Liver. The liver is the largest gland of the body and lies to the ventral aspect of the digestive tract. It is present in all craniates and arises as a tubular outgrowth (Fig. 6.1) from the endodermic epithelium of the intestine close to the junction of the latter with the stomach. The diverticulum divides again and again, the ultimate branches forming the glandular part of the organ. The proximal parts of the outgrowths give rise to the bile ducts. The liver, thus, is a compound tubular gland, the lumina of the tubules forming gall capillaries. The tubular condition is clear in the fishes and amphibians, but it is obliterated in the amniotes especially in the mammals. The bile duct (or one of the bile ducts) forms a lateral diverticulum, the gall-bladder, which stores bile. This is usually present on the dorsal surface of the liver, but it may be buried in the substance of the gland. The main functions of the liver include secretion of bile, production and storage of glycogens and formation of urea and uric acid, substances of great importance in the animal economy. The bile is passed to the intestine by the bile duct (choledochal or hepatic duct) but other products are carried away by blood to places where they are got rid of.

The acraniate chordates also possess what is designated as liver. It is simple sac-like caecum from intestine in *Amphioxus*, lying just behind the pharynx. The ammocoete larva of *Petromyzon* possesses a well-developed liver with a gall bladder and bile duct, but during metamorphosis these disappear and are lacking in the adult. In myxinoid the enormously developed liver is divided into two lobes, an anterior and a posterior.

Among the fishes the liver is relatively larger and in the carnivores it is generally larger than that of the herbivores. In the elasmobranchs the liver is large, two-lobed containing the gall bladder usually in the right lobe (it may occur in the left in some individuals). The liver is yellowish in colour because of large quantity of fat. The liver of the teleosts is simple, two-or three-lobed with an exceptionally small gall-bladder.

The liver of anurans is large comprising several lobes. In the urodeles it is quite simple and undivided in some cases divided as in others. Among reptiles it is a massive organ in the lizards chelonians and crocodilians. Usually it is two-lobed, the lobes may be completely separate (Chelonia) or connected anteriorly (Lacertilia, Crocodilia). A gall bladder is always present. In some forms (*Uromastix*) the posterior part of the liver forms a process round the posterior vena cava called the **processus venae cavae.** The birds have a large and compact liver usually consisting of two or three lobes. The gall bladder and processus venae cavae are absent in this case.

The liver of mammals is many-lobed and presents different shapes in different groups. The liver of monotremes has four lobes and numerous secondary lobules are met with in marsupials. The liver of the rabbit is large and made up of five lobes, the right and the left

central, the left lateral, the caudate and the spigelian lobes. The main large gall bladder lies between the right and left central lobes. The cystic bile duct or cystic duct arises from the gall bladder, receives subsidiary bile ducts from various liver lobes and opens in the beginning of the duodenum.

Pancreas. The pancreas is the second largest digestive gland in the vertebrates. It secretes important digestive ferments (trypsin, steapsin, amylopsin) which digest both carbohydrates and proteins. The pancreas arises from the anterior part of the mid-gut in the form of several sac-like outgrowths near the liver. The primary rudiments include three main diverticula, one dorsal, two ventral, the distal portion of these rudiments develops into glandular part having glands of the acinous type and the proximal portions form the ducts. The ventral diverticula soon unite. In the cyclostomes (*Petromyzon*) the pancreas arises as islands of cells derived from endodermal epithelium of the posterior fore-gut and also from the bile-duct. In other cyclostomes (*Myxine*, *Bdellostoma*) the pancreas lies round the bile ducts. The pancreas is a prominent structure in elasmobranch fishes and opens into the anterior part of the intestine by means of a duct. In the bony fishes (teleosts) the pancreas is a widely diffuse organ.

The pancreas is a compact gland in the amphibians lying between the stomach and the duodenum. It opens on the duodenum by a single duct or by many ducts (in Urodela). In the reptiles the pancreas is much like that of the amphibians but usually it retains three openings into the intestine (as it arises from three diverticula one dorsal, two ventral). In some only one opening is present and in others many. The pancreas of the birds is also similar in origin and position. In the adult it has only one duct or (sometimes) two opening into the duodenum.

