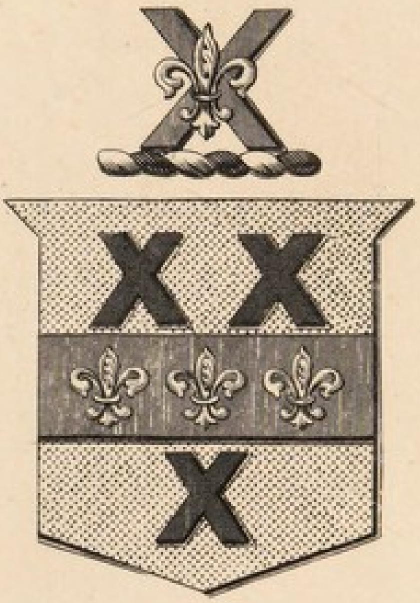

FIRST STEPS

TO

ANATOMY.

BY

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LONDON:
JOHN VAN VOORST, PATERNOSTER ROW.

1845.

PREFACE.

The title of this little work expresses in truth the object which is its principal aim, namely, to prepare the young medical student by some initiatory broad views of the general component parts of the animal frame, that he may thereby be better enabled to enter on the innumerable and minute details of physiology and descriptive anatomy. It too often happens that students are late in joining classes of medical science, and hence they lose a number of the early lectures; the evil consequences of which may be felt throughout the entire session.

I should only advert, however, to my own class in the Royal Belfast Institution, many of the members of which consist, annually, of first-year students, and numbers of those come from the country in complete ignorance of everything connected with medical science. Some have never read a line on the subject of anatomy; and though a few may have been for some time in an apothe-

cary's shop, or had access to a country dispensary, they are scarcely better informed.

It is customary to appropriate the first lectures of the course to an explanation of the general component materials of which the animal body is composed, and these are consequently lost to all who have been dilatory in joining the class. After repeated experience of the injurious effects resulting from this defect of introductory knowledge, I thought of putting some of the lectures alluded to into a printed form, so as to serve, at least, as a partial remedy for the evil. On considering the subject farther, I dressed the following preliminary matter of my course in what I conceived to be somewhat of a popular style, and, with some illustrations, I now offer it to the public, in the hope, perhaps a vain one, that it may prove of interest, not to the medical student alone, but to the general reader.

I regret that the illustrations possess too little of an original character, they being mostly copied from other works; though I trust that they will sufficiently answer their intended object.

J. L. D.

Belfast, Sept. 1845.

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ANATOMY.

CHAPTER I.

WHAT is Anatomy?—The term is derived from the Greek ανατεμνω (*anatemno*), to cut up; but it implies much more than the simple act of dissection: it includes whatever relates to the structure of any organ, its situation, form, dimensions, weight, connexions, consistence, colour, development—in short, everything connected with it as an organic structure; and hence Anatomy has been defined "The Science of Organization."

And what is Physiology?—This word is derived from φυσις (*phusis*), nature, and λογος (*logos*), a discourse; and hence any essay, discourse, or book, on Natural History, might be considered a work on Physiology: but the term has been long restricted to the phenomena

displayed in the actions or functions of living bodies, and hence it has been defined "The Science of Life." For illustration, let us take the lungs: we examine their investing membrane (the pleura), their lobes and lobules, their air cells, the windpipe branching through them, their arteries, veins, absorbents, and nerves, their situation in the thorax, their colour at different ages, their connexions, their relations to the diaphragm, ribs, &c. and any other circumstances connected with their structure—*that* is Anatomy. But the lungs are the great organs of respiration; whatever, therefore, relates to their inhalation and exhalation of air, the changes which such air undergoes in breathing, the alterations effected by its presence on the blood contained in the pulmonary blood-vessels, and all such other points as relate to the *function* of the lungs, are included under the head of Physiology; and so it is with the functions of other organs. You will recollect, then, that whatever relates to the *structure* of any organ, belongs to Anatomy, and whatever relates to the vital phenomena displayed by such organs, or, in other words, to the *actions* or *functions* it performs in the animal economy, belongs to Physiology.

It is to be observed, however, that while Anatomy and Physiology are thus defined as separate and distinct branches of science, yet, so intimate is their connexion, that neither can be fairly understood without the other. Physiology can never be comprehended without a previous knowledge of Anatomy; and the latter, when isolated from the former, loses half its value.

You will now attend to the following terms:—

1. Human Anatomy (*Anthropotomy*) relates, of course, to the structure of man alone.

2. Comparative Anatomy (*Zootomy*), to that of other animals compared with man.

3. Morbid or Pathological Anatomy, relates to those changes in structure which are caused by disease.

4. Vegetable Anatomy (*Phytotomy*).

5. Vegetable Physiology contemplates the vital phenomena of plants; for you must recollect, that although the latter are neither possessed of locomotion, sensation, nor perception, still they are living bodies; of which innumerable proofs might be advanced if necessary: and as you have not, probably, directed your attention to this subject, I will make a few remarks upon it.

Have you ever observed the different appearance which a field of clover presents on a fine sunny day, and on one which is bleak and lowering? In the first case, the leaves are all expanded and spreading their upper surface to the light; in the second, they are shrunk up or closed, their leaflets being bent down to elude the chilling influence of the air and moisture. In numerous other plants you will find a similar sensibility: observe, for instance, the common daisy after sunset or in wet weather, and you will remark that the flower is no longer expanded, but that the petals or flower-leaves of its ray or border are raised up, their tips being in contact, and forming a canopy over the disk, or central part, to defend it from the rain or dew.

Here, then, are two very familiar examples of sensitiveness to the states of the weather, and which can only be referred to the life or vitality of the species mentioned. But much more remarkable examples may be adduced of vegetable life from some plants which possess higher degrees of irritability, and a contractility of fibre apparently analogous to that of an animal muscle. Thus the appendage attached to the extremity of the leaf of the *Dionæa muscipula*

(Venus's Catchfly), is so curiously constructed, and is endowed with so high a degree of irritability, that the moment the latter is excited by the touch of an insect, the appendage suddenly closes, and crushes the animal in manner of a spring rat-trap.

The leaves, again, of the moving plant *Hedgsarum gyrans*, a native of India, are in almost constant motion, revolving on their foot-stalks from side to side. A stamen of the Barberry, when touched on the inside of the filament near its base, strikes the anther against the stigma with violence, as if it had been let loose from a spring; while in the sensitive plant, and some other *mimosæ*, the phenomena displayed in the successsive closures of the winged leaves, and bending down of their foot-stalks, when only one portion of the plant has been touched, are still more remarkable and simulative of animal life.

The rise of the sap in plants, their dependance on air for respiration, the formation of innumerable substances by the action of their vessels, as oils, resins, sugars, gums, odours, poisons, &c. &c. their sexual distinctions, their germination and propagation of their species, their intolerance of temperatures not suited to

their individual constitutions, their being killed like animals by arsenic and other poisons, with endless other phenomena exhibited in their history, might be adduced in proof of their vitality; and hence you will perceive, that the term Physiology is as legitimately applied to *their* functions, as to those which characterize animal life.

All *organic* bodies, then, that is to say, all animals and plants, are possessed of life, which no inorganic body is. A stone does not live; it has not organs for receiving nutriment, and others for converting such into its own substance; it has no vessels for circulating fluids, no organs for elaborating various secretions; it has not sprung from parents; does not grow from infancy to maturity, and produce other bodies like itself; and, as it has never lived, it cannot go through the process of dying, as all animals and plants do: and the same facts apply to all other inorganic bodies whatever, and to organized bodies also, after their vital spirit has become extinct.

But, while all the individuals belonging to the animal and vegetable kingdoms possess life, it must be easily apparent that there are mighty differences in the vitality enjoyed by

those belonging to each; that the animal has, in addition to the living properties of the vegetable, others of a higher order peculiar to itself; that it has not only the vegetable life, but, superadded to this, an *animal* life also. The animal, like the vegetable, takes in nutritive matter which it converts into its own substance, and by which it grows and is supported; like the vegetable, it originates from a predecessor, exists for a time, and then dies. All organized bodies, whether animal or vegetable, possess these properties; and hence the term applied to this kind of life is that of *organic*,—it is called *Organic Life*.

As a stone possesses none of the above functions, so the plant enjoys not those of *animal* life: it hears not, sees not, tastes not, feels not; for, though the shrinking of the sensitive plant may seem very like an effect produced by a sense of touch, it is not so—it is owing merely to irritability, and is unaccompanied by any degree of sensation. The heart of a skate will pulsate strongly after it has been separated twenty-four hours from the fish, and I have seen it beat when touched with a needle after a considerably longer period. Now, although the heart contracted under such

circumstances, it would be absurd to suppose that it *felt;* and so it is with the sensitive and other plants that have been referred to—they have irritability and contractility, but not sensation.

Now, as the various functions of a vegetable are carried on independent of volition or sense, as it absorbs nutriment for its support, as it breathes air by its leaves, as its sap flows in its vessels, and its other functions are similarly carried on without any knowledge whatever on the part of the plant itself, let us inquire whether these processes are, in an equal manner, carried on in animals. In Sir Astley Cooper's Lectures on Surgery (Lect. xvii.) we have a most remarkable case, than which there could not be a stronger illustration of the vegetable life in the animal organization; it is as follows:—

"A man was pressed on board one of his Majesty's ships at Gibraltar, early in the late revolutionary war. While on board this vessel in the Mediterranean, he received a fall from the yard-arm, and when he was picked up, he was found to be insensible. The vessel soon after making Gibraltar, he was deposited in an hospital in that place, where he remained

for some months still insensible; and some time after he was brought from Gibraltar, on board the Dolphine frigate, to a depot for sailors at Deptford. While he was at Deptford, the surgeon, under whose care he was, was visited by Mr. Davy;—the surgeon said to Mr. Davy, 'I have a case which I think you would like to see. It is a man who has been insensible for many months; he lies on his back with very few signs of life; he breathes, indeed, has a pulse, and some motion in his fingers, but in all other respects he is apparently deprived of all powers of mind, volition, or sensation.' Mr. Davy went to see the case, and, on examining the patient, found that there was a slight depression on one part of the head. Being informed of the accident which had occasioned this depression, he recommended the man to be sent to St. Thomas's Hospital. He was placed under the care of Mr. Cline; and when he was first admitted into this hospital, I saw him lying on his back, breathing without any great difficulty, his pulse regular, his arms extended, and his fingers moving to and fro to the motion of his heart, so that you could count his pulse by this motion of his fingers. If he wanted food, he had the power

of moving his lips and tongue; and this action of his mouth was the signal to his attendants for supplying this want.

"Mr. Cline, on examining his head, found an obvious depression; and thirteen months and a few days after the accident, he was carried into the operating theatre, and there trephined. The depressed portion of bone was elevated from the skull. While he was lying on the table, the motion of his fingers went on during the operation; but no sooner was the portion of bone raised than it ceased. The operation was performed at one o'clock in the afternoon; and at four o'clock, as I was walking through the wards, I went up to the man's bedside, and was surprised to see him sitting up in his bed. He had raised himself on his pillow. I asked him if he felt any pain, and he immediately put his hand to his head. This showed that volition and sensation were returning. In four days from that time the man was able to get out of bed, and began to converse; and in a few days more he was able to tell us where he came from. He recollected the circumstance of his having been pressed and carried down to Plymouth or Falmouth; but from that moment up to the time when the operation was

performed (that is, for a period of thirteen months and some days), his mind remained in a state of perfect oblivion. He had drunk, as it were, the cup of Lethe; he had suffered a complete death, as far as regarded his mental and almost all his bodily powers; but by removing a small portion of the bone with the saw, he was at once restored to all the functions of his mind, and almost all the powers of his body."

It must be obvious, that in this remarkable case, the patient was, from compression of the brain, reduced to an almost vegetative state: all consciousness was obliterated; the animal life was for above thirteen months completely suspended, but the organic life continued perfect; the digestive organs did their duty, the lungs respired as usual; the heart never ceased to pulsate, nor the blood to circulate; and the secretions and excretions were not retarded. The man was in a deep, continued sleep; and we are all, during a portion of the twenty-four hours, in a somewhat similar state, though from a natural cause. In the deepest sleep, the organic or vital functions proceed as when we are awake; they never tire, and but for this, to sleep would be to die: nor in our waking hours

are they under the control of the will. If we say to the heart, beat sixty times in the minute, or beat ninety times in the same period, it will not obey our commands; if we bid the stomach to digest more rapidly or more slowly, the order is unheeded; the liver will not regulate the secretion of bile by our direction, neither will the pancreas, nor the kidney, listen to our dictation: and so it is with all the actions of organic life,—they are regulated by a power over which we have no control; and fortunately so, for, to use the words of Paley, "we cannot consider, but with gratitude, how happy it is that our vital motions are *involuntary*. We should have enough to do, if we had to keep our hearts beating and our stomachs at work. Did these things depend, we will not say upon our effort, but upon our bidding, our care, or our attention, they would leave us leisure for nothing else. We must have been continually upon the watch, and continually in fear; nor would this constitution have allowed sleep."*

The organic actions are thus carried on with an untiring patience, and without fatigue

* Natural Theology, chap. x.

or necessity for rest. "An anatomist," says the author just quoted, "who understood the structure of the heart, might say beforehand, that it would play; but he would expect, I think, from the complexity of its mechanism, and the delicacy of many of its parts, that it should always be liable to derangement, or that it would soon work itself out. Yet, shall this wonderful machine go, night and day, for eighty years together, at the rate of a hundred thousand strokes every twenty-four hours, having, at every stroke, a great resistance to overcome; and shall continue this action for this length of time, without disorder and without weariness." What is the *durability* of any steam-engine compared to this!

While the machinery of organic existence thus continues to work without intermission or fatigue, through the period of a long life, the very opposite character belongs to that of *animal* life. If we walk far, we become fatigued; if the eye be long occupied, it becomes wearied; even the "concord of sweet sounds" at length tires the ear; and if the brain be overwrought by thinking, it must rest for a time from its labours; and thus all the organs of sense and voluntary motion have to be periodically re-

cruited and refreshed by repose. They all must seek the aid of

> "Tired nature's sweet restorer, balmy sleep."

For, as Dr. Southwood Smith observes in his excellent work, the Philosophy of Health,* "sleep is the repose of the senses, the rest of the muscles, their support and sustenance. What food is to the organic, sleep is to the animal life. Nutrition can no more go on without aliment, than sensation, thought, and motion, without sleep.

"But it is the animal life only that sleeps: death would be the consequence of the momentary slumber of the organic. If, when the brain betook itself to repose, the engine that moves the blood ceased to supply it with its vital fluid, never again would it awake. The animal life is active only during a portion of its existence; the activity of the organic life is never for a moment suspended; and in order to endow its organs with the power of continuing this uninterrupted action, they are rendered incapable of fatigue: fatigue, on the contrary, is inseparable from the action of the organs of the animal life; fatigue imposes the necessity of rest, rest is sleep, and sleep is renovation."

* Vol. i. chap. ii.

While organic life includes the functions of digestion, circulation, respiration, secretion, excretion, and reproduction, all processes intended for the mere support of the animal and the continuation of its species; the functions of the animal life, serve to maintain a correspondence between the individual and the external world. A vegetable, having only organic life, can have no perception of objects, nor can it be sensible even of its own existence. The great link of connexion between an animal and external objects, lies in the nervous system, and of this system, the brain, in the higher orders of animals, is the centre of all sensation. All the organs of feeling and locomotion are dependent on its integrity for the full and healthy exercise of their functions, and all thought and sensation centre in it alone: a finger is wounded, and pain is felt, but were the communication with the brain cut off, no pain whatever would be perceived; the eye is the organ of vision, but the brain is the immediate seat of that sense, for, were the optic nerve, which is the "internunciate cord" between the eye and the brain, severed, that eye would serve for sight no more; and such is the case with regard to the other senses, and the

organs of locomotion. Let the communication between any of these and the brain be destroyed, and their function is gone.

Several marks of distinction have been pointed out, between the organic and animal organs; thus, the former are generally single and unsymmetrical, the stomach is single, so are the liver, the spleen, the pancreas, &c. while the organs of animal life are double and symmetrical; thus, there are two eyes similar to each other, two ears the same, two upper and two lower extremities, each the counterpart of its fellow; but this distinction has perhaps been made too much of, since there are organs, even in the human species, belonging to the *organic* life, not only symmetrical, but also double. The kidneys are double, and although not always exactly alike in size, they generally are so; and the same remark may be applied to the ovaria, while the organ to which they are an appendage is not only single, but is regularly symmetrical. Again, we find that the stomach in the ruminating quadruped is quadruple; the heart, which in the mammalia is double and unsymmetrical, is in fishes symmetrical and single; and in them the lungs or gills are regularly symmetrical also.

Another distinction insisted on, is, that the organic life is perfect at once, and requires no teaching, while the animal life is at first feeble and uncertain, and has to be perfected by time, experience, or education; but however this may apply to man, it fails altogether with respect to almost all the insect tribes, and many others. Very few fishes pay any attention to their young, or indeed know that there is such a thing; but the fry, on escaping from the spawn, have the animal life perfect, and immediately swim about in quest of food. The same remark applies to the tadpole, and indeed, the young of most, if not all, the frog, lizard, serpent, tortoise, and turtle tribes, have the animal life perfect at birth. This is the case also in many hot-blooded animals. Helm, who travelled in South America, states that on one occasion his attendants had collected about fifty ostrich eggs,* which soon chipped, and the young immediately shifted for themselves. "The heat of the sun," he says, "being very great, and each of us having put some of them into his hat, the young birds, to our no small astonishment, broke the shell and ran away into the grass, which they began to devour

* *Rhea Americana*, not the true ostrich.

with as much appetite as if they had been long accustomed to such a diet."* It is well known, indeed, that many birds run about in search of food as soon as they are excluded from the shell, and even when part of the latter is still adhering to them; but I will only mention farther on this subject the following striking exemplification of it:—Sir George Mackenzie, in his Illustrations of Phrenology, page 38, observes that "Sir James Hall had been engaged in making experiments on hatching of eggs by means of artificial heat, and on one occasion he observed, in one of his boxes, a chicken in the act of breaking from its confinement. It happened that just as the creature got out of the shell, a spider began to run along the box, when the chicken darted forward, seized, and swallowed it."

Let us now ask the question, What *is* Life? We might as well ask, What is Gravitation? for, simple as the question may seem, we only know life by its phenomena, as we know the attraction of gravity; but what this attraction is, we cannot tell, and of Life, farther than its attendant phenomena, we know as little; and we cannot define it, for, as Blumenbach has

* Voyages, Modern and Cotemporary, vol. v. p. 10.

well observed, it is "one of those subjects which are more easily known than defined, and which are usually rendered obscure, rather than illustrated, by an attempt at definition." When, therefore, we use the word life or vitality, vital principle or vital power, we only give a name to the *unknown* cause of the *phenomena* of life. These phenomena are peculiar to itself, and among them one of the most remarkable is the preservation of the living body in defiance of the laws of chemistry. An animal, when dead, no longer resists the play of chemical action, and in a temperature even much lower than that of the living body, runs rapidly into putrescence, and dissolves; but while life remains, a mandate is imposed on this otherwise irresistible power which it cannot disobey; and hence when a man dies, the mighty spell being broken, chemical decomposition comes into active operation, and the body returns to the dust, that is, to the insensient elements from which it had been formed.

While the principle of life thus resists the decomposing operations of chemistry, we must recollect that it is only the injurious part of chemical action which is resisted, and so far is life inimical to this action, that it is only

when life itself would be endangered, that it is opposed and forbidden; for many chemical processes are carried on in the animal body, modified, however, by the living power; among these, I may mention respiration and digestion, but these are all for good, and those chemical affinities only, which would tend to injure and destroy the organization, are forbidden to exert their powers. It is not, therefore, *all* chemical action which life restrains or conquers, but only that which, if left uncontrolled, would overcome and destroy life itself. The chemistry, indeed, of organized nature is not only very extensive, but produces combinations and results, which anything short of vitality, will never, in all human probability, be able to accomplish, and hence, the great Cuvier uses an expression not overcharged, when he speaks of the "impenetrable laboratory" of the human body.

We may next, I believe, take for granted, that Life is never of spontaneous birth, and that Life must always originate from Life.

The mode, indeed, in which many Entozoa, and some other tribes, forming the lowest links in the great chain of animation, are produced, is not yet cleared up; but there is thence little reason to conclude, that they must

be entities of equivocal generation, a doctrine acknowledged by few British, though warmly embraced by various continental physiologists, and formerly supposed to be the origin of animals much higher in the scale.

In the childhood of science, indeed, it could scarcely be expected that any other solution should be given to the appearance of living creatures emerging from decaying animals and vegetables, excrementitious matters, and the alluvium of lakes, stagnant ponds, and rivers. The axiom of *omnia ex ovo* was not dreamt of, and the living and vegetable worlds were, in imagination, stocked with races of individuals engendered, through the influence of heat and moisture, from every variety of lifeless and unorganized matter. Every element of nature, indeed, poured out its swarms of spontaneous birth; the air, according to these notions, rained down showers of frogs and lemings, engendered from its clouds and vapours. Stagnant waters swarmed with beings unborn of parents, and springing from imaginary generative atoms, hatched into life and form by the genial moisture. The mud left by the overflowing Nile, when shrunk into its former bed, teemed with animation, concocted by the solar

beams, and living creatures were described in all stages of formation, some springing into birth, some as yet unfinished in their members, and others partly alive, and partly composed of crude, insensible earth. Ovid, in the first book of his Metamorphoses, refers to this, but in his time, it was not considered merely as a poetical fiction, but as an established truth:—

> "Sic ubi deseruit madidos septemfluus agros
> Nilus, et antiquo sua flumina reddidit alveo,
> Æthereo recens exarsit sidere limus,
> Plurima cultores versis animalia glebis
> Inveniunt, et in his quædam modò cœpta sub ipsum
> Nascendi spatium; quædam imperfecta, suisque
> Trunca vident numeris; et eodem in corpore sæpe
> Altera pars vivit, rudis est pars altera tellus.
> Thus when the Nile from Pharian fields is fled,
> And seeks with ebbing tide, his ancient bed,
> The fat manure with heavenly fire is warmed,
> And crusted creatures as in wombs are formed;
> These, when they turn the glebe, the peasants find
> Some rude, and yet unfinished in their kind:
> Short of their limbs, a lame imperfect birth,
> One half alive, and one of lifeless earth."—DRYDEN.

Not only the air, the waters, and the earth, were supposed to produce spontaneous births, but even to the snow and the fire were attributed the power of bringing forth similar generations; and hence it was believed, that the copper furnaces, in the island of Cyprus, engendered

certain flies which could only live amidst the flames, and perish when brought into the open air. Ivy, also, was thought to grow from the horns of the stag, and asparagus from those of the ram, while the animals were living; and to crown these mistaken notions, frogs were believed to be resolved into mud, during the winter, which mud was again metamorphosed into frogs, on the return of spring.

These examples form only a very small part of the theories formerly entertained on the subject of spontaneous generation, but which have all been long since disproved by a more strict examination into nature; and if much obscurity still prevails respecting the origin and mode of production in many infusorial animalcules, hydatids, and intestinal worms, I have little doubt that the increasing light of science will at length prove that these, equally with the larger animals, have proceeded in regular succession from their first parents at the creation, down to the present time.

While we are unable to comprehend the exact nature of life, we may yet derive much interesting information from inquiring into the different degrees in which it is bestowed on various animals; or, in other words, the facility

with which some lose it, and the tenacity with which it clings to others.

On considering how easily death is produced in man, we might conclude that in animals of equal, or apparently even more delicate structure, it would be still more easily produced; but in many instances the result is very different, and indeed, unless it be perhaps in the Reptile tribe,* there is no criterion in the anatomical structure from which we might, *a priori*, calculate on the tenacity of life in different species. Many of the mammiferous animals are as easily destroyed as man, while others retain the vital principle in a much superior degree, so far at least as wounds and external violence are concerned. This is so remarkable in the domestic cat, as to have become proverbial, it being a common saying, that a cat has nine lives. Of that idea Shakespeare has made the following use in Romeo and Juliet:—

> *Mercutio.* Tybalt, you rat-catcher, will you walk?
>
> *Tybalt.* What wouldst thou have with me?
>
> *Mercutio.* Good king of cats, nothing but one of your nine lives, that I mean to make bold withal, and as you shall use me hereafter, dry-beat the rest of the eight.
>
> *Act* 3, *scene* 1.

* This class includes the amphibia of Linnæus, *viz.* the lizards, frogs, toads, tortoises, and serpents.

The panther and leopard, which belong to the same natural family as the cat, are, on the contrary, said to be killed by a comparatively slight wound.

Among birds, again, there are some which the sportsman can only obtain by hitting in some vital organ, while others are brought down by a shot which the former would nearly disregard. Thus, Wilson* says of the hairy and red-headed woodpeckers of America, that they are hard to kill, and will "hang by the claws even of a single foot, as long as a spark of life remains, before they drop." In opposition to this, the woodcock is killed by an apparently trifling injury.

Some fishes die almost immediately when taken out of the water; such are the mackerel, the gwiniad, the shad, and the herring, and from this circumstance the vulgar saying, "as dead as a herring," has been derived. The eel, the plaice, the skate, the carp, and various other species, will, on the contrary, live for many hours after being brought to land. The perch has been known to survive a journey of sixty miles packed in straw,† and the carp can

* American Ornithology.

† Pennant's British Zoology.

even be fattened when placed on wet moss in a cellar, crammed with bread and milk, and occasionally dipped in water; but it will live for a fortnight out of the water altogether. The turbot will also live and take food if placed in a damp and cold situation; while the spotted, the smooth, and some other blennies, live several days after removal from their natural element.

The eel, the shark, the dogfish, and various others, suffer the most dreadful mutilations without being speedily killed. The Reptiles have membraneous lungs; and an opinion has been entertained, that great tenacity of life is always an accompaniment of lungs of that kind. Thus, the tortoise of Redi's horrid experiment lived for several months after its brain had been scooped out, and the cavity washed; and the water-newt or lizard (*Triton palustris*) will not only bear the loss of its limbs with impunity, but will reproduce an entirely new set, with all the bones, muscles, vessels, nerves, &c. as perfect as in those which had been amputated. But even the reproduced limbs, when cut away, are succeeded by others; and this experiment has been repeated to the fifth time, each new crop being as perfect as

the original. "Nay," says Spallanzani, "let the four legs be completely cut off, and the whole tail, as also the two mandibles,—the newt, in addition to reproducing the limbs, will, at the same time, repair the jaws and the tail." Bonnet found, also, that even the eye of the newt, when almost entirely removed, was reproduced, and in twelve months was nearly as perfect as the eye of the opposite side.

The reproduction of limbs is common also among the crustaceous animals, as the crab and lobster; though, in them, the new limb is always smaller than the previous one. What occurs in the snail is even more singular; for Spallanzani ascertained, that it will frequently reproduce the entire head. Numbers die after this cruel operation; but some survive, and acquire a head in all respects as complete as the one lost.

To many insects the loss of a limb seems a mere trifle, and even the removal of their head does not, for a time, in many species, suspend their usual operations. The common blue fly (*Musca carnaria*) will move about for several hours after its head has been removed, be sensible to the least touch upon its claws, and rub the brushes of its legs together, with as

much deliberation as though nothing unusual had occurred. A beetle, in similar circumstances, will, when it has crept to the edge of a table, recognise its situation, and by turning back, show that it is as sensible to the contiguity of the precipice, and as prompt to avoid it, as if it still had a head. When the common cleg-fly (*Tabanus pluvialis*) has fastened on a person's hand, it may be cut through with scissars, after which, it will continue sucking for some seconds, the blood flowing from the divided end; and then will fly off. If, again, a wasp be cut through the isthmus which joins the abdomen to the thorax, while employed in devouring any ripe fruit, its anterior half will seem as anxiously bent on eating as if nothing had happened. It will even explore the surface of a gooseberry until it discovers any accidental aperture through which the pulp may be reached, and will immediately begin to eat with the greatest avidity.

It is known that some of the annelidæ will reproduce parts that have been lost; and the medicinal leech will continue to suck after its posterior end has been snipped off. "In one instance," says Dr. Johnston, "in a leech just fallen off and fully gorged, I employed this

method of ridding it of its contents, and severe as many might deem this treatment, the leech was no sooner returned to its former situation, than it began sucking with the same avidity as when first applied."

It has been imagined, that the coldness of their blood is intimately connected with the great tenacity of life in eels, lizards, &c.; but what militates against such a theory is, that *some* only among cold-blooded animals, exhibit this strong vitality. Thus, most fishes are as easily killed as animals of warm blood; and even among the reptile tribe, some die from comparatively slight injuries: hence, the rattle-snake is struck dead by the blow of a switch.

With respect to fishes, an opinion has long been entertained that the sudden death of some, when taken from the water, is owing to their gill-apertures being large; but, as Mr. Yarrel well observes, "the carp, tench, barbel, perch, and most of the various flat-fish, have large gill-apertures, and yet they are all proverbially known to be able to sustain life long after they are removed from the water."*

A theory is also entertained, that those fishes which swim near the surface have a

* History of British Fishes, vol. i. page 65.

greater necessity for oxygen, and die sooner than those which reside at the bottom; but I would question this, for I am not acquainted with any fish that lives invariably near the surface, unless it be truly a littoral species, inhabiting pools among stones or rocks. Even the herring retires to the depths of the ocean when the spawning season is over, and the eel, which is so tenacious of life, notwithstanding its preference to the bottom, does not inhabit deeper water than the trout; but, on the contrary, is more often found inhabiting the mud, or cavities among stones, near the edges of lakes or rivers, than their middle depths.* The spotted blenny, so common on our shores, not in deep water, but often under a stone or in a little pool with scarcely more water than will cover it, has as much, if not more tenacity of life than the eel; and the smooth blenny is almost always found in situations where it must necessarily be near the surface; yet so far is it from dying suddenly, when taken from the water, that it will live for many hours in the open air.

A remarkable circumstance connected with

* Besides, the eel has a large air-bladder, and often swims near the surface.

this subject of vitality is, that often the possession of vigorous life renders animals more prone to death, while mutilation and wounds prolong their existence even beyond the natural period. It has been ascertained, that a dragon-fly, if decapitated, will live several months afterwards;.whereas, if no such operation have been performed, death (from hunger) takes place in a few days. The locust tribe of insects are very voracious, and, I believe, cannot survive long without food; yet, we learn from Vaillant, that wishing to preserve a species of this family at the Cape of Good Hope, he opened its belly, removed the contents, and filled the cavity with cotton, he then fixed it down by a pin stuck through its thorax; and yet five months afterwards, it exhibited unequivocal signs of life.

