on somnambulism and animal magnetism, &c., contain some very interesting facts on this subject.

To illustrate this section, the brain of a sheep should be exhibited, which can easily be done by sawing through the skull from behind the eyes down to the opening for the spinal marrow (taking care not to saw too deep), and then wrenching it off with a screw-driver or other strong lever. The membranes covering the brain will be observed. These should be slit open, and the brain lifted up anteriorly, when the different nerves, commencing with the olfactory, will come into view, and must be cut through, and the brain taken out and placed in spirits for a few hours to harden it. The nerves, as seen in Fig. 33, the ventricles in the interior of the brain, and the other parts described here, and in anatomical works, may then easily be seen. A cod's or haddock's brain and spinal marrow may easily be shown, by cutting with a strong pair of scissors the spinal rings and skull.

Besides these, if wished, the progressive development of the brain in different species may, with a little care and patience, be shown in the fowl, the hare or rabbit, the adder or frog, &c.

A few casts, showing the size and appearance of the human brain, that of the orang-outang, of idiots, &c., and casts of the heads of the Carib, Negro, European, &c., form excellent illustrations of this section, and can easily be got from O'Neil in Edinburgh, and other stucco dealers.

Appropriate figures for illustrating this section will be found in Fletcher's Rudiments of Physiology, Part 1, pages 47 and 48; in Lizars's coloured plates, pages 64, 67, 68; in Roget's Bridgewater Treatise, vol. ii. pages 547, 550, 552.

SECTION IX.

THE SENSES.

168. The senses are the means by which the mind becomes acquainted with external objects. Without the materials which they furnish, its exercise would be impossible. When the mind has once experienced various sensations, the memory can recall them when they are gone; the judgment can compare them, and can perceive their relations, and the imagination can combine them into endless varieties; but still, with all this, we are incapable of figuring to ourselves any image, the elements at least of which have not first been made known to us through sensation.

276. What of the senses, and sensation?

169. The senses generally enumerated are five, viz.: touch, taste, smell, hearing, and vision. There are other sensations, however, such as those of thirst, hunger, nausea, sneezing, &c., which cannot properly be classed under any of these heads.

170. The sense of *touch* is diffused over almost the whole external surface of the body, but is possessed in greatest delicacy by certain parts, such as the lips and the ends of the fingers. When the innermost layer of the skin is examined with a microscope, it presents numerous projecting points or papillæ, to each of which it is probable a branch of a sensitive nerve is sent, as they are seen in greatest numbers where the sense is most acute. To exercise this sense in perfection, it is requisite that the organ should be so constructed as to be capable of being readily applied to bodies, in a variety of directions; and it is in the human hand that this quality, the distribution of the sensitive nervous filaments, and a thin cuticle covering these, are united in the highest degree.

171. The late eminent Dr. Thomas Brown, professor of moral philosophy in Edinburgh, contended that touch gives us no, or at least very imperfect, ideas of extension or space, and of hardness or solidity. Our ideas of these, he thought, are principally derived from what he calls muscular sensations. Connected with this point, we may remark, that Francisco Cæsario, whose case has been before referred to, although entirely deprived of sensation on one side, so that even cutting it gave him no feeling, could yet, with the same, judge of the weight and consistence of bodies.

172. A similar conjecture, as to the feelings derived from temperature, seems to be supported by such cases as the following:—A physician of Geneva, after an attack of palsy, could be pricked or scratched in the right hand or arm, without giving him any sensation. When, however, he took a cold body into his hand, he felt it, but it

277. Name the senses, and other sensations.
278. What of touch?
279. Anomalous varieties of this sense.

appeared to him lukewarm. Here the feelings of touch seem to have been lost, but a deranged perception of temperature existed.

173. The soft bodies of the lowest classes of animals are well fitted for the exercise of the sense of touch, and it is doubtful whether many of them possess any other. The organs of touch in insects, if, indeed, they are not allotted to some higher sense, are especially their antennæ or feelers, which, though in themselves minute, are generally feathered or radiated, so as to include parts too small for human vision, and the sensations of which must be of an exquisitely delicate nature. Huber, in his interesting work on bees, states, that it is by feeling with the antennæ that they seem to direct their various works in the interior of the hive. If an insect be deprived of its antennæ, it either remains motionless, or, if it attempts to fly, appears bewildered. A queen bee, thus mutilated, ran about, without apparent object, as if in a state of delirium.

