Till you'd almost think they'd been and caught the devil in the trawl;
The trawl's for fancy drugin' and the work's about the same,
The only diff'rance I can see is that wot's in the name.

A scientifick genelman, our Genius on the cruise,
Explained to us the hanimals, their habits, and their use;
I don't tumble to it much; but, Bill, he spun a yarn
About the objeck of the cruise which I was glad to larn.
He said 'twas for the good of man to raise him summat higher,
Since it was proved by some one that a monkey was his sire;
I don't see how it follers—but he sed from wat he found
There was fields of blazing sea weed below upon the ground;
And every little blessed thing we druge out of the sea
Was for the good of all mankind, including u and me.
He likewise said, and bid us all partikilarly remark,
That at the bottom also 'twas most exceedin' dark,
Cause from twenty million fathoms once we got a curus prize
(He didn't want 'em in the dark) a fish with many eyes.
He told us that we'd all be dooks when this 'ere cruise is done;
I think he was mistaken, or he meant he would be one.

Thare goes the pipe, my hearty; so I'll no more at present write
But ax you to believe yours most faithful

JACK SKYLIGHT

THE COMMON FROG*

X.

The Nervous System of the Frog.

THE nervous system consists of the brain, spinal marrow, and nerves.

The whole consists of a soft, white substance, ultimately composed of minute threads, termed *nerve-fibres*, and minute round bodies called "ganglionic corpuscles."

The brain is contained in the cavity of the skull, and consists of a rounded mass made up of corpuscles and fibres, and itself contains a cavity which is a remnant of the original canal formed by the upgrowth and overclosure of the walls of the primitive groove of the embryo.

The spinal marrow (as has been said earlier), traverses the canal formed by the successive neural arches of the vertebræ being directly continuous with the brain which it, as it were, continues on down the back. Like the brain, it is largely composed of corpuscles, as well as fibres, and itself contains a longitudinal cavity (continuous with that in the brain), which is also the ultimate condition of the canal formed from the primitive embryonic groove.

The nerves generally (which are made up of fibres) proceed forth from the brain and spinal marrow, which therefore are called the *central*, or (from their position along the dorsal axis of the body), the *axial* portion of the nervous system.

All the nerves which so proceed together constitute what is called the *peripheral*, or (because going to the limbs which are appendages of the trunk), the *appendicular* portion of the nervous system.

From the brain proceed the nerves of special sense: a pair, one on each side, going to the nostrils (1, the *olfactory nerves*), another pair going to the eyes (2, the *optic nerves*), and a third pair going to the ears within the skull (3, the *auditory nerves*). Other nerves go to the tongue and palate, ministering to taste, and again others to the little muscles (orbital muscles), which move the eyeball in various directions, and to different parts of the face.

The nerves which come forth from the spinal marrow are called spinal nerves. They proceed out in pairs (one on each side), and are distributed to the limbs and trunk.

Each nerve consists of fibres, of the sorts proceeding respectively from the ventral (in man anterior), and the dorsal (in man posterior) aspects of the spinal marrow. But these two kinds of fibres are distributed side by side in the ramifications and distributions of each nerve.

* Continued from p. 266.

The fibres which come ultimately from the dorsal aspect of the spinal marrow are those which carry inwards the effect of a stimulus applied towards their ultimate termination, and are therefore called *afferent*, or *sensory*.

The fibres which come ultimately from the ventral aspect of the spinal marrow, are those which carry an influence outwards, and produce a contraction in the muscles, and are therefore called *efferent* or *motor*.

It is the nervous system of the Frog, rather than any other set of its organs, which has especially excited interest and attention. It is especially to the relations *inter se*, of the parts of this system that inquiry has been directed. The relations, that is, of its central or axial portion (the brain and spinal column) to its peripheral or appendicular portion (the nerves of the body and limbs).

In the ever memorable year 1789, Galvani accidentally discovered in the separated legs of certain Frogs, prepared for broth, those motions produced by irritation of the exposed great nerve of the thigh, now so familiar to most. This action was long called galvanism, after this observer, not, however, that he was absolutely the first to notice a fact of which he was but a re-discoverer—Swammerdam as long ago as 1658 having observed such motions.

