EXPERIMENTAL INQUIRIES

INTO THE

FORMATION

OF THE

RED PARTICLES OF THE BLOOD.

Sufseju Rajak . 1809

Experimental Inquiries:

PART THE THIRD.

CONTAINING A

DESCRIPTION

OF THE

RED PARTICLES OF THE BLOOD

IN THE

HUMAN SUBJECT and in other ANIMALS;

WITH

An ACCOUNT of the Structure and Offices of the LYMPHATIC GLANDS, of the THYMUS GLAND, and of the SPLEEN:

BEING

The remaining Part of the OBSERVATIONS and EXPERIMENTS of the late Mr. WILLIAM HEWSON, F. R. S. and Teacher of Anatomy.

By MAGNUS FALCONAR,

SURGEON, AND TEACHER OF ANATOMY.

Nullius addictus jurare in verba magistri,
Et verum et veri cupio cognoscere causas. Hor.

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MDCCLXXVII.

TO

WILLIAM BROMFIELD, Esq,

SURGEON TO HER MAJESTY,

AND TO St. GEORGE's HOSPITAL;

AND TO

PERCIVAL POTT, Esq; F. R. S.

AND

SURGEON TO St. BARTHOLOMEW's HOSPITAL,

THE FOLLOWING SHEETS

ARE MOST HUMBLY INSCRIBED,

AS A TRIBUTE OF GRATITUDE AND RESPECT,

BY

THEIR MUCH OBLIGED, AND

VERY HUMBLE SERVANT,

THE EDITOR.

PREFACE.

THE following ſheets compriſe the remaining part of the diſcoveries and experiments of my late friend Mr. WILLIAM HEWSON, in whoſe death the Public ſuſtained an almoſt irreparable loſs; the loſs of a Genius, whoſe ſuperior abilities in his profeſſion, rendered him eminently conſpicuous among his cotemporaries, and I have no doubt, will tranſmit his fame to poſterity, enrolled among the higheſt names of antiquity. But to the men of ſcience of this age, his talents require no commendation from my pen.

UNFORTUNATELY for the world, his death prevented him from completing the work he had begun: the firſt Chapter of this Treatiſe only was written by him, and read in the Royal Society, June 17th and 24th, 1773; which was afterwards publiſhed in the Second Part of the ſixty-third volume of the Philoſophical Tranſactions; and it is much to be lamented, that among his papers we have not found the ſmalleſt note upon the ſubject of the other four Chapters.

Chapters. But a three years acquaintance, during the greateſt part of which the ſtricteſt intimacy and friendſhip ſubſiſted between us, afforded me numberleſs opportunities of diſcourſing with him upon this ſubject, and of making myſelf perfectly acquainted with his ideas; beſides which, as I had the advantage of aſſiſting him in other anatomical purſuits, it was frequently my good fortune to make and repeat many of the experiments; by which means I became not only better acquainted with the doctrine, but alſo perfectly confirmed in my knowledge of its truth.

As far as I can recollect, I have recited the experiments in the order they were made by Mr. HEWSON; but lest I might err, or not represent facts in their true state, I have repeated all the experiments frequently since his death, and have written them circumstantially as they appeared to me. But to make these experiments with the attention and circumspection necessary upon so curious a subject, requires more time than my other employments would permit, on which account I have been obliged to defer the publication of them till this time, when I hope their greater accuracy will in some measure compensate for my delay.

I HAVE chofen to publifh them under the form of Chapters and Sections, for the fake of more precifion for thofe who are not much converfant in anatomy; at the fame time, I flatter myfelf, this method will not be wholly unacceptable to thofe who have made that branch of natural philofophy their particular ftudy: for as the facts are numerous, by this method they will be referred to with much greater facility, and the propriety of the inferences will be judged of the more readily.

To fuch Gentlemen as are not well acquainted with anatomy, the fubject, from the quantity of new matter

matter it contains, may appear obſcure; but as this is a doctrine in which not only the medical part of the world, but Philoſophers in general, are much intereſted, we moſt earneſtly intreat them to ſuſpend their judgment till they have deliberately conſidered all the facts. The inductions will then, I preſume, be thought juſt.

As it is the ultimate end of Philoſophy to inveſtigate truth, ſo it muſt afford the greateſt pleaſure to generous minds to embrace it, in whatſoever form they find it. The Remarks and Criticiſms of ſuch, I ſhall eſteem the greateſt obligations. Some there may be, who having early imbibed prejudices, will find it very difficult to ſhake them off. Others may be very unwilling to believe, that they have erred both in opinion and practice, all the preceding part of their lives. I ſhall at all times eſteem it a happineſs and an honour to remove the doubts of theſe Gentlemen, not ſo much from a wiſh to perſuade by argument, as to convince by demonſtration:

And as many Gentlemen who are not poſſeſſed of glaſſes, may be

deſirous

desirous of seeing the Experiments upon the Blood, I shall at all times be happy in shewing them to such Gentlemen as will do me the favour of calling upon me.

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47. —— 1. Note, *after* inveni *inſert a comma* (,).
3. —— *for* ligatio *read* ligatum.
16. —— *for* vaſſe *read* vaſe.
48. —— *ult.* —— *for* vaſculorum glandula *read* vaſorum glandulæ.
56. —— 7. *for* and by far *read* and in by far.
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EXPERIMENTAL INQUIRIES

INTO THE

FORMATION

OF THE

RED PARTICLES OF THE BLOOD.

CHAP. I.

On the figure and composition of the Red Particles of the Blood, commonly call ed, the Red Globules.

THE red particles of blood in the human ſubject have, ſince the time of Leeuwenhoeck, been ſo generally allowed to be ſpherical, that in almoſt all books of phyſiology they are denominated *red globules.* A few authors, however, have, at different times, doubted whether they were ſpheres, and amongſt the reſt Father de la Torré, whoſe curious obſervations, together with his glaſſes, were preſented to the Royal Society, *anno* 1766.

It is a curious and important fact, that theſe particles are found ſo generally through the animal kingdom, that is, they are found in the human ſpecies, in all quadrupeds, in all birds, in all amphibious animals, and in all fiſh, in which animals they are red, and colour the blood.

The blood even of inſects contains particles ſimilar in ſhape to thoſe of the blood

blood of more perfect animals, but differing in colour.

In water insects, as the lobster and shrimp, these particles are white, in some land insects, as the caterpillar and grasshopper, they appear of a faint green when in the vessels, as I am persuaded from experiments. I have seen them in an insect no bigger than a pin's head, and suspect they exist almost universally through the animal kingdom.

What is so generally extended through the creation, must be of great importance in animal œconomy; and highly deserving the attention of every inquirer into the works of nature. This subject becomes the more interesting, so much reasoning in the theory of medicine being built on the properties of those particles.

It is by the microſcope alone, that we can diſcover theſe particles; and as ſome dexterity and practice is required in the uſe of that inſtrument, there have not been wanting men of character and ingenuity, who, having been unſucceſsful in their own experiments, have queſtioned the validity of thoſe made more fortunately by others. Some have gone ſo far as to aſſert, that no credit can be given to microſcopes; that they deceive us, by repreſenting objects different from what they really are.

These aſſertions, though not entirely without foundation, when we ſpeak of one ſort of microſcopes, are very unjuſtly applied to them all. In compound microſcopes, when the object is viewed through two, or more glaſſes, if theſe glaſſes be not well adapted to the focus of each other, the figure of the object may

may be diſtorted; but no ſuch circumſtance takes place when we view an object through a ſingle lens. All who uſe ſpectacles agree, that the figures of objects appear the ſame through them, as they do to the naked eye. And as the ſingle microſcope has, like the ſpectacle, but one lens between the eye and the object, there is no reaſon to ſuppoſe the one can deceive us more than the other. The compound having a larger field, is more pleaſant than the ſingle microſcope for many purpoſes; but the ſingle ſhould be always preferred by thoſe who wiſh to aſcertain the figures of minute bodies. It was this inſtrument, ſupported on a ſcroll, as delineated by Mr. Baker, (Microſcope made eaſy, Plate 2. Chap. ix.) that has been uſed in theſe experiments, and almoſt all the obſervations were made with *lenſes*, as they are prepared by ſome of our more ſkilful workmen in London. One obſervation only, was made by means of thoſe globules, made of glaſs, which the ingenious Father de la Torré preſented to the Royal Society, and which they were ſo obliging to lend to me. Of theſe globules, two only were fit for uſe, when they came to my hands; *viz.* that which, according to Father de la Torré, magnifies the diameter of the object 640 times, and that which magnifies 1280 times. The *lenſes* of the greateſt magnifying power made in London, are thoſe of $\frac{1}{50}$ of an inch focus; which, even allowing eight inches to be the focal diſtance of the naked eye, magnifies the diameter of the object only 400 times; a power much inferior to what may be obtained by globules, and particularly by that globule, which, according to Father de la Torré, magnifies the dia-

meter

meter 1280 times; and this globule I have uſed in ſome of theſe experiments. But our *lenſes*, though inferior in magnifying power to theſe globules, are much ſuperior in diſtinctneſs. The globules are full of clouds made by the ſmoke of the lamp uſed in preparing them, and the object can be ſeen only through the tranſparent parts of the globules; which makes it difficult to get a ſatisfactory view of it: this, with the trouble of adapting the object to the focus of the glaſs, made me prefer our own *lenſes* for all the experiments mentioned in theſe ſheets, except one; and it is but doing juſtice to the ingenious gentleman above mentioned, to acknowledge, that the greater power of his glaſſes was found, in that experiment, more than to compenſate for their want of diſtinctneſs.

THESE *particles of the blood*, improperly called *Globules*, are in reality *flat bodies*; Leeuwenhoeck and others have allowed, that in fiſh, and in the *amphibia*, they are flat and elliptical, but in the human ſubject and in quadrupeds, almoſt all microſcopical obſervers have agreed in their being ſpherical. When we conſider how many ingenious perſons have been employed in examining the blood with the beſt microſcopes, it will appear wonderful that the figure of theſe particles ſhould have been miſtaken; but our wonder will be leſſened, when we conſider how many obvious things are overlooked, till our attention is very particularly directed to them: and beſides the blood in the human ſubject, and in quadrupeds, is ſo full of theſe particles, that it is with great difficulty we can ſee them ſeparate, unleſs we find out a method

method of diluting the blood. It is to ſuch a diſcovery, that I attribute my ſucceſs in this inquiry; for having examined the blood as it flows from the veſſels of the human body, it appeared a confuſed maſs, notwithſtanding I ſpread it thin on a glaſs, or a piece of talk. It then occurred to me to dilute it, but not with water, for this I knew diſſolved the particles, but with *ſerum*, in which they remained undiſſolved. By the *ſerum* I could dilute it to any degree, and therefore could view the particles diſtinct from each other; and in theſe experiments I found, that theſe particles of the blood were as flat as a guinea. I likewiſe obſerved, that they had a dark ſpot in the middle, which Father de la Torré took for a hole; but upon a careful examination, I found it was not a perforation, and therefore that they were not annular. I next made experiments by mixing theſe particles with a variety of other fluids, and examined them in many different animals, and the reſult of theſe experiments was, that their ſize is different in different animals; as is ſeen in Plate I. where they are repreſented of the ſize they appeared to my eye, when viewed through a lens of $\frac{1}{23}$ of an inch focus; which, allowing eight inches to be the focal diſtance of the naked eye, magnifies the diameter 184 times.

It may not be improper to obſerve here, that the accurate Leeuwenhoeck, not having diluted the human blood or that of quadrupeds, ſo as to ſee theſe particles ſeparate from each other, was thence not qualified to deſcribe them from his own obſervation, as he has done thoſe of fiſh and of frogs, and ſuſpecting a round figure

figure was more fit for circulating in our veſſels, was thence led to ſuppoſe theſe particles ſpherical in the human ſubject. But I ſhall hereafter be able to ſhew from his own words, that it is not his obſervations, but his ſpeculative opinions, or his theory, that differs from what I have diſcovered by theſe experiments.

In Plate I. it appears, that of all the animals which I have examined, the particles are larger in the fiſh called a ſkate; next to a ſkate they are larger in a frog and a viper, and other animals of this claſs: they are ſomewhat ſmaller in the common fiſh, as the ſalmon, cod, and eel. In birds they are ſmaller than in fiſh; in the human ſubject ſmaller than in birds; and in ſome quadrupeds ſtill ſmaller than in the human ſubject. Leeuwenhoeck, ſpeaking of their ſize, ſays,

he

he is confident the red particles of the blood are no larger in a whale, than in the ſmalleſt fiſh *. And others have ſince his time ſaid, they are of the ſame ſize in all animals; but it is evident from comparing their ſize as delineated in the above-mentioned plate, that it differs conſiderably, and that they are not larger in the largeſt animals; for we find that in an ox they are not ſo large as in a man, and ſo far are they from being larger in the whale than in the ſmall fiſh, it appears probable, from comparing their ſize, as delineated Plate I. N° 2. from a porpoiſe which belongs to the ſame genus as the whale, that they are ſmaller in thoſe animals than in fiſh; neither is their ſize inverſely as in the ſize of the animal, for they are as large in an ox, as in a mouſe. The difference in their ſize

* Conſ. Arcan. Nat. p. 220.

ſize therefore depends on ſome other circumſtance than a difference in the ſize of the animal.

As to their ſhape, I have already mentioned, that they are flat in all animals, even in the human ſubject; of which any one may be convinced by repeating the following experiments.

EXPERIMENT I.

TAKE a ſmall quantity of the *ſerum* of human blood, and ſhake a piece of the *craſſamentum* in it till it is coloured a little with the red particles; then with a ſoft hair pencil ſpread a little of it on a piece of thin glaſs, and place this glaſs in the microſcope, in ſuch a manner as not to be quite horizontal, but higher at one end than the other, by which means the

ſerum

ſerum will flow from the higher extremity to the lower; and as it flows, ſome of the particles will be found to ſwim on their flat ſides, and will appear to have a dark ſpot in their middle; others will turn over from one ſide to the other, as they roll down the glaſs. No perſon who ſees them turn over, can doubt of their being flat; he will ſee them, in turning, have all the phaſes that a flat body has; firſt, he will ſee them on one ſide, then riſe gradually on the edge, and turn over to the other ſide. I have in this way ſhewed their figure to a number of curious perſons, and particularly to many ſtudents of anatomy, who have attended Lectures in London within the laſt ſix years. If inſtead of *ſerum* the particles ſhould be diluted with water, containing rather more ſalt than *ſerum* does, or if inſtead of human blood, that of an animal with larger

larger particles be uſed, then they will ſometimes be ſeen not only flat, but a little bended, like a crooked piece of money.

