tables too often supply us with instances of this fact, in dishes of roast or boiled meat too long exposed to the action of the fire, and hence reduced to juiceless and ragged fibres, totally devoid of nutriment, and capable of keeping for weeks or months, without betraying any putrefactive indication.

In like manner, when bodies are buried beneath the hot and arid sands of Egypt or Arabia, with a sultry sun shining, almost without ceasing, upon the sandy surface, the heat hereby produced is so considerable as to raise the whole of the fluids of the animal system to the cuticle, whence they are immediately and voraciously drunk up by the bibulous sands that surround it; or, piercing their interstices, are thrown off into the atmosphere in the form of insensible vapour. In consequence of which, when a body thus buried is dug up a few weeks after its interment, instead of being converted into its original elements, it is found changed into a natural mummy, altogether as hard, and as capable of preservation as any artificial mummy, prepared with the costliest septics employed on such occasions.

When dead animal organs are deposited in situations in which only a very small portion of atmospheric air is capable of having access to them, a change indeed takes place, but of a very different description from that of putrefaction, and which is of a most curious and extraordinary nature. For in such cases the animal organs, instead of being converted into their original elements, are transmuted into fat, wax, or spermaceti; or rather into a substance *sui generis*, and possessing a middle nature between that of the two former, whence the French chemists have given it the appellation of ADIPOCIRE; a term not strictly classical, but for which the chemists of our own country have not hitherto substituted any other.

This result is observed, not unfrequently, in bodies that are drowned, and rendered incapable of rising to the surface of the water; for in such a situation but very little air, and, consequently, very little oxygen, can reach them from the external atmosphere. And it is to these circumstances we ought, perhaps, to resolve the singular appearance in the body of Colonel Pollen, who was wrecked a few years ago in the Baltic Sea, near Memel, and within sight of the coast; and whose corpse was six months afterward thrown on shore, with the features of the face so little varied, that every one of his acquaintance recognised him at the first glance. The body had probably been entangled in the submarine sands on first sinking, and been retained in this situation for months, cut off from that exposure to external air which is absolutely necessary in all cases of putrefaction properly so called. A similar conversion into wax-fat was observed also in 1786 and 1787, on opening the *fosses communes*, or common burial pits in the churchyards of the Innocents at Paris, for the purpose of laying the foundation of a new pile of buildings. For the bodies that on this occasion were dug up, instead of being dissolved into their elementary corpuscles, were found for the most part converted into this very substance of waxy fat or adipocire. The populace were alarmed at the phenomenon, and the chemists were applied to for an explanation. M. Fourcroy, among others, attended upon this occasion; and his solution, which will apply to all cases of a similar kind, referred the whole to the extreme difficulty with which external air had obtained any communication with the inhumed bodies, in consequence of the close adaptation of coffin to coffin, and the compactness with which every pit had been filled up. Difficult, however, as this communication must have been, he conceived that, from the natural elasticity of atmospheric air, some small portion of it had still entered, conveying, perhaps, just oxygen enough to excite the new action of decomposition. This having commenced, the constituent oxygen of the dead animal organs would itself be progressively disengaged, and rapaciously laid hold of by all the other constituent principles, from their strong and general affinity to it. During this gradual evolution, there can be little doubt that the greater part of it would be seized by the predominant azote, a very considerable part by the carbon, and the rest by the hydrogen; and the result would be, upon the total but very slow escape of the constituent and disengaged oxygen, that the whole or nearly the whole of the azote, a considerable portion of the carbon, and a certain quantity of the hydrogen, would escape also —leaving behind the remainder of the carbon and the hydrogen, now incapable of escape from the want of oxygen to give wings to their flight, together with the residual earth of the animal machine.