174. Spallanzani discovered that bats could thread their way with ease through the darkest and most intricate passages, where obstacles had been purposely placed in their way, even when their eyes were put out or covered over, and hence thought that they must have some other sense to direct them. It has been rendered probable, however, that they owe this power to the delicacy of the sense of touch in their wings and other parts.

175. The senses of *taste* and *smell* may be spoken of together, as they appear in many cases to be intimately connected. The sense of taste resides in the tongue and mouth, and has generally been considered by physiologists as little more than a modification of touch. The 5th nerve was supposed to confer both touch and taste. Panizza, however, as was mentioned, has recently disputed this. The papillæ, already spoken of, are particularly well seen in the tongue. If a fluid, such as strong vinegar, be ap-

280. Peculiarities in the inferior animals.
281. What of bees and bats?
282. What two senses seem related to touch?
283. What of the papillæ?

plied with a hair pencil, they will be seen to become curiously elongated.

176. The tongue is covered with a thin cuticle, and the nostrils are lined by a soft membrane, called, from a celebrated anatomist, the Schneiderian membrane. It is upon this that the olfactory nerve (No. 1, Figs. 32 and 33) ramifies; not, however, covered by it, but protected from the air that passes through the nostrils merely by the natural secretion, called mucus. The vapour of different bodies thus comes directly into contact with these nerves.

177. Substances tasted must be either naturally fluid or must be dissolved by the saliva. When this condition is observed, we are sensible of certain feelings, commonly supposed to be produced in the mouth. A large proportion, however, of the feelings conveyed by the tongue, are little more than different degrees of pungency, which we may almost conceive capable of being felt by the ends of the fingers, had their cuticle been fine enough. The flavour of bodies, generally included when we speak of their taste, is a sensation entirely owing to the action of their vapour on the back part of the nostrils; so that, when the membrane that lines these is inflamed, or otherwise diseased, whisky, vinegar, mustard, and many other substances, can with some difficulty be distinguished from each other. Any one may easily satisfy himself of the indefinite nature of the sensation of taste, by pushing out the tongue, accurately closing the mouth and nostrils, and then applying to it different substances.

178. In the savage state, the sense of smell is much used, and becomes proportionately acute. The American Indians can easily distinguish different tribes and nations by the odour of their bodies. The blind and deaf boy, James Mitchell, whose history has been recorded by Mr. Wardrop and Professor Dugald Stewart, knew his friends, and at once detected strangers in a room, by this sense.

179. These senses are very acute in some of the lower animals, and particularly in the carnivorous Vertebrata.

284. Peculiarities of taste.
285. Acuteness of smell illustrated.

The olfactory nerves of most birds are small. In the duck and similar tribes, however, they are large, and are much used. The nostrils of fishes do not communicate with the mouth, and smell becomes with them more like taste, from the substance being dissolved in water instead of air.

180. The sense of *hearing* results from vibrations in an elastic substance, such as air or water, being communicated to the ear. When a bell is shaken in the exhausted receiver of an air-pump, no sound is heard, because the air which usually carries the vibrations to the ear is absent. Sound travels through air at the rate of about twelve and a half miles in a minute; through water its velocity is four or five times greater; and ice and other solid bodies are known to transmit it even more quickly.

181. The organ of hearing in man may be divided into external, middle, and internal parts. The external consist of the gristle of the ear (Fig. 37, *c*), of use in most animals for collecting the sounds; and of a funnel-shaped canal (*m*), which leads to the middle part or drum (*t*). The external and middle parts do not communicate directly, there being interposed between the two a thin membrane (*d*), attached to the bony sides of the canal, exactly like the parchment on a real drum. On this membrane the vibrations of the air strike, and to it

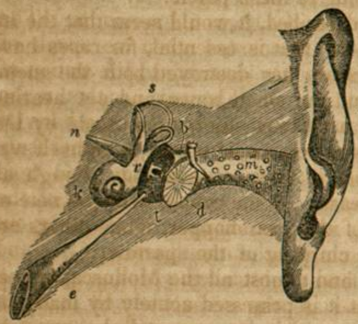

Fig. 37. The Ear.*

* *c*, concha or external gristle. *m*, canal leading to *t*, the tympanum or drum. *d*, membrane of the drum. *b*, small bones of the drum. *v*, vestibule. *s*, semi-circular canals. *k*, cochlea. *n*, auditory nerve. *e*, Eustachian tube.