THESE experiments not only prove, that the particles of the blood are flat, and not globular, but likewiſe, by proving that they are flat, they ſhew that they are not fluid, as they are commonly believed to be; but, on the contrary, are ſolid, becauſe every fluid ſwimming in another which is in larger quantity, if it be not ſoluble in that other fluid, becomes globular. This is the caſe when a ſmall quantity of oil is mixed with a larger quantity of water, or if a ſmall quantity of water be mixed with a large one of oil, then the water appears globular; and as theſe particles are not globular but flat, they muſt be ſolid, a circumſtance

that

that will appear ſtill more evident from future experiments.

It is neceſſary to remark, that in a few minutes after the particles are ſpread out on a glaſs, they run in cluſters, and ſtick to each other, and then they appear confuſed.

When one of theſe particles is attentively examined, while ſeparate from the reſt, it appears, as it lies on its flat ſide, to have a dark ſpot in the middle, and round that dark ſpot it is more tranſparent. This dark ſpot was believed to be a perforation, or the particle was ſuppoſed to be a hollow ring, by the ingenious Father de la Torré. But I find from a great number of experiments, that the dark ſpot is a ſolid particle contained in a flat veſicle, whoſe middle only it fills,

fills, and whoſe edges are hollow, and either empty or filled with a ſubtile fluid. This will be evident to every one who will carefully make the following experiments.

EXPERIMENT II.

TAKE a drop of the blood of an animal that has large particles, as a frog, a fiſh, or what is ſtill better, of a toad; put this blood on a thin piece of glaſs, as uſed in the former experiment, and add to it ſome water, firſt one drop, then a ſecond, and a third, and ſo on, gradually increaſing the quantity; and in proportion as water is added, the figure of the particle will be changed from a flat to a ſpherical ſhape. When much water is added, the veſicle will by degrees become thinner and more tranſparent, and will at laſt be diſſolved. When the veſicle has thus aſſumed a ſpherical ſhape, it will roll down the glaſs ſtage ſmoothly, without thoſe phaſes which it had when turning over whilſt it was flat; and as it now rolls in its ſpherical ſhape, the ſolid middle particle can be diſtinctly ſeen to fall from ſide to ſide in the hollow veſicle, like a pea in a bladder. Sometimes indeed, inſtead of falling from ſide to ſide, the ſolid middle particle is ſeen to ſtick to one part of the veſicle; and in proportion as the veſicle, inſtead of being flat, aſſumes a ſpherical ſhape, its longeſt diameter is ſhortened, as might be expected on the ſuppoſition of its being hollow and flat.

After this experiment has been made on the blood of ſuch animals as have large veſicles, it may be made on human blood,

blood, where the water will be found to have the ſame effect; the veſicles will become ſpherical, the diameters of theſe ſpheres will be leſs, than the largeſt diameter of the veſicle in its flat ſtate.

It is remarkable, that more water is in general required to produce this change on the veſicles of the human blood, than on thoſe of frogs, or other amphibious animals; and thoſe of the *amphibia* require ſtill more than thoſe of fiſh, for the ſubſtance of theſe veſicles being thicker, and more coloured in man and in quadrupeds, than in the *amphibia*, is therefore later in being diſſolved in water; and being thinneſt in fiſh, it thence moſt readily diſſolves. Thoſe who are deſirous of repeating theſe experiments, had beſt begin with the blood of toads and frogs, whoſe veſicles are large, and remain ſome time without diſſolving in the water; (when that is uſed with the abovementioned precaution) by which means any one accuſtomed to microſcopical experiments may readily be ſatisfied of theſe curious circumſtances.

From the greater thickneſs of the veſicles in the human ſubject, and from their being leſs tranſparent when made ſpherical by the addition of water, and likewiſe from their being ſo much ſmaller than thoſe of fiſh or frogs; it is more difficult to get a ſight of the middle particles, rolling from ſide to ſide in the veſicle *, which are become round; but with a ſtrong light, and a deep magnifier, I have diſtinctly ſeen it in the

* Theſe experiments were all made with day-light, in clear weather.

human

human ſubject, as well as in the frog, toad, and ſkate.

SINCE water makes theſe particles round, and makes the dark ſpot in their middle diſappear, it is evident, the red particles of the human blood are not perforated; but that dark ſpot is owing to ſomething elſe than a hole, and this is likewiſe confirmed, by obſerving, that although the particle does, in an obſcure glaſs, appear only to have a dark ſpot, which might be ſuppoſed to have a hole, yet with a very tranſparent *lens*, and a good light, after diluting the blood with *ſerum*, that middle part can be diſtinctly ſeen, to be only of a deeper red than the reſt of the veſicle, and thence appears darker.

In these experiments, made by adding water to the blood, the middle particles appear to be less easily soluble in water, than the flat vesicle which contains them; so that a little time after the proper quantity of water has been added, the flat vesicles disappear, leaving their middle particles, which seem to be globular, and very small.

That these red vesicles of the blood, although flat, are not perforated, is evident, likewise, from a curious appearance which I have repeatedly observed in blood that has been kept three days in the summer season, until it was beginning to putrify; the vesicles of this blood being diluted with *serum*, and examined with a *lens* $\frac{1}{50}$ of an inch focus, (but more particularly when examined with M. de la Torre's glass, which by his

his computation magnifies the diameter 1280 times) were found to have become ſpherical, the diameter of theſe ſpheres were leſs than their largeſt diameter when flat, and their external ſurface was corrugated in ſuch a manner, as to make them appear like ſmall mulberries.

I HAVE ſeen the ſame appearance on mixing *ſerum* (that had been kept three days in a warm place, and ſmelt putrid) with freſh drawn human blood: the veſicle aſſumed this globular and mulberry-like appearance. In theſe experiments on human blood beginning to putrify, I have likewiſe obſerved ſome of theſe veſicles break into pieces, without becoming ſpherical, and I have diſtinctly perceived the black ſpot in the centre fiſſured through its middle, another proof that it is not a perforation.

In the blood of an eel, which was beginning to putrify, I have ſeen the veſicle ſplit, and open, and the particle in its centre come out of the fiſſure. As the putrefaction advances, theſe veſicles which had become rough ſpheres, or like mulberries, and thoſe which had been merely fiſſured, each break down into ſmaller pieces: M. de la Torre ſeems to think they have joints, and break regularly into ſeven parts; and Leeuwenhoeck ſuſpected theſe globules, *(as he called them)* were conſtantly made of ſix leſſer globules.

But from obſervations I am convinced there is nothing regular, or conſtant,

ſtant, in the number of pieces into which they break: I have ſeen them fall into ſix, ſeven, eight, or more pieces, by putrefaction; for putrefaction breaks them down in the manner it deſtroys other animal ſolids. I need hardly take notice, that the ſmall pieces into which the veſicles break, are equally red as the veſicle itſelf. The theory of the red globules being compoſed of ſix ſerous ones, compacted together, and the ſerous globules of ſix of lymph, has not the leaſt foundation, and is entirely overthrown by the ſimple experiment of mixing the blood with ſix, or thirty-ſix, times its quantity of water; for the water diſſolving the globules, ought to reduce them to yellow *ſerum*, or colourleſs lymph*; but it does not, on the contrary it is coloured red by theſe

* See Gaubii Pathologia.

particles,

particles, even when ufed in much greater proportion than thirty-fix parts of water to one of blood.

THESE red veficles of the blood have not only been commonly fuppofed globular and fluid, but they have with equal injuftice been imagined to be oily, and more inflammable than the reft of the blood. That they are not oily, is evident from their fo readily diffolving in water, and that they are not more inflammable than the reft of the blood, is manifeft, by burning them after they are feparated from the reft of the blood; which feparation may be effected, by fhaking the *craffamentum* in the *ferum*, fo as to diffufe the particles through it, and then by pouring off the *ferum* when they have fubfided in it: I have feparated them in this manner, and compared their inflammability

mability with that of inſpiſſated *ſerum*, and of dried coagulable lymph, and have not obſerved them more inflammable than the *ſerum*, or the lymph; nor do they melt like oil as ſome have ſuſpected, but burn like a piece of horn. Some authors who have written on the figure of theſe veſicles in quadrupeds, and in the human ſubject, have expatiated on the great advantage of their (ſuppoſed) ſpherical ſhape, in order for their more eaſy circulation; as it is probable that no form is preferable to a ſpherical one for eaſy motion; but as theſe veſicles are evidently not ſpherical, but flat in all animals, we muſt believe that nature has ſome good purpoſe to anſwer by making them of that form.

It has been objected, that notwithſtanding they appear flat out of the body, they may poſſibly be globular in the body while circulating; and it has been ſaid, that it is almoſt inconceivable that ſo many ingenious men ſhould at different times have viewed them through a microſcope, and have concluded them ſpherical, if they be really flat. But however that may have happened, it is a fact, that they are as flat in the body as out of it. Of this I am convinced, by having repeatedly obſerved them, whilſt circulating in the ſmall veſſels, between the toes of a frog, both in the ſolar microſcope, and the more ſimple one abovementioned. I have ſeen them with their ſides parallel, like a number of coins, laid one againſt another.

I HAVE likewiſe in that animal where they are elliptical, ſeen them move with one end foremoſt, and ſometimes with an edge turned towards the eye. I have moreover ſeen them when entering a ſmall veſſel, ſtrike upon the angle between it and the larger trunk, and turn over with the ſame variety of phaſes, that they have when turning over upon a piece of glaſs.

UPON this occaſion, I may remark, that it has been ſaid by ſome microſcopical obſervers, that in paſſing through very ſmall veſſels, they ſeem to alter their ſhape and to be lengthened.

THIS concluſion I ſuſpect has taken its riſe from the obſerver having ſeen them with their edge turned towards his eye, in which caſe they would appear long and ſmall, as if lengthened by compreſſion, eſpecially to one who ſets out with the notion of their being globular.

I have

I have ſeen them, in blood veſſels which would admit only ſingle veſicles, move with difficulty, as if ſtreightened for room, but never ſaw them altered in their ſhape by the action of the veſſels.

If then they really be not globular, but flat, and if water ſo readily alters their ſhape, whence is it, that the *ſerum* has the property of preſerving them in that form, which ſeems ſo neceſſary? becauſe it is ſo general through the animal creation.

It is principally by the ſalts of the *ſerum*, that this effect is produced, as is proved by adding a ſmall quantity of any neutral ſalt to water, when the water is no longer capable of diſſolving thoſe particles, nor does it alter their ſhape

when

when the ſalt is uſed in a certain proportion.

EXPERIMENT III.

If a ſaturated ſolution of any of the common neutral ſalts be mixed with freſh blood, and the globules (as they have been called, but which for the future, I ſhall call flat veſicles) be then examined in a microſcope, the ſalt will be found to have contracted or ſhrivelled the veſicles, ſo that they appear quite ſolid, the veſicular ſubſtance being cloſely applied all round the central piece. In proportion as the ſolution of ſalt is diluted with water, it has leſs effect, and when diluted with ſix, eight, ten, or twelve times its quantity of water, it produces no change in the figure of the veſicles,

veſicles, whoſe flat ſhape can then be ſeen, even more diſtinctly than when mixed with *ſerum* itſelf.

The neutral ſalts, which when diluted with water, have been obſerved to have the effects above deſcribed, are Glauber's ſalt, Epſom ſalt, formed of the volatile alkali and the vitriolic acid, common nitre, cubic nitre, a ſalt made with the volatile alkali and the nitrous acid, as well as the ſalts made with the nitrous acid and magneſia, or with the nitrous acid and chalk, and alſo common ſalt, digeſtive ſalt of Sylvius, and a ſalt made with vinegar and the foſſil alkali. Theſe experiments were ſufficient to convince me, that this property was very general among thoſe ſalts which conſiſt of acid and alkali, and therefore it ſeemed unneceſſary to proſecute

ſecute this inquiry further *. But acids and alkalies have different effects on theſe veſicles from what neutral ſalts have.

The fixed vegetable alkali, and the volatile alkali, were tried in a pretty ſtrong ſolution, and found to corrugate the veſicles, and in proportion as they were diluted, their effects became ſimilar to water alone: but it is not eaſy to find the point of ſtrength where the veſicles would remain unaltered in the ſolution. And here we may obſerve, that ſince theſe veſicles are found to diſſolve ſo readily in water, and not to be diſſolved

* Theſe experiments were made by putting one drop of the ſaturated ſolution of the ſalt into a tea cup, and then adding diſtilled water by a few drops at a time, and to this mixture, the *ſerum* of the blood highly tinged with the red veſicles was added.

in theſe ſolutions of alkali, it is a ſtrong argument againſt their being oily, or ſaponaceous, as they have been ſuſpected.

THE effect of acids are very different. I have tried the vitriolic, nitrous, muriatic, diſtilled vinegar, and the acid of phoſphorus; theſe, when much diluted, have the ſame effect as water in making the veſicle ſpherical, and in proportion as they are leſs diluted, they diſſolve the veſicles, without making them ſpherical as water does. I never could find any point of dilution, where the acids, like the neutral ſalts, produced no change on the figure of the veſicles. This experiment is the more to be attended to, as theſe veſicles have been ſuppoſed to be oily and ſaponaceous, which is improbable, ſince they diſſolve more readily in acids than in alkalies.

SALTS made with earth of alum, and any of the acids, always corrugate thoſe veſicles, unleſs they be much diluted, when their effects are ſimilar to thoſe of water alone; that is, they make the veſicle aſſume a ſpherical ſhape. I could not diſcover any point of ſtrength in theſe ſolutions, where the particles would remain in them, without being changed in their ſhape.

THE ſame was obſerved of ſpirits of wine; ſome of the metalline ſalts, as copperas, ſublimate and Roman vitriol, were tried, and when much diluted, their effects were not different from thoſe of water; but in proportion as the ſolution was ſtronger, they corrugated the veſicles more and more.

URINE when containing much of its ſalts, has effects ſimilar to the *ſerum*, but in proportion as it is weaker, its effects are more like thoſe of water.

THE uſe therefore of thoſe ſalts which enter into the compoſition of the blood, is probably to preſerve the red veſicles in their flat form, for we muſt ſuppoſe ſome advantages attend that ſhape, ſince nature has made uſe of it ſo generally in the blood of different animals. And as both a very ſtrong ſolution of neutral ſalts, and a very diluted one, alters the ſhape of the veſicles, it is probable, nature has limited the proportions of the water, and the ſalts, in our blood.

A DEGREE of latitude in theſe proportions, however, ſeems to be admitted, for

for I obſerved the veſicles equally unchanged, when mixed with a ſolution of ſalts, conſiſting of eight drops of water to one of the ſaturated ſolution. And when added to a mixture of fifteen drops of water, to one of the ſame ſolution: not only the neutral ſalts in the blood are capable of preventing the *ſerum* from diſſolving the veſicles, but the mucilage, or lymph, with which the *ſerum* is ſo much impregnated, ſeems to contribute to the ſame effect.