They are generally considered as demonstrating the purely "reflex action" of the nervous system—the responsive action, that is, upon muscles, of nervous centres acted on by external stimuli without the intervention of sensation.

It is affirmed that not only will a decapitated frog endeavour to remove an irritating instrument by means of its hind legs and feet; but that if a caustic fluid be applied to a spot easily reached by one foot, the decapitated frog will apply that foot to the spot. More than this, if that foot be cut off it will move the stump as before, seeking to reach the spot, and failing so to do, will then apply the other foot to the irritated locality.

These, and such experiments, are of course conclusive, if the common assumption be conceded that the brain is the indispensable nervous instrument of sensation.

It may be, however, that the faculty of sensation may be subserved by the spinal cord without the brain, and if so, all these much vaunted experiments are valueless as regards the proof of pure reflex action, not but that they are of extreme interest, as showing what may be done in lower animals without the intervention of any brain action whatever.

Mr. G. H. Lewes has long contended against the attribution of sensation to the brain exclusively, and Dr. Bastian has recently supported and enforced similar views.

The latter remarks in his "Beginnings of Life,"—"instead of accepting the popular view, that the brain is the organ of mind, I believe it would be nearer the truth to look upon the whole nervous system as the organ of mind."

Dr. Bastian here uses the word "mind," not as denoting a rational intellect but as a generic term equivalent to psychical activity.

It may be remarked in passing that these views of Messrs. Lewes and Bastian closely approximate, as far as they go, to that most rational belief that the soul of every creature is whole and entire in every atom of its bodily structure so long as the latter preserves its integrity and vital activity.

The brain of the frog consists of the same essential parts as does the brain of all the vertebrate animals, including man. In the form and in the proportions of those parts, however, it differs extremely from the higher animals (and above all from man) and resembles the lower forms—the brain of the frog (and of Batrachians generally) offering a much closer resemblance to that of a lizard than to that of a mammal.

The brain of man consists of the following fundamental parts:

1. A pair (one on each side) of small rounded bodies, each connected, by a long stalk, with the mass of the brain,

and each shaped somewhat like a life preserver. These are the "*olfactory* lobes," and from the swollen head of each proceed the delicate nerves of smell.

2. An enormous pair of folded masses which form the great bulk of the human brain and are called the *cerebral lobes* or hemispheres. These are so large and preponderant in man, as to hide every other part of the human brain when that organ is viewed from above.

3. A relatively very small portion, but one easily recog-

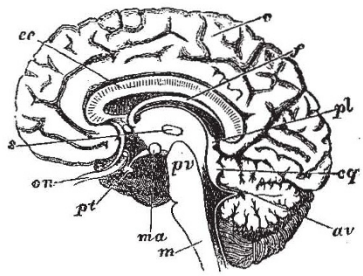

FIG. 69.—The Brain as seen when a Vertical Longitudinal Section has been made through its middle. *Av*, arbor vitæ of the cerebellum; *c*, cerebrum; *cc*, corpus c allosum; *cq*, corpora quadrigemina; *f* fornix (between the fornix and the corpus callosum is the septum lucidum); *m*, medulla oblongata; *ma*, corpus mammillare; *on*, optic nerve; *pl*, pineal gland; *pt*, pituitary body; *pv*, pons Varolii; *s*, soft, or middle commissure.

nised since it supports two conspicuous little bodies. One of these (Figs. 69, 70, 71, *pl*) is called the *pineal gland*, and projects more or less upwards; the other (Figs. 69, 70, 71, *pt*) projects downwards and is called the *pituitary body*.

4. An also very small portion relatively, is distinguished by bearing certain small prominences (Fig. 69, *cq*, and Fig. 70, *na* and *te*) placed behind the pineal gland, and called *corpora quadrigemina*.