But hydrogen and carbon, though in this case incapable of sublimation for want of oxygen, would still, from their mutual attraction and juxtaposition, enter into a new union and produce a new result, and this result must necessarily be fat; for fat is nothing else than a combination, in given proportions, of carbon and hydrogen. And hence, whatever the respective animal organs of the bodies deposited in these burial caverns may have antecedently consisted of, whether muscles, ligament, tendon, skin, or cellular substance, when thus deprived of their oxygen and azote, the whole must of necessity be converted into fat. Pure and genuine fat it would have been, provided there had been nothing left behind but mere carbon and hydrogen, and in their respective proportions for the formation of fat; but as we can scarcely conceive such proportions could take place, or that every corpuscle of the azote could be carried off before the total escape of the oxygen, many parts of it must necessarily have assumed a flaky, soapy, or waxy appearance, from the union of the azote left behind with some portion of the hydrogen, and the consequent production of ammonia or volatile alkali; since, by an intermixture of alkali with fat, every one knows that soap or a saponaceous substance is uniformly produced.

But, excepting in situations of this kind, in reality, in every situation in which dead animal matter, destitute of its living principle, is exposed to the usual auxiliaries of putrefaction, putrefaction will necessarily ensue, and the balance will be fairly maintained:—the common elements of vital organization will be set at liberty to commence a new career, and the animal world will restore to the vegetable the whole which it has antecedently derived from it.

In this manner is it, then, that nature, or rather that the GOD of nature, is for ever unfolding that simple but beautiful round of action, that circle of eternal motion, in which every link maintains its relative importance, and the happiness of every part flows from the harmony of the whole. Can we, then, do better than conclude with the correct and spirited apostrophe of one of our most celebrated poets?—

> Look round the world! behold the chain of love
> Combining all below and all above.
> See plastic nature working to this end;
> Atoms to atoms—clods to crystals tend.*
> See dying vegetables life sustain;
> See life, dissolving, vegetate again.—
> All serv'd, all serving, nothing stands alone,
> The chain holds on, and where it ends unknown.

LECTURE XIV.

ON THE PROCESSES OF ASSIMILATION AND NUTRITION; AND THE CURIOUS EFFECTS TO WHICH THEY LEAD.

WE have traced out in our preceding studies something of the means by which form, and magnitude, and motion are produced in the inorganized world:—how the various substances that surround us combine and separate, vanish from us and reappear, and, in the multifarious processes they undergo, give rise to new products by new and perpetually shifting involutions. We have farther traced an outline of the means by which organized matter is capable of building up the curious structures of plants and animals; how the chief func-

* This line is altered to answer the present purpose in a better manner.

tions they possess are carried on, and by what means they respectively acquire maturity and perfection.

But it is not only necessary that the system should in this manner be matured and perfected by a fresh application of materials, but that the old materials which constitute every organ should be progressively removed from the system, in consequence of their being worn out by use, and their place supplied from definite stores. Let us, then, devote the present hour to an inquiry how this latter change occurs in vascular and living matter, in the vegetable and animal system: by what means the dead or exhausted and worn-out elements of the different organs are carried off, and replaced by new reformative materials, and what are the principal phenomena that result from such a series of operations.

The blood, then, in animals, and the sap, which may be regarded as a species of blood, in plants, of both which we have already treated, are the vital currents from which every organ of the individual frame derives the nourishment it stands in need of, and into which it pours ultimately a considerable portion of its waste and eliminated fragments; for the provident frugality of nature suffers nothing to be lost, and, as far as possible, works up the old materials, time after time, into fresh food for the subsistence of the entire system.

To produce this double purpose two distinct sets of vessels are necessary: one for that of separating from the common mass of the blood, and recombining into new associations, those particular parts of it which the formation of the fresh matter demands; and the other for that of carrying back the rejected materials into the general current. And hence these two sets of vessels bear the same relation to each other as the veins and arteries of the animal frame, accompany every part of the frame to its farthest extremities, and, indeed, constitute the general mass of the frame itself. From the respective offices they perform, they are denominated SECERNENT and ABSORBENT systems: in their utmost ramifications they are too minute to be traced by the keenest eye, or the nicest experiment of the anatomist; but where they are not quite so minute, they are sufficiently discoverable, and their course is sufficiently capable of being followed up, from the delicate apertures or mouths by which, in infinite numbers, they open on all animal surfaces, or hollows whatever, to their incipient sources.