WHEN the veſicles have been made ſpherical by being mixed with water, if a ſmall quantity of a pretty ſtrong ſolution of a neutral ſalt be added, they are immediately ſhrivelled; a few of them recover their former flat ſhape, but the greateſt part are contracted irregularly into ſmall ſpheres. When theſe veſicles thus recover their ſhape, after having been a ſhort time mixed with water, they are generally more tranſparent, and appear thinner, a part of their ſubſtance having been diſſolved in water; and thence it is more eaſy to diſtinguiſh the little ſolid particle which is contained in them. By this experiment I have had the pleaſure of convincing many curious perſons, of the compoſition of this part of the blood, who were not quite ſatisfied from ſome of the other experiments.

I HAVE mentioned above, and ſhewn in Plate I. that theſe veſicles are of different ſizes in different animals. I have likewiſe obſerved, that they are not all of the ſame ſize in the ſame animal, ſome being a little larger than others, and ſome

diſſolve

diſſolve in water more readily than others.

In the ſame ſpecies of animals, they even differ in ſize in the different periods of life. In a chicken, on the ſixth day of incubation, I found them larger than in a full-grown hen, as it is repreſented in the Plate, and I have found them larger in the blood of a very young viper, than in that of its mother, out of whoſe belly it was taken. I have not however been convinced from experiments, that there is any difference in ſize between thoſe of a child at its birth, and thoſe of an adult perſon.

In the blood of ſome inſects, the veſicles are not red, but white, as may eaſily be obſerved in a lobſter, (which Linnæus calls an inſect) one of whoſe legs being cut off, a quantity of a clear ſanies flows from it; this after being ſome time expoſed to the air jellies, but leſs firmly than the blood of more perfect animals. When it is jellied, it is found to have ſeveral white filaments; theſe are principally the veſicles concreted, as I am perſuaded from the following experiment.

EXPERIMENT III.

If one of the legs of a lobſter be cut off, and a little of the blood be catched upon a flat glaſs, and inſtantly applied to the microſcope, it is ſeen to contain flat veſicles, that are circular, like thoſe of the common fiſh, and have each of them a leſſer particle in their centre, as thoſe of other animals. But there is a curious change produced in their ſhape, by being expoſed to the air, for ſoon after they are received on the glaſs, they are corrugated, or from a flat ſhape are changed into irregular ſpheres, as is repreſented in Plate I. This change takes place ſo rapidly, that it requires great expedition to apply them to the microſcope ſoon enough to obſerve it.

I HAVE obſerved the ſanies or blood of a ſhrimp, by cutting off its tail, and found veſicles in it ſimilar to thoſe of the lobſter; which have been a ſhort time expoſed to the air. But I never could apply the blood, ſo as to ſee them in their flat form; but ſince they change by expoſition

poſition to the air, I conjecture, that like them they are flat in the blood veſſels, but being more ſuſceptible of changes from the contact of air, they were corrugated before I could get them applied to the microſcope.

THE ingenious Leeuwenhoeck has obſerved, that in the blood of a graſs-hopper, its veſicles or globules, as he calls them, are green; I have ſeen the ſame circumſtance in the white cater-pillar, whoſe *ſerum* appeared green when in its veſſels, but when let out from this animal, or from a graſshopper, the colour cannot be diſtinguiſhed.

THE ſmalleſt animal in which I have diſcerned theſe veſicles, is an inſect no bigger than a pin's head, that is ſeen

almoſt

almoſt conſtantly in the river water which we have in London. This inſect, which is a ſpecies of the monoculus, being put into a concave glaſs with a little water, and the rays of the ſun being made to paſs through it, the heart may be ſeen to beat, and the tranſparent blood or ſanies found to have a few veſicles, which appear to move one after the other; being made viſible though tranſparent, by the light paſſing in ſuch a manner, as to be refracted by them.

SINCE ſo ſmall an animal as this, has theſe curious veſicles, equally as the larger and more perfect animals, is it not probable, that they are diffuſed through the whole animal creation? And what is found ſo generally amongſt animals, muſt be of great uſe in their œconomy.

As theſe curious veſicles therefore are ſo univerſally found amongſt all animals, and as their ſtructure is in all animals ſimilar, we are naturally led to conclude, that parts ſo complicated cannot be made by a mere mechanical agitation of the chyle in the blood veſſels, or lungs; but that nature has ſet apart certain organs in the body for their formation. And which we ſhall next inquire into,

CHAP. II.

On the Structure of the Lymphatic Glands.

THESE Glands, which by Anatomists are called the *Lymphatic Glands*, and vulgarly known by the name of Waxen Kernels, since the discovery of the Lymphatic vessels by Rudbec and Bartholine (*anno* 1651-2.), have been properly considered as appendages to the Lymphatic System; and though many excellent anatomists since that period, have employed themselves with great

great aſſiduity, and made many curious experiments with a view to complete the diſcovery of this important ſubject; yet the Lymphatic Glands ſeem to have derived fewer advantages from this ſpirit of inquiry, than the other parts of the ſyſtem; their ſtructure and office being unknown, except what relates to their groſs anatomy, and even in that reſpect the beſt anatomiſts are not well agreed. Some ſuppoſe, that each Lymphatic Gland is compoſed of large cells, and others that they are formed of convoluted lymphatic veſſels; and ſome, that the red veins communicate with the lymphatic veſſels in the ſubſtance of the Gland *. But in order to avoid perplexing

* Non raro mihi in repletione vaſorum lymphaticorum mercurii ope occurrit, liquidum hoc penetrabiliſſimum abſque extravaſatione ex vaſis lymphaticis in venas ſanguiferas tranſiiſſe. Hinc cavam venam inferiorem ex injectione

ing a ſubject of itſelf too intricate, we ſhall paſs over unnoticed, the various opinions

tione in vaſa lymphatica, mercurio plenam inveni nulla interim, ne guttula quidem mercurii per thoracicum ductum, prope inſertionem ſuam ligato in venam cavam ſuperiorem effuſa. Glandulam nempe lumbarem ſemi-ſcirrhoſam, per ductum lymphaticum ex pelvi trans arteriam iliacam adſcendentem, mercurio replevi. Intravit mercurius in glandulam, ejuſque dimidiam partem, inferiorem nempe, pelvi propriorem replevit. Reſiſtentia in glandula inſignis, columnam mercurii in tubulo injectionis octodecim pollicum ſuſtinebat, nec viam in vas glandulæ lymphaticæ excretorium, mercurius pandere ſibi valebat.

Preſſione itaque digiti denique mercurium in ductus glandulæ minores, per vas lymphaticum glandulæ inſertum adegi. Senſi diminutionem fluentis, et fugam ex vaſſe glandulam intrante, attentus exſpectabam majorum ex glandula ſurſum exporrectorum ductuum lymphaticorum intumeſcentiam, ſed ſpe mea fruſtratus, eleganti ſpectaculo, minutiſſimos mercurii globulos, in venam ex glandula ad venam inferiorem cavam euntem elapſos, hujus ramulos ad truncum uſque expandentes vidi. Per venam hanc, trunco venæ cavæ in ſuperficie ſua exteriori ſub exitu ſpermaticæ dextræ inſertam, mercurius omnis, per vas lymphaticum ad glandulam advectus, et via quidem magis aperta, ſola ponderis mercurii preſſione, facili demum negotio in venæ cavæ truncum tranſiit ut brevi tempore magna liquidi hujus copia truncum venæ opinions advanced by different authors who have written on this ſubject, and endeavour to deſcribe their ſtructure and uſes, from the ideas and experiments of the ingenious author of the ſubſequent diſcoveries; and as the anatomy of many parts is to be maturely conſidered, before we can reaſon on the functions of any one of them (from the mutual depend-

venæ cavæ intraverit, trunculis lymphaticis ſuperioribus, ex glandula exeuntibus, plane vacuis.

Anaſtomoſin in glandulis hiſce lymphaticis conglobatis, inter vaſa minora glandulæ tortuoſa lymphatica ipſa ac venam glandulæ ſanguiſeram intercedere, nemo vix unquam cogitaſſet.

Attamen adeſſe immediatam inter vaſa lymphatica et minimos venæ glandularum conglobatarum ramulos anaſtomoſin, nullum amplius poſt has obſervationes meas dubium reſtat. Mercurius enim, in globulos minimos diviſus, ductu continuo ex vaſis lymphaticis glandulæ in venæ ramulos tranſiit, nullum præterea in glandula extravaſatum aderat, nec liquidum ponderoſum, uti mercurius, in reſorbentia vaſcula alia ratione intrare potuiſſet, niſi per anaſtomoſin ſive inoſculationem, extremitatum vaſculorum glandula immediatam atque continuam.

ance they have on each other) we ſhall firſt deſcribe their ſtructure, and afterwards inquire into their uſe.

SECT. I. A LYMPHATIC gland, in ſize and ſhape, is commonly compared to a ſmall acorn; though I think it more generally reſembles the figure of a kidney bean, being oblong, rounded at the extremities, and a little flattened on the upper and under ſides, particularly in the uninjected ſtate. But independent of any change produced by injection, we obſerve great variety in the ſize and figure of the lymphatic glands in different bodies, and in different parts of the ſame body. In ſome they are large and round, in others ſmall and flat, and in every cluſter of theſe glands, this difference in ſhape and ſize is obſervable. Vid. Plate II.

IN females they are generally ſmaller than in males, and are always conſiderably leſs in proportion before the time of puberty than after it.

SECT. 2. THESE glands are diſperſed in the courſe of the lymphatic veſſels, in different parts of the body, and through them the lymphatic veſſels paſs. Their various ſituations have been already ſo accurately delineated by Mr. Hewſon *, that a repetition would be tedious and unneceſſary.

* Hewſon on the Lymphatic Syſtem, Vol. II. Plates I, II, III, IV.

SECT.

SECT. 3. EACH gland is a congeries of tubes, consisting of arteries, veins, lymphatic vessels and nerves, connected by the cellular substance; the whole forming a circumscribed apparatus for the purpose of secretion. The cellular substance surrounding the gland is a little condensed, and forms what has been called, but improperly, its *capsula*. For though we consider the cellular membrane to be the common connecting medium of all the parts of the body, yet we cannot allow of its forming a peculiar coat to any part; since it cannot be separated from those lymphatic glands, without destroying the texture of them.

SECT. 4. THE branches from the aörta supply the lymphatic glands with blood, in common with all other parts of the body. In general two or three small branches enter each of theſe glands at different parts, and theſe branches ramiſy to exceeding minuteneſs throughout the whole gland, and their correſponding veins return the blood into the adjacent venous trunks.

SECT. 5. THE nerves in their courſe give off extremely ſmall twigs to the lymphatic glands, but not modified to convey an acute ſenſation; for theſe glands, unleſs in a ſtate of inflammation, are very little ſenſible.

SECT. 6. BESIDES arteries, veins, and nerves, every one of theſe glands has a number of ſmall lymphatic veſſels. They are no where to be found, but in the courſe of the larger lymphatic veſſels, which in their paſſage from the extreme parts

parts of the body, towards the thoracic duct, enter and paſs through the lymphatic glands in the following manner.

SECT. 7. ABOUT a quarter of an inch before a lymphatic enters a gland, it divides into two, three, or four ſmaller branches, ſometimes into a greater number. Theſe enter the gland at the part fartheſt from the thoracic duct, and are then ſubdivided into branches, as ſmall as the ramifications of the arteries and veins before deſcribed, and which they accompany to every part of the gland. After being thus minutely divided, they reunite and gradually become larger, as they approach the oppoſite ſide of the gland, forming three or four branches, which are joined by other lymphatics, that ariſe from the cells of the gland. All theſe branches unite together, about a quarter of an inch from that part where they come out of the gland, and form a common trunk, but larger by the additional lymphatic veſſels, it receives from the cells of the gland. See Plate II. Fig. 3.

SECT. 8. SOMETIMES only one lymphatic veſſel, and ſometimes three or four of them, paſs through the ſame gland, in the manner deſcribed above; and theſe either paſs through other glands in the ſame way, or continue their courſe on to the thoracic duct. Vide Plate II. Fig. 1. Sometimes we obſerve, a ſingle lymphatic paſs by all the glands, without entering any one of them, and continue on to the thoracic duct. This obſervation may perhaps account for the venereal, variolous, or other poiſons, being ſometimes taken into the habit, without inflaming

flaming a lymphatic gland in its paſſage.

SECT. 9. IN Sect. 3. we ſaid, that each lymphatic gland is a congeries of veſſels; and in Sect. 7. we obſerved, that ſome lymphatic veſſels aroſe from the cells of the gland: but here we do not mean thoſe appearances which have been called cellular *, (and that are in reality only little eminences, formed by the bending of one veſſel round another) but other cells which really do exiſt in the ſubſtance of the gland, and are ſo very ſmall as to become viſible only by the aſſiſtance of the microſcope.

IF we inject † a lymphatic gland with mercury, or inflate it with air, an irre-

* M. de Haller. Elem. Phyſiolog. tom. i. page 183.
† Vide Plate V. Fig. 3.

gular appearance is produced, very much resembling cells; and if a gland prepared in this manner, is dried and cut through, at first sight it looks like a honeycomb, but if we examine it more attentively, we shall find this cellular appearance evidently made of convoluted vessels, and by far the greater part of lymphatic glands, that we prepare, the subdivision of the lymphatic vessels into smaller and smaller branches, and not into cells, is apparent to the naked eye. Vide Plate II. Fig. 3, and 4.

SECT. 10. THE cellular appearance in the lymphatic glands is, I think, probably a deception, which may happen in the following way. The very small lymphatic vessels, are very much convoluted, and running in a serpentine direction one over the other, a part of one vessel

veſſel is covered by that part of another veſſel, which lies over it. This being general, an irregular ſurface is produced, ſo that it looks like a number of ſmall globules, or very ſmall pin heads; (vide Plate II. Fig. 1.) ſimilar to what we obſerve in the *epididymis* when injected with mercury; and that this is really the caſe, I am convinced, from what I have obſerved on the examination of other lymphatic glands, when the veſſels have been leſs convoluted, and where the vaſcular texture has been more evident; for in ſome we can diſtinctly trace the continuity of veſſels through the glands, eſpecially in the more ſimple ones.

SECT. 11. Plate II. Fig. 2. exhibits a lymphatic veſſel A, forming three lymphatic glands: the firſt at B, is a ſubdiviſion of the trunk A, into about nine or ten

ten branches which are convoluted, and form a gland. Theſe unite again, and form the trunk at C, which, aſcending about three inches, divides into about ſix branches, running parallel to each other, and form a lymphatic gland at D, not larger than the trunk of the veſſel, which is the moſt ſimple I have ever ſeen: the branches are again united to form the trunk E; this veſſel then aſcends about three inches further, and divides into two branches F and G; the branch G is continued on where it is joined with other lymphatic veſſels. The branch F is again divided into four veſſels, that are ſubdivided to form the third gland at H, evidently compoſed of ſmall convoluted lymphatic veſſels: theſe veſſels are again united and form the large lymphatic veſſel at I, which paſſes on to com-

communicate with ſome other lymphatic veſſels, not expreſſed in this Plate.

