of South America, found among trees, and a devourer of other insects and even small birds. It is of so enormous a size that its fangs are equal to the talons of a hawk; and its eyes, which are eight in number, arranged as a smaller square in the middle of a larger, are capable of being set in the manner of lenses, and used as microscopes.

In many animals, especially the herbivorous, the tongue itself is armed with a serrated apparatus, the papillæ being pointed and recurvated, and enabling them to tear up the grass with much greater facility. In the cat-kind the tongue is covered with sharp and strong prickles, which enable the animal to take a strong hold; and similar processes are met with in the bat and the opossum. In the lamprey and myxine families, the tongue itself is covered with teeth. In that grotesque and monstrous bird the toucan, whose bill is nearly as large as its whole body, the tongue is lined with a bundle of feathers, of the use of which, however, we are totally ignorant, though it is probably an organ of taste.

In the crab and lobster tribes the teeth are placed in the stomach, the whole of which is a very singular organ. It is formed on a bony apparatus, and hence does not collapse when empty. The teeth are inserted into it round its lower aperture or pylorus: their surface is extremely hard, and their margin serrated or denticulated, so that nothing can pass through the opening without being perfectly comminuted. The bones and teeth are moved by peculiar muscles. It is a curious fact, that at the time the animal throws off its shell, it also disgorges its bony stomach and secretes a new one.

The teeth of the cuttle-fish are arranged not very differently, being situated in the centre of the lower part of the body; they are two in number, and horny, and in their figure exactly resemble the bill of a parrot.

The teeth of the echinus genus (sea-hedgehog) are of a very singular arrangement. A round opening is left in the centre of the shell for the entrance of the food: a bony structure, in which five teeth are inserted, fills up this aperture; and as these parts are moveable by numerous muscles, they form a very complete organ of mastication.

Such is the variety which the hand of nature, sometimes, perhaps, sportive, but always skilful, has introduced into the structure and arrangement of the teeth of animals, or the organs that are meant to supply their place.

The SKIN AND ITS APPENDAGES offer an equal diversity, and constitute the next subject of our inquiry.

All living bodies, whether animal or vegetable, are furnished with this integument: in all of them it is intended as a defence against the injuries to which, by their situation, they are commonly exposed; and in most of them it also answers the purpose of an emunctory organ, and throws off from the body a variety of fluids, which either serve by their odour to distinguish the individual, or are a recrement eliminated from its living materials.

This integument accompanies animals and vegetables from their first formation: it involves equally the seed and the egg; and possessing a nature less corruptible than the parts it encloses, often preserves them uninjured for many years, till they can meet with the proper soil or season for their healthy and perfect evolution.

This is a curious subject, and must not be too hastily passed over. After fish-ponds have been frozen to the very bottom, and all the fishes contained in them destroyed; or after they have been completely emptied, and cleared of their mud; eels and other fishes have been again found in them, though no attempt has been made to restock the ponds. Whence has proceeded this reproduction? Many of the ancient schools of philosophy, and even some of those of more modern date, refer us to the doctrine of spontaneous generation, and believe that they have here a clear proof of its truth. But this is to account for a difficulty by involving ourselves in one of a much greater magnitude. It is a *petitio principii* which we stand in no need of, and which we should be careful how we concede. The reproduced fishes have alone arisen from the ova of those which formerly inhabited the fish-pond; and which, from some cause or other, had sunk so deep into the soil, as to be

beyond the germinating influence of the warmth and air contained in the supernatant water, communicated to it by the sun and the atmosphere. But the indestructible texture of the integument which enclosed the fecundated ova has preserved them, perhaps for years, from injury and corruption; and they have only waited for that very exposure to light, air, and warmth, which the removal of the superior stratum of mud has produced, to awaken from their dormant state into life, form, and enjoyment; and but for which they would have remained in the same state, dormant but not destroyed, for ten or twelve times as long a period.