It would seem, then, that often when the vital energy is subdued or rendered latent, if I may use the expression, it retains its hold with greater pertinacity than when in vigorous action. In seeds and eggs, it is long preserved when they are placed in circumstances unfavourable to its development: thus, it is said that eggs which had been enclosed in plaster in the wall of an old church, were fresh when discovered, though they must have lain there

for fully three hundred years. It is generally known, that wheat and bulbous roots, found in mummy cases, grow freely on being planted, though they must have been shut up for several thousand years.

This latent vitality may be traced in some very familiar occurrences:—when an apple, for instance, receives a bruise, the bruised part dies, and being dead, soon loses its consistence and colour, and runs rapidly into corruption; in common language, it becomes rotten, and the limits between the rotten and the sound, that is, between the dead and the living parts, are clearly defined. Fruits, after a certain period, which is greater or less, according to their vitality, uniformly rot; but then, it is the pulp only that submits early to this change; the seeds (the pippins of the apple, for example) retain their living principle, and the dead pulpy matter has been thought to serve as a manure for forwarding their germination and growth.

The obstinacy with which seeds retain their vitality is, in some cases, very remarkable. That they are little affected by cold, is obvious from their germinating in spring after the most severe winter; but we need not be surprised at this, since animals, in their fully developed state,

are sometimes frozen, and again revive on being thawed. Hearne, in his very interesting narration of a Journey to the Northern Ocean, states that he had frequently, when pitching his tents in the winter, seen frogs, dug up with the moss, frozen as hard as ice, quite insensible, of course, and their limbs as brittle as pipe-stems; but, on being slowly heated, they recovered their former activity. Various spiders and grubs, which were turned up by thousands, were frozen quite hard. "The spiders," says Hearne, "if let fall from any height on a hard substance, would rebound like a grey pea, and all the grub kind were so hard frozen as to be as easily broken as a piece of ice of the same size; yet when exposed to a slow heat, even in the depth of winter, they will soon come to life, and in a short time recover their usual motions."

The lesser lamprey, being packed in snow, is carried to great distances in Russia, and then being thawed in water, its former vivacity is restored; and Captain Franklin, in his perilous journey to the shores of the Polar Sea, observed repeatedly, that fishes of various kinds, but especially the red carp of Winter Lake, after suddenly freezing when taken out of the nets, again recovered life and motion on being

thawed. The cold was so intense, that in a very short time they became a solid mass of ice, so that by a blow or two of a hatchet they could be split open, and the intestines taken out in one lump. "We have seen," Captain Franklin observes, "a carp recover so far, as to leap about with much vigour after it had been frozen for thirty-six hours." You will, perhaps, think this less wonderful when I state, that the gold-fish, so often kept, on account of its beauty, in glass vases, will bear to be frozen, enclosed in a solid block of ice, and will again recover perfectly by gradual thawing.

Though the history of the Hydra or fresh-water polype must, in some degree, be familiar to every reader, yet so remarkable are the phenomena connected with its living principle, that I cannot close this chapter without giving it some particular notice. We find in the Hydra a vitality more indestructible than imagination almost could conceive, and existing in a structure of the very utmost simplicity. The animal presents no multiplication of viscera, no apparatus of vessels, no nerves, no organ of vision, nor hearing, nor taste, nor smell; it is throughout one homogeneous mass of granular jelly, so that, to use the words of Dr. Roget,

"it would almost seem as if nature had formed it with the design of exhibiting to us the resources of vitality in carrying on the functions of animal life, without the aid of the complicated apparatus which she has bestowed upon the higher orders of the creation."*

The Hydra was first described by Lieuwenhoeck, in the Philosophical Transactions for 1703, but little of its wonderful history was known until more than forty years afterwards, when Trembley gave his discoveries to the world. There are several distinct species, but the one best known is the *Hydra viridis* or green polype, on which Trembley made his chief observations, and which he first discovered in the summer of 1740. It is found generally on the under surface of the leaves of aquatic plants in still ponds and ditches, and when in a quiescent state, seems a pea-like mass of transparent jelly. In a state of activity, however, it stretches out its tentacula or arms, and with them seizes on minute worms, and such small aquatic insects as may come within their reach. These are brought to the mouth, swallowed, digested, and the insoluble remains afterwards ejected from the same opening. "A hungry

* Bridgewater Treatise, vol. i. page 176.

polypus spreads its arms as a fisherman his nets; it extends them every way, so that they form a circle of considerable extent, every part of which is entirely within the reach of one of them; in this expanded posture it lies in expectation of its food; whatever comes within the verge of this circle is seized by one or another of its arms. The arms are then contracted till the prey is brought to the mouth, when it is soon devoured."* Now, all this seems a very simple process; but, when we consider the softness and tenuity of these arms, and indeed, the delicate substance of the whole animal, it will readily be obvious that something more than mere mechanical means is required for enabling the hydra to take its prey, which indeed, is often larger than itself. The aquatic worms, on which it frequently feeds, have such tenacity of life as to writhe and turn long after being cut in pieces: the polype, too, sometimes devours minute fishes, the struggles of which, we might conceive, would tear its tentacula to fragments; or that the fish, if swallowed, would burst its way through the hydra's pulpy walls; but the polype has poison in its touch, probably in the tentacula, but most certainly in its lips,

* Adams on the Microscope, page 409.

for no sooner does a worm come in contact with the latter, than it instantly expires.

Omitting many remarkable circumstances in the history of the Hydra, we must now attend to that part of it more immediately connected with the subject of vitality. Nothing could be more natural, than that philosophers, such as Leibnitz and Boerhaave, in considering the various gradations in the great chain of organized being; in running down the links from man to the animalcule, and from the oak or the cedar to a diminutive moss or a microscopic fungus, should conjecture, that as life is so varied, certain phenomena thought peculiar to the one great kingdom, might possibly exist also in the other; and that, hence, there might be animals, which, like the willow and innumerable other vegetables, would bear to be multiplied by slips or cuttings. If we divide a spray from the willow into one hundred pieces, and plant them in moist ground, each will, in time, grow to be as perfect a tree as the parent from which it was removed. Might not analogous instances occur among species as certainly belonging to the animal, as the willow does to the vegetable kingdom? Yes: but this was still only matter of conjecture, till the dis-

coveries of Trembley, whose work on the polypus was published in 1744, and which divulged such a series of extraordinary facts respecting the Hydra, as at the time staggered the belief even of those most inclined to indulge in the wonderful. Some of these facts are the following:—

1. Let a polype be treated like a willow branch, by being cut into several pieces, each piece will, in a short time, become a complete animal.

2. Even a minute portion of the skin will become a new and perfect animal.

3. Cut a polype into three portions, the head part will acquire a new tail; the tail part, a new head; and the middle portion, a tail and head also; so that, in a short time, there will be three polypes as perfect as the original: and if, instead of being divided into three parts, the animal had been separated into three dozen, there would soon be thirty-six individuals, all as complete, in every part and function, as the original before mutilation.

4. "If a polype is slit, beginning at the head, and proceeding to the middle of the body, a polype will be formed with two heads, and will eat at the same time with both. If the polype is slit into six or seven parts, it becomes a

Hydra with six or seven heads; if these are again divided, we shall have one with fourteen; cut off these, and as many new ones will spring up in their place, and the heads thus cut off will become new polypes, of which so many new Hydras may again be formed: so that, in every respect, it exceeds the fabulous relation of the Lernæan Hydra."*

5. We might here suppose, that the history of the vital principle of the polype would terminate; but more still remains. As the polype, like a branch of willow, can be multiplied by cuttings, it can also equally bear the process of grafting; so that if two or more separate portions be kept for some time in contact, end to end, they will unite, and form one individual. "You may fix the head of one polype to the trunk of another, and that which is thus produced will grow, eat, and multiply, like another."† What is not less remarkable, two entire individuals may be converted into one. It has been ascertained, that if one polype be forced into the mouth of another, till their two heads come in contact, and be so kept for some time, the two amalgamate and form one individual, enabled, perhaps, to seize its prey with

* Adams on the Microscope, page 419.

† Adams on the Microscope.

greater facility, from being furnished with a double quantity of arms.

Every portion of a polype seems equally endued with life, and, probably, as occasion may require, with similar functions; and it has been ascertained, at least in one species, the *Hydra fusca*, that when turned inside out, like the finger of a glove, its economy continues unchanged: what was the stomach, is now the skin; and what before was the skin, performs every office of that which had previously been the stomach.

What the feelings of existence, or of personal identity may be, which the Hydra possesses, we cannot well conjecture; it may enjoy considerable happiness, and in the mutilations spoken of can suffer little, if any pain; it probably possesses the sense of taste, as also the sensations of appetite, since it is extremely voracious; its touch is exquisite, and that it is acted on by the presence of light appears evident, from its invariably moving to the most illuminated part of the vessel in which it is kept. "We are driven," says Mr. Jones,* "to the supposition, that in this case the sense of touch supplies

* A General Outline of the Animal Kingdom, and Manual of Comparative Anatomy, by Thomas Rymer Jones, F.Z.S. London, 1841.

to a certain extent the want of other senses, and that the Hydræ are able, as an Italian author elegantly expresses it, '*palpare la luce*,' to feel the light." Yet, it may be unconnected with sensation, and depend on that unknown cause which directs the leaves of plants to shun darkness, and oppose their upper surfaces to the sunbeams.*

From all that has now been said, it must be obvious that our knowledge of the immediate cause of life only becomes more obscure, the more we attempt to penetrate the mystery; we find it in a thousand forms; we trace it in various states in animals and their germs, and in plants and their seeds; but in what its original essence consists we cannot understand.

I have now only to observe farther, that I trust you will not, by experimenting on living animals, attempt to gain farther light upon this subject; enough is known to satisfy a rational curiosity, and such experiments, while they harden the heart and deaden all the finer feelings of humanity, must prove utterly futile, and end in nothing but disappointment.

* The *Actiniæ*, *Planariæ*, and some other animals, possess powers of reproduction almost equal to those of the Hydra.

CHAPTER II.

OF THE CELLULAR SUBSTANCE.

The object of this chapter will be, to impart to you some knowledge of the most generally diffused tissue or component material of the animal frame; namely, the cellular membrane or cellular substance. This forms the basis of every solid part of an animal; for, with the exception of the enamel of the teeth, and it may be, of the crystalline lens of the eye, it enters largely into the composition of every organ; it is the matrix or mould, as it were, in and by which every structure is imbedded, pervaded, or enclosed; it exists, indeed, in such quantity, that the conjecture has been hazarded, that if every other part of the body could be removed, the latter would, notwithstanding, retain its shape and general appearance; it forms the basis even of the bones; it is the general connecting medium between the various organs of the body; it forms a large part of the bulk of the viscera; the arteries,

veins, nerves, and absorbents, run imbedded in it, and a principal portion of their constituent parts is formed of the same tissue. In a condensed state it constitutes the proper coats of the muscles, and also envelops the smaller fasciculi of which these are composed, and there is not a fibre belonging to one of them, nor indeed, a fibre in any other structure, which may not be considered as connected by cellular substance to its fellows. It forms the chief bulk of tendons and ligaments, and from these strong and resisting parts to the most delicate membrane, the *arachnoid* coat of the brain, or the hyaloid tunic of the vitreous humour in the eye, it is the chief component material. Sometimes it appears as a most delicate network; in some situations, in a very condensed and unyielding form; and in some others its presence can be demonstrated only by a prolonged maceration in water.

That a tissue of such universal diffusion in the animal structure should early engage our attention, must, I think, be sufficiently obvious; and now I will attempt to impart some more definite ideas respecting it.

I suppose, then, that you are acquainted with the knavish, but common practice of blow-

ing up flesh meat, to give it a plump appearance. When the animal is bled, a small aperture is made through the skin, generally, I believe, at the hock; into this a quill or straw is introduced, air is blown forcibly through it, and during this process the carcase of the animal may be seen evidently to swell. This enlargement, however, is very different from what would be produced by inflating the *belly* of the animal; the quill is not thrust into any cavity of the body, it is merely inserted beneath the skin, and it is into the cellular substance, connecting the skin to the body, that the air urged through the quill is forced.

But, suppose that the air were pressed on with still greater propelling power, it would then penetrate much farther than to the subcutaneous layer, and be forced even into the cellular substance of the viscera themselves: it might, indeed, be made to pervade almost every part of the body, and this must prove to you that the cells of this substance communicate freely with each other, and allow a gas or fluid forced into them at any one point, to pass on from cell to cell, till they, at length, become very generally distended.

Now, this substance is usually described as

being composed of whitish fibres or filaments, and lamellæ (or small plates) crossing each other in every direction, so as to form a delicate network. These fibres and plates thus interlacing in every possible direction, must necessarily leave interspaces or areolæ* between them, and as these all communicate with each other, the cellular substance has been not unaptly compared to a sponge; but this, you will recollect, can only fairly apply to those parts of it where the structure is loose, as beneath the skin; taking the latter form of it, however, as an example, let us try some strong point of resemblance.

Suppose, then, that you pour water on a damp sponge, what will be the consequence? Why, that in a few minutes you will see it dripping out at the bottom, showing that all the cells and pores of the sponge communicate with each other, and that the water, by its gravity, has found its way from one cell to another, till at length it has reached from the top to the bottom, and thence falls to the ground.

Well, then, you cannot but have observed in very delicate or unhealthy persons (especially

* From *area*, a void space.

females), that their feet and ancles often become greatly swelled in the evenings; so much so, indeed, that they are obliged to change, or at least, are much relieved by changing the shoes worn throughout the day for others of wider dimensions. Now, this phenomenon is analogous to what we observe in the sponge; the swelling is caused by water, which has all day been gradually subsiding by its own weight, and passing through the cellular substance, from cell to cell, to the most dependent parts, till it has reached the bottom, and if unconfined by the skin, it would, in like manner with that in the sponge, ooze out and run off from the sole of the foot.

But you will naturally ask, where does this water originate? Now, consider for a moment how necessary a soft, yielding, flexible state of the human frame is towards the performance of its various motions and changes of posture; think what would be the consequence, if the different organs of the body were connected to each other by any dry, unelastic material, though it were as fine and delicate as a cobweb: every motion would be impeded, and on every strong exertion the fibres forming this connexion would give way; the play of the muscles would be

confined or interrupted; the arteries, veins, and absorbents, would be exposed to perpetual irritation; the nerves so affected as to produce one universal state of pain and suffering; and existence, supposing that existence could be continued at all under such circumstances, would be almost intolerable. But, in fact, we could not live were not the cellular substance constituted as it is, soft, yielding, elastic, insensible, mobile, moist, and its density varying according to the office it has to perform in different situations.

Whence, then, comes the moisture which keeps it pliant where its texture is loose, and lubricates it where condensed into fasciæ and other firm membranes? The source of this is the blood, which important fluid, formed from our daily ingesta, is the great pabulum of animal life. This vital fluid is propelled from the heart, through the arteries, to all parts of the body, and is distributed, by millions upon millions of their ramifications, to the different parts of the animal frame, their medium of communication being the cellular membrane.

In the larger vessels, and in those even of much minuteness, the red globules of the blood circulate, and, of course, its red colour is con-

spicuous; but the extreme arterial branches diminish so much, that red globules will no longer pass, or at least in such small numbers as not to betray their colour, and then the limpid or colourless part chiefly of the vital fluid is received, whence the idea might be entertained, that there are parts of the body to which the blood does not penetrate. But, though in many organs the vessels are so minute that they will not give admittance to our most subtle injections, yet all analogy leads us to the persuasion, that no part of the animal structure, unless it may be the enamel of the teeth and the cuticle or outer layer of the skin, is independent of the influence of the circulating blood, either in its coloured or its transparent character.

But, be this as it may, we find many parts of the cellular membrane supplied with red blood, and we know that in all its parts it is bedewed with a watery vapour or halitus, given out (at least, such is the general belief) by the minute or capillary vessels, ramifying through it, and the great use of which is, to preserve it in that soft, mobile, and yielding state, on which so great a share of our well-being depends.

The cellular substance, then, is everywhere kept moist by a watery vapour given out by its capillary vessels, and in a state of health, this is prevented from accumulating by being carried off and returned again to the blood by a different class of vessels named the absorbents. But suppose that from a relaxed state of body, or from an inordinately increased action of the capillaries, the latter throw out more of this fluid than is necessary, or, on the other hand, that the absorbents, from inaction or a loss of power, are unable to carry it off as freely as it is supplied, then it must necessarily accumulate, and falling down by its own weight, cause the swelling of the feet alluded to.

But after a night's rest, the swelling is gone, and the person can then wear the ordinary sized shoes, as before. How is this to be explained? Chiefly, perhaps, in this way. The body lying in the recumbent posture, the line of gravitation in the fluid is changed; it gradually infiltrates back into a large portion of the cells from which it had passed during the preceding day, and thus, by being exposed to a wider surface, it is absorbed and disappears. Added to this, however, we must recollect that the accumulation of water, during the erect

posture, is increased by the weight of the column of blood in the veins of the lower extremities, which, by retarding in some degree, the circulation from the arteries, causes the smaller branches of the latter to throw out a more than usual portion of their serous or watery contents into the cellular membrane.

When a more decidedly dropsical tendency takes place, the swelling continues, and in the morning may be even greater than when the patient lay down at night. It progressively accumulates; from the feet and ancles it mounts up to the leg; the thighs swell; the skin of the body then becomes undermined; the face and head grow tumid; and thus general dropsy of the skin, named anasarca,* is established.

In this state, or in the slighter effusion (*œdema*) of the feet and ancles, when we make pressure on the swelled parts with the point of the finger, a depression or pit is left, which continues for some time afterwards, but at length the skin assumes its former level. The pitting thus produced resembles what would be made by pressing with the finger on a piece of dough or putty, and we can easily

* From *ανα* (ana), throughout; and *σαρξ* (sarx), the flesh.

understand how it takes place. The pressure drives the water into the neighbouring cells, but on being withdrawn, the liquid gradually oozes back, and the cells from which it had been dislodged become filled with it as before. —The water, we saw, dropped out of the sponge, because there are pores opening on its surface through which the fluid finds an exit; and so it would be in effusion under the skin, did the latter possess pores of sufficient magnitude; and hence in anasarca, if punctures be made in the skin, or if it become ulcerated, the water oozes through, and thus in a greater or less quantity is drained off.

In comparing the cellular substance to a sponge, there is one circumstance which you must not lose sight of, and in which the analogy fails, which is, that the structure of the sponge is always cellular, whether it contain fluid or not, but the cellular substance, unless it be distended by some foreign body, as water or air, has all its parts in contact, there being then nothing like areolæ or vacancies, and hence the appellation filamentous tissue is, by various writers, considered as more correct.

As air is so easily urged into the cellular substance of the dead animal, it is easy to con-

ceive that it may be similarly diffused through it in the living; and it is well known, that in some countries horses and calves are made to simulate fatness by being inflated through a puncture in the skin, and a similar fraud is said to be practised on the camel in the East. Artificial inflation of the human body has also been practised; thus, Hildanus* mentions an instance, where the parents of a child, for the purpose of extorting money as charity, inflated its head to a great size through a puncture in the scalp, pretending that it laboured under *Hydrocephalus* or dropsy of the brain. Borelli, too, gives another example of fraud in an unprincipled father, who inflated the whole body of a boy, his son, so as to resemble dropsy; and instances formerly occurred, both in our army and navy, of men attempting, and sometimes successfully, to obtain their discharge from the service, by producing inflation of the cellular substance, and passing it off as rupture.

In accidents, where the end of a broken rib wounds the lungs, the air escaping from the latter into the cavity of the chest is thence forced into the cellular substance around the fractured bone, and from that finds its way, being driven

* Cent. iii. obs. 18.

by the action of the respiratory muscles, to a greater or less extent, under the integuments, or even to parts more deeply situated, and sometimes giving the body an appearance rather like that of a blown-up skin, than of a human being. And yet this inflation is not in itself necessarily injurious, except in its connexion with a wound of the lungs, which is, in all cases, more or less dangerous. Of many instances which I have witnessed of this affection, the most dreadful was that of a girl of five years old, who was run over by a cart; the ribs were broken, and the lower jaw crushed; she lived about fifteen or twenty minutes after the accident, and in that time the skin upon the breast and neck was raised more than an inch above its natural level, while the air bubbling through the blood which flowed from the lacerated lip and gums, presented a very shocking appearance.

From the ready communication between the areolæ of the cellular substance, it may easily be conceived that a fluid discharged into it may travel to a considerable distance from its original seat, and hence we readily account for the bursting of an abscess at a part very remote from the place it first occupied. Thus, a col-

lection of matter formed in the parotid gland at the ear has been known to burst at the elbow, and, in medical works, may be found many similar instances, as well as of needles and other foreign bodies, wandering under the skin to great distances.

The observations I have now made refer chiefly to the cellular substance in its loose or reticular form; and its various other modifications will be understood, from time to time, in the progress of your studies. The fat, or adipose tissue, will form the subject of the next chapter.

CHAPTER III.

OF THE FAT.

The next component part of the animal frame to which I wish to turn your attention is the fat; and I will commence with a very homely illustration. Suppose, then, that you place a bit of rendered * lard on the palm of your hand, you will soon find that it melts. Try a small slice of bacon in the same way; it may slightly moisten the part it touches, but will *not* melt. Now, how does this happen? The fat or oily material of the bacon is as easily liquefied by heat as that of the lard; why, then, does the mass of bacon not equally become fluid? The reason is, that it is confined in extremely minute globular cells, which neither communicate with each other, like those of the cellular substance, nor have they any openings in their walls by which their contents, however thin, could flow out. The lard was similarly circumstanced

* Lard that has been previously melted and separated from the membraneous parts.

before its cellules were burst by heat, and their contents liberated. These cells, when highly magnified, appear of a globular form; and, hence, in descriptions of the fat, especially of the marrow, they have often been likened to masses of pearls or of beads cohering together, or to the roe of a fish, which affords, perhaps, a better similitude.

The fat is, by no means, so generally diffused throughout the system as the filamentous tissue, and in some situations, though for the wisest reasons, it is always wanting. For example, it is not allowed to be formed within the cavity of the skull. Now, why should it not occur there as well as in so many other situations? It is found, generally speaking, in considerable quantity, within the cavity of the abdomen; why then is no trace of it to be discovered within the cavity of the cranium? To answer this question, you must recollect the circumstance of the fat being in a constant state of fluctuation as to quantity. In the course of your own life, you have been much fatter at some periods than at others; in full health it is considerable or abundant, and in a weakened and sickly state of body, it diminishes; so that in some diseases it nearly vanishes altogether.

Now, the brain, with its accessory parts, occupies the entire cavity of the cranium, and it is, you must be aware, soft and pulpy, and when subjected to pressure, as by blood, for instance, which has escaped from a ruptured vessel, immediate insensibility and loss of motion take place, soon followed, in most cases, by the total extinction of life. From these circumstances it must be sufficiently obvious, that did but a small portion of adipose matter find a habitation within the skull, its frequent variations in bulk would, at one time, make it press injuriously upon the brain, and at another, by its absorption, the support it had given being removed, the vessels of the brain would be liable to burst.

Similar examples of the absence of fat occur in various parts of the animal frame, of which I shall only mention the lungs and the eyelids. Had it been permitted to form in the lungs, it would be continually interfering with the function of respiration; and in the eyelids its fluctuating dimensions would as often alter the expression of countenance, besides being an impediment to the healthy play of those moving veils so necessary for protecting the organ of vision.

There is another circumstance connected

with the varying increase and diminution of the fat, well worthy of our consideration, namely, that these are not partial but general. If a person labour under any wasting disease, as pulmonary consumption, disease of the hip or knee joint, or other lingering complaint, the fat disappears, but the extenuation is general. It is not merely the fat of the diseased limb that is removed, but it is carried off equally from the whole body. If the diseased limb waste, the opposite limb wastes also, and not only it but the other limbs, and the fat throughout the system; the wasting is general, there being seemingly a law in the constitution that from whatever cause the fat may be absorbed from one part, it becomes proportionally so from every other.

The *growth* of the fat, also, appears to be regulated by a similar general rule, and were it not so, we should sometimes have one side of the body fat and the other lean, one cheek plump and the other hollow, or one leg or arm bearing no proportion in size to its opposite neighbour. It is true, indeed, that *local* accumulations of fat frequently occur in form of tumours, but these are supernumerary growths, and consequently, deviations from the natural state.

The wasting of the adipose substance is much greater in some diseases than in others, but even in the most extenuated subjects it is still found in some situations, as the cheek, orbit of the eye, and around the kidney; and indeed, if Dr. Hunter be correct, the only disease in which it *totally* disappears is anasarcous dropsy.

In the natural state of the body, the fat is found plentifully about the kidney, it is often very thick on the front of the abdomen, forming a layer sometimes three inches or more in thickness. The latter, however, is but part of a general stratum which lies under the true skin, and is named the adipose membrane (*membrana adiposa*).* In some parts this stratum is very thin, if not wanting, as on the forehead. In young children it is generally copious at the surface, giving them the chubby appearance so pleasing in infancy; in females it is commonly more copious than in men, and to it such beautifully rounded forms as that of the Venus de Medicis, are principally owing; so that the exquisite outline of a perfect female figure is chiefly indebted for its beauty to a subcutaneous layer of fat.

* Panniculus adiposus; and on the abdomen, thighs, &c. it has now the name of the superficial fascia.

After the period of infancy, the plumpness by which the latter was marked disappears, and the growing boy or girl is comparatively thin. It would in them, indeed, be rather an incumbrance, but in the infant it is highly beneficial, forming a soft cushion, and thus obviating any ill effects from pressure. In middle life, it again is apt to form in considerable quantity, and it as frequently disappears in advanced age, when the skin, having lost its elasticity, and being deprived of this support beneath, puts on the shrivelled aspect indicative of man's having fallen "into the sere and yellow leaf."

In herbivorous quadrupeds and granivorous birds, the fat is more common than in the carnivorous, though there are exceptions. Thus, the common hare is herbivorous, and yet is almost destitute of fat, and you may at a glance perceive how advantageous this must be to an animal whose escape from its enemies depends almost solely on its rapidity of motion, its speed not being impeded by a weight of fat. The same may be said of the antelopes in the south of Africa, which are so lean that they cannot be dressed for table without larding.* The hare, however, by being domesticated, is apt to

* Barrow's Travels.

become excessively corpulent; even, it is said, to suffocation: and the antelopes would probably be affected in a like manner, under similar circumstances. In most animals the adipose substance is limited to certain bounds, but there are some in which its diffusion is much more general. In the herring, for instance, and the eel, there are few parts which do not contain oil, or in other words, fat; while in fishes of the ray tribe, it is more limited than in the quadruped, being in them apparently confined to the liver alone.*

With respect to the ordinary quantity of fat in a healthy adult, it is supposed that in an individual of 120 ℔s. weight, its proportion is about 20 ℔s.; but it is difficult to come to any certain conclusion on this point, since the quantity is so variable that perhaps no two persons of the same weight could be found, in whom the quantity of adipose tissue would prove alike. A person having large bones and muscles may be scantily supplied with fat, while another, with a slender skeleton and little bulk of muscle, may be overloaded with this substance. Still, however, the above proportion is considered as about the average.

* The liver of the cod and various other fishes abounds in oil, though little or none is found in any other part.

I will now offer you a few remarks on corpulency, or what might be considered a morbid accumulation of fat. You are aware, I suppose, that while England is known as the favoured land of roast beef, so its inhabitants are said to be the fattest of civilized Europe; but whether for one fat person found in France or Spain there are a hundred in England, I will with Mr. Wadd * "leave others to determine the fairness of such a calculation," though with him I must agree that we may approach, if not exceed it, when we reflect on the

————————"Expensive plans
For deluging of dripping-pans;"

"introduced by the modern improvements in the art of grazing, and the condescension of some of our physicians, who have added the culinary department to the practice of physic."

You are not to suppose, however, that roast beef is the most fattening food in the world; and you will remember also, that some persons are so constitutionally disposed to form fat from any kind of food, if taken in abundance, that in them nothing but the greatest degree of ab-

* See his instructive and entertaining work, entitled, "Cursory Remarks on Corpulency."

stinence will prevent its inconvenient accumulation.

There are others, on the contrary, whom no quantity of food will fatten; but taking mankind in general, it may be said with truth, that full feeding, combined with an indolent disposition of mind and an inactive life, will make them full and plump; and hence there is much truth in Dr. Arbuthnot's observation, that "spare diet and labour will keep constitutions, where this disposition is the strongest, from being fat. You may see," he says, "an army of forty thousand foot-soldiers without a fat man; and I dare affirm that by plenty and rest twenty of the forty shall grow fat."

Another remark which I may make is, that lean persons have frequently an inordinate appetite, while others, who are corpulent, consume but little food; and hence it must be obvious, that in many cases the tendency to corpulency, or the contrary, depends on constitutional idiosyncracies which cannot be explained.

That an anxious and irritable temper conduces to leanness, is, I believe, generally true; and that a disposition which is cheerful and not easily disturbed by trifles, or the ordinary cares of the world, produces an opposite ten-

dency, is equally so; and hence the common saying of "laugh and grow fat" is founded in observation and truth. That many persons remarkable for thinness have the happiest dispositions and the best regulated minds possible, is undoubtedly true; but it is not less so, that a temper which is peevish or deeply soured by envy or disappointment, is an almost certain cause of an accompanying leanness of body. How well aware was the immortal dramatist of this. Cæsar says,—

> "Let me have men about me that are fat,
> Sleek-headed men, and such as sleep o' nights:
> Yond' Cassius has a lean and hungry look;
> He thinks too much, such men are dangerous."

Antony answers,—

> "Fear him not, Cæsar, he's not dangerous;
> He is a noble Roman, and well given."

But Cæsar, true to the original impression, says,—

> "Would he were fatter:—but I fear him not:
> Yet, if my name were liable to fear,
> I do not know the man I should avoid
> So soon as that *spare* Cassius."
>
> *Julius Cæsar, act* 1, *scene* 2.

Extreme degrees of emaciation are not so frequent as of extreme corpulency, though instances do occur in which we are surprised

how life and tolerable health could be maintained in connexion with so great an annihilation, not only of fat, but of muscle. A remarkable example of this was well known to the public some years ago, in the person of Claude Ambroise Seurat, who was exhibited in Pall Mall, under the name of the *anatomie vivante* or living skeleton, for a full account of whom, I must refer you to the first volume of Hone's Every-Day Book.