286. Upon what does hearing depend?
287. Describe the diagram.

there is attached a chain of small bones (*b*), which are also connected with the internal ear, in which last is placed the nerve of hearing. The vibrations, therefore, first strike the membrane of the drum, and then pass along these bones to the auditory nerve, seen in Fig. 37, *n*. The cavity of the drum (*t*), though it does not communicate with the external ear, yet has air admitted to it. This passes through a canal (Fig. 37, *e*), called the Eustachian tube, which opens into the back part of the throat or pharynx. Most persons have felt their hearing become dull when inflammation of the throat closes this tube, and prevents the passage of the air. The internal ear is very intricate, and the uses of its different parts are not well known. In Fig. 37 are seen parts of it called semicircular canals (*s*), the cochlea (*k*), the vestibule (*v*), which are all filled with a fluid, and there is also seen the auditory nerve (*n*), going to these parts.

182. Of the parts described, it would seem that the internal ear is the only one that is essential, for cases have occurred in which disease has destroyed both the membrane of the drum and the small bones, and yet hearing has remained. It is a curious observation, made by Dr. Wollaston, that there are persons, of whom he himself was one, who are insensible to very acute sounds, though all others are perfectly heard. Some cannot hear the note of the bat or the chirp of the grasshopper, while others are insensible even to the chirping of the sparrow.

183. The Radiata, and almost all the Mollusca, appear to want this sense, but it is possessed acutely by many insects, though the organ used is not accurately known. In the sepia is found the simplest organ of hearing. It is merely a sac filled with fluid, with the nerve expanded in it, and having a hard body attached to its extremity. Fishes have this organ a little more complicated, but in neither these nor the sepia is there any external opening. They hear as we do when a hard body is held between the teeth, the conducting power of water for sound being

288. What connects the ear and throat.
289. Varieties in this sense and its organ.

much greater than that of air. When the Abbé Nollet sank his head under water and struck two stones together, the shock to the ear was almost insupportable. This organ becomes progressively more complicated in Reptiles, Birds, and the Mammalia. Among the last we first find external cartilages, which, as well as the internal tube, are directed forwards in those which pursue their prey, and backwards in timid animals, such as the hare, rabbit, &c.

184. The next and last sense we have to treat of is *vision*. All the affections of this sense are derived from the action of light. We think we see the bodies themselves that are scattered round us, but this is a mistake, for they themselves have no colour. The colour, or, more properly speaking, the power to produce the sensation we call colour, resides entirely in the rays of light that are thrown off or reflected from these bodies to our eyes. In spite of our convictions, however, we cannot help conceiving of our sensations as abiding qualities in these different objects.

185. If a ray of light be admitted through a small opening into a dark chamber, it appears white, but by causing it to pass through a three-sided piece of glass called a prism, it is seen to be composed of different coloured rays. These, according to Dr. Wollaston, are red, yellowish green, blue, and violet. In this way a ray of light is decomposed: when these colours are all uniformly blended, as when a card on which they are separately painted is rapidly whirled round, the resulting colour is again white. Now, it is from the power bodies possess of throwing off or of absorbing special rays out of the number, that they appear to us differently coloured. If a body appears blue, the blue rays alone have been reflected; and so on with red, green, and other colours. We do not notice any interval between looking at an object and the impression on our eye (as we can do with distant objects in the case of sound), from the rapidity with which light

290. What is said of vision?
291. What of light and its decomposition?
292. Relative velocity of light and sound.

travels, and from not having any other sense that can give us information more quickly. There is always an interval, however, and in the case of the distant heavenly bodies this has been calculated. We have said sound travels at the rate of between twelve and thirteen miles in a minute, but light passes through 195,000 miles in the sixtieth part of the same time.