The pancreas in mammals may be compact or diffuse to a varying degree. In rodents, for instance, it is diffuse consisting of several lobes. In many mammals two ducts persist, the ventral forming the main pancreatic duct (Wirsung's duct), the dorsal the accessory (or Santorini's) duct. The ducts may remain distinct or they may unite before opening into the intestine or one of them may unite with the bile duct. In most mammals the pancreatic duct opens into the anterior section of duodenum, in others it may be far removed from the pylorus.

Comparision. Digestive glands 1. Liver & Pancreas.

Characters	*Scoliodon* (Dogfish)	*Rana* (Frog)	*Uromastix* (Spiny-tailed lizard)	*Columba* (Pigeon)	*Oryctolagus* (Rabbit)
3. Pancreas	Compact, bilobed whitish gland between cardiac and pyloric stomachs. A single pancreatic duct opens into proximal end of intestine.	Highly branched, irregular, cream coloured gland lying between stomach and duodenum. Small pancreatic ducts open into bile duct.	Elongated, narrow, white coloured gland between pyloric stomach and duodenum. A single pancreatic duct opens directly into duodenum.	Band-like, narrow pinkish gland between the two limbs of duodenum. Three pancreatic ducts open separately into distal limb of duodenum.	Irregular, diffused pinkish gland surrounded by duodenal loops. A single pancreatic duct leads into the distal end of duodenum.
4. Liver	Large, bilobed, yellowish gland in abdominal cavity.	Large, 3-lobed reddish brown gland.	Large, bilobed, dark red coloured gland. Right lobe extends up to gonad.	Large, compact, bilobed dark red coloured gland. Right lobe larger.	Large, 5-lobed-right and left, left lateral, caudate and spigelian lobes, and red coloured.
5. Gall bladder	V-shaped, thin-walled attached to right liver lobe in which bile is collected from both the liver lobes. A single bile duct from gall bladder opens into the beginning of intestine.	Large, spherical, greenish situated ventrally between two main lobes of liver. Cystic ducts from gall bladder and hepatic ducts from liver join to form bile duct which receives several pancreatic ducts to	A spherical gall bladder present between right and left lobes of liver ventrally. Two bile ducts open separately into duodenum.	Absent. Two separate bile ducts start from liver to open separately in the proximal and distal limbs of duodenum.	Elongated, dark green coloured gall bladder found ventrally in the posterior part of right central lobe of liver. A cystic duct from gall bladder meets with several hepatic ducts from liver to form a

from hepatopan creatic duct. that opens into duo

common bile duct, that opens into proximal of duodenum with constriction

Scanned by CamScanner

Comparitive account of Alimentary Canal of Vertebrates (frog , pigeon & rabbit)

ALIMENTARY CANAL OF VERTEBRATES

The alimentary canal is a continuous passage starting from the mouth and ending at the anus which carries food through different parts of the digestive system and allows waste to exit the body. The alimentary canal varies widely in organism, but is only seen in organism which are *bilaterally symmetrical*. Various sections of the alimentary canal contain cells which secrete digestive enzymes, allowing food to be broken down. Other specialized cells allow for the absorption of materials into the body. In human and other highly complex animals, the alimentary canal is organized into specialized tissues and organs. These organs and tissues were derived from the alimentary canal of our earliest ancestors, which likely consisted of a simple tube connecting the mouth and anus.

ALIMENTARY CANAL ORGANS

The organs present in the alimentary canal vary widely between groups of organisms. Some organisms have no well defined organs or tissues in their alimentary canal, while other have many unique structures. Starting from the mouth, a membrane lined tube connects the mouth to the *esophagus*, which is called the *pharynx*. The pharynx has evolved a number of functions in different animals, from housing the gills to providing a structure for filter feeding. Typically, the alimentary canal then continues through the esophagus, which carries food to the *stomach*. Some animals, such as *ruminants*, have multiple stomachs which carry different enzymes and microbiomes to process different parts of their food. After the stomach, food typically passes into the *small intestine*, which is responsible for extracting the newly freed nutrients into the body, as well as continuing the breakdown of foods. The configuration and arrangement of the small intestine can vary widely, but it usually ends by dumping its contents into the *large intestine*. The large intestine functions within the alimentary canal to remove excess water and any remaining nutrients from the food being processed. By the end of the large intestine, only waste and indigestible material remains, and is excreted as stool. The alimentary canal ends at the *anus*, where waste is excreted into the environment.