The SECERNENTS, or that set of vessels whose office it is to separate particular parts from the blood for particular purposes, are evidently continuations of some of those very subtile ramifications of the arteries which, on account of their fineness, are called capillary; and the ABSORBENTS, or that set of vessels whose office it is to imbibe or drink up the waste and exhausted materials, are as evidently distinct and attenuate tubes, progressively uniting, and ultimately emptying themselves into the venous system; the common trunk in which they concentre, and in which also concentre the lacteals of the alimentary canal, named the thoracic duct, being a tough membranous channel, situate upon the interior part of the spine, of about the diameter of a crow-quill in man, and running in a serpentine direction through the diaphragm or midriff to an angle formed by a union of the jugular and subclavian veins, into which it opens, and where of course it terminates, leaving the waste and the new food, now ultimately intermixed, to be still farther elaborated and refitted for use by those subsequent and specific operations of the heart and the lungs which we have already described.*

The simplest action, perhaps, that is evinced by the mouths of the secre-

* This double action by a double set of vessels was little, if at all, known to the ancients, who referred the economy of both secretion and absorption to the powers of peculiar arteries and veins; and hence, the porosity of these vessels was a doctrine in common belief till the time of Hewson, Hunter, and Cruickshank. M. Magendie and M. Flandrin, of Paris, have of late been very active in establishing a view of the subject in many respects not essentially different from that of the old school, and in teaching that the only general absorbents are the veins; that the lacteals absorb food, but nothing else; and that the lymphatics have no absorbent power whatever. Their experiments are plausible and striking, but by no means decisive enough to subvert the system explained above. The argument on both sides may be found in the author's Study of Medicine, vol. v. p. 278, 2d edit. 1825.

tory or secernent vessels, consists in separating and throwing forth a fine lymph from the surface of all membranes and organs whatever, for the purpose of lubricating them, as we grease the axletree of our carriage-wheels; and thus preventing one membrane or organ from being injured by the friction of another. Of this every one who has been present on the cutting up of slaughtered oxen must have seen an abundant and striking instance, in the vapour that ascends from every part of the warm carcass: which vapour, when condensed by cold or any other cause, is found to be little more than the serum or watery part of the blood. And one of the simplest actions evinced by the mouths of the absorbent vessels consists in their drinking up, as with a sponge, this attenuate or lymphatic fluid, when it has answered its purpose, so as to make room for a fresh and perpetual effusion: whence these vessels are often called LYMPHATIC, as well as absorbent, in consequence of their being so frequently found loaded with this fine and colourless material.

And here, perhaps, the first remark that must occur to every one is, the necessity there seems to exist, that these correspondent systems of vessels should maintain the nicest harmony or balance in their respective functions; since, if the one operate either with a less or a larger power than the other, disease must inevitably follow; the nature of the malady being determined by the nature of the cause that produces it.

We have all of us heard, and most of us have seen, instances of the disorder called dropsy; and many of us have surveyed it both in a local and a general form, as dropsy of the head, dropsy of the chest, dropsy of the abdomen, and dropsy of the cellular membrane or system at large. This disease may take place from two causes; as, for example, from a too great excitement of the secernent system, or a too little excitement of the absorbent. If, from a morbid irritability in the secernent vessels of any one of the cavities I have just adverted to, an undue proportion of lubricating lymph be secreted and steam forth, the natural tone and action of the correspondent absorbent vessels will not be sufficient to carry off the surplus; and hence that surplus will accumulate, and dropsy ensue, although the absorbent vessels of the part affected be in a state of usual health and vigour: the disease depending altogether on the morbid and predominant excitement of the secernents.

But suppose the absorbent vessels of a particular cavity, in consequence of cold, exhaustion from great previous exercise, or any other cause, to be rendered torpid and inert, and, consequently, incapable of continuing their accustomed measure of action: in this case, dropsy will also ensue, notwithstanding the corresponding secernent vessels are in a state of natural health, and no larger portion of lymph is secreted than a state of natural health demands; for the fluid will now accumulate, from the morbid torpitude of the absorbent system, and its inability to fulfil its function. It is hence, as every one must perceive, a point of the utmost consequence to determine the nature of the cause in dropsy; as, in truth, it is in every other disease, before we attempt a remedy; since an error upon this subject may be productive of the most serious, and indeed fatal consequences. For it is obvious that we may stimulate where we ought to diminish action, or we may diminish action where we ought to stimulate.

