeparation of theſe from the papillæ without any laceration, and our not being able to inject coloured liquors from the veſſels of the glands of the uterus into the placentulæ, ſeem to prove beyond a reply, that there can be here no anaſtomoſes betwixt the veſſels; on their coats run a great number of veſſels that are ſent to the ſeveral placentulæ, on the exter-

external ſide next to the uterus; whereas in creatures that have but one placenta, as in the human ſubject, cats, dogs, &c. the adheſion is ſomewhat firmer: The placentæ are likewiſe joined to the papillæ in the cornua uteri. We ſhall next give the hiſtory of the *allantois.*

This is a fine tranſparent membrane contiguous to the former. It is not a general involucrum of the fœtus in the mother, for it covers only a ſmall part of the amnios. It is moſtly lodged in the cornua uteri. In mares, bitches, and cats, it ſurrounds the amnios, being every-where interpoſed betwixt it and the chorion. In ſheep and goats it is the ſame as in this animal; and in ſwine and rabbits it covers ſtill leſs of the amnios. This ſac 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 veſſels are ſo exceſſively fine and few, that we cannot force an injected liquor farther than the beginning of this coat. This membrane is ſo far analogous to the cuticula, as not to be liable to corruption, or eaſily irritated by acrid liquors. The exiſtence of this membrane in women has been very warmly diſputed on both ſides. Thoſe who are againſt its exiſtence deny they could ever find it; and, allowing it were ſo, allege, that ſince the urachus is impervious, as appears by our not being able to throw liquors from the bladder into it, or *vice verſa*, it cannot ſerve the uſe that is agreed by all it does ſerve in beaſts; and therefore in the human body there is no ſuch thing. But when I conſidered on the other hand, firſt, that there ſeems to be the ſame neceſſity for ſuch a reſervoir in man as in other animals: ſecondly, 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 ſtopped, which urine without this conduit would have fallen into the cavity of the abdomen: fourthly, that midwives have pretended to remark two different ſorts of waters come away at the time of birth: and laſtly, that Dr Littre and Dr Hale have given in this membrane of an human ſubject, with all the other ſecundines curiouſly prepared, the one to the royal academy at Paris, the other to the royal ſociety at London; by which ſocieties their reſpective accounts are atteſted; not to mention Verheyen, Heiſter, Keill, &c. who affirm their having ſeen it; and Mr Albinus, that famous anatomiſt, profeſſor at Leyden, ſhows, as I am told, to his college every year a preparation of it: On all theſe accounts I muſt own, that it ſeemed not improbable to me there was ſuch a membrane in the human body. But in four bodies I purpoſely diſſected, wherein I was aſſiſted by a very accurate anatomiſt, Dr Sinclair, I could not obſerve any ſuch thing. However, my want of ſkill will more probably be doubted, than the truth of relations, ſupported by ſuch authentic vouchers, called in queſtion.

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 veſſels ſpread upon it, the lateral branches of which ſeparate a liquor into its cavity. This is the proper liquor of the amnios: which at firſt is in a ſmall quantity, afterwards increaſes for ſome months, then again decreaſes; 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; 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

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 placentulæ.

Having thus conſidered the ſeveral involucra of this animal in a fœtus ſtate, let us next obſerve the ſpecialities 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 betwixt the right and left auricles. At the edge of the hole is fixed a membrane, which when 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,

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 thro' 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 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 Winflow will not allow as proof. After all, I remain in the common opinion; and that for the following reaſons: Firſt, the pulmonary artery being 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, are returned unto the right auricle, where meeting with the other third from the *foramen ovale*, with it they are 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 race 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 pretty 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 pretty 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

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 ventricles 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 γαϛηρ, *ventriculus*, and κοιλια, 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 into the ſecond; but that might be eaſily determined by making them drink before ſlaughter. The ſecond ſtomach

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 this ſtomach the *millet*. From this it paſſes into the fourth, whoſe names are ενυστρον, *abomaſum*, *caillè*, 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. *Caillè* 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 ſhows 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 remainder ſent out by the anus very little altered. From this different ſtructure

ture 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

eaten a pretty large quantity: after which ſhe lies down, if ſhe can 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 thoſe of a bitch, moſtly as to the form of the cornua uteri, which are here contorted

in

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 ſtraight up in the abdomen, and contain the fœtus themſelves.

The ſituation of the *heart* is pretty 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 they are for the moſt part employed in; 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 have the ſtrongeſt muſcles of their whole body inſerted into their wings; whence by the way we may

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 pretty much; 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 pretty much 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 and necks, ſo as to make the centre of gravity fall upon the feet; and when

when they have occaſion for climbing up a ſteep place, they ſtretch out their heads and necks forward, eſpecially if they are ſhort-legged, the better to preſerve properly the balance of the body. Thus we may obſerve a gooſe entering a barn-door, where generally there is an aſcending ſtep, to ſtretch out its neck, which before was raiſed, and incline its body forwards. This is laughed at by the common people, who aſcribe it to a piece of folly in the gooſe, as if afraid of knocking its head againſt the top of the door.

