

Chapter 2.4

Morphology of Animals

RANA TIGRINA (The Common Indian Frog)

Systematic position

Phylum	-	Chordata
Sub phylum	-	Vertebrata or Craniata
Class	-	Amphibia
Order	-	Salientia or Anura
Genus	-	<i>Rana</i>
Species	-	<i>tigrina</i>

Habitat

Rana tigrina is the most widely distributed species in Northern India. Generally frogs are found in ponds, tank, pools, ditches, etc. However, they may leave their aquatic habitat to come on land to hunt for their prey, which are mostly insects.

Habits

(1) **Locomotion** : (a) Jumping and leaping, (b) Swimming. Absence of neck is helpful in swimming in water and jumping on land.

(2) **Feeding** : The adult frog is carnivorous. Tadpole (larva of frog) is herbivorous.

(3) **Croaking** : The male frog croaks louder than the females because of the presence of two vocal sacs in male frog. The vocal sacs act as resonators. The croaking is mating call to attract the female frog.

(4) **Hibernation (Winter sleep)** : During hibernation frog respires through skin (cutaneous respiration) only.

(5) **Aestivation (Summer sleep)** : During this period frog takes rest in shady, cool and moist place and recuperates its energy.

(6) **Protective Colouration** : The frog is capable of changing its body colour with change in its surroundings. It can not only avoid its enemies but can catch its prey unnoticed.

(7) **Breeding** : The male frog jumps on the female frog and holds her tightly with the help of his fore-limbs. Gripping of the female by the male is also very much aided by the presence of nuptial pads. This sexual embrace is called the amplexus. Fertilization is external. During development, a fish like tailed tadpole is produced, which respites with the help of gills and feeds upon vegetable matter.

(8) **Moultting** : The frog sheds off almost once a month its skin during its active life in the form of small casting. This phenomenon is known as moultting or ecdysis.

External morphology

The dorsal surface of frog is spotted olive green and ventral pale yellow; this protective colouration help to camouflage, i.e. escape the detection by enemies.

Body division : The body of frog has two main divisions head and trunk; absence of neck and tail helps both in jumping on land and swimming in water.

(1) **Head** : Head is anterior flattened triangular part with, a wide transverse terminal mouth, a pair of small dorsal external nares, two dorso-lateral eyes, a mid-dorsal light coloured brow spot or third eye or pineal body and obliquely placed pigmented circular tympanum or ear drum. Eyes are provided with nictitating membrane for protection.

(2) **Trunk** : Trunk is the large, oval, flattened main part of the body. It is differentiated into hard anterior thorax and soft posterior abdomen. The trunk is provided with a pair of fore and hind limbs. The fore limbs are shorter and stouter, end in four digits thumb or pollex is absent. The hind limbs are much larger and muscular than the fore limbs, end in five digits.

Sexual dimorphism

The male and female frogs can be differentiated externally. The male frog possesses vocal sacs, which are most developed during the breeding season. During the breeding season an amplexus or nuptial pad is developed on first finger of each hand of the male frog.

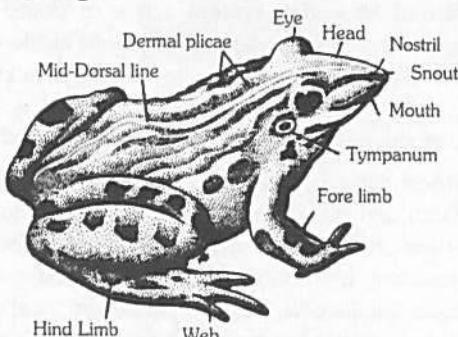


Fig : 2.4-1 External morphology of frog

Internal morphology

Skin (Integument)

Histologically, the skin consists of outer epidermis and inner dermis.

(1) **Epidermis** : Epidermis is ectodermal in origin and is made up of stratified squamous epithelium. It consists of stratum germinativum (S. malpighii), S. spinosum, S. granulosum, S. lucidum and S. corneum (horny layer). S. corneum is protective in function and is periodically cast off (moulting). This phenomenon, is known as ecdysis.

(2) **Dermis** : It is punctured at places by ducts of cutaneous glands. Dermis is region of skin that lies below the epidermis. It has a loose connective tissue or stratum spongiosum on the outside and compact dense connective tissue or stratum compactum on the inner side. Stratum spongiosum has lymph spaces, nerve fibres, blood capillaries, mucous glands, poison glands, and chromatophores. Mucous glands secrete mucus which makes the skin moist and slippery. Chromatophores provide colouration to skin. They are of three types-melanophores (brownish black), lipophores (reddish and yellowish) and guanophores (whitish).

Digestive system

It consists of alimentary canal and digestive glands.

Alimentary canal : The alimentary canal of frog is a long and coiled tube with varying diameter extending between mouth and cloaca.

(1) **Mouth** : The mouth is a terminal wide opening bounded by two bony jaws. Upper jaw is fixed while lower jaw can move up and down with the help of hinge joint.

(2) **Buccopharyngeal cavity** : Teeth are present on premaxillae, maxillae of upper jaw and vomers of the roof of buccopharyngeal cavity. The lower jaw of frog is toothless. Teeth are homodont, acrodont and polyphyodont. These are not used for chewing instead they help to hold the prey. The tongue is large muscular, sticky, bilobed at the tip and free from behind and is used for capturing the prey. Frog has no salivary glands. Various apertures like opening of eustachian tube, vocal sac (only in male), gullet and glottis are present in the buccopharyngeal cavity.

(3) **Oesophagus** : Because of the absence of neck in frog, the oesophagus is only a short tube. The oesophagus leads to the stomach.

(4) **Stomach** : It is divisible into two parts. Cardiac stomach, the anterior larger part is present near the heart. The opening of the oesophagus into the cardiac stomach is guarded by a cardiac sphincter, a powerful narrow tapering part, which is separated from the duodenum by a muscular constriction, the pyloric constriction externally, which indicates the position of pyloric sphincter, which controls the entry of food into duodenum.

(5) **Small Intestine** : It is the longest part of the alimentary canal suspended by mesentery, and is divisible into duodenum and ileum.

(i) **Duodenum** : It is a 'U' shaped structure. It receives the hepatopancreatic duct from the liver and pancreas.

(ii) **Ileum** : It is a narrow tube which is coiled in order to accommodate itself in a limited space. The internal lining of the ileum is thrown into a large number of finger like branched projections known as villi which increases the absorptive surface area.

(6) **Rectum (Large Intestine)** : Posteriorly, it opens into the cloaca through an aperture known as anus which is guarded by an anal-sphincter. The rectum stores the faecal matter and water is absorbed by its wall.

(7) **Cloaca** : It is the last part of the alimentary canal, which receives the rectum in both the sexes, but in female frog, the cloaca also receives the ureters and oviducts, while in the male the urinogenital ducts are received in addition to the rectum.

The urinary bladder also opens into the cloaca. The cloaca opens out through a cloacal aperture.

Digestive glands

(1) **Liver** : It is the largest gland of the body. It consists of three lobes-right, left and median. Liver secretes a greenish alkaline fluid bile, which is temporarily stored in gall bladder before being released into the duodenum. Bile helps in digestion of food by changing its pH from acidic to alkaline and by emulsifying the fat.

(2) **Pancreas** : It is diffused creamish gland that lies in the loop between stomach and duodenum. It has lobules that secretes pancreatic juice. Pancreatic juice is alkaline. It contains amylolytic, proteolytic and lipolytic enzymes. Pancreatic juice is poured alongwith bile into duodenum through hepatopancreatic duct.

(3) **Gastric Glands** : They secrete gastric juice having HCl and pepsinogen. Oesophagus also has glands which produce propepsin. Both propepsin and pepsinogen are changed into active pepsin.

(4) **Intestinal Glands** : Their secretion is called intestinal juice or succus entericus. It contains enzymes peptidases, maltase, lipase, etc.

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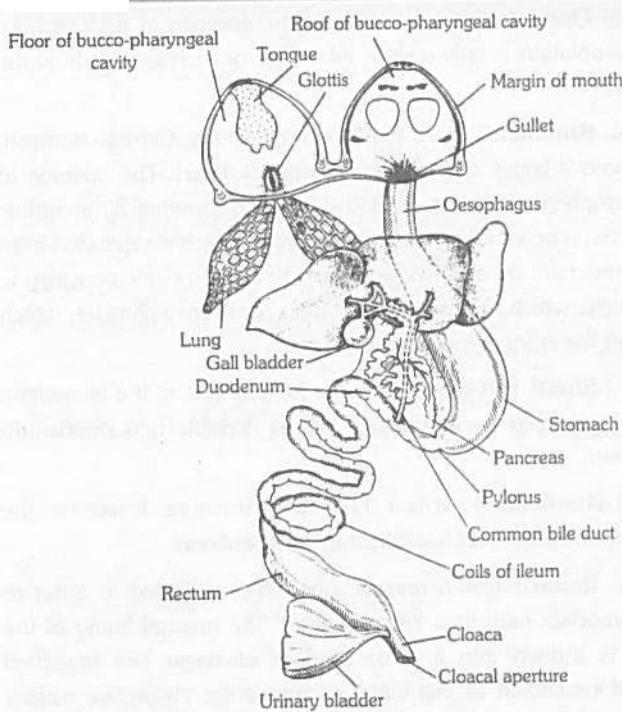


Fig : 2.4-2 The digestive system of frog

Respiratory system

Frog can perform respiration through three methods—cutaneous, buccopharyngeal and pulmonary.

(1) **Cutaneous Respiration** : Skin of Frog is thin and richly supplied with blood capillaries. It is kept moist by mucus and water. Oxygen from air diffuses into blood through moisture over the skin. CO_2 similarly, diffuses in the reverse direction from blood to air through moist surface of skin. Cutaneous respiration occurs in water, during hibernation and even aestivation. So it is the most vital mode of respiration.

(2) **Buccopharyngeal Respiration** : Exchange of gases take place in the lining layer of buccopharyngeal cavity. Throat is raised and lowered alternately by petrohyal and sternohyal muscles respectively. This expels out foul air and brings in fresh air. Buccopharyngeal respiration is performed when oxygen requirement is less, during rest over land and while 'floating' in water.

(3) **Pulmonary Respiration** : It occurs when oxygen demand is high. The rate is not more than 20/min. as compared to 80/min for buccopharyngeal respiration. Throat is lowered, air from outside enters buccopharyngeal cavity, it is called aspiration. Throat is raised, glottis opens and air passes into lungs through laryngotracheal chamber, it is called inspiration. Lungs are two ovoid pinkish elastic bags having a large number of small shallow chambers or alveoli. Blood capillaries overlie the epithelial lining of the alveoli. Exchange of gases occurs between air and blood capillaries. Lungs contract and foul air is pushed into buccopharyngeal cavity by lowering of throat. Throat is now raised, external nares opened and the foul air is passed out. The process is called expiration.

Laryngotracheal chamber

It is voice box of frog. Laryngotracheal chamber possesses two vocal cords, an opening of glottis into pharynx and bronchus

into lungs. It is supported by three cartilages, two arytenoid and one cricoid.

Circulatory system

The circulatory system of frog consists of blood vascular system and lymphatic system.

(1) **Blood Vascular system** : It is of closed type as the blood flows in the blood vessels. It represents single circulation. It means both the oxygenated and the deoxygenated blood enters the heart and get mixed in the ventricle. Blood vascular system comprises blood, heart and blood vessels.