186. As the eye is strictly an optical instrument, we must state that it is a law of optics that the rays of light, while passing through the same medium, proceed in straight lines, but that they are turned out of their course when they pass from a less into a more dense medium. They are then said to be refracted. This takes place when the rays of light pass from air into water, and it is by virtue of the same law that a common magnifying or double convex glass collects the sun's rays into a focus or point.

187. The eye has various appendages, which require some explanation. The first to be noticed are the eyelids. These are composed chiefly of a gristly substance placed under the skin that accurately fits the ball of the eye, and which is lined internally by a thin membrane called the conjunctiva, that turns over on the globe of the eye, and keeps it in its socket. Attached to the eyelids are the eyelashes, which protect the eye from too great a glare of light, from particles of dust, &c. Persons without eyelashes have always tender eyes. The chief purposes served by the eyelids are, 1st, to protect from external injury, and to exclude the light when they are closed; and, 2dly, to distribute equally over the eyeball the fluid which moistens it. This fluid is usually carried off as quickly as it is formed; but when the eye is irritated, or the mind affected by various emotions, it is then secreted in such quantity as to run over the eyelids in the form of tears. The source of this fluid is a gland, named the lachrymal gland, situated above the outer angle of the eye. Tears there secreted, pass downwards to the eye, whence they

293. What law of optics is cited?
294. What are appendages to the eye?

flow, through two small holes (puncta lachrymalia) near the inner angle of the eyelids, into a small receptacle called the lachrymal sac, placed immediately behind the inner angle, and from which there is a communication to the nostrils by what is called the nasal duct. This is the reason why, when tears are copious, a necessity for blowing the nose is felt. When the nasal duct is obstructed, as often happens, the nostril on that side is dry, and the tears run over the eyelids. The puncta lachrymalia may easily be seen by everting the eyelids, and looking at their inner angle; and the opening of the nasal duct may be seen by looking into the nostril of the horse. The two edges of the eyelids, when closed, form a channel, along which the tears flow. Birds have a third eyelid, at the inner angle of the two others, which they may often be seen moving. Fishes have neither eyelids nor lachrymal apparatus.

188. Others of the appendages are the muscles that move the eye, six in number. There are, besides these, two that move the eyelids. A broad circular one, which closes the eyelids, lies immediately under the skin. The other, which raises the upper eyelid, is a long muscle, and is attached to the bone deep behind the eyeball.

189. We now come to consider the globe of the eye, the parts composing which are seen in Fig. 38, representing a horizontal section of it. C, the cornea, is the transparent part of the eye in front, which, it will be seen, forms part of a lesser circle, and therefore projects more than the rest of the globe. It is set into the white part of the ball of the eye, and after steeping, can be taken out of it like a watch-glass. S, the sclerotic or hard coat, is the outermost one, or the white part of the eye seen in front. It extends over the whole ball posteriorly, and, from its toughness, forms its principal support. In the tortoise and in birds this part anteriorly has bony matter in its composition; and in the immense eye of the extinct

295. Use of the eyelids.
296. Source of the tears, and their course.
297. What of the muscles of the eye?
298. Define the cornea, sclerotic, and choroid coats of the globe.

reptile called the ichthyosuarus, it appears to have been composed of bony plates. The coat (X), which lies internal to the sclerotic, is called the choroid coat. It is lined on its inner surface, in the human eye, by a brownish-black paint (contained in hexagonal cells), which we see when we look deep into the eye. Its use seems to be

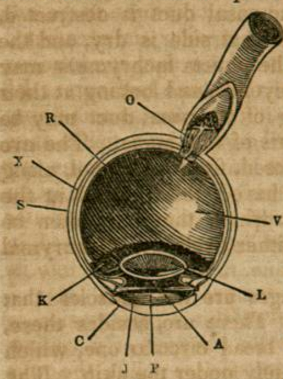

Fig. 38. Human Eye Dissected.*

to absorb the rays of light not required in vision. The colour of this paint is, as every one has seen, yellowish-green in the eye of the cat. It is chocolate-brown in the hare and rabbit, silvery-blue in the horse, and pale golden yellow in the lion and bear. In general, it is of a light shade in such animals as prowl by night. This paint is wanting altogether in albino animals, such as white rabbits or ferrets, and the red blood-vessels can then be seen in the eye. This coat seems to be continuous with a number or foldings called ciliary processes (K). The innermost of the coats of the eye (R) is called the retina, from its netted appearance. It consists of a very fine membrane, with the pulpy, half-transparent substance, which is continuous with the optic nerve (O),† expanded upon it. This is the seat of vision. All visual impressions must, in the first place, be made upon this expansion, and are then conveyed by the optic nerve to the mind.