Occasionally, however, the action is equally increased in both sets of vessels; as, for example, in inflammation of the leg or arm; and in this case there is great heat and dryness, and at the same time considerable intumescence or swelling. For under this affection the mouths of the secernent vessels, being more distended than in a natural state, pour forth the coagulable lymph in a grosser and less attenuate form, and not unfrequently, perhaps, intermixed with some particles of red blood; while the mouths of the absorbents, though they as eagerly drink up the finer parts of what is thus rapidly strained off, are incapable of carrying away with equal ease those of a grosser texture; in consequence of which these last remain behind, and produce tumefaction by their accumulation.

At times, also, we meet with an equal degree of diminished instead of

increased action in both these sets of vessels; as on exposure to cold and damp temperatures; in cases of spare and coarse diet; or of old age. And the result of this double decrease of energy is dryness, as in the former instance, but combined with leanness and corrugation of the organs that are thus affected. It is hence the bones of old people are more easily broken, and the skin is harsher and more wrinkled than in the middle of life; hence the shrivelled and squalid appearance of gipsies and beggars; and hence, in a considerable degree, the low and stinted stature of the Esquimaux, Laplanders, and Tongooses.

For all the usual purposes of health and organic nutrition, the common action and common degree of action evinced by these respondent systems of vessels are perfectly sufficient, though not more than sufficient. It may happen, however, that in consequence of severe violence from external injury or internal disease, a considerable portion of an organ, as a part of some of the muscles that belong to an arm or a leg, may be totally destroyed or killed, and, consequently, rendered incapable of performing its proper function. How is nature, or, which is the same thing, the remedial principle of life, to act in such circumstances? If the dead part remain, it is manifest that it must impede the living parts that surround it in the execution of their appropriate office: independently of which they want the space which the dead part occupies, and the aid which it formerly contributed. It is obvious that two processes are here necessary: the dead part must be carried off, and its post must be filled up by a substitute of new matter possessing the precise properties of the old. And here we meet with a clear and striking instance of that wonderful instinctive power which pervades every portion of the vital systems, both of the animal and vegetable world, and which is perpetually prompting them to a repair of whatever evils they may encounter, by the most skilful and definite methods.

In order to comply with this double demand of carrying off the dead matter, and of providing a substitute of new, each of the systems before us commences, in the living substance that immediately surrounds that which requires removal, a new mode and a new degree of action.

A boundary line is first instinctively drawn between the dead and useless, and the living and active parts; and the latter retract and separate themselves from the former, as though the two had been skilfully divided by a knife. This process being completed, the mouths of the surrounding absorbent vessels set to work with new and increased power, and drink up and carry off whatever the material may be of which the dead part consists, whether fat, muscle, ligament, cartilage, or bone; the whole is equally imbibed and taken away, and a hollow is produced, where the dead part existed. At the same time the mouths of the corresponding secernent vessels commence a similar increase and newness of action, and instead of the usual lymph, pour forth into the hollow a soft, bland, creamy, and inodorous fluid which is denominated pus; that progressively fills up the cavity, presses gradually against the superincumbent skin, in the gentlest manner possible distends and attenuates it, and at length bursts it open, and exposes the whole of the interior to the action of the gases of the atmosphere.

It was at one time conceived, and by writers of considerable eminence and judgment, and of as late a date as the time of Mr. Hewson, that the injured and dead parts were themselves dissolved and converted into pus; but this opinion has been disproved in the most satisfactory manner by the minute and accurate experiments of Mr. John Hunter, Sir Everard Home, and Mr. Cruickshank; and the process has been completely established as I have now related it.

