## CHAPTER XV

## PHYLUM CHORDATA — PART II

### SUB-PHYLUM VERTEBRATA. CLASS III — AMPHIBIA

**General Characteristics.** The Amphibia are Vertebrates which occupy a land habitat, though still remaining for the most part near or in water. All are averse to salt water. Some breathe entirely by means of gills, while others breathe by means of gills during the tadpole stage, but after metamorphosis by means of lungs. The nostrils open into the mouth, and air for the lungs is drawn in through these passages. The heart has one ventricle and two auricles. The left auricle receives oxygenated blood from the lungs while the right auricle receives blood returned from the rest of the body. Paired limbs are present. Their structure is typical for all higher Vertebrates. The differences between paired fins of fishes and limbs of higher Vertebrates are greater than the resemblances. Huxley first noted the great similarities between Fishes and Amphibia and united the two groups, giving them the name *Ichthyopsida*. There are also many differences.

**Differences between Fishes and Amphibia**

| *Fishes* | *Amphibia* |
|---|---|
| 1. Gills present throughout life. | 1. Gills may be lacking in adults. |
| 2. Swim bladder acts as a lung only in Dipnoi and a few other types. | 2. Lungs present in many. |
| 3. Paired appendages are fins. | 3. Paired appendages are legs with digits. |
| 4. Heart has two chambers. | 4. Heart has three chambers. |
| 5. Usually scales or bony plates. | 5. Skin slimy. Fossil forms and a few modern forms with bony plates on surface of body. |

| *Fishes* | *Amphibia* |
|---|---|
| 6. Nostrils do not open into mouth except in Dipnoi. | 6. Nasal passages from external nares to mouth cavity. |

The most commonly known forms of Amphibia are frogs and toads, of which there are many kinds. A general description of a frog, of the genus Rana, follows.

### Study of a Type: The Frog. Its Anatomy and Physiology

**External Features.** The body is divided into the head and trunk, there being no neck. The head is about as broad as long, triangular in shape and somewhat flattened vertically. The wide gaping mouth is in front. At the tip of the snout are the two small external nostrils. The eyes protrude somewhat from the upper lateral region of the head. Behind the eyes are the circular ear drums or tympanic membranes on a level with the surface of the head. The front limbs are short and weak and are used merely to support the front end of the body. The hind limbs are long and powerful. They form the main organs of locomotion. There is no tail. The skin is smooth and loose. In the skin are many glands, secretions of which keep the skin moist. Pigment cells are found in the skin. To a certain extent the frog can " change its spots," due to diffusion or concentration of the pigment in these cells. This action is under the influence of the nervous system.

**Muscles.** Underneath the skin are the *skeletal muscles*, that is, those associated with the skeleton in body movements. These muscles are supplied with nerves and in response to motor nerve impulses give quick contractions. Muscles are attached to bones by means of tendons which are white, inelastic cords of connective tissue. For moving parts of a limb, muscles occur in pairs, antagonistic in action. That is, there are *flexors* and *extensors*, *adductors* and *abductors*, *depressors* and *levators*. When one member of a combination contracts, its mate relaxes, and vice versa. Thus orderly movement is possible. This would not be the case if all relaxed or all contracted at the same time. Team work is essential. The frog has many muscles. Careful dissection of the muscles of the hind limb would reveal at least eighteen principal ones. Under the mouth, forming part of its

floor, is the *mylo-hyoid*. Its contractions raise the floor of the mouth, making the mouth cavity smaller and thus forcing air into the lungs. The *pectoralis* muscles are a pair of large fan-shaped muscles extending from the mid-line of the ventral surface of the pectoral girdle outwards to be inserted into the upper part of the arm on either side. Their contraction moves the front legs. The *rectus abdominis* is a flat muscle on the middle ventral side. On either side of it, forming the ventral and lateral sides of the trunk, is the *obliquus externis*. The *gastrocnemius* is the muscle of the calf of the hind leg. It has its origin at the lower end of the femur and is attached by a broad tendon to the foot. This is the *tendon of Achilles*.