(i) **Blood** : It is mobile connective tissue consisting of blood plasma (fluid) and blood corpuscles (cells). Three types of blood corpuscles are present in the plasma, viz, erythrocytes (RBCs—Red blood corpuscles), leucocytes (WBCs—white blood corpuscles) and thrombocytes—spindle cells. RBCs are nucleated, oval and biconvex and have haemoglobin (respiratory pigment). WBCs are amoeboid shaped and are protective in function. Thrombocytes are spindle shaped and help in blood clotting.

(ii) **Heart** : The heart lies enclosed by a thin, transparent, two layered sac, pericardium. It is a three-chambered structure made of two upper auricles and a single lower ventricle. Two additional chambers connected to the heart of frog are sinus venosus and truncus arteriosus. Sinus venosus is a triangular chamber attached dorsally to heart formed by the union of three main vena cava. A short sac like truncus arteriosus is present on the ventral side of the heart over the larger right auricle. Truncus arteriosus is further divided into a long basal thick walled conus arteriosus or pylangium and a short distal thin walled bulbous aorta or synangium. A large twisted spiral valve further divides incompletely the cavity of pylangium into a left dorsal cavum pulmocutaneum and right ventral cavum aorticum. A definitely arranged network of arteries and veins forms the arterial and venous systems.

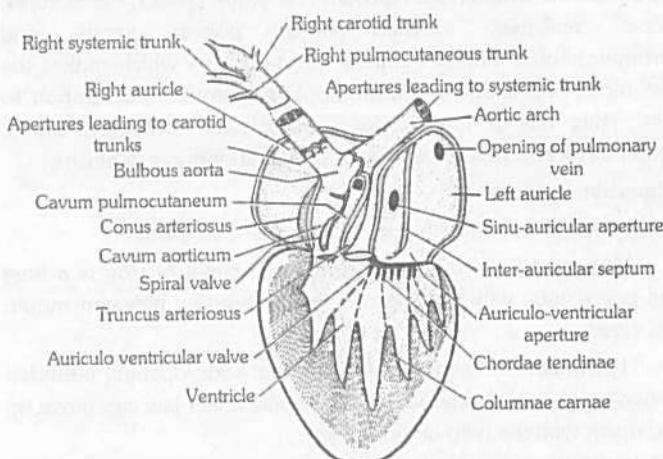


Fig : 2.4-3 Heart of frog

(2) **Portal system** : In some vertebrates there is a characteristic arrangement where the veins does not directly take blood towards the heart but divides into a capillary set and supply the organ. This is known as portal system. In frog there are two portal systems –

- (i) Renal portal system
- (ii) Hepatic portal system

Portal System :

(i) **Renal Portal System** : A branch from femoral called femororenal combine with sciatic vein to form renal portal vein. It proceeds towards kidney of its side, receives a dorso-lumbar and then enters the kidneys breaking up into capillaries for quicker extraction of nitrogenous waste products and salt. The purified blood is then collected from the kidney by renal veins.

(ii) **Hepatic Portal System** : It is formed of two veins, hepatic portal vein and anterior abdominal vein. Hepatic portal vein is formed by fusion of a number of veins from digestive tract - rectal, intestinal, splenic, duodenopancreatic, gastric and oesophageal. Anterior abdominal is formed by the union of pelvic branches from femorals. It receives vesicular vein from urinary bladder and a number of small veins from abdominal wall. Near liver it is joined to hepatic portal vein by a small branch. The two then enter liver, break up into capillaries for disposal of their contents. Purified blood is taken out by hepatic veins into postcaval.

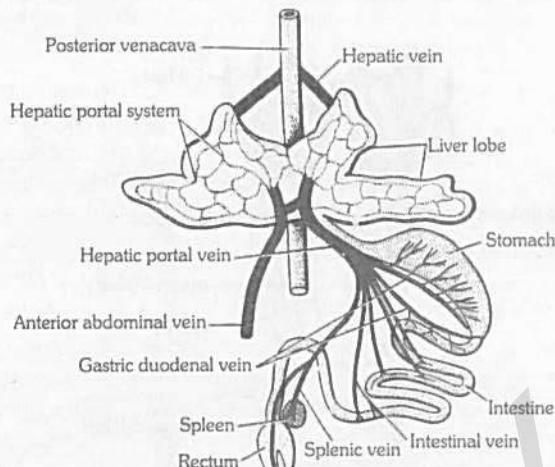


Fig : 2.4-4 Portal system of frog

(3) **Lymphatic system** : Lymph flows through the lymphatic system. Lymph is like blood but it is without RBCs and thrombocytes. It is colourless. Lymph acts as "middle man". In addition to the lymph, lymphatic system comprises lymph capillaries, (closed at the tip), lymph sinuses (spaces filled with lymph) and two pairs of lymph hearts. The flow of lymph is from the lymph capillaries → lymph sinuses → lymph hearts → veins.

Nervous system

The nervous system of frog is composed of central nervous system, peripheral nervous system and an autonomic nervous system.

(1) **Central nervous system** : It comprises the brain and spinal cord. The brain is lodged in the skull, while spinal cord is enclosed by the vertebral column.

(2) **Peripheral nervous system** : The nerves arising from the central nervous system constitute the peripheral nervous system. The nerves originate from the brain and spinal cord and are known as cranial nerves and spinal nerves respectively.

(3) **Autonomic nervous system** : It includes the nerves and ganglia that control and coordinate such organs which are not under voluntary control. It comprises sympathetic nervous system and parasympathetic nervous system.

Brain : The brain is the anterior most part of the central nervous system. It is situated in the cranial cavity and is covered by

a delicate, pigmented and vascular membrane, the piamater. The cranial cavity is internally lined with a tough membrane, the duramater. The space in between duramater and piamater is filled with a shock absorbing cerebrospinal fluid. The brain is divided into forebrain, midbrain and hindbrain. The forebrain includes olfactory lobes, paired cerebral hemisphere and unpaired diencephalon. The mid brain, the broadest, bears dorsolaterally a pair of large rounded optic lobes (corpora bigemina). The hind brain consists of a poorly developed cerebellum and medulla oblongata. Medulla oblongata passes out through the foramen magnum and continues into spinal cord, which is contained in the neural canal of vertebral column.

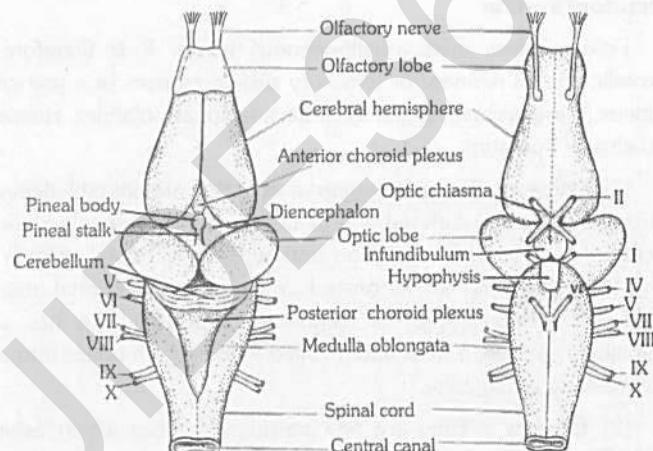


Fig : 2.4-5 Brain of frog, (a) Dorsal view, (b) Ventral view

Cranial nerves : The nerves which connect the brain and leave the brain box (cranium) are known as cranial nerves. The number of cranial nerves is definite in a particular group of animals. In frog, the number is ten pairs. The serial number of a nerve is also definite.

Sense organs

Sense organs receive stimuli (changes in the environment) from outside or inside of the animals and pass impulses to the nervous system. Frog has following five types of sense organs –

(1) **Tango-receptors (organs of touch)** : These are nerve endings and touch corpuscles which are found in the skin. Nerve ending are also present in the viscera (soft internal organs).

(2) **Olfacto-receptors (organs of smell)** : They are present in the nasal epithelium of the nasal chambers.

(3) **Gustato-receptors (organs of taste)** : These are found as taste buds which are present in the epithelium of the tongue and the buccopharyngeal cavity.

(4) **Photo-receptors (organs of sight)** : Eyes.

(5) **Statoacoustic receptors (Hearing and balancing organs)** : Ears.

Out of these, eyes and internal ears are well organized structures and the rest are cellular aggregations around nerve ending. Eyes in a frog are a pair of large, spherical structures situated in the orbit in the dorsolateral side of head protected by eyelids. The eye ball is composed of three concentric layers, sclerotic, choroid and retina. The cornea is transparent and permit entry of light into the eye.

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Ears are statoacoustic organs meant for equilibrium and hearing. Ear of frog consists of only two parts, middle and internal ears; external ear is absent. Tympanum is a dark, flat circular patch of skin found externally behind eye. Middle ear contains bony columella auris and cartilagenous stapedial plate, which passes vibrations to internal ear or membranous labyrinth.

Endocrine system

The chemical coordination of various organs of the body is done by hormones secreted by the endocrine glands. The important endocrine glands found in a frog are pituitary, thyroid, parathyroid, thymus, pineal body, pancreatic islets, adrenals and gonads.

Excretory system

Frog excretes urea as nitrogenous waste. It is therefore, ureotelic animal. Urinary or excretory system consists of a pair of kidneys (mesonephric), a pair of ureters, a urinary bladder, cloaca and cloacal aperture.

(1) **Kidneys** : The main organ of excretion are paired kidneys which are compact, dark red and bean like structures situated little posteriorly in the body cavity on both sides of vertebral column. Each kidney is composed of several structural and functional units called uriniferous tubules or nephrons. Each nephron has a Malpighian capsule, a neck and a coiled tubule which opens into a transverse collecting tube.

(2) **Ureters** : They are fine transparent tubes which arise singly from back of kidney, proceed posteriorly and pass into cloaca. In male each ureter contains a swelling called seminal vesicle for temporary storage of sperms. Ureters of male are also called urinogenital ducts.

(3) **Urinary Bladder** : It is distensible transparent bilobed sac which is connected to cloacal chamber below the opening of ureters. Urine coming into cloacal chamber from ureters is passed into urinary bladder for storage. As the urinary bladder gets filled, the sphincter guarding opening of urinary bladder relaxes and urine flows into cloacal chamber and from here to the outside through cloacal aperture.

Other Excretory Organs : Liver is the organ where urea is formed from ammonia released during deamination of excess amino acids. It also synthesises bile pigments (biliverdin, bilirubin) from decomposition products of haemoglobin. Bile is passed into duodenum for elimination of waste bile pigments. In rectum a small quantity of salt is excreted by its wall into faecal matter, e.g., calcium phosphate.

Reproductive System

Sexes are separate. Male frog is generally larger with narrower body. It has vocal sacs in the throat region for louder croaking. In breeding season male frog becomes brightly coloured. Its inner fingers develop nuptial or amplexus pads. Female frog is generally smaller with broader body. During breeding season its abdomen swells up. Nuptial pads and vocal sacs are absent.

Male reproductive system : Male reproductive organs consists of a pair of elongated or ovoid yellowish testes, vasa efferentia, kidneys, urinogenital ducts and cloaca.

(1) **Testes** : Testes are found attached to the antero-ventral surface of kidneys by a double fold of peritoneum called mesorchium. Testis is composed of a large number of small tubes, the seminiferous tubules. The wall of seminiferous tubules is made up of germinal epithelium, which forms sperms by spermatogenesis.

(2) **Vasa efferentia** : These are 10-12 in numbers and after arising from testes run through the mesorchium and enter the kidneys of their side. In kidneys, vasa efferentia open into Bidder's canal which is connected to the urinogenital duct through collecting tubules.