190. The parts of the eye remaining to be described

* C, cornea. S, sclerotic coat. X, choroid coat. R, retina. O, optic nerve. V, vitreous humour. L, lens. A, aqueous humour. P, pupil. J, iris. K, ciliary processes.

† Also seen in Figs. 32 and 33. In Fig. 33 the two optic nerves are seen to join, and the fibres at this point are supposed partially to cross.

299. What gives colour to the eyes of animals?
300. Define the retina, and the optic nerve.

are the humours and the iris. A is the aqueous or watery humour, placed immediately behind (C) the cornea. It is divided into an anterior and a posterior chamber by (J) the iris, which floats like a curtain in it. The iris is the part that gives the blue, gray, or black colour to our eyes, and which has in its centre an opening (P) that enlarges or contracts according to the quantity of light to be admitted. It is supposed to possess a circular and a radiated set of fibres to effect this. Behind the aqueous humour lies the lens (L), the firmest of the three humours. Its form in the human eye, as seen in the figure, is something like a highly convex magnifying-glass. In fishes it is globular, and it is it that falls out like a pea when the eye is boiled.* Behind this, again, is placed the largest or vitreous humour (V), which appears of rather greater consistence than the white of an egg, and is enclosed in a very fine transparent membrane, ramifying also into its interior.

191. By the united action of all these parts, vision is produced. The cornea serves the purpose of a convex or magnifying-glass, to collect into foci or points the rays of light that pass from an object to the eye, and this effect is still further assisted by the lens placed behind it. The point where these foci are thus formed, is the retina; and the eye may be compared to the optical instrument called the camera obscura, which is indeed but an imitation of the eye itself. Those who have seen this instrument will know, that when the part corresponding to the cornea is presented to a landscape, there is an exact picture of it formed on the back part of the box. Kepler, the great astronomer, made the interesting discovery that the same thing may be seen in the eye. If the eye of a recently killed bullock be carefully stripped of its sclerotic and choroid

* A globular form of the lens (which refracts light in the highest degree) is rendered necessary from the greater refraction required, this being less when the rays of light pass from a dense medium like water to the eye, than when they pass from air to it.

301. Describe the humours of the eye, and the iris and pupils.
302. What of the lens?
303. Describe the organ of vision.

coats posteriorly, and the retina be supported by a piece of transparent silk, it may be placed in the hole of a window shutter looking out upon a landscape, and a diminutive but distinct picture of the whole may be seen depicted on the retina. From the thinness of the coverings of the eye in albino animals (such as the white rabbit), this exquisitely beautiful experiment may be performed even without removing any of the coats.*

192. It is truly wonderful to think that all the accurate perceptions of this sense are derived from the images of a crowded picture formed at the bottom of the eye, on a space so small that it may be covered with the point of the finger. What can be more astonishing than the fact, that the image of the sail of a windmill, six feet in length,

* The course of the rays of light coming from an object, and passing through the eye, is shown in Fig. 39, from which it will be seen that the object represented on the retina is inverted. The cause of this is, that the rays from different points (as may be observed in the figure) cross, and that those coming from the lower part of the object (*c*) have their focus on the upper part of the retina (*d*), while those from the upper part of the object (*a*) have their focus on the lower part of the retina (*b*). It must be understood that a double convex glass, or the eye, has the power of converging rays of light not merely to one focus or point, but to many foci. What is commonly called *the focus* of a glass or lens is merely its principal focus. Although, however, the objects are inverted on the retina, we see them in their proper position, that is, in a position corresponding with the sensations of touch. Various explanations of this fact have been attempted, but our space does not allow us to enter upon the subject.

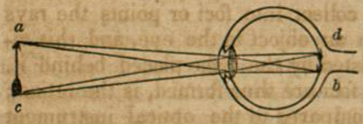

Fig. 39. Inversion of Rays on the Retina.