Other groups of animals, such as birds, have an entirely different arrangement of organs in the alimentary canal, and contain structures not seen in humans. For example, birds often have a *gizzard*, which is a muscular organ used to grind food before it enters the stomach.

Table 33.11. Comparison : Digestive System of Vertebrate Types

Characters	*Scoliodon* (Dogfish)	*Rana* (Frog)	*Uromastix* (Spiny-tailed lizard)	*Columba* (Pigeon)	*Oryctolagus* (Rabbit)
			ALIMENTARY CANAL		
1. Parts of alimentary canal	It consists of buccal cavity, pharynx, oesophagus, stomach, intestine and cloaca	It consists of buccal cavity, pharynx, oesophagus, stomach, intestine and cloaca.	It consists of buccal cavity, pharynx, oesophagus, stomach, intestine and cloaca	It consists of buccal cavity, pharynx, oesophagus, stomach, intestine and cloaca	It consists of buccal cavity, pharynx, oesophagus, stomach, intestine and anus. Cloaca is absent.
2. Mouth opening	Small, crescentic at the ventral side of head, bounded by jaws and leads into buccal cavity.	Wide, terminal, horizontal, semicircular along the anterior end of head, bounded by jaws and leads into buccal cavity.	Wide, terminal along the anterior end of head, semicircular, bounded by jaws and leads into buccal cavity.	Terminal, wide slit-like aperture bounded by horny beaks and leads into buccal cavity.	Transverse, slit-like subterminal aperture at the snout, bounded by jaws and leads into buccal cavity.
3. Jaws and lips	Lower jaw movable, lips absent.	Lower jaw movable, lips hard and immovable, scaleless.	Lower jaw movable, lips hard immovable and scales present.	Lower jaw movable, lips absent, beaks cover the jaws.	Lower jaw movable, lips present, fleshy and hairy. Upper lip cleft bearing vibrissae.
Buccal cavity	Dorsoventrally flattened and spacious.	Wide and large.	Narrow anteriorly and broad posteriorly.	Somewhat triangular and narrow.	Large, spacious and wide.

Characters	*Scoliodon* (Dogfish)	*Rana* (Frog)	*Uromastix* (Spiny-tailed lizard)	*Columba* (Pigeon)	*Oryctolagus* (Rabbit)
(i) Vestibule	Absent.	Absent.	Absent.	Absent.	Narrow space between lips, cheeks and jaws is called vestibule in which mouth opens.
(ii) Teeth	Homodont ; similar, directed backwardly, several rows on the skin covering jaws and are replaced several times during life time (polyphyodont). These are modified placoid scales. Used in grasping prey.	Small, conical teeth present on upper jaw only in one row, attached to jaw bones (acrodont), homodont and polyphyodont, used in holding the prey.	Teeth small, conical, acrodont and pleurodont present on both the jaws in a single row, used in grasping and holding the prey.	Teeth not found.	Teeth of several types on both the jaws (heterodont), embedded with their roots in the sockets of jaws (thecodont) and are replaced once in life time (diphyodont), used in cutting, holding and masticating the food.
(iii) Diastema	Absent.	Absent.	Absent.	Absent.	Diastema, a toothless space between incisor and premolar, characteristic.
(iv) Palate	Absent, skull forms the roof of buccal cavity.	Absent, skull forms the roof of buccal cavity.	Absent, skull forms the roof of buccal cavity.	Palate incompletely developed.	Palate developed, separates the nasal passage from food