5. A rounded mass of finely folded brain-substance, placed at the lower part of the back of the head beneath the hinder portion of the cerebral hemispheres. This is

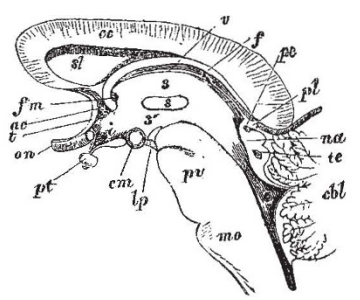

FIG. 70.—Enlarged and Diagrammatic View of a Vertical Section carried through the Corpus Callosum and the parts below. *ac*, anterior commissure; *cc*, corpus callosum; *cbl*, cerebellum; *cm*, corpus mammillare; *f*, fornix; *fm*, foramen of Monro; *i*, infundibulum; *lp*, locus; perforatus medius; *mo*, medulla oblongata; *na*, nates; *on*, optic nerve; *pc*, posterior commissure; *pv*, pons Varolii; *pl*, pineal gland; *pt*, pituitary body; *s*, soft, or middle commissure; *sl*, septum lucidum; *t*, lamina terminalis; *te*, testes; *v*, velum interpositum (between it and the fornix is a space enclosed by the folding over of the cerebrum upon the roof of the third ventricle); 3, upper, and 3', lower part of third ventricle; 4, fourth ventricle—between them is the *iter a tertio ad quartum ventriculum*.

called the *cerebellum*, and when cut through exhibits singular, radiating, tree-like markings, due to the infoldings of the surface of the organ, and called the *arbor vitæ* (Fig. 70, *av*).

6. That part which directly continues the brain into the spinal marrow (Fig. 71, *m*). It is overlapped by the cerebellum, and contains that portion of the remnant of the primitive nervous canal, which is named the *fourth ventricle*. This sixth fundamental part of man's brain is called the *medulla oblongata*.

On turning to the brain of the frog from that of man it is at first sight difficult to find out the resemblances, and to determine which portions of the one answer to definite regions of the other.