It may be mentioned here, also, that the reason why humours of different densities, and consequently different refracting powers, are used, appears to be, that the eye may be rendered what is called an acromatic instrument; that is, one that gives a clear picture of an object, without coloured fringes. These fringes used to annoy opticians and astronomers much, until the year 1729, when the happy thought struck a gentleman of the name of Hall to ask himself how nature obviated the difficulty in the eye. By using the same means, namely, constructing telescopes with lenses of different refracting powers, his success was complete.

304. Curious illustrations of this sense.

seen at the distance of twelve paces, occupies only the twentieth part of an inch on the retina, and that the image of the same sail, when removed to the limits of distinct vision, occupies, according to the calculations of M. de la Hire, only the eight thousandth part of an inch, or less than the sixtieth part of the breadth of a common hair! "We can never," to quote again Dr. Paley's words, "reflect without wonder upon the smallness yet correctness of the picture formed at the bottom of the eye. A landscape, of five or six square leagues, is brought into a space of half an inch diameter, yet the multitude of objects which it contains are all preserved—are all discriminated in their magnitudes, positions, figures, colours. The prospect from Hampstead Hill is compressed into a compass of a sixpence, yet circumstantially represented. A stage-coach, travelling at its ordinary speed for half an hour, passes in the eye over only one-twelfth of an inch; yet is this change of image distinctly perceived throughout its whole progress, for it is only by means of that perception that the motion of the coach itself is made sensible to the eye."

193. After what has already been said of the proofs of design furnished by other parts of the body, it is almost unnecessary, in that point of view, to direct attention to this admirable organ. Its mechanism is so clear that no one can mistake its objects. A celebrated philosopher held (and with good reason) that an examination of the eye was a cure for atheism; and he might have added, that it not only proves, beyond all doubt, the existence of a great first cause, but also, perhaps, more than any other organ, that our Creator's design is to mingle pleasure with our existence. If only what was necessary had been done, it has been well remarked, that nothing but the tame, dull outlines of objects might have been made sensible to us. But colour, endless in its shades, ever variegated in its tints, has been spread over the face of nature—for what purpose, it may be asked, if not to convey to us delight,

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305. Name the moral reflections inspired.

and to prove that He who made us always wishes us to be happy.

194. Among even the lower tribes of the Radiata, indications of sensibility to light have been observed, but no distinct organs for this sense have been discovered. Ehrenberg has lately described some small spots in the rays of the star-fish, which he conceives answer the purpose of organs of vision. As we rise higher, visual organs are seen, but the Sepia is the lowest that has eyes constructed like those of the Vertebrata. The eyes of insects are called compound, being, in truth, immense aggregations of eyes, apparently to compensate for their want of mobility. The common house-fly has 8000 of these eyes; the dragon-fly 12,544; and some other species have upwards of 25,000.

195. The diseases of the eye are very numerous. The conjunctiva, lining the eyelids and reflected on the eyeball, the sclerotic coat (S, Fig. 38), and the iris (J), are particularly liable to inflammation. The ophthalmia that affected our soldiers in Egypt, generally commenced in the conjunctiva, and destroyed the eyes of great numbers. The lens (L) often becomes opaque, especially in old people, and causes blindness. When this happens, it is called cataract, and very frequently an operation is performed to restore vision. The duke of Sussex was successfully operated on a few years ago. The operation consists either in taking out the opaque lens, by cutting the cornea, or in pushing the lens downwards into the vitreous humour (V), out of the course of the rays of light. Blindness also arises from opacity of the cornea, closure of the pupil, disease of the retina or optic nerve, called amaurosis, &c.

To illustrate the sense of smell, a longitudinal section of the nose of a sheep can be easily made, keeping the saw as much as possible to one side, when the spongy or turbinated bones, which are covered with the Schneiderian membrane, and are convoluted to increase the extent of surface, may be observed. The structure of the nose of the cod or haddock is also curious. It does not communicate with the mouth, and ought to be shown. The olfactory nerves going to it

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306. Singular varieties of structure in animals.
307. What of diseased eyes?

from the brain, may easily be exposed in the fish with a strong pair of scissors.