Characters	*Scoliodon* (Dogfish)	*Rana* (Frog)	*Uromastix* (Spiny-tailed lizard)	*Columba* (Pigeon)	*Oryctolagus* (Rabbit)
					passage, hence, forms the roof of buccal cavity.
(v) Tongue	The so called tongue is thick, flat, non-muscular, non-glandular and non-protrusible fold of mucous membrane at the base of buccal cavity. Not used in food capture and taste buds also absent.	Large, muscular, sticky, attached anteriorly and free posteriorly which is notched to form two lobes. Protrusible, used in capturing prey and bears few taste buds.	Large, muscular, glandular, attached midventrally free anteriorly which is bifid and protrusible covered with papillae having taste buds.	Large, narrow, triangular attached ventrally and non-protrusible covered with horny processes and few taste buds.	Large, muscular, attached mid-ventrally and grooved mid-dorsally. Anterior tip free, protrusible and covered with four kinds of papillae having taste buds.
(vi) Internal nares	Absent.	Two small openings on the roof of buccal cavity in front of vomerine teeth.	Two small rounded openings near the anterior end on the roof of buccal cavity.	Two small slit-like openings situated at the posterior end of buccal cavity or pharynx.	Both the nostrils open into a nasal passage which opens posterior to buccal cavity into the pharynx.
(vii) Pharynx	Posterior region of buccal cavity represents pharynx.	Posterior region of buccal cavity represents short pharynx.	Posterior region of buccal cavity represents a broad pharynx.	Buccal cavity merges behind into pharyngeal cavity.	Pharynx is short at the posterior end of buccal cavity and differentiated into

Characters	*Scoliodon* (Dogfish)	*Rana* (Frog)	*Uromastix* (Spiny-tailed lizard)	*Columba* (Pigeon)	*Oryctolagus* (Rabbit)
					nasopharynx, oro-pharynx and laryn-gopharynx.
(viii) Eustachian opening	Absent.	A pair of wide eustachian openings lie on the roof, one on either side laterally near jaw angles.	A pair of eustachian openings lie, one on either side of roof.	Single eustachian opening in the middle of roof behind internal nares.	Sides of nasopharyngeal wall are pierced by a pair of oval eustachian openings.
(ix) Glottis	Since there is neither trachea nor lungs, hence, it is absent.	Median slit-like opening in the bucco-pharyngeal cavity leading into laryngo-tracheal chamber.	Median slit-like opening leading into trachea.	Oval opening on the floor of pharynx which leads into trachea.	Median vertical slit-like opening in the floor of laryngo-pharynx.
(x) Epiglottis	Absent.	Absent.	Absent.	Absent.	Bilobed cartilaginous flap or epiglottis guards glottis against food entering into it.
(xi) Other bucco-pharyngeal structures	Mucous lining of the pharynx contains dermal denticles.	Floor of pharynx in males only contains an opening of vocal sac on either lateral	Mucous lining of the pharynx is thrown out into distensible longitudinal folds.	Nasal passages open through internal nares into the roof of the pharynx.	Nasal passages open through internal nares into roof of the laryngo-pharynx.

Characters	*Scoliodon* (Dogfish)	*Rana* (Frog)	*Uromastix* (Spiny-tailed lizard)	*Columba* (Pigeon)	*Oryctolagus* (Rabbit)
		side near jaw angles. Eye balls bulge internally on the roof into buccal cavity.			
5. Oesophagus	Short, wide tube with thick muscular wall having longitudinal mucous folds. Opens into cardiac stomach with a sphincter or oesophageal valve.	Short, wide, highly distensible with prominent longitudinal folds and not demarcated from pharynx and stomach.	Long, narrow muscular tube with mucous folds and highly distensible.	Long wide, distensible, muscular, thick-walled tube. At the base of neck, it expands into a thin-walled, bilobed elastic sac called crop or food-reservoir.	Long, narrow, elastic muscular tube of uniform diameter. No crop and opens into stomach.
6. Stomach	Long, muscular, U-shaped, divisible into proximal broad cardiac part and short distal pyloric part. The junction is marked by a blind sac and a sphincter valve. Cardiac part has well developed longitudinal mucous folds.	Large, broad, curved, muscular sac on the left side in the body cavity. Proximal cardiac and distal pyloric parts not marked off externally. Blind sac and sphincter valve absent.	Long, curved, muscular tube on the left side in the body cavity. Not demarcated into cardiac and pyloric parts externally but cardiac part possesses well developed longitudinal muscular folds.	Represented by an anterior narrow tube-like glandular proventriculus and a posterior broad, thick-walled muscular gizzard.	Large, sac-like bean-shaped on the left side in the abdominal cavity lying transversely and differentiated into cardiac, fundic and pyloric parts.