So, in the hollows upon our waste lands, when they have been for some time filled with stagnant water, we not unfrequently find eels, minnows, and other small species of the carp genus, leeches,* and water insects, and wonder how they could get into such a situation. But the mud which has been emptied out of the preceding fish-pond has perhaps been thrown into these very hollows; or the ova of the animals have been carried into the same place by some more recondite cause; and they have been waiting, year after year, for the accidental circumstance which has at length arrived, and given them the full influence of warmth, water, light, and air.

The ova of many kinds are peculiarly light, and almost invisibly minute. They are hence, when the mud, which has been removed from fish-ponds becomes dry and decomposed into powder, swept by the breeze into the atmosphere, from which they have occasionally descended into the large tanks which are made in India as reservoirs for rain-water; and producing their respective kinds in this situation, have appeared, to the astonishment of all beholders, to have fallen from the clouds with the rain itself. Dr. Thomson, in adverting to this curious fact, observes that it is difficult to account for it satisfactorily.† The explanation now offered will, if I mistake not, sufficiently meet the case.

Many insects can only be hatched in a particular animal organ; and it is the office of the integument of the ovum to preserve it in a perfect state till it has an opportunity of reaching its proper nidus. Thus the horse-gadfly, or oestrus *equi*, deposites its eggs on the hairs of this animal, and sticks them to the hair-roots by a viscous matter which it secretes for this purpose. But here they could never be hatched, though they were to remain through the whole life of the horse: their proper nidus is the horse's stomach or intestines, and to this nidus they must be conveyed by some means or other; and in their first situation they must remain and be preserved, free from injury or corruption, till they can obtain such a conveyance. The integument in which they are wrapped up gives them the protection they stand in need of; and the itching which they excite in the horse's skin compels him to lick the itching part with his tongue; and by this simple contrivance the ova of the gadfly are at once conveyed to his mouth, and pass with the food into the very nidus which is designed for them.

It is the same integument that, by its incorruptibility, preserves the caterpillar during the torpitude of its chrysalid state, while suspended by a single thread from the eaves of an incumbent roof; and which thus enables the worm to be transformed into a butterfly. The larve of the gnat, when approaching the same defenceless state, dives boldly into the water, and is protected by the same indestructible sheath from the dangers of an untried element.

In several species the insect remains in its chrysalid state for many years: the locust, in one of its species at least, the cicada *septendecim*, appears *in numbers* once only in seventeen years, and the palmer-worm once only in thirty years; cycles not recognised by the meteorologist, but which are well entitled to his attention: and, through the whole range of their duration, it is the integument we are now speaking of that furnishes the animal with a secure protection.

Whence comes it that plants of distant and opposite climates (for every

* See Willd. p. 120, note.

† Annals of Philos. viii. p. 70.

climate has its indigenous plants as well as its indigenous animals) should so frequently meet together in the same region? that those which naturally belong to the Cape of Good Hope should be found wild in New-Holland? and those of Africa on the coast of Norway? and that the Floras of every climate under the heavens should consociate in the stoves and gardens of our own country? It is the imperishable nature of the integument that surrounds their seeds by which this wonder is chiefly effected. Some of these seeds are provided with little hooks, and fasten themselves to the skins of animals, and are thus carried about from place to place; others adhere by a native glue to the feathers of water-fowls, and are washed off in distant seas; while a third sort are provided by nature with little downy wings, and hence rise into the atmosphere, and are blown about by the breezes towards every quarter of the compass. Of this last kind is the light seed of the betula *alba*, or birch-tree; which, in consequence, is occasionally seen germinating on the summit of the loftiest rocks and the tops of the highest steeples.* But it is to man himself that this dissemination of plants is chiefly owing. He who in some sort commands nature—who changes the desert into a beautiful landscape—who lays waste whole countries, and restores them to their former fruitfulness—is the principal instrument of enriching one country with the botanical treasures of all the rest. Wars, migrations, and crusades, travel, curiosity, and commerce, have all contributed to store Europe with a multitude of foreign productions, and to transplant our own productions into foreign quarters. Almost all the culinary plants of England, and the greater number of our species of corn, have reached us from Italy or the East;† America has since added some; and it is possible that Australia may yet add a few more.