In what immediate way the gases of the atmosphere operate so as to assist the secernent mouths of what is now the clean and exposed surface of a wound, in producing incarnation, or the formation of new matter of the very same kind and power as that which has been carried off, and enable them to fill up the cavity with such new matter, and perfect the cure, we do not exactly know. Various theories have been offered upon this very curious subject;

but at present they are theories, and nothing more; and I shall not, therefore, detain you with a relation of them. Thus much, however, we do know, that the co-operation of the atmosphere with the action of the mouths of the secernent system engaged in the work of restoration is, in some way or other, peculiarly beneficial; and that, generally speaking, the wider the opening, and the freer the access of atmospheric air of a due temperature to the surface of the wound, or, which is the same thing, the freer it comes in contact with the mouths of the secernent vessels, the more rapidly and auspiciously the work of impletion and assimilation proceeds. Neither do we know, precisely, why pus, rather than any other kind of fluid, should in the first instance be poured forth, for the purpose of filling up the hollow, and producing a rupture of the skin; but we know to a certainty that some such general process is in most cases absolutely necessary; we know that such a rupture must take place in the natural mode of cure; that the atmosphere must come into close contact with the mouths of the restorative secernents; that a milder or softer fluid could not possibly be secreted for such a purpose; and that the entire process exhibits proofs of most admirable skill and sagacity. It is at times possible for us to assist the process by the lancet, which accelerates the opening. Yet, even in this case, we do no more than assist it, and are only, as we ought ever to be in all similar cases, humble coadjutors and imitators of nature, and admirers of that all-perfect and ever-present wisdom which we are so often called upon to witness, but are never capable of rivalling.

A process closely similar to this is perpetually unfolding in vegetable life. And it was merely by taking advantage of this process that Mr. Forsythe was able to make old, but well-rooted, stumps of fruit-trees throw forth, far more rapidly than he could saplings, a thrifty family of vigorous and well-bearing shoots: for the compost for which he was so celebrated does nothing more than merely increase the secernent and absorbent action of the vegetable frame by its stimulating property, and defend the wounded part to which it is applied from being injured by the inclemency of the weather.

From what has thus far been observed, it appears obvious that all the different parts of the living body are assimilating organs, or, in other words, are capable of converting the common nutriment of the blood into their own respective natures, and for their own respective uses. And it has also appeared, that under particular circumstances every part is capable, moreover, of secreting a material different from that of its own nature; as, for example, the material of pus, whenever such a substance is necessary.

This view of the subject will lead us to understand with facility how it is possible for various organs of the system to maintain two distinct secretions at the same time: one of a matter similar to its own substance, and exclusively for its own use; and another of a matter distinct from its own substance, and in many instances subservient to the system in general.

Of this last kind are the stomach, the liver, the respiratory organ, and the brain: each of which secretes, independently of the matter for its own nourishment, a matter absolutely necessary to the health and perfection of the general machine: as the gastric juice, the curious and wonderful properties of which I described on a former occasion; the oxygenous principle of the inspired air, and, as some suppose, those of light or caloric; the bile; and the nervous fluid, or material of sensation.

There are various other organs of a smaller kind, and simpler texture, which also perform the same double office, and secrete materials of a much more local use, or which are intended to be altogether thrown away from the system, as waste or noxious bodies. And to the one or the other of these classes belong the kidneys, the intestinal tube, the minute and very simple perspiratory follicles of the skin, the delicate organs that separate the saliva and mucus that serve to lubricate the mouth and nostrils, and those that elaborate the tears, the wax of the inner ear, and the fat.

The organs, of whatever size or texture, that perform this double function, are called secretory glands; and they are distinguished into different sets,

either from their peculiar office or peculiar structure: as salivary, lachryinal, mucous, which are denominated from the former character, and apply to the smallest and simplest of them; conglobate, which are of a larger form, and of an intricate convolution, and belong exclusively to the absorbent system,—as the mesenteric and lumbar; and glomerate and conglomerate, which are composed of a congeries of sanguineous vessels, without any cavity, but with one or more mouths, or excretory ducts as they are called, which, in the latter, open into one common trunk,—as the mammary and pancreatic; both which kinds are denominated from the character of their structure.

It is by this peculiar organization in animals and plants that all those nice and infinitely varying exhalations or other fluids are thrown forth from different parts of them, by which such parts, or the whole individual, or the entire species of individuals, are respectively characterized. Our own senses are too dull to trace a discharge of any kind of essence or vapour from the surface of the human skin in its ordinary action; but the discoloration which soon takes place upon the purest linen, when worn in the purest atmosphere, sufficiently proves the existence of such an efflux; and there are various animals whose olfactory organs are much acuter than our own, as our domestic dogs, for example, that are able to discern a difference in the odour of the vapour which issues from the skin of every individual, and that in fact identify their respective masters, and distinguish them from other individuals, by this character alone.