(3) **Urinogenital duct** : The urinogenital duct comes out of the kidneys and finally opens into the cloaca. Before opening into cloaca, it dilates to form a seminal vesicle to store the sperms temporarily. In some frogs the seminal vesicles are not found.

(4) **Cloaca** : The cloaca is a small median chamber that is used to pass faecal matter, urine and sperms to the exterior.

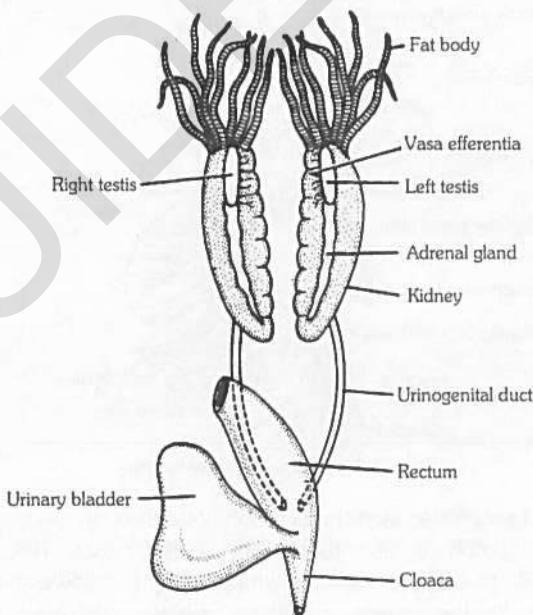


Fig : 2.4-6 Male urinogenital organs of frog

Female reproductive system : Female reproductive system of frog is formed of a pair of ovaries, a pair of oviducts and cloaca.

(1) **Ovaries** : A pair of ovaries, situated near kidneys, comprises the female reproductive organs. The ovaries are attached to the dorsal abdominal wall, supported by a peritoneal fold called mesovarium. The wall of ovary consists of an outermost germinal epithelium. The cells of the germinal epithelium give rise to the ovarian follicle. In each follicle, one cell becomes larger than the others cells to form ovum or female gamete by oogenesis. During the breeding season, the wall of the ovary ruptures to release the ova into the coelom. A mature female can lay 2500 to 3000 ova at a time.

(2) **Oviducts** : These are paired, white glandular, long, coiled tubes lying one on either side of the body cavity. Each oviduct consists of ovarian funnel, ovarian tubule and ovisac.

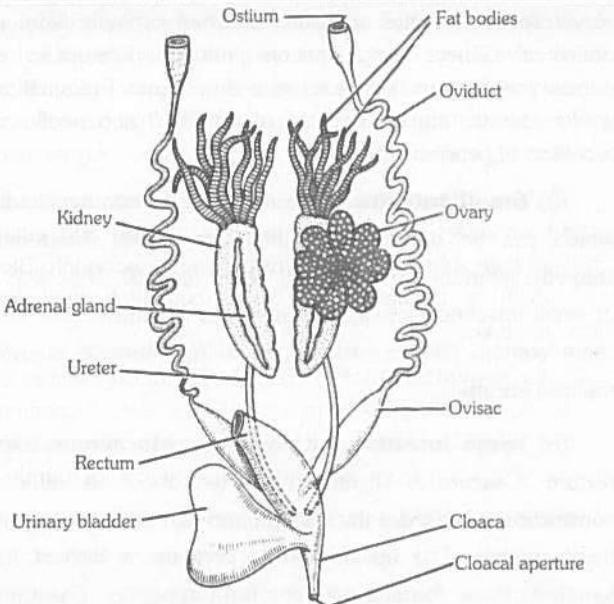


Fig : 2.4-7 Female urinogenital organs of frog

Interaction with Mankind

(1) Frog is a beneficial animal for human being. It is used for laboratory study and is used as an experimental material for teaching and research.

(2) Frog is a good friend of farmers as it eats on insect pests and this saves expenditure on pesticides.

(3i) The muscular hind legs of frog are used as food by men.

(4) Small froglets are used as fish bait.

(5) Frogs maintain ecological balance because these serve as an important food link in ecosystem.

Rattus rattus (The common house Rat)

Systematic position

Phylum	- Chordata
Subphylum	- Vertebrata or Craniata
Super Class	- Gnathostomata
Class	- Mammalia
Order	- Rodentia
Family	- Muridae
Genus	- <i>Rattus</i>
Species	- <i>rattus</i> (Black Rat)

Habits and Habitat

They are the common house rats which are cosmopolitan in distribution and found all over the world. They are herbivorous, fossorial and nocturnal animals and undergo hibernation. They show sexual dimorphism. They are prolific breeders. Fertilization is internal. The time interval between fertilization and birth (gestation) is about 22 to 23 days. They are completely grown at six to eight months of age. The rat breeds more than four times in a year producing 6-8 young ones in each litter. Newly born young ones are blind, deaf and without hairs. The mother feeds the young ones on milk. Average age of a rat is 3 years. The most common species are *Rattus rattus* (black rat) and *Rattus norvegicus* (brown rat or Norway rat).

External morphology

Their body is covered with hairs. The body is divisible into head, neck, trunk and tail.

Head : Head is broader posteriorly and tapers anteriorly as a naked terminal muzzle or snout. A pair of nostrils, shaped like inverted commas, is present above the mouth opening, which leads into nasal passages. Below the nostrils is the cleft upper lip, which exposes the two upper incisors. On the lateral sides of the head are large, paired bulging eyes. Eyelids have very fine and short eyelashes; the nictitating membrane is reduced. The head bears a pair of external ear or pinna at its posterolateral position. The mouth is sub-terminal and located beneath the nostrils and remains guarded by upper and lower lips. Long, stiff, bristle-like hair known as pili lactiles or vibrissae are present on both sides of nostrils. They help the animal in measuring width of area through which the animal is to pass even in perfect darkness.

Neck : It is a short connection between head and trunk. With the help of neck the animal can bend its head in different directions.

Trunk : It is depressed fusiform major part of the body which has two parts-anterior narrow but stouter thorax and posterior wider softer abdomen. The ventral surface of female bears 6 pairs of teats or nipples, three pectoral (thoracic) and three inguinal (abdominal). The trunk bears two pairs of limbs, two forelimbs and two hindlimbs. Forelimbs are smaller than the hindlimbs. Each limb is made up of proximal segment (stylopodium), middle segment (Zeugopodium) and distal segment (autopodium). Five digits are present in autopodium of each limb. The first digit is thumb or pollex, which is much reduced with a peculiarly flattened nail and two phalanges. Nail is keratinized structure occupying position above the distal phalanx of each digit. Typical walking pads, the tori are present on the tips of digits, palm and at the base of palm. These are also present on the feet, but palms and soles do not have hair. Anus lies posteriorly at the base of tail.

Tail : It is quite long cylindrical and tapering structure that develops above the anus. It bears overlapping scales and sparse hair in between. Tail is used as a balancing organ.

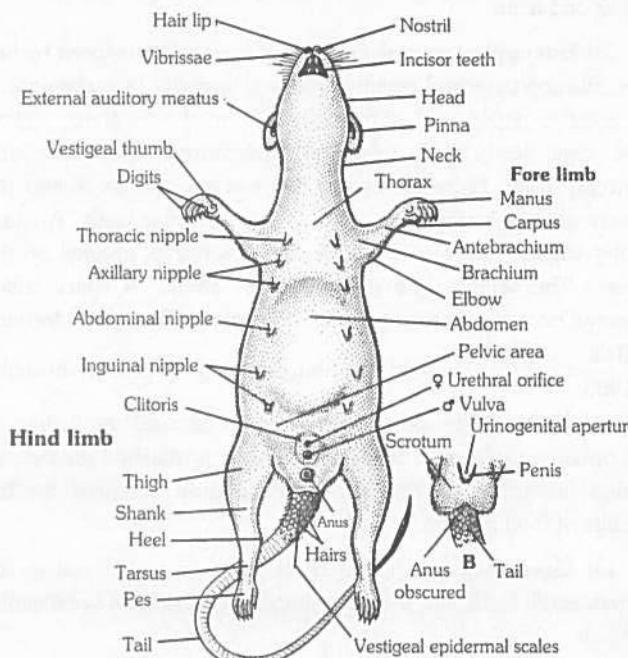


Fig : 2.4-8 External morphology of rat (a) Ventral view of female rat; (b) Ventral view of pelvic region of male rat

Internal morphology**Skin (Integument)**

Histologically, the skin consists of outer epidermis and inner dermis.

(1) **Epidermis** : Epidermis is ectodermal in origin and is made up of stratified squamous epithelium. It consists of stratum germinativum (S. malpighi), S. spinosum, S. granulosum, S. lucidum and S. corneum. There are some layers of cells above the stratum lucidum which constitute the stratum corneum. The cells contain a protein called keratin and have lost all other internal structures including nuclei.

(2) **Dermis** : It develops from the mesoderm of embryo. It is composed of dense fibrous connective tissue with blood vessels, lymph vessels, nerve fibres, pigment cells etc.

Derivatives of skin : Hairs, cutaneous glands and claws are formed from the skin. Major skin glands are sudoriferous glands (sweat glands), sebaceous glands (oil glands), mammary glands (modified sweat glands), meibomian glands (modified oil glands, present along the edges of the eye lids) and ceruminous glands (wax glands, present in the external auditory canal of external ear).

Digestive system

It consists of alimentary canal and digestive glands.

Alimentary canal : Alimentary canal is coiled tube of variable diameter. It begins at mouth and ends at anus. The various parts are mouth, buccopharyngeal cavity, oesophagus, stomach, small intestine (duodenum, jejunum and ileum), large intestine (caecum, colon and rectum) and anus.

(1) **Mouth** : The mouth opens in the buccal cavity that is surrounded by the vestibule, which is a space between the lips, cheeks and teeth.

(2) **Buccopharyngeal cavity** : It is a space enclosed by two jaws. Buccopharyngeal cavity consists of broader buccal cavity in the anterior region and narrow pharynx in the posterior region. Jaws bear teeth. The teeth are heterodont, thecodont and monophyodont. Each jaw carries two incisors and six molars the incisors grow throughout life and act as growing teeth. A sharp cutting edge is maintained due to the absence of enamel on the surface. The canines and premolars are absent. A space called diastema occurs between incisors and molars. The dental formula

$\frac{1003}{1003} \times 2 = 16$. The middle of buccal cavity contains a muscular

tongue. Taste buds occur on tongue as well as lining of buccopharyngeal cavity. Unlike frog tongue is attached posteriorly. Behind lies pharynx. Pharynx is a common chamber for the passage of food and air.

(3) **Oesophagus** : It is a short tube situated dorsal to the trachea and it leads into the pear-shaped or somewhat semicircular stomach.

(4) **Stomach** : It is wide curved part of alimentary canal which lies on the left side behind the diaphragm. It has a greater

curvature on left side, a lesser curvature on right side, cardiac orifice/valve where oesophagus open into it and pyloric sphincter is narrow posterior and where it meets duodenum. Stomach contains goblet cells for mucus, oxytic cells for HCl and peptic cells for secretion of pepsinogen.

(5) **Small intestine** : Stomach leads into small intestine, which can be differentiated into three parts duodenum (U-shaped), jejunum (straight) and ileum (coiled). Digestive glands of small intestine secrete intestinal juice or succus entericus. The same contain lipase, nuclease, peptidase, lactase, sucrase and maltase enzymes.