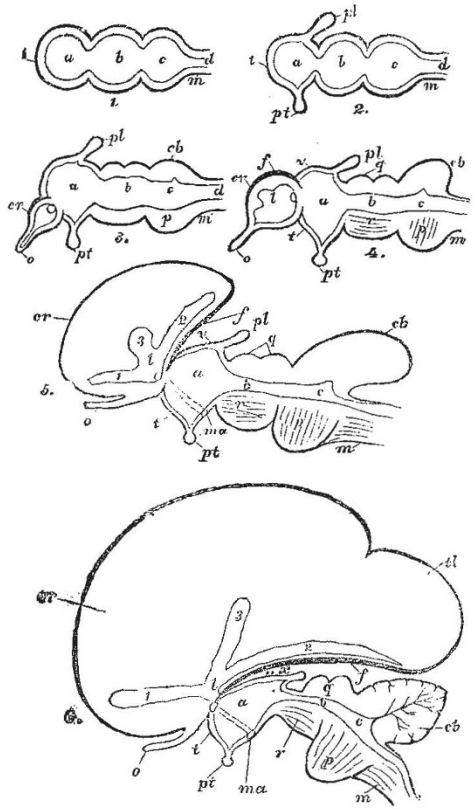

FIG. 71.—Diagram illustrating the progressive Changes that take place during successive stages of the Development of the Brain. 1. The brain in its very early condition, when it consists of three hollow vesicles the cavity of which is continuous with the wide cavity (*d*) of the primitive spinal marrow (*m*). The brain substance forms an envelope of nearly equal thickness throughout. 2. Here the first vesicle or forebrain has developed the pineal gland (*pl*) above and the pituitary body, (*pt*) below. The wall at the anterior end of the first vesicle (or forebrain) is the lamina terminalis (*t*). 3. This figure shows the cerebrum (*cr*) budding from the first vesicle, its anterior part (*o*) being prolonged as the olfactory lobe (the so-called olfactory nerve), the cavity of the cerebrum (or incipient lateral ventricle) communicating with that of the olfactory lobe in front and with that of the first cerebral vesicle (third ventricle) behind. The latter communication takes place through the foramen of Monro. The walls of the three primitive vesicles are becoming of unequal thickness, and the cavity (*b*) of the middle vesicle (*iter a tertio ad quartum ventriculum*) is becoming reduced in relative size. 4. The cerebrum is here enlarged, and the inequality in thickness of the wall of the primitive vesicle is increased. The thickened upper part of the wall of the cerebrum is the fornix (*f*). 5. This figure shows the cerebrum still more enlarged, and with a triradiate cavity (*l*, 1, 2, 3). The fornix has now come to look slightly downwards; dotted lines indicate the downward extension of its anterior part, into the corpora mammillaria. 6. Here the cerebrum is still more enlarged and backwardly extended. The fornix is shown bordering the descending cornu and extending into the temporal lobe (*tl*) of the cerebrum, which lobe is destined to descend (when the brain is fully developed) so much more that it comes to advance forwards. The fornix borders the margin of the very thin outer wall of the descending cornu, which when torn forms the fissure of Bichat. The bending back of the cerebrum has now almost enclosed (between the fornix and the velum) the space (*x*) which in Fig. 4 is widely open, making what is morphologically called the outside of the brain come practically to be in its very centre. *a*, fore-brain; *b*, mid-brain; *c*, hind-brain; *cb*, cerebellum; *cr*, cerebrum; *d*, cavity of the medulla; *f*, fornix; *l*, lateral ventricle; *m*, medulla oblongata; *ma*, corpora mammillaria; *o*, olfactory lobe; *p*, pons Varolii; *pl*, pineal gland; *pt*, pituitary body; *q*, corpora quadrigemina; *r*, crura cerebri; *t*, lamina terminalis; *tl*, temporal lobe of the cerebrum; *x*, space, enclosed by the extension backwards of the cerebrum; 1, anterior cornu of lateral ventricle; 2, its middle or descending cornu; 3, its posterior cornu.

In the earliest conditions of the human brain the resemblance is much more marked and obvious; it is later

that the correspondence between the brain of the frog and that of man becomes so disguised through the unequal growth of different portions of the organ in the human brain as it advances in its growth and development. The same six successive portions, however, exist in each.

1. In the frog the olfactory lobes acquire a much larger relative size, and they retain permanently an internal cavity which exists only transitorily in man.

2. The cerebral lobes (or hemispheres) exceed those just noticed but are insignificant indeed, when compared with the corresponding human structures. They may, however, be more insignificant than in the frog, as, for example, in the lamprey, where they are actually smaller than the olfactory lobes. In that the cerebral lobes of the frog each contain a cavity (the lateral ventricles) they have a character which is constant in all animals above fishes, they open by a common aperture (foramen of Monro) into the cavity of the next brain segment behind.

3. This third segment retains a great relative magnitude compared with that of man.

4. The fourth segment, however, consisting of the optic lobes, attains a still further relative development, though consisting only of two bodies instead of four, but these contain a cavity not found in the corpora quadrigemina of the human brain.

5. The fifth segment, the cerebellum, is very small, and

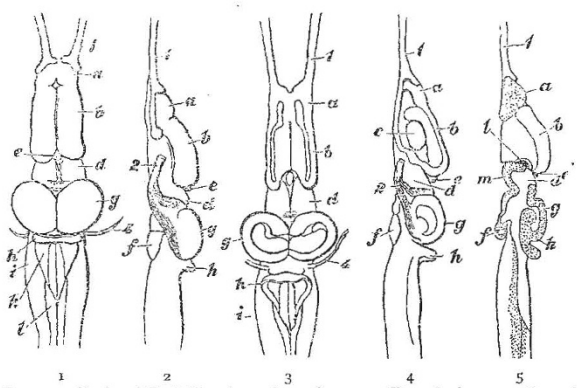

FIG. 72.—Brain of Bull Frog in various views. 1, Dorsal view. 2, Lateral view; 3, Transverse horizontal section showing the cavities of the olfactory cerebral and optic lobes. 4, Longitudinal section a little to the left of the median line. 5, Longitudinal section in median line. The corpus striatum, *c*, is here exposed to view and also a body, *g*, within the optic lobes. 5, Longitudinal section in median line. In all five figures:—1, Olfactory nerve; 2, optic nerve; 4, auditory nerve; *a*, olfactory lobe; *b*, cerebral lobe; *c*, corpus striatum; *d*, optic thalamus; *e*, pineal gland; *f*, pituitary body; *g*, optic lobes; *h*, cerebellum.

smaller than the same part in animals both higher and lower in the scale; indeed, in the frog class, this organ may be said to be at its minimum. When cut it exhibits no trace of an *arbor vitæ*.