It is to this sense chiefly that quadrupeds, birds, fishes, and most insect tribes trust themselves in their search after food; and hence the superior acuteness of this power in animals of such kinds is a strong proof of that unerring Wisdom which regulates the world, and is equally conspicuous in every part of it. Under peculiar circumstances, however, the sense of smell appears to be far more lively among mankind than when such circumstances do not exist. M. Virey, who has written a very learned treatise upon this subject, asserts, that it occurs among savages in a far higher degree of activity than among civilized nations, whose olfactory nerves are blunted by an habitual exposure to strong odours, or intricate combination of odours, and by the use of high-flavoured foods. And among persons in a keen morbid state of irritability it has been often found, even in civilized life, much sharper than among savages. The Journal des Sçavans, an 1667, gives a curious history of a monk who was said to be able to ascertain, by the difference of odour alone, the sex and age of a person, whether he were married or single, and the manner of life to which he was accustomed.*

When the exhalation from the human skin is increased by muscular exercise, or any other exertion, it is rendered visible; and in this state it is generally found to combine with it a certain portion of dissolved animal oil or fat. Even without much increased action of the system, it is possible at times to obtain a knowledge of its existence under particular circumstances, or by particular applications. Thus, in cold subterraneous caverns, where the air is dense and heavy, the natural evaporation often escapes from the surface of the body in the form of thick clouds; and a bright mirror, when held near a warm and naked skin, in the temperature of the atmosphere, soon becomes obscured by a moist vapour.

The quantity of this fluid discharged, either in a state of quiescence or of increased action, has not been determined with any great degrees of exactness. According to M. de Sauvages,† a man of middle stature and age, weighing 146lbs., takes daily of food and drink about 56 ounces (circiter quinquaginta sex uncias), his dinner being about twice as much as his supper. In the same period he perspires about 28 ounces; viz. about twelve during the third part of his time in which he sleeps, and sixteen during the two-thirds in which he is awake. It appears certain, from the experiments of Gorter, that

* In a paper on the Petiveria, in the Swedish Academy Transactions, there are a variety of curious observations on the peculiar properties given to the smell, flesh, &c. of different animals in consequence of their feeding on different foods. It is entitled Petiveria, en Americansk vaxt. Anal. Trans. tom. i p. 346.

† Nosol. Method. ii. 369.

the weight of the body is more diminished by the same quantity of sweat than of mere perspiration.

Sanctorius, whose experiments of measuring the weight of the body were made in the warm climate of Italy, ascertained that in that region eight pounds of food received by the mouth were, by the different insensible secretions, reduced to three; making the proportion of insensible exhalation as five to eight. In cold climates, however, it has been determined that it does not amount to more than two-thirds of this proportion; and of either quantity it has lately been very satisfactorily established, that more than half this secretion has been thrown forth from the surface of the lungs; which I estimated in a previous lecture, and from the experiments and calculations of Lavoisier, as discharging not less than eleven ounces of solid carbon or charcoal in every four-and-twenty hours.*

Plants transpire precisely in the same way, and to a much greater extent, through the medium of their leaves; which, while they form a great part of their cuticle, may, as I have observed on a former occasion,† be also contemplated as their lungs. Hales calculated that a sun-flower, three feet high, transmits in twelve hours one pound four ounces of fluid by avoirdupois weight. Bishop Watson put an inverted glass vessel, of the capacity of twenty cubic inches, on grass which had been cut during a very intense heat of the sun, and after many weeks had passed without rain; in two minutes it was filled with vapour, which trickled with drops down its sides. He collected these on a piece of muslin, carefully weighed, and repeated the experiment for several days between twelve and three o'clock; and estimated, as the result of his experiment, that an acre of grass land transpires in twenty-four hours not less than 6,400 quarts of water. Dalton, for dew and rain together, makes the mean of England and Wales 36 inches, thus amounting, in a year, to 28 cubic miles of water. Grew, in 1711, calculated the number of acres in South Britain at 46,800,000, and allowed a million to Holland.‡ Smith, for England alone, gives 73¼ millions in the present day.§