The frog leaps on land. The front of the body is held off the ground by the fore legs, the trunk and head form an angle with the earth. The hind legs are folded alongside the body. The powerful muscles contract, the hind legs suddenly straighten out, and the body is hurled through the air. In the water, frogs oftentimes float beneath the surface with just the tip of the snout exposed and the hind legs hanging down. If surprised, they double up or fold the hind legs; the forelegs depress the front end of the body, the hind legs suddenly straighten out and the animals disappear into the depths below. The frog propels itself in the water by the powerful strokes of the hind legs. The web between the toes and the spreading out of the toes as the legs kick back in swimming, help to propel it through the water rapidly.

**Skeleton.** Most of the skeleton of the frog is bone (Fig. 239). The *axial skeleton* consists of the skull and vertebral column. The *appendicular skeleton* consists of the pectoral and pelvic girdles and the bones of the limbs. The *skull* is somewhat flattened and has a number of open spaces (fenestrae) in it. It is composed of a number of bones. The *vertebral column* consists of nine vertebrae and a long posterior bone called the *urostyle*. The *pectoral girdle* and *sternum* form an incomplete arch around the front part of the body. The girdle does not form a bony union with the backbone but is joined to it by tendons, ligaments and muscles. The *pelvic girdle* consists of three pairs of bones. One pair (the *ilia*) have long extensions. The anterior ends of these are immovably fixed to the outer ends of the transverse processes of the ninth vertebra. The hinder end of the urostyle rests in a depression above the pelvic arch at the junction of its parts. This arrange-

ment makes a strong apparatus, well adapted to withstand the strains of leaping. The fore limb skeleton consists of a *humerus*, the *proximal* end of which articulates by a movable junction at a certain point on the shoulder girdle. Distal to the humerus is the *radio-ulna* which is a fusion of two bones — the radius and ulna. Distal to these are the *carpal* or wrist bones and beyond these are the hand bones or *metacarpals*, to which are attached the

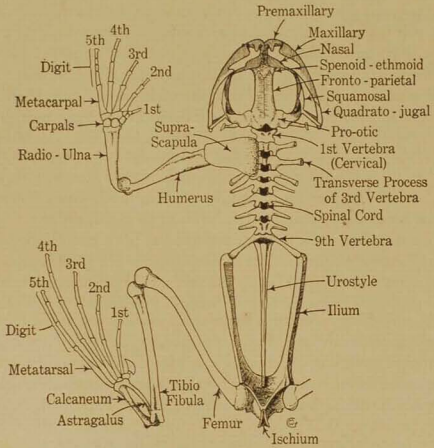


FIG. 239. — Skeleton of frog. From Thomson, *Outlines of Zoology*. D. Appleton & Co. Reprinted by permission.

digits, and of these the second, third, fourth and fifth are present, the first (thumb) or *pollux* being *vestigial*. The bones of the digits are called phalanges.

The hind limbs begin with the thigh or *femur* bone, the proximal end of which forms a *ball-and-socket joint* with the socket or *acetabulum* on the side of the pelvic girdle. Distal to the femur is the *tibio-fibula*, which is a fusion of the tibia and fibula bones. At the outer end of this bone are two long, slender ankle bones

(*tarsals*), (*a*) the astragalus and (*b*) calcaneum. At the distal end of these are three more *small* tarsal bones. Then come the five foot bones or *metatarsals*, at the end of each of which is a *digit* composed of phalanges.

**Mouth.** There is a large mouth cavity (Fig. 240). The flat broad *tongue* lies on the floor of the mouth, is attached at the front end and is free underneath and behind. It is slimy and can be quickly extended, the forked tip curling around and capturing moving insects and worms, which are then brought into the mouth. The *teeth* are small and occur on the upper jaw. Two patches of teeth (*vomerine*) are found on the roof of the mouth. They merely prevent the escape of prey. Externally, on either side of the vomerine teeth, are the mouth openings of the nasal passages. In the back of the mouth can be seen the opening of the *oesophagus*. Just in front of this on the floor and between the hinder fork of the tongue is a vertical slit, the *glottis* leading to the lungs. On the back part of the roof of the mouth on either side are the mouth openings of the *Eustachian tubes* each of which leads to the middle ear of its side.