Carnivorous animals are provided with ſtrong crooked claws for the catching their prey: water-fowls uſe them for ſwimming; and, principally for this purpoſe, have a ſtrong firm membrane interpoſed betwixt the toes. There is a beautiful mechaniſm to be obſerved in the toes of fowls, which is of conſiderable uſe to them. For their toes are naturally drawn together, or bended, when the foot is bended: this is owing to the ſhortneſs of the tendons of the toes, which paſs over them, which is analagous to our heel; and that the toes are ſet in the circumference of a circle, as our fingers are: Hence, when the foot is bended, the tendons muſt conſequently be much ſtretched; and, ſince they are inſerted into the toes, muſt of neceſſity bend them when the foot is bended; and when the foot is extended, the flexors of the toes are again relaxed, and they therefore expanded. This is alſo of great uſe to different kinds of fowls: thus the hawk deſcending with his legs and feet extended, ſpreads his talons over his prey; and the weight of his body bending his feet, the toes are contracted, and the prey is ſeized by the talons. This is alſo of great uſe to water fowls: for had there been no ſuch contrivance as this, they muſt have loſt as much time when they pulled their legs in as they had gained by the former ſtroke; but, as the parts are now framed, whenever the creature draws in its foot, the toes are at the ſame time bended and contracted into leſs ſpace, ſo that the reſiſtance refiſtance made againſt the water is not near ſo great as before: on the contrary, when they ſtretch their foot, their toes are extended, the membrane betwixt them expanded, and conſequently a greater refiſtance made to the water. Again, ſuch fowls as live moſtly in the air, or have occaſion to ſuſtain themſelves on branches of trees in windy weather, and even in the night-time when aſleep, while all their muſcles are ſuppoſed to be in a ſtate of relaxation; ſuch, I ſay, have no more to do but lean down the weight of their bodies, and their toes continue bended without any muſcles being in action; and whenever they would diſentangle themſelves, they raiſe up their bodies, by which their foot, and conſequently their toes, are extended.

The roſtrum, bill, or beak of fowls, is compoſed of two mandibulæ, and, as in quadrupeds, the upper one has no motion but what it poſſeſſes in common with the head. But parrots are an exception to this rule; for they can move the upper mandible at pleaſure: this is exceeding convenient, as it enables them to lay hold of whatever comes in their way. Carnivorous fowls have their beaks long, ſharp, and crooked; the domeſtic fowls, ſuch as the hen-kind, &c. have ſtrong ſhort beaks, commodiouſly fitted to dig up and break their food; the water-fowls, again, have long or very broad ſcoop-like beaks, which is moſt convenient for them. The ſternum of fowls is much larger proportionally than the human, and has a ridge riſing in its middle for the more commodious origin of the muſcles that move the wings. It is alſo leſs 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 muſcles have been loſt, or elſe ſome other muſcles muſt have come in play to keep firm the ſternum; but this additional weight would have been inconvenient for their progreſſion.

What other things are moſt remarkable in the ſtructure

ture of the feveral vifcera, we fhall confider in that common domeftic animal the cock or hen, and afterwards obferve the difference of their vifcera chylopoietica from a carnivorous fowl.

The ANATOMY of a COCK.

THOUGH this kind of birds live upon food fomewhat fimilar to that of man, yet as they have no teeth to feparate or break down this food, we would expect to find fomething to compenfate for the want of teeth, fomething remarkable in the organs of digeftion: we fhall therefore begin with thefe parts.

The *œfophagus* of this creature runs down its neck, fomewhat inclined to the right fide; and terminates in a pretty large membranous fac, which is the ingluvies or crop, where the food is macerated and diffolved by a liquor feparated by the glands, which are eafily obferved every where on the internal furface of this bag. The effect of this maceration may be very well obferved in pigeons, who are fometimes in danger of being fuffocated by the peafe, &c. they feed upon, fwelling to fuch an immenfe bulk in their ingluvies, that they can neither get upwards nor downwards. If it be a favourite fowl, it might be preferved by opening the fac, taking out the peafe, and fewing up the wound.

The food getting out of this fac, goes down by the remaining part of the œfophagus into the *ventriculus fuccenturiatus*, or *infundibulum Peyeri*, which is a continuation of the gullet with more numerous glands, which feparate a liquor to dilute the food ftill more, which at length get into the true ftomach or gizzard, *ventriculus callofus*, which confifts of two very ftrong mufcles covered externally with a tendinous aponeurofis, and lined on the infide by a very thick firm membrane, which we evidently difcover to be a production of the cuticula. This might have been proved in fome meafure *à priori*, from taking notice, 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, excepting the cuticula.—Hence may be drawn ſome kind of proof of what I have ſometimes affirmed concerning the tunica velloſa 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 thoſe creatures take down. 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 rugged little 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 ſo well fed, turn lean for want of theſe ſtones to help their digeſtion. But this was put beyond all diſpute by Mr Tauvry, who gave a ſpecies of metal to an oſtrich, convex on one ſide, and concave on the other, but carved on both; and opening the creatures body ſome time after, it was found, that the carving on the convex ſide was

* Spallanzani 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 aud vegetables.

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: which 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 mechanical 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 pretty 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*, betwixt the orifices; and in thofe creatures who have fuch a ftrong mufcular ftomach, it is a matter of great indifference whether the entry of the œfophagus or pylorus be higheft, provided that the entry from the œfophagus does not allow the food to regurgitate, fince the force of the ftomach can eafily protrude it towards the duodenum. This gut is moftly in the right fide, 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 left, 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 *ſmall guts* 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 betwixt the two folds of the duodenum, and ſends two or three ducts into this gut pretty near the biliary.

The *ſpleen* is here of a round globular figure, ſituated between the liver and ſtomach; and betwixt theſe and the back-bone it enjoys the ſame properties as in other animals, viz. large blood-veſſels, &c. All its blood is ſent into the *vena portarum*, and has a perpetual conquaſſation. 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 obſerve, that it is not proper to that bowel to lie on the right ſide; which

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is ſtill more confirmed by what we obſerve in fiſhes, where the greateſt part of it lies in the left ſide.

The ſhape of their *gall-bladder* is not much different from that of quadrupeds; but is thought to be longer in proportion to the ſize of the animal, and is farther removed from the liver.

The principal difference to be remarked in their *heart*, is the want of the *valvulæ tricuſpides*, and their place being ſupplied by one fleſhy flap.

The *lungs* are not looſe within the cavity of the thorax, but fixed to the bone all the way; neither are they divided into lobes, as in thoſe animals that have a large motion in their ſpine. They are two red ſpongy bodies, covered with a membrane that is pervious, and which communicates with the large veſicles or air-bags that are diſperſed over their whole abdomen; which veſicles ſerve two very conſiderable uſes. The one is to render their bodies ſpecifically light, when they have amind to aſcend and buoy themſelves up when flying, by diſtending their lungs with air, and alſo ſtraiten their *trachca arteria*, and ſo return the air. Secondly, they ſupply the place of a muſcular *diaphragm* and ſtrong abdominal muſcles; producing the ſame effects on the ſeveral contained viſcera, as theſe muſcles would have done, without the inconveniency of their additional weight; and conducing as much to the excluſion of the egg and fæces.