(6) **Large intestine** : It has three parts caecum, colon and rectum. Caecum is slightly constricted about its middle. The constriction sub divides the caecum into two parts, an apical and a basal portion. The apical portion contains a distinct mass of lymphoid tissue forming the vermiform appendix. Caecum opens into the first part of large intestine, the colon which is divisible into an ascending, a transverse and a descending colon leads into rectum, which opens outside through the anus.

Digestive glands

(1) **Salivary glands** : There are three pairs of salivary glands.

- (i) Sublingual glands
- (ii) Submandibular glands and
- (iii) Parotid glands.

Infraorbital salivary glands are reported but probably they are absent in rat, however, dogs have these glands.

(2) **Liver** : It is the largest gland of the body which is located in the upper and right side of the abdominal cavity below the diaphragm. The liver of rat consists of four lobes (left, middle, right and caudate) and the spigelian lobe is a part of caudate lobe. The cells of liver are called hepatocytes which secrete bile. Bile is carried to the duodenum by bile duct. Bile contains no digestive enzymes but helps in digestion of food in the small intestine. Gall bladder is absent in rat. Gall bladder is also absent in whale and horse.

(3) **Pancreas** : It is a very diffuse structure and is present between the duodenal loops. It secretes pancreatic juice which contains digestive enzymes such as trypsinogen (proenzyme), amylase and lipase. Islets of Langerhans of the pancreas secrete certain hormones such as insulin. Insulin converts glucose into glycogen in the liver and muscles.

(4) **Gastric Glands** : These are found in stomach and secrete gastric juice containing digestive enzymes (e.g., pepsin) and hydrochloric acid (HCl) which help in digestion of food.

(5) **Intestinal Glands** : These are present in the small intestine and secrete intestinal juice containing digestive enzymes (e.g., maltase, sucrase, lipase, etc.) which help in digestion of food.

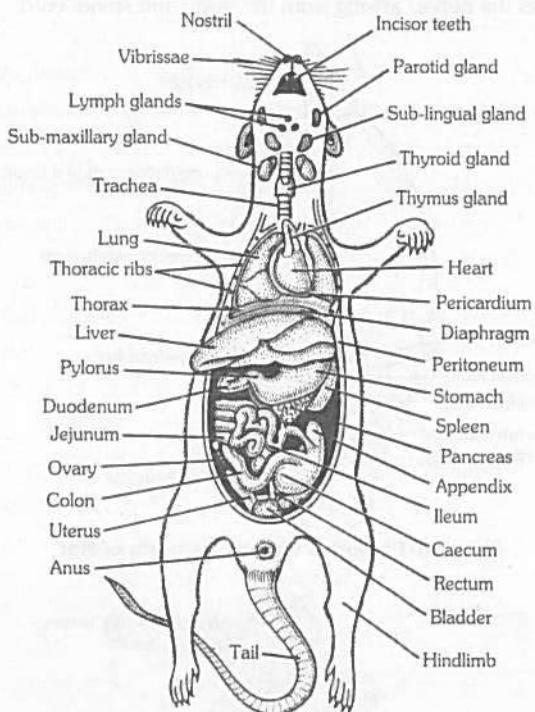


Fig : 2.4-9 General anatomy and digestive system of rat

Respiratory system

It consists of respiratory tract, two lungs and a mechanism for inspiration and expiration. Respiratory tract consists of nostrils, nasal chambers, internal nares, glottis, larynx, trachea, bronchi, and bronchioles. The nostrils lead into the olfactory or nasal chambers. The two nasal chambers lead into pharynx through internal nares. Pharynx contains a slit like glottis, which leads into voice box called larynx. Larynx passes into trachea and wind pipe which runs ventral to oesophagus. Trachea divides into two primary bronchi that pass into lungs. The lungs are placed one on either side of the heart lying in the thoracic cavity and are covered by visceral pleura. There are three lobes of the right lung and only one in the left. Each lung possesses a large number of alveoli where gaseous exchange occurs between air and blood.

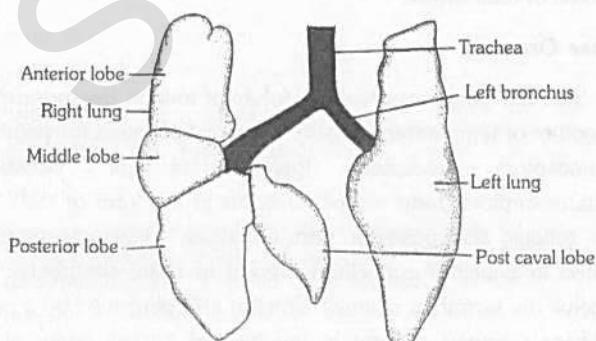


Fig : 2.4-10 Trachea and Lungs of Rat

Circulatory system

The circulatory system of rat consists of blood vascular system and lymphatic system.

(1) **Blood vascular system** : Like other mammals rat possesses closed and double circulation. Blood vascular system comprises blood, heart and blood vessels.

Blood : The volume of blood is about 5-7 ml/100 gm body weight. The blood consists of blood plasma and three types of blood corpuscles namely RBCs (6-7 lac/cubic microlitre), WBCs (6-10 thousands/cubic microlitre) and platelets. RBCs are without nucleus on maturation. They contain haemoglobin (respiratory pigment). WBCs provide immunity and defence against diseases. The platelets help in clotting of blood.

Heart : The heart lies on the midline and placed obliquely in the thoracic cavity, surrounded by pericardial cavity. The heart has four chambers; the right atrium and right ventricle and the left atrium and left ventricle. Blood flows from the right atrium into the right ventricle via the tricuspid valve (right atrio-ventricular valve) with three cusps of fibrous tissue. Blood flows from the left atrium into the left ventricle via the bicuspid or mitral valve (left atrio-ventricular valve). Aortic and pulmonary valves each have three leaflets and called semilunar valve. The right cardiac arteries supply right and left atria, whereas the left cardiac arteries only supply to small portion of the left atrium. Well developed arterial and venous system similar to other mammals is found in the rat. Only the left aortic arch is present and two precavae are present in the rat. Hepatic portal system is present which comprises veins collecting blood from alimentary canal and supply to the liver after branching in capillaries. The renal portal system is absent.

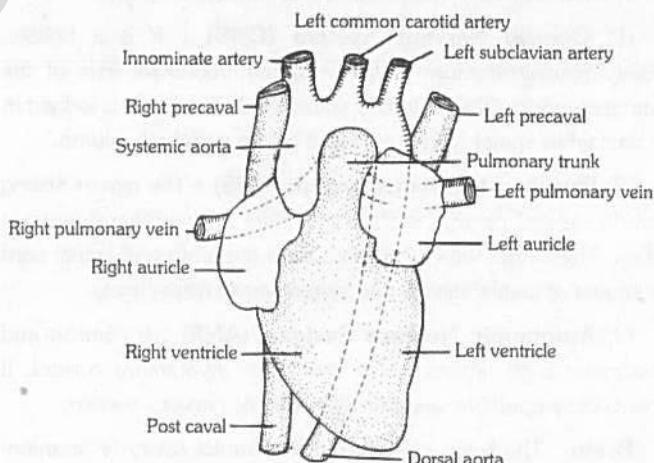


Fig : 2.4-11 Heart of rat in ventral view

(2) **Lymphatic system** : It consists of lymph, lymph vessels and lymph nodes. Lymph is colourless fluid which is similar to blood but lacks red blood corpuscles and blood platelets. Lymph is formed by lymph capillaries from tissue fluid. Lymph capillaries join to form lymph vessels. At places lymph vessels bear lymph nodes. The latter contain minute channels where germs are entrapped by leucocytes. Lymph nodes also produce lymphocytes. Tonsils a type of lymphatic node are, however, absent. Lymph vessels form lymph ducts of two types, right and thoracic. They also open into veins.

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Excretory system

The excretory system includes paired kidney, ureters, a urinary bladder and urethra.

(1) **Kidneys** : There is a pair of kidneys which are dark red and bean shaped. The right kidney is slightly higher in position. The kidney consists of outer cortex and inner medulla. A kidney has numerous structural and functional units called nephrons (= uriniferous tubules). Each nephron is made up of Bowman's capsule, proximal convoluted tubule (PCT), Henle's loop and distal convoluted tubule (DCT). The Bowman's capsule is a cup shaped structure which contains a meshwork of blood capillaries, the glomerulus. Filtration of metabolic wastes takes place in the glomerulus. Filtrate comes to the Bowman's capsule from the glomerulus and then to the other parts of the nephron.

(2) **Ureters** : There is a pair of ureters. Each ureter arises from each kidney. Ureters carry urine from the kidneys to the urinary bladder.

(3) **Urinary bladder** : It is muscular sac-like structure in which two ureters open. The urinary bladder stores urine temporarily.

(4) **Urethra** : In male it carries both urine and semen. In female it carries urine only. Thus in male rat there is only one urinogenital aperture to pass urine and semen. However in female rat both urinary and genital apertures are separate.

Nervous system

The nervous system is divisible into three main parts :

(1) **Central Nervous System (CNS)** : It is a hollow, dorsally placed structure lying along the middorsal axis of the body. It comprises the brain and spinal cord. The brain is lodged in the skull while spinal cord is enclosed by the vertebral column.

(2) **Peripheral Nervous system (PNS)** : The nerves arising from the central nervous system constitute the peripheral nervous system. The nerves which originate from the brain and spinal cord are known as cranial nerves and spinal nerves respectively.

(3) **Autonomic Nervous System (ANS)** : It controls and coordinates such organs which are under involuntary control. It consists of sympathetic and parasympathetic nervous system.

Brain : The brain is lodged in the cranial cavity (= cranium of the skull). It is covered by three membranes called meninges. The inner most membrane is called piamater, the next is the arachnoid mater (= arachnoid membrane) and outer most is the duramater. The sub dural space is present below the dura mater and sub arachnoid space lies below the arachnoid mater. These spaces are filled with a fluid. The meninges are protective in function.

The brain is composed of two large hemispheres separated by a median fissure. The cerebral hemispheres form the largest part of the brains. The posterior portion of the brain is composed of medulla oblongata which tapers in the spinal cord. The spinal cord

is a long tube like thick walled structures which emerges out through the foramen magnum of the skull and passes through neural canal of vertebral column. The peripheral nervous system comprises the nerves arising from the brain and spinal cord.

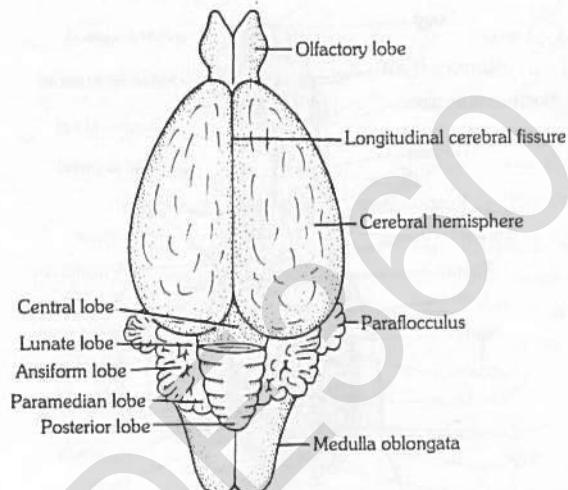


Fig : 2.4-12 Dorsal view of the brain of Rat

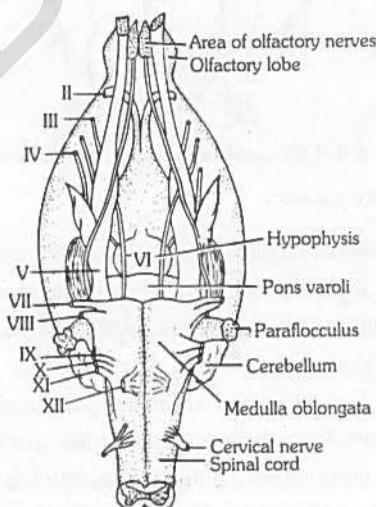


Fig : 2.4-13 Ventral view of the brain of Rat

Cranial nerves : Rat has 12 pairs of cranial nerves originating from brain.