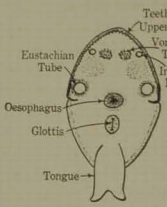

FIG. 240. — Mouth parts of frog.

**Digestive System** (Fig. 241). The *oesophagus* extends from the mouth into the abdominal cavity and connects with the *stomach* toward the left side of the body. The left end of the stomach is large and saccular, while the right end tapers off into the *duodenum*.

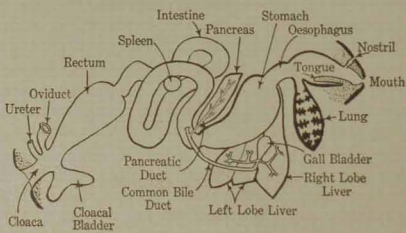

FIG. 241. — Diagram of digestive tract of frog. Associated organs are indicated.

The *pyloric valve* is between the stomach and duodenum. The duodenum is the first part of the *small intestine*. It receives the ducts from the *liver* and *pancreas*. The remainder of the *small intestine* is coiled and leads into the abruptly widening *rectum*. This connects with the *cloaca*, which is similar to the cloaca of the dogfish. From the ventral side of the cloaca originates a thin, bilobed cloacal (urinary) *bladder*. Urine passes into this from the cloaca. The *liver* is a large, dark red, three-lobed, gland lying under the stomach and part of the intestine ventrally. The *gall bladder* is in the liver on the right. From lobular ducts, bile collects in the gall bladder and from this, by the *common bile duct*, passes into the duodenum. The *pancreas* is a filmy white gland between the pyloric end of the stomach and the duodenum. Its secretions pass through the *pancreatic duct* into the bile duct and so into the duodenum. Digestion begins in the stomach and continues in the intestine, from which the digested food is absorbed into the blood.

**Respiratory System.** The skin is plentifully supplied with capillaries capable of absorbing oxygen from the water or air. The frog's body is always moist and the skin serves as an organ of respiration even in air. But the frog also has lungs (Fig. 241). The *glottis* leads into the short windpipe, from which originate, almost at once, the *lungs*. These are delicate sacs which lie on either side of the front end of the body cavity next the liver. The area of the inner surface is increased by the presence of small membranous chambers called *alveoli*. The walls of the lungs are rich in capillaries. The *larynx*, or voice-box, is between the glottis and the lungs. In it are the vocal cords, elastic membranous bands stretched across the larynx. The edges of these bands are vibrated by air expelled from the lungs thus producing the croaking sound. In breathing, the mouth, oesophagus and glottis openings are closed. The floor of the mouth descends. Air rushes into the mouth through the nasal passages. The external nostrils are closed, the floor of the mouth is raised and the air is forced into the lungs. When the muscles of the body wall contract, the air is forced out of the lungs into the mouth cavity and out through the nasal passages.

**Excretory System.** The *kidneys* (Fig. 242) are a pair of dark red bodies about two centimeters long and somewhat less than half a centimeter in diameter, located in the posterior part of the body cavity on the dorsal wall, on either side of the backbone. A small

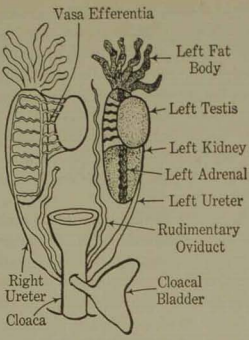


FIG. 242. — Male reproductive and excretory systems of frog, ventral view. The left figure shows *vasa efferentia* from testis to kidney.

*ureter*, or urinary duct, passes from each kidney to the cloaca. On the ventral side of each kidney is a yellow linear-shaped body. This is the *adrenal*, a ductless gland. At the anterior end of each kidney is an adipose or *fat body*. These have yellow, light-colored, finger-like processes. It is thought that reserve food supplies are stored in these for use during the hibernating season and early spring. Through the kidneys are excreted primarily wastes of metabolism such as urea.

**Reproductive System** (Fig. 242). The sexes are separate. Sperm are formed in the *testes*. These are yellow bodies about a centimeter long and half as wide, situated underneath, and toward the front end of the kidneys. Each is connected with a kidney by a transparent membrane. In this membrane are very fine ducts, the *vasa efferentia*, through which sperm pass from the testis to the kidney. The sperm then pass through ducts in the kidney to the Wolffian ducts, or ureters, thence to the cloaca. Eggs are fertilized outside in the water. The ureter of the male thus serves as a *vas deferens*, that is, duct for conveyance of sperm.