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.

The *trachea arteria*, near where it divides, is very much contracted; and their voice is principally owing to this coarctation. If you liſten attentively to a cock crowing, you will be ſenſible that the noiſe 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 of 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 lacteals indeed, in the ftricteft fenfe, are the lymphatics of the inteftines; and, like the other lymphatics, carry only a tranfparent lymph; and inftead of one thoracic duct, there are two, which go to the jugular veins. In thefe circumftances, it would feem that birds differ from the human fubject, fo far at leaft as we may judge from the diffection of a *goofe*, the com-

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mon 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 upon 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, 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 vein and this ſubclavian one. 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 conſiſt of two large branches, on each ſide of the neck, accompanying the blood-veſſels; and theſe two branches join near the lower part of the neck, and form a trunk which runs cloſe to the jugular vein, and opens into a lymphatic gland; from the oppoſite ſide of this gland a lymphatic comes out, which ends in the jugular vein.

On the left ſide, the whole of this lymphatic joins the thoracic duct of the ſame ſide: but, on the right one, part of it goes into the inſide of the jugular vein a little above the angle; whilſt another joins the thoracic duct, and with that duct forms a common trunk, which opens into the inſide of the jugular vein, a little below the angle which that vein makes with the ſubclavian. This ſyſtem in birds differs moſt from that of quadrupeds, in the chyle being tranſparent and colourleſs, and in there being no viſible lymphatic glands, neither in the courſe 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 ſide of the back-bone, from which there is ſent out a bluiſh-coloured canal running along by the ſide 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 *veſica urinaria*, it was thought by ſome they never paſſed any urine, but that it went to the nouriſhment of the feathers: but this is falſe; for that whitiſh ſubſtance that you ſee their greeniſh fæces covered with, and which turns afterwards chalky, is their urine. Let us next conſider the organs of generation of both ſexes, and firſt thoſe of the male.

The *teſticles* are ſituated one on each ſide of the back-bone; and are proportionally very large to the creature's bulk. From theſe run out the *vaſa ſeminifera*; at firſt ſtraight; but after they recede farther from the body of the teſticle, they acquire an undulated or convoluted form, as the epididymis in man. Theſe convolutions partly ſupply the want of *veſiculæ ſeminales*, their coition being at the ſame time very ſhort: Theſe terminate in the penis, of which the cock has two, one on each ſide of the common cloaca,

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pointing directly outwards. They open at a diſtance from each other, and are very ſmall and ſhort; whence they have eſcaped the notice of anatomiſts, who have often denied their exiſtence. In birds there is no proſtate gland. This is what is chiefly remarkable in the organs of the male.

The *racemus vitellorum*, being analogous to the ovaria in the human ſubject, 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 averſe with reſpect to the ovaria; yet notwithſtanding, by the force of the *orgaſmus venereus*, it turns round and graſps the *vitellus*, which in its paſſage through this duct called the *infundibulum*, receives a thick gelatinous liquor, ſecreted by certain glands. This, with what it receives in the uterus, compoſes the white of the egg. By this tube then it is carried into the uterus. The ſhell 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 inſide; here the egg is completed, receiving its laſt involucrum, and is at laſt puſhed out at an opening on the ſide of the common cloaca. From the teſtes in the male being ſo very large in proportion to the body of the creature, there muſt neceſſarily be a great quantity of ſemen ſecerned; hence the animal is ſalacious, and becomes capable of impregnating many females. The want of the *veſiculæ ſeminales* is in ſome meaſure ſupplied by the convolutions of the *vaſa deferentia*, and by the ſmall diſtance betwixt the ſecerning and excretory organs. The two *penes* contribute alſo very much to their ſhort coition; at which time the opening of the uterus into the cloaca is very much dilated, that the effect of the ſemen on the vitelli may be the greater.

A hen will of herſelf indeed lay eggs; but theſe are

are not impregnated, and yet 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 occular 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 pretty tough, membrane; which, dividing at or very near to the obtufe end of the egg, forms a fmall bag, where only air 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 it is 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 it is fpecifically heavier than the white.

7. The chalazæ are two white fpongy bodies, rifing very fmall from oppofite fides of the membrane of the yolk, but gradually become larger as they are ftretched 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 paffing through the fpherical vitellus, this fphere will

will be compofed of two equal portions, its axis not paffing through its centre; confequently, fince it is heavier than the white, its fmaller portion muft always be uppermoft in all pofitions of the egg.

9. The yellowifh-white round fpot, called *cicatricula*, is placed on the middle of the fmaller portion of the yolk; and therefore muft (by § 8.) always appear on the fuperior part of the vitellus.

10. The cicatricula feems to be compofed of feveral circles of different colours; and, in a fecundated egg, contains the embryo or chick. See Malpighi *.

11. Eggs, whofe obtufe ends are all rubbed over with linfeed-oil, or fuch other fubftances as block up fmall pores, are as fit for bringing forth chickens, when incubated by a hen, as other eggs are.

I did not make the experiment; but can give a voucher, whofe fcrupulous candour, with fincere good wifhes and endeavours for the improvement of phyfic in this place, numbers muft be acquainted with: I mean my father; who befmeared eighteen eggs in the manner mentioned; then having put a mark on them, he fet them, with the like number of other eggs, under three hens, who brought out thirty-fix chickens, not one egg of the whole number failing.

12. After incubation, the *folliculus aëris* is gradually extended; till, near the time of the exclufion of the chick, it occupies, as near as I could judge, fome more than a third of the cavity of the fhell.

13. The extended folliculis does not collapfe, upon being expofed to the preffure of the atmofphere after incubated eggs are opened †.

14. By

* De Ovo Incubat.