Characters	*Scoliodon* (Dogfish)	*Rana* (Frog)	*Uromastix* (Spiny-tailed lizard)	*Columba* (Pigeon)	*Oryctolagus* (Rabbit)
	longitudinal mucous folds.				
7. Bursa entiana and gizzard	Bursa entiana is a small, thick-walled muscular sac at the distal end of pyloric stomach through which it opens into intestine. No gizzard.	Neither bursa entiana nor gizzard.	Neither bursa entiana nor gizzard.	Bursa entiana absent but a well developed, muscular gizzard present which contains stone grits to help in grinding the food.	Bursa entiana and gizzard absent.
8. Intestine	Straight, short and wide tube. Not differentiated into small and large intestines.	Coiled, long and narrow tube, differentiated into small and large intestines.	Coiled, long and narrow tube, differentiated into small and large intestines.	Coiled, long and narrow tube differentiated into small and large intestines.	Coiled, long and narrow tube differentiated into small and large intestines.
(i) Small intestine	Not differentiated.	Differentiated into duodenum and ileum.	Duodenum and ileum well marked.	Duodenum and ileum well differentiated.	Duodenum and ileum well marked.
(a) Duodenum	Absent.	Straight tube, forms "U" with stomach, receives hepato-pancreatic duct.	Straight tube, receives separate ducts from pancreas and gall bladder.	U-shaped tube, receives two ducts from liver and 3 ducts from pancreas.	U-shaped loop-like, receives one duct each from pancreas and gall bladder.
(b) Ileum	Not distinct. Internal mucous lining is folded into a longi-	Small and coiled. Mucous lining forms several longi-	Long and coiled. Mucous lining forms folds but spiral valve	Long and coiled. Inner mucous lining projects into several	Very long and coiled. Villi numerous and well deve-

Characters	*Scoliodon* (Dogfish)	*Rana* (Frog)	*Uromastix* (Spiny-tailed lizard)	*Columba* (Pigeon)	*Oryctolagus* (Rabbit)
	tudinal spiral or scroll valve. Villi absent.	tudinal folds. True villi absent. No spiral valve.	and true villi absent.	small finger-like villi. No spiral valve.	loped but no spiral valve.
(c) Accessory structures					
(i) Sacculus rotundus	Absent.	Absent.	Absent.	Absent.	Ileum at its distal end expanded to form sacculus rotundus.
(ii) Caecum	Absent.	Absent.	Junction of small and large intestines bear a large caecum and an ileocolic valve.	Junction is marked by the presence of a pair of short rectal caeca.	Large, tubular, spirally constricted caecum present into which sacculus rotundus opens through ileo-caecal valve.
(iii) Vermiform appendix	Absent.	Absent.	Absent.	Absent.	Caecum ends distally into a blind vermiform appendix.

Characters	*Scoliodon* (Dogfish)	*Rana* (Frog)	*Uromastix* (Spiny-tailed lizard)	*Columba* (Pigeon)	*Oryctolagus* (Rabbit)
9. Large intestine	Distal end of intestine forms a short rectum which opens into cloaca.	Short and broad rectum opens into cloaca.	Represented by thin-walled narrow colon and thick-walled broad rectum opening into cloaca.	Represented by a short but broad rectum only which leads into cloaca.	Long and consists of anterior sacculated colon and a posterior beaded rectum.
10. Rectal glands	Rectum receives a tubular rectal gland of unknown function dorsally.	Absent.	Absent.	Absent.	Absent.
11. Cloaca and associated structures	Rectum opens into simple cloaca through anus guarded by anal sphincter. It contains urinogenital apertures, a pair of abdominal pores from peritoneal coelom.	Single sac-like cloaca into which rectum opens by anus. It contains urinogenital apertures. Abdominal pores not found.	Rectum opens into 3 linear chambers forming cloaca ; coprodaeum, urodaeum and proctodaeum. Anal sphincter present but abdominal pores not found.	Rectum opens into cloaca by anus guarded by anal sphincter. Cloaca 3 chambered as in lizard. Abdominal pores not found. In young birds only a thick-walled small pouch called bursa Fabrici present dorsally on proctodaeum.	Cloaca absent. Rectum opens directly to outside by anus having anal sphincter. Abdominal pores and bursa Fabrici not found.