In opposition to this acme of innutrition, examples of extreme corpulency are of almost daily occurrence; for numerous cases of which, you may consult Mr. Wadd's book, but as this is very scarce, I copy from it, for your present information, the following narrative. "A few years ago, a man of about forty years of age hired himself, as a labourer, in one of the most considerable ale breweries of the city: at this time he was a personable man; stout, active, and not fatter than a moderate-sized man, in high health, should be. His chief occupation was to superintend the working of the new beer, and occasionally to sit up at night to watch the sweet wort, an employment not requiring either activity or labour; of course, at these times, he had an opportunity of tasting

the liquor, of which, it appears, he always availed himself; besides this, he had constant access to the new beer. Thus, leading a quiet, inactive life, he began to increase in bulk, and continued to enlarge, until, in a very short time, he became of such an unwieldy size as to be unable to move about, and was too big to pass up the brewhouse staircase; if, by any accident, he fell down, he was unable to get up again without help. The integuments of his face hung down to the shoulders and breast; the fat was not confined to any particular part, but diffused over the whole of his body, arms, legs, &c. making his appearance such as to attract the attention of all who saw him. He left this service to go into the country, being a burthen to himself, and totally useless to his employers. About two years afterwards he called upon his old masters in very different shape to that above described, being reduced in size nearly half, and weighing little more than ten stone. The account that he gave of himself was, that as soon as he had quitted the brewhouse, he went into Bedfordshire, where, having soon spent the money he had earned, and being unable to work, he was brought into such a state of poverty as to be scarcely able

to obtain the sustenance of life, often being a whole day without food; that he drank very little, and that was generally water. By this mode of life he began to dimish in size, so as to be able to walk about with tolerable ease. He then engaged himself to a farmer, with whom he staid a considerable time, and in the latter part of his service he was able to go through very hard labour, being sometimes in the field ploughing and following various agricultural concerns for a whole day, with no other food than a small pittance of bread and cheese. This was the history he gave of the means by which this extraordinary change was brought about. He added, his health had never been so good as it then was."

In addition to the many cases of obesity contained in the work referred to, I may glance at one stated in Barrow's Travels in Southern Africa. It relates to a Hottentot female of the name of Van Vooren, who for many years was unable to walk, on account of the load of adipose matter with which she was encumbered. The only locomotion she could exert, was that of raising herself in bed, by grasping a stick fastened to a rope, which, at its upper end, was attached to a rafter of the hut in which she

passed her vegetative life. Her end was a melancholy one: in an attack made by the Boors, in a civil war raging in the colony of the Cape, the hut was set on fire, its other inmates escaped, but were unable to carry off this unwieldy mass of fat, which, of necessity, was left to feed the flames. Remarkable as the instances of obesity just referred to may be, they fall far short of that of the famous Lambert, who, unquestionably, is entitled to the sovereignty over all, who, like himself, have moved in the majesty of fat. He was playfully styled "the *greatest* man of his age," and weighed fifty-two stone, eleven pounds.

Such accumulations of fat as these now mentioned may be truly termed morbid, and have, indeed, often proved fatal, since many authentic cases are on record of persons dying, whose only complaint was an inordinate load of fat; and although, in general, a proper supply of this substance may indicate a healthy state of body, yet, an over quantum is destructive to health, and neither goodness of constitution nor personal strength is to be calculated on as holding an equal ratio with the degree of corpulency. There is no mistake, indeed, more common than that of supposing

that when persons grow fat, they also become proportionably strong.

That certain kinds of food favour obesity much more than others is well known; an abundant supply of flesh-meat has, as we might, *a priori*, expect, that property, and hence the generally robust and healthy appearance of butchers in England, and the dealers in sausages and pork in Italy;* sugar too, especially when in combination with farinaceous matter, produces this effect in a remarkable degree; and it is well known that slaves, during the season of cutting the sugar-cane, increase much in weight and bulk, by sucking its juice: instances have been known, indeed, of their becoming so fat from this, as to be unable to work for several weeks.†

But, besides the kinds and quantity of nutriment, there are various other circumstances highly conducive to the growth of fat, such as great indulgence in sleep; small bleedings often repeated; gentle courses of mercury; confinement from slight accidents; hereditary predisposition; the introduction of more food than the demands of nature require: thus, in the state of Tunis, in Barbary, the test of female beauty consists in the degree of obesity which

* Wadd. † See Wadd, page 79.

the lady can exhibit, and young women are there fattened for marriage by being cooped up in a small room and fed with a very nourishing grain called durra (*sorghum vulgare*), with which they are crammed while they are able to gape and swallow.

I before stated, that inordinate fatness is sometimes a fatal disease, and the admission is general, I believe, that even when not directly so, it tends materially to shorten life; it also enfeebles the energy both of body and mind, and is a common cause of sterility;—and that not in the human race only, for every one knows that the fattest fowl lays the fewest eggs. It is said also to favour spontaneous combustion, and a proneness to receive contagion.

With respect to local accumulations of fat, or adipose tumours, they appear on various parts of the body, generally as a single swelling, but sometimes, though rarely, on almost every part of the external surface. They are of slow growth, and may continue for years with little inconvenience; adults are more liable to them than the young, but they occur at all ages, and sometimes acquire a very great bulk. When once established, they never disappear, but, in general, they may be safely removed by

the knife. One of these tumours removed from a man's thigh, weighed nearly fifteen pounds, and another, operated on by Mr. Copeland, was twenty-two pounds. Mr. Cooper states, that he had seen one or two examples which weighed nearly fifty pounds, and that larger ones are upon record.*

Before terminating this chapter, I must still make a few remarks on the fat of animals. This substance in the carnivorous is softer than in the herbivorous tribes, and in the latter, it is firmer in some than in others; in the sheep, for instance, than in the ox. It assumes, too, a diversity of appearance in different tribes, as is sufficiently evidenced by the various names it has received in popular language, according to the animals by which it is furnished. Thus, it is named tallow, in the ox; suet, in the sheep; lard, in the hog; oil, in fishes; blubber, in the whale; and grease, in the goose.

In mentioning fishes and the whale, I cannot omit pointing out to you the wisdom which has directed that in them the fat should be of a much more fluid consistence than in land

* Outlines of Surgery, page 297.—A very interesting case of adipose sarcoma, with a figure, may be found in the third volume of the Lancet, page 25.

animals; for, when we consider the cold medium in which they live, it must be obvious, that were their adipose matter as easily congealed as that of the sheep or ox, much inconvenience might be the result. In the seal tribe, the walrus, the manati, and other web-footed mammalia, it is equally fluid, and equally resists the cold of the water and of the frozen regions which those animals inhabit.

Fat is a bad conductor of heat, and hence the thick coating of blubber which invests the whale tribe prevents their animal caloric from escaping, and thus enables them to endure the utmost severities of winter. But it serves to them also another very important purpose, namely, that of enabling them to keep at the surface of the water, with a small exertion of muscular power; a matter of the utmost importance to animals which must rise to breathe air, as man and other hot-blooded animals do, by lungs, and not like fishes, which act upon the air contained in water by gills. The great mass of light blubber makes them nearly equiponderate with the water, and enables them to rise to the surface to breathe with little effort, and what is not less important, keeps them at the surface during sleep.

In the cachalots or spermaceti whales, the provision for this last state is even still more evident. Their head is of a vast size, and within it are enormous chambers filled with the light substance called spermaceti, which, mixed with oil, gives their head such a buoyancy, that when the animal is at rest or sleeping, it resembles a rock or small island emerging from the sea. To this circumstance, we may trace the fabulous accounts detailed by Gesner and other old naturalists, of sailors disembarking on the back of a whale, mistaking it for an island, and not aware of their situation till the huge animal, annoyed by their presence or pained by the fire they had kindled, began to move and plunge into the deep. To these fictions we are indebted for the following exquisite lines of Milton, which are not less beautiful, perhaps, as poetry, that the epithet "*scaly rind*" is incorrect:—

"Him haply slumbering on the Norway foam,
The pilot of some small, night-foundered skiff
Deeming some island, oft, as seamen tell,
With fixed anchor in his scaly rind,
Moors by his side, under the lee, while night
Invests the sea and wished morn delays."

CHAPTER IV.

OF THE MUSCLES.

You know what beef is; that it is the red flesh of an ox. Well, then, beef is muscle; but seeing it as you have been accustomed to do, will give no more an adequate idea of what a muscle is, than a heap of dilapidated walls and rubbish could give of the beauty and regularity of the temple or building of which they previously had formed a part. Though beef is red, muscle is not always nor necessarily of that colour, for you know that, in general, the flesh, or in other words, the muscles of fishes, are white; in many birds it is nearly white also, and in various parts of the human body the muscular fibre is whitish grey, as in the muscular coat of the stomach.

The bones may be considered as passive materials in our composition, but the muscles are the grand instruments of animal motion; you cannot advance a single step, nor lift your hand to your mouth; you can neither open nor shut the latter, nor raise your eye to heaven,

nor bend it to earth, but through the action of muscles: in short, all animal motions, a few excepted, depending on what is named the erectile tissue, are performed by muscular contraction.

But, before proceeding farther, I must give you some idea of the structure of these moving organs. First, then, the chief bulk of a muscle is composed of certain fibres or threads, connected to each other by cellular membrane, and I cannot now, perhaps, give you a better general idea of this kind of fibre, and its connecting medium, than by directing you to a very humble illustration; namely, the examination of a bit of boiled hung, or smoked beef. You know that this can be easily separated into threads, and in so doing, you will observe that as each fibre is torn from another, you bring into view a white cottony substance, which had joined the separated thread to its fellows. The thread is the muscular fibre, and the cottony medium is the cellular substance.

In this simple way you recognise these two components of a muscle; but you must not stop here, examine closely any one of the detached threads, and you will find that it may be divided

into still smaller threads or fibres, and when you have arrived at a fibre, which, to your naked eye, appears absolutely single, use a magnifying glass, and you will discover that even this apparently single part is not simple but compound, that is, composed of fibres still smaller.

Having gone so far in your examination, you will be aware that the ultimate muscular fibre must be extremely minute, though, perhaps, you will not go so far as Haller in supposing that it can only be seen *cum acie mentis*, which is equivalent to saying, that it cannot be seen at all. Nothing is more certain, however, than that the ultimate muscular fibres are wonderfully minute; as a proof of which I may mention, that Lieuwenhoeck counted in one fibre 3181 fibrillæ or smaller fibres, and that Hook found fibres in the claw of a crayfish, five hundred times smaller than a human hair.

You will remember, therefore, that every fibre which you can perceive in a muscle is compounded of many fibrillæ, or smaller fibres; and, now, we must consider how these are united to form a muscle, strictly so called. When we examine, for instance, the deltoid

muscle, which covers the upper end of the os humeri or bone of the arm, where it is connected to the shoulder, while we observe the fibres composing the flesh of the muscle, we may farther remark darker and stronger lines, or furrows, in various parts of it; showing that the surface is not uniform throughout, but that the muscle exhibits fasciculi, or bundles of fibres, in themselves distinct, but which, by their union with other fasciculi, make up the substance of the entire muscle.

Now, every muscle is composed of fasciculi of fibres,* and while each visible fibre is made up of smaller fibres, so every muscle is compounded of smaller muscles, namely, the fasciculi alluded to, and these bundles aggregated and enclosed in one common coat of condensed cellular substance form *a* muscle. Every muscle, therefore, consists essentially of bundles of fibres, surrounded by one common coat, the *tunica propria musculorum*, of Haller. This, on some muscles, is strong, and in others, very fine and delicate; but still it exists, though not in all instances, very obvious to the naked eye.

But not only is the entire muscle surrounded

* To this the fibres of the heart form an exception.

by a covering of condensed cellular membrane, but each fasciculus of fibres entering into its general composition, is surrounded by a similar coat; and there is reason to believe that even every individual fibre, however minute, is similarly protected.

The muscular fibre is contractile, and this forms its great peculiarity. There are various other structures in the body which are fibrous, but without the property of contracting—farther, at least, than may depend on their tonicity. But the muscles have a peculiar power of contraction, a power totally independent of any mechanical explanation—a power, implanted in them by the Deity, altogether distinct and independent of any thing that can be referred to ordinary matter, to chemical action, to gravitation, or to any other law in nature with which we are acquainted. It is a thing *per se*, admirable in its nature and results, but of which we are farther ignorant—we cannot explain it, and know not where to find a solution of the secret.

It is, then, by the faculty it possesses of shortening itself, that the muscular fibre is endowed with such extraordinary power—a power sufficient, in some instances, to break

the bones themselves; and, when we reflect that such an amazing force can be exerted by masses of soft flesh, our wonder may well be highly excited. But I must illustrate this more clearly. Suppose, then, that in one of your walks you see a horse, dead, skinned, and lying by the road side, you observe the red soft flesh of which his muscles are composed; yet it was by the contractions of those yielding masses, acting upon the bones of the skeleton, that the horse, during life, was enabled to draw his ponderous load.

Now, consider how difficultly we should, if not previously acquainted with the fact, be able to imagine that such a power could exist in so soft a material: if you look on a beam of oak you find no difficulty in concluding that it possesses great strength; but what strength or power could you expect to reside in a mass of soft and yielding flesh? yet, it is this very substance which enables the draft-horse to move his enormous load, and gives power and energy to the soldier's arm, when he unseams his fellow-man from the "nave to the chaps."

But, while the every-day action of these mysterious and powerful agents excites our admiration, we find instances in which their

usual operation is far outstripped in power and intensity. As some men have better vision than others, or a more acute sense of smell, or a greater power of enduring hunger or thirst, so some possess a degree of muscular strength, which leaves all its ordinary operations at a vast distance behind. Milo, of Crotona, it was said, could rend an oak; and the brutal Roman Emperor, Maximin, exhibited his strength by knocking out a horse's teeth with a single blow of his fist, or breaking the animal's thigh bone with a kick.

In Sir D. Brewster's volume of Natural Magic, you will find some remarkable examples of amazing personal strength; and, among them, an account of the strong man, Topham, who, if Lambert stands unrivalled in the majesty of fat, may well be considered as the monarch of muscle. But even where there is no extraordinary developement of the muscles, yet, under the influence of morbid irritation, or of great mental stimulus, they may be excited to such a violent exertion of power, as, under ordinary circumstances, they could not exert. Thus, a person in delirium, or convulsions, will struggle so violently that several others can scarcely hold him down, and in

tetanus their violent contractions have even been known to snap the bones asunder.

A curious instance occurred in London at one time of the power which volition can exercise in maintaining muscular contraction, in a fellow who, from his feats, had acquired the nick-name of leather-coat Jack. This man, for a trifling sum, would lie upon the street, and by contracting the thin layer of abdominal muscles, allow the wheel of a laden carriage to pass over his belly with impunity. But when stimulated to their utmost efforts by mental operation, the force exerted by the muscles is almost inconceivable, as the following account of the execution of Damien will strongly illustrate. "Damien was executed for the attempt to murder Louis XV. Four young horses were attached to his legs and arms, and were forced to make repeated efforts to tear his limbs from his body, but could not effect this purpose; and after *fifty* minutes, the executioners were obliged to cut the muscles and ligaments to effect his dismemberment, or, in homelier phrase, to hew him limb from limb."*

Besides the contractile fibre, there enter into

* Sir Astley Cooper on Fractures and Dislocations, page 16.

the composition of a muscle numerous arteries, and of course, veins; also, a full supply of nerves and absorbent vessels:—but we must now attend a little to the tendons or sinews.

Now, with regard to these there is a very common misconception among persons unacquainted with anatomy, who imagine that the tendon is the moving organ. How often do we hear, for instance, of the sinews of war, or the sinews of trade, or read of bulkiness of bone and sinew as characteristic of strength; and so it often is, but in a secondary way, for both bone and sinew, you will recollect, are altogether passive, and the muscular fibre alone is the active agent in producing motion, and in it only does active strength reside. The bones are levers on which the muscles act, and the tendons are cords on which they pull, and through whose intervention the moving force is extended to the part to be pulled or acted on. Suppose, now, that you saw a sailor pulling upon the painter of a rope floating in the water, and for a moment imagine that his arm is a muscle, and the rope a sinew or tendon. He is pulling the boat towards the shore, and as he pulls, it approaches the land. But you cannot for a moment suppose that the *rope* has any power

farther than that of a passive instrument, a connecting medium, in producing this effect. The sailor's arm is the effective organ, it is *the* muscle which by contracting pulls upon the rope (or tendon as we may suppose it), and thereby completes the desired object.

Now, take the plantaris muscle, which arises behind the knee joint, and which, though small and possessed of little power, I select on account of the great length of its tendon, in preference to one of more bulk and importance. You observe its fleshy belly (*Plate* 1, *Fig. a*), consisting of muscular fibres, and also, of course, of bloodvessels, nerves, absorbents, and their uniting medium, the cellular membrane. Now, this portion (*a*) you may compare to the arm of the sailor, and the long tendon (*e*) to the rope. When, then, the muscle (*a*) contracts or shortens itself, it consequently pulls the tendon (*e*), and the latter draws the heel, so far as the mobility of the latter will admit, towards the muscle, precisely as the rope attached to the boat drew the latter towards the seaman; the only difference being that the rope was acted on by the numerous muscles of the sailor's arm, the tendon (*e*) by the fibres of the belly of the plantaris (*a*) alone.

I need not, I presume, press upon you farther, that the muscle is the moving power, and the tendon the passive medium through which the ultimate object, that is, the motion of the part into which the tendon is implanted, or to speak anatomically, is inserted, becomes accomplished; and now I must offer you some general remarks upon the tendons.

And with respect to them, I have to observe, that they are *toto cœlo* different from the muscles themselves, though such intimate neighbours: they are not red as muscles are; they have no contractility; in the healthy state they are not sensible, though the muscles are highly so; the muscles abound in bloodvessels, but by our subtlest injections, we cannot fill the vessels of the tendons; they have no nerves sensible to sight; and we cannot find their absorbents: though little doubt can be entertained that they possess, to a certain degree, all those component parts, but anatomical art cannot as yet demonstrate them.

The tendons are of a pearly white colour, and often present a very beautiful silvery appearance. They are extremely various in form, some being round, others flat, again they are in form of an expanded web (or aponeurosis),

some are digitated, or divided into distinct smaller tendons, each running to its own insertion, while others are perforated to admit the tendons of other muscles to pass through them, and thereby acquire a more favourable direction, but I will not occupy you longer on this head; by honest dissection, you will, in time, become acquainted with all their varieties.

As the contractility of muscles is a property of life, we might expect that when the latter becomes extinct, the power and resistance of the muscle would, in a great measure, be lost; and, accordingly, it is known that a living muscle will with ease support a weight, by which, were the muscle dead, it would be torn to pieces: and the fact is not less established that this vital property continues in the muscular fibre for a considerable time after the cessation of life in the animal as a mass.

Of this I may adduce a few examples, and there is a common one, which, I dare say, you have witnessed, namely, the quivering and starting contraction of various muscles in the carcase of an ox, lately suspended in the slaughter-house. Again, if you view the intestines of a sheep, newly killed, you will perceive that they are in active motion, and

present an appearance resembling the contortions of a congregation of earthworms. This is caused by the successive contractions and relaxations of the fibres belonging to the muscular coat of the intestine, and is named the vermicular or peristaltic motion. It is by this motion that the food is propelled through the tract of the alimentary canal.

These vital properties of the muscular fibre are retained still more pertinaciously in the muscles of cold-blooded animals. Thus, the jaws of a tortoise or turtle bite with great force for many hours after the head has been cut off; and the bite of that of a serpent, severed a whole day and night from the body, has proved fatal; while the heart of a skate, as formerly mentioned, beats strongly, if stimulated, even when separated for a longer period from the animal. I had, on one occasion, a rather novel illustration of muscular action in an organ dismembered from the body it belonged to. Being on the sea-shore, at Pulo Bay, in Sardinia, and searching for specimens of natural history, I observed a large lizard running for shelter under a heap of stones. I was just in time to seize it by the end of the tail, but suddenly the resistance made by the animal

to my attempt to drag it from its hiding-place ceased, and I gave it up for lost; but as suddenly had cause for alarm myself, on seeing what appeared to be a small snake, leaping with great agility about my feet, and springing as high as my knee. I instantly started out of its way, and watched it at a respectful distance, when I found that it was the tail of the animal, which I was not before aware could so easily separate; it kept leaping about for a few minutes, but long after it had become spontaneously quiescent, it exhibited lesser degrees of muscular contraction when disturbed. I suppose you are aware that the increase of firmness in the muscles of crimped fish is owing to their contractility continuing for some time after death. The fish, when caught, is killed by a blow on the head, and then a number of deep transverse cuts are made with a knife from the back to the belly margin. The wounds gape, and continue to do so, from the cut fibres having contracted between the incisions, and thereby the fish is much improved for the table. I might adduce many other examples of muscular contractility after death, or after the connexion with the brain and heart has been dissolved, but it is unnecessary.

I have now to remark, that, when a muscle is in a state of action its form may be altered, but there is no actual change of bulk, it being of equal area whether in a state of quiescence or one of contraction, since, in the latter state, it gains in thickness what has been lost in length. This is very clearly proved in the following experiment of Mr. Mayo. "The ventricular portion of the heart removed from a large dog, immediately after death by hanging, was immersed in warm water contained in a glass vessel, which was closed below with a ground glass stopper, and terminated above in an open vertical tube, one third of an inch in diameter. The ventricles continued alternately to contract and dilate for a considerable length of time, during which the water stood at the same level in the tube, totally unaffected by the varying condition of the muscular fibre."*

I have next to observe, that the strength of muscles is greatly increased, in the living animal, by being often thrown into violent, and not long-continued action; and hence, as is well known, the muscles of the legs in dancing-masters, and those of the arms in blacksmiths,

* Anatomical and Physiological Commentaries, vol. i. page 12.

acquire great bulk and power, while, on the contrary, they become weak and diminished in cases where they are comparatively unemployed, as in the limbs of tailors, and others used to sedentary employments.

My present object being to give you only general ideas of the several component parts of the animal frame, I have, in this chapter, little more to say with regard to the muscles, though there are a few circumstances which I cannot omit, and which I will first attempt to illustrate by *Figure* 2, *Plate* 1, which represents the gastrocnemius muscle, one of the principal extensors of the foot, and the belly of which forms the most prominent part of the calf of the leg. I have mentioned the word belly, and now I must observe, that, in a great majority of muscles, there are three parts especially noted in their description, namely, their origin, belly, and insertion, or to use the older nomenclature, the *caput* or head, the *venter* or belly, and the *cauda* or tail.

Now, the gastrocnemius muscle arises from the posterior surfaces of the two condyles, or inferior protuberances of the thigh bone, by two heads (*a* and *b*), and forms two muscular bellies which terminate in a powerful tendon

(*c*) which is broad above, but contracts as it descends and is finally implanted in the back of the heel-bone, at (*e*).* You will recollect that this is common to most muscles, and, in reading their description, you will generally find that their origin, belly, and insertion, form essential parts in the detail.

Suppose, then, that you are examining the muscles of an animal, how are you to know what is the origin, and what the insertion of any one which you may expose to view? In this, there can, in general, be little difficulty, if you will recollect that the *origin* of the muscle is that which arises from the *fixed* point, and the *insertion* is the end implanted into the part to be moved. In the *figure*, for instance, the two upper ends of the gastrocnemius (*a*, *b*) form its origins, but the lower end (*d*), fixed in the heel-bone, is the insertion: because, when the bellies of the muscle (*a*, *b*) contract, though they may pull with equal force on each end, yet, as the lower is implanted into the part which will be moved by pulling upon it, and

* It is called the tendon of Achilles (tendo Achillis), it being the part by which Thetis, the mother of Achilles, is fabled to have held him, when she dipped him in the river Styx to render him invulnerable.

the other not, it, of course, is the insertion. You will remember, therefore, that the end of a muscle which is attached to the part to be moved is its *insertion*, while that attached to the part that is not moved is its *origin*.

This, then, you will adopt as a general rule; but, in your prosecution of the anatomy of the muscles, you will find not a few instances where one end of a muscle may at one time, according to circumstances, be the fixed, and at another, the moving point. But this is not the time to dwell much on minutiæ. I am now teaching you the first steps to anatomical science, and must not overload your memory.

While muscles, in general, have one or more distinct origins and insertions, there are some which cannot be well said to have either. How, for example, do you close your mouth? why, by the action of a muscle which can scarcely be said to have either beginning or end: a circular muscle, which runs round the mouth, forming the chief bulk of the lips, and, from its form, named the *orbicularis oris*. This affords a fine illustration of the capability of dilatation and power of contraction in the muscular fibre, as will be apparent on reflecting to what an extent the mouth may be

opened, and again, in the twinkling of an eye, be closed by the contraction of the orbicularis, so as not to allow the smallest object either to be received or expelled unless your own will sanction the act, and permit the orbicularis to relax. Muscles of this kind are named sphincters, or sphincter muscles, from their office of closing orifices, the term being derived from the Greek verb *σφιγγω* (sphingo), to shut up. To dwell on the various kinds of muscles as depending on their office and action, their form, their direction, or disposition of their fibres, their uses, &c. would now be out of place; and the proper time to become acquainted with these and other circumstances, connected with the muscular system, will be when you are employed in actual dissection of the things themselves.

CHAPTER V.

SKETCH OF THE CIRCULATION OF THE BLOOD.

EVERY one has heard of the circulation of the blood, but it is surprising how very few persons, beyond the pale of the medical profession, have any definite ideas on the subject. All know that the blood flows in the veins, and that when a large artery is wounded, a fatal hemorrhage will ensue; and this forms the sum total of the knowledge of a large proportion even of the best generally informed inhabitants of these islands, so far as relates to this wonderful and beautiful process. It is difficult, indeed, to acquire, and, perhaps, still more so to convey, precise notions of the circulation; and though I may now conceive that the following explanation will be found clear and simple, yet I am sufficiently sensible, that in this I may be deceived.

You know what a muscle is;—in man, and other hot-blooded animals, the heart is a combination of four hollow muscles, of peculiar

texture—composing, apparently, a single, but in reality a double, organ. Now, one division of the muscles of the body is into that of voluntary and involuntary. You can at any time raise your hand to your head, or stretch out or bend your foot, and hence the muscles performing these motions are called voluntary, because they are under the direction and control of the will; but you cannot at pleasure command the movements of the heart, and hence the muscles forming it belong to the involuntary class, because they are *not* obedient to the dictates of the will; and so, being governed by the laws of organic, and not of animal life, the pulsations caused by their action go on from our earliest state of existence till the last dying moment, and then the heart's contractions, sensation, and life, cease together; yet, during all that period of existence, be it long or short, the heart never, like the voluntary muscles, gets fatigued, never slumbers at its post, and, like the steam-engine, is never tired with its work.

The object accomplished by the beating of the heart, is, to circulate the blood to all parts of the body; the arteries are tubes of one kind, which carry this vital fluid *out* from the heart,

and the veins are others by which it is brought *back* again to the same organ, while the contraction of the muscular walls of the heart is the chief, if not sole, propelling force by which the blood is urged on in this perpetual round. The cavities in the heart, formed by its muscles, are four in number, two occupying the larger and fleshy conical portion, and two formed by muscular appendages, or sacs, attached to its broad end or base. The former are named *ventricles*, the latter *auricles*, there being a right and a left of each.

Let *a* (*Fig.* 3, *Plate* 1) be a hollow body, intended as a diagram of the *right auricle;* (*b*) is a tube entering its top, and (*c*) another entering its bottom;—let these stand for two great veins, through which a current of blood is constantly setting in to fill the auricle (*a*), as represented by the arrows. These great veins are named the descending *vena cava* (*b*), and the ascending *vena cava* (*c*). Now, remember that these are always full of the congregated blood that had flowed through the different organs of the body, and which is eventually brought to them to be discharged into the auricle; that which had circulated in the head, arms, and other superior parts,

being returned by the *descending* cava (*b*), and that of the trunk, and lower extremities, by the ascending cava (*c*). This figure, then, you will consider as the right auricle (no matter how unlike the portrait may be), and the two venæ cavæ which fill it with blood.

The next figure (*Fig.* 4) has, in addition to these, *another* hollow body continuous with the auricle, and which is marked (*d*); this is named the *ventricle;* and you observe, that there is a communication at (*e*) through which the fluid in (*a*), the auricle, can pass into (*d*), the ventricle. You have now, therefore, the blood passing from the two great venæ cavæ (*b*) and (*c*) into the auricle (*a*), and from that into the ventricle (*d*), through the opening (*e*), which latter is named the auriculo-ventricular opening, or ostium venosum.

Figure 5 represents the same parts; and, also, another tube (*f*) going out of the ventricle (*d*) and splitting into two branches (*h* and *i*), one going to the right side, and the other to the left. This is intended to represent the pulmonary artery, and its two great divisions through which the blood passes from the *right* ventricle, and is distributed by their innumerable ramifications, through the lungs

in the right side of the chest, and also through those in the left.

In these plans, then, we have the principal parts necessary to the formation of a heart; viz. an auricle with veins to fill it, a ventricle to receive the same blood from the auricle, and then an artery to carry it from the ventricle to its required destination; and these plans you will consider as representing the *right* side of your own heart, or your right heart, more strictly speaking. Well, then, in yourself, as in all other men, and in all the mammalia, the right auricle, ventricle, and pulmonary artery, give passage to the blood which has been brought to the heart by the two venæ cavæ.

Now, you will remember this, viz.: the blood brought by the venæ cavæ to the *right* auricle is unfit for the purposes of life; it is not of the florid hue, which you observe in that which flows from a cut in your finger or the prick of a needle, but is of a dark purple colour, almost approaching to black. It has already circulated through the different parts of the body, and, in its passage through these, has lost those qualities on which your life depends, if it have not become even poisonous, as some physiologists maintain.

But this *right* side of the heart is *not* for circulating the blood through the body, but only for driving it through the lungs. And why must it be circulated through them?—That it may there be changed, and again fitted for distribution through the system at large, and possessed of those qualities which are necessary for sustaining the life and healthy function of every part. This change takes place through the intervention of the air which we breathe in respiration; it is a subject, however, on which I must not now enter farther. Suffice it at present, therefore, to know, that the blood brought by the two venæ cavæ to the right auricle, right ventricle, and pulmonary artery, is almost black, and incapable of supporting life; but, after being distributed through the myriad branches of the pulmonary artery on the air cells of the lungs, it is again rendered vital, has lost its dark venous colour, and assumed the florid crimson of arterial blood.