† It is fomewhat out of my fphere 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 obferve how this folliculus diftends and keeps ftretched in an exhaufted receiver of an air-pump; to exhauft the air gradually out of the fhell, while it ftands expofed to the atmofphere, both while the folliculus is entire, and after it is broke, obferving always the rifing or falling of the mercurial gage; to confider § 11. and 13.; and to confult Bellini *de mot. cord.* prop. ix. and Hale's Staticks.

14. By incubation the albumen becomes thinner and more turbid, eſpecially on its upper part near to 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 cicutricula 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 betwixt 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 it 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 and guts, but to prove purgative. He muſt unluckily have examined none but ſubventaneous eggs: which is further confirmed by his deſcription of the ſmall particles in the colliquated albumen, that reflect light ſo ſtrongly as the eye cannot bear it; which I ſaw in ſome ſubventaneous eggs, but could not obſerve 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

* De Motu Cord. prop. vi.

† Ibid.

I found the ſucceſs 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 generally coagulate; but after that, it frequently did.

19. Very ſoon after incubation, the volume of the yolk appears increaſed; and, by its riſing then nearer to the upper part of the egg, one may conclude that its ſpecific weight decreaſes.

20. The yolk becomes pale and more fluid for ſome time, eſpecially on the ſide next to the chick, where its bulk alſo ſooneſt increaſes; but afterwards the membranes of the yolk turn firmer and ſtronger, and the liquor in them is leſs in quantity, and becomes more viſcous.

21. As the chick increaſes, the yolk is depreſſed in the middle; and is ſoon brought into a form ſomething like to a horſe-ſhoe, in the middle of which the chick is lodged.

22. The yolk remains freſh and uncorrupted all the time of incubation, and is always coagulable.

23. Not long before the excluſion of the chick, the whole yolk is taken into its abdomen.

24. The whole albumen and vitellus are not conſumed by the chick: for ſome part of the humours of the egg eſcapes through the ſhell, and is not ſupplied by any thing from without; as evidently appears by an egg's becoming ſo much ſpecifically 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

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.

N. 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 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.

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 that the heart is obſerved.

I did not inquire into this fact; but have two very good vouchers for its truth, Harvey ‡ and Malpighius §.

32. The umbilical veſſels gradually diſperſe their

* De Ovo Incubato.

† Malpig. Append. de Ovo Incub. tab. vii.

‡ De Generat. Animal. exercit. 16. and 17.

§ De Ovo Incubato.

branches upon the amnios, upon the vitellus, and upon the membranes of the albumen: The extremities of the much greater number, being immerfed into the white, are extended proportionally as it is colliquated.

33. Near to the end of incubation, the umbilical veffels begin to fhrivel and decreafe, till at the exclufion they are very fmall.

34. The embryo is feen in an egg at firft in form of a fmall worm: then its carina or fpine, with the large prominences, that afterwards fhow themfelves to be the brains and eyes, appear; the other bowels feem hanging from the fpine; the chafm of the mouth difcovers itfelf; the extremities fprout out; the vifcera are gradually covered with the teguments; and at laft the beak, nails, and feathers are feen: after which all the parts become ftronger and firmer, the proportional bulk of the head decreafing.

For the particular times when all thefe changes are thus orderly brought about, confult Fabric. ab Aquapendente, Harvey, and Malpighius.

35. After all the parts of the chick are formed, it is always found lying on its fide, with its neck greatly bended forward, the head being covered with the upper wing, and the beak placed between the thighs.

36. When the fhell is opened after the chick is large and ftrong, it may be feen to bounce and fpurn, fometimes opening its mouth wide, efpecially if it is ftirred or pricked.

37. The mouth, œfophagus, and ingluvies, are always found moift; but never contain any quantity of liquor that can be collected or will run out in drops.

38. The bulbous glandular part of the œfophagus immediately above the ftomach, or what Peyer * calls the *infundibulum*, and the ftomach, are full of a liquor, in the youngeft chick we can diffect, and continue full the whole time of incubation; neither infundibulum nor ftomach having yet got the tendinous firmnefs they have

* Comment. in Anat. Ventricul. Gallin.

have in adults; nor can we obferve the dry pellicle which is fo eafily feparated from thefe parts in hens.

39. This liquor of the ftomach is at firft thin and more watery; afterwards it becomes curdy; and at laft is all in form of a greyifh white mucus, unlefs that fome part of it frequently is coloured yellow or green by a mixture of bile. It always coagulates, by boiling, into a firm yellowifh white fubftance.

40. The quantity of fæces was not large in the great guts of any chickens I opened before exclufion.

41. A little time before the exclufion, the chick may frequently be heard making the fame piping found that hatched chickens make. In three eggs, which were all I opened in this ftate, the beak of the chick had perforated the membrane of the *folliculus aëris*.

42. The fhell at the obtufe end of the egg frequently appears cracked fome time before the exclufion of the chick.

43. The chick is fometimes obferved to perforate the fhell with its beak; but, in thofe I faw tumbling out of the fhell, it was broke off irregularly, at the place where the membrane of the *folliculus aëris* was joined to it.

44. After the exclufion of the yolk is gradually wafted, being conveyed into the fmall guts by a fmall duct, its membranes gradually contract themfelves, and the duct becomes fhorter. On the tenth day after exclufion, the vitellus was no larger than a fmall pinhead, 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.

2 I fhall

* De Mot. Cord. prop. ix.

I ſhall examine the arguments they uſed in proof of this, and then ſhall ſubjoin ſome negative reaſons which they have not taken notice of.

Bellini* has deſcribed the cicatricula, or *ſacculus amnii*, with the chalazæ firſt formed in the back of the hen; to which, according to him, the vitellus is afterwards joined, and the white is acquired as they tumble down the oviduct. He ſays the chalazæ are compoſed of numerous canals, which open into the amnios, and ſend out their roots into the cavity of the yolk, and into the white. It is eaſy to conceive what conſequences may be drawn from this deſcription, by thoſe who aſſert the nouriſhment to be carried by the mouth, viz. That here are direct paſſages into the cavity where the chick is, which can take up the liquors no other way than by the mouth.