Comparitive account of Alimentary Canal of Vertebrates (frog , pigeon & rabbit)

ALIMENTARY CANAL OF VERTEBRATES

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ALIMENTARY CANAL ORGANS

The organs present in the alimentary canal vary widely between groups of organisms. Some organisms have no well-defined organs or tissues in their alimentary canal, while other have many unique structures. Starting from the mouth, a membrane lined tube connects the mouth to the *esophagus*, which is called the *pharynx*. The pharynx has evolved a number of functions in different animals, from housing the gills to providing a structure for filter feeding. Typically, the alimentary canal then continues through the esophagus, which carries food to the *stomach*. Some animals, such as *ruminants*, have multiple stomachs which carry different enzymes and microbiomes to process different parts of their food. After the stomach, food typically passes into the *small intestine*, which is responsible for extracting the newly freed nutrients into the body, as well as continuing the breakdown of foods. The configuration and arrangement of the small intestine can vary widely, but it usually ends by dumping its contents into the *large intestine*. The large intestine functions within the alimentary canal to remove excess water and any remaining nutrients from the food being processed. By the end of the large intestine, only waste and indigestible material remains, and is excreted as stool. The alimentary canal ends at the *anus*, where waste is excreted into the environment.
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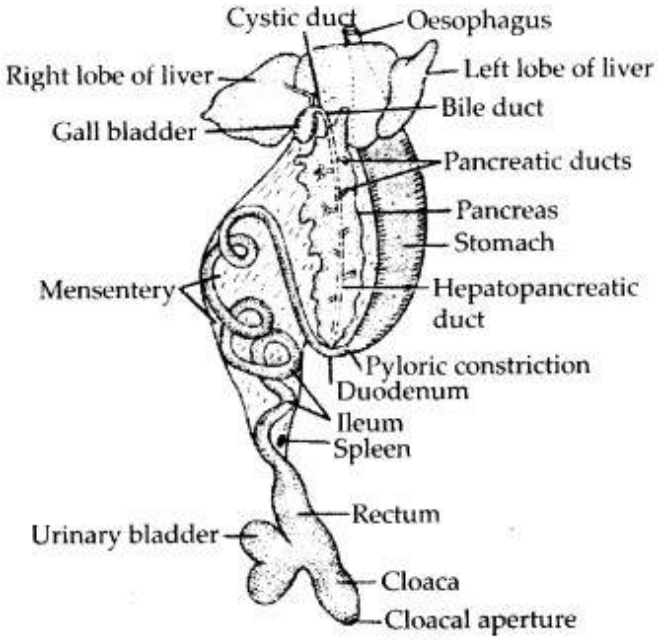


Fig.: Alimentary canal of frog.