Spinal Nerves : 33 pairs which come out from intervertebral foramina. Spinal nerves are mixed. They supply various organs in the area of their origin.

Sense Organs

Skin has tangoreceptors (receptors of touch), thermoreceptors (receptors of temperature) algesioreceptor (receptors for pain) and rheoreceptors (receptors for current or vibrations). Gustatoreceptors (taste receptors) occur in the form of taste buds over tongue and posterior part of palate. Olfactoreceptors are located in olfactory epithelium present in nasal chambers. They perceive the sensation of smell. Smell is also perceived by a pair of Jacobson's organs present in the wall of buccal cavity of Rat. Organs of sight are eye while statoacoustic organs are ears.

Reproductive system

Male Reproductive system : The male reproductive organs of a rat are a pair of testes, epididymis, vas deferens, urethra, penis and spermatic cord.

(1) **Testes :** A pair of testes is found in the scrotal sacs. Each testis is an elongated and ovoid body attached posteriorly to scrotal sac by gubernaculum. Testis of male rat descends in the scrotal sacs between the 30th to 40th day of life through inguinal canal. The inguinal canal remains open throughout life, but during sexually inactive period, the testis may be withdrawn into abdominal cavity.

(2) **Epididymis :** These are paired structures. Each epididymis is a mass of long narrow coiled tubule lying along the testis which consists of anterior caput epididymis, middle corpus epididymis and posterior cauda epididymis. Epididymis stores the sperms.

(3) **Vasa deferentia :** There is a pair of vasa deferentia. A vas deferens arises from the cauda epididymis. Vasa deferentia carry sperms.

(4) **Seminal vesicles :** There is a pair of seminal vesicles which are large and lobulated except for the smooth tip which is doubled back upon itself. They are not storage houses for sperms. Their secretion is alkaline and forms the bulk of seminal fluid (semen).

(5) **Urethra :** It is divided into three parts –

(i) Prostatic urethra is surrounded by the prostate gland.

(ii) Membranous urethra is the shortest portion and runs from the prostate to the bulb (base) of the penis.

(iii) Penile urethra passes through the penis and opens at the tip of the penis as urinogenital aperture.

(6) **Penis :** It is a copulatory organ which is covered by a loose sheath, the prepuce. The penis of the rat has a bony process called the os penis. Penis bone is also present in bat, dog, walrus and whale.

Accessory Glands : Male accessory sex glands –

(1) **Ampullary glands :** The outer end of the vas deferens near the entrance into the urethra is enlarged into ampulla, which contain ampullary glands to secrete mucus.

(2) **Vesicular glands :** These are branched glands which originate from the vas deferens behind the ampulla.

(3) **Coagulating glands :** Closely applied along the minor curvature of the seminal vesicles and within the same sheath are the coagulating glands. The secretion of these glands serve to coagulate the seminal fluid (Semen).

(4) **Prostate glands :** There are two prostate glands whose secretion is rich in citric acid, lipid and acid phosphatase.

(5) **Cowper's glands :** (Bulbo-urethral glands) : These are one pair which originate from the urethra at the base of penis. They produce a secretion during sexual excitement which protects the sperms from traces of acids found in the urethra (as the urine also passes through the penile urethra).

(6) **Preputial glands (Glands of Tyson) :** They develop from the skin forming prepuce. They are modified sebaceous (oil) glands which secrete peculiar odorous secretion.

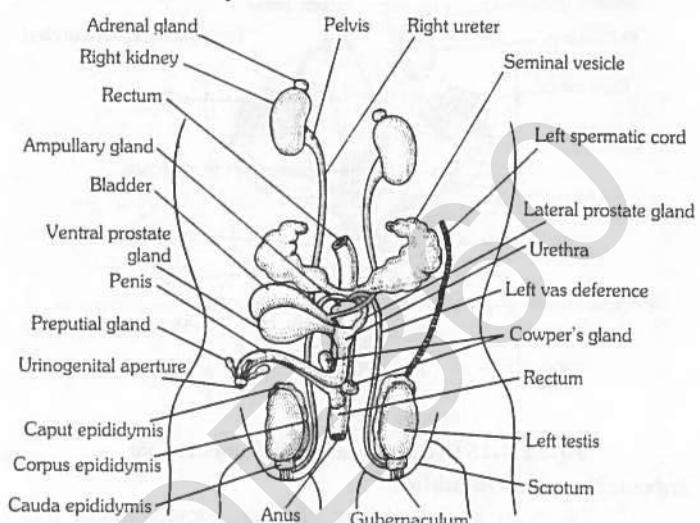


Fig : 2.4-14 Male urinogenital organs of rat

Female reproductive system : The female reproductive organs consist of a pair of ovaries, fallopian tubes, two uteri, a single common vagina and a clitoris. Female rats mature rapidly and become sexually mature in about 72 days.

(1) **Ovaries :** Ovaries are paired small yellowish compact structures suspended in the body cavity by mesovarium.

(2) **Fallopian Tubes (Oviducts or uterine tubes) :** There is one pair of convoluted Fallopian tubes. Each Fallopian tube begins with fimbriated funnel which receives ova from the ovary. As the fertilization is internal, it takes place in the dilated uppermost portion of the Fallopian tubes.

(3) **Uterus (Womb) :** The uterus is a hollow muscular structure. The uterine horns are fused near vagina. The wall of the uterus consists of outer covering of peritoneum, the perimetrium, middle layer of smooth muscle fibres, the myometrium and inner layer of simple columnar epithelium, the endometrium. The embryo gets attached to the uterine wall through placenta. Embryonic development takes place in the uterus. Placenta provides the physiological connection between developing foetus and uterine wall (endometrium) of the mother.

(4) **Vagina :** It is a tubular structure which extends from the uterus and opens outside as vaginal opening (= vulva). Penis of the male rat is inserted into the vagina during copulation. The vagina also helps to deliver the young ones at the time of birth.

(5) **Clitoris :** It corresponds to the penis of the male but it is reduced in size and does not have any passage (it is solid structure). The clitoris is found anterior to the vulva.

Accessory Glands

(1) **Vestibular glands :** These are small mucous glands which open on the surface of the vestibule of the vagina.

(2) **Bulbo-urethral glands :** These are small glands which are present in relation with the urethra.

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(3) **Preputial glands** : There is one pair of large preputial glands which are near the tip of the clitoris.

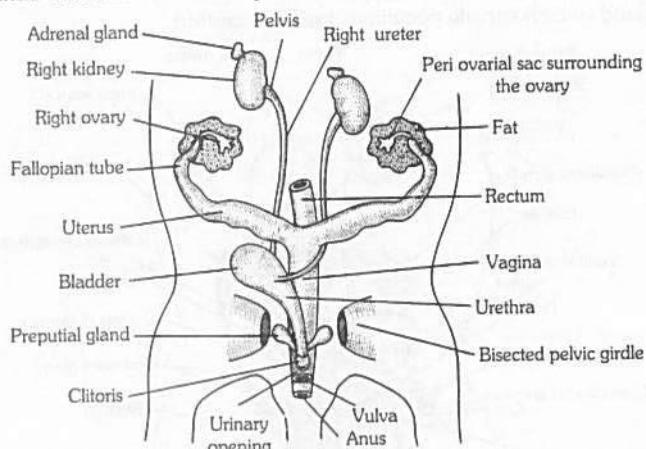


Fig : 2.4-15 Female urinogenital organ of rat

Interaction with mankind

(1) Rat is an important pest of crops, stored grains, fruits, vegetables, etc.

(2) Rat destroys field by making burrows and tunnels which often provide shelter to snakes.

(3) Rat makes burrows in the houses and causes damage to the household including books, clothes, food, etc.

(4) Rat is a host of rat flea, *Xenopsylla*, which is the vector for the disease bubonic plague.

(5) Rat is an important component of food chain as several animals like cats, snakes, mongoose, owls and some other birds use it as their food.

(6) The albino rat that is commonly used for teaching and researches in institutions is a product of laboratory breeding.

(7) The albino rats are also used as an experimental animal to test drugs that are to be finally used by the human beings.

Note : See Morphology, Anatomy and functions of different systems (digestive, circulatory, respiratory, nervous and reproductive) of an insect (cockroach) is given in the chapter 1.7 Animalia (Phylum Arthropoda) page no. 206.

Tips & Tricks

Frog's skin is not concerned with thermoregulation. There is no synthesis of vitamin D in the skin of frog. Frog can absorb water through the skin.

Digit formula of fore limb of frog is 0, 2, 2, 3, 3. Digital formula of hind limb of frog is 2, 2, 3, 4, 3.

Largest Frog. : *Rana goliath* (35 cm).

The scientific study of body movements is known as kinesiology.

Wistar Rat is an inbred strain of rats, homozygous for most traits, produced by strict brother-sister inbreeding over many generations to develop animals for research with the same general genetic composition (wistar Institute).

Rat population is 70 times that of humans. 6 rats consume food equivalent to one human being.

Ordinary Thinking

Objective Questions

Morphology of Frog

1. Frogs and toads belong to the order [Odisha JEE 1995]

- (a) Anura
- (b) Apoda
- (c) Caudata
- (d) Gymnophiona

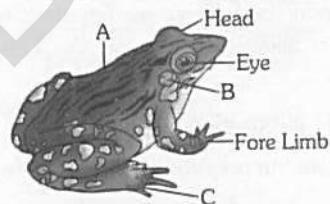
2. The cloaca in frog is a common chamber for the urinary tract, reproductive tract and [Kerala PMT 2008; AFMC 2010]

- (a) Alimentary canal
- (b) Portal system
- (c) Hepaticportal vessels
- (d) Notochord
- (e) Lymphatic system

3. Which one of the following is not a characteristic feature of frog [Kerala PMT 2009]

- (a) The skin is moist and slimy
- (b) Each of the fore limbs and hind limbs end in five digits
- (c) Hepatic portal and renal portal systems are present
- (d) Skin, buccal cavity and lungs are the respiratory organs
- (e) Heart is three-chambered

4. See the following figure and identify A to C respectively [INCERT]



- (a) Neck, Tympanum, Hind limb

- (b) Trunk, Tympanum, Hind limb

- (c) Neck, Brown eye spot, Web

- (d) Trunk, Tympanum, Web

5. The scientific name of common toad is

- (a) *Hyla arborea*
- (b) *Xenopus laevis*

- (c) *Bufo melanostictus*
- (d) *Bombinator igneus*

6. The toad possesses

- (a) Bifid tongue, slippery skin and mucous glands

- (b) Salivary glands, mucous glands and parotid glands

- (c) Parotid glands, warty skin and semicircular snout

- (d) Slippery skin, yellow pigment and abundant mucous glands

7. Parotid glands are found in

- (a) *Bufo*
- (b) *Hyla*

- (c) *Rana*
- (d) *Alytes*

8. Which statement is true about the venous blood vessels of frog [AMU (Med.) 2010]

- (a) Lingual and submandibular unite to form the internal jugular

- (b) Musculo-cutaneous and brachial unite to form the subclavian

- (c) The ventral abdominal vein drains into the posterior vena cava

- (d) The pelvic veins unite to form the renal portal vein

9. Frog hibernates during

- (a) Winter
- (b) Spring

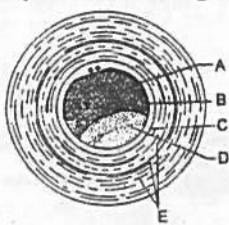
- (c) Summer
- (d) Autumn

10. The summer sleep of frog is termed as

- (a) Neoteny
- (b) Aestivation

- (c) Paedogenesis
- (d) Hibernation

11. The following is a diagram of the just spawned frog's egg; with the parts labelled from A to E. Identify the parts and choose the correct option from those given below