The organ of hearing lies deep in the bone, and is not easily got at. However, the membrane of the drum in a sheep can be very nicely shown, by taking off the bone containing the ear from the skull, and then cutting away the external bony canal leading to it, until it is exposed. The small bones of the ear may also be got at by breaking into the drum with a strong pair of cutting pliers. They should be taken out, and fastened with gum on a card covered with a piece of black velvet.

A simple apparatus to show the vibrations of the air, in imitation of the external ear, may be constructed by forming two pieces of firm Bristol board into a shape like a common funnel used for decanting liquors, cutting the narrower extremity slopingly, so as to leave an opening about two inches by one and a half, and gumming *loosely* over this a piece of goldbeater's skin. The other extremity may be made about seven inches in diameter. When this funnel is supported on a wire-stand, so as to bring the goldbeater's skin into a horizontal position, and some fine sand is placed on it, the vibrations produced by the air may be seen, by beating on a sheet of tin, or other strongly vibrating body, at the larger extremity. Any tinsmith will give the shape for the Bristol board.

The structure of the eye can be admirably shown. Direct attention to the puncta lachrymalia; to the appearance of the pupil, contracting and dilating as more or less light is directed on the eye; to the correspondence of the motions of the two eyes; the colour of the iris, &c. The muscles of the eyeball can be beautifully seen in the sheep, but they require a good deal of dissection. The globe of the eye may be easily shown, however. Get a bullock's or sheep's eye, clear off the fat, &c., and observe the optic nerve entering it posteriorly. Take hold of the optic nerve, introduce a pair of sharp scissors through its coats, rather more posteriorly than the middle of the globe, and cut the coats round transversely. The exterior sclerotic coat, the pulpy retina (often curled up) interiorly, and the choroid coat between these, will then be seen. Some of the vitreous humour will probably escape in making the section, and both it and the lens, lying behind the pupil, will be seen when the posterior section of the eye is removed. A number of lines on the choroid coat, radiating from the circumference of the lens, and called ciliary processes, may also be seen. The aqueous humour may be seen to escape when the eye is made tense (when entire), and the cornea is punctured. The iris may be examined when the humours are removed. A similar section of a cod's eye should be made to show the globular lens. The eye of a fowl may also be examined, and its bony sclerotic, third eyelid, &c. observed.

Such a section as has been mentioned should of course always be made, but the anatomy of the eye is made much more simple by having a horizontal section model of it. In this its coats, humours, &c., are all seen, and their relations may be comprehended with the utmost ease by young pupils. As these section-models are difficult to be had, and are expensive, some cheap ones have been constructed for teachers, which may be had, by applying to Messrs. Chambers, at five shillings and sixpence each.

To show the inverted image on the retina, the eye of a white rabbit answers well. It is seen best by candle-light, and when two or three lights are moved before the eye. All the muscles and fat must first of course be removed posteriorly.

A prism, to show the decomposition of light, and a small camera obscura, should be exhibited.

Fig. 39 is rendered more plain by colouring the upper rays red, and the under ones blue, or the reverse.

For figures to illustrate this section, see Lizars's Coloured Plates, pages 75, 76; Roget's Bridgewater Treatise, vol. ii. pages 384, 400, 401, 425, 464, 467.

SECTION X.

REPRODUCTION.

196. As the law throughout the whole of animated nature is, that each individual shall, after a period more or less limited, die, so also have arrangements been made to secure the reproduction of the various tribes of animals. The modes adopted by nature, in accomplishing this object, vary much, in some cases being very simple, in others more complicated. Among the simplest modes of propagation is that in which an animal divides into two similar halves, each half becoming a separate creature, which also, in due time, undergoes the same process. This takes place among monads and other animalcules. Another very simple mode of propagation is seen in the polype (Fig. 2), on the body of which a small bud appears, grows, and ultimately separates from the parent, to become an animal of the same kind. As we rise higher in the scale of creation, we observe that animals are either *oviparous*, that is, produced from an egg, or *viviparous*, that is, born alive. Three classes of the vertebrata—fishes, reptiles, and birds—as well as the great proportion of the inferior divisions of animals, are all *oviparous;* but the animals composing the highest of the vertebrate classes, the mammalia, are all viviparous. In both these divisions, however, we do not find that the animal produced has always

308. Simplest mode of reproduction.
309. Define oviparous and viviparous.