The anſwer to this obſervation is the ſame as has been made to the other facts already quoted from this author. I deny that the *ſacculus amnii* is formed before the vitellus; on the contrary, the vitellus is evidently to be ſeen before the cicatricula or chalazæ can be diſcerned. Next, I deny the chalazæ (if they are canals) to have the leaſt communication with the amnios, at any time, or in any ſtate of the egg, otherwiſe than as they 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 chicken, which being covered with feathers, having no mammæ, bladder of urine, or large ſalivary glands, can only ſup-

* De Mot. Cord. prop. 15.

ply 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, ſeeing the liquor in the mouth and crop is in ſuch 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 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 ever any thing like fæces has been ſeen in the crop of chickens, as has been alleged 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

* De Generat. Animal. exercit. 58.

lodging near to the glottis; whereas creatures that breathe cannot allow any fubftance to remain there without danger of the glottis being ftopped, or of fuch fubftances falling down the trachæa, either of which would be of bad confequence; which the creature prevents, by forcing fuch fubftances out of fuch a dangerous fituation.

But, to enforce the negative of the colliquamentum paffing by the mouth, obferve, that there are only three days in which this paffage can moft probably be fuppofed to happen, which are from the 15th to the 18th day of incubation: for before the 15th, the quantity of the *liquor amnii* is increafing, which is no great fign of its being fwallowed; and after the 18th this liquor is not to be feen, (*vid.* § 28.) If, then, the *liquor amnii* were all fwallowed between the 15th and 18th days, the ftomach ought to be fuller at this time, and its contents fhould be thinner, more pellucid, &c. like to the colliquamentum; which I am certain does not happen. Befides, if we fuppofe the power of digeftion fo ftrong as to expel this liquor as faft as it is taken down in thefe three days, it would certainly follow, that this powerful digeftion continuing in the three fucceeding days, while there is no liquor to be fwallowed, the ftomach ought to be quite emptied; which every one who 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 any way 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 eſſay to this ſubject; and therefore I ſhall only deſire the reader to compare the poſture of a chick, and of a hen while ſhe ſwallows liquors, that they may ſee the poſture of the chick's neck to be moſt unfavourable to the ſuppoſition of deglutition being performed; and then ſhall conclude with a very ſhort hiſtory of incubation, aſſigning what I imagine to be the moſt probable reaſons of the ſeveral appearances.

By the heat of the hen, or of ſtoves equal to it, aſſiſted poſſibly by the action of the air contained in the *folliculus aëris* (§ 2. 3. 12.), the albumen becomes thinner, eſpecially where it is moſt expoſed to theſe forces (§ 14.); and the vitellus in the ſame manner becomes ſpecifically lighter (§ 19.), and therefore readily riſes in the white. And as, by being divided into two unequal portions by its axis the chalazæ, it preſents the ſmaller portion to the incubating heat at firſt, (§ 8. 9.); ſo the change in conſequence of incubation being ſooneſt and moſt produced here (§ 20.), and the cicatricula being enlarged at the ſame time, the ſmaller portion of the yolk becomes of the leaſt ſpecifical weight; and therefore is buoyed up to the ſuperior part of the egg; whereby the *folliculus aëris* and membranes of the cicatricula become contiguous when they enlarge (§ 26.), and the vitellus can never be in hazard of compreſſing the tender embryo; and the umbilical veſſels are ſituated ſo as to have their extremities immerſed in the liquors that firſt undergo the proper change, for being imbibed by their orifices, (§ 32.)—The incubation continuing, the white is ſtill more and more colliquated, and the umbilical veſſels are proportionally extended, the veins to abſorb it, and the arteries to throw out any particles that are unfit for the chick till they are farther prepared, but eſpecially 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 exhauſted, its membranes become

come contiguous to the amnios, (§ 15.); and thereby the membranes involving the fœtus, become ſufficiently ſtrong to reſiſt the motions of the chick, when its eaſe or ſafety prompt it at any time to ſpurn.—The powers of incubation above-mentioned, aſſiſted by the pulſation and conquaſſatory motions of the numerous umbilical veſſels ſpread on the yolk (§ 32.), diſſolve that humour more, and render ſome part of it fine enough to be taken up by the ſmall extremities of the umbilical vein, ſome of which penetrate its membrane: by which the liquor at laſt becomes thicker (§ 20.); and the membrane, being in part emptied, will more eaſily yield to the weight of the chick; and is preſſed into the form of a horſe-ſhoe (§ 21.), while the network of veſſels extended on this membrane renders it ſtronger and firmer.—The *folliculus aëris* not only aſſiſts in colliquating the albumen; but, when the humours of the egg come to occupy a leſs ſpace, by eſcaping through the ſhell (§ 24.), and by being changed into the ſolid ſubſtance of the chick, the folliculus enlarging (§ 12.), keeps the chick and humours ſteady, without danger of being diſordered and broke by the motions of the egg.——Branches of the umbilical veſſels being diſtributed 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 becomes 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, 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 deficiences, till the chick is sufficiently confirmed and strong (§ 44.); after which it is no longer the subject of my present inquiry.

After

After having obferved the contents of the abdomen and thorax, we next proceed to examine the parts about the neck and head.

Thefe creatures, as was obferved of fowls in general, have no teeth. Some, indeed, have an appearance of teeth; but thefe are only fmall proceffes or ferræ rifing out from the mandible, without any focket, &c. which would have been needlefs, as they fwallow their food entire. But their *tongue* is made pretty firm, left it fhould be hurt by the fharp points of the grain they feed on. It is of a triangular figure, and pointed before; and as by their depending pofture their meat is in hazard of falling out of their mouths, to prevent this there are feveral fmall pointed papillæ ftanding out upon their tongue and palate, with their points inclined backwards, allowing an eafy paffage 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 nofe, there is only a long narrow rima fupplied with pretty ftrong mufcles, and fuch another fupplies the place of a glottis. The creature has a power of fhutting both at pleafure; and the nature of their food feems not only to exempt them from the hazard of its getting into the nofe or trachea, but its fharp points would hurt an uvula, or epiglottis, if they had any. Hence we fee with what difficulty they fwallow dough or other fort of food that can be eafily moulded into any form. 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.