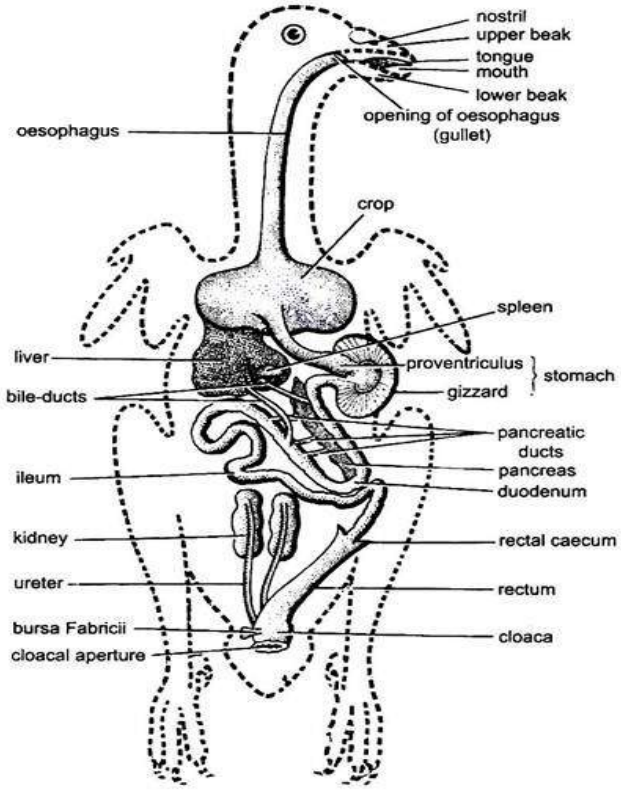
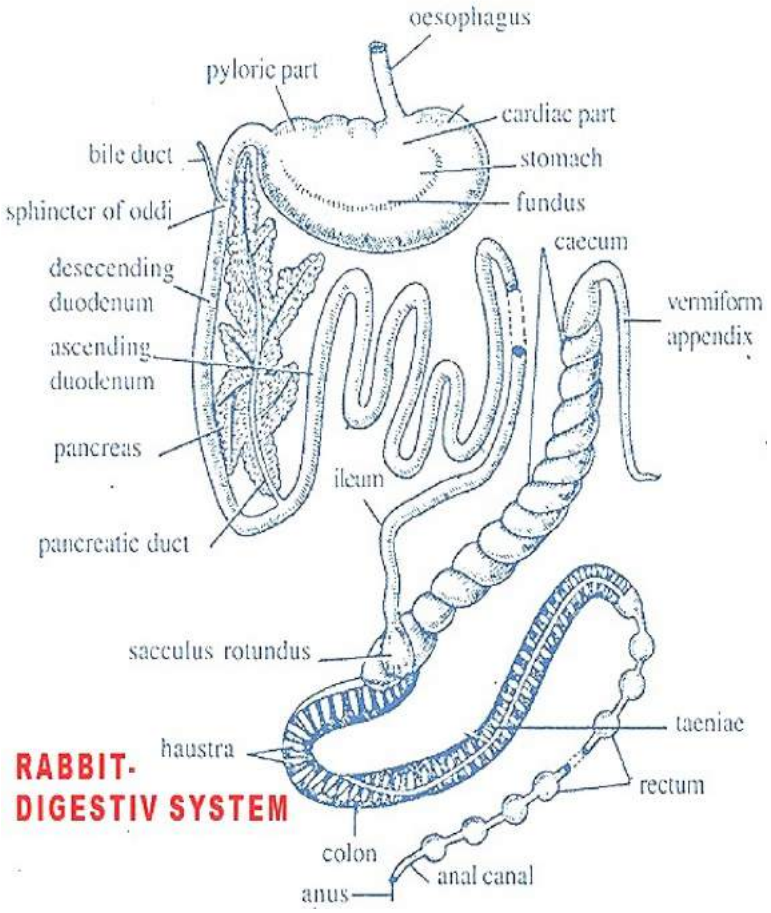


Fig. 26.28. Pigeon. Alimentary canal.



Rabbit alimentary canal

Comparative account of digestive gland – Pancreas and Liver in different vertebrates (fish to mammal)

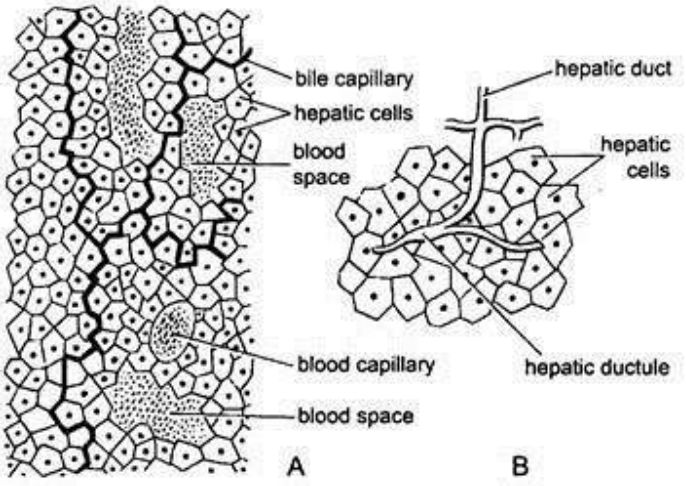


Fig. 18.23. Frog. T.S. of liver. A–A part of section; B–Showing hepatic ductule.