But the same general surface in animals and vegetables that thus largely secretes delicate fluids, largely also imbibes them by the corresponding system of absorbent vessels, opening with their spongy mouths or ducts in every direction. Hales ascertained that the above sun-flower, which threw off not less than twenty ounces of fluid in twelve hours, suspended its evaporation as soon as the dew fell, and absorbed two or three ounces of the dew instead. And among animals, and especially among mankind, the manifest operations of medicines and other foreign substances, merely diffused through the air, or simply applied to the skin; of various vapours, as those of mercury, turpentine, and saffron; of various baths, as of tobacco, bitter-apple, opium, cantharides, arsenic, and other poisons, producing the most fatal effects, and altogether absorbed by the skin, are decisive and incontrovertible proofs of such an action. It is hence the bradypus, or sloth, supports itself without drinking, perhaps, at any time, and the ostrich and camel for very long periods, though the latter is also possessed of a natural reservoir. And hence the chief impletion of the human body, in many cases of abdominal dropsy; since persons labouring under this disease have often been observed to fill with rapidity during the most rigid abstinence from drinks of every kind.

Along with the common odour of insensible perspiration, discharged from the human surface, we often meet with other odours of a much stronger kind, produced by particular diseases or particular modes of life, and which are distinctly perceptible. Thus the food of garlic yields a perspiration possessing a garlic smell; that of pease a leguminous smell; coarse oils and fat a rancid smell, which is the cause of this peculiar odour among the inhabitants of Greenland; and acids a smell of acidity. Among glass-blowers, from the large quantity of sea-salt that enters into the materials of their manufacture, the sweat is sometimes so highly impregnated, that the salt they

* Series i. Lecture xiii.

† Series i. Lecture ix.

‡ Phil. Trans. for 1811, p. 265

§ Phil. Mag. xix. 197. Young's Nat. Phil. ii. 369.

employ, and imbibe by the skin and lungs, has been seen to collect in crystals upon their faces.

Hence, too, the various smells that are emitted from the surface of other animals, and especially that of musk, which is one of the most common. We trace this issuing generally from the bodies of many of the ape species, and especially the simia *jacchus;* still more profusely from the opossum, and occasionally from hedgehogs, water-rats, hares, serpents, and crocodiles. The odour of civet is the production of the civet-cat alone, the viverra *zibetha*, and viverra *civetta* of Linnæus; though we meet with faint traces of it in some varieties of the domestic cat, the felis *catta* of the same writer. Genuine castor is, in like manner, a secretion of the castor fiber; but the sus Tajassu, and various other species of swine, yield a smell that makes an approach towards it.

Among insects, however, these odours are considerably more varied, as well as considerably more pleasant; for the musk-scent of the cerambix *moschatus*, the apis *fragrans*, and the tipula *moschifera*, is far more delicate than that of the musk quadrupeds; while the cerambix *suaveolens*, and several species of the ichneumon, yield the sweetest perfume of the rose; and the petiolated sphex a balsamic ether highly fragrant, but peculiar to itself. Yet insects, like other classes of animals, furnish instances of disagreeable and even disgusting scents, as well as of those that are fragrant. Thus, several species of the melitæ breathe an essence of garlic or onions; the staphilinus *brunipes* has a stench intolerably fetid, though combined with the perfume of spices; while the caterpillars of almost all the hymenoptera, and the larves of various other orders, emit an exhalation in many instances excessively pungent. The carabus *crepitans*, and sclopeta of Fabricius, pour forth a similar vapour, accompanied with a strange crackling sound.

The odorous secretions belonging to the vegetable tribes are well known to be still more variable; sometimes poured forth from the leaves of the plant, as in the bay, sweet-briar, and heliotrope; sometimes from the trunk, as in the pines and junipers; but more generally from the corol. It is from the minute family of the jungermannia, nearly related to the mosses, and often scarcely visible to the eye, that we derive the chief sense of that delightful fragrance perceptible after a shower, and especially at even-tide:* and from the florets of the elegant anthoxanthum *odoratum*, or spring-grass, that we are chiefly furnished with the sweet and fragrant scent of new-mown hay. But occasionally the odours thus secreted are as intolerable as any that are emitted from the animal world; of which the ferula *asafœtida*, or asafetida plant, and the stapelia *hirsuta*, or carrion-flower, are sufficient examples.