This, then, is the office of the right heart, to send the already circulated blood to the lungs, that it may there be purified, and made ready to circulate again as before. But how is it then circulated? How does the blood,

thus changed, find its way to the toes or finger ends? This is effected by the *left* half of the heart; and in it we find, also, an auricle, ventricle, and artery, as in the right; the auricle, too, is filled by veins, as the right is; but, whereas the latter is supplied by the two venæ cavæ (and the coronary vein from the heart itself), the *left* is filled by four veins, viz. the pulmonary veins coming from the lungs—two from those in the right, and as many from the lungs in the left side of the chest. These arise by innumerable origins from the terminating branches of the pulmonary artery, so that, supposing there are ten millions of such terminal branches, there will be as many millions of origins of the pulmonary veins; and the black blood of the pulmonary *artery* has, during this minute division, been converted into arterial blood, and, as such, passes into the minute commencing branchlets of the pulmonary veins; these all congregate from point to point, and finally form the four trunks mentioned, which at last open into the *left* auricle; and thus the same blood, sent from the pulmonary artery, through the lungs, from the *right* side of the heart, passes round to the left —changed, from dark to red, from venous to

arterial, from a state unfit to maintain life, to one endued with qualities by which the vital principle is upheld throughout the system.

And now, the purified blood is prepared to take the round of the body, and convey nutriment and life to all its organs. This is the office assigned to the *left* side of the heart; and while the right sends the blood through the lungs alone, the left is the fountain from which it starts, to be distributed to every nook and corner of the frame. The *arterial* blood, then, brought from the lungs by the four pulmonary veins, flows from them into the *left* auricle, thence into the left ventricle, and from the latter into a great artery, the aorta, which arises from *it*, as we have seen the pulmonary artery to arise from the right; but this, as has been stated, goes only to the lungs, whereas the great aortic tree sends its branches through the entire body, and even nourishes the lungs themselves, the venous blood in the pulmonary artery not being fit for that purpose.

Thus, there are, in truth, only *two* arteries, the pulmonary artery, and the aorta; though anatomists describe very numerous arteries, each by a distinct appellation, and this is absolutely necessary; but you will keep in mind

that these are only the branches into which the aorta divides; they are always full of blood (from the left ventricle, of course), and this is taken up by innumerable veins, and by them is carried to the cavæ, to be discharged, as we have seen, into the right auricle; and thus the sanguine tide is never stagnant nor at rest, but is perpetually flowing from the left heart through the arteries, and thence coursing back to the right heart through the veins, and, from it, by way of the lungs, passing round to the left again. This, then, is a sketch of the circulation of the blood; but, after first referring to the two next figures (*Plate* 2), it will be necessary to dwell a little, in a general way, on the mechanism displayed in the several parts of the heart, before we can satisfactorily understand the admirable process.

Figure 6 (*Plate* 2) is a diagram, in which the two hearts are supposed to be separated, a vertical section having been made through the septum, or partition, by which they are naturally united. 1, descending vena cava—2, right auricle—3, ascending cava—4, fleshy substance of the right heart, the cavity within which is the right ventricle—5, the pulmonary artery—6, its bifurcation into 7, the great

branch to the lungs of the right side—and 8, the branch to those of the left.

Relating to the left side (the systemic heart, or heart of the body), 9, 9, point to the four pulmonic veins running to 10, the left auricle —11, fleshy substance of the left, or systemic heart, within which is the left ventricle—12, the aorta rising from the left ventricle—13, arch of the aorta, with the trunks arising from it, which supply arterial blood to the head and upper extremities—14, the trunk of the aorta, which, having turned down behind the heart, descends along the spine, and distributes its various branches as it proceeds, so as to supply the chest, abdomen, thigh, leg, and, finally, lose its extreme branches in the foot.

Figure 7 (*Plate* 2) represents the human heart nearly as it is found in nature, the two sides being so incorporated that it seems a single organ. The upper thick end is named its base, and its pointed extremity, the apex. It is the latter part which you feel beating in the left side, after running or other violent exercise ; and you will recollect that the heart is situated in the left side of the thorax or chest, and is placed obliquely, its base, or broad end, looking in a direction towards the right shoulder, and its

apex, or point, turned to the sixth rib. It lies between the two lobes of the lungs; for, in the left side of the thorax, the lungs are in two great lobes or divisions only, while in the right there are three, the middle lobe occupying the space in the right side, which the heart does in the left.

Figure 7.—1, apex of the heart—2, right auricle—3, left auricle—4, right ventricle—5, left ventricle—6, descending cava—7, ascending cava—8, shews the trunks of the great veins from the liver (*venæ cavæ hepaticæ*,) joining the ascending cava before it enters the auricle—9, the pulmonary artery—10, its bifurcation into the two great branches 11, 12, which go to the lungs—13, trunks of the pulmonary veins entering the left auricle—14, the aorta rising behind the pulmonary artery (9) from the left ventricle (5)—15, arch of the aorta—16, the three great arteries which rise from the arch, and are sent to the head and upper extremities—17, branches of the left coronary artery and vein, lying superficially on the line of demarcation, between the right and left ventricle—18, branches of right coronary artery and vein—19, the descending aorta, after having passed down behind the heart.

In this figure the arch of the aorta is raised up to show the bifurcation of the pulmonary artery, on which, in its true situation, the aorta naturally lies, connected to it by cellular membrane, and the ligamentous remains of the ductus arteriosus, a part connected with the circulation before birth.

As the auricles do not require much muscular power to throw their contents into the ventricles, we find, that, in comparison with the strong walls of the latter, they are through their chief extent of very inconsiderable thickness. The thinnest part which, on a superficial glance, seems to be an expansion of the venæ cavæ, is named the *sinus* of the auricle, and the loose edge which overhangs the base of the ventricle, is called its appendix or process. The muscular fibres of the dilated portion, or sinus, are not very numerous; and, indeed, the auricle at that part is semi-transparent when held to the light. But in the overlapping part, or appendix, we observe a number of muscular fasciculi, or small muscles, which must have considerable power, and which being arranged side by side, so as to have a distant resemblance to the teeth of a comb, are hence named the *musculi pectinati*. Besides

the two venæ cavæ, a third vein also enters the right auricle, called the coronary vein, which comes from the heart itself. Does the heart, then, which is the fountain, through which all the circulating blood of the body passes, and from which it is propelled to the most distant parts, require a system of arteries and consequently veins, for its own support? It does so, as much as any other organ: it is, indeed, so profusely vascular, that the celebrated anatomist, Ruysch, imagined it to be altogether composed of vessels.

Now, you will remember farther, that the bloodvessels themselves require to be supported by smaller vessels, and hence, the coats or walls of the arteries, let these run where they may, have numerous branchlets from the other arterial branches in their neighbourhood, and when, by any cause, this source of life and sustenance is cut off, the ·blood flowing in their *own* cavity avails them nothing, and the part thus deprived of collateral supply, inevitably ulcerates and perishes. These small vessels which nourish the larger, are named the *vasa vasorum*. *Figure* 8 (*Plate* 3) gives an idea of these, as they appear after a good injection, on the arch of the aorta.

While the arteries depend for their support on the adventitious vessels which they derive from other arteries in their course, the heart itself is supplied by two distinct branches from the aorta, the two first which it gives off, and which arise almost immediately after its emergence from the left ventricle. These are named the right and left coronary arteries of the heart, of the distribution of which through its substance the skeleton plan (*Plate* 3, *Fig*. 9) will give a general idea.

This plan, I must observe, however, gives a very inadequate idea of the vascularity of the heart; as for every branchlet here marked there are in it more than a thousand at least.

And, now, having in the adult traced the blood to the venæ cavæ, and from them into the right auricle, what then takes place? The auricle contracts the moment it is filled. And why does this contraction not force the blood back into the cavæ? The reason is, that the veins are constantly full of blood; this fluid is unceasingly passing onwards in their cavity, and though the reflux wave from the auricle when it contracts, may form a momentary check to this onward flow, still its chief gush passes immediately into the ventricle,

while the backward impulse which had been given to the blood in the venæ cavæ, serves to render the next rush from them only the more impetuous, and hence, the auricle is no sooner emptied than it is again filled from the same source.

When, then, the auricle contracts, its contained blood is almost all thrown into the ventricle, and what then happens? The moment the ventricle is filled, it contracts in *its* turn, and as its muscular walls are very powerful, it would throw back the blood upon the auricle were not some special barrier provided to hinder the reflux. But such a barrier does exist, and in it we have a most beautiful specimen of nature's mechanism. This consists in an apparatus of valves, or rather, a valve formed of several connected divisions, which can shut up the aperture between the auricle and ventricle, and, when the latter contracts, closes the opening, so as to prevent the circulating fluid from returning back to the auricle, whence it had come. This apparatus is called the *tricuspid valve.* It is a white tendinous membrane, consisting of several, generally three, principal portions, each of a triangular shape, the base of the triangle being attached to the edge of

the auriculo-ventricular opening. We next observe a number of silvery tendinous threads attached to the loose, pointed ends of the triangular divisions ; and these, from their being, in fact, tendons, are named the *chordæ tendineæ.* We next find, that the other ends of these tendinous cords are attached to distinct masses of flesh, or small muscles, which interlace like a network on the inner surface of the ventricle, especially towards its apex, or else they project fairly and partly insulated into the cavity. These latter, particularly, are distinct muscles, and are named *musculi papillares*, but they all are called *columnæ carneæ* from their pillar-like or columnar appearance, whether they stand partly insulated or not.

We have now the ventricle filled with blood; it contracts, but the blood cannot get back into the auricle, being prevented by the tricuspid valve: there is no obstacle, however, to its passing into the pulmonary artery, and therefore taking the easy road, it gushes on into it. But the blood is no sooner there, than the ventricle again relaxes. Now, in this moment of relaxation or collapse, why does the blood in the artery not rush back into the ventricle? It would do so; but here we have another admirable

contrivance for obviating this, as *Figs.* 10 and 11, *Plate* 4, will explain; 10 represents the origin of the pulmonary artery, and you observe that it is apparently impervious, its caliber being occupied by the three semilunar membranes, marked (1). Now, these are three valves, but for the performance of their office, they require no columnæ carneæ, and no tendinous cords; a facility of being thrown down, and expanded by the refluent blood in the artery, is all that is necessary. They are, therefore, simple cups, convex towards the ventricle, and concave towards the long axis of the artery. Suppose, then, that the blood in the latter attempts to rush back when the ventricle relaxes, these cups are filled, and thrown down by the fluid, are consequently expanded, and cast across the caliber of the vessel, so as completely to prevent the retrograde passage of the fluid. And you will remember that the arteries, as well as the veins, are constantly full of blood, so that but for the intervention of these cup-like valves, neither ventricle could relax a moment without the contents of the pulmonary artery, or the aorta (for the latter vessel has also a similar valvular apparatus, *Fig.* 12, *Plate* 4), flowing back upon the heart.

The next figure (*Fig.* 11, *Plate* 4) represents the mouth of the pulmonary artery laid open to shew the semilunar valves, and you observe their crescentic and cup-like form (*a*), and that in the centre of each, there is a small projecting body (*b*). This is named the *corpus Arantii*,* or *corpus sesamoideum*, and has been thought to serve the purpose of more completely closing the opening when the valves meet. Now, behind each valve there is a bulging out of the walls of the artery, the object of which is sufficiently obvious; it allows the blood to pass freely behind the valve, and thereby to ensure the falling down of the latter when the ventricle collapses. These bulgings are named the *sinuses of Morgagni, or of Valsalva*.

When we next pass on to the left side of the heart, we find almost precisely the same appearances as in the right; the same mechanism, the same arrangement of valves, the fleshy columns, and tendinous cords, and everything similar, though there are some variations in the detail. Thus, the walls of the left ventricle are much thicker and stronger than those of the right, and for a very obvious reason, namely,

* Arantius was a celebrated anatomist, who died at Bologna, in 1589.

that by their contraction the arterial blood may be urged on to every, even the remotest part of the system, whereas the office of the right ventricle is merely to carry on the lesser circulation through the lungs. The cavity of the left ventricle is somewhat smaller than that of the right; the *ostium arteriosum*, or left auriculo-ventricular opening, is of smaller diameter than the *ostium venosum;* the valve (called the mitral) for closing it, is less developed in breadth, though more complex, than the tricuspid in the right side; the network formed by the columnæ carneæ, is in higher relief, and more beautiful; the left auricle is of a squarer shape, it has the openings of the four pulmonary veins, but there is nothing in it like the eustachian valve, and no entrance, of course, of a coronary vein.

I have now given you a sketch of the heart, and general mechanism of the circulation in man and hot-blooded animals; but I cannot quit the subject without making a few remarks on those beautiful contrivances found in the heart and pulmonary artery, before birth, for diverting the blood from the lungs, through which it could not at that period circulate.

Before birth the lungs are perfectly col-

lapsed, and of very small bulk; the blood, however, is brought by the venæ cavæ to the right auricle, as in the adult, and but for the contrivances alluded to, would, as in the adult, require to be all sent to the lungs; and, under such circumstances, life could not proceed, for it would be impossible for all the blood brought to the auricle and ventricle to pass through the pulmonary vessels in their collapsed state.

Suppose then (as is the case), that, before birth, the right auricle is filled as in after life, by the two venæ cavæ; suppose, what is equally true, that this blood *cannot* pass through the lungs, how is it to be diverted from them, and only a small portion be sent there adapted to their unexpanded condition? In the first place, the two auricles are connected behind, by a septum or partition wall, and before birth this septum is perforated by an aperture called the *foramen ovale*, or oval opening (*Plate* 4, *Fig.* 14, 6), and, when the right auricle contracts, a *part* of its contents rushes into the *left* auricle through this opening, which, of course, lessens the quantity going down into the right ventricle. But still, much more does pass into the latter than *could* circulate through the lungs, and another contrivance was necessary

to prevent its reaching them. We have, therefore, a still more remarkable provision in the pulmonary artery. We have seen that this vessel in the adult divides into two trunks, one to the lungs of the right side, and the other to those of the left. But in the child before birth, the pulmonary artery instead of dividing only into two, divides into *three* trunks, the middle one of which is larger than the other two put together,—indeed it nearly equals in size the pulmonary artery itself,—and it opens directly into the aorta, so that the blood in this great *temporary* trunk does not go to the lungs at all, but is discharged at once into the systemic circulation. (*Fig.* 15, *Plate* 4, *e*.)

By these beautiful contrivances the blood is diverted from the collapsed lungs, by passing partly through the foramen ovale from the right to the left side of the heart, but chiefly through the large middle trunk of the pulmonary artery (technically named the *ductus arteriosus*), at once into the aorta. On the left side of the oval opening there is a membraneous valve, which prevents the blood regurgitating back into the right auricle, and soon after the child is born, this coalesces with the margin of the opening and closes the passage. The *ductus*

arteriosus also soon becomes impervious, and degenerates into a ligamentous cord. As soon as the child breathes, the air-cells of the lungs are inflated, by which the latter are so enlarged as to fill the whole cavity of the chest; there is then no impediment to the full flow of the entire blood of the right auricle and ventricle through their myriad vessels: it now circulates through these; the foramen ovale and ductus arteriosus are rapidly obliterated, and the lesser, or pulmonic circulation, which is to continue through the remainder of life, is perfected.

CHAPTER VI.

OF THE ARTERIES AND VEINS.

ARTERIES.—Of these vessels, you know that, strictly speaking, there are only two, the pulmonary artery and the aorta ; and, also, that it is not only convenient but necessary to designate, by particular names, and describe as distinct arteries, the various branches of the aorta which run to different parts and organs. The branches of the pulmonary artery in the lungs have not, nor could have, any separate appellations, and the only distinctive divisions belonging to it are its two great branches before mentioned, and which are often called the right and left pulmonary arteries, and the still greater, though temporary branch, in the fœtus, viz. the ductus arteriosus.

Considering, then, the ramifications of the aorta as distinct arteries, we find, on examining any one of these, that its walls are formed of three coats, connected one to another by the common uniting medium, the cellular substance. The *outer* coat is composed of the

latter, together with blood-vessels, nerves, and absorbents, and is named the external or outer coat, or the *tunica cellulosa propria*. Many small vessels creep on it, namely, the *vasa vasorum*, and it is generally well supplied with nerves; it is the medium through which the artery itself is supplied with blood, and it also gives strength and elasticity to the vessel.

Sometimes, too, besides this proper coat of the arteries, there is an adventitious covering of surrounding cellular substance, forming a sort of sheath or case in which the artery runs. But wherever these adventitious coats are found, the vessel does not run singly, but in company with other organs. Thus, the sheath of the carotid artery in the neck contains, besides that vessel, the internal jugular vein, and par vagum of the eighth pair of nerves; the sheath of the femoral artery contains it and the femoral vein; and the sheath or capsule of Glisson, which involves the hepatic artery going to the liver, contains also the vena portæ, and the bile ducts. These adventitious sheaths, therefore, are to be considered as walls of defence not for one single vessel or organ, but for several running together under its common covering.

You will next remember that the outer coat of an artery, though only the second thickest of the three composing it, is much the toughest, and hence when a ligature is tied tightly round one of these vessels, the middle and innermost coats will be cut through, while the outer resists, and maintains its integrity.

The *middle* coat of an artery, often called its muscular or fibrous coat, is composed of many threads or fibres running in an obliquely transverse direction, and encircling the vessel. I say encircling, but remember that no one of these fibres is a complete ring; each, on the contrary, forms but a portion of the circle, being of a semilunar or crescentic shape, though by their union they effect the tubular form of the vessel.

Each fibre, then, of this middle coat is formed thus, (, not a circle, but only a portion of one; and a number of these conjoined complete the annular form.

These fibres of the middle arterial coat are of a peculiar nature, and though often called muscular, they have no resemblance farther than their mere fibrous structure, to the fleshy and true muscular fibre, and to this hour it remains a disputed point whether they possess

muscularity or not. Their colour is whitish yellow, and the coat is so thick, that when an artery is cut across it stands with open mouth; the fibres are all transverse, none being longitudinal.

The outer coat, then, of an artery gives it strength and toughness, and the middle elasticity, by which it preserves its open state, and thus offers little resistance to the onward course of the blood. Indeed, after all that has been said respecting the muscularity of this middle coat, it is not improbable that its peculiar substance and structure may have been given chiefly for this purpose, and that while the windpipe is provided with numerous rings of cartilage to render it always pervious to the air in breathing, so the tendency of the middle coat to preserve the open state of the arteries will essentially relieve the efforts of the heart to propel the blood through them.

I have farther to observe, that the middle coat may be separated into several layers; but there is no reason to believe that these are naturally distinct, like the coats of an onion, but that they depend on the facility with which the fibres allow themselves to be detached from each other, and hence, the more pains that are

taken, the more layers may be formed, but they are all artificial.

The *inner* coat of the arteries is extremely thin, dense, and smooth. It has a polished appearance, and offers no asperities to obstruct the passage of the blood along its surface. It is destitute of vessels; but by this you must understand that its vessels are so small as not to admit the finest injection, for there is no part, perhaps, of the animal frame unconnected with the circulating system, unless, as before said, we may except the enamel of the teeth.

The three coats of the arteries now mentioned, are connected to each other by fine cellular substance which some writers have dignified with the name of distinct coats, but to this they are not entitled, and you will recognise this connexion as another example of the office of the cellular membrane in being the medium by which the various parts of the animal structure are united together, no matter how much these may vary in their nature and functions.

VEINS.—While the arteries are the tubes which carry the blood to all parts from the left or systemic heart, the veins form the channels by which it is again returned to the right or

pulmonic heart, and in one circumstance they differ most materially from the arteries, viz. they have no middle fibrous coat. In consequence of this, when you cut a vein across, its sides collapse, come in contact, and do not shew an open mouth like an artery.

Still, however, though a vein has no resiliency in itself sufficient to retain its caliber patent, yet it may be so supported by its connexion to neighbouring parts as to stand open-mouthed when divided. This is the case in some of the veins of the liver, for instance, and, on making a section of this viscus, you will see many veins standing as patent or open-mouthed as arteries, but this arises from their connexion to the parts immediately around them.

The veins, then, are considered as having only two coats, an outer of condensed cellular substance, and an inner, very fine, dense, and smooth; it is supposed, however, that in the large veins near the heart, some longitudinal fibres, thought to be muscular, exist. The veins are more capacious than the arteries, they have a greater number of large trunks, and are more irregular. Their coats are very thin, and of a watery bluish colour, owing to which, and the colour of their contained blood

shining through them, they appear, when lying immediately under the skin in a living person, of a fine azure hue.

Suppose, now, that you wished to inject the *arteries* of the arm:—by inserting the pipe of the syringe into the trunk of the vessel in the arm-pit, that is, into the axillary artery, you will inject all its branches to the finger-ends. But, if instead of the artery you attempt to inject the *veins* of the arm from the axillary vein, which lies equally in the arm-pit, your injection will not, perhaps, run a couple of inches. You never could fill the veins either of the arm or leg from their main trunk, but the arteries of any part of the body you can best inject from their trunks.

Now, how is this to be accounted for? Why will the injection run freely from the axillary artery to the finger ends, and not equally fill the veins from *their* axillary trunk? The reason is this: there are no valves in the arteries, as has already been stated, except those at the origin of the pulmonary artery and of the aorta; but in the veins of the extremities there are numerous valves, and these are so constructed as completely to prevent regurgitation of their contents; though they offer no ob-

struction whatever to the passage of the blood in its onward course to the heart.

The injection, therefore, thrown into the trunk of the vein is interrupted by the first or second pairs of valves it meets with, and can make no farther progress. These, like the semilunar valves at the origins of the two great arteries, are in form of cups, and as the hollow of these is turned towards the heart they are similarly expanded, and close the vessel by any fluid that may be urged into the veins contrary to the natural flow of the blood.

The next figure (*Fig.* 16, *Plate* 5) represents a portion of one of the superficial veins of the arm partly laid open. The arrow points to the course of the blood, which you already know is from the hand and fore-arm to the axilla, on its way to the heart: *a* shews the valves which are usually in pairs, though frequently triple (or even more numerous), and of such a size, as, when filled by the refluent blood in the living body, or any fluid in the dead, to completely cross the area of the vessel, and prevent its farther backward progress.

Suppose again, that in place of an arm or leg, you wished to inject the veins of any of the abdominal viscera, would you succeed by fixing

the pipe of the injecting syringe in a venous *trunk?* Yes, perfectly; because those internal veins are *not* furnished with valves,*—they are not required, and consequently do not exist. While, therefore, in injecting the veins of the leg or arm, you must fix your syringe-pipe in one or more veins of the foot or hand, that the fluid may run in its natural course, and not be interrupted by the valves; you may, in the veins of cavities, inject from trunk to branch, there being no valves to impede its passage. With respect to the head, there are some valves in the jugular veins of the neck, forming an obstacle to the injection of the venous system of the brain from them, but in the veins of the brain itself, there are no valves whatever.

Now, why should the veins of the extremities possess valves, while there are none in those of the brain, liver, intestines, stomach, kidney, spleen, &c.? The reason is, that in the extremities these vessels are subjected to the frequent and almost immediate pressure of the muscles of the limb, and of foreign bodies, and were they not furnished with this provision, the pressure alluded to would push back the

* The few pairs of valves in the azygous and spermatic veins scarcely form an exception.

blood of the veins upon the terminations of the arteries, and thereby impede its progress in both; but in the cavities they are not subjected to any such violent and partial pressure, and in them valves are consequently not requisite. It is true, indeed, that in the abdomen and chest the veins undergo a very considerable degree of general pressure, from the action of the diaphragm and abdominal muscles; but there is no compression on any particular vein, such as to stop for an instant the progress of the blood within it.

As a farther provision too in the limbs, it may be stated that the veins run in two principal sets, one superficial or subcutaneous, and the other deep-seated, accompanying the arteries, so that if the onward flow in either be impeded by any sort of compression, the blood can find its way by the other, and thus the circulation be freely maintained.

The valves of the veins are very numerous, and we find in connection with them the same contrivance which we observed belonging to the valvular apparatus within the mouths of the great arteries, viz. a bulging out of the coats of the vessel so as to allow the retrograde blood to pass easily behind the valves, and

thereby throw them across the cavity of the vessel. It is owing to this, that when you examine a preparation of either extremity, in which the veins are injected with wax, you observe them not to have the smooth continuous surface of arteries, but to exhibit, every here and there, knotty protuberances, as in *Fig.* 17, *Plate* 5. These knots, or tubercles, mark the places of the valves, and the cause of their projection is, the dilated portion of the vessel behind them being filled with the injection.

Many particulars relating to the sanguiferous system remain to be explained, such as the pericardium or bag which surrounds the heart; the full account of the fœtal circulation; the occasional great developement of vessels and their return to their former dimensions, as in the uterine vessels, in consequence of gestation; the enlargement of collateral branches when the main artery of a part is obliterated; the arterial thickness of the femoral veins; the ramification of the vena portæ; the tortuosity of the temporal and some other arteries; the varieties in arterial ramification, &c. &c.; but to attempt explaining these and various other matters connected with the blood-vessel system,

at present, would only weary out your patience. These, together with the morbid states of the vessels, the accidents they are liable to, and the methods of cure, must be pursued afterwards, as you advance in your studies; for, as before stated, my wish now is to direct you on the way to the Hygeian temple of knowledge, without pretending to lead you into the *ima penetralia* of the edifice.

CHAPTER VII.

OF THE ABSORBENT SYSTEM.

When food is received into the stomach, it is in a few hours reduced to the form of a greyish pulp, called chyme. This passes from the stomach into the intestine, and at a few inches distance from the former it receives the bile flowing from the liver, and the pancreatic juice from the *pancreas*, or sweet-bread, a gland placed behind the stomach, and similar to the salivary glands of the mouth. Soon after this, a white fluid separates from the mass, and this, which is the most nutritive part of our aliment, is named the chyle.

Here, then, we have the food reduced in the stomach to a pulp; next we find it in the upper end of the small intestines (the duodenum) combining with the bile and pancreatic secretion, which are conveyed by their respective ducts to the alimentary canal, after which we find the nutritive part of the mass, the white

chyle separated from the grosser materials; and it is one part of the office of the absorbent system to carry this bland and milky chyle into the blood.

Eustachius may be considered as the first anatomist who discovered any part of the absorbent system. About the year 1563, he saw the thoracic duct in a horse, and described it under the name of the *vena alba thoracis* (the white thoracic vein); but he could not understand it, and succeeding anatomists neglected his discovery, so that no more of the absorbent system was heard of till 1622, when Asellius detected the lacteals. That anatomist was inspecting the motion of the diaphragm in a dog, when he observed a number of white lines on the mesentery, which he at first thought to be nerves, but on puncturing them a white liquid was discharged, and the lines then collapsed and became invisible. From this first observation and subsequent research, Asellius clearly ascertained that the whiteness of these vessels arose from the colour of their contents shining through their transparent coats, and that they, and not the mesenteric veins, as had been previously supposed, were the channels by which the chyle taken up from the alimentary mass

was conveyed to the blood. He called them lacteals (*vasa lactea*), but being unacquainted with the thoracic duct in which they finally terminate, he conceived that they carried the chyle to the liver. As human dissection was not then practised, Asellius had no opportunity of observing them in man, though from analogy he justly concluded that they must exist in the human structure; in this, however, they were not detected till the year 1634, when they were seen by Veslingius, who published a figure of them. Veslingius, also, according to Haller, was the first, after Eustachius, who discovered the thoracic duct. It is also known that Rudbeck, a Swede, thirty-two years after Asellius's discovery, but without any previous information on the subject, discovered the lymphatics in quadrupeds. He named them *vasa serosa* (serous vessels). About the same time, also, these vessels were seen by Bartholine, the Dane, and by Dr. Jolyffe, in England; Bartholine called them *vasa lymphatica* (lymphatic vessels), which name they still retain.

Now, as the office of the lymphatics and of the lacteals is similar, namely, that of absorbing or sucking up fluids and carrying them to the blood; the term absorbents is given to all,

whether arising from the alimentary canal and conveying white chyle, or from other parts and carrying a transparent lymph. The chyle, too, you will remember, is not in all animals white, for in birds it is transparent; the lacteals, therefore, and the lymphatics are precisely the same sort of vessels, the colour alone of the chyle causing the distinctive epithet of lacteal.

The absorbent system, then, consists *first*, of the absorbent vessels, that is, of the lacteals and lymphatics; *second*, the conglobate or absorbent glands, through which these vessels pass on their way to (*third*) the thoracic duct, which is the great trunk receiving their contents and conveying them into the blood; it is, however, nothing more than a large lymphatic, for as the vena cava is as much a vein as the smallest branch opening into it, so the thoracic duct, notwithstanding its size, is as much a lymphatic, as the vena cava is a vein.

Let us now trace the progress of the chyle through the lacteals to this duct, or great lymphatic trunk (*a*). *Figure* 20 (*Plate* 6) represents a portion of small intestine, with a part of the mesentery (*b*), that membrane by which it is connected to the spine, and from between the two layers of which it receives its

numerous arteries, and through the same medium transmits its veins to the general circulation, and the lacteals to the thoracic duct. You know that the veins of the extremities have numerous valves, but these are trifling in number compared with those of the absorbents, which are extremely plentiful, not only in the extremities, but in the cavities, and, indeed, wherever they exist. You see the jointed appearance (*c*, *c*—*Fig.* 20, *Plate* 6) of the lacteals when filled with quicksilver, so that they look like strings of beads; this is caused by the valves, which, like those of the veins, are duplicatures of the inner coat of the vessel forming pairs of crescentic cups.

Now, when an animal (a calf, for instance) is killed a few hours after having had a full meal, the lacteals are seen in vast numbers, running from the intestine along the mesentery, in form of white lines, but presenting no jointed appearance, and the latter, in the injected preparation, is caused by the weight and pressure of the mercury distending the sides of the vessel; but, where the valves are situated, a much greater resistance is given to this pressure than in the interspaces, and consequently a constriction is there apparent, and hence the

jointed or bead-like appearance. Soon after the animal has been opened the white lines disappear, the transparent lacteals having emptied themselves by their own contractility, the latter being increased perhaps by the cold and stimulus of the external air; and hence, as even after death, these vessels urge on their contents without any assistance from a contractile fountain-head, like the heart in the circulating system, it is to be inferred that they possess a muscular coat for this office. At the same time, however, they are so thin and pellucid, that this opinion must be received rather as a hypothesis than as a fact proved by actual demonstration.

That the contents of the lacteals flow with great rapidity to the thoracic duct, there can be no doubt. "The chyle," says Mr. Cruickshank, "in the lacteals of the mesentery of dogs, in some of my experiments, evidently ran through a space of four inches in a second, which is twenty feet in a minute; I have at other times seen the absorbed fluids vanish with almost incredible velocity."* The rapidity, however, with which these vessels take

* Anatomy of the Absorbent Vessels. Ed. 2d, page 30.

up and convey fluids will be greater or less according to their healthy state; thus, in dropsy, their action is defective, and the effused fluid will remain in the cavity where it has been accumulated, for months, without the absorbents carrying it off, when being stimulated by mercury or other medicines, they may become so roused into activity, as to remove it entirely in a few days or weeks. Their absorbing power may also be occasionally increased to an injurious degree, especially under the use of iodine; and various instances have occurred in which they have been excited to such over-action, that the breasts in females, and not less important glands in men, have disappeared, in consequence of the excessive absorption caused by the use of that drug.