The utmost period of time to which seeds may hereby be kept, and be enabled to retain their vital principle, and consequently their power of germination, has not been accurately determined; but we have proofs enough to show that the duration may be very long. Thus, M. Triewald relates that a paper of melon-seeds, found in 1762, in the cabinet of Lord Mortimer, and apparently collected in 1660, were then sown, and produced flowers and excellent fruit;‡ and Mr. R. Gale gives an instance of a like effect from similar seeds after having been kept thirty-three years.§

M. Saint-Hilaire sowed various seeds belonging to the collection of Bernard de Jussieu, forty-five years after the collection had been made. They consisted of three hundred and fifty distinct species; of these many, though not the whole, proved productive. In some the cotyledon appeared to have nearly, but not entirely, perished: in which, therefore, though the seeds swelled, and promised fairly at first, they died away gradually. And as it is a well-known fact that melons improve from seeds that have been kept for two or three years, he conceives that in this case the cotyledons have been ripened during such period.‖

Animal seeds or eggs, when perfectly impregnated, appear capable of preservation as long. Bomare, indeed, affirms, that he himself found three eggs, which, protected from the action of the air, had continued fresh in the wall of a church in which they must have remained for a period of *three hundred years.*¶

The integument which covers seeds, eggs, insects, and worms, seldom consists of more than two distinct layers, and is sometimes only a single one; but in the four classes of red-blooded animals it consists almost uniformly of three layers, which are as follows: first, the true skin, which lies lowermost, is the basis of the whole, and may be regarded as the condensed external surface of the cellular substance, with nerves, blood-vessels, and absorbents interwoven in its texture; secondly, a mucous web (rete mucosum), which gives the different colours to the skin, but which can only be traced as a distinct

* There is an interesting article on this subject published long since the above was delivered; an account of which may be found in the Journal of Science and the Arts, No. vii. p. 3.
† Willdenow, Principles, &c. § 357. ‡ Phil. Trans. vol. xlii. § Ib. vol. xliii.
‖ Tilloch's Phil. Mag. vol. xlii. p. 208, article of M. Saint-Hilaire. ¶ Dictionnaire, art. Oeuf.

layer in warm-blooded animals; and, thirdly, the cuticle, which covers the whole, and is furnished in the different classes with peculiar organs for the formation and excretion of a variety of ornamental or defensive materials—as hairs, feathers, wool, and silk.

The CUTIS, or TRUE SKIN, is seldom uniformly thick, even in the same animal: thus, in man, and other mammals, it is much thicker on the back than in the front of the body; but in the different classes or genera of animals it offers us every possible variety. Generally speaking, it is thinnest in birds, excepting in the duck tribe and in birds of prey. Its consistency and elasticity in horses, oxen, sheep, and other cattle, render it an object of high value, and lay a foundation for a variety of our most important trades and manufactures. In many animals it is so thick and tough, as to be proof against a musket-ball. It is sometimes found so in the elk, but usually so in the elephant, which, at the same time, possesses the singularity of being sensible to the sting of flies. The skin of the rhinoceros despises equally the assault of swords, musket-balls, and arrows.

I have observed already, that in many animals the skin performs the office of a muscle, though it is seldom that any thing like a fibrous structure can be traced in it. The skin of man offers a few partial instances of this power, as in the forehead and about the neck. In most quadrupeds we trace the power extending over the whole body, and enabling them to throw off at their option insects and other small animals that irritate them. The skin of the horse shudders through every point of it at the sound of a whip, and is said to be generally convulsed on the appearance of a lion or tiger. Birds, and especially the cockatoo and heron tribes, derive hence a power of moving at pleasure the feathers of the crest, neck, and tail; and the hedgehog, of rolling himself into a ball, and erecting his bristles by way of defence.