In the early spring the *ovaries* (Fig. 243) of the female are enormously enlarged. They have the appearance of great

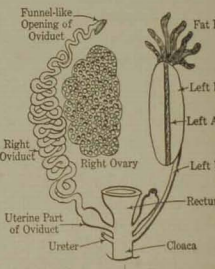


FIG. 243. — Ventral view, female urinogenital system of frog. The left half of the reproductive system and right half of urinary system are omitted from the diagram.

masses of eggs. The eggs are budded off from the ovary into the body cavity. In the body cavity the ripe eggs are passed forward. At the front end of the body cavity they pass into the funnel-shaped anterior ends of the oviducts. The *oviducts* are long, very much coiled tubes, which pass on either side back to their entrance into the cloaca. In their passage through the oviduct, the eggs receive a coating of gelatinous material. During the day and night eggs continue to pass from the ovary back through the oviduct, collecting in a saccular enlargement, the *uterus*, at the posterior end of the oviduct. Eggs are laid in the early morning. The male clasps the female with his forelegs just behind her forelegs. This is kept up for several days. The eggs which have accumulated in the uterus pass into the cloaca, thence to the water outside. As this occurs the sperm are discharged over them and fertilization takes place. The gelatinous coating of the egg now swells. The fertilized egg, from which the embryo is to be formed, is a large cell containing a large amount of yolk, which is absorbed during development. It is surrounded by gelatinous material secreted by the oviduct. Frogs' eggs with their albuminous coverings are similar to hens' eggs without shell membranes or shells.

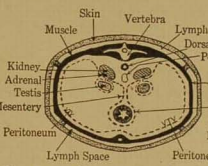


FIG. 244. — Cross-section of body of frog, showing peritoneum, mesentery and position of organs. Modified from Parker and Parker, in Holmes' *Biology of the Frog*, 4th revised edition, 1927, copyright, Macmillan Co. Reprinted by permission.

**Membranes** (Fig. 244). The inside wall of the body cavity is covered with a thin protecting membrane, the *peritoneum*. The *viscera* are suspended from the body wall along the dorsal area by similar thin, sheet-like membranes, the *mesenteries*. In these and near the stomach somewhat to the left side is a small red body, the *spleen* (Fig. 241). This is a lymph gland.

**Blood** (Fig. 245). The blood of the frog consists of (1) a liquid *plasma* containing water, salts, food and wastes; (2) *white blood corpuscles* (leucocytes) which are ameboid in form and activity, and which swallow invading microorganisms like Bacteria and so act as scavengers; and (3) *erythrocytes* or *red corpuscles* which are flat,

oval-shaped, nucleated cells containing *hemoglobin*, which has a great affinity for oxygen and by virtue of which the red corpuscles transport oxygen from the lungs and skin to the tissues.

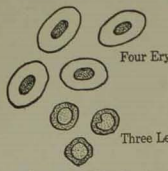


FIG. 45. — Blood cells of frog.

**Circulatory System** (Figs. 246 *A* and *B*). The *heart* is triangular in shape. It is located just under the pectoral girdle. Posteriorly is the thick, muscular *ventricle*. Anterior to this are the right and left *auricles* which are not so muscular. Between the two auricles on the ventral side is the thick tubular *truncus arteriosus* which arises from the *ventricle*. The incoming venous blood empties into a thin-walled sac, the *sinus venosus*, connected with the right auricle. *Arteries* carry blood *away from* the heart while *veins* carry blood *to* the heart. Capillaries are thin-walled net-works of fine vessels interposed between arteries and veins and ramifying among the various tissues.