SECT. 12. THIS circumſtance of the lymphatic glands being formed of convoluted lymphatic veſſels, is demonſtrable, not only in this preparation, but alſo in many of the larger and complete glands, particularly in Plate II. Fig. 3, and 4.; and though we have not ſo clear a demonſtration, that every lymphatic gland is a convolution of lymphatic veſſels, or that ſome glands may not have large cells; yet we have this uſeful fact, that a lymphatic gland is not always or neceſſarily compoſed of cells; and as we can prove that ſome, nay many glands, are only convoluted lymphatic veſſels, and as the cellular ſtructure in any is rather doubtful, it is probable that all lymphatic glands are formed of convoluted lymphatic veſſels, and that the appearance of large cells may be a deception, from the circumſtance I have already mentioned; and I am the more confirmed in my opinion that this is the caſe, on taking a more general ſurvey of this ſubject in the animal kingdom; as in the turtle, where the lymphatic glands are wanting; or at leaſt that circumſcribed form of a lymphatic gland, ſo general in the more perfect animals, is not to be found in thoſe of the amphibious claſs.

SECT. 13. IN the meſentery of a turtle, no lymphatic glands are obſervable; yet in this, animal nature does her buſineſs as well, though the apparatus is differently conſtructed. The ſmall blood veſſels in the meſentery of this animal are tranſparent in an unprepared ſtate, and the large veſſels form a network, making

ſeemingly

ſeemingly pretty conſiderable meſhes, but if we inject them, (*i. e.* the veins and arteries) we find this part exceeding-ly vaſcular, and from its tranſparency we can here prove the artery terminating in the vein by continuity of canal (a fact not eaſily demonſtrable in the human body); and if we inject the lymphatic veſſels, we find them very numerous, forming the moſt beautiful network imaginable.

The lacteals come from the edge of the inteſtines upon the meſentery. Part of them aſcend, ſurrounding the blood veſſels, but do not communicate with them. Theſe ſend off lateral branches to the tranſparent part of the meſentery, whilſt others come immediately from the inteſtines to it, where they divide to exceeding minuteneſs, making frequent anaſto-

anaſtomoſes, and gradually becoming larger as they approach the upper angle, where they communicate with the larger branches, and paſs on to the thoracic duct. Vide Plate III.

SECT. 14. THE arteries and veins, are principally ſpread on the coats of the lymphatic veſſels, ſo that we here find the requiſites to form a lymphatic gland; for as we prove, that many of the lymphatic glands in the human body are no more than a congeries of arteries, veins, nerves, and lymphatic veſſels convoluted; it is probable, that all lymphatic glands may be formed in the ſame manner: ſo, perhaps, it may be the ſame thing in nature, or the ſame purpoſes of animal œconomy may be equally well anſwered, whether the parts compoſing a gland (*viz.* arteries, veins, nerves, and lymphatic

phatic veſſels) be circumſcribed in a proper membrane, or ſpread over a larger ſurface. This perhaps will be more fully proved by ſome experiments and obſervations, which I ſhall hereafter publiſh on the minute ſtructure of glands.

SECT. 15. ON cutting into a freſh lymphatic gland, we find it contains a thickiſh, white, milky fluid. Then if we carefully wipe, or waſh this fluid from any part of it, and examine it attentively in the microſcope, we obſerve an almoſt infinite number of ſmall cells, not ſuch as have been before deſcribed, or that have been ſuppoſed to exiſt in the lymphatic glands, but others too ſmall to become viſible to the naked eye, expreſſed Plate IV. Fig. 4.

SECT.

SECT. 16. IF the arteries and veins of a lymphatic gland have been previously injected with a coloured fluid, and a part of the gland be then viewed through the microſcope, we obſerve theſe cells are extremely vaſcular; and it is into theſe cells that the white fluid found in the gland is ſecreted. This fluid is abſorbed by the lymphatic veſſels, which we obſerved Sect. 7. aroſe from the cells of the gland; and is by them, in common with the other fluids, carried into the courſe of the circulation.

SECT. 17. THE lymphatic veſſels therefore, which originate from the cells of the gland, are in the lymphatic glands analogous to the excretory ducts of other glands; and we have the ſame proofs that the lymphatic glands ſecrete this white fluid, and that it is carried from the

the glands by the lymphatic veſſels, that we have of glands in other parts of the body ſeparating different fluids, and having excretory ducts; for if we cut into a lymphatic gland we find a white fluid; and if a ligature be made on the lymphatic veſſel coming from that gland, we find a fluid of the ſame kind contained in thoſe lymphatic veſſels. This is as convincing a proof of the lymphatic veſſels being excretory ducts to the lymphatic glands, and as ſatisfactory, as that the hepatic duct is the excretory duct of the liver. We know the liver ſecretes bile, becauſe we find it in that viſcus; and we know the *ductus hepaticus* is its excretory duct, becauſe we find bile contained in it. The proofs are ſimilar and equally concluſive.

SECT. 18. * The exiſtence of a white thick mucus-like fluid, in the lymphatic gland, has been long generally known to anatomiſts, and is particularly remarked by M. de Haller; but the properties of this fluid ſeem to have been entirely overlooked and neglected.

THIS may perhaps have been owing to the ſame cauſe, that the ſhape of the particles of the blood, till lately, has been ſo little known, viz. the want of diluting this liquor; for if we examine this fluid in the natural ſtate, we find it a homogeneous maſs, diſcovering nothing of its compoſition, or properties. But if we

* Succum glandulis conglobatis ineſſe, album, ſerofum lacte tenuiorem, in juniori potiſſimum animali conſpicuum, id quidem certum eſt. Eum, cremori ſimilem dixit Thomas Wharton, cinerum Malpighius diaphanum Nuckius album Morgagnius, recte et ad naturam, ut puto omnes. Haller, tom, i. p. 184.

dilute

dilute it with a ſolution of Glauber's ſalts in water, or with the *ſerum* of the blood, and view it with a *lens* of the $\frac{1}{23}$ of an inch focus, as formerly mentioned in the experiments on the blood, we then obſerve the following appearance.

SECT. 19. NUMBERLESS ſmall, white, ſolid particles, reſembling in ſize and ſhape thoſe central particles found in the veſicles of the blood, are to be ſeen diſtinctly gliding down on the ſtage of the microſcope, and if we dilute it ſufficiently, we can examine them ſeparately, and view them as diſtinctly as we can the particles of the blood.

SECT. 20. THESE particles found in the lymphatic glands, likewiſe agree remarkably in their properties with the central particles found in the veſicles of the blood, not only as to ſize and ſhape, but alſo in being inſoluble in *ſerum*, or a ſolution of any of the neutral ſalts in water (except putrefaction takes place), and are like the blood ſoluble in water, and in the ſame order. Theſe particles are by the lymphatic veſſels taken into the courſe of the circulation, and mixed with the blood, where they are for a time retained, to be again ſeparated from it, as we ſhall ſee afterwards in our inquiry into the anatomy of ſome other parts.

CHAP. III.

On the Situation and Structure of the Thymus Gland.

SECT. 21. THE term Gland has been given to certain parts of an animal body, that are by nature deſtined to ſeparate fluids of different properties from the general maſs of blood, which are to be applied to the various purpoſes of the animal œconomy, or to be excreted, as being either uſeleſs or hurtful to the conſtitution.

SECT. 22. BUT though the term Gland is properly given only to ſuch parts as are known to perform this office; yet it has alſo been applied to ſome parts whoſe uſes are unknown; becauſe their ſtructure being apparently the ſame with that of Glands (properly ſo called), it has thence been conjectured that their uſes might likewiſe be ſimilar. Thus the Thymus has acquired the name of Gland. In like manner we uſe the terms Thyroid Glands, and *Glandulæ Renales*. For whenever any part receives more blood than is neceſſary for the immediate growth, or nouriſhment of that part, it is concluded *(a priori)* that this blood is to undergo ſome change, or that ſome ſecretion is to be made from it. And for theſe reaſons, the appellation of Gland has been given to the Thymus, the Thyroid, and *Glandulæ Renales*.

SECT.

SECT. 23. The Thymus is ſituated in the ſuperior part of the cheſt, in that ſpace called the anterior *mediaſtinum*; which in the fetus ſtate, and for a few years after birth, is large. The ſhape and ſize of this gland is various; differing in almoſt every ſubject. It is triangular, adapted to the ſpace between the right and left lobe of the lungs. The ſuperior part of the gland ſeldom riſes higher than the upper edge of the firſt bone of the ſternum. Sometimes one and ſometimes two proceſſes of the ſame glandular ſtructure, ariſe from the upper part of the Thymus, and aſcend on the fore-part of the neck, almoſt as high as the *Glandula Thyroidea*; and lies between the *Trachea arteria*, and carotid arteries *; but this is a circumſtance that rarely occurs.

* Hall. tomus, i. p. 115.

occurs. The two ſides of the gland are placed next the lungs, and the inferior part, or baſis of the triangle, extends downwards, (ſometimes much lower than is expreſſed in the Plate) lying on the upper and outer part of the pericardium, to which it is attached by the reticular ſubſtance. The ſuperior and poſterior part of the Thymus lies on that part of the aörta, called *ſinus aörtæ*, which ariſes from the left ventricle of the heart to form the curvature, the fore-part of which and the common trunk of the right carotid and ſubclavian arteries, it generally embraces. The inferior poſterior part is always connected with the upper part of the pericardium.

SECT. 24. THE Thymus receives two ſmall arteries, called *arteriæ thymicæ*; which moſt commonly originate from the

the *ſinus aörtæ*; ſometimes they ariſe from the curvature of the aörta, and I have ſeen ſome inſtances of one ſmall artery coming from the common trunk of the right carotid and ſubclavian arteries, to the upper part of this gland. Beſides theſe, the Thymus receives ſeveral ſmall arterial branches on its fore-part, from the mammary, and other arteries, that ſupply the mediaſtinal ſpace with blood.

SECT. 25. THE veins are always more regular in their termination, and are generally two in number. They open into the trunk of the jugular and ſubclavian veins on the left ſide; of which a part is covered by the ſuperior portion of the Thymus.

SECT. 26. The Thymus is a gland of the conglomerate kind; and like others of that claſs, has no particular centre of ramification for its blood veſſels; but they enter promiſcuouſly at different parts of it. It is formed of a great number of ſmall lobules, or *acini*, united to each other by blood veſſels, and the *tela celluloſa*; and over the whole, giving it greater compactneſs, is a condenſed cellular ſubſtance, which forms a kind of capſula to the gland, and gives it a pretty regular ſmooth external ſurface, except where it is fiſſured into larger lobes. But this capſula is not of that kind we find on ſome other glands, as on the kidneys, &c. which can be readily ſeparated from them. It is nothing more than a coarſer condenſed reticular ſubſtance adhering firmly to all parts of it; from which it cannot be ſeparated, without doing injury to the glandular ſubſtance.

SECT. 27. MANY attempts have been made, by diſſection and other means, to diſcover an excretory duct from this part. For the organization being apparently the ſame in it, as in ſome other known glands, it was but natural to conclude that, ſimilar to them, it alſo ſhould have an outlet. Accordingly, many fruitleſs experiments have been made, and much time employed to diſcover it, but with ſo little ſucceſs, that all attempts of that kind ſeem long ſince to have been given up. Nay, ſome have been led into very unphiloſophical conjectures (viz.) that perhaps it was uſeleſs, or that if it did perform any office, it was ſo obſcurely as to eſcape inveſtigation.

SECT.

SECT. 28. BUT the ingenious author, whoſe experiments we are about to relate, entertained too exalted an idea of nature, to ſuppoſe that any part of the animal frame was uſeleſs, though the ſtructure of ſome parts might be ſo intricate, and their uſes ſo obſcure, as to elude the reſearches of the moſt aſſiduous and ingenious inquirers, into the operations of nature.

SECT. 29. MR. Hewſon, after having made many attempts by diſſection and injections to diſcover the uſe of this gland, with almoſt as little ſucceſs as his predeceſſors, began to employ the microſcope; but microſcopical experiments, in the manner they were then conducted, afforded no other ſatisfaction here than that the blood veſſels were diſtributed in a ſimilar manner to thoſe of the lymphatic

phatic glands; but the external appearance, as well as the minute ſtructure of the Thymus, (ſo exactly correſponding with the ſtructure of other glands) convinced Mr. Hewſon, it muſt have an excretory duct; yet poſſibly it might be ſo ſmall, or the coats ſo tranſparent, that when collapſed in the dead body, it might become almoſt inviſible; though during life, while diſtended with the natural fluid, it might be more readily perceived. Therefore the following experiments were made in order to detect it.

EXPERIMENT I.

SECT. 30. THE ſternum of a half grown dog being removed, a ligature was paſſed round the Thymus; including at the

the ſame time all the neighbouring parts. The animal ſoon died. On examining the parts contained within the ligature, no excretory duct could be found; but a great number of lymphatic veſſels made their appearance, filled with a darker coloured fluid than ordinary *.

As the gland in this dog was ſmall, it was ſuggeſted that the experiment would probably ſucceed better in a larger animal, which gave riſe to the following experiments.

* Ubinam his ſuccus habitet nondum conſentitur, Ex thymi tamen exemplo, maximæ glandulæ crediderim cum Nuckio in areolis cellularum reſidere. Nam in tota thymi glandula ubicunque læſeris exiguo etiam vulnere in eam violationem exprimi poteſt, neque tamen aut manifeſta cavitas reperitur, qua contineatur, neque ex vaſe aliquo effluere videtur, cum et copia eam guttulam ſuperet, quæ ex vaſe non magno inciſo ſperetur, neque ex remotis glandulæ partibus per vaſcula adeo facile in vulnus urgeri poſſet, et denique manifeſto cum ſpuma ex cellulis cavernuliſque exprimatur. Hall. Elem. Phy. tom. i. p. 184.

EXPE-

EXPERIMENT II.

SECT. 31. THE cheſt of a calf being opened, a ligature was paſſed round the lower part of the Thymus, as had been done in the former experiment, and the parts contained within the ligature were taken out. On examining theſe very attentively, a great number of lymphatic veſſels, containing a fluid almoſt ſimilar to chyle, of a white colour, but not quite ſo opaque, were ſeen coming from every part of the gland; one of which was ſo large, that at firſt ſight it had the appearance of an excretory duct; but on a more attentive examination, it was diſcovered to be no other than a large lymphatic

phatic veſſel. The remaining parts were diſſected with all poſſible care, but no excretory duct could be ſeen.

SECT. 32. THE fluid found in the lymphatic veſſels, coming from the Thymus, differing ſo much in colour from what is contained in the lymphatic veſſels of the other parts of the body, was an inviting circumſtance to examine the properties of it, with intent to determine upon what cauſe this remarkable difference in colour depended.

EXPERIMENT III.