The lymphatics, like the veins, run in two sets, a superficial and a deep; and it almost invariably happens that before they reach the thoracic duct, to which they generally tend, they pass into one or more roundish, or oval bodies, which are called the absorbent, lymphatic, or conglobate glands. The term *gland* is taken from the Latin *glans*, a nut or acorn, but it is applied to organs which differ both in form and structure very materially from each

other. Some are named conglomerate glands, because they seem to be composed of an aggregate of numerous smaller glands united together. The office of these is to form from the blood, by the process called secretion, various fluids intended either for definite uses, or as excretions from the system; thus, the part of the female breast which forms or secretes milk, is a conglomerate gland, as are also the lachrymal gland placed within the outer angle of the socket of the eye, which secretes the tears, and the parotid and other salivary glands which form the saliva. The structure of the conglobate or lymphatic glands is very different, and their use is unknown or only guessed at; they consist chiefly of a tissue of convoluted absorbents, connected by cellular substance, and enclosed in an envelope, or capsule of the same substance condensed. They are copiously supplied with bloodvessels, and are generally arranged in clusters. They have various names, which are usually taken from their situation: thus, those in the arm-pit are called *axillary*, and those in the mesentery, *mesenteric* glands. There is a chain of them on each side of the neck, called the *glandulæ concatenatæ*, and in this situation one or more

of them are very often swelled and painful, especially in scrofulous children. Such swellings in this country are vernacularly termed wax-kernels; and their frequent occurrence is probably owing to the free exposure of the neck to cold.

With respect to colour, the lymphatic glands immediately under the integuments, are redder and firmer than those in the cavities; and the bronchial glands, at the bifurcation of the windpipe, are bluish, or often almost black. The lacteal glands in the mesentery are very numerous, amounting even to 150, and scattered over it; but in some quadrupeds, as the dog, they are massed together, and have been called the *pancreas Aselii*. The size of the absorbent glands, also, is very various, some not being larger than a grain of barley, and others larger than the kernel of an almond.

The thoracic duct (*Fig.*21, *Plate* 6—*Nos.* 14, 15, 16)—which is not quite correctly named, as a large portion of it lies in the abdomen—arises usually by three trunks, formed by the lymphatics of each lower extremity, and of the pelvic viscera; the single tube formed by the union of these three over the second lumbar vertebra, runs up along the spine between the vena cava and aorta, then passes behind the

arch of the latter, and finally opens into the angle formed by the meeting of the left internal jugular and left subclavian veins, and thus its contents derived from the lacteals and lymphatics, are poured into the torrent of circulating blood, almost in the immediate neighbourhood of the heart.

After this very general sketch of the absorbent system, I may remark that the lymphatics are extremely numerous. "In my dissections," says Cruikshanks, "I have found more lymphatics than either arteries or veins, in such parts of the body where I have succeeded well in the injection: and I have no reason to doubt but they are as numerous in the other parts."* An idea of their number, indeed, may be formed, when it is stated that in the extremities, each cutaneous vein is generally accompanied by no less than fourteen lymphatic trunks.

In the progress of your studies, you will have many more facts relating to the absorbent system than it has been my intention to mention here; as, for instance, that there is a small second thoracic duct opening into the right

* Loc. cit. page 90.

subclavian vein, and carrying the contents of the lymphatics of the right side of the head, right arm, and right side of the lungs—that veins have powers of absorption—that the skin can in a few hours absorb some pounds of water from a damp atmosphere—that the conglobate glands in young animals contain a white fluid, the use of which is unknown—that they, also, especially the mesenteric glands, often enlarge to an enormous size in scrofulous constitutions, forming the fatal disease called *tabes mesenterica*: De Haen states one case in which they had increased to the weight of thirty pounds; &c. &c.

CHAPTER VIII.

OF THE NERVES.

While the sanguiferous system consists of the heart, arteries, and veins, the nervous system is composed of the brain, spinal marrow, and nerves. And as the heart is a double organ, united into one, so is the brain formed of two conjoined organs: and, while each side of the heart has a larger part, the ventricle, and a smaller, the auricle; the brain has on each side a larger mass, named the *cerebrum*, and a smaller, called the *cerebellum*. *Fig.* 22 (*Plate* 7) represents the base of this organ, in which *a*, *b*, *k*, point to the cerebrum or greater, *f*, *f*, to the cerebellum or lesser brain, and *h* to the *medulla oblongata*, that part which, in comparing the spinal marrow to a column or pillar, would represent its capital.

You have seen the brain of a rabbit or a sheep, and are aware of its soft consistence; the human brain is equally soft, and a very

slight force will penetrate it. Its parts are numerous and complex, and few portions of the animal frame are more difficult to explain or comprehend; no verbal description could give you sufficiently clear notions respecting the numerous parts of it mentioned by anatomists, and, at present, it would be idle to attempt offering you any lengthened description of it.

No merely verbal account, indeed, unless it be of some simple parts, will ever convey sufficiently full and clear ideas, unless accompanied by an actual examination of nature itself. Plates and casts, it is true, serve very materially, in giving general ideas of the construction of parts; but dissection alone, careful, reiterated, and patient dissection, can give that truly accurate knowledge, which you must aim at in your anatomical pursuits; and whatever you may now read or learn, will only pave the way towards that real and satisfactory information, respecting the animal structure, which is to be acquired from practical anatomy alone. The subject, the scalpel, the minute and accurate description, zeal, patience, and perseverance, are the things necessary to form a real anatomist; but you have had neither opportunity nor trial in these matters,

and, therefore, a few remarks farther concerning the brain will not be unnecessary nor uncalled for.

Notwithstanding, then, its soft and pulpy nature, it is, as being the seat of the mental faculties, the noblest part of the human frame; it also is the prime director and governor of the animal actions, and the immediate seat of feeling and sensation. The muscles could not perform their functions without the nervous influence connecting them with the brain, or its continuation, the spinal marrow; independent of it the eye could not see; neither without the brain could we possess the sense of smelling, nor could we be sensible to sound: for, however admirable the formation of the complex organ of hearing is, it would have been made in vain but for the cerebral mass which communicates with the mind. The curious apparatus for conveying the vibrations of the air, the delicate arrangement of tubes, and expanded nervous pulp, with the other exquisite contrivances of the auditory organ, would have been of no avail but for the part of the brain which gives birth to the acoustic nerve: without this part, or without a communication being kept up between it and the

external organ through the nerve, though the vibrations of sound were equally communicated, still, they might as well fall on as much lead, for the ear, notwithstanding its admirable and multiplied machinery, does not hear of itself, it is but the organ for receiving vibrations; and though the pulpy extremities of the optic nerve in the eye, and of the auditory nerve in the ear, are often considered as the immediate seat of seeing and hearing, they are only media of communication—necessary, indeed, for such communication—but the portions of the brain from which the nerves arise are the real and final organs of the sense, without which the mind could neither feel, appreciate, nor enjoy the phænomena and operations of light and sounds.

And so it is with all the organs of sensation and locomotion; let the nerves supplying a limb be cut through, and its communication with the brain be thereby intercepted, that limb is henceforth deprived of all voluntary motion, it is no longer obedient to the commands of the will, its sensibility, too, is gone, and it hangs a useless and unfeeling appendage to the body.

But, while the organs of voluntary motion, and the functions of the senses are so imme-

diately influenced by the brain, there are other parts of the system in some measure independent of it, and over which the will has no power—I allude to the sympathetic or ganglionic system of nerves which is the great agent in regulating the involuntary actions of the body, and under the control of which the processes of circulation, digestion, secretion, absorption, nutrition, and other functions of organic life, are carried on silently but surely, without any interference of the will, and without our being conscious of the presence of so powerful and certain an agent directing and controlling the most important functions of the body. These sympathetic nerves in man and the higher classes of animals, can scarcely be said to have either any defined origin or termination. They communicate with the ordinary nerves, by numerous inosculations; and, as they keep up a very general connexion and sympathy with many parts of the system, they have acquired the name of the sympathetic nerves. They have also the appellations of ganglionic nerves, from the swellings named ganglions observable in their course: and vital, or organic nerves, from the heart, stomach, intestines, and other vital organs, being under their control.

These nerves occupy chiefly the cavities of the body, as we might, *a priori*, expect from their office, and they are said to appertain to all animals in which a nervous system has been discovered, whether they possess what can strictly be called a brain or not. But I must now attempt to explain what a nerve is. With the exception of the sympathetics, which cannot be truly said to have any distinct origin, the nerves are described usually as arising from the brain or the spinal cord. But this you must consider as only a language of convenience to express that they are continuous, or connected with these parts, for it has been ascertained, that, in the successive developement of the nervous system, the spinal marrow is formed before the brain, and some parts of the brain before others.

Taking, however, the ordinary view of the subject, let us suppose that the nerves are productions, or branches from the brain and spinal marrow. Now, the *essential* part of a nerve is composed of the same soft, pulpy substance, as that which forms the bulk of the brain itself and of the spinal cord. How, then, is so tender a part to be conveyed safely to the limbs, or other situations, where it

must be subjected to frequent, and often violent pressure?

This is to be explained by considering the manner in which it is involved in the nervous tunics. The brain has three coats—the outermost exceedingly strong, named the dura mater; the next to that, the arachnoid coat, which is as delicate nearly as a cobweb; and, thirdly, the pia mater, which is considerably thicker than the arachnoid, though still of very great tenuity. The two first serve as envelopes, surrounding the brain; but the pia mater penetrates to all its parts, and forms the medium by which the blood-vessels are conveyed to its most intimate substance: and here you may recollect that no blood-vessel, whether artery or vein, exists in the brain itself, except in a state of very minute division. If you make a section of the liver, or kidney, or lungs, you see large branches, both arterial and venous, coursing through their substance; but, in a soft pulpy organ like the brain, it must be at once obvious, that any but the smallest ramifications of vessels would form a source of the utmost risk; in increased action they would compress it, and any obstruction to the return of blood would cause dilatation of the vessels

and rupture. Therefore, while a very large proportion of blood is sent to the brain, still, the vessels through which this is distributed to its proper substance are very minute, every artery separating into extremely small ramifications on the pia mater, previous to its entering the brain itself. The arterial coats, too, are very thin, compared with those of other organs, and thus another provision is made for obviating injury to this very delicate organ.

Now, the three coats of the brain are thought to be prolonged upon the spinal marrow and nerves, their outer coat being a continuation of the dura, and the inner of the pia mater. But, if these formed merely a tube, surrounding the enclosed medullary substance, the latter would have no effectual guard against pressure, and a muscle could scarcely contract without bruising and disorganizing it; while, therefore, the outer coat of a nerve, composed of attenuated dura mater, may be considered as a simple tube, the pia mater dives into the nervous pulp, separates it into innumerable minor cords, so that every nerve and nervous branch, while it has its external covering of dura mater, is internally compounded of nerves still smaller, and this minute division of

the pulp saves it from innumerable injuries. The pia mater, thus continued on a nerve, loses that name, and is called the neurilemma, or nerve-tunic.

But, while the nerves are themselves compound, the smaller cords composing them are compound also; and hence, when subjected to the microscope, every fibril is seen to be composed of smaller fibrils, and this to such a degree of minuteness as to render most of our opinions respecting their precise structure, rather matters of inference, than of actual demonstration.

It has been stated, that, when the nervous connexion between a limb and the brain is cut off, the limb loses all sense and motion; when the spinal marrow is wounded, these results are still more striking. Suppose that a sailor is stowing the cargo of a ship, and that while stooping under the hatchway, some heavy body, in the act of being lowered into the hold, escapes from the slings, and falls sheer upon his back. He is not killed by the blow, but when extricated from the fallen body, every part of his frame, below the part struck, is totally devoid of feeling and motion; he cannot move a muscle, nor is he conscious of possessing

any part of his body below the injury. The spinal marrow has been ruptured; and this being the great cord of communication between the body and the brain, and that communication having been dissolved, the brain cannot influence the muscles of the limbs, and consequently no motion can be exerted. The same cord is the medium by which sensation is conveyed, but there is sensation no longer, because the internunciate line is broken, and all communication interrupted; and the parts below the injury are so totally devoid of sensation, that they might be dissected as deliberately as the limbs of a subject on an anatomist's table, without the person, though alive, being conscious of the operation.

I may illustrate this by a melancholy example. A woman, who had been thrown from a cart, was brought to the Belfast Hospital, affected with total insensibility and loss of motion from the loins downwards. The spinal marrow, in its channel through the lumbar, or lower vertebræ of the spine, had been severely injured. On one occasion, during the period (about a fortnight) between the time of the accident and her death, the nurse of the ward in which she lay, remarking that her feet and

legs were very cold, thought of heating them by the application of a warm brick, rolled in a cloth; the brick was too hot, and, in a short time, the bed-clothes were on fire, and the patient's feet and legs were dreadfully scorched; but of this she was totally unconscious, and, indeed, she would have been equally so had they been burnt to a cinder.

You observe then, that, in these cases, both feeling and motion are destroyed by the communication with the brain being cut off; and here a question arises, namely, are all nerves the conveyers of both these, or do some serve for motion only, and others only for sensation? The admirable reasoning and conclusive experiments and observations of Sir Charles Bell have taught us how to answer these questions. He proved the important fact, that some nerves serve for motion alone, and are totally incapable of conferring any degree of sensibility on the parts to which they are distributed. The portio dura, for instance, of the seventh pair of the brain which supplies the muscles of the face, if it be divided, the muscles to which it is distributed become instantly paralytic, but the sense of feeling remains as before. On the other hand, if this nerve be untouched, and the

fifth pair be cut across, sensation in the side of the face is as instantaneously destroyed; but the portio dura being uninjured, the voluntary control over the facial muscles remains perfect.

Well, then, in injury of the spinal cord, you have seen that *both* sense and motion are destroyed. How is this to be explained? Are the nerves proceeding from this continuation of the brain possessed of an influence capable of producing not sensation alone, nor motion alone, or have they a power over both? Suppose, now, that the fifth nerve which gives sensation to the face, and the portio dura which gives it motion, were wrapped up in one common coat, that instead of remaining apart they were intimately joined together, so that wherever the one was, the other would be found close to its side, what would then result from cutting the cord formed by them both? It must be obvious, that the sense of feeling belonging to the one, and the power of influencing motion possessed by the other, would both be destroyed at the same moment.

And such is the case with the nerves proceeding from the spinal marrow; they seem simple, homogeneous cords, but they in reality are not so, each combines in itself a nerve of

sensation and a nerve of motion, but so indissolubly connected that no eye, even assisted by the microscope, can distinguish the one from the other, so similar are they in structure and appearance, and so intimately amalgamated together.

But you may enquire whether we know this from any other circumstance, than simply, that their division annihilates feeling and motion in the parts which they supply? Sir Charles Bell has given a most satisfactory solution to this query, which I must now endeavour to explain.

The vertebræ, or bones composing the spine, are so constructed, that behind the body of each there is a large hole or ring for giving passage to the spinal marrow, so that when conjoined in their natural state, one continued canal is formed running through the whole chain, from the skull to the pelvis. The spinal cord passing through this bony channel, and bearing a similitude to the way in which the marrow is encased in the long cylindrical bones of the skeleton, has acquired the improper name of spinal marrow; but it resembles the marrow in no other circumstance—it is not marrow, but brain. In this passage it gives out the

spinal nerves, one upon each side, between every two vertebræ, making with those from the os sacrum in the pelvis, thirty pairs in all.

Now, every spinal nerve has a double origin, each commencing by a number of roots; and it was reserved for Sir C. Bell to discover that the portion of each nerve characterized by the particular kind of root, shews whether it is intended for sensation, or for voluntary motion. The roots from the anterior surface of the spinal marrow are such as represented (*Figure* 23, *Plate* 7, *c*), without any farther mark to distinguish them; but the roots originating from the posterior surface, unite before entering the nerve, and form a swelling or tubercle, named a ganglion (*Plate* 7, *Fig.* 23, *d*), and therefore here is a very marked distinction between the two sets of roots, namely, those from the *posterior* surface of the spinal cord unite to form a ganglion, and those from the *anterior* surface do *not* unite to form any such swelling.

This anatomical structure has been known from a very early period of medical history; but no real explanation of the different office performed by the nervous filaments proceeding from the ganglionic, and non-ganglionic roots was given, till Sir C. Bell ascertained that

those from the ganglionic origins are the agents of sensation, and the others of motion. Suppose, then, that in a living animal the roots of the nerves arising from the *anterior* column of the spinal cord are cut through or destroyed, what will the result be? That the parts to which the nerve runs will be deprived of motion, not a muscle nor fibre of a muscle belonging to them will contract at the bidding of the will; but feeling, and the sense of touch, will remain undiminished, and if the skin be pinched, pain will be equally pungent as if nothing had happened to any part of the nerve.

Suppose, again, that the anterior roots are left undisturbed, but that the posterior or ganglionic roots are cut through; precisely the reverse follows, voluntary motion remains, but sensation and feeling are destroyed; the muscles act as before, but the skin may be pinched, or the flesh wounded, and no pain, nor unpleasant feeling will be excited.

You must next remember that all nerves are not in this way double; as, for instance, those which minister to the senses of sight, smelling, and hearing, and, also, those which serve for muscular motion only and not for feeling, as

the third, fourth, sixth, portio dura of the seventh and the ninth pairs of nerves proceeding from the brain, all of which are nerves of motion alone, and, of course, have no ganglion at their roots. It does not follow, however, that the muscles these nerves supply are devoid of sensation; but then, the latter is derived from *other* nerves which *do* proceed from a ganglionic root. The difference is, that while the double cords, composing the spinal nerves, are enclosed in one common covering, here they run separately; but still, the effects produced by them are the same as though they were similarly united.

I have next to observe, that the spinal marrow is compounded of two columns in front, and two behind, each pair forming its right and left halves, a furrow on each surface marks their limits; but internally they are so intimately joined that no line of demarcation can be perceived. In addition to these, a third and lateral column, on each side, is supposed by Sir C. Bell to exist, the nerves arising from which serve for respiration; this opinion he supports by some very ingenious arguments, and almost proves it to be true; but for farther details I must refer you to his writings.

And now, I must terminate this brief view by reminding you, that, if this third column exist, then the spinal marrow is composed of six cords—three composing its right, and as many its left half: the two in front giving off nerves for motion, the two behind those of feeling, and each lateral those of respiration. The double rooted are named by Sir C. Bell the symmetrical nerves, and of these, thirty pairs proceed from the spinal marrow, and one from the brain, namely, the fifth pair, in which resides the property of giving sensation to the face, while the motor nerve of its muscles is the portio dura of the seventh pair.

CHAPTER IX.

OF THE BONES.

The first step which we will take in examining the structure of the bony system, will be to attend to the appearance presented by a longitudinal section of the thigh bone, the upper end of which section is shewn at *Fig.* 24, *Plate* 8. In this, we observe that the sides, or walls of the bone, are very compact and solid in the middle of the bone (*a*), but that they become gradually thinner towards the end (*b*), until from their being nearly a quarter of an inch thick in the centre they are at their extremities (*c*, *c*) as thin as writing paper; but still, so long as we can distinguish them, they retain their compactness and solidity, however extenuated they may have become. These solid walls form the *compact substance* of bone, which is also sometimes named the cortical or vitreous part.

When we next attend to either end of the bone, where the compact walls are exceedingly thin, we find its whole thickness occupied by

an innumerable quantity of osseous cells (*d*), and bearing a considerable resemblance to a sponge. These cells all communicate with each other, and thus we have a second form of osseous structure, which is named the *spongy substance*, or the cancelli, or lattice-work. It is, also, called the *diploë*, but this term is seldom applied, except to the spongy substance between the tables of the cranium, and to that of the irregular bones of the spine, hand, and foot.

When we examine the section farther, we perceive that the central cavity of the bone for lodging the marrow, is crossed in various places by bony threads (*e*) which inosculate with, and traverse each other, forming wide areolæ, like the meshes of a net. This reticular structure is found most conspicuous, not exactly in the middle of the cavity, but towards either end at the commencement of the cancelli,—it is called the *reticular substance* of bone.

We have, then, in the osseous structure three distinctly named substances,—the *compact*, the *spongy*, and the *reticular*; but it must be remembered that these differ from each other only in arrangement, as they are all composed of the same materials, and chemical analysis gives similar products from each. It is only

in the long cylindrical bones that all are present, and in some of the thin flat bones we discover only the compact substance, while in most of the short ones, as the patella or kneepan, *Fig.* 25, and those of the wrist and foot, the compact walls are extremely thin, and the bulk of the bone is made up of cancelli or spongy substance.

By the older anatomists, the bones were thought to be lamellated, or composed of plates, an opinion which has been combated in more modern times, especially by Scarpa and Howship, whose observations tend to shew that their structure is continuous throughout. Cheselden, however, had long since given the same view :—"Nor are the parts of bones (he says) disposed into lamellæ, stratum, super-stratum, as Gagliardi and others have painted ; for though young bones may in some places be split into lamellæ, yet they not only appear one solid uniform mass to the naked eye, but even with a microscope, till we come to their inner spongy texture, which also appears uniform." Still, however, there are some circumstances which countenance the old opinion ; thus, when a bone is exposed to great heat along with moisture, in a Papin's digester, it splits into a kind of layers ; and the bones of

whales, which have been long exposed to the weather, exhibit a similar imperfectly laminated structure: but these appearances, it must be confessed, carry no great weight.

With regard to the classification of bones, their processes, depressions, foramina, &c. it is not my intention to occupy you now, as these and other technical points will be best learned when you come to study the descriptive anatomy of the skeleton, and, consequently, would here be out of place. Neither will I attempt any minute detail of the formation and growth of the bones, though it will be proper to state a few circumstances connected with that part of their history. The bones, then, as every one knows, are extremely hard; but they are not so at every period of their formation, for before assuming this solidity they are in a state resembling cartilage or gristle, and even in their hardest condition their basis is composed of a similar cartilaginous substance. This you can ascertain by a very easy experiment: take a rib of beef or mutton, or a bone of any kind, and steep it in a mixture of equal parts of muriatic acid and water for a day or two, and then examine it, and what will it then be like? Why, it will have precisely the same appearance

that it had at first. Your eye will perceive no difference; its bulk, its shape, and its colour will all be exactly what they were. But examine its consistence, and you find that it is hard no longer, its solidity is gone, it is flexible and yielding, and you may cut it with a knife, as you would an apple or a turnip.

The change mentioned is produced by the acid having dissolved the earthy part (subphosphate of lime), on which the solidity of the bone depended, while the cartilaginous portion through which it had been diffused is left untouched. Supposing that a rib has been the subject of your experiment, it will have become so flexible, that you may easily tie it into a knot, and so squeeze it through the neck of a bottle; when, filling the latter with spirits, and corking it up, you will have, apparently, a solid rib with a knot on it, and cooped up in so small a space that to those unacquainted with the process, the whole will seem as inexplicable as that other well-known puzzle, namely, "a reel in a bottle." A scapula or shoulder-blade, treated in a similar way, is, perhaps, still better adapted for this kind of exhibition.

Now, a bone, during its formation, undergoes a change the reverse of your experiment; by

abstracting its earthy matter, you have reduced it to the state of a cartilage, but, while growing, it is cartilage first, and bone afterwards. The first cartilage, however, seems to serve merely as a nidus for the young bone, which is formed not only of earthy matter, but also of new cartilage, and as these are deposited, the original, older cartilage, is absorbed and disappears.

To understand this somewhat more clearly, we may select the *patella*, which at birth is altogether cartilaginous. At length there are seen vessels carrying red blood into it, and whenever that takes place the actual formation of bone has commenced. *Fig.* 26 (*Plate* 8) represents the cartilaginous patella some months after birth, with the commencement of ossification in its centre; and the osseous formation, thus begun, goes on until the bone is perfected, which in the patella is extremely slow, requiring years for its accomplishment. But there are some bones in which a like delay could not be permitted, without, to say the least, great inconvenience. Some require to be all but completed (their size excepted) even at birth ; the small internal bones of the ear, for example, and the collar-bone or clavicle necessary to the motion of the infant's arms, as also the ribs for

respiration; while others, whose early developement is not equally required, are much later in arriving at their perfect state, and, hence, the skeleton is not fairly matured till after the twentieth year.

That part of a bone in which the deposition of earthy matter commences, is named its *point of ossification;* and of such points, some, as the patella, and parietal bone (*Fig.* 27, *Plate* 8, *a*), have only one. The long bones of the extremities have their middle portion or shaft, unconnected with the ends, except by cartilage, till after a considerable number of years, and various prominences of bones, or as they are called, processes, remain unossified for a long period.

We may now dwell a little on the colour of the bones. This, in man and quadrupeds, is white, in the dead state, and of a light rosy hue in the living, owing to the blood circulating through them. In some fishes the bones are of a beautiful pea-green colour, as in the gar-fish (Belone *vulgaris*), and the viviparous blenny (Zoarces *viviparus*), both natives of the British seas. The first of these fishes is in some places common, but a strong prejudice often exists against it as an article of food, from an

idea that the green colour of its skeleton arises from the fish feeding on copper banks: this error requires no refutation. At the same time, it has been long known that the colour of bones may be changed by various ingredients in the food, since, when animals have lived for some time on substances with which madder has been mixed, their skeleton acquires a red or rosy tinge; logwood produces a dark purple hue; and, during an attack of jaundice, the bones are yellow from a deposition of bile in their substance; while after death from Indian cholera, they are said to be so dark coloured that no maceration will whiten them.

You will next recollect that bones are as much *living* parts of an animal as any other organs, though, from their ponderous and fossil appearance, they might perhaps be hastily considered as belonging rather to the mineral than the animal kingdom. In their healthy state, indeed, they have little, if any sensibility, and the nerves that have been traced into them are very small; but there is nothing in this to militate against their vitality, as many other parts of the body are similarly circumstanced, and even a large part of the brain itself is, when wounded, insensible to pain. Such parts,

however, when they become inflamed, or otherwise diseased, are acutely sensible; and the diseases of the bones are productive of suffering not to be surpassed by that of any other organs. Toothache, indeed, might be advanced as a proof of this.

That the bones possess absorbents (unless, indeed, the veins perform their office), may be inferred from many of their phenomena, though these vessels have not hitherto been actually detected in them. With respect to bloodvessels, the osseous system abounds in them nearly as much, perhaps, as most of the soft parts, and they can be beautifully shown in a preparation made in the following manner:—The arteries in the extremity of a young animal are to be filled with a minute injection, such as oil of turpentine with some varnish, well coloured with vermilion. The flesh is then to be perfectly cleaned from the bone to be preserved, and the latter is to be immersed in diluted muriatic acid till all the earthy parts are removed; it is after this to be steeped for some hours, or for a night, in a considerable quantity of water, to remove the acid with which it is penetrated, and next, it must be hung up till it is *perfectly* dry. If it be then placed in a

glass jar of oil of turpentine it becomes so transparent that the injected vessels are seen in great numbers ramifying through it in the most beautiful manner. Even in the living bone we have many proofs of its circulation, and, consequently, of its vitality: thus, after amputation of a limb, blood is seen oozing from even its compact walls; if the surface of a living bone be scraped, blood oozes from the abraded part; but when a bone has been deadened by a blow, then its circulation being destroyed, it cuts dry and bloodless.

But, independent of these and other phenomena connected with the osseous system, in its healthy state, we have in its diseases but too many painful proofs of its vitality; and, indeed, there are few morbid affections to which the soft parts are liable, from which it is exempt. I will not now, however, occupy your attention farther than by making some remarks on a few aberrations from the natural state, and in which almost the whole bony fabric becomes equally involved.

It is first necessary to understand, that almost all parts of the body are undergoing a perpetual loss of their component particles, and that these are again renewed from our daily

food, through the medium of the blood, the materials of which are derived from the digestive organs; the old particles are carried off, and new ones are deposited by the arteries to supply their place. Now, suppose that from some morbid or irregular mode of action in the arteries, or in the absorbent vessels, or from some defect in the blood itself, the due balance of the component materials of the bones is no longer preserved, then the consequence will be that some of these will preponderate, or, on the contrary, be defective. When you keep a bone red-hot for some time in the fire, you find that from its animal parts being consumed, it has become remarkably brittle, and hence you may conceive that if, in the living body, the due proportion of cartilage is not kept up, the same effect, to a certain degree, will be produced as in the bone which has been burnt; it will lose its tenacity, become brittle, and consequently be easily fractured.

Such a state does occur, at times, in the living body, and is named *fragilitas ossium* (fragility, or brittleness of the bones). It is usually thought to be owing to a preponderance of the earthy part, with a proportional decrease of the animal or cartilaginous, while

others attribute it to a defect of both. Be this as it may, brittleness of the skeleton forms a very melancholy state of disease. An acquaintance of mine gave me the particulars of his own mother's last illness; she had been long confined, and suffered much, and there was scarcely one of her long bones that was not fractured, simply from the exertion of turning in bed. A similar case is related in the London Medical Journal, in which the patient could not turn in bed without breaking some bone. Louis mentions a nun whose arm was fractured, simply by leaning on a servant in getting into a carriage; and there are many similar instances on record.

In advanced age, the bones, also, are diminished in size, brittle, and, of course, more liable to fracture than in early life; and while those of a child will even bend, to a certain degree, without breaking, a comparatively slight violence will break them in the very old. Dr. Good states that he "was once present at a church in which a lady, nearly seventy years old, in good general health, broke both the thigh bones, in merely kneeling down; and on being taken hold of to be carried away, had an os humeri also broken without any violence,

and with very little pain."* In this case the bones reunited in a few weeks. Even a violent fit of coughing has been known to produce fracture. †

Sometimes a directly opposite state takes place, and the bones, perhaps, from a too active absorption of their earthy parts, or from the latter not being properly formed, instead of being brittle, are, on the contrary, soft and yielding, forming the disease called mollities ossium or malacosteon. This disease, when general, is always fatal, but partial softening of the bones without such a result is not very unfrequent, as in rickets. One of the most remarkable cases of malacosteon is that of a French woman, Madame Supiot, in whom, along with a general softening of the skeleton, the thigh bones were so flexible, that her feet could be placed on each side of her head.