The colour of the skin is derived from the RETE MUCOSUM, or MUCOUS WEB, which, as I have already remarked, is disposed between the true skin and the cuticle. The name of rete, or web, however, does not properly apply to this substance, for it has no vascularity, and is a mere butter-like material, which, when black, has a near resemblance in colour, as well as consistency, to the grease introduced between the nave of a wheel and its axletree. It is to this we owe the beautiful red or violet that tinges the nose and hind-quarters of some baboons, and the exquisite silver that whitens the belly of the dolphin and other cetaceous fishes. In the toes and tarsal membrane of ravens and turkeys it is frequently black; in hares and peacocks, gray; blue in the titmouse; green in the waterhen; yellow in the eagle; orange in the stork; and red in some species of scolopax or woodcock. It gives that intermixture of colours which besprinkles the skin of the frog and salamander; but it is for the gay and glittering scales of fishes, the splendid metallic shells of beetles, and the gaudy eye-spots that bedrop the wings of the butterfly, that nature reserves the utmost force of this wonderful pigment, and sports with it in her happiest caprices.

The different colours, and shades of colours, of the human skin, are attributable to the same material. Most of these, however, are intimately connected with a very full access of solar light and heat; for a deep sun-burned skin has a near approach to a mulatto.* And hence the darkness or blackness of the complexion has been generally supposed to proceed from the effect produced upon the mucous pigment by the solar rays, and especially those of the calorific kind, in consequence of their attracting and detaching the oxygen of the pigment in proportion to the abundance with which it impinges against the animal surface, and in the same proportion setting at liberty the carbon, which is thus converted into a more or less perfect charcoal. As this, however, is a subject which I shall have occasion to revert to in a distinct study upon the varieties of the human race,† it is unnecessary to pursue it any farther at present.

It is a most curious circumstance, that the children of negroes are uniformly

* Humboldt, Essai Polit. sur la Nouvelle Espagne, &c. † Series II. Lecture iii.

born white, or nearly so; and that the black pigment which colours them is not fully secreted till several months after birth. It sometimes happens, though rarely, that from a morbid state of the secretory organs there is no pigment secreted at all, or a white pigment is secerned instead of a black; whence we have white negroes, or persons exhibiting all the common characters of the negro-breed in the form of the head and features of the face, with the anomaly of a white skin. And it sometimes happens, though still more rarely, that from a similar kind of morbid action affecting the secretory organs, the black pigment is secreted in alternate or interrupted divisions; and in this case we have negro children with brindled, marbled, or spotted skins: an instance of which was brought to me by a gentleman about two years ago, who had purchased the child in America, and who, I believe, afterward exhibited it in this metropolis as a public show.

The CUTICLE is the thinnest of the layers that form the general integument of the skin. It often, however, becomes thicker, and sometimes even horny, by use. Thus it is always thicker in the sole of the foot and palm of the hand; and horny in the palms of blacksmiths and dyers; and still more so in the soles of those who walk barefooted on burning sands. It is annually thrown off whole by many tribes of animals—as grasshoppers, serpents, and spiders—and as regularly renewed; and by some animals it is renewed still more frequently: it is shed not less than seven times by the caterpillar of the moth and butterfly before either becomes a chrysalis. There are a few plants that exfoliate their cuticle in the same manner, and as regularly renew it. The West India plane-tree throws it off annually.

From the cuticle shoots forth a variety of substances, which either protect or adorn it, the roots of which are not unfrequently imbedded in the true skin itself. Of the harder kind, and which serve chiefly as a defence, are the nails, scales, claws, and horns; of the softer and more ornamental kinds, are hair, wool, silk, and feathers.

HAIR is the most common production, for we meet with it not only in all mammals, but occasionally in birds, fishes, and insects, varying in consistency and fineness, from a down invisible to the naked eye, to a bristle strong enough to support, when a foot long, ten or twelve pounds weight without breaking.

WOOL is not essentially different in its chemical properties from hair, and it varies equally in the fineness and coarseness of its texture. It is generally supposed by the growers, that the fineness of its texture depends upon the nature of the soil; yet of the two finest sorts we are at present acquainted with, that of Spain and that of New South Wales, which last is an offset from the Cape of Good Hope, and has yielded specimens of broad cloth, manufactured in this country, as soft and silky as that of unmixed Merino wool—that of Spain is grown on a pure limestone soil, covered with small leguminous plants instead of with grass; and that of New South Wales on a soil totally destitute of lime, and covered with a long, rich, succulent grass alone.