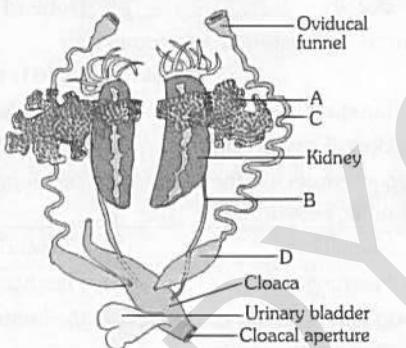
[KCET 2006]

- (a) A= cytoplasm, B= plasma membrane, C= vitelline membrane, D= yolk, E= jelly coat
- (b) A= cytoplasm, B= vitelline membrane, C= plasma membrane, D= yolk, E= jelly coat
- (c) A= yolk, B= plasma membrane, C= vitelline membrane, D= cytoplasm, E= jelly coat
- (d) A= yolk, B=jelly coat, C= vitelline membrane, D= cytoplasm, E= plasma membrane

12. Dissection of frog is done from ventral side because

- (a) Ventral skin is soft
- (b) Abdominal vein is present ventrally
- (c) Vertebral column is present on dorsal side
- (d) All of these

13. The given figure is related with female reproductive system of frog. Identify A to D [NCERT]



	A	B	C	D
(a)	Ovary	Urinogenital duct	Bidder's canal	Oviduct
(b)	Ovary	Urinogenital duct	Ovisac	Oviduct
(c)	Ovary	Urinogenital duct	Bidder's canal	Ovisac
(d)	Ovary	Ureter	Oviduct	Ovisac

14. Male frogs can croak louder than females because of

- (a) Vocal sacs
- (b) Stronger
- (c) Larger in size
- (d) Larger sound box

15. Croaking of frog is

[AIIMS 1996; EAMCET 1999; CPMT 2000]

- (a) Hunger call
- (b) Danger call
- (c) Musical tone
- (d) Sex call for female

16. The development of frog is

- (a) Direct
- (b) Indirect
- (c) Parthenogenetic
- (d) None of these

17. How many eggs are laid by a female frog at a time

- (a) 100 - 200
- (b) 500 - 1000
- (c) 2500 - 3000
- (d) 5000 - 6000

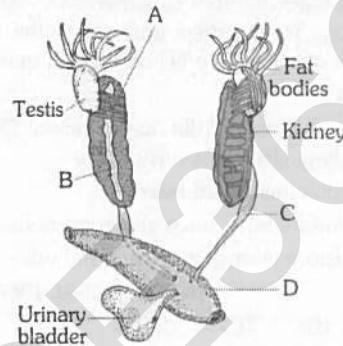
18. The opening of rectum in frog is called [CBSE PMT 2000]

- (a) Vestibule
- (b) Cloaca
- (c) Coccyx
- (d) None of the above

19. A common cloacal aperture is found in

- (a) Rana
- (b) Nereis
- (c) Rabbit
- (d) Pheretima

20. Observe the following figure indicating the male reproductive system of frog. Identify A, B, C and D [NCERT]



	A	B	C	D
(a)	Vasa efferentia	Thyroid gland	Urinogenital duct	Cloaca
(b)	Vasa efferentia	Adrenal gland	Urinogenital duct	Cloaca
(c)	Bidder's canal	Adrenal gland	Urinogenital duct	Cloaca
(d)	Bidder's canal	Adrenal gland	Urinogenital duct	Rectum

21. Disappearance of the tadpole tail during metamorphosis is brought about by [AMU (Med.) 2010]

- (a) Endoplasmic reticulum
- (b) Golgi bodies
- (c) Lysosomes
- (d) Peroxisomes

22. The number of fingers in the hindlimb of frog is [NCERT]

- (a) 4
- (b) 5
- (c) 6
- (d) 7

23. In the buccal cavity of frog the internal nares are

- (a) One
- (b) Two
- (c) Fused
- (d) Absent

24. Mucus helps frog in making [CBSE PMT 1993]

- (a) Dry skin
- (b) Moist skin
- (c) Rough skin
- (d) Thick skin

25. Acrosome of the sperm of frog helps in fertilization by

- (a) Activating the oocyte to engulf the sperm
- (b) Inducing formation of cone of reception in oocyte
- (c) Stimulating oocyte to undergo second maturation division
- (d) Secreting sperm lysin to dissolve covering membrane of oocyte

26. Chromatophores in skin of frog found in stratum

[CBSE PMT 1992, 93]

- (a) Corneum
- (b) Compactum
- (c) Germinativum
- (d) Mostly spongiosum

27. One of the main functions of frog's skin is

[INCERT; CBSE PMT 1991]

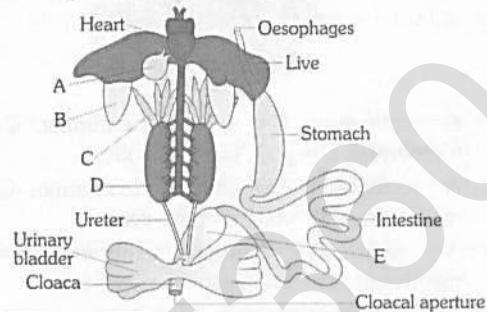
- (a) Diffusion of respiratory gases
- (b) Absorption of ultraviolet rays to produce vitamin D
- (c) Storage of excess food in the form of subcutaneous fat
- (d) Excretion of nitrogenous waste in the form of uric acid

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- 28.** When a sperm enters an egg of frog
 (a) First polar body is formed
 (b) First meiotic division occurs
 (c) Second meiotic division occurs
 (d) Fertilization process is completed
- 29.** In frog, jelly around the eggs is deposited in [BHU 2000]
 (a) Ovary (b) Oviduct
 (c) Water after fertilization (d) Water during fertilization
- 30.** Consider the following four statements (A – D) related to the common frog *Rana tigrina* and select the correct option stating which ones are true (T) and which ones are false (F)
Statements :
 (A) On dry land it would die due to lack of O_2 if its mouth is forcibly kept closed for a few days
 (B) It has four-chambered heart
 (C) On dry land it turns uricotelic from ureotelic
 (D) Its life-history is carried out in pond water
- Options** [INCERT; CBSE PMT (Mains) 2011]
 (A) (B) (C) (D)
 (a) F F T T
 (b) F T T F
 (c) T F F T
 (d) T T F F
- 31.** A Bidder's canal in each kidney of frog
 (a) Runs longitudinally in lateral region of kidney
 (b) Runs longitudinally in medial region of kidney
 (c) Runs transversely across the width of anterior part of kidney
 (d) Runs transversely across the width of posterior part of kidney
- 32.** In frog, the surface of attachment of tongue is [CBSE PMT 1992, 97]
 (a) Palatine (b) Sphenoid
 (c) Pterygoid (d) Hyoid apparatus
- 33.** Read the statements with regard to frog. Which of the statement(s) is/are correct and incorrect
 1. The medulla oblongata passes out through foramen of Monro and continues into spinal cord
 2. Vasa efferentia are 10-12 in number that arise from testes
 3. Ovaries have no functional connection with kidneys
 4. Frogs are uricotelic
- [Kerala PMT 2011]
- (a) 1, 2 and 3 are correct but 4 is incorrect
 (b) 1 and 2 are correct while 3 and 4 are incorrect
 (c) 2 and 3 are correct while 1 and 4 are incorrect
 (d) 2, 3 and 4 are correct while 1 is incorrect
 (e) 3 and 4 are correct while 1 and 2 are incorrect
- 34.** In frog pyloric sphincter is located between
 (a) Fundus and pylorus (b) Cardiac and fundus
 (c) Oesophagus and pharynx (d) Stomach and duodenum
- 35.** In frog, digestion of fats occurs mostly in [NCERT; CBSE PMT 1993]
 (a) Rectum (b) Stomach
 (c) Duodenum (d) Small intestine

- 36.** A fully grown tadpole larva of frog respires through [BCECE 2001]
 (a) Gills (b) Skin
 (c) Lungs (d) Tail fin

- 37.** The given figure is related to diagrammatic representation of internal organs of frog. Identify A to E [INCERT]



	A	B	C	D	E
(a)	Gall bladder	Lung	Fat bodies	Kidney	Rectum
(b)	Gall bladder	Lung	Testis	Kidney	Rectum
(c)	Gall bladder	Lung	Fat bodies	Testis	Rectum
(d)	Gall bladder	Lung	Ovary	Testis	Rectum

- 38.** If the mouth of frog is kept open for some time, it dies because it is unable to
 (a) Eat (b) Drink
 (c) Breath (d) None of these
- 39.** During hibernation, frog respires with [Manipal 2001; CBSE PMT 2001]
 (a) Lung only (b) Moist skin only
 (c) Buccal cavity only (d) External gills and lungs
- 40.** Oxygen carrier or the respiratory pigment in blood of frog and other vertebrates is [CPMT 1992]
 (a) Myoglobin (b) Cytochrome
 (c) Haemoglobin (d) Haemocyanin
- 41.** A frog must swallow air to expand the lungs because frog
 (a) Has no diaphragm
 (b) Has no vagus nerve
 (c) Is relatively primitive vertebrate
 (d) Normally breathe through its skin
- 42.** In frog, glottis is controlled by muscles of
 (a) Sternum (b) Vocal cords
 (c) Pectoral girdle (d) Arytenoid cartilages
- 43.** The lungs in frogs are
 (a) Compact spongy masses
 (b) Thin-walled elastic, hollow bags
 (c) Thick-walled nonelastic, hollow bags
 (d) Thick-walled nonelastic solid masses
- 44.** In frog, respiration occurs by [INCERT]
 (a) Lungs (b) Trachea
 (c) Gills only (d) Both (a) and (b)
- 45.** In which of these animals, skin serves as an accessory organ of respiration [CBSE PMT 1990; WB JEE 2010]
 (a) Bird (b) Frog
 (c) Lizard (d) Rabbit

46. In frog, cutaneous respiration takes place
[NCERT; CBSE PMT 1992]

 - Always
 - Only on land
 - Only in water with pulmonary respiration
 - Only in water pulmonary respiration is not occurring

47. The epithelial lining of respiratory system in frog is derived by
[CPMT 1993]

 - Ectoderm
 - Endoderm
 - Mesoderm
 - Mesoderm and endoderm

48. Frogs differ from humans in possessing
[NCERT; AFMC 1997; MP PMT 2007; CBSE PMT (Mains) 2011]

 - Nucleated red blood cells
 - Thyroid as well as parathyroid
 - Paired cerebral hemispheres
 - Hepatic portal system

49. Heart of frog differs from that of man by presence of
[NCERT]

Or

Heart of rat differs from that of frog by the absence of

 - Two aortae
 - Mitral valve
 - Sinus venosus
 - Four-chambers

50. The sinus venosus is located on

 - Dorsal surface of the heart of frog
 - Ventral surface of the heart of frog
 - Dorsal surface of the heart of rabbit
 - Ventral surface of the heart of rabbit

51. In frog
[CBSE PMT 1991]

 - Acetylcholine is the only neurotransmitter
 - Noradrenaline is the only neurotransmitter
 - Both acetylcholine and noradrenaline act as neurotransmitters
 - Neither acetylcholine nor noradrenaline acts as neurotransmitter

52. Amphibian heart is
[NCERT; AFMC 2001]

 - One-chambered
 - Three-chambered
 - Two-chambered
 - Four-chambered

53. Ureters act as urinogenital ducts in
[INCERT; CBSE PMT 1991, 92; CBSE PMT (Mains) 2011]

 - Frog's both males and females
 - Frog's males
 - Human males
 - Human females

54. Mesorchium in frog refers to
[INCERT; CBSE PMT 1990]

 - Fold of peritoneum between a kidney and a testis
 - Internal tissue of testes
 - Capsules of testes
 - None of these

55. When heart of frog is cut, it will

 - Not beat at all
 - Stop beating soon after
 - Continue to beat for a long time it kept dry
 - Continue to beat for a long time it kept moist

56. The heart of frog beats at the rate of

 - 25 times/min.
 - 64 times/min.
 - 72 times/min.
 - 100 times/min.