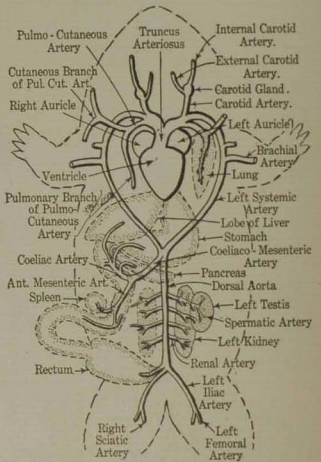


FIG. 246 *A*. — Ventral view, arterial circulation of frog. The shaded organs indicated are *shadow outlines*.

The principal arteries are: (1) the *carotids*. Each one of this pair arises from a branch of the *truncus arteriosus* and passes forward, supplying the brain, eye, tongue and other parts of the head. (2) The *pulmo-cutaneous*. These also each originate as a branch of the *truncus arteriosus*. The common pulmo-cutaneous

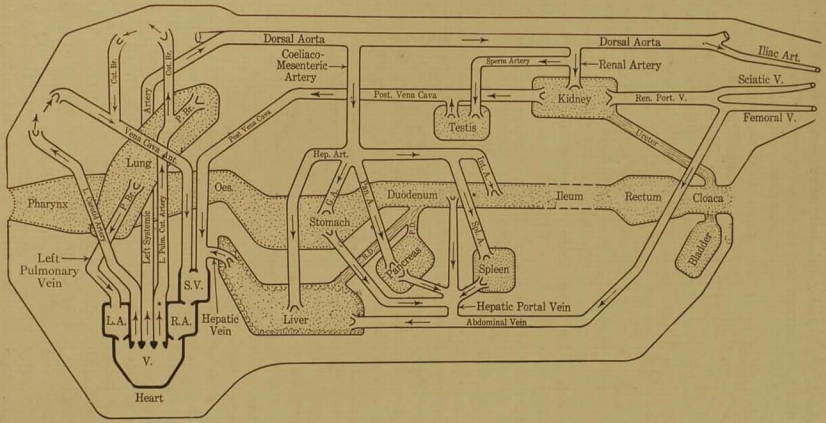


FIG. 246 *B*. — Scheme of arterial and venous system of frog.

soon divides into (*a*) the *pulmonary*, which passes to the lungs, and (*b*) the *cutaneous*, a branch which goes to the skin. They carry blood to the lungs and skin to be oxygenated.

(3) Between the carotid and pulmo-cutaneous on either side and arising as a branch of the truncus arteriosus is a third artery, the *systemic*. Each systemic passes dorsally and posteriorly *around the alimentary tract. They unite above the intestine to form the* (4) *dorsal aorta*. This passes posteriorly, giving off large branches to various organs. At the posterior end of the body it divides into the two (5) *iliac arteries*, each of which subdivides into the arteries of the hind leg. Each systemic artery before it unites with its fellow gives off important branches to the head, backbone and arm. At the junction of the systemics with the dorsal aorta arises the (6) *coeliaco-mesenteric*, which gives important branches to the liver, stomach, pancreas, spleen and intestine. Small branches from the dorsal aorta supply the muscles of the body wall, the ovaries, testes and kidneys.

The blood from the lungs returns through the pulmonary veins to the left auricle. A large *anterior vena cava* (jugular) vein on either side returns venous blood from the head to the sinus venosus. The single *posterior vena cava* returns blood to the sinus venosus from the liver, from the kidneys, ovaries, etc. Certain veins from the hind legs pass into the *renal portal* veins which carry blood to the kidneys. This blood passes via the *post cava* to the *sinus venosus*. Other veins from the hind legs unite to form the *abdominal* vein. This vein runs forward along the mid-ventral line of the abdominal wall and passes into the liver. Blood from the stomach, intestine, spleen and pancreas passes into the *hepatic portal vein* which joins the abdominal vein. The liver is connected in turn with the *hepatic veins*, which join the *post. vena cava*, which connects with the adjacent *sinus venosus*. Thus the blood returning to the heart from the hind legs passes through *either* the *renal-portal* system or the *hepatic-portal* system to the heart. Wastes of metabolism such as urea are removed from the blood as it circulates through the kidneys. These substances excreted by the kidneys pass into the ureters, and thence into the cloaca and from this to the cloacal bladder from which they are discharged later and out the cloacal opening, *i.e.*, the anus. The hepatic-portal system carries blood containing absorbed food and certain secretions into the general circulation of the body.