To the same secernent powers, moreover, of animals and vegetables, existing in particular organs rather than extended through the system generally, we are indebted for a variety of very valuable materials in trade and diet, as gums, resins, wax, fat, oils, spermaceti. And to the same cause we owe, also, the production of a multiplicity of poisons and other deleterious substances: such, for instance, as the poison of venomous serpents, which is found to consist of a genuine gum, and is the only gum known to be secreted by animal organs; the electric gas of the gymnotus *electricus* and raia *torpedo;* the pungent sting of the stinging-nettle, urtica *urens*, and of the bee, both which are produced from a structure of a similar kind; for every aculeus or stinging point of the nettle is a minute and highly irritable duct, that leads to a minute and highly irritable bulb, filled with a minute drop of very acrid fluid: and hence, whenever any substance presses against any of the aculei or stinging points of the plant, the impression is communicated to the bulb, which instantaneously contracts, and throws forth the minute drop of acrid fluid through the ducts upon the substance that touches them.

As the secernent system thus evidently allots particular organs for the secretion of particular materials, the absorbent system is in like manner only capable of imbibing and introducing into the general frame particular materials in particular parts of it. Thus, opium and alkohol, the juice of aconite, and essential oil of laurel or bitter almonds, produce little or no effect upon the absorbents of the skin, but a very considerable effect upon the coating of the stomach. In like manner, carbonic acid gas invigorates rather than injures, when applied to the absorbents of the stomach, but instantly destroys life when applied to those of the lungs; while the aroma of the toxicaria *Macasariensis*, or Boa upas, of which we have heard so much of late years, proves equally a poison, whether received by the skin, the stomach, or the lungs.

So, also, substances that are poisonous to one tribe of animals are medicinal to a second, and even highly nutritive to a third. Thus, swine are poisoned by pepper-seeds, which to man are a serviceable and grateful spice; while henbane-roots, which destroy mankind, prove a wholesome diet to swine. In like manner, aloes, which to our own kind is a useful medicine, is a rank venom to dogs and foxes; and the horse, which is poisoned by the phellandrum *aquaticum*, or water-hemlock, and corrosive sublimate, will take a drachm of arsenic daily, and improve hereby both in his coat and condition.

It has already appeared, that the secernent vessels of any part of the system, in order to accomplish a beneficial purpose, as, for example, that of restoring a destroyed or injured portion of an organ, may change their action, and secrete a material of a new nature and character. An equal change is not unfrequently produced under a morbid habit, and the secretion will then be of a deleterious instead of being of a healthy and sanative kind. And hence, under the influence of definite causes, the origin of such mischievous and fatal secretions, in some instances thrown forth generally, and in others only from particular organs, as the matter of small-pox, measles, putrid fevers of various kinds, cancer, and hydrophobia, or the poisonous saliva of mad dogs.

But the field opens before us to an unbounded extent, and we should lose ourselves in the subject if we were to proceed much farther. It is obvious, that in organic, as in inorganic nature, every thing is accurately arranged upon a principle of mutual adaptation, and regulated by an harmonious antagonism, a system of opposite yet accordant powers, that balance each other with most marvellous nicety; that increase and diminution, life and death, proceed with equal pace; that foods are poisons, and poisons foods; and, finally, that there is good enough in the world, if rightly improved, to make us happy in our respective stations so long as they are allotted to us, and evil enough to wean us from them by the time the grant of life is usually recalled.

* Hooker's Monography of British Jungerm.

LECTURE XV.

ON THE EXTERNAL SENSES OF ANIMALS.

The subject of study for the present lecture is the organs of external sense in animals: their origin, structure, position, and powers; and the diversities they exhibit in different kinds and species.

The external senses vary in their number: in all the more perfect animals they are five; and consist in the faculties of sight, smell, hearing, taste, and touch.

It is by these conveyances that the mind or sensory receives a knowledge of whatever is passing within or without the system; and the knowledge it thus gets possession of is called perception.

The different kinds of perception, therefore, are as numerous as the different channels through which they are received, and they produce an effect upon