I will now detain you by only a few remarks on another affection of the skeleton, which is often partial, but sometimes involves it throughout. I allude to general anchylosis, in which all the bones are immoveably consolidated with

* Good's Study of Medicine. Ed. 3d. Vol. 5, page 332.

† Gooch. Ibid.

each other—the joints are obliterated, and the skeleton is one continued mass of bone from head to foot. I will state an outline of one case of this kind, which will be sufficient: the detailed account you may find in the first volume of Smith's History of Cork. The skeleton it relates to is preserved in Trinity College, Dublin, and is known to the public by the name of *the ossified man.*

William Clark was born at Newmarket, in the County of Cork, in the year 1677. In infancy, he could neither turn his head nor bend his body, and when a boy, could not lift his hands higher than the bend of his elbow, nor place them behind his back. His under jaw became so fixed that he could only take spoonmeat by sucking it through an aperture formed by some of his teeth having been broken by accident; anything solid he forced into his mouth with a stick made for the purpose. In walking, he advanced the right foot with difficulty, and then dragged the left after it. If he fell, he could never rise without assistance; as his years increased, numerous bony excrescences were observed in his thighs and arms, which he had not in his youth. His constitution, notwithstanding the general anchylosis, must

have been very good, as he lived till the age of sixty-seven years.

Smith, after describing the numerous excrescences, which, like stalactites, projected from the several bones, observes, that, "it would require a volume of itself, composed of a new kind of osteology, to give a minute description of this surprising skeleton and its irregularities, being as difficult a task as to describe Calypso's grotto;" and, therefore, this being so, I must refer you to the figures given of it in his work.

CHAPTER X.

APPENDAGES OF BONES.

OF THE PERIOSTEUM.

THIS is a thin membrane, which, as its name implies,* immediately invests the bones, and forms their peculiar covering. In some parts, however, it assumes different appellations, on account of a particular locality: thus, on the cranium it is called the pericranium, and in the socket of the eye, periorbita.

The older anatomists imagined that all the membranes in the body were derived from those of the brain. Agreeably to their theories, the periosteum was thought to arise from the strong membrane lining the inside of the cranium, and named the dura mater. They imagined the latter to pass out through the sutures or joinings of the bones of the skull, that it formed the *pericranium*, and then passed down, covering

* From περι (peri) around, and οστεον (osteon) a bone.

all the bones of the skeleton with one continued sheet of membrane.

Now, although this notion of the periosteum originating from the dura mater must be considered as fanciful, yet, in various instances, it does pass from one bone to another; and, also, it sometimes runs over cartilages, and sometimes over ligaments. When on the surface of a ligament, it is named, not periosteum, but *peridesmium*,* and on a cartilage, *perichondrium*.† The periosteum, then, on the cranium, is named *pericranium*—in the sockets of the eyes, *periorbita*—on a ligament, *peridesmium*—and on a cartilage, *perichondrium;* in all other situations it is called the *periosteum*.

This membrane is strong, but not thick; it is always thin enough to possess some degree of transparency, and it has considerable elasticity. Perichondrium and peridesmium are sometimes so extremely thin, as to be with difficulty detected. Like most membranes, the periosteum is described generally as being composed of laminæ or layers, and these are formed of fibres, firmly interwoven with each

* From περι (peri) around, and δεσμος (desmos), a ligature, band, or ligament.

† From *peri* and χονδρος (chondros), a cartilage.

other—those of the external layers being more loose than those of the internal, whence Monro was inclined to apply the term periosteum to the latter only.

But the periosteum is not formed of these fibres alone, there being many bloodvessels entering into its composition. It was once, also, supposed to abound in nerves, but these are extremely minute, few in number, and scarcely to be plainly demonstrated. On tearing off the periosteum, we observe innumerable cotton-like fibrillæ connecting it to the bone, most of which are minute vessels carrying blood from the membrane to the bone, or from the bone to the membrane. In advanced age many of these are obliterated, and the adhesion of the membrane to the bone is consequently less firm than in earlier periods of life.

The uses of the periosteum are various:—

1*st*. It covers all the bones, the enamel of the teeth excepted, as also those parts of a bone invested with obducent cartilage.

2*d*. The laxity of its external layers is supposed to allow the superincumbent parts to play over the bone, without causing injury from friction; it is equally found, however, where there are no muscles overlying it, as

on the superficial side of the *tibia* or shin bone.

3d. It strengthens the union between the middle or shaft of the long bones, and their ends or epiphyses, until the period of their consolidation by bony union, and whether this be considered as merely an accidental circumstance or not, it is as a matter of fact unquestionable. In an experiment, it required 550 ℔s. to detach an epiphysis from a growing bone, the periosteum remaining untouched, while 119 ℔s. detached that of the opposite side, from which the periosteum had been removed.*

4th. Its principal use seems to be that of forming a medium for the conveyance of blood to and from the bone.

5th. Other uses of an imaginary nature have been attributed to it, such as its limiting the growth of bones, and serving to warn us when an injury is offered to them; but the skin and other parts overlying it, are sufficiently sensible to give us warning (supposing that anything of the kind could be available); and, besides, from the paucity and minuteness of its nerves, we would infer that the periosteum, in its natural

* Wilson on the Bones, page 45.

and healthy state, should be quite insensible, as was taught by Hunter, in 1746, and more fully confirmed afterwards by the experiments of Haller.

OF THE MARROW.

The marrow, in its sensible and chemical qualities, resembles the fat elsewhere, though it approaches more nearly to the nature of butter.* Like the fat, it is contained in minute vesicles, which have no mutual communication, and hence the marrow in bones long buried has a granular appearance, the containing vesicular walls having vanished, while their more indestructible contents remain undecayed. These vesicles may be considered as off-sets from the delicate membrane lining the cavity of the bone, named the *medullary membrane*, or internal periosteum.

This membrane, after acting as the general covering of the marrow, sends off innumerable slips or processes, which run inwards to cover the cancelli, and form the medullary vesicles. I have stated that the chief use of the peri-

* Berzelius.

osteum is to serve as a medium of communication between the bone and surrounding parts. The medullary membrane, lining the cavity of the bone, performs a similar office to the internal osseous structure, and there is not a lamella nor fibre of either the spongy or reticular substances which is not invested and supported by it. Without such medium, indeed, for sustaining the circulation, these parts could not live, and hence, when the marrow and medullary membrane are destroyed by mechanical injury, in a living animal, the bone infallibly dies.

The marrow is usually considered as a kind of appendage to the adipose system, and, like the fat, it is absorbed in dropsy and other extenuating diseases; it varies, also, in consistence and richness, according to the more or less healthy habit of body: and its appearance is various in different parts of the skeleton, being reddish in the medullary cavity of the larger bones, white in that of the lesser, and an oily fluid in the spongy.* It is also more firm and copious in the bones of male than of female animals. In birds, while they are

* Riolan. Osteologia nova.

young, it is a medullary fluid, which disappears as they grow older, and its place is occupied by air.

The marrow is naturally insensible, and patients do not complain of pain when it is divided in amputation; but when diseased, it is productive of extreme suffering.

OF CARTILAGE.

This has been said to be the most elastic of all animal substances, which it is not; whalebone has ten times its degree of elasticity. It is firm, smooth, and cuts like wax, is pearl-coloured, and, as in opal, a thin slice of it, held against the light, shows a slightly reddish tinge. Its hardness is that of a middle state between bone and ligament; its structure fibrous, as is shown by maceration; and it has no cavities nor appearance of cancelli. Except in those cartilages which are substitutes for bone, no vessels can be shown to exist in it,* nor can any nerves be demonstrated, though their presence is inferred from its occasional ulceration and pain.

* Red vessels sometimes appear in disease.—BRODIE.

The perichondrium is extremely thin, except where it is a distinct continuation of the periosteum, as on the cartilages of the ribs, and in such places its vessels admit of injection.

There are various classifications of the cartilages, of which that into the three following kinds is the most simple :—

1. Obducent, or articular cartilages, consisting of a thin plate or crust spread over the ends of the bones, as in the joints.

2. Interarticular Cartilages. The *obducent* cartilages play immediately upon each other, in the motions of the joints, but the *interarticular* prevent this by being placed between them, so as not to admit of their coming into actual contact. The object of this is to hinder attrition, and, consequently, the articular cartilages are only found in those articulations where the motion is almost perpetual. That of the lower jaw is one, and when you recollect that you cannot speak, nor eat, nor open your mouth in any way, without the articulating condyles of the jaw moving in their sockets in the temporal bone of the cranium, it must be obvious that where there is such continual motion, this intermediate cartilage will be highly serviceable by performing a similar

office with that of a friction ring in machinery. Neither can you move your arm without an attendant motion in the joint by which the collar-bone is attached to the upper outer angle of the sternum or breast-bone, and there an interarticular cartilage is placed, as also in the articulations of the ribs with the spine, on account of their almost incessant movement caused by respiration.

3. UNITING OR CONNECTING CARTILAGES. These join one bone to another; thus, the ribs terminate anteriorly in cartilages, which seem continuations of the ribs themselves, only destitute of bony matter, and by them the ribs and sternum are united to each other.

The chief uses of the cartilages are the following:—they prevent abrasion in joints; break the force of collisions, as in jumping, &c.; they prevent anchylosis; and, from their flexible and elastic nature, are subservient to a greater variety of motion than could be effected without their agency. They, also, in a number of situations, supply, as it were, the place of bone, forming a substitute which answers better than the unyielding nature of the latter, for various purposes. Of this kind, I may mention the cartilages of the ear and nose; the uniting car-

tilages of the ribs; the cartilages of the larynx; and the cartilaginous rings of the windpipe.

OF THE LIGAMENTS.*

The ligaments are very strong membranes, of a nature almost tendinous, which run from one bone to another, at the different joints, and in general serving to strengthen the latter. Some completely enclose the joint, as in a capsule or case, and hence these are called capsular ligaments; in some instances they add considerable strength, as in the hip-joint; and sometimes their perfection consists in being capacious and loose; thus, in the shoulder joint the capsular ligament is wide and lax, to admit the utmost freedom of motion, the strength of the joint depending on the muscles surrounding it, and receiving scarcely any aid, in this respect, from the ligament.

* From *ligo*, to bind.

CHAPTER XI.

OF THE SKELETON IN GENERAL.

The term skeleton is derived from the Greek verb σκελλω (skello), to dry, and though many dried preparations are made of the blood-vessels, &c. yet the term is exclusively applied to the bony, or other frame-work, on which the soft parts are placed and supported. The bones of a skeleton are connected together in two ways, viz.—either by wires and other artificial contrivances, or by letting their natural connexions, the ligaments, remain at the joints holding the different bones together. The first is named an *artificial*, the second a *natural* skeleton; that of small animals is almost always made of the latter kind, and that of larger species of the former.

Many animals, as worms and medusæ, are altogether destitute of a skeleton, and in some there is only the rudiment, as it were, of one; such is the calcareous plate found in the back of the slugs or naked snails. In the cuttle-fish

tribe, besides a rudimental skeleton of cartilage, there is in the back of some species, a transparent, horny, sword-shaped lamina, and in that of the officinal cuttle-fish, and others of the same division, a kind of bony substance of very elaborate construction, long known in the materia medica by the name of *os sepiæ* (cuttle-fish bone), or *may-shell*, and much used by farriers, in form of powder, for blowing into the eyes of horses to remove opacities.

In the chondropterygious or cartilaginous fishes, the skeleton is either composed of cartilage altogether, as in the lamprey eel, or partly bony, as in the sharks, the spine and jaws of which are formed of a light, though tolerably firm, osseous material. In all the vertebrated animals, viz. man, quadrupeds, birds, amphibia, and fishes, the cartilaginous kinds of the latter excepted, the skeleton is composed of bones variously articulated to each other.

The shell of the lobster, crab, and other *crustaceous* tribes, is often, and I think, correctly, considered as an *external* skeleton; and the calcareous shell of the *testacea*, as the periwinkle, scallop, oyster, cockle, &c. may be viewed in the same light. In all of these, too, it serves the triple office of a skeleton, a coat

of defence, and a habitation. Some of the vertebrated animals, also, in addition to their internal bony structure, have cutaneous coverings which, without any material stretch of fancy, may be elevated to the same rank. In some, as the armadilloes, this envelopes a considerable part of the body in form of bands composed of osseous plates, and facets like a beautiful mosaic work. In others, as the MANIS, or scaly lizard, as it is improperly called, it is a formidable clothing of sharp, horny scales, bristling like lancets from every part of the skin. In the CROCODILE, the latter is protected, in many parts, by bony scales which resist a musquet bullet; and, in many fishes, the surface of the body is composed of a firm, horny crust, assuming a great diversity of appearance, while in the bony pike (Esox *osseus* Lin.), this covering consists of rhomboidal osseous scales of great hardness. I might farther illustrate this subject by adverting to the mailed gurnard, the hippocampus, the armed bull-head, the trunk-fish, the pipe-fish, &c.; but for more particular information, I must refer you to works on natural history. I may state, however, that in the turtles and tortoises, the internal and external skeletons are combined.

In them, the ribs, spine, and sternum, are expanded into broad laminæ, which form a strong case enclosing the animal; and these bony expansions are covered with *horny* plates, which, in some species, are arranged, sculptured, and coloured, in the most beautiful manner. The true tortoise-shell of commerce is the horny covering of the hawksbill turtle (Chelonia *caretta*), a species found in the Asiatic and American Seas. In insects, especially in the coleoptera or beetle tribes, the dermoid covering bears a considerable resemblance to the shell of the crustacea.

You will next observe that the *human* skeleton is symmetrical, that is, the right and left sides harmonize exactly, so that were it cut vertically through its centre, each half would form a precise counterpart of the other. To this remark, however, some slight exceptions may be offered; the bone, for instance, named the vomer, which forms a considerable share of the partition between the nostrils, is often bent much to one side; the impressions on the upper internal surface of the skull a reseldom exactly symmetrical; and sometimes the short ribs on one side are longer than on the other. These circumstances, however, have no influence on

the external figure, and I may observe, that, in almost all animals, this is exactly symmetrical, though there are some remarkable exceptions. One of the most frequent of these occurs in the crustaceous tribes, where we often find a great disparity in the comparative bulk of the claws. Thus, on examining the common lobster, one claw is always seen to exceed the other greatly in magnitude, and, also, to differ in some points of structure, the inner edges of the large claw being knobbed or tuberculated, and those of the *smaller*, finely toothed or serrated. The larger probably serves for grasping the animal's prey, while, with its smaller, it cuts it into pieces. In some species, however, the bulk is so very disproportionate, as not to be easily accounted for; thus, in the calling crab of Jamaica (Cancer *vocans* of Linnæus), the large claw is so overgrown that the animal has to support it on its back in walking; and, in another American crab, it is as large as all the rest of the body. Captain Flinders speaks of a small red crab, seen in great numbers at Keppel's Bay, on the east coast of Australia, whose large claw was "nearly as big as the body, and this it keeps erected and open, so long as there is any expectation of disturbance. It was curious (he

says) to see a file of these pugnacious little animals raise their claws at our approach, and open their pincers ready for an attack, and afterwards, finding there was no molestation, shoulder their arms and march on." *

Of the vertebrated animals, the fishes of the Pleuronectes genus alone, exhibit any remarkable deviation from perfect symmetry. The species included in it are generally known by the name of *flat* fishes; of these, *Fig.* 28 (*Plate* 11) represents the plaice (Platessa *vulgaris*), and *Fig.* 29, the turbot (Pleuronectes *maximus*): *a* is the upper surface usually termed the back, and is of a dark colour, while the lower surface, or belly, as it is commonly designated, is white; but these, in fact, are not the back and belly, but the sides of the fish; and you observe that the eyes are both placed on one side of the head. In some species these are on the right, and in others on the left; thus, in the plaice, they are on the right side, and it is equally plain that they are situated on the left in the turbot.

The next thing to be mentioned, is the mode of growth of the skeleton. That this solid framework in man and other vertebrata grows

* Flinders's Voyage, vol. ii. page 26.

along with the general growth of the body is obvious, it being small in childhood, increasing with the stature, and arriving at its full developement during the period of adult manhood. But, in the lobster, crab, and others of the same family, it does not augment by slow degrees in this way, but is rapidly generated, and so remains without any farther individual increase. Now, for the sake of illustration, just compare your own clothes to the shell of the lobster; they form your outward covering, but when younger, as you increased in dimensions, this covering became too small, and you had, from time to time, to cast it off and provide another suited to your more enlarged growth. And so it is with the lobster and crab tribes,—the shell is thrown off at intervals, and a new and larger one adapted to the animal's increase occupies its place. In the lobster, this process is gone through annually; but it is said that, when the female is in pea, no new shell is produced that year. It is probable that the nutriment which otherwise would go to the generation of the new covering, is during the breeding period directed to the formation of the ova.

This moulting of the shell is not unattended with suffering to the individual, which pines

away, and seems to undergo much sickness previous to the change. The shell, however, becomes loosened from the skin underneath, and splits so as to allow the animal, after repeated agitation and struggling, to escape from its old domicile. Having done so, it is helpless and unprotected, being covered only by the naked skin, and is thus exposed to the attacks of dog-fishes, and numerous other enemies. In a very few days, however, the skin hardens by the deposition of stony matter, the lobster appears encased in a new shell, even more solid than the old, and its bulk is increased about one-fifth beyond what it had been prior to the change. Of this size it necessarily remains till the next annual moulting, when a similar process is gone through; and in this way the growth of the lobster proceeds from year to year, not by a gradual development, but by a great and rapid augmentation at determinate periods.*

While every part of the lobster is enclosed and defended by its calcareous envelope, there are various species of crab which are only par-

* The moulting is said to be much more frequent when the animal is young, and the necessity for increased growth more pressing.

tially protected in this manner; such are the hermit-crabs, one species of which is common on the British coasts, and named Bernard, the hermit (Pagurus *Bernhardus* of Lamarck). It always resides in the dead shell of some of the testacea, and, according to its age, is found inhabiting them from the smallest univalve up to the largest found on our shores, the Murex *despectus*. The reason why it requires such a habitation is, that while its claws and anterior parts are encrusted by a hard shell, as in the lobster, its posterior half is defenceless and naked, and hence it requires the extraneous covering as a means of protection.

Of these hermit-crabs there is a West-Indian species, which, from its pugnacious disposition, is named the soldier crab, and of which Goldsmith, though perhaps we must make some little allowance for fancy, gives the following graphic description :—" The little soldier is seen busily parading the shore along that line of pebbles and shells that is formed by the extremest wave; still, however, dragging its old incommodious habitation at its tail, unwilling to part with one shell, even though a troublesome appendage, till it can find another more convenient. It is seen stopping at one shell,

turning it, and passing it by; going on to another, contemplating that for a while, and then slipping its tail from its old habitation to try on the new; this also is found to be inconvenient, and it quickly returns to its old shell again. In this manner it frequently changes, till at last it finds one light, roomy, and commodious—to this it adheres, though the shell be sometimes so large as to hide the body of the animal, claws and all. Yet, it is not till after many trials, but many combats also, that the soldier is thus completely equipped, for there is often a contest between two of them for some well-looking favourite shell for which they are rivals. They both endeavour to take possession: they strike with their claws, they bite each other, till the weaker is obliged to yield by giving up the object of pursuit. It is then that the victor immediately takes possession, and parades it in his new conquest three or four times backward and forward upon the strand before his envious antagonist."*

I may farther observe, with respect to the hermit-crab, that the posterior extremity is furnished with a hook, besides several others on

* Animated Nature.

its sides, by which the animal has so firm a hold, as to drag its extraneous house, with little effort, from place to place.

By various physiologists the shell of the crustacea is considered merely as the cuticle, or outer unorganized layer of the skin, impregnated with carbonate of lime; but if so, we observe here in the hermit-crabs that the covering of the anterior part of the body is a hard crust, and that of the remainder a delicate semi-transparent skin; but whether the former be merely a modification of the latter, or a distinct organ overlying it, there can be no question that while it serves as a defensive covering, it also, to all intents and purposes, serves the office of a skeleton: the muscles are attached to it, and its several parts being acted on by them are the levers through which the progression and other motions of the animal are effected.

If a crab may be only partially covered by a shell, we might equally conceive that species should exist having no shell at all, and this actually happens. Dr. Gould, in his admirable "Report on the Invertebrata of Massachusetts," gives the following interesting account of a small crab (Pinnotheres *ostreum*) to

which this remark applies:—" It is not protected by a hard crust, and in order to supply the want of it, the crab lives among the oysters, and becomes a guest within the walls of their shells; whether a bidden and a welcome one or not, we have it not in our power to say. The crab, however, seems not to molest the oyster, and is even said to act as a monitor, to inform it when to close its shell, so as to entrap the food on which they may both subsist. They live peaceably together, are captured together, served up for the table together, and are scarcely to be distinguished from each other in the eating."

CHAPTER XII.

THOUGHTS ON ANATOMICAL EDUCATION.

It has been stated in the preface to the foregoing observations, that my chief object in publishing them was to supply, in some measure, the loss which anatomical students suffer from not attending the commencement of courses of lectures. But it must be obvious that such means can only be effective in a very minor degree, since more can be clearly comprehended by seeing the specimens themselves, combined with large explanatory drawings and diagrams to assist them, than could be by the most particular description without such aid.

The first year's attendance of a student on medical lectures is often considered to be of such slight importance, that it matters little whether his progress be slow or not; it is considered as a kind of breaking in, an opening merely, to the field of study on which he is entering; and that, should he do little during

the first session, all deficiencies can be made up with little difficulty in those which are to follow. This I conceive to be a vital mistake. The first medical session is to the student the most important, perhaps, of all sessions; and if, during it, his studies be slurred over, if he do not acquire habits of attention and *thinking*, if he fall into the lazy apathy of letting what he hears at one ear pass out at the other, if he let his thoughts wander to foreign subjects, instead of keeping them fixed on that treated of by the lecturer, and to which he ought to give his undivided attention, the best that can be said of his acquirements, at the close of the session, will be, that they consist of a heterogeneous mass of ideas, fixed on no solid basis, and connected by no tie of systematic union. In anatomy, he may know a little of the bones, a little of the muscles, a little of the blood-vessels, a little of the viscera, &c. but he knows nothing as he should do; and, having spent his first session in so desultory and fruitless a manner, the probability will be, that his second and succeeding sessions may be passed over in a similar way; so that, at length, his final resource will be, during weeks and months of anxiety and distress, to remain in the hands of

a grinder, till he have the *chance* of passing an examination for his degree or diploma.

It would be unfair to insinuate that all students thus mismanage their studies; but no teacher will deny that it is an extremely frequent occurrence, though there are always some young men who, from the first, are sensible of the importance and necessity of making the best use of their time; and it will invariably be found, that those who have honestly studied during the *first*, will continue to do so through every succeeding session, and will always hold a high position over their more careless companions. In the remarks now made, I have no intention of bringing a sweeping accusation against *medical* students, as if *they* were more given to idleness than those of any other description. I believe that the fault lies, not in the student, but in the plan of anatomical education which has been so long pursued; and the proper remedy for the evil would be, I conceive, to approximate, at least for the first session, such education, as nearly as possible, to the method followed with regard to the classics, and the other branches of knowledge taught in our ordinary schools. If a boy commence the Latin grammar, he must

first commit to memory the declensions, and understand them well, before he learns the pronouns, and these before he goes on to the conjugations, &c. If he learn arithmetic, he is not permitted to commence subtraction until he has mastered addition, nor to multiplication till he has mastered subtraction, nor to division till he has learned the other three. He must get well acquainted with any one branch before he is allowed to go on to the next. It would be absurd to put him into the second book of Euclid while he remained ignorant of the first. But, in a course of anatomy, the student has, in the progress of the lectures, to listen to the descriptions and details of the most complicated parts of the human structure, when, perhaps, he is most imperfectly acquainted with osteology and myology, which form the very *grammar* of the science, and consequently, he can scarcely understand, and certainly not digest, the greater part of what he hears.

I have just stated, that I consider the bones and muscles as the grammar of anatomy, and I would propose that no one should have the privilege of being enrolled as a second year's student until he had proved, by a close exami-

nation, that he had acquired a sufficient knowledge of these during his first. But I would go farther than this, I would make the *entire* first winter's course a *preparatory* one. When we consider that a large majority of medical students commence as mere youths, and that they often remove at once from school to college, it must be plain, that with almost every branch of information connected with medical studies, directly or collaterally, they must necessarily be totally unacquainted, how can it be expected that minds so unprepared will make much certain progress through the numerous and difficult branches of anatomy, constituting a course, as taught in our medical schools, the technical terms of which alone, independent of anything else, require no ordinary degree of attention and memory to secure and retain?

But, were the young student to go through a *first* course, in which he would be absolutely *obliged* to acquire a competent knowledge of osteology and myology, the two great fundamental roots of the science, and in which he would also have laid before him extended views of the animal economy, not confined to man alone, but embracing every class in the animal kingdom,

with what superior advantages would he enter on his *second* course. The groundwork of human anatomy would then have been securely laid, and his mind enlarged by a knowledge of the living functions, as connected with the varieties of structure in the numerous tribes of animated being.

The sort of course I would contemplate with the above views, might be somewhat of the following description. First—general explanations of the principal component materials of the animal frame, such as are given in the preceding chapters, but, of course, more ample in every way, and including the blood, with general observations on the secretions formed from it. Second—the bones to be fully demonstrated, and the students to be closely examined on them from day to day. Third—the muscles to be similarly treated. Fourth—digestion, and its various organs in mammalia, birds, fishes, &c. Fifth—respiration, and the other organic functions, similarly treated. Sixth—the nervous system, organs of sense, &c. &c. I do not, however, pretend to lay down any certain outline of the order in which such a course ought to be conducted, nor of its exact extent; but I would ask whether a first

year's course, founded on the principle I suggest, would not be infinitely more advantageous to the student—as giving him comprehensive and enlarged views of the animal economy—as exciting an enthusiasm for knowledge—as imparting extended views of nature, and, at the same time, as laying a sound basis on which to rest his future progress, in acquiring a minute knowledge of the human structure, than any ordinary course of medical anatomy could possibly do? Lectures, embracing a large portion of the subjects treated of in Dr. Roget's Bridgewater Treatise, Jones's General Outline of the Animal Kingdom, &c. would, I am certain, prove to the student of the first year of incalculable advantage.

With regard to the qualification of students for recognition to a second course, I have stated that a proper knowledge of the bones and muscles should be a *sine qua non*. When I say a proper knowledge, I do not mean to include the minuteness that describes every facet of the bones of the carpus or tarsus, the separate origins and insertions of the interossei muscles, or of the deep muscles of the back, such minutiæ being oppressive to the memory which cannot long retain them, and while

retained, savouring more of pedantry than use. As to the *other* parts of the course, I would suggest that an examination of a general nature should be held, and that some kind of honorary reward should be conferred on such students as had made the greatest progress, provided, however, that they had previously come fairly through their examination on the bones and muscles.

A difficulty now presents itself, which is this:—one professor could not properly perform the entire duties of an initiatory course, and of another connected with human anatomy alone; and hence two teachers would be requisite—one for first year's students especially, and a second for purely professional objects. With respect to the first, I will suppose that three months would be sufficient for getting through the preliminary lectures, as well as the bones and muscles in detail; and, as the subjects to be treated of, in the remaining three, would partake much of a popular character, this second division of the course (which, like the former, should consist of sixty lectures) might prove available to non-medical as well as to medical students.

However crude these few observations may

be, I am certain that the principle they involve is one of great importance, and that its adoption, in some form, would be an act of justice to the student, and be ultimately useful to the public and the profession. It is easier, however, to propose plans, than to bring them into operation; and however desirable I, as an individual, may consider that now suggested to be, it could only be realized by a Board, under legal sanction, which would lay down a regular curriculum of medical education for all future medical students in the united empire; or else, by an agreement among the different colleges, to make this curriculum uniform in all, and of a more systematic and defined nature than at present is the case.

Before closing this little work, I would suggest farther, that before any one should be recognised as a medical student at all, he should pass an examination in some well-considered elementary course of school education, prescribed by a competent legal authority; a course not too strict, but sufficiently comprehensive, and so clearly laid down that its scope and extent could neither be misunderstood nor evaded. I wish not to speak harshly, nor uncharitably of any, but I feel bound, in truth, to

say, that it is not very unfrequent to meet with medical students who are scarcely acquainted even with the rudiments of their own language. To conclude, it will be observed that I have limited my remarks to the subject of anatomy alone, and I am not prepared at present to hazard an opinion as to what extent they might be applicable to other branches of medical education.

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EXPLANATION OF THE PLATES.

PLATE I.

FIG. 1.

a—The belly of the plantaris muscle.

b—Tendon of the soleus muscle.

c—The tendon of the gastrocnemius—its fleshy bellies, which overlapped the soleus, having been removed.

d—Lower end of the thigh-bone.

e—Long tendon of the plantaris.

f—The popliteus muscle.

g—The tendo Achillis, formed by the coalescence of the tendons of the soleus and gastrocnemius.

FIG. 2.

a, *b*—The condyles of the thigh-bone, and the two origins of the gastrocnemius.

c—Tendon and bellies of the gastrocnemius.

d—Tendo Achillis.

FIG. 3.—A diagram of the right auricle of the heart and the two venæ cavæ.

a—Auricle.

b—Descending vena cava.

c—Ascending vena cava.

FIG. 4.

a, *b*, *c*, as in Fig. 3.

d—Right ventricle.

e—Opening from the auricle *a* into the ventricle *b*, called the auriculo-ventricular opening.

FIG. 5.

a, *b*, *c*, *d*, *e*, as in the last two figures.

f—Trunk of the pulmonary artery.

g—Its bifurcation into

h—The right pulmonary branch, and

i—The left pulmonary branch.

PLATE II.

Fig. 6.—The right and left hearts, supposed to be separated from each other.

1—Descending vena cava.
2—Right auricle.
3—Ascending cava.
4—Right fleshy side of the heart, in which the right ventricle is situated.
5—The pulmonary artery.
6—Its bifurcation into 7, the right pulmonic branch, and 8, the left.
9, 9—Branches of the pulmonary artery and pulmonary veins, the trunks of the latter in shadow.
10—The *left* auricle.
11—Left ventricle.
12—The aorta.
13—Its arch, with the large arteries arising from it, which supply the head and upper extremities.
14—The trunk of the aorta, after having passed down behind the heart.

Fig. 7.—The heart in outline.

1—Its apex.
2—Right auricle.
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4—Right ventricle.
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6—Descending, and 7, ascending vena cava.
8—The hepatic veins entering the ascending cava.
9—Pulmonary artery. 10—Its bifurcation.
11—Right pulmonary artery. 12—Left.
13—A space left by the arch of the aorta, having been raised up from its natural situation on the bifurcation of the pulmonary artery.
14—Ascending arch of the aorta.
15—Its transverse arch.
16—The arteria innominata, dividing into the right subclavian and right carotid arteries—also, the left carotid and the left subclavian.
17, 18—Superficial branches of the coronary arteries and veins.
19—Aorta.