From the sinus venosus the blood passes into the *right auricle*. The blood from the lungs returns to the *left auricle* via the *pulmonary* veins at the same time. Both auricles contract simultaneously and both bloods are discharged into the ventricle filling it. Valves between auricles and ventricle prevent the blood from returning to the auricles when the ventricle contracts. The ventricle contracts, forcing blood into the truncus arteriosus and into its right and left branches. Each of these, as shown, has three branches. The opening to the truncus arteriosus is rather to the right of the ventricle, so that when the latter contracts, the blood on that side of the ventricle is driven out and enters the *pulmocutaneous artery*, thus transporting *un-oxygenated* blood to the lungs and skin. The blood filling the mid-portion of the ventricle follows. This blood is a mixture (slight) of unoxygenated and oxygenated blood which passes into the *systemic* arteries and thence throughout the body behind the head. Next the blood on the left side of the ventricle (oxygenated, and just returned from the lungs) passes forward into the *carotid* arteries supplying the head including the central nervous system. Valves within the truncus aid in the sorting out of the different kinds of blood referred to above.

We shall find a more effective device for the separation of oxygenated and unoxygenated blood in reptile, bird and mammal hearts. Blood carried away from the heart by the arteries transports soluble food compounds, salts and oxygen into the capillary network present in the various tissues. Some of these products diffuse from the thin-walled capillaries into tissue spaces and so near to the tissue cells. The fluid in the tissue spaces is called *lymph*. It resembles blood without red blood cells. Tissue cells absorb water, salts, oxygen and foods from lymph and also discharge wastes into it. A constant current of blood flows from arteries, through capillaries into veins and hence back to the heart. But the lymph is also constantly finding *its* way slowly through lymph vessels and veins back to the heart. *In the frog*, the lymph vessels communicate with lymph sinuses, some of which are located just beneath the skin. The skin seems to be loosely fitted to the body wall. The sinuses noted above are subcutaneous spaces somewhat separated from each other by fibrous partitions which connect the skin with the underlying tissues. Two pairs of dorsal *lymph hearts*, one pair located above the pectoral girdle,

and one pair near the hinder end of the urostyle, *pump* the lymph into veins and so back into the general circulation.

**Nervous System.** The nervous system is divided into three regions (Fig. 247): (1) the *central nervous system* composed of brain and spinal cord; (2) *peripheral*, composed of nerves branching into the body from the central nervous system; (3) *sympathetic system.*

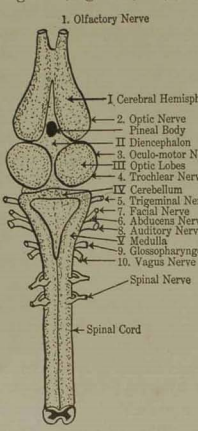


FIG. 247. — Dorsal view of frog's brain. Cranial nerves also indicated.

(1) The brain possesses two large *olfactory lobes.* Behind these is the *cerebrum*, composed of two *cerebral hemispheres.* Next comes the small *between-brain* or *diencephalon*, which has the *pineal gland* above and the *pituitary gland* (ductless) below; behind this are the *optic lobes* and behind these, the small transverse *cerebellum.* Between this and the *spinal cord* is the triangular *medulla* with the *fourth ventricle* on the dorsal side.

(2) The frog has ten pairs of *cranial nerves.* Of these the first pair are the *olfactory*, which carry sensory impulses of smell to the brain, the second or *optics* carry sensory impulses of vision to the brain, the eighth or *auditory* carry sensory impulses from the ear (auditory and equilibrium) to the brain. The third pair, *oculomotor;* the fourth, *trochlearis;* and the sixth, *abducens*, all carry motor impulses from the brain to muscles of the eye.

The fifth, *trigeminal*, is a large nerve which contains both sensory and motor-fibers; *chiefly sensory* from skin of face, mouth and tongue and motor to lower jaw muscles.