Their *cranium* is more cellular and cavernous than ours. By this means their heads are light, yet ftrong enough to refift external injuries; for the enlarging the diameter of bones contributes to their ftrength. By this cavernous cranium the organ of fmelling is ſuppoſed to be conſiderably enlarged; and further, ſinging birds, as is obſerved by Mr Ray and Mr Derham, have this 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 has a reſemblance of the *corpora ſtriata* as to give riſe to the olfactory nerves. The whole of it appears to us as imperfect, and we can ſcarce 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 theſe 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 to me to have no foundation but in the author's fancy. I have already owned my ignorance of the uſes of the particular parts of the brain, ſo ſhall not pretend to give reaſons for their being different in different animals; but all 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

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 near 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 betwixt 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, therefore, 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 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 attolens* (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 opake, 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 membrane 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, is, a pretty long 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 one would imagine it gave 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*. This 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 place thereof a tuft of very fine feathers covering the *meatus auditorius*, which eaſily allows the rays of ſound to paſs them, and likewiſe prevents duſt or any inſect from getting in. An external ear would have been inconvenient in their paſſing 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 further 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 conſiſtence: 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

human ear by mufcles. The femicircular canals are very diftinct, and eafily prepared.

The ANATOMY of a CARNIVOROUS BIRD.

WE come next to the birds of prey, and for an example fhall take a ftannel or fmall hawk. The principal difference to be obferved in them, is in their chylopoietic vifcera, which may be accounted for from their different way of life.

Immediately under their clavicles, you will obferve the œfophagus expanded into their *ingluvies*, which is proportionally lefs than in the granivorous kind, fince their food does not fwell fo much by maceration; and for the fame reafon, there is a lefs quantity of a menftruum to be found here.

They have alfo a *ventriculus fuccenturiatus*, plentifully ftored with glands, fituated immediately above their ftomach, which we fee here is thin and mufculo-membranous, otherwife than in the granivorous kind: and this difference, which is almoft the only one we fhall find betwixt the two different fpecies of fowls, is eafily accounted for from the nature of their food, which requires lefs attrition, being eafier of digeftion than that of the other kind; neverthelefs, it feems requifite it fhould be ftronger than the human, to compenfate the want of abdominal mufcles, which are here very thin.

The fame mechanifm obtains in this creature's *duodenum*, that we have hitherto obferved. As being a carnivorous animal; its guts are proportionally fhorter than thofe of the granivorous kind; for the reafon firft given, viz. its food being more liable to corrupt, therefore not proper to be long detained in the body; and for that reafon it has no *inteftina cæca*, of which the other fpecies of fowls have a pair. The difference in their

their wings, backs, 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 made up of different pieces; and theſe are more or leſs diſtinct in different animals. Their feet are ſmall and weak; and they are exceedingly ſlow in motion.

It has neither tongue nor teeth; to make up for which, their 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 paſ-

paſſage in the 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 or 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 in 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 in the right lobe of the liver; the other on the left ſide receives the blood in 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,

phatics, with their common trunks the thoracic ducts; but differs from it in having no obvious lymphatic glands on any part 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 fubclavian.

Into the above-mentioned receptaculum the lymphatics of the ftomach and duodenum likewife enter. Thofe of the duodenum run by the fide of the pancreas, and probably receive its lymphatics and a part of thofe of the liver. The lymphatics of the ftomach and duodenum have very numerous anaftomofes, and form a beautiful net-work on the artery, which they accompany. From this receptaculum likewife (befides the trunk already mentioned, which goes to the right fide) arife two other trunks pretty equal in fize; one of which runs upon the left fide, and the other upon the right fide of the left aorta, till they come within two or three inches of the left fubclavian vein; where they join behind the aorta, and form a number of branches which are afterwards joined by the lymphatics of the left fide of the neck; fo that here a plexus is formed as upon the right fide. From this plexus a branch iffues, which opens into the angle between the jugular and fubclavian vein.

SERPENT AND CROCODILE. The circulation in thefe is fimilar to that of the turtle; but we find only one ventricle. The blood goes from the right auricle to the ventricle which fends 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. Thefe differ from the former animals, in having only one auricle and a ventricle: and befides, the ventricle fends out a fingle artery, which afterwards fplits into two parts; one to fupply the lungs, the other runs to all the reft of the body: from the lungs and from the other parts, the blood returns into the auricle.

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 the tiles of 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 their 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 them 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 anterior nor pofterior 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 their back; but by the reſiſtance theſe fins meet with when inclined to either ſide, they are kept with their backs always uppermoſt.

The beſt account of this matter, we have in the treatiſe before-mentioned, viz. *Borelli de Motum Animalium, cap.* 23.

It may be next obſerved, that theſe creatures have nothing that can be called a *neck*, ſeeing 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 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 bronchi, and the two round bodies ſituated in the poſterior part of the jaws, have a great number of tenterhooks 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 in along with their food in too great quantities to be received into their jaws in deglutition, paſſes betwixt the interſtices of the bronchi and the flap that covers them. The compreſſion of the water on the bronchi is of conſiderable uſe to the creature, as we ſhall explain by and by.

The *œsophagus* in these creatures is very short, and scarcely distinguished from their stomach, seeing their food lies almost equally in both. The stomach is of an oblong figure. There are commonly found small fishes in the stomach of large ones still retaining their natural form; 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* in 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.