PLATE III.

THE ARCH OF THE AORTA, SHOWING ITS NUTRITIVE VESSELS, THE VASA VASORUM.

FIG. 8.

1—The arteria innominata, dividing into

a—The right subclavian, and

b—The right carotid artery.

2—Left carotid artery.

3—Left subclavian artery.

FIG. 9.—A skeleton view of the coronary arteries of the heart.

1—Aorta.

2—Ascending arch of the aorta.

3—Left coronary artery.

4—Right coronary artery.

5—Branches to the left auricle.

6—Branches to the right auricle.

PLATE IV.

FIG. 10.—Origin of the pulmonary artery.

1, 1, 1—The three semilunar valves thrown down, and closing its orifice.

FIG. 11.

a, a, a—The semilunar valves of the pulmonary artery displayed.

b, b, b—The corpora Arantii.

FIG. 12.—A foreshortened view of the arch of the aorta.

1—Its ascending portion.

2—The large arteries from its transverse arch.

3—One of the coronary arteries.

4—Part of the fleshy walls of the heart.

5—The semilunar valves of the aorta.

FIG. 13.—A similar view to the last, the artery being laid open.

1—The semilunar valves.

2, 2—Orifices of the coronary arteries.

FIG. 14.—Fœtal heart.

1—The ascending cava.

2—The trunks of the hepatic veins.

3—Descending cava.

4—The right auricle laid open.

5—Valve of the foramen ovale.

6—Aperture at its upper part, opening into the *left* auricle.

7—Opening into the right ventricle.

8—Left auricle.

9—Pulmonary artery.

10—Aorta.

FIG. 15.—View of the fœtal heart, the auricles having been cut away, and the aorta raised up from its position on the pulmonary artery.

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f—Pulmonary artery.

g—Its branches to the right lungs.

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FIG. 16.—Portion of a vein laid open to show the valves, *a*, *a*.

FIG. 17.—A portion of a vein injected with wax, to show the knot-like protuberances at the situation of the valves, 2, 2, 2.

FIG. 18.—A vein opened.

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2—Larger branches formed by their union.

3—Branches still larger and increasing in bulk, by the conflux of many branchlets, till at length they terminate by one trunk in the great vein 4.

4—A large vein, mostly laid open to show the valves, 5, 5.

The direction of the arrows shows that of the blood, flowing from branch to trunk.

FIG. 19.—An artery ramifying into its numerous branches.

1—Trunk of the vessel.

2—Its division into large branches.

3—Its division into smaller.

4—Its termination in the capillary branchlets, from which the veins originate.

The arrows point out the course of the blood, flowing from trunk to branch.

PLATE VI.

FIG. 20.—A portion of intestine with lacteal vessels running from it.

a—Intestine.

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2—Continuation of the aorta.

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4—Left vena innominata.

5—Left internal jugular vein.

6—Left subclavian vein.

7—Right vena innominata.

8—Right internal jugular vein.

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10—The right subclavian artery.

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15—The thoracic duct splitting into two branches, at the middle of the dorsal region of the spine, which again reunite.

16—The termination of the thoracic duct, turning down to enter at the angle formed by the junction of the left internal jugular vein (5) with the left subclavian vein (6).

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b—Its middle lobe.

c—The corpora mammilaria.

d—The tuberculum annulare.

f, *f*—The two lobes of the cerebellum, or little brain.

h—The corpora pyramidalia, forming the middle of the medulla oblongata.

i—Corpus olivare of one side.

k—Posterior lobe of the cerebrum.

1 to 9—The nerves which arise from the brain.

FIG. 23.—A portion of the spinal marrow, its investing membrane being turned aside.

a—Front of spinal marrow.

b—A spinal nerve, formed by the junction of

c—The anterior roots intended for motion, and

d—The posterior roots for sensation. The letter is placed over the ganglion.

PLATE VIII.

OSSIFICATION AND GENERAL STRUCTURE OF BONE.

FIG. 24.—Vertical section of the upper end of the femur or thigh-bone.

a—The solid compact walls at the small diameter of the bone.

b—These walls getting gradually thinner as they approach the expanded spongy ends.

c—Compact substance on the head of the bone, reremarkably thin.

d—The spongy substance, cancelli, or lattice-work.

e—The reticular substance.

FIG. 25.—A vertical section of the patella or knee-pan, showing the great predominance of spongy substance or *diploë*.

FIG. 26.—The patella in an early stage of formation. The dark part is intended for cartilage through which vessels are running, and the white spot in the centre shows the commencing ossification.

FIG. 27.—A fœtal scull.

a—The left parietal bone, the point of ossification in its centre, and bony rays running from it to the circumference.

b—Right parietal bone.

c—Point of ossification of the left half of the os frontis, or bone of the forehead.

d—The anterior fontanelle, or open of the head, occupied by membrane.

PLATE IX.

FIG. 28.—Cavities of the right heart laid open.

1—Descending vena cava.

2—Ascending vena cava.

3—Sinus of the right auricle.

4—Fossa ovalis.

5—Opening of the coronary vein.

6—Portion of the musculi pectinati.

7—Aorta.

8—Pulmonary artery.

9—Appendix of the left auricle.

10—Semilunar valves of the pulmonary artery.

11—The right ventricle opened.

12—The tricuspid valve.

13—Chordæ tendineæ, and columnæ carneæ.

14—Walls of the right ventricle.

PLATE X.

FIG. 29.—The cavities of the left side of the heart.

1—Cavity of the left auricle.

2—Entrance into it of two of the pulmonary veins.

3—Two pulmonary veins.

4—Two do. do.

5—Part of the musculi pectinati.

6—Appendix of the left auricle.

7—Great cardiac vein.

8—Section of the outer wall of the left ventricle.

9—The mitral valve.

10—Columnæ carneæ, and chordæ tendineæ.

12—Appendix of the right auricle.

13—Cavity of the left ventricle at the apex opened.

This and the preceding plate are very inferior to what I could have wished.—J. L. D.

PLATE XI.

FIG. 30.—Platessa *vulgaris*, the common plaice, showing that the eyes are on the right side of the fish (*a*).

FIG. 31.—Pleuronectes *maximus*, the turbot, the eyes placed on the left side.

PLATE XII.

FIG. 32.—Dionæa *muscipula*, Venus's fly-trap. Page 4.

a—Irritable appendage of the leaf.

b—The same contracted with a fly entrapped.

c—Leaf; or the appendage may be considered as the real leaf, and (*c*) a winged petiole or leaf-stalk. The plant is a native of Carolina.

PLATE I.

Fig 1

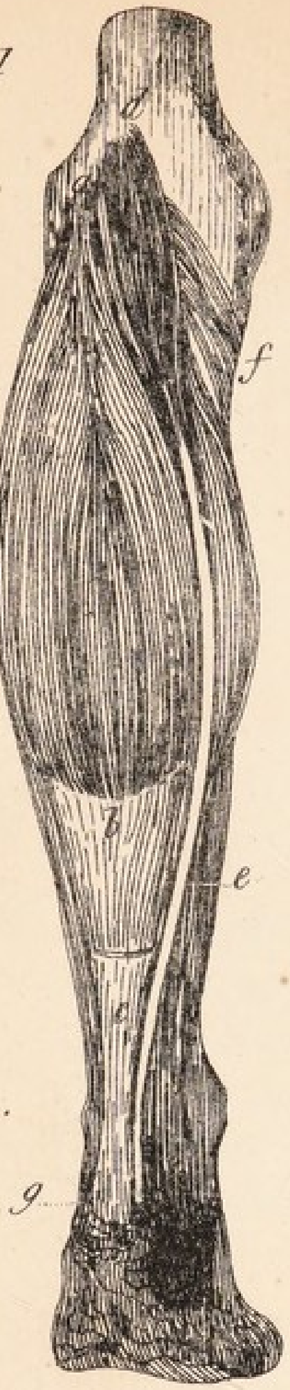
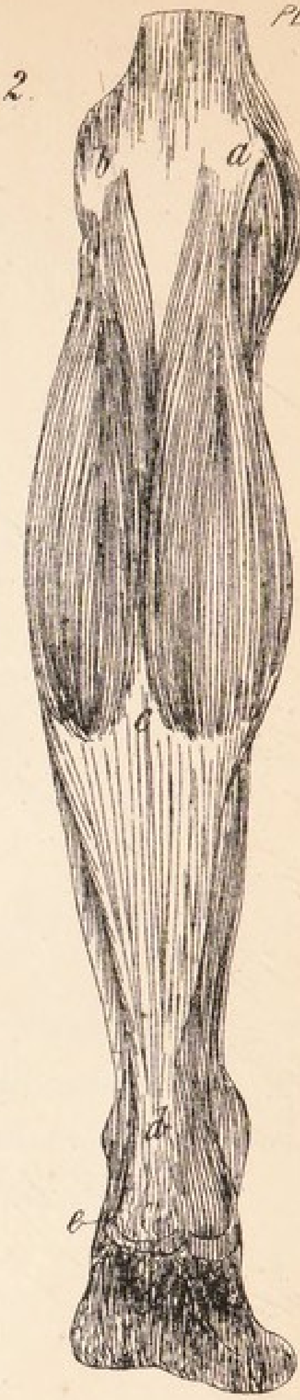


Fig 2.



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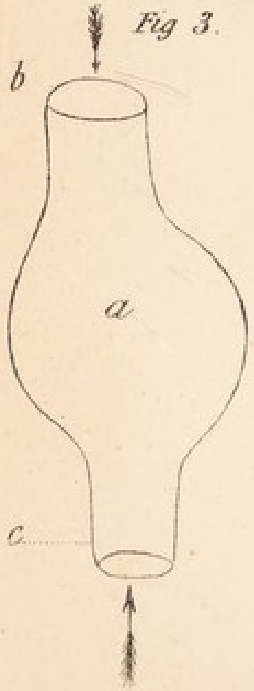

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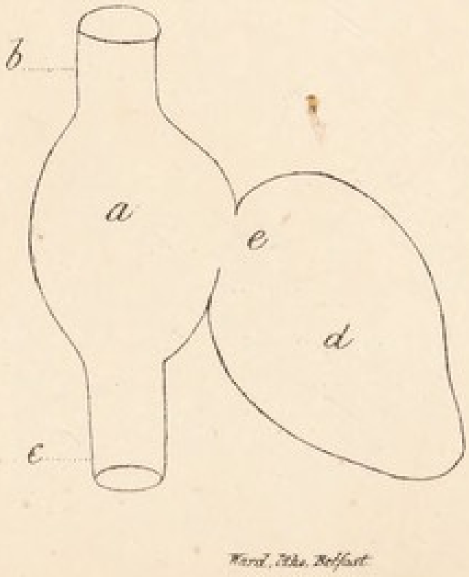

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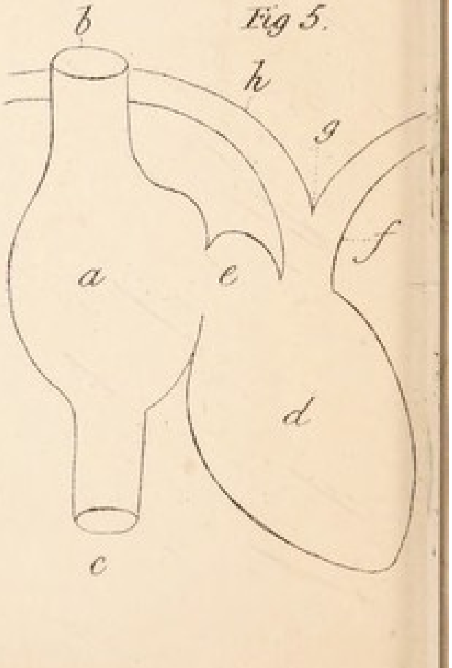
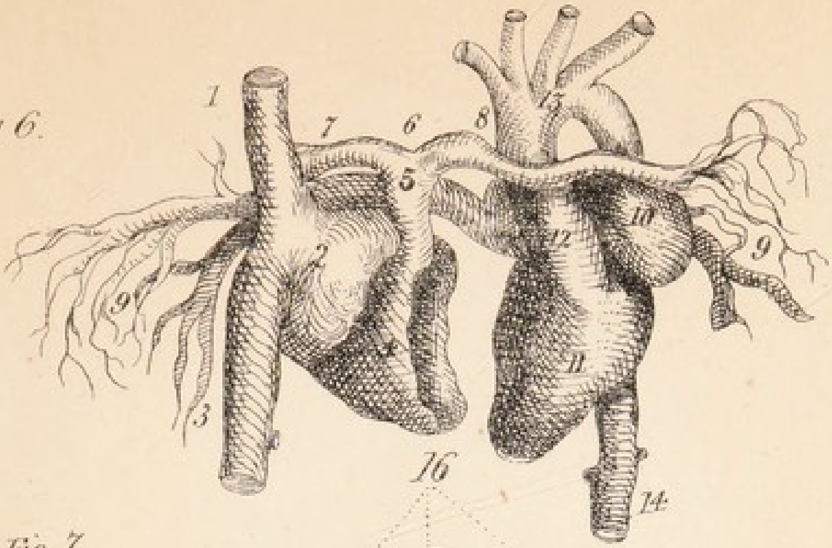


Ward, lith. Belfast

Fig 6.



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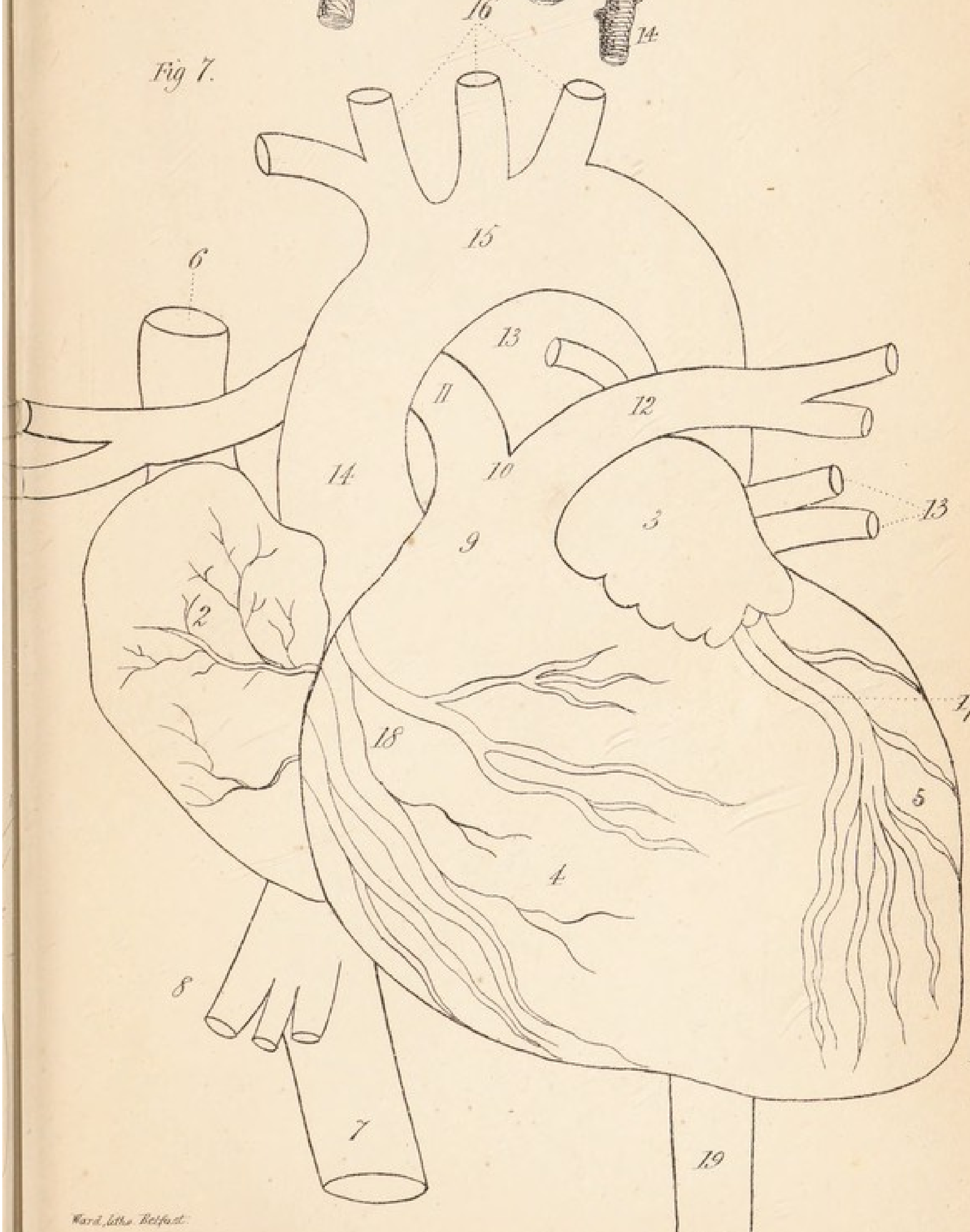

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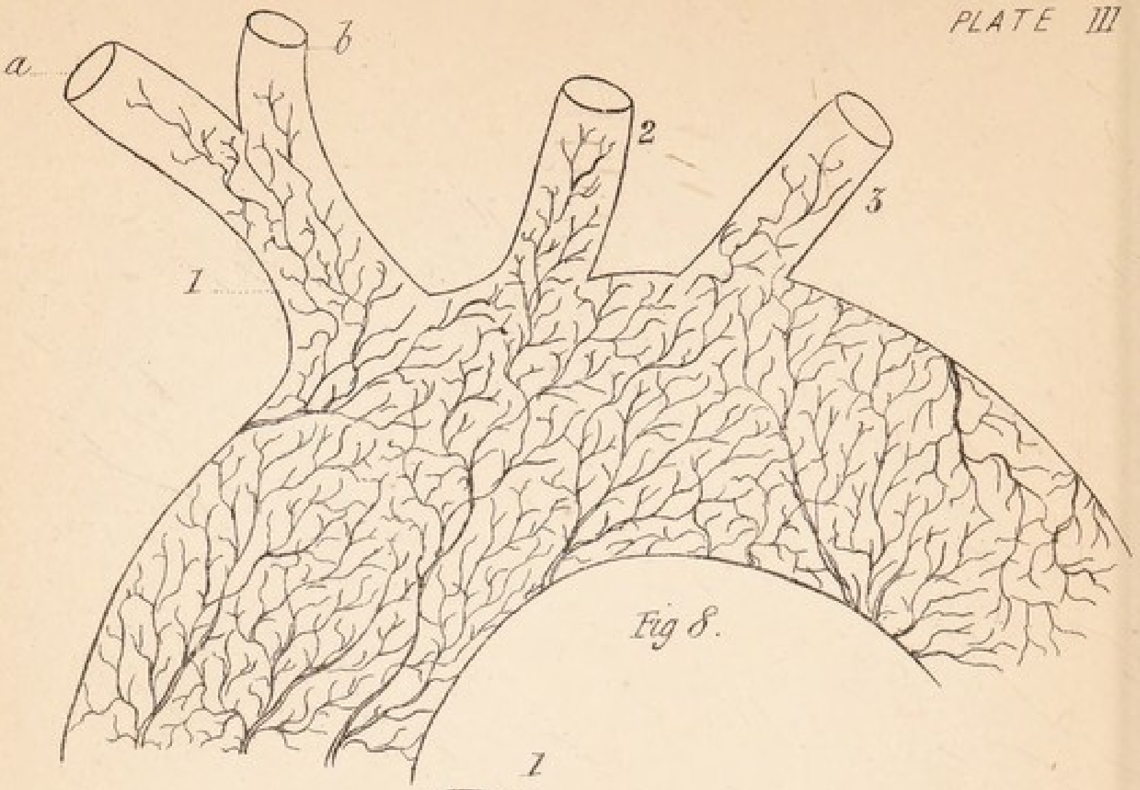
PLATE III



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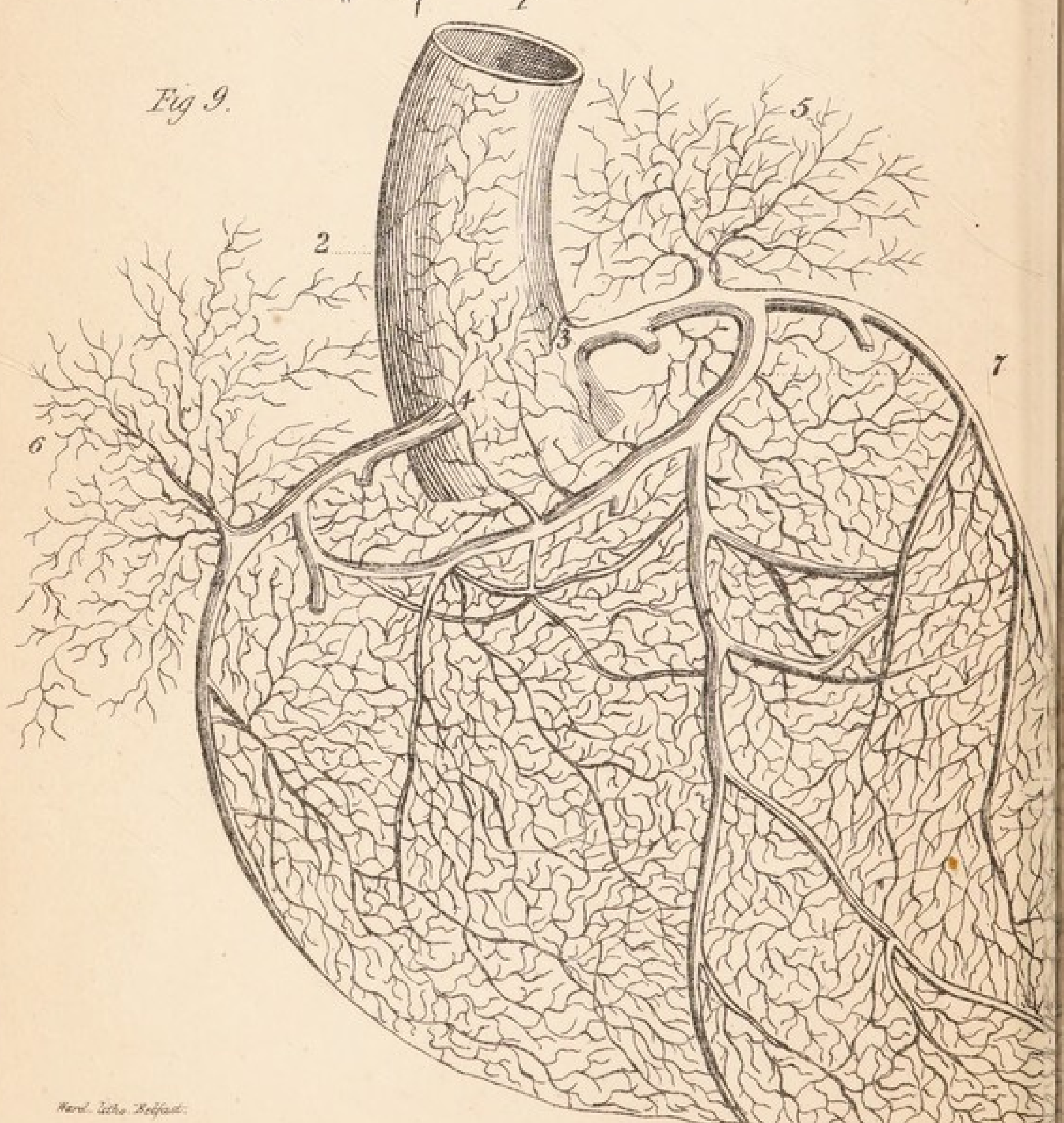
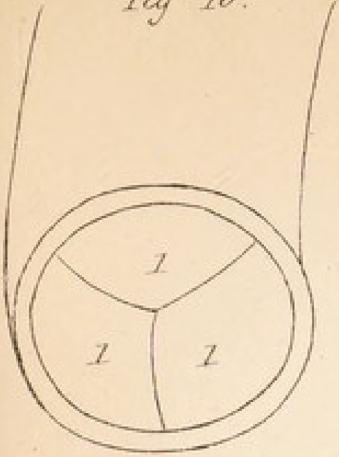


Fig 9.

Ward. Litho. Belfast.

PLATE IV.

Fig 10.



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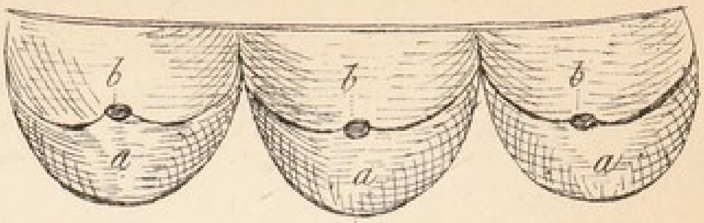


Fig 12.

Fig 13.

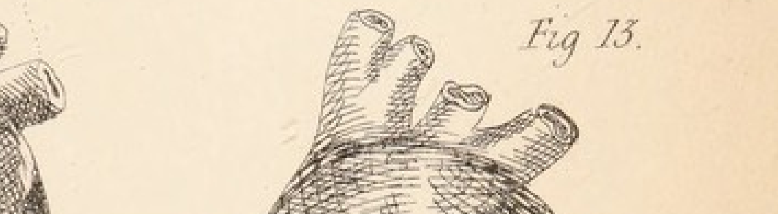
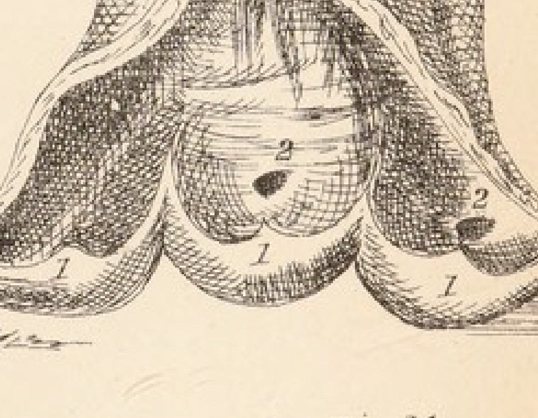


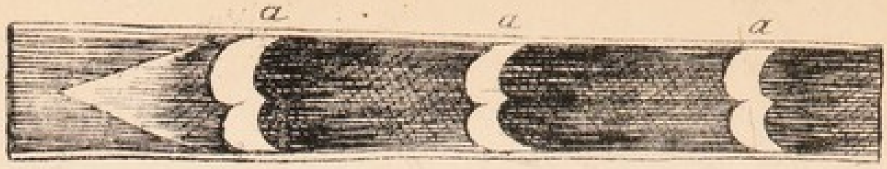
Fig 15.

Fig 14.



Ward, Lithr. Belfast.

Fig 16.