The seventh is the *facial*, also a large compound nerve. It carries *chiefly motor* impulses to the muscles of the face. The ninth is the *glossopharyngeal* and the tenth is the *vagus*, both compound nerves, *i.e.*, sensory and motor. The ninth innervates the pharynx and

tongue, while the tenth is interesting and so called because it *leaves the head and "wanders" back into the body*, supplying lungs, heart, stomach and intestine. Similar cranial nerves are found in all Vertebrates. Higher Vertebrates have two more pairs of cranial nerves, *i.e.*, twelve.

There are ten pairs of *spinal nerves* arising from the spinal cord, which is inclosed in the bony spinal canal above the bodies of the vertebrae. Each spinal nerve originates from the cord by two roots, a *dorsal root*, which carries sensory impulses *into* the cord from the periphery, and a *ventral root*, which carries motor impulses *out of* the cord to body muscles. The two roots unite outside the cord to form the *spinal nerve*, some of whose fibers originate in sensory organs of the body wall while other fibers terminate in motor end-plates in muscles. (See Fig. 322.) The largest spinal nerves are the *brachials*, which run to the arms, and *sciatics*, which supply the legs. In each of these cases, more than one pair of spinal nerves cooperate to form the nerves of the legs.

(3) The *sympathetic system* is collateral to the *central system*. It possesses two main, thread-like ganglionated trunks, one on either side of the backbone. Each sympathetic ganglion is connected to a spinal nerve ganglion. Nerves from the sympathetic system are distributed to the heart, liver, lungs, kidneys, head, alimentary tract and other internal organs and blood vessels.

**Sense organs.** The skin of the frog contains sense organs activated by temperature changes, by contact, chemical and light stimuli. The tongue and membranes lining the mouth cavity contain taste sense organs, and the olfactory nerves end in among cells forming the lining membrane of the nasal passages. The eye has the same general structure as that of other Vertebrates (Fig. 338). The ear contains the sense organ of hearing and of equilibrium. The ear of the frog differs in detail from that of other Vertebrates such as the Mammal (Fig. 337) but the same basic structural plan is evident. Three differences are noted here; (1) the frog has no external ear; (2) Sound wave vibrations are carried across from the tympanum to the inner ear by the rod-like columbella instead of the chain of bones of the Mammals (Fig. 337); (3) The portion of the inner ear which contains the sense organ of hearing is an irregular, oval-shaped sac rather than the spiral cochlea of the Mammal.

**Development** (Fig. 248). From the developing egg of the frog hatches a tadpole. This is a fish-like form. It has gills, and swims by means of a long tail. It feeds mostly on vegetable matter. Two sets of gills are formed. First, *external gills* which project out from the walls of the pharynx. These are replaced by *internal gills* more like those of fishes. Hind limbs appear as buds and gradually increase in size and perfection. The front limbs appear later and are first formed inside of a temporary sac called the *operculum*. The operculum incloses a sort of atrial chamber about the sides and floor of the mouth. Water taken into the mouth passes out through the gill slits into the atrial

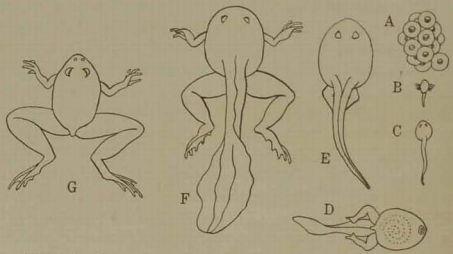


FIG. 248. — Development of frog. *A*, egg cluster; *B* and *C*, young tadpoles; in *D* and *E*, hind legs appear; in *F*, front legs also; in *G*, tail has been absorbed. From Paulmier — Bull. N. Y. State Museum.

chamber and from this to the outside. The developing front limbs break their way through the operculum. The tail is gradually absorbed and lungs appear. With the formation of these, the circulatory system develops new arrangements also. It changes from a fish-like type to the adult frog type. With the assumption of land existence the frog moves about and breathes like a land animal. The changes connected with the transition from the aquatic fish-like form to that of a land-inhabiting frog constitute *metamorphosis*.

### Classification

There are about a thousand species of Amphibians. They form a transitional group between the Fishes and land Vertebrates. The name of the group signifies that they live in the water and on land.

**Order 1. Apoda or Gymnophiona.** A few species are limbless and snake-like in form. These are called *Coecilians*. They are tropical burrowing animals with poorly developed eyes. The tail is very short and there are transverse rows of plates in the skin.