This fact has a special interest as bearing on alleged functions of this portion of the brain.

It has been asserted by some that the cerebellum ministers to the sexual functions, by others that this part co-ordinates and directs locomotive movements, and, quite lately, that it is related to movements of the eyes.

The first two of these hypotheses seem to be completely overthrown by our frog. In the first matter there is anything but a deficiency of energy and activity, and as to the second, many reptiles are less active and continuous than the frog in their locomotive efforts. As to the third hypothesis, it should be remembered that the eyes of the Frog are large and very moveable, as also that they require a power of ready adjustment to enable the animal to secure its insect prey.

6. The sixth and last segment of the brain, the medulla oblongata, is also relatively large, and is exposed to view through the rudimentary development of the cerebellum which, as has been said, overlaps it in man.

It has been already said, that in man and the higher animals there are nerves supplying the orbital muscles and different parts of the face.

The eyeball in man is moved by six little muscles, four straight, (the *recti*) and two *oblique*, one being the upper, the other lower, oblique.

Now a nerve called the *third*, because it follows the first two (olfactory and optic) goes from the brain to all the orbital muscles except the upper oblique and the outer rectus.

Another nerve, the *fourth*, proceeds to the upper oblique muscle only.

The *fifth nerve* is a very large one, and supplies the nose, tear-gland, eyelids, upper and lower jaws, tongue and teeth.

The *sixth nerve* is a very small one indeed, being exclusively applied to the outer rectus muscle of the orbit.

The *seventh nerve* is, in part, the auditory nerve in part it sends fibres to the face.

The *eighth nerve* is a very complex structure, and consists of, at least, three nerves united together, all arising from the medulla oblongata. It sends branches to the parts about the throat, as well as to the organ of voice, to the lungs, the stomach and the heart.

The nerves of the frog exhibit certain intermediate conditions like those we have seen to exist in various other parts of its anatomy.

In the higher vertebrate animals, as in Man, the

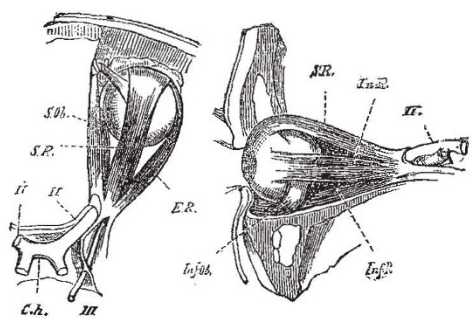

FIG. 73.—The Muscles of the Eyeballs, viewed from above and from the outer side. *R.S.*, the superior rectus; *Inf.R.*, the inferior rectus; *E.R.*, the external rectus; *In.R.*, the internal rectus; *S.Ob.*, the superior oblique; *Inf.Ob.*, the inferior oblique; *Ch*, the chiasma of the optic nerves (*II.*); *III.*, the third nerve, which supplies all the muscles except the superior oblique and the external rectus.

muscles which move the eye-ball are supplied by three distinct nerves termed respectively the 3rd, 4th, and 6th. The 5th nerve being a very large and complex one, sending branches to various parts of the head and its organs.

Now in the frog there is no distinct 6th nerve, it being replaced by an extra branch of the 5th nerve. This modification, however, is but one step towards a condition which obtains in the Mud-fish (*Lepidosiren*), when all these three nerves are quite blended with one division (the Ophthalmic) of the fifth nerve.

Again in the higher Vertebrates, as in Man, the 8th nerve is a very large and complex one, and distributed as in him. It is also so distributed in the adult frog.

In the tadpole, however, this nerve shows a very different arrangement. After issuing from the skull this nerve sends a branch down the outer side of each branchial arch and then gives off a very long one, which extends laterally, *i.e.* along the side of the body and tail.

Nothing like this exists in any Beast, Bird or Reptile, but when we come to the class of Fishes we encounter a precisely similar state of things. Here we find the eighth nerve sending a branch to each branchial arch, and giving off a great nerve proceeding along the side of the body and tail, and on that account named the *nervus lateralis*.

ST. GEORGE MIVART

(*To be continued.*)