Food, however, or climate, or both, must be allowed, under certain circumstances, to possess a considerable degree of influence; for it is a curious fact, that the hair of the goat and rabbit tribes, and the wool of the sheep tribe, are equally converted into silk by a residence of these animals in that district of Asia Minor which is called Angora, though we do not know that a similar change is produced by a residence in any other region; while, on the contrary, the wool of sheep is transformed into hair on the coast of Guinea.

The fine glossy SILK of the Angora goat is well known in this country, as being often employed for muffs and other articles of dress. How far these animals might be made to perpetuate this peculiar habit by a removal from Angora to other countries has never yet been tried. Upon the whole, the soil and climate of New-Holland offer the fairest prospect of success to such an attempt; and under this impression I have for some time been engaged in an endeavour to export a few of each genus of these animals from Angora to Port Jackson.

Silk, however, is chiefly secreted by insects, as some species of spider, whose threads, like the hair of the Angora goat, assume a silky gloss and lubricity, and the phalæna *mori*, or silk-worm, which yields it in great abundance. Yet there are a few shell-fishes which generate the same, and especially the genus pinna, or nacre, in all its species; whence Reaumur calls this kind the sea silk-worm. It is produced in the form of an ornamental byssus or beard: the animal is found gregariously in the Mediterranean and Indian seas; and the weavers of Palermo manufacture its soft threads into glossy stuffs or other silky textures. And I may here observe, that there are various trees that possess a like material in the fibres of their bark, as the morus *papyrifera*, and several other species of the mulberry: in consequence of which it has been doubted by some naturalists whether the silk-worm actually generates its cocoon, or merely eliminates it from the supply received as its food; but as the silk-worm forms it from whatever plants it feeds on, it is obviously an original secretion.

From the integument of the skin originates also that beautiful PLUMAGE which peculiarly characterizes the class of birds, and the colours of which are probably a result of the same delicate pigment that produces, as we have already remarked, the varying colours of the skin itself; though, from the minuteness with which it is employed, the hand of chemistry has not been able to separate it from the exquisitely fine membrane in which it is involved. But it is impossible to follow up this ornamental attire through all its wonderful features of graceful curve and irridescent colouring,—of downy delicacy and majestic strength,—from the tiny rainbow that plays on the neck of the humming-bird, to the beds of azure, emerald, and hyacinth, that tesselate the wings of the parrot tribe, or the ever-shifting eyes that dazzle in the tail of the peacock;—from the splendour and taper elegance of the feathers of the bird of paradise, to the giant quills of the crested eagle or the condur—that crested eagle, which in size is as large as a sheep, and is said to be able to cleave a man's scull at a stroke; and that condur which, extending its enormous wings to a range of sixteen feet in length, has been known to fly off with children of ten or twelve years of age.

Why have not these monsters of the sky been appropriated to the use of man? How comes it that he who has subdued the ocean and cultivated the earth; who has harnessed elephants, and even lions, to his chariot wheels, should never have availed himself of the wings of the eagle, the vulture, or the frigate pelican? That, having conquered the difficulty of ascending into the atmosphere, and ascertained the possibility of travelling at the rate of eighty miles an hour through its void regions, he should yet allow himself to be the mere sport of the whirlwind, and not tame to his use, and harness to his car, the winged strength of these aerial racers, and thus stamp with reality some of the boldest fictions of the heathen poets? The hint has, indeed, long been thrown out; and the perfection to which the art of falconry was carried in former times sufficiently secures it against the charge of absurdity or extravagance.

LECTURE XII.

ON THE DIGESTIVE FUNCTION AND THE ORGANS CONTRIBUTORY TO IT: THE DIFFERENT KINDS OF FOOD EMPLOYED BY DIFFERENT ANIMALS: CONTINUANCE OF LIFE THROUGH LONG PERIODS OF FASTING.

UNDER every visible form and modification matter is perpetually changing: not necessarily so, or from its intrinsic nature; for the best schools of ancient times concur with the best schools of modern times, in holding its elementary principles, as I have already observed, to be solid and unchangeable; and we have still farther seen, that even in some of its compound, but