SECT. 33. A DROP or two of the fluid found in the lymphatic veſſels, coming from the Thymus Gland, being received

upon

upon a thin piece of glaſs, and examined in a microſcope, with a lens of $\frac{1}{23}$ of an inch focus, it appeared opake, and like a drop of milk. But on diluting it with a few drops of the *ſerum* of human blood, the ſame appearance was exhibited, as was obſerved on examining the fluid found in the lymphatic glands, *(vid.)* a great number of ſmall, white ſolid particles, exactly reſembling in ſize and ſhape the central particles in the veſicles of the blood; or ſuch as are found in the fluid of the lymphatic glands.

EXPERIMENT IV.

SECT. 34. A few drops of the ſame kind of fluid as in the former experiment, were diluted with a ſmall quantity of a ſolution of Glauber's ſalts in water, (as mentioned in experiments on the blood) and on viewing this with the microſcope, the ſame particles were more diſtinctly ſeen than in the preceding experiment, on account of the fluid being more diluted.

SECT. 35. PARTICLES of this ſhape being found in large quantities in the lymphatic veſſels, coming immediately from the Thymus, through the ſubſtance of which lymphatic veſſels ramify to every part, gave reaſon for ſuſpecting that theſe lymphatic veſſels were poſſibly the excretory ducts of the Thymus: and the following experiment proved the conjecture to be well founded.

EXPERIMENT V.

SECT. 36. ON cutting into the ſubſtance of the gland, it was found to contain a white thick fluid *; in moſt reſpects reſembling the fluid found in lymphatic glands, only in larger quantity. A ſmall portion of this fluid being received on a thin piece of glaſs, was diluted firſt with *ſerum*, then with a ſolution of Glauber's ſalt in water, and examined with a microſcope. In both theſe experiments the appearances were exactly the ſame, as we have related in the

* Interiorem ſi rimeris fabricam, in omnibus, quos unquam vidi, fetubus reperies, inciſione facta, quocumque loco viſum fuerit, ut tamen omnino caro glandulæ lædatur, ſuccum lacteolum, frequenter etiam ſanguine tinctum, ejuſque non minimam copiam exprimi poſſe. Preſſa quacunque glandulæ parte ſuccus in vulnus confluit. Eum ſuccum ſtillatitius vini liquor in grumos cogit.
Hall. tom. iii. p. 116.

Experiments third and fourth; namely, numberleſs ſmall particles preciſely correſponding with thoſe found in the lymphatic veſſels, paſſing from the Thymus; and with thoſe found in the fluid of the lymphatic glands.

EXPERIMENT VI.

SECT. 37. A SMALL portion of the Thymus Gland having remained in water a few minutes, in order to waſh the white fluid from its ſurface, was examined with the microſcope, and the cellular appearance was ſeen here as evidently as in the lymphatic gland, which it in every reſpect reſembles.

SECT. 38. FROM theſe experiments we are led to make the following concluſions.

clufions. That one ufe of the Thymus, is to fecrete from the blood a fluid, containing numberlefs fmall folid particles, fimilar to thofe found in the lymphatic glands; and that the lymphatic veffels arifing from the Thymus, convey this fecreted fluid through the thoracic duct into the blood veffels, and thus become the excretory ducts to this gland. That the ftructure and ufes of this gland are fimilar to thofe of the lymphatic glands, to which it may be confidered as an appendage. And that this is the fact, is more probable, from obferving, that the Thymus exifts during the early periods of life only; when thofe particles feem to be moft wanted.

SECT. 39. PROBABLY the Thymus is formed in the human embryo, in the fame proportion with all the other parts of the

 animal.

animal. It appears diſtinctly about the end of the third or beginning of the fourth month from conception. From this period to the time of birth, its ſize is conſiderably increaſed, when it is commonly about the ſize of a ſmall walnut, though not of that figure. In ſome, it is much bigger; but in others, it does not exceed the ſize of a large filberd-nut.

SECT. 40. FROM the time of birth to the end of the firſt year, the gland continues to grow larger, and keeps pace with the general growth of the other parts of the body. From the end of the firſt to the third year, it is neither perceptibly increaſed nor diminiſhed, but preſerves nearly the ſame ſize it had acquired at the end of the firſt year. From the third to the eight, or tenth, it de-

creaſes

creaſes in ſize, and gradually waſting, becomes leſs and leſs till the child has reached to between its tenth and twelfth year, when ordinarily it is perfectly effaced, leaving only a ligamentoſe remains, that degenerates into a kind of reticular ſubſtance. As the gland becomes leſs, the veſſels that ſupplied it with blood for ſecretion diminiſh in proportion, and at length when the gland totally diſappears, theſe, like the umbilical veſſels, being no longer wanted, degenerate into mere ligaments. Sometimes, though very rarely, they continue pervious (but their diameters are exceedingly contracted), and carry blood to the remains of the Thymus, and the Mediaſtinum.

SECT. 41. THIS curious circumſtance of the Thymus being largeſt in the

the earlier periods of life, and becoming gradually leſs, as the animal advances towards maturity, conſtantly takes place in the human ſubject: though the periods, when theſe changes happen, may vary occaſionally; and it is probable, that they do ſo in ſome degree in almoſt every individual. But I have never ſeen an inſtance of the Thymus continuing till the time of puberty. Theſe changes in the Thymus are not confined to the human body. The ſame generally take place in all quadrupeds. The Thymus of a calf, called by butchers, the *neck ſweet-bread*, is not found in the bullock of eight years old; at that age it is entirely waſted, and the ſame change obtains in every other quadruped that I have had an opportunity of examining.

SECT. 42. THE inference naturally drawn from theſe experiments is, that the Thymus is neceſſary to perform an office requiſite in the fetus ſtate, and in the early part of life depending upon reſpiration.

WHAT this office is, we ſhall hereafter endeavour more fully to explain.

CHAP. IV.

On the Situation and Structure of the Spleen.

SECT. 43. IT hath at all times been matter of ſurpriſe among the learned, that a viſcus ſo large, and ſo advantageouſly ſituated as the Spleen is, added to the frequent opportunities of inſpecting it in different ſtates of health, ſhould, notwithſtanding, have its uſes ſo involved in obſcurity, as to elude the reſearches of ſo many ingenious and induſtrious inquirers.

SECT. 44. NOT that the Spleen has at any time been conſidered as uſeleſs, for at different periods a variety of different offices have been aſſigned to it. Among the ancients, the moſt celebrated opinion was, that it made the *atra bilis* or *ſuccus melancholicus*, which they ſuppoſed was carried by the *vaſa brevia* into the ſtomach: but later obſervations have entirely exploded that idea, in ſo much that the very term is almoſt extinct. And we ſhall endeavour to prove, that the more modern opinion, of its producing ſome change on the blood, preparatory to the ſecretion of bile, hath no better foundation in nature.

SECT. 45. BUT it will be unneceſſary to repeat the various opinions that have been entertained at different times reſpecting the uſe of this viſcus. Our preſent

present endeavour will be to describe its situation and structure, and afterwards to inquire into some particulars respecting its use.

SECT. 46. THE Spleen then, forms the superior part of the abdominal *viscera* on the left side; its figure is rather oblong, a little convex on its outer or upper, and a little concave on its inner or lower side; it is placed obliquely in the left hypochondrium, with its convex surface exactly corresponding with the concave or under surface of the diaphragm, to which it sometimes adheres, but is always in contact with it, unless when the left lobe of the liver extends very far over into the left side, and covering the upper surface of the Spleen is interposed between it and the diaphragm; which is sometimes, though very rarely, the case. The inner or con-

cave

cave ſide of the Spleen, from its oblique ſituation, is turned a little downwards, looking at the ſame time towards the ſpine; and to this part a portion of the *omentum* is attached. The edges of the Spleen are not thin like thoſe of the liver, but thick and round, giving a ſpheroidal figure to the whole.

SECT. 47. BUT the Spleen is not uniformly of the figure above deſcribed, ſometimes we find it fiſſured into two or three lobes, almoſt dividing it into ſo many diſtinct ſpleens, and frequently we find the edge of it ſerrated.

SECT. 48. IT is generally a ſolitary viſcus, yet two * diſtinct Spleens have

* Hall. tom. vi. p. 387. Eſt tamen unus tantum quamvis præter naturam duplex quoque nonnunquam obſervatus ſit. Adr. Spigelius de humani corporis fabrica. Cap. xiv. p. 309.

been found in the ſame body, ſometimes three, and ſometimes a cluſter, as it were, of little Spleens; but theſe are extraordinary deviations from the general conformation of the body, and when found, may properly enough be conſidered as ſo many *luſus naturæ.*

SECT. 49. THE ordinary weight of the Spleen is from ſix to ten ounces; in ſome ſubjects it has been found very large, exceeding the weight of five pounds; but as this preternatural enlargement is ever found to be the effect of diſeaſe, ſo from diſeaſe in other caſes, or from ſome cauſe exiſting in the body, it is found conſiderably diminiſhed. One inſtance, I have alſo ſeen of a Spleen not more than one ounce in weight, yet it had the appearance of being perfectly ſound.

SECT.

SECT. 50. FROM the Spleen being in contact with the diaphragm, and not fixed to the sides of the *abdomen*, its situation will be continually varying in the act of respiration, which will occasion much difficulty to determine at all times the exact situation of it.

SECT. 51. A SPLEEN weighing nine ounces most commonly measures about six inches long, and four inches broad.

SECT. 52. IN a well-formed chest, in a state of the deepest expiration, from the cartilaginous margin of the thorax to the highest lateral part of the diaphragm, generally measures about six inches; therefore, supposing this to be the standard in the utmost expirations, the upper end of the Spleen will ascend so high up as the lower edge of the eighth rib, and in this ſtate, the inferior part will be oppoſite to the lower edge of the tenth rib, or the whole of the Spleen will be contained between the eighth and tenth ribs. In the deepeſt inſpirations it never deſcends below the cartilaginous margin of the cheſt, unleſs it be preternaturally enlarged. Thus by attending to the ſtate of reſpiration, we may be able to form a good judgment of the ſituation and extent of this viſcus; but if we wiſh to determine it with greater exactneſs, let the arm be raiſed as high as poſſible, and a line drawn from the inferior angle of the *ſcapula*, parallel to the ſpinous proceſſes of the *vertebræ dorſi*; the whole of the Spleen will be contained within the line drawn, and be found to occupy the ſpace between the eighth and tenth ribs in a ſtate of expiration; but in a deformed cheſt, or the cheſt of a woman whoſe

whoſe ribs are preſſed in by ſtays, it may differ conſiderably. In a woman whoſe ribs had been preſſed in by ſtays, but not more than is ordinarily found, from the cartilaginous margin of the eleventh rib to the centre of the diaphragm, meaſured ſix inches and a half. The Spleen weighed nine ounces two drachms and a half, and meaſured five inches and three quarters in length, three inches and ſeven-eighths in breadth, and one inch ſeven-eighths in thickneſs; the upper edge was oppoſite to the upper edge of the eighth rib, and the lower part was oppoſite to the upper edge of the eleventh rib; thus the whole Spleen in this ſubject was placed between the eighth and eleventh ribs. And this will in females, I fancy, be found to be the general ſtandard.

SECT. 53. THE Spleen has generally been deſcribed of a dark, blueiſh, leaden, or livid colour, and this is the aſpect it commonly wears when we examine it in a body a few days after death, or when putrefaction has taken place; but if we examine it in a human body a few hours after death, or in an animal ſoon after it has been killed, we find it of a deep red, or blood colour, which gradually changes as putrefaction advances. We ſhall therefore conclude, that the colour, which has been generally conſidered as characteriſtical of the Spleen, is no more than the effect of that change which takes place in all animal ſubſtances after life is extinct.

SECT. 54. THE Spleen, in common with all other *viſcera* contained in the cavity of the *abdomen*, hath an external covering

covering from the *peritoneum:* Under the peritoneal coat is a proper *capſula* ſurrounding the whole gland, and to which its tender ſubſtance cloſely adheres.

SECT. 55. THE ſubſtance of the Spleen, particularly if putrefaction hath taken place, is extremely ſoft and tender, readily breaking down under the touch, and exhibiting that appearance called by the Greeks *parenchyma**: and at the firſt ſight, it hath much the appearance of effuſed blood; but many experiments prove that this tender ſubſtance is no other than very ſmall veſſels broken down by putrefaction, and not *parenchyma.*

SECT. 56. ON cutting into the Spleen, many ſmall ligaments are ſeen paſſing

* Quarta denique, *parenchyma* in qua ſanguis effuſus circa venas nulla ſerie diſpoſitas.

Adriani ſpigelii de humani corporis fabrica, 108.

from ſide to ſide of it, and thoſe in quadrupeds being large and interſecting each other, gave riſe to the opinion, that the Spleen was full of large cells into which the blood was thought to have been poured: and theſe cells were ſuppoſed to be demonſtrated by a Spleen prepared in the following manner. An injecting pipe being fixed into the artery or vein of the Spleen of an ox, warm water is injected, and the ſubſtance of the Spleen is kneaded (by which the ſmall veſſels are broken down) with the hand; the bloody water being preſſed out, and with it the ſmall veſſels, freſh water is injected, and this proceſs repeated until the water returns colourleſs; it is then inflated and dried. On cutting into a dried Spleen thus prepared, it exhibits a cellular appearance, which has been called the cells of the Spleen, but although theſe cells are artificial,

artificial, and the ſtructure of the gland is entirely deſtroyed by that mode of preparation; yet we ſhall preſently endeavour to prove, that there are cells, but of a different ſort, exiſting in the ſubſtance of the Spleen.

SECT. 57. THE Spleen is compoſed of arteries, veins, nerves, and lymphatic veſſels, which are diſtributed to every point of it, ſo that it ſeems a mere congeries of veſſels, and conſequently receives a very large quantity of blood; and for that cauſe it has been very properly ſuppoſed to be a gland; and agreeable to that idea, anatomiſts have made every attempt that their invention could deviſe, to diſcover its excretory duct, but without ſucceſs.

SECT. 58. THE *aörta*, whilſt in the cavity of the *abdomen*, gives off from its fore-part three branches: the firſt of theſe, called the cœliac artery, ſprings from the main trunk of the *aörta* as ſoon as it enters the cavity between the two *crura* of the diaphragm; and is immediately divided into three diſtinct branches; the firſt of which is called the conorary artery of the ſtomach, and carries blood to the leſſer curvature of the ſtomach. The ſecond branch, which carries blood to the liver for its nouriſhment, is called *arteria hepatica*. And the third branch, which is that we are now about to trace, is called *arteria ſplenica*, and carries blood to the Spleen.