57. The venous system of frog differs from that of rabbit in having

 - Hepatic vein
 - Three vena cavae
 - Renal portal system
 - Hepatic portal system

58. In frog, the vein that carries blood from tongue is termed

 - Lingual
 - Azygous
 - Cutaneous
 - Anterior abdominal

59. Sciatic vein of frog opens in
[BHU 2005]

 - Heart
 - Kidney
 - Pelvic region
 - Liver

60. Chromatophores in frog's skin are controlled by
[CBSE PMT 1992]

 - Hormones
 - Environment
 - Nervous activity
 - Nervous and hormonal activities

61. Match the following column I with column II and choose the correct combination.

Column I	Column II
(a) Earthworm	(i) Gizzard
(b) Cockroach	(ii) Caecum
(c) Frog	(iii) Clitellum
(d) Rat	(iv) Cloaca

[Kerala CET 2005]

 - (a) – (i), (b) – (ii), (c) – (iv), (d) – (iii)
 - (a) – (iii), (b) – (i), (c) – (iv), (d) – (ii)
 - (a) – (iii), (b) – (i), (c) – (ii), (d) – (iv)
 - (a) – (i), (b) – (iii), (c) – (iv), (d) – (ii)

62. Fenestra ovalis in frog is the
[CBSE PMT 1992; KCET 2001; MHCET 2002]

 - Air-filled cavity of middle ear
 - Communication between pharynx and tympanic cavity
 - External opening of tympanic cavity covered by tympanic membrane
 - Opening of auditory capsule which separates middle ear from internal ear

63. Main excretory organs in a frog are

 - Skin
 - Lungs
 - Kidneys
 - Malpighian tubules

64. In frog, sclerotic is

 - Bony
 - Fibrous
 - Cartilaginous
 - None of these

65. The ciliated funnels on the ventral side of the kidney in frog are called

 - Ostia
 - Nephrostomes
 - Corpora adiposa
 - Bidder's organ

66. How do you differentiate a frog from a toad
[KCET 2011]

 - Frog has no exoskeleton but toad had scales
 - Frog respires through lungs but toad respires through skin
 - Frog has a tail but toad has no tail
 - Frog has no parotid glands but toad has a pair of parotid glands

67. In frog the urinary bladder is
[INCERT]

 - Absent
 - Paired
 - Bilobed
 - None of these

480 Morphology of Animals

Morphology of Rat

- 1.** The most important mammalian character of rat is
 (a) Hair (b) Pinna
 (c) Diaphragm (d) Mammary glands

2. The second layer of epidermis in rat integument is
 [Kerala PMT 2009]
 (a) Stratum lucidum (b) Stratum germinativum
 (c) Stratum corneum (d) stratum granulosum
 (e) Dermis

3. In rat, testes lie in
 (a) Scrotum (b) Thoracic cavity
 (c) Abdominal cavity (d) Retroperitoneal position

4. Rats are
 (a) Arboreal (b) Fossorial
 (c) Scansorial (d) None of these

5. The common brown rat is
 (a) *Rattus rattus* (b) *Rattus meltada*
 (c) *Rattus norvegicus* (d) *Bandicota bengalensis*

6. The three parts of the limb of a rat from proximal to distal end are
 (a) Autopodium, zeugopodium and stylopodium
 (b) Stylopodium, zeugopodium and autopodium
 (c) Stylopodium, autopodium and zeugopodium
 (d) Zeugopodium, autopodium and stylopodium

7. Accessory glands associated with the genital organs in female rats are
 (i) Vestibular Bartholins (ii) Cowper's glands
 (iii) Ampullary glands (iv) Vesicular gland
 [Kerala PMT 2009]
 (a) (i) and (ii) (b) (iii) and (ii)
 (c) (iv) only (d) (iii) only
 (e) (i) only

8. The chromosome number in *Rattus rattus* is
 (a) 40 (b) 42
 (c) 44 (d) 38

9. How many nipples are present in a female rat
 (a) Two pairs (b) One pairs
 (c) Three pairs (d) Six pairs

10. The teeth of rat are
 (a) Homodont, acrodont and diphysodont
 (b) Heterodont, thecodont and diphysodont
 (c) Heterodont, thecodont and polyphyodont
 (d) Heterodont, pleurodont and polyphyodont

11. Which of the following teeth are absent in a rat
 (a) Canines and molars (b) Incisors and molars
 (c) Incisors and premolars (d) Canines and premolars

12. The total number of teeth in a rat
 (a) 10 (b) 16
 (c) 20 (d) 28

13. Which type of placenta is found in a rat
 (a) Epitheliocchorial (b) Haemochorionic
 (c) Haemoendothelial (d) Endotheliocchorial

14. A diastema is found in
 (a) Rat (b) Man
 (c) Both (d) None

15. Premolars are absent in
 (a) Rat (b) Elephant
 (c) Both of these (d) None of these

16. The life span of rat is about
 (a) Two years (b) Four years
 (c) Six years (d) Eight years
17. Which of the following is present in a rat not in a frog
 (a) Ileum (b) Jejunum
 (c) Stomach (d) Duodenum
18. Select the false statement [Kerala PMT 2006]
 (a) In rats the teeth are heterodont and thecodont
 (b) In female rats, the urinary and genital apertures are located above anus
 (c) In female rats, six pairs of nipples are present on the ventral surface of the trunk
 (d) In rats, 12 pairs of cranial nerves and 33 pairs of spinal nerves are present
 (e) In rats, the gestation period is 22 – 23 days
19. Which type of circulation is found in rat
 (a) Open and double (b) Open and single
 (c) Closed and single (d) Closed and double
20. Gestation period of rat is
 (a) 20-22 days (b) 28-32 days
 (c) 52-65 days (d) 60-65 days
21. The site of fertilization in rat is
 (a) Vagina (b) Uterus
 (c) Vestibule (d) Fallopian tube
22. How many meninges are present in rat
 (a) Two (b) Three
 (c) Four (d) Many
23. Which aortic arch is present in a rat
 (a) Left (b) Right
 (c) Both (d) None
24. Hepatic portal system collect blood from
 (a) Liver (b) Lungs
 (c) Kidney (d) Alimentary canal
25. Which of the following is absent in a rat
 (a) Tonsils (b) Renal portal
 (c) Gall bladder (d) All of these
26. The kidney in rat are
 (a) Holonephros (b) Pronephros
 (c) Mesonephros (d) Metanephros
27. Where do you find Graafian follicles of a rat
 (a) Ovary (b) Brain
 (c) Kidney (d) Thyroid
28. Rat is
 (a) Oviparous (b) Viviparous
 (c) Ovoviviparous (d) Parthenogenetic
2. Layer of actively dividing cells in skin of frog is termed as stratum [CBSE PMT 1993]
 (a) Malpighi (b) Corneum
 (c) Compactum (d) Spongiosum
3. When a frog is transferred from 20°C to 30°C, its body temperature
 (a) Falls to 15°C (b) Rises to 30°C
 (c) Falls to 12°C (d) Remain unchanged
4. Which of the following statement is true with reference to teeth in frog
 (a) The lower jaw is toothless
 (b) The upper jaw is toothless
 (c) Both lower and upper jaws are toothless
 (d) Both lower and upper jaws are toothed
5. Which of the following part is not a part of the small intestine of frog
 (a) Ileum (b) Jejunum
 (c) Duodenum (d) None of these
6. In frog, pancreas produces [CBSE PMT 1991]
 (a) Two digestive enzymes, one hormone
 (b) Three digestive enzymes, one hormone
 (c) Three digestive enzymes, two hormones
 (d) Three digestive enzymes, three hormones
7. Stomach of frog does not have
 (a) Fundic part (b) Cardiac part
 (c) Pyloric part (d) All of these
8. Contraction of sternohyal muscles during breathing in frog [CBSE PMT 1992]
 (a) Closes glottis
 (b) Opens the nostrils
 (c) Raises floor of oral cavity
 (d) Lowers floor of oral cavity
9. Pylangium in frog is found in [CBSE PMT 1990]
 (a) Atrium (b) Ventricle
 (c) Sinus venosus (d) Conus arteriosus
10. A spiral valve is present in
 (a) Sinus venosus of frog's heart
 (b) Right auricle of rabbit's heart
 (c) Pylangium of the conus arteriosus of frog's heart
 (d) Synangium of the conus arteriosus of frog's heart
11. Three chambered heart of frog is not as efficient as four-chambered human heart because [EAMCET 1999]
 (a) Heart muscles are not strong
 (b) It does not hold enough blood
 (c) Ventricle does not pump blood properly
 (d) Oxygenated and deoxygenated blood mix up
12. Velocity of conduction of nerve impulse in frog is [CBSE PMT 1991, 93]
 (a) Faster than sound (b) 30 metre per second
 (c) 300 metre per second (d) None of these
13. Which one of these are never present in frog's ovary
 (a) Oogonia (b) Corpus luteum
 (c) Ovarian follicles (d) Germinal epithelium
14. There is no gall bladder in
 (a) Rat (b) Horse
 (c) Whale (d) All of these

Critical Thinking

Objective Questions

1. Frog has [NCERT; AFMC 1991]
 (a) 4 fingers in hand and 5 toes in foot
 (b) 5 fingers in hand and 5 toes in foot
 (c) 5 fingers in hand and 4 toes in foot
 (d) 6 fingers in hand and 5 toes in foot

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Answers

Morphology of Frog

1	a	2	a	3	b	4	d	5	c
6	c	7	a	8	b	9	a	10	b
11	a	12	c	13	d	14	a	15	d
16	b	17	c	18	b	19	a	20	b
21	c	22	b	23	b	24	b	25	d
26	d	27	a	28	c	29	b	30	c
31	b	32	d	33	c	34	d	35	d
36	a	37	a	38	c	39	b	40	c
41	a	42	d	43	b	44	a	45	b
46	a	47	b	48	a	49	c	50	a
51	c	52	b	53	b	54	a	55	d
56	b	57	c	58	a	59	c	60	a
61	b	62	d	63	c	64	b	65	b
66	d	67	c	68	d	69	d	70	d
71	d	72	a	73	a	74	b	75	c
76	a	77	b	78	d	79	d		

Morphology of Rat

1	d	2	a	3	a	4	b	5	c
6	b	7	e	8	b	9	d	10	b
11	d	12	b	13	c	14	a	15	c
16	b	17	b	18	b	19	d	20	a
21	d	22	b	23	a	24	d	25	d
26	d	27	a	28	b				