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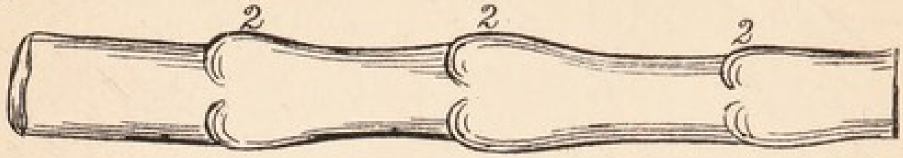


Fig 18

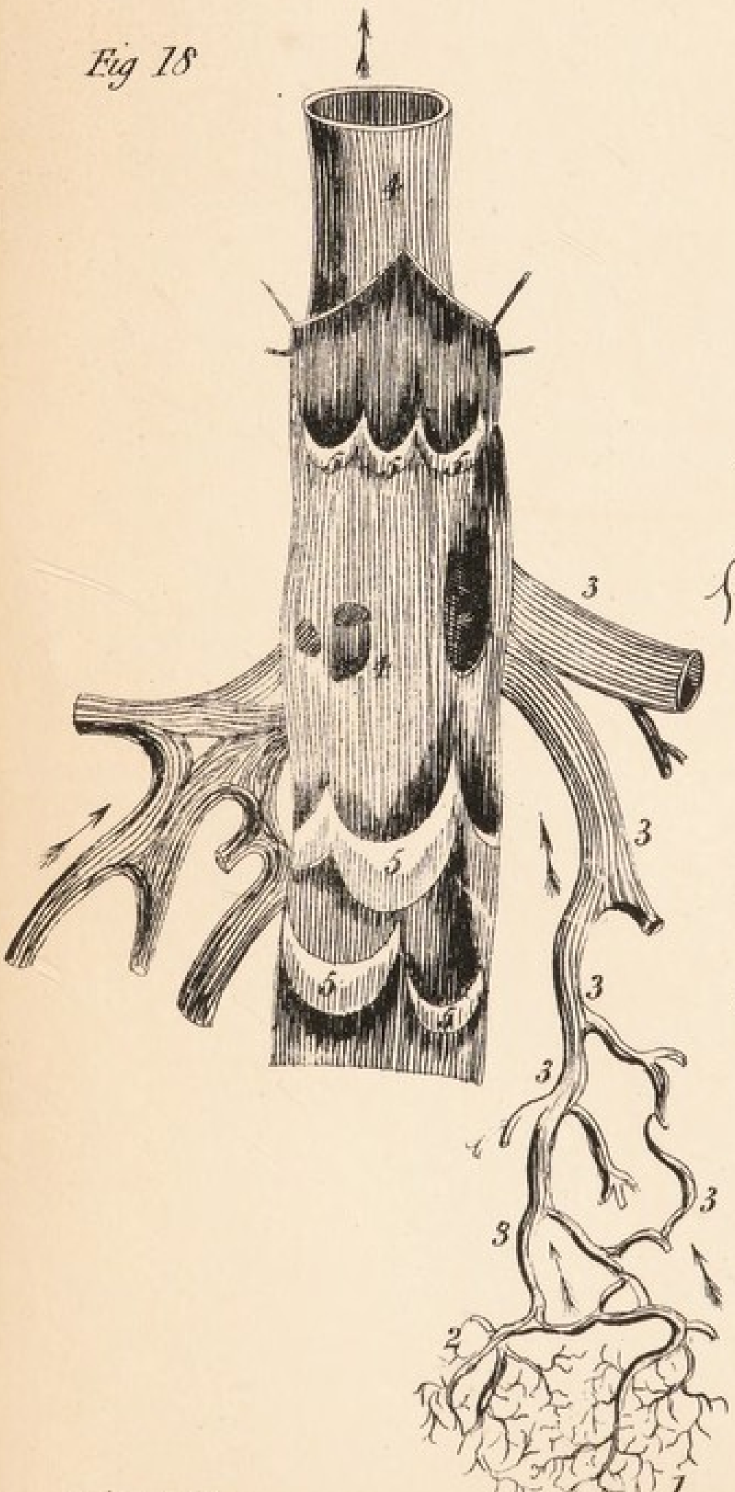
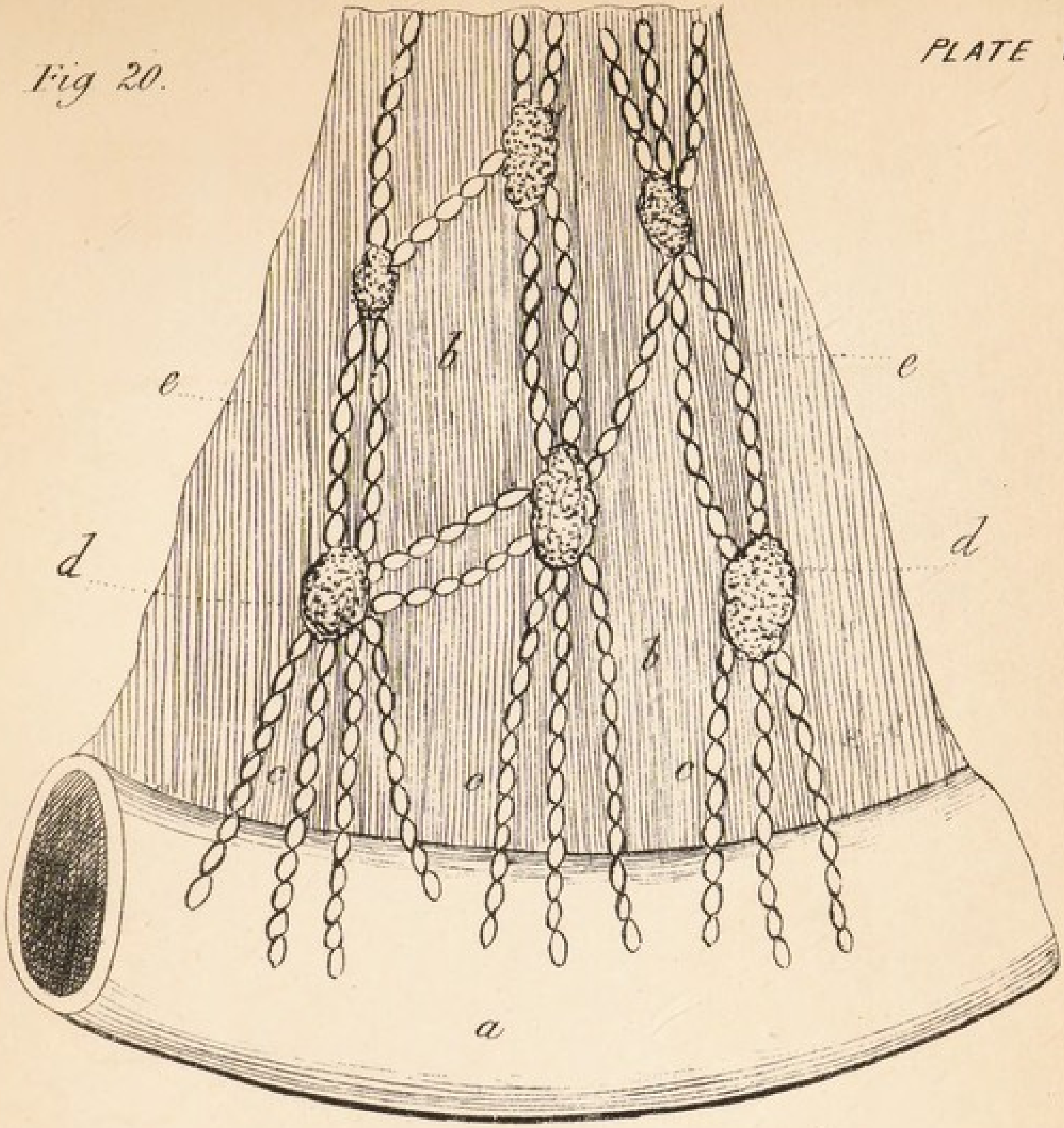


Fig 19.

Ward, litho. Belfast.

Fig 20.



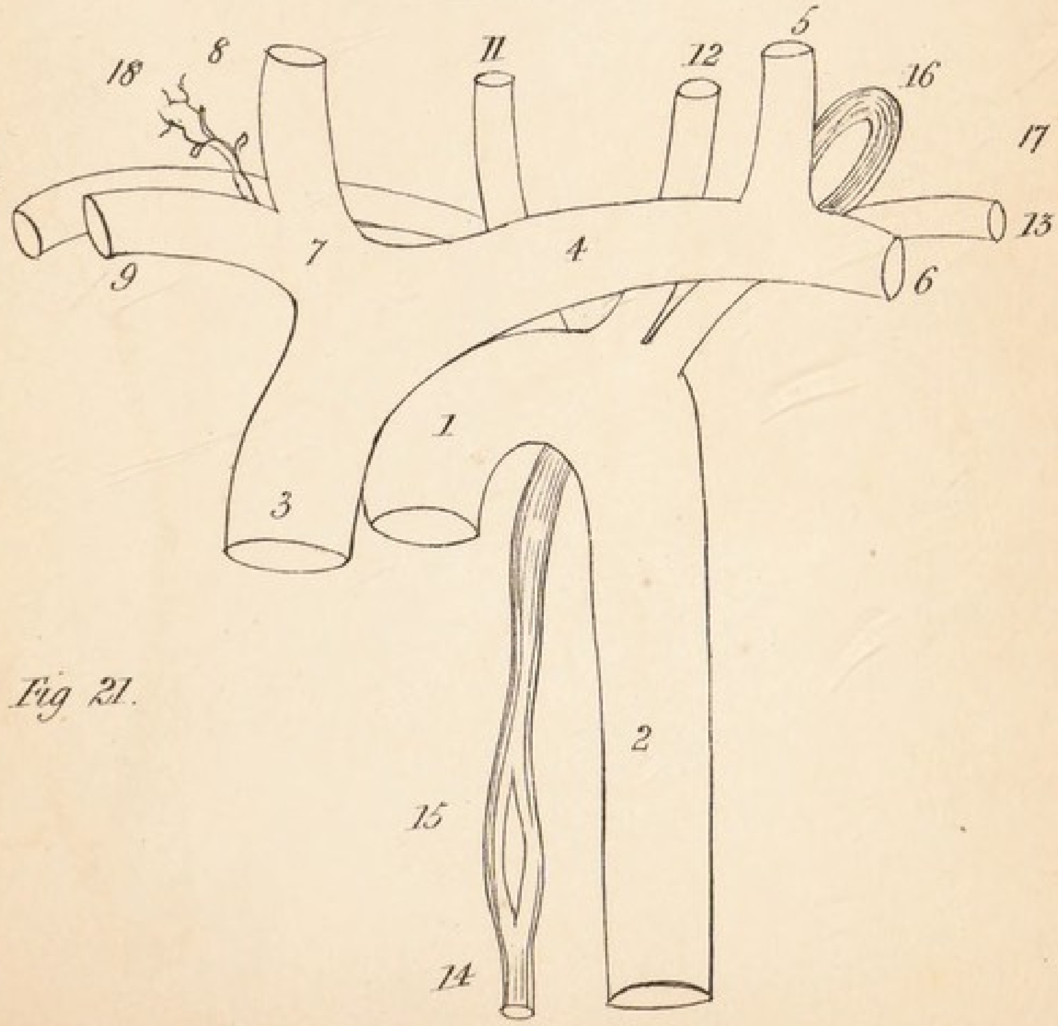


Fig 21.

PLATE VII.

Fig 22.

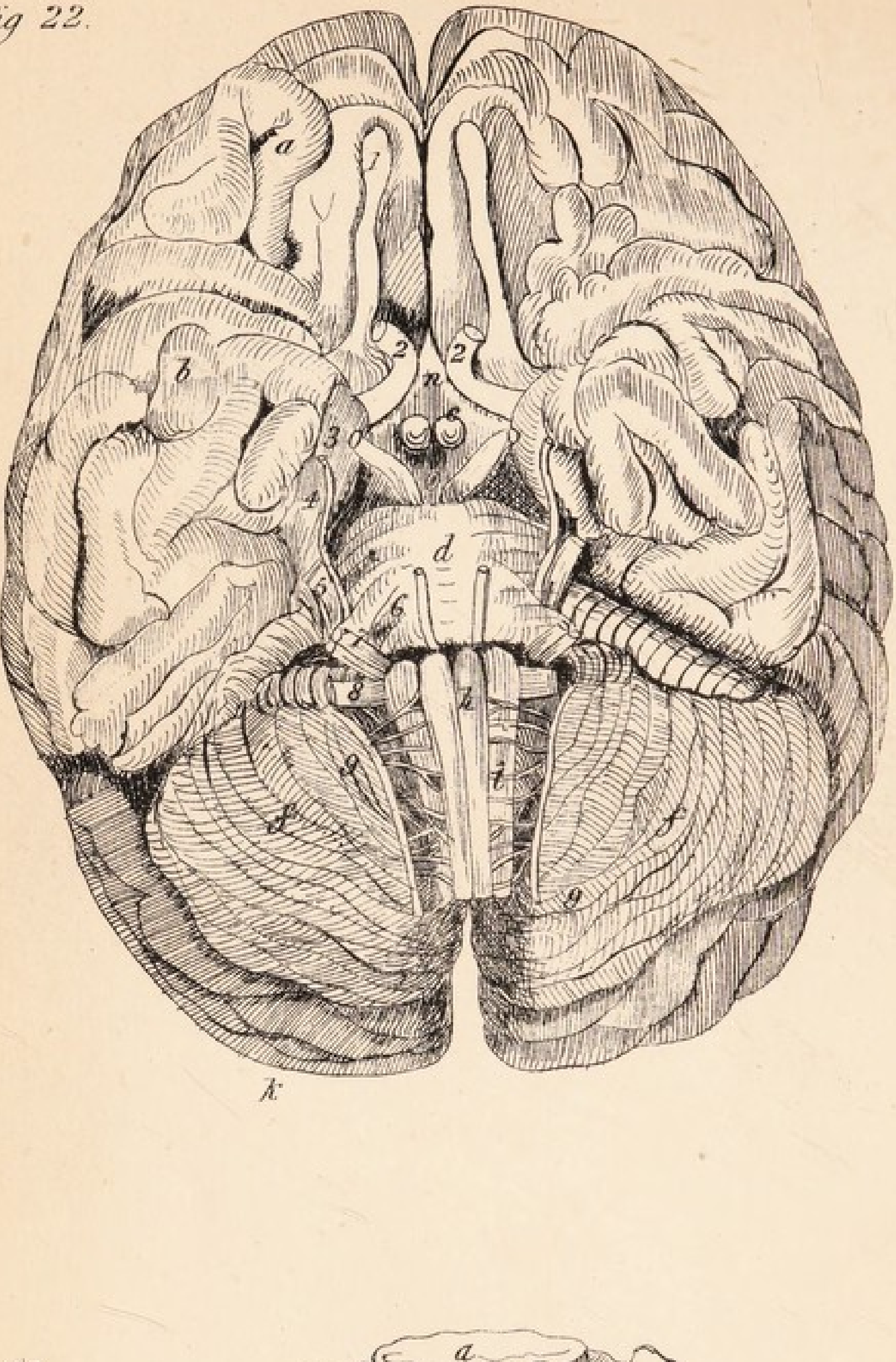


Fig 23.

PLATE VIII.

Fig 24.

Fig 25.

Fig 26.

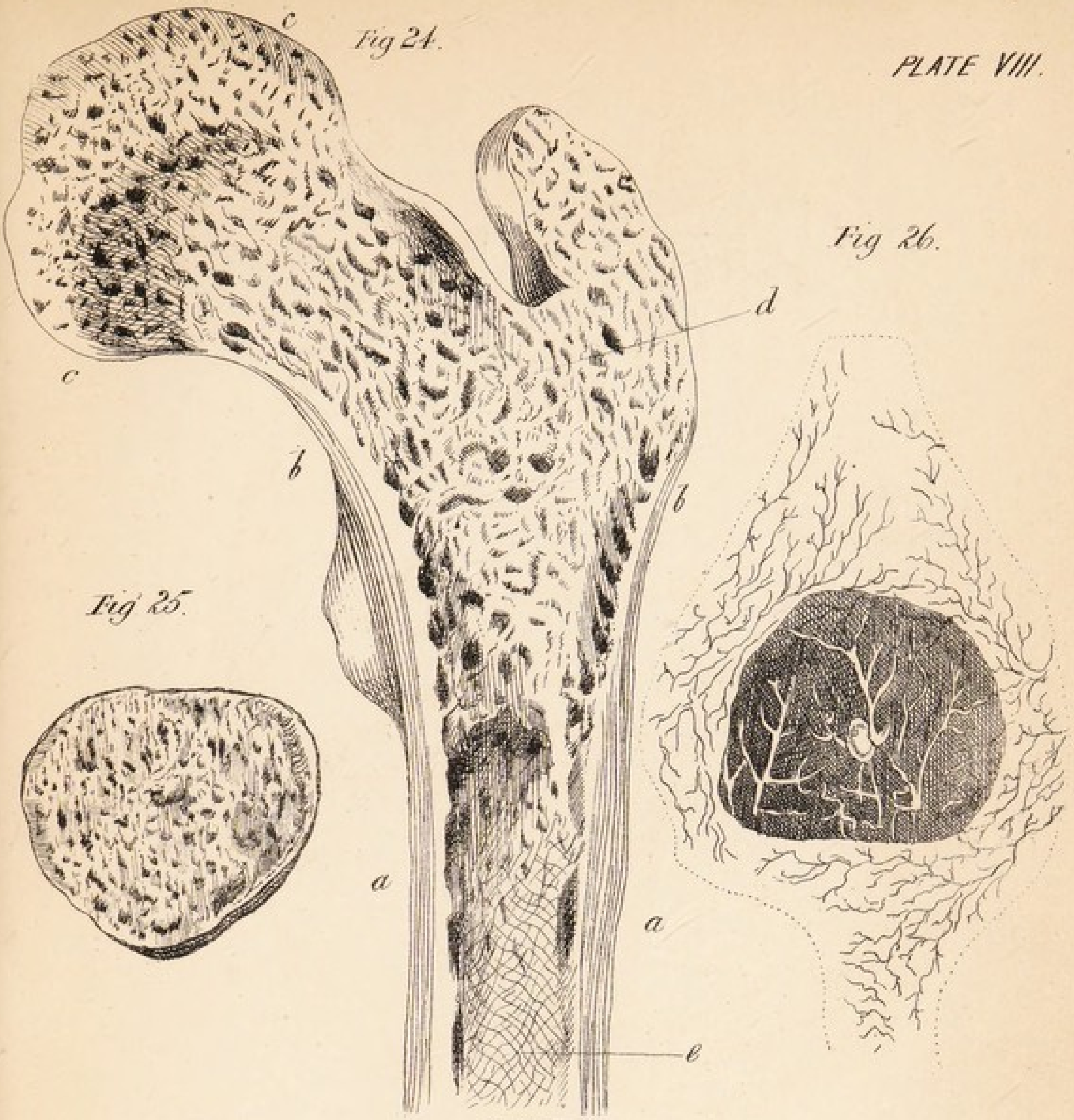
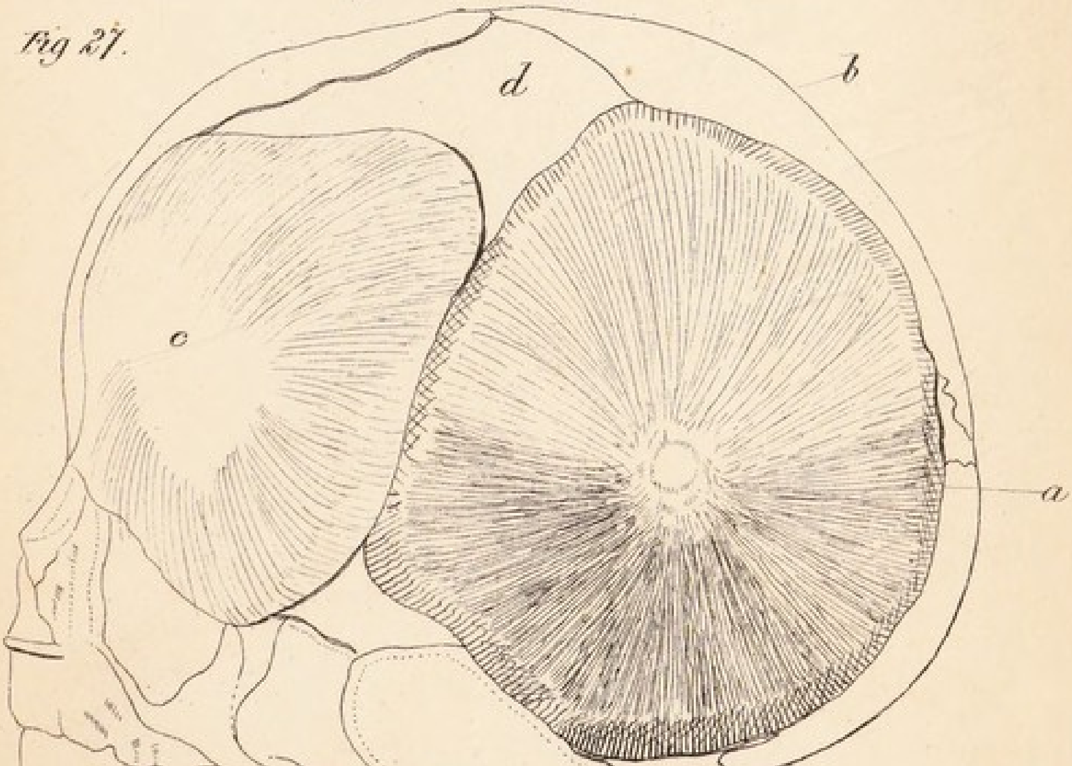
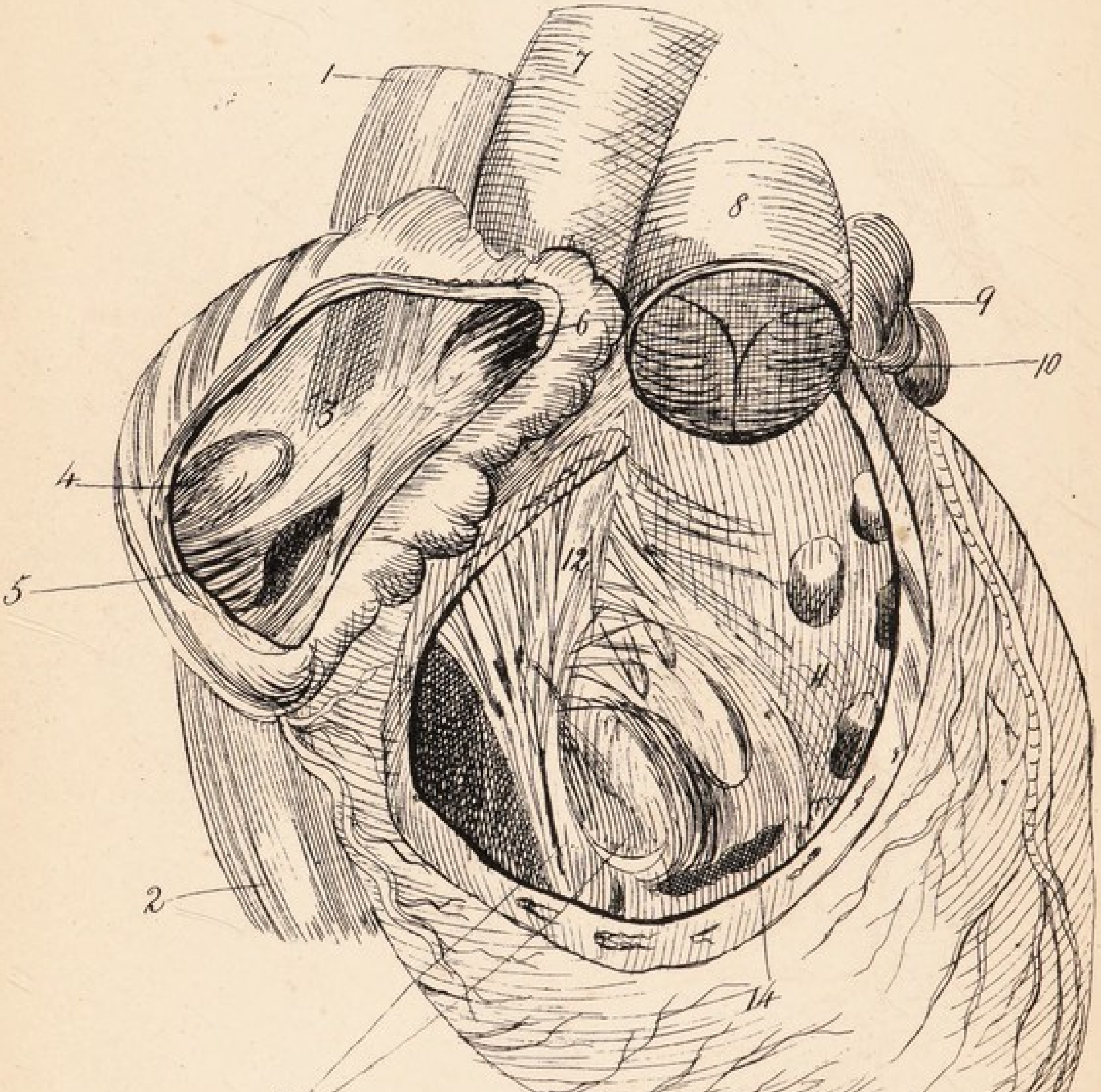


Fig 27.



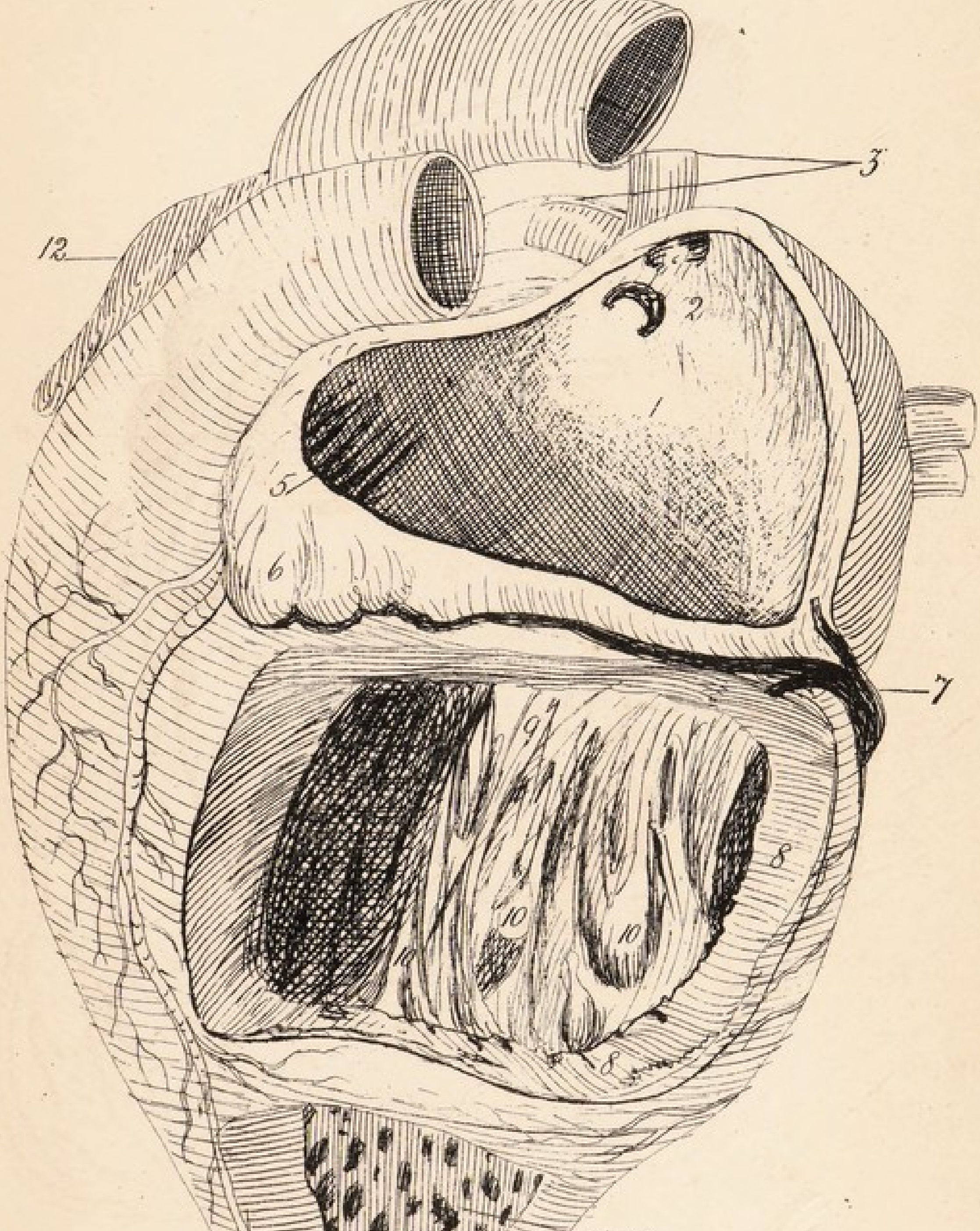
Ward, lith.

Fig 28.



M. Ward, litho.

Fig 29.



M. Ward, litho

Fig 31.

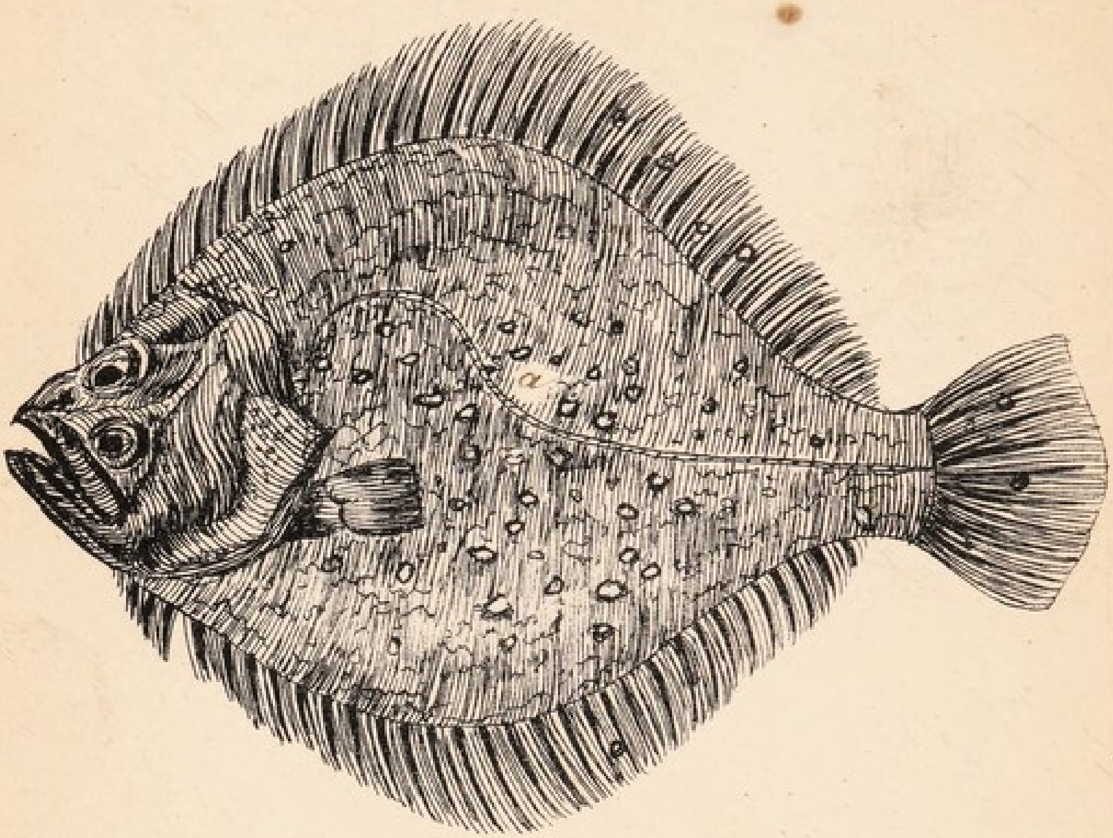
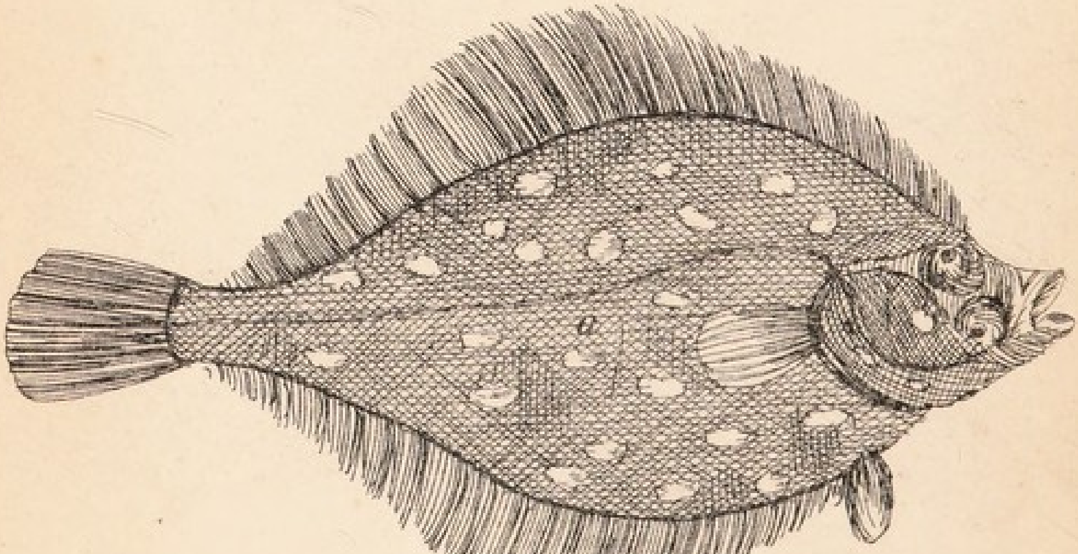


Fig 30.



M. Ward, litho.

PLATE XII.

Fig 32.