SECT. 59. THE ſplenic artery, in its paſſage to the Spleen, runs in a *ſulcus* through the whole length of the *pancreas*, and by ſeveral ſmall branches ſupplies that gland with blood for the ſecretion of the *ſuccus pancreaticus*; beſides which, in its courſe nearer toward the Spleen, this veſſel alſo gives off four other arterial branches, called *vaſa brevia*, which are diſtributed to the greater curvature of the ſtomach, and the laſt of theſe going near the left extremity of the greater curvature, is called *gaſtrica ſiniſtra*. The trunk of the artery then paſſes on to the Spleen, and is divided into five or ſix branches, which enter the concave ſide at the *ſulcus* or ſinuoſity, of the Spleen, and as ſoon as they have paſſed through the *capſula*, are divided into exceedingly ſmall twigs, which are diſtributed to every point of the gland. The arteries, thus minutely divided, tranſmit the redundant blood to the veins, which becoming larger as they approach nearer to the ſinuoſity of the

 Spleen,

Spleen, at length paſs out in branches, which every where accompany the arteries that entered it; theſe branches uniting form the ſplenic vein, *the blood of which will not coagulate by expoſition to the air, like other venous blood.* The trunk of the vein then attends that of the artery, receiving veins from the ſtomach and *pancreas*, which correſpond with the branches given off by the artery; the vein then paſſing on joins other veins from the inteſtines, *&c.* which tranſmit their blood by the *vena portarum*, to the liver, for the purpoſe of ſecretion.

SECT. 60. LYMPHATIC veſſels in great numbers may be diſtinctly ſeen running every where on the external ſurface of this gland; in ſo much that the Spleen of a calf has ordinarily been choſen on which to demonſtrate the lymphatic veſſels;

veſſels; and they are alſo as numerous in the internal ſubſtance as on the external ſurface, which we can prove in fiſh, whoſe lymphatic veſſels are without valves, ſo that we can inject them from trunk to branch. Now if we fill the lymphatic veſſels coming from the Spleen of a fiſh with a red injection, we can colour the gland as highly as if it had been injected by the artery or vein; hence it is evident, that the lymphatics are co-extended with the blood veſſels to all parts of this gland.

SECT. 61. IN the human body, the lymphatic veſſels paſs through ſome lymphatic glands which are ſituated near the ſinuoſity of the Spleen, from whence they paſs on towards the thoracic duct, into which they empty themſelves.

SECT. 62. THE nerves infervient to the Spleen are branches from the *par-vagum*, and intercoftal nerves, which form a *plexus* called the fplenic; thefe enter the finuofity with the blood veffels, and attend them through their minuteft ramifications.

SECT. 63. THUS we have fhewn that the Spleen is extremely vafcular; in fo much that when injected it appears a mere congeries of veffels, and that the quantity of blood circulating through it is very confiderable.

SECT. 64. IN Section 56, we faid, that there are cells in the Spleen, but not of the kind commonly fuppofed to have been demonftrated in Spleens prepared as there defcribed; but although we deny the exiftence of fuch large cells (which

are

are no other than what may be called the ſkeleton of a Spleen, made by deſtroying its minute ſtructure) yet we aſſert, that there are innumerable cells diſperſed throughout the whole ſubſtance of the Spleen, but they are ſo very ſmall as to be diſcovered only by the aid of a microſcope: theſe may be ſeen in the following manner.

SECT. 65. TAKE a ſmall thin piece of a Spleen that has been minutely injected (*i. e.* the arteries and veins completely filled with a coloured injection), ſteep it a day in clean water, changing the water frequently, upon examination of this with a *lens* $\frac{1}{15}$ of an inch focus, an almoſt infinite number of cells may be diſtinctly ſeen: the round figure of which, as well as their great regularity, ſufficiently diſtinguiſhes them from the irregular

irregular interſtices of the reticular ſubſtance. The ſize and ſhape of theſe cells ſo nearly reſemble thoſe we have before deſcribed in the lymphatic glands, that a tolerably accurate idea of them may be obtained by referring to Plate IV. Fig. 3. The ultimate branches of the arteries and veins are ſo diſtributed, as to form a moſt beautiful net-work of blood veſſels upon each particular cell, and we ſhall render it probable, that the extreme branches of the arteries form a ſecretion into theſe cells.

SECT. 66. MR. HEWSON, in the beginning of his inquiries after the excretory duct of the Spleen, was not more ſucceſsful than his predeceſſors had been; but having obſerved that the lymphatic veſſels were the excretory ducts of the lymphatic glands, and alſo, that the lymphatic

phatic veſſels of the Thymus performed the office of an excretory duct to that gland, he was led, from this circumſtance, to conjecture that the great number of lymphatic veſſels found in the Spleen, might poſſibly be intended to return the ſecreted fluid from it, and thereby become in effect its excretory duct. In order to diſcover if his conjectures were well founded, the following experiments were made.

EXPERIMENT I.

SECT. 67. A DOG was opened alive, and after a ligature had been paſſed round the ſplenic veſſels, the whole Spleen was cut out.

SECT. 68. ON examination of the lymphatic veſſels upon the ſurface of the Spleen, they were found very turgid, and the fluid contained in them appeared of a much darker colour than he had obſerved in any other lymphatic veſſels; on puncturing one of the largeſt of theſe veſſels, a ſmall quantity of the fluid it contained was received into a tea-cup, which was red, and coagulated ſoon after being expoſed to the air.

SECT. 69. MR. HEWSON ſoon diſcovered, that a dog was an unfavourable ſubject on which to make this experiment completely, becauſe, in that animal, the ſplenic blood veſſels, both arteries and veins, are divided into many branches, which enter the Spleen at ſome conſiderable diſtance from each other. Therefore the following experiment was made.

EXPE-

EXPERIMENT II.

SECT. 70. As ſoon as a bullock was killed, and the *abdomen* opened, a ligature was paſſed round the ſplenic veſſels, (which in this animal enter the Spleen at its upper part) and tied; the lymphatic veſſels which accompany the artery and vein, were alſo included in the ligature; and as abſorption continues ſo long as the animal remains irritable, the lymphatic veſſels, over the whole ſurface of the Spleen, ſoon became turgid, and were diſtinctly ſeen filled with a red fluid, ſo highly coloured as equal parts of claret and water: the larger lymphatic veſſel was then opened, and a quantity of the fluid it contained was received into a tea-cup; which, on being expoſed to the air, ſoon coagulated.

EXPERIMENT III.

SECT. 71. A PORTION of this fluid was diluted with pure *ſerum*, when the red colour ſeemed evidently owing to a quantity of red particles, which were diſtinctly ſeen in very conſiderable numbers.

SECT. 72. But leſt it ſhould be objected, that the red particles were contained in the *ſerum*, this experiment was carefully repeated.

EXPERIMENT IV.

SECT. 73. ANOTHER portion of the fluid received from the lymphatic veſſel, was diluted with a weak ſolution of the

Glauber's ſalts, when exactly the ſame appearances were exhibited as were formerly mentioned in experiments upon the blood: ſo that there can be no doubt, but that the red colour of the lymph from the Spleen, is communicated to it by a quantity of red particles of the blood.

SECT. 74. IT may be objected to Experiment II. that the animal, in being driven to the ſlaughter-houſe, might have received ſome blow on the Spleen, by which blood was extravaſated, or that extravaſation might happen in the very act of killing, and that this newly extravaſated blood might be abſorbed and found in the lymphatic veſſels in the form of red particles.

SECT. 75. To theſe objections we anſwer; firſt, that the Spleen is ſo well defended from external injuries, that it is very improbable ſuch accident could happen. And ſecondly, that if ſuch an accident had really taken place, the lymph at the greateſt diſtance from the ligature ſhould be of a redder colour; which is not the fact; for the colour of the lymph in any of the lymphatic veſſels of the Spleen, as nearly as we can determine, is the ſame; but that which is neareſt the ligature, to a careleſs obſerver, ſeems to be of a deeper red; but this appearance is occaſioned only by the quantity being larger from the increaſed ſize of the veſſel.

SECT. 76. THESE experiments were frequently repeated during Mr. Hewſon's life-time, and many times ſince his de- ceaſe,

ceaſe, and the appearances have been uniformly the ſame.

SECT. 77. THAT the Spleen is the organ ordained by nature for the more perfectly forming theſe red particles, we ſhall endeavour to prove in the next chapter.

CHAP. V.

Containing an Account of the Manner in which the Red Particles of the Blood are formed, deduced from the Experiments and Obſervations related in the preceding Chapters.

SECT. 78. IT hath been ſhewn, in a paper delivered by the late Mr. Hewſon *, and read June 17th and 24th, 1773, intitled, " An account of the " figure and compoſition of the red par- " ticles of the blood, commonly called " the Red Globules ;" that theſe red

* Vid. Chap. I.

particles

particles are not globules, as was generally believed, but that each particle is a compound body confiſting of two parts, *viz.* an external portion, which, from its reſemblance to a ſmall bladder, is called a veſicle; and an internal, contained in the centre of this veſicle, which is called the central particles; and that theſe particles while circulating in the blood-veſſels in their natural ſtate, are not ſpheres, but round and flat, reſembling a piece of money.

SECT. 79. THIS fact has been proved by experiments; firſt, if the red particles of the blood be diluted with freſh *ſerum*, and examined with a microſcope, their flat figure may be immediately diſcerned, and the ſhape of the particles remain unaltered; but if a ſmall quantity of water be mixed with theſe particles, they are immedi-

immediately transformed from a plane to a ſphere, the veſicle will gradually diſſolve, and diſſolving becomes tranſparent, at which time the central particle may be ſeen rolling from ſide to ſide like a pea in a bladder; the veſicle at length burſts, and the central particle will be entirely diſengaged from it; but if a drop or two of a ſolution of any neutral ſalt be added to this mixture before the burſting of the veſicle, it immediately becomes flattened, and the particle of blood reaſſumes its original figure. In the natural ſtate of a particle of blood, the veſicle is collapſed, and is in contact with, or adheres to, the central particle ſo firmly as to retain the particle in the middle of it; but when water is added to the blood, and the veſicle becomes a ſphere, that union is broken, the central particle becomes looſe in the veſicle, and then only its motion can be diſtinguiſhed.

SECT. 80. THE figure and ſize of the particles of the blood differ in different animals; but the general conformation of veſicle and particle extends probably throughout animal nature. That particles thus formed, ſhould not be made by the mere agitation of the chyle in the lungs, ſeems probable; that they are not, it ſhall be our buſineſs to prove; and alſo, that the lymphatic ſyſtem and its appendages are the organs employed by nature to do this office. By the lymphatic ſyſtem and its appendages, we mean, the lymphatic veſſels, the lymphatic glands, the Thymus, and the Spleen.

SECT. 81. AT the firſt view it may ſeem extraordinary, that nature ſhould have given ſo many and ſo complicated organs, to form a part only of the blood, when ſhe effects other ſecretions by organs apparently more ſimple; but our ſurpriſe muſt ceaſe when we reflect, that upon a due formation of theſe particles, not only the various functions of the body, but alſo the very exiſtence of the animal, in a great meaſure depends. When we conſider how liable theſe parts are to diſeaſe, by which their offices would be impeded, we muſt neceſſarily admire the goodneſs of the author of our nature for ſo forming theſe parts of our body, that the diſeaſe of a part ſhould not be attended with the deſtruction of the whole.

Sect. 82. The lymphatic veſſels, which ariſe from every part of the body, have already been deſcribed as performing the office of abſorption, or taking all thoſe fluids

fluids into the body, by which alone the animal is ſupplied with nouriſhment for its preſervation and growth; and the lymphatics not only do this, but they alſo aſſiſt in forming the red part of the blood.

SECT. 83. EACH lymphatic veſſel is vaſcular, and, when minutely injected, appears to have more blood veſſels than are neceſſary for the nouriſhment and growth of that veſſel. The coat of each lymphatic is likewiſe muſcular, and conſequently has a power of diminiſhing its capacity upon the application of a ſtimulus.

SECT. 84. THE lymphatic glands through which the lymphatics paſs, ſecrete a fluid which, when examined with a microſcope, Chap. I. Sect. 19.

exhibits numberleſs ſmall ſolid particles, exactly reſembling in ſize and ſhape the central particles contained in the veſicles of the blood. The lymphatic veſſels which ariſe from the cells of the lymphatic glands, into which the central particles are ſecreted, we have called Chap. II. Sect. 17. the excretory ducts of the lymphatic glands, which convey the ſecreted particles into the lymphatic veſſels which paſs through the gland, and from thence they paſs on through the thoracic duct, into the blood veſſels.

SECT. 85. IF we open a lymphatic veſſel after it has emerged from a lymphatic gland, we find not only a great number of theſe central particles, but alſo many of the particles of the blood completely formed; that is, the central particle is ſurrounded by a veſicle. We may conjecture

conjecture with a great degree of probability, that the veſicle is either a ſecretion from the internal coat of the lymphatic veſſel, or that the lymphatic veſſel has a plaſtic power over its contained fluid, ſo as not only to form a veſicle round the central particle, but alſo to give it its red colour, for till the red veſicle is formed, the central particle is evidently white.

SECT. 86. THAT a lymphatic veſſel, after it has paſſed through a lymphatic gland, contains lymph, red blood, and central particles, will not admit of a doubt to any one who will take the trouble of making the experiment. How then are theſe red particles formed, if not by the lymphatic veſſels?

SECT. 87. CHAP. I. Sect. 19. we prove, that central particles are formed in the lymphatic glands; and from our finding them in the lymphatic veſſels, preſently afterwards taking on their veſicular portions, or being completely made, we cannot doubt but that the lymphatic veſſel gives them the red veſicle; but in what manner this is performed, whether by a ſecretion from the internal coat of the veſſel, or by a plaſtic power of the veſſel itſelf over its contained fluid, is perhaps a circumſtance among the *arcana* of nature too minute for human inveſtigation.

SECT. 88. AND it is amply ſufficient to our purpoſe to prove, that the lymphatic veſſels and glands are of themſelves capable of forming the red part of the blood.

SECT. 89. IT will probably be aſked, if the lymphatic glands are given to form the central particles, how are thoſe particles formed where the lymphatic glands are wanting, and yet the red blood is perfect? In anſwer to this, we beg leave to repeat what has been obſerved in a former Chapter, that though animals of the amphibious claſs have not that circumſcribed form of lymphatic gland which we find in the human body, and in the bodies of quadrupeds, yet nature has in them conſtituted a different apparatus to ſerve the ſame end; namely, a net-work of lymphatic veſſels on the meſhes of the meſentery found in the turtle. For, as we have already ſhewn, the ſuppoſed cellular ſtructure of the lymphatic glands is by no means neceſſary to conſtitute a lymphatic gland; it is very probable, the ultimate branches of the lymphatic veſſels in the meſentery of the *amphybia*, may perform the ſame office in that claſs of animals, which the ſmall cells do in the human body, or in the bodies of quadrupeds; that is, as the central particles in thoſe animals which have lymphatic glands are formed in the ſmall cells of thoſe glands, ſo nature in the amphibious claſs makes the ultimate ramifications of the lymphatic veſſels do that office; ſo that the ſame purpoſes of animal œconomy may be equally well effected, whether the parts compoſing a gland are circumſcribed in a proper membrane, or whether the ſame parts are ſpread out over a large ſurface.