What I call *pancreas*, some give the name of *intestinula cæca* to: 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 viscuous 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 in the left-side wholly, 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 none that I know of have 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 con-

consequently must either be secerned 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 subjected 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 somewhat that may give it a conquassation; as in the human subject and quadrupeds, it is contiguous to the diaphragm; in fowls, it is placed betwixt the back bone, the liver, and stomach; in fishes, it lies on the saccus aërius: 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 to 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 another time the male organs can scarce be distinguished from the female; nor is there any proper instrument in the male for throwing the seed into the organs 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 in the small specks wrapped up in a whitish glutinous liquor; these specks are the rudiments of the young frogs, which are nourished in that liquor

 till

* 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.

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 incubated 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 large jaws of other 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 get to obferve their way of copulation, and 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 contained but a quantity of elaftic air. This is the *fwimming-bladder:* it lies clofe to

* Spallanzani has found, that the eggs of frogs, toads, and water mewts, 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.

to the back-bone; and has a pretty ſtrong muſcular coat, whereby it can contract itſelf. By contracting this bag, and condenſing the air within it, they can make their bodies ſpecifically heavier than water, and ſo readily fall to the bottom; whereas the muſcular fibres ceaſing to act, the air is again dilated, and they become ſpecifically lighter than water, and ſo ſwim above. According to the different degrees of contraction and dilatation of this bladder, they can keep higher or lower in the water at pleaſure. Hence flounders, ſoles, raia or ſkate, and ſuch other fiſhes as want this ſac, are found always groveling at the bottom of the water: it is owing to this that dead fiſhes (unleſs this membrane has been previouſly broke) are found ſwimming a-top, the muſcular fibres then ceaſing to act, and that with their bellies uppermoſt; for the back-bone cannot yield, and the diſtended ſac is protruded into the abdomen, and the back is conſequently heavieſt at its upper part, according to their poſture. There is here placed a glandular ſubſtance, containing a good quantity of red blood; and it is very probable that the air contained in the ſwimming-bladder, is derived from this ſubſtance. From the anterior part of the bag go out two *proceſſes* or *appendices*, which, according to the gentlemen of the French academy, terminate in their fauces: In a variety of other fiſhes we find communications with ſome parts of the alimentary canal, particularly the œſophagus and ſtomach. The ſalmon has an opening from the fore end of the air-bag into the œſophagus, which is ſurrounded by a kind of muſcular fibres. The herring has a funnel-like paſſage leading from the bottom of the ſtomach 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, ſeems to be the more probable opinion, as the glandular body is found in all fiſhes, whereas there are ſeveral without this paſſage of communication.

 But

But in ſome fiſhes, as the cod and haddock, I never 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 fiſhes; whence authors too haſtily denied them in all. Theſe creatures have a *membranous diaphragm*, which 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*. It has but one *auricle* and one *ventricle*, becauſe they want lungs, and one great artery. The ſize of the auricle and that of the ventricle are much the ſame; the artery ſends out numberleſs 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 their heads, and ſeem to be all they have 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 ſubjected to an alternate motion and preſſure from the water; and we may here remark, that we have not

found

found any red blood but in places ſubjected to this alternate preſſure. This obſervation will help us in explaining the action of the lungs upon the blood. Over theſe 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 paſſing into their ſtomach: it is owing to theſe flaps coming ſo far down that the heart is ſaid commonly to be ſituated in their heads. The blood is collected again from the gills by a vaſt number of ſmall veins, ſomewhat in the ſame manner as in our pulmonary vein; but inſtead of going back to the heart a ſecond time, they immediately unite, and form an aorta deſcendens without the intervention of an auricle and ventricle. Hence a young anatomiſt 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 conſiderably leſſened when we conſider the manner in which the blood is carried through the liver from the inteſtines in man and quadrupeds. The aorta in fiſhes ſends off branches which ſupply all the parts of the body excepting the gills. From the extremity of thoſe branches the blood returns to the heart ſomewhat in the ſame manner as in the former claſs of animals; only there are two inferior venæ cavæ, whereas the former has but one.

Abſorbent Syſtem in Fiſhes. We ſhall take the Haddock as a general example: for the other fiſhes, particularly thoſe of the ſame ſhape, will be found in general to agree with it.

On the middle of the belly of a haddock, immediately below the outer ſkin, a lymphatic veſſel 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 paſſes between the two pectoral fins; and having got above them, it receives their lymphatics. It then goes under the ſymphyſis of the two bones which form the thorax, where it opens into a net-work of very large lymphatics, which lie close to the pericardium, and almoſt entirely ſurrounds the heart. This net-work, beſides that part of it behind the heart, has a large lymphatic on each ſide, 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 ſends off a large branch from its inſide to join the thoracic duct. After detaching this branch, it is joined by the lymphatics of the thoracic fins, and ſoon after by a lymphatic which runs upon the ſide of the fiſh. It is formed of branches, which give it a beautiful penniform appearance.

Beſides theſe branches, there is another ſet deeper which accompanies the ribs. After the large lymphatic has been joined by the above-mentioned veſſels, it receives lymphatics from the gills, orbit, noſe, and mouth. A little below the orbit, another net-work appears, conſiſting in part of the veſſels above-deſcribed, and of the thoracic duct. This net-work is very complete, ſome of its veſſels lie on each ſide of the muſcles of the gills; and from its internal part, a trunk is ſent out which terminates in the jugular vein.

The lacteals run on each ſide of the meſenteric arteries, anaſtomoſing frequently acroſs thoſe veſſels. The receptaculum into which they enter is very large, in proportion to them; and conſiſts at its lower part of two branches, of which one lies between the duodenum and ſtomach, and runs a little way upon the pancreas, receiving the lymphatics of the liver, pancreas, thoſe of the lower part of the ſtomach, and the lacteals from the greateſt part of the ſmall inteſtines. The other branch of the receptaculum, receives the lymphatics from the reſt of the alimentary canal. The receptaculum formed by theſe two branches lies on the right ſide of the upper part of the ſtomach, and is joined by ſome lymphatics in that part, and alſo by ſome from the ſound and gall-bladder, which in this fiſh adheres

heres to the receptaculum. This thoracic duct takes its riſe from the receptaculum, and lies on the right ſide of the œſophagus, receiving lymphatics from that part; and running up about half an inch, it divides into two ducts, one 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 from the left ſide, 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 confifts of a large trunk that begins from the lower part of the fifh, and as it afcends receives branches from the dorfal 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 pretty much 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 pretty 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 fhall 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 fmell, 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 fhall 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 they have 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 betwixt their

their origin and the orbit, but the one paſſes over the other without any communication; ſo that the nerve that comes from the left ſide of the brain goes diſtinctly to the right eye, and *vice verſa.*