Fig. 249. — Cryptobranchus — Hellbender. (Amer Mus. Nat. Hist.)

**Order 2. Caudata or Urodela.** In these the tail persists throughout life. The external gills and gill clefts may also persist throughout life. The limbs are small and weak. They include salamanders, newts and the mud-puppy, Necturus.

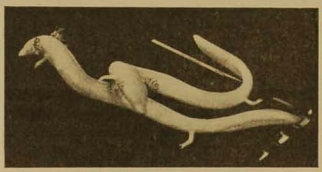

Fig. 250. — Amphiuma — Congo eel. (Amer. Mus. Nat. Hist.)

*Cryptobranchus maximus* is the largest living Amphibian. It is found in Japan and may grow to be over three feet in length. *Cryptobranchus alleghaniensis* (Fig. 249) is the hellbender found in streams in the eastern part of the United States. It attains a length of about eighteen inches. The Congo eel (Fig. 250), *Amphiuma means*, is eel-shaped and has two pairs of small limbs far apart. *Ambystoma tigrinum* (Fig. 251), about six inches long, breeds in the larval form if metamorphosis is prevented. Such a larval form of *Ambystoma* was formerly thought to be a separate species. It was called the *Axolotl*. *Desmognathus fusca* lives in dark, moist

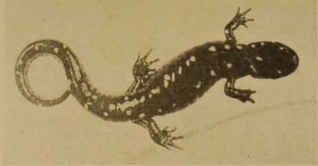

Fig. 251. — Ambystoma tigrinum. (Amer. Mus. Nat. Hist.)

places. It has no lungs or gills. Two long strings of eggs are laid by the female, and wound about her body and there they remain until hatched.

FIG. 252.—Bufo—Common toad. (Amer. Mus. Nat. Hist.)

**Order 3. The Salientia or Anura.** These are the frogs and toads and include about nine hundred species. They have no tail, nor do the adults possess gills. *Bufo*, the toad (Fig. 252), has a "warty" skin. The secretions of the skin glands of some tropical species are very poisonous. Common toads destroy garden insects in great numbers and so are valuable aids to agriculture. Toads breed in the water. Eggs are laid in strings. Development from egg to adult condition takes but a few weeks. At the end of this time, the very small toads leave the water.

Very unique and effective methods of protecting and caring for eggs and young are found among the Amphibia. For example, the female Surinam toad (Fig. 253) (Dutch Guiana) by everting the cloaca can deposit the eggs upon the soft, spongy tissue of her back, where the young develop. The male of *Alytes obstetricans* (Germany) winds eggs about his hind legs and keeps them there until it is time for them to hatch, when he moves to water. While

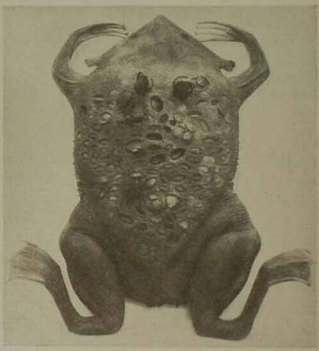

FIG. 253. — Pipa americana — Surinam toad. Note young toads in sacs on back. (Amer. Mus. Nat. Hist.)

most Amphibia are oviparous, yet *Salamandra atra* (Switzerland) is viviparous, for the two developing young are kept in the oviduct until after metamorphosis.

**Fossil Amphibia.** *Stegocephalia* were large, tailed and salamander-like forms which flourished in the Carboniferous age. They had large bony plates on the head and other parts of the body. No more ancient forms possessing the typical land type of limb have been found.

**Phylogenetic Relations of Amphibia.** Many zoologists consider that the ancestors of the Amphibia were Stegocephalia which were derived from the ganoid fishes, of which the sturgeon is a *modern* example. There is evidence also that these primitive fishes (ganoids) were the ancestors of the Teleostomi on the one hand and the Dipnoi on the other. The Elasmobranchs are even more primitive than the ganoids. The Caudata more closely resemble the Stegocephalia in form while the Salientia are more highly specialized.

The Stegocephalia appear also to have given rise to the Reptilia.

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