SECT. 90. IT may be objected by ſome, that the appearance of central particles may be a deception, for that appearance may be ſeen in many fluids; but the

the uniformity of their figure in the ſame ſort of animal, and the difference of their ſize and ſhape in different animals, will put this matter out of diſpute. In birds, as the common fowl for inſtance, the particles of the blood are oblong like a plumb-ſtone (*vid.* Plate), and the central particles found in the lymphatic glands of that bird are alſo oblong, correſponding in every reſpect with the central particle found in the veſicle of the blood of that animal.

SECT. 91. IN Chap. III. it was obſerved, that the ſtructure of the Thymus gland is ſimilar to that of the lymphatic glands, and that it ſecretes from the blood particles like thoſe ſecreted by the lymphatic glands; in fine, in its office, that it is no more than a large lymphatic gland. But why ſhould the Thymus be large

large in the *fœtus*, and as the animal increaſes in ſize, become ſmaller and ſmaller until at length it quite diſappears? or, in other words, Why does not the Thymus, like the liver or *pancreas* continue through life? The reaſon why the Thymus is larger during the early part of life, is, we conceive, that it may act as an auxiliary to the lymphatic ſyſtem, for the purpoſe of forming more of the central particles of the blood, than could have been made by the lymphatic glands alone during that time, when nature wants them moſt; for the human body grows more, in proportion to its weight, from the ſecond month after conception to the end of the third year, than it does in any future period of its exiſtence of no longer duration; a greater quantity of blood is therefore wanted and applied by the conſtitution in the quick growth of the

the animal, than is ever afterwards applied to that purpofe in the fame time.

SECT. 92. IF the Thymus Gland were wanting in the young animal, the lymphatic veffels and glands muft have been made confiderably larger than they now are, or out of proportion to the other parts of the body; otherwife the animal could not have been duly nourifhed, and the purpofes of nature muft have been defeated; but by the affiftance of the Thymus, a fufficient quantity of the central particles, to be converted into blood, neceffary for the growth of the animal, are formed; and nature at the fame time preferves a juft proportion in the lymphatic fyftem; then, as the animal becomes larger, and of confequence the lymphatic fyftem more extended,

 that

that alone and unaſſiſted can now furniſh a ſufficient quantity of theſe particles for the growth of the animal and repair of the conſtitution; the Thymus being no longer neceſſary, and occupying a ſpace which by this time will become uſeful for other purpoſes, the ſize of it will be gradually diminiſhed, and its parts abſorbed into the habit.

SECT. 93. THE Thymus Gland is placed in the cheſt, becauſe the ſpace it fills is not wanted by the *fœtus*. After birth, when reſpiration takes place and the animal increaſes in ſize, the growth of the lungs requires the cavity of the cheſt to be enlarged, which is done partly by the abſorption of the Thymus, but chiefly by the extenſion of the ribs.

SECT. 94. THE Thymus Gland then we confider as being an appendage to the lymphatic glands, for the more perfectly and expeditioufly forming the central particles of the blood in the *fœtus*, and in the early part of life.

SECT. 95. IN Chap. II. we confidered the lymphatic veffels arifing from the cells of the Spleen as its excretory ducts, which term, perhaps, when applied to lymphatic veffels, may be objected to by fome, but we think not with reafon; for if we confider the office of an excretory duct, we fhall find that there is no more impropriety in calling thefe lymphatics excretory ducts, than there is in ufing the term excretory duct, to exprefs that tube which conveys the fecreted fluid of any other gland to its place of deftination.

The excretory duct of the liver conveys the bile into the *duodenum*, becauſe that fluid is required in the inteſtines for the purpoſe of digeſtion. So the lymphatic veſſels of the Spleen convey the red particles of the blood into the thoracic duct, and from thence they paſs into the blood veſſels, which is the place aſſigned to them by nature, and from whence they are to be conveyed to the different parts of the body, to anſwer the purpoſes of nutrition and vivification.

SECT. 96. THAT the Spleen really does ſecrete the veſicular portion of the red particles of the blood, we have very convincing proofs.

SECT. 97. FIRST, If the Spleen be diſeaſed, the body for a time gradually waſtes.

SECT.

SECT. 98. SECONDLY, We have proved, that vaſt numbers of central particles made by the Thymus and lymphatic glands, are poured into the blood veſſels through the thoracic duct; and if we examine the blood attentively, we ſee them floating in it. Nature ſurely would not make ſo infinitely many particles to anſwer no purpoſe? What then becomes of theſe particles after they are mixed with the circulating blood; are they immediately deſtroyed? No. They are, we believe, carried with the blood to the Spleen, not that the Spleen has any elective attraction over them; but that being equally and uniformly diffuſed through the general maſs of blood, a due proportion of them is received by the Spleen with its arterial blood, and that when arrived there, the Spleen has a power of ſeparating them from the other parts of the blood, and of depoſiting them in the cells of that gland already deſcribed; where the arteries which are ſpread out in form of net-work upon the ſides of the cells, ſecrete from the blood the veſicular portion, and that when thus perfectly made, the lymphatic veſſels which originate from the cells abſorb them, and convey them thence into the thoracic duct, and ſo into the blood veſſels.

SECT. 99. THAT the Spleen does ſecrete ſomewhat, is evident, from the change obſervable in blood drawn from the ſplenic vein, which is diſtinguiſhed by this remarkable property, that it will not coagulate like blood taken from other veins; the reaſon we apprehend is, becauſe the coagulable lymph is employed by nature in the formation of the red veſicle; it remains therefore fluid until the thinner parts have evaporated, leaving the red particles a dry maſs.

SECT. 100. FOURTHLY, We have frequently examined blood taken from the ſplenic vein, but could never diſtinguiſh any central particles in it.

SECT. 101. FIFTHLY, In every animal which has red blood, a Spleen is found; but in thoſe animals which have not red blood, the Spleen is wanting.

SECT. 102. LASTLY, We find that vaſt quantities of the red particles of the blood are brought from the Spleen, by the lymphatic veſſels which originate in its ſubſtance; and for this reaſon we have called theſe lymphatic veſſels the excretory ducts of the Spleen.

SECT. 103. THAT the red particles of the blood are completely formed by the Spleen, we have therefore as ſtrong proofs, as we have that the liver ſecretes bile, or the teſticles *ſemen*; we find bile in the *ductus hepaticus*, *ſemen* in the *epididymis*, and red particles of blood in the lymphatic veſſels of the Spleen.

SECT. 104. IT may then reaſonably be aſked, How is the red blood formed when the Spleen is taken out, if the Spleen is the *viſcus* intended by nature to form the red blood? This objection will militate equally ſtrong againſt any other uſe the Spleen is ſuppoſed to have; for that the Spleen may be taken out,

and

and the animal ſuffer but little inconveniency, by no means prove it to be uſeleſs, but it proves that ſome other part is capable of performing its office. Every philoſopher muſt entertain too exalted an idea of nature, to believe that any part of the creation is uſeleſs, much leſs could he ſuppoſe a *viſcus* in the human body, ſo large as this is, has no office of importance aſſigned to it.

SECT. 105. SUPPOSE then for a moment, we allow the Spleen to do the office aſſigned to it by the moderns, *viz.* that it produces ſome change on the blood preparatory to the ſecretion of bile; what muſt do that office when the Spleen is wanting? for as the animal lives and is well nouriſhed afterwards, if that ſuppoſed change is abſolutely neceſſary for the ſecretion of bile, either ſome other

viſcus

viſcus muſt do its office; or the bile, a fluid ſo requiſite for aſſimilating our food, could not be formed, and the animal for want of being duly nouriſhed muſt die.

SECT. 106. IF we may reaſon from analogy, we ſhould ſay, that it is contrary to the eſtabliſhed laws of animal œconomy, to ſuppoſe the uſe of one organ or gland, to be merely ſubſervient to another organ or gland, in preparing the blood, in order to render it fit for ſuch organ or gland to do its office; it would be aſſerting, that the liver which nature intended to ſecrete bile could only do it by the intervention of the Spleen; and yet if we allow that bile can be formed without the uſe of the Spleen, we admit that intervention to be by no means neceſſary. But to carry our analogy ſtill farther, nature has given to the animal body certain glands, and has aſſigned to each

each peculiar offices, that is, ſhe has endowed them with a property of ſeparating from the blood divers fluids, as different from each other, as they are from the maſs of blood from out of which they were originally ſeparated.

SECT. 107. THE lachrymal gland ſecretes the tears; the ſalivary glands, the *ſaliva*; the kidneys, urine; the teſticles, *ſemen*, &c. &c. without the intervention of any auxiliary gland. If then a fluid ſo elaborated, and ſo different from any thing we find in the blood, as *ſemen* is, a fluid which has an office of no leſs dignity than to perpetuate the whole race of animals, can be formed from the blood by the veſſels of the *teſtis*, without any preparatory change being produced on it; may we not reaſonably conclude, that the liver is capable of ſecreting bile from the blood without any

any antecedent change being made on it by the Spleen? For to ſay that the blood muſt be prepared by the Spleen, before bile can be ſecreted from it by the liver, is to deny, that the liver, which is given to form bile, can do the office which nature has intended it to perform.

SECT. 108. BUT if we allow the Spleen to make the red part of the blood, we can readily account for the reaſon why the Spleen may be cut out of an animal, and yet the animal ſurvive, and ſuffer but little inconvenience, for though the office of the Spleen is to form the red particles of the blood, yet it is not the only organ in the body capable of doing that office; for we have already proved Sect. 88. that the lymphatic veſſels do alſo form the veſicular portion; the Spleen therefore is not the only organ capable of doing it. But nature has given

the

the Spleen as an auxiliary to the lymphatic ſyſtem, in order to the more commodiouſly, expeditiouſly, and completely forming the red part of the blood.

SECT. 109. IF then the Spleen be cut out, or its office obſtructed by diſeaſe, nature has a reſource, in exciting the lymphatic veſſels to form a larger quantity of red particles than they had ordinarily been accuſtomed to do, and theſe in proportion to the exigencies of the habit; but here nature does not aſſign a new office to the lymphatic veſſels, but only excites them to exert in a higher degree, a power of which they were before poſſeſſed; and this notion is conformable to what we obſerve in other circumſtances of animal œconomy; as when an animal is fat and well nouriſhed, the ſtomach is much longer in performing its office, than it is when emaciated by long faſting, and its life is in danger from want of nouriſhment, or than it is when the body is waſting by diſeaſe, witneſs the ſurpriſing quantities of food the ſtomach will digeſt, in a ſhort time after a recovery from the ſmall-pox, or a violent inflammatory fever; under theſe circumſtances, it is aſtoniſhing to obſerve how much Nature will exert herſelf, and how ſoon food taken into the ſtomach will be digeſted, and applied to the purpoſes of the conſtitution: in like manner, moſt probably, if the Spleen be diſeaſed or cut out, Nature is capable of making the lymphatic veſſels exert themſelves more powerfully in the execution of their office; or on the contrary, if the lymphatic ſyſtem be diſeaſed, the Spleen is excited to form a larger quantity of blood in order to make up the deficiency: thereby the life of the animal will be leſs frequently endangered from a partial diſeaſe.

SECT. 110. But how much ſoever the manner in which the red veſicle is formed may be diſputed, we think it cannot be denied, but that the office of the thymus and lymphatic glands is clearly proved to form the central particles found in the veſicles of the blood; and though the operation of Nature in forming the veſicular portion is more obſcure, yet the probability of its being performed in the manner we have related will, we hope, be readily admitted.

SECT. 111. A ſyſtem ſo new and ſo different as this is from the opinions at preſent ſo generally entertained of the blood, perhaps may meet with much oppoſition; and as no doctrine ſhould be admitted in philoſophy, till it has ſtood the teſt of the moſt careful and accurate examination, it may therefore be ſome time before this is univerſally allowed: for

for as the experiments are numerous, and ſome of them not eaſily made, few, but lovers of ſcience, will take the neceſſary pains to inquire into them: but we will be bold to aſſert, that whoever repeats theſe experiments will be amply rewarded for his trouble. We ſhall add, that when theſe facts are viewed with candour, and experiments of this kind are proſecuted with induſtry, they may probably direct the way to diſcover many operations of animal œconomy, that are at preſent conſidered among the inexplicable *arcana* of nature.

SECT. 112. Having now finiſhed the relation of the facts, and the experiments to prove them, whether the concluſions drawn from them are juſt, we ſhall ſubmit to the judgment of the learned reader.

F I N I S.

A comparative view of the FLAT VESICLES of the Blood in different Animals, exhibiting their size & Shape as they appear thro' a Lens $\frac{1}{23}$ of an Inch Focus.

Fig. I.  Their Size in an Ox, a Cat, an Ass, a Mouse, & a Bat.

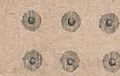
II.  ——— in Man, in a Rabbit, a Dog, & a Porpus.

III.  ——— in Birds, viz a Pigeon, a Hen, a Chafinch, & a Duck.

IV.  ——— in a Chick from the Egg, on the 6th day of Incubation.

V.  ——— in the common Fish, as the Salmon, Carp, Eel.

VI.  ——— in a Full grown Viper, & in a Turtle.

VII.  Their Size in a small Viper taken from the Belly of its Mother.

VIII.  ——— in a Slow Worm.

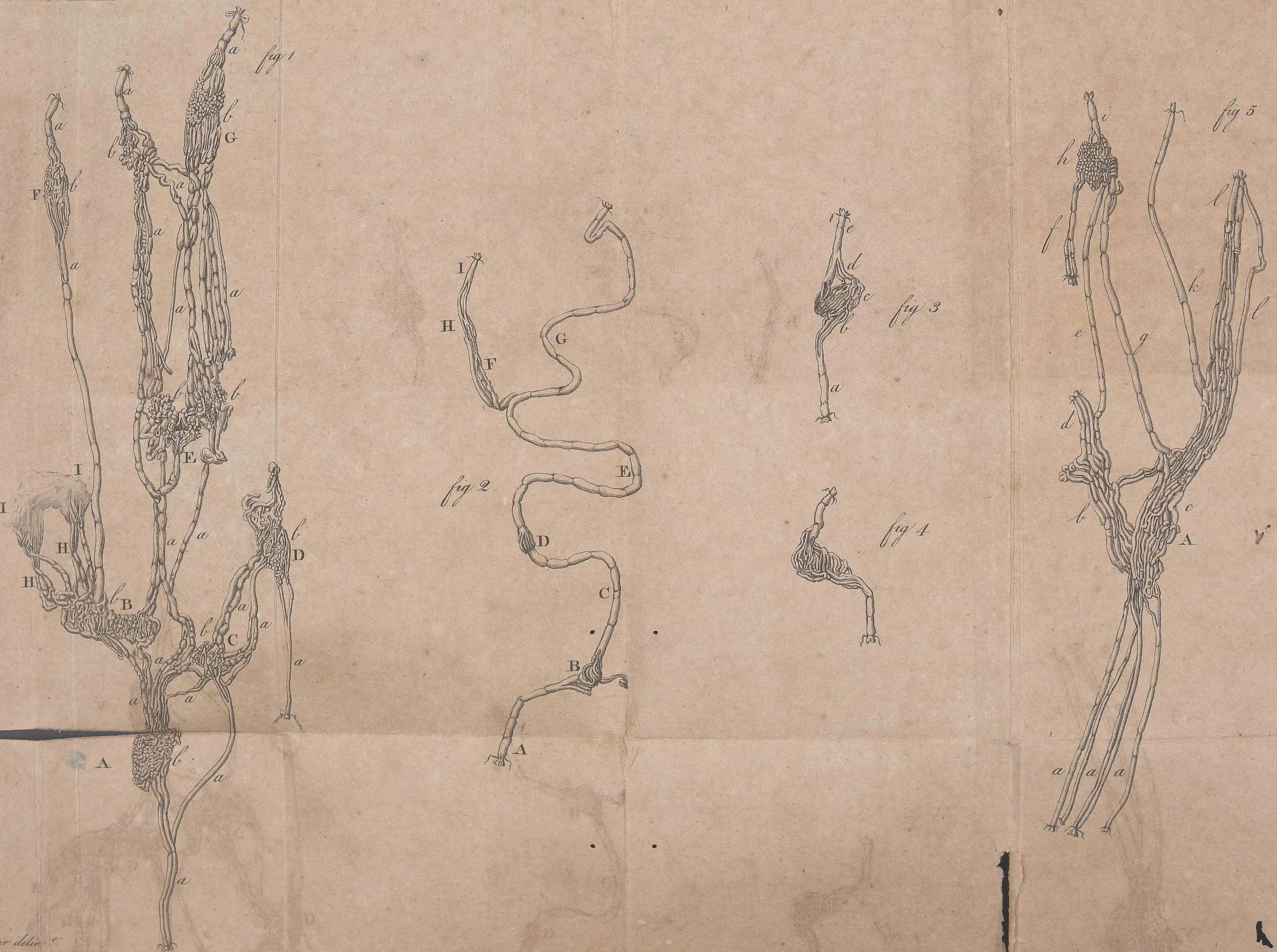
IX.  ——— in a Frog.