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 itſelf the eye muſt be expoſed to ſeveral injuries, there was a neceſſity 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 digited 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

larly thofe of the fkate kind, have a bag at fome diftance behind the eyes, which contains a fluid and a foft cretaceous fubftance, and fupplies the place of veftibule and cochlea. There is a nerve diftributed upon it, fimilar to the portio mollis in man. They have femicircular canals, which are filled with a fluid, and communicate with the bag: they have likewife, as the prefent profeffor of anatomy here has lately difcovered, a meatus externus, which leads to the internal ear. The cod fifh, and others of the fame fhape, have an organ of hearing fomewhat fimilar to the former; but inftead of a foft fubftance contained in the bag, there is a hard crutaceous ftone. In this kind of fifh no meatus externus has been yet obferved.

The ANATOMY of INSECTS.

AS infects and worms are fo exceedingly numerous, it would be endlefs to examine all the different kinds, nor would it ferve any ufeful purpofe to the anatomift. We fhall therefore be content with making a few general obfervations, and thefe chiefly on the ftructure of their body; leaving the variety of their colour, fhape, &c. to the naturalift. Infects differ from the former claffes, by their bodies being covered with a hard cruft or fcale, by their having feelers or antennæ arifing from their head, and many of them breathing the air through lateral pores. As to the fhape of their bodies, though it fomewhat differs from that of birds, being in general not fo fharp before to cut and make way through the air, yet it is well adapted to their manner of life, The bafe of their bodies is not formed of bone, as in many other animals, but the hard external covering ferves them for fkin and bone at the fame time. Their feelers, befide the ufe of cleaning their eyes, are a guard to them in their walk or flight. Their legs and wings are well fitted for their intended fervice; but the latter vary fo much in diffe-

rent

rent infects, that from them naturalifts have given names to the feveral orders of the clafs. As, firft, the

Coleoptera, or beetle tribe, which have a cruftaceous elytra or fhell, that fhuts together, and forms a longitudinal future down their back.

Hæmiptera—as in cimex, cockroach, bug, &c. which have the upper wings half cruftaceous, and half membranaceous; not divided by a longitudinal future, but incumbent on each other.

Lepidoptera—as the butterfly, have four wings, covered with fine fcales in the form of powder.

Neuroptera—as the dragon-fly, fpring-fly, &c. have four membrenaceous tranfparent naked wings, generally reticulated.

Hymenoptera—as wafps, bees, &c. have four membranaceous wings, and a tail furnifhed with a fting.

Diptera—as the common houfe-fly, have only two wings.

Aptera—as the lobfter, crab, fcorpion, fpider, &c. have no wings.

The ftructure of the Eye in many infects is a moft curious piece of mechanifm. The outer part is remarkably hard, to guard againft injuries; and has commonly a reticular appearance, or the whole may be looked upon as an affemblage of fmaller eyes; but whether they fee objects multiplied before them, has not yet been determined.

Linnæus, and feveral others following him, deny the exiftence of a Brain in thefe creatures. But it is certain, that at leaft a number of the larger kinds, as the lobfter, crab, &c. have a foft fubftance fimilar to the brain, from which the optic and other nerves take their rife; befides, when this fubftance is irritated, the animal is thrown into convulfions: hence we would conclude, that infects have a brain as well as the former claffes, although this is fmaller in proportion to their bodies.

Their

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 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 by ſome has been denied. But late experiments and obſervations ſhow, 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 their like. Thus the ſilkworm, 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, and ſo 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;

mals; and it is only found among thofe infects which form themfelves into focieties, as bees, wafps, and ants: and here thefe eunuchs are real flaves, as on them lies the whole bufinefs of the economy. No hermaphrodites have as yet 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 putrefied fubftances: but a contrary opinion is now more generally adopted; and it is pretty 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 in having no antennæ, and in being furnifhed with tentaculo.

Many of them, particularly thofe without fhells, are remarkably tenaceous 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 vaſcular and nervous ſyſtem, with the parts of generation, which can be diſtinctly ſeen. Some, as the cuttle fiſh, form a kind of connection between fiſhes and worms, in poſſeſſing gills but wanting fins, &c. while others, as thoſe of the loweſt order, or zoophyta, join the properties of the animal and vegetable kingdom together.

The claſs is divided by Linnæus, &c. into the following orders, viz.

Inteſtina—as the earth worm, leech, &c. which are the moſt ſimple animals, being perfectly naked, and without limbs of any kind.

Molluſca—as the naked ſnail, ſea ſtar, cuttle fiſh; which are likewiſe ſimple animals without any ſhell, but they are brachiated or furniſhed with a kind of limbs.

Teſtacea—as the ſnail, oyſter, &c. which have the ſame characters as the former order, but are covered with a ſhell, and include the greater part of what we commonly call ſhell-fiſh.

Lithophyta—as corals, madrepors, &c. which are compound animals fixed upon a calcareous baſe, conſtructed by the creatures themſelves.

Zoophyta—as the ſponge, polypus, &c. Theſe are likewiſe compound animals, furniſhed with a kind of flowers, and having a vegetating root and ſtem.

Some of theſe creatures inhabit the earth, others live on the reſt of the animal or on the vegetable kingdom, and many are found in the hardeſt ſtones; while an innumerable tribe of them live in the waters. In general, they are ſaid to be of the hermaphrodite and oviparous kind; while the loweſt claſs, as the polypi, in a great meaſure reſemble the vegetable kingdom in their manner of growth: but for the propagation of theſe animals, as well as of the others of this claſs, we refer the reader to the various books which have lately been written on natural hiſtory.

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