Critical Thinking Questions

AS **Answers and Solutions**

Morphology of Frog

- (a) Anura is characterized by the absence of tail, also known as salientia, the Leaping animals.
 - (c) The scientific name of common toad is *Bufo melanostictus*.
 - (a) The elevated poison secreting glands or parotid glands are present behind each tympanum of *Bufo*.
 - (a) Being cold blooded or poikilothermous (the body temperature changes with environment) frogs undergo aestivation or 'summer sleep' in summer and hibernation or 'winter sleep' in winter.
 - (a) Croaking is a natural voice of frog which is heard more commonly during breeding season. Male frog croaks more loudly because it possesses two vocal sacs over its throat which act as resonators.
 - (b) In indirect development, the young ones do not resemble the adults. The young ones usually pass through one or more intermediate stages before obtaining the shape of the adults.
 - (b) A pair of internal nares, in the form of two small opening are present on the roof of the buccal cavity lying outer to vomerine teeth.
 - (b) The mucous glands secrete a slimy fluid, the mucus, which makes the skin moist and slippery in nature.
 - (d) During capacitation sperms undergo acrosomal reaction and release various chemicals contained in the acrosome. These chemicals are collectively called sperm lysin, which dissolve covering membrane of oocyte.
 - (d) Just beneath the stratum germinativum there are present many scattered pigment cells (chromatophores) in the stratum spongiosum.
 - (a) The skin of frog provides an extensive surface for the exchange of gases (cutaneous respiration).
 - (b) Each frog's egg is surrounded by the vitelline membrane (secondary egg membrane) and many layers called tertiary egg membrane of adhesive jelly which were added as it passes through the oviduct or during fertilization.
 - (b) Bidder's canal is present in the kidney of male frog. It is helpful in the transfer of sperms from the vasa efferentia to water.
 - (d) The pyloric stomach is separated from the duodenum by a muscular constriction, the pyloric constriction externally, which indicates the position of pyloric sphincter, which controls the entry of food into duodenum.
 - (c) Frog is a positive pressure breather. It fills its lung by forcing air into them, for this, mouth has to be kept closed.
 - (b) In frog, cutaneous respiration occurs in water, during hibernation and even aestivation.
 - (b) The lungs of frog are two delicate, elastic, pinkish, ovoid, thin walled hollow sacs lying on either side of the oesophagus.

45. (b) In frog, the skin serves as an accessory organ of respiration because the skin of frog is thin and richly supplied with blood capillaries. It is kept moist by mucus and water.
46. (a) In frog, the cutaneous respiration is always carried out. During winter sleep and summer sleep it is the only method of respiration in frog.
48. (a) RBCs of frog are nucleated, oval and biconvex and have haemoglobin (respiratory pigment).
49. (c) Two additional chambers connected to the heart of frog are sinus venosus and truncus arteriosus.
50. (a) Sinus venosus is a triangular chamber attached dorsally to heart formed by the union of three main vena cava.
52. (b) Amphibian heart is a three-chambered structure formed by two upper auricles and a single lower ventricle.
54. (a) Mesorchium is a thin mesentery that suspends testis from ventral anterior part of kidney.
57. (c) Frog also possess well developed renal portal system. While it is absent in mammals.
62. (d) The fenestra ovalis leads into auditory capsule.
63. (c) The main organs of excretion are paired mesonephric kidneys which are compact, dark red and bean like structure situated little posteriorly in the body cavity on both sides of vertebral column.
64. (b) Sclerotic is the outermost layer of eye ball which is fibrous in nature.
67. (c) Urinary bladder of frog is a transparent, highly distensible bilobed sac, attached to the ventral side of the cloaca.
69. (d) Embryologically columella auris of frog is homologous to stapes of mammals.
70. (d) In the tadpole, the end product of nitrogen metabolism is ammonia which is easily disposed off by diffusion in water. After metamorphosis, the frog excrete most of their nitrogen in the form of urea.
72. (a) Presence of external ear or pinna is a typical mammalian character.
73. (a) Thin roof of cerebrum in frog is called pallium. This term is also used in reference to mantle of a mollusc or brachiopod.
74. (b) The number of spinal nerves is definite in a particular group of animals. In frog the number is ten pairs.
76. (a) Optic is second cranial nerve of frog, which carries impulse of sight from the eye to the brain and its nature is sensory.
14. (a) Diastema is a natural toothless space in mammals, in rat found between incisor and molar teeth.
19. (d) Like other mammals rat possess closed and double circulation.
20. (a) The time interval between fertilization and birth (gestation period) is about 22 to 23 days.
21. (d) Fertilization is internal and takes place in the dilated uppermost portion of the fallopian tube.
22. (b) The brain is protected by three membrane known as meninges.
24. (d) Hepatic portal system is well-developed in mammals. The food-laden blood from various region of the digestive tract is collected by four vein –
 (i) lienogastric from stomach and spleen
 (ii) Duodenal from duodenum
 (iii) Anterior mesenteric from small intestine, caecum and colon.
 (iv) Posterior mesenteric from rectum.
26. (d) The functional kidney of higher vertebrates or amniotes is a metanephros.
27. (a) Graafian follicle is a matured ovarian follicle, which is found in the mammalian ovary.

Critical Thinking Questions

1. (d) Most important character of mammals is the presence of mammary glands (modified sweat glands).
3. (a) In male rat, a pair of testes is found in the scrotal sacs.
4. (b) Rat is fossorial animal i.e. living in burrows.
5. (c) *Rattus norvegicus* is common brown rat.
6. (b) Each limb of rat is made up of proximal segment, the stylopodium, middle segment the zeugopodium and distal segment the autopodium.
9. (d) One pair of thoracic nipples, two pairs of axillary nipple, one pair of abdominal nipples and two pairs of inguinal nipples.
12. (b) The dental formula of rat is $\frac{1003}{1003} = 16$.
13. (c) In haemoendothelial placenta, all the three uterine tissue barriers (foetal connective tissue and trophoblast) are absent with only one placental barrier. e.g. rabbit, rat and guinea pig.
1. (a) In frog, the fore limbs are shorter and stouter, end in four digits and the hind limbs are much larger and muscular than the forelimbs, end in five digits.
2. (a) The cells of stratum malpighi of frog are continue growing and divide mitotically throughout life to form new layer being pushed towards the surface successively.
4. (a) The lower jaw of frog is toothless. Teeth are present on premaxillae, maxillae of upper jaw.
5. (b) Stomach is followed by a coiled small intestine made of a small anterior duodenum and much longer posterior ileum. Jejunum is absent in frog.
6. (b) In frog, pancreas is made up of lobules, connective tissue and islets of langerhans. The islets of Langerhans secrete a hormone known as insulin. The pancreatic juice contains three enzymes. The trypsin, amylopsin and steapsin or lipase.
7. (a) Stomach of frog comprises a large broader anterior part called cardiac stomach and a short narrower posterior part called pyloric stomach. Fundic stomach is absent.
8. (d) Throat is lowered and raised alternatively by sternohyal and petrohyal muscles.
9. (d) Truncus arteriosus of frog is divided into a long basal thick walled conus arteriosus or pylangium and a short distal thin walled bulbous aorta or synangium.
10. (c) A large twisted spiral valve divides incompletely the cavity of pylangium into a left dorsal cavum pulmocutaneum and right ventral cavum aorticum.
13. (b) Corpus luteum, an endocrine structure, is formed in the mammalian ovary from ruptured Graafian follicle after ovulation.
14. (d) Gall bladder is absent in rat (also in whales, some artiodactyla and all perissodactyla).

Morphology of Animals

SET Self Evaluation Test

1. During breeding season, nuptial pad is found in the thumb of

(a) Male frog	(b) Female frog
(c) Both of these	(d) None of these
2. The glands present in the skin of frog are

[INCERT; AFMC 1993]

(a) Sweat and mucous
(b) Sweat and mammary
(c) Mucous and poisonous
(d) Sweat and sebaceous
3. The structure present in man but absent in frog is

[INCERT; AFMC 2001]

(a) Pancreas	(b) Thyroid gland
(c) Adrenal gland	(d) Salivary gland
4. The epithelial lining of the alveoli of frog's lungs facing lung cavity is

[CBSE PMT 1990]

(a) Columnar and ciliated
(b) Squamous and ciliated
(c) Squamous and nonciliated
(d) Columnar and nonciliated
5. RBCs of rat are

(a) Small, round, nonnucleated and biconcave
(b) Small, round, nonnucleated and biconvex
(c) Small, oval, nonnucleated and biconcave
(d) Small, round, nucleated and biconcave
6. The jaws, eye orbits and nasal chambers in frog are supplied by

(a) Occipital arteries
(b) Vertebral arteries
(c) External carotid arteries
(d) Internal carotid arteries
7. Which one is the correct statement in regard to frog

[CBSE PMT 1993]

(a) Fertilization occurs in uterus
(b) Ova from ovary are shed into infundibuli, pass through oviducts and stored in uterus
(c) Testes develop inside kidney, so that sperms are able to reach the urinogenital ducts
(d) Male and female frogs are similar but gonads appear at the time of reproduction
8. Anterior abdominal vein in frog is formed by union of

[CBSE PMT 1991; AMU (Med.) 2009]

(a) Right and left pelvic veins
(b) Right and left sciatic veins
(c) Right and left femoral veins
(d) Right and left dorsolumbar veins
9. Which of the following is true of hibernating gland in rat

(a) It is gland formed during hibernation
(b) It secretes digestive enzymes to metabolise fat
(c) Its secretion regulates the body temperature during winter sleep
(d) It is not a gland at all, but a multicellular adipose tissue

10. Glands of Swammerdam are related with

(a) Spinal nerves of frog	(b) Cranial nerves of frog
(c) Endocrine system of frog	(d) Alimentary canal of frog
11. Bidder's canal is meant for passage of

[INCERT]

(a) Ova	(b) Urine
(c) Sperms	(d) All of these

AS Answers and Solutions

1	a	2	c	3	d	4	a	5	a
6	a	7	b	8	a	9	d	10	a
11	c								

1. (a) Frog exhibit sexual dimorphism. Male and female are distinguishable externally only during breeding season when the male develop roughed nuptial pads on the bases of the thumb. Nuptial pads help male in holding female, a sexual embrace called amplexus.
2. (c) Skin is soft, moist and slimy consists of epidermis and dermis. Mucous glands and poison glands are present in the dermis and their ducts open at the surface.
3. (d) Frog has no salivary glands.
4. (a) Ciliated columnar epithelium comprises columnar cells which have cilia on free surface. This epithelium lines most of the respiratory tract and fallopian tubes.
5. (a) RBCs of rats are small round, nonnucleated and biconcave containing red coloured respiratory pigment namely haemoglobin.
6. (a) The occipital artery in front supplies jaws, eye orbit and nasal chambers. It is a branch of occipito-vertebral artery.
8. (a) The pelvic veins of both sides unite to form a median ventral or anterior abdominal vein. It receives blood from urinary bladder and ventral abdominal wall.
9. (d) A fatty mass of pinkish colour, located in the region between the scapulae and neck of rat is often called hibernating gland.
10. (a) Glands of swammerdam are soft chalky masses of calcareous bodies found in the dorsal root ganglion of spinal nerve in frog. These form reserve supplies of calcium.
11. (c) Bidder's canal is present in the kidney of male frog. It is helpful in the transfer of sperms from the vasa efferentia to water.