X.  ——— in a Skate.

XI.  ——— in a Lobster.

XII.  The Vesicles of the same Lobster, as they appear after being a short time exposed to the Air.

XIII.  The size of the Globules of Milk.



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Wm. Darling Sculpt.t

DESCRIPTION of the PLATES.

PLATE I.

A Comparative view of the flat veſicles of the blood in different animals, exhibiting their ſize and ſhape, as they appear through a lens $\frac{1}{23}$ of an inch focus.

PLATE II.

Fig. 1. Exhibits the Lymphatic veſſels of the lower extremity, injected with mercury, paſſing through a cluſter of Lymphatic Glands taken from the groin. The arteries and veins were not injected in this preparation.

a, a, a, a, a, a, a, a, a, a, a, a, a, a, a, a, a, a, the Lymphatic veſſels.

b, b, b, b, b, b, b, b, b, the Lymphatic Glands ſeen of different ſizes and ſhapes, with the Lymphatic veſſels paſſing through them.

A, *B*, *C*, *D*, *E*, Lymphatic Glands that have a cellular appearance.

F, *G*, Lymphatic Glands evidently formed of convoluted Lymphatic veſſels; theſe likewiſe ſhew the manner in which the veſſels enter, and paſs through the Glands.

H, *H*, Lymphatic veſſels running to the edges of two Lymphatic Glands not injected.

I, *I*, Lymphatic Glands uninjected.

Fig. 2. Exhibits a Lymphatic veſſel that forms three ſmall Lymphatic Glands.

A, A Lymphatic veſſel.

B, A Gland made by a ſubdiviſion of the trunk *A*, into nine or ten branches, which are convoluted; theſe reuniting, form the Lymphatic veſſel *C*.

C, A Lymphatic veſſel aſcending to form the Gland *D*.

D, A Lymphatic Gland.

E, A Lymphatic veſſel formed by the union of the Lymphatic veſſels that compoſed the Gland *D*, which divides into the two branches *F* and *G*.

F,

F, The Lymphatic veſſel ſubdivided into ſmall branches to form the third Lymphatic Gland *H*.

H, The third Lymphatic Gland.

I, A Lymphatic veſſel formed from the Gland *H*, which paſſed on to communicate with other Lymphatic veſſels, not expreſſed in this Plate.

G, A Lymphatic veſſel.

Fig. 3. Exhibits the manner in which a ſingle Lymphatic veſſel enters, and paſſes through a Lymphatic Gland.

a, The trunk of a veſſel filled with mercury.

b, The diviſion of the trunk into four branches before it enters the Gland.

c, The Gland, with the Lymphatic veſſels paſſing through it.

d, The Lymphatic veſſels having paſſed through the Gland, form four veſſels on the oppoſite ſide, to which they had entered the Gland. Theſe veſſels unite to form the trunk *e*.

e, The Lymphatic veſſel, having paſſed through the Gland, is become larger than before it entered the Gland.

Fig. 4. Exhibits a Lymphatic Gland with the Lymphatic veſſels injected with mercury, in which the ſubdiviſion of the larger veſſels into ſmaller branches, running in a ſerpentine direction through the Gland, is apparent to the naked eye.

Fig. 5. Exhibits Lymphatic veſſels and Glands, taken from the axilla in which the ſubdiviſion of the trunks into branches, and their frequent communication with each other, may be traced diſtinctly.

a, a, a, The trunks of five Lymphatic veſſels that come from the arm into the axilla, and as they aſcend, divide into many branches, which make frequent anaſtomoſes, and then form the plexus *A.*

A, A plexus of Lymphatic veſſels dividing into two parts *b, c.*

b, A cluſter of Lymphatic veſſels that run parallel to each other.

PLATE III

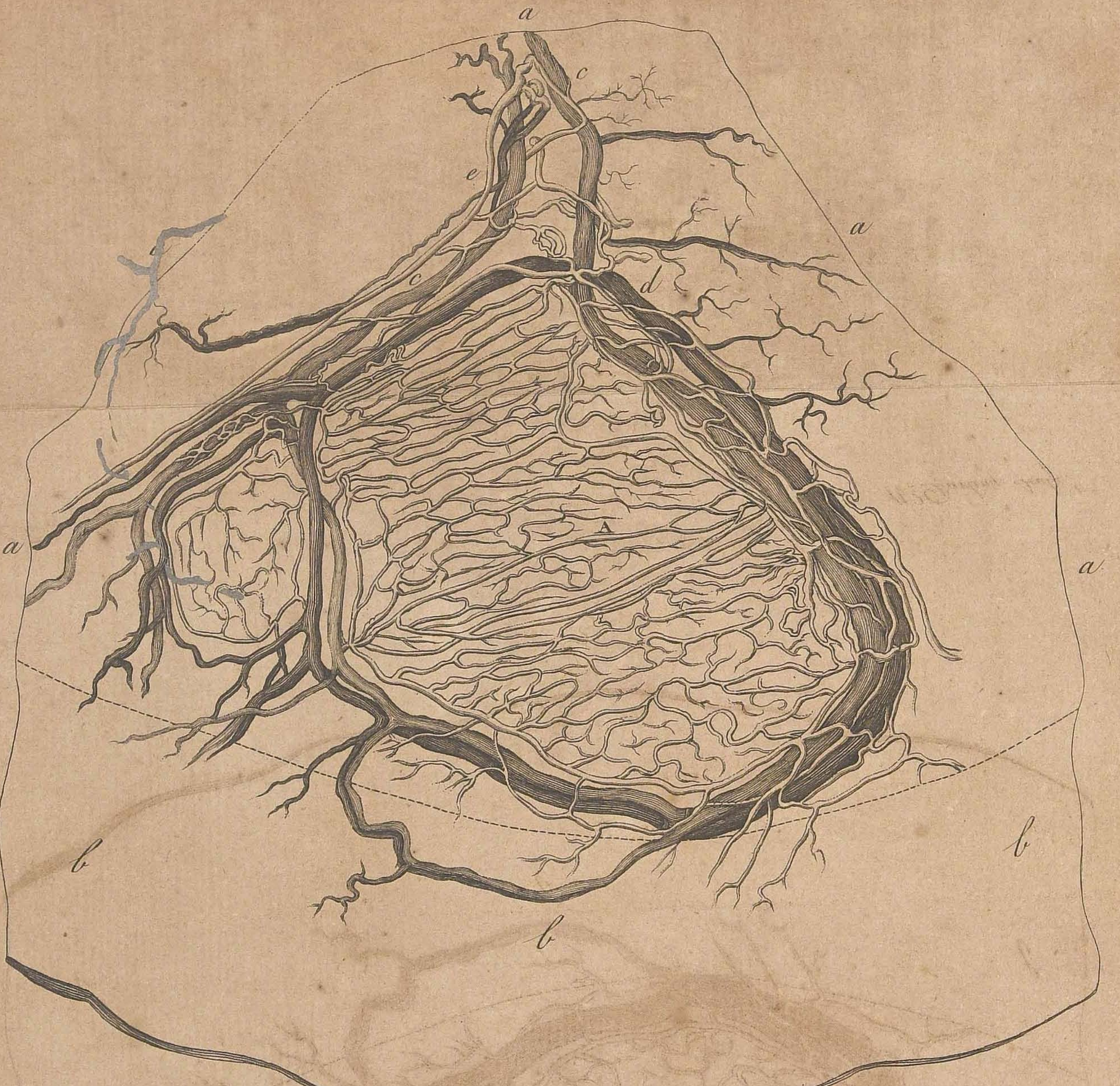

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PLATE IIII

fig 1

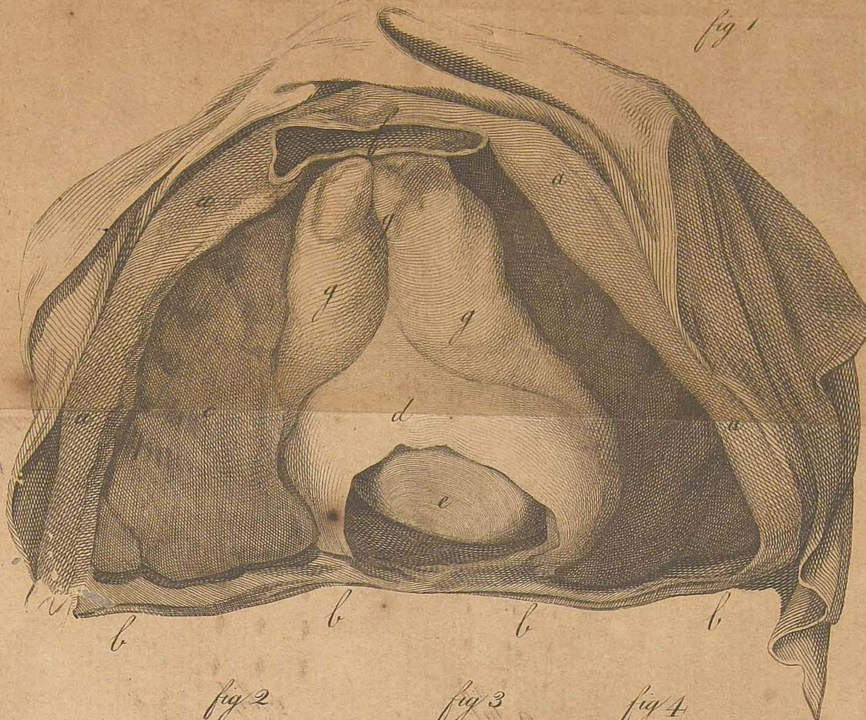

fig 2

fig 3

fig 4

fig 5

fig 6

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d, Lymphatic veſſels that ſurrounded the artery, and paſſed on to Lymphatic Glands not repreſented.

e, *f*, *g*, Lymphatic veſſels that form the Gland *h*.

i, The Lymphatic veſſel ariſing from the Gland *h*.

c, A plexus of Lymphatic veſſels communicating frequently with each other, and then aſcending divides into the branches *k*, *l*, *l*.

k, *l*, *l*, Lymphatic veſſels that paſſed on to to open into the angle between the jugular and ſubclavian vein, on the right ſide, without entering any Lymphatic Gland in their paſſage.

PLATE III.

Exhibits a part of the meſentery of a turtle injected. The arteries were filled with red wax, the veins with black, and the lacteals with mercury.

The meſenteric artery, and vein, as they paſs on to the gut between two folds of the peritoneum, divide into branches that make frequent

frequent anaſtomoſes. Theſe larger veſſels leave ſpaces that reſemble a net-work, and form meſhes of different ſizes. Theſe in the unprepared ſtate are tranſparent; but when the blood veſſels are minutely injected, we obſerve ſeveral ſmall arteries, and veins, ramifying to the utmoſt minuteneſs. And from the tranſparency of the peritoneum, we can here diſtinctly trace the artery terminating in the vein, by continuity of canal. It is on theſe meſhes that the lacteals, as they come from the gut upon the meſentery, divide into innumerable branches, that communicate frequently with each other, and form a beautiful plexus of lacteal veſſels. That in its office, we conſider analogous, to the Lymphatic Glands, ſeen in the meſentery of other animals.

a, *a*, *a*, *a*, *a*, The outline of the meſentery.

b, *b*, *b*, The inteſtine.

c, The artery.

d, The vein.

e, The lacteals ſurrounding the artery and vein.

A, A mesh of the mesentery on which a plexus of lacteal vessels are delineated.

PLATE IV.

Fig. 1. Exhibits the chest of a still-born child, opened to shew the situation of the Thymus Gland.

a, a, a, a, The skin, muscles, and ends of the ribs, the sternum and cartilaginous part of the ribs being removed.

b, b, b, b, The edge of the diaphragm.

c, c, The right and left lung.

d, The pericardium.

e, The heart.

f, Part of the first bone of the sternum.

g, g, g, The Thymus Gland.

Fig. 2. Exhibits the size, and figure, of the vesicles of the human blood; as they appeared in the microscope, when viewed through a lens the $\frac{1}{23}$ of an inch focus. In which the solid central particle, as formerly described, is seen distinctly in the centre of each vesicle.

Fig.

Fig. 3. Represents the size and figure of the particles found in a Lymphatic Gland, taken from the human body, as they appeared, viewed by a strong sun light, through the same lens used in the former experiments.

Fig. 4. Represents a portion of a Lymphatic Gland from the human subject greatly magnified, in which the cells of the Lymphatic Gland are shewn.

Fig. 5. The size and figure of the vesicles of the blood, taken from a common fowl.

Fig. 6. Exhibits the size and form of particles, taken from a Lymphatic Gland, found on the neck of the fowl whose blood is expressed Fig. 5.

Note. All the Experiments were made by a clear day light, and the objects viewed through the same lens, *viz.* $\frac{1}{23}$ of an inch focus. Except Plate IV. Fig. 4. which was examined with a lens the $\frac{1}{50}$ of an inch focus.