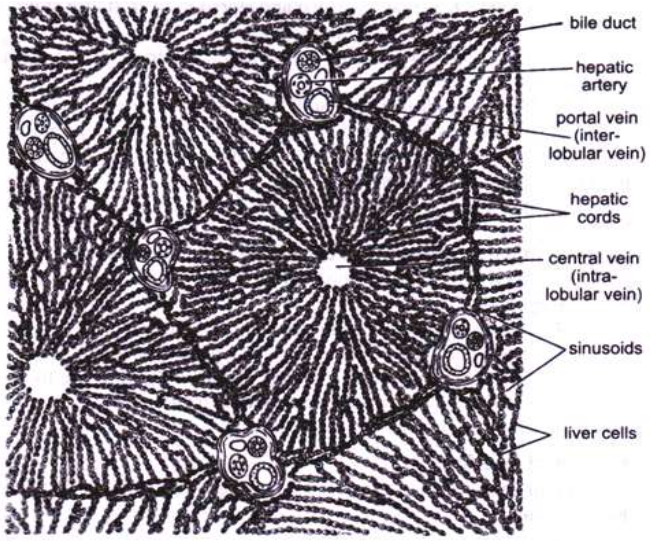


Fig. 29.34. Rabbit. T.S. of liver.

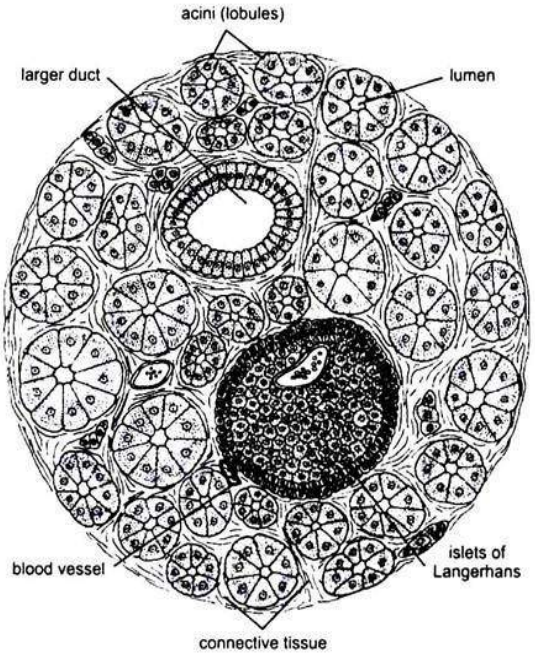


Fig. 29.33. Rabbit. T.S. of pancreas.

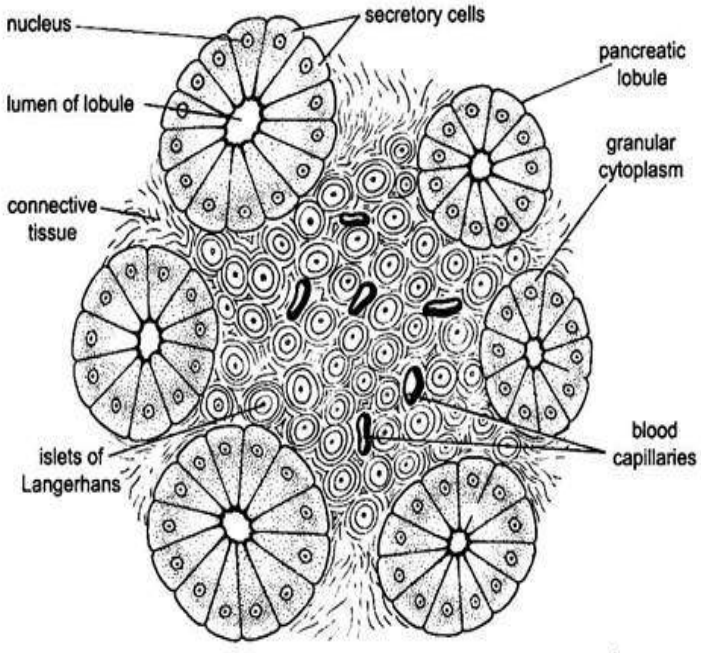


Fig. 18.24. Frog. T.S. of pancreas.

Department of Zoology,SSCASC,Tumakuru

II SEMESTER ZOOLOGY

2.7 PAPER II- COMPARATIVE ANATOMY AND DEVELOPMENTAL BIOLOGY OF VERTEBRATES

COMPARATIVE ANATOMY OF BRAIN:

Brain of vertebrates from fish to human being built with same basic plan. But however the form of brain in different vertebrates varies with the habits and behaviour of the animal.

BRAIN OF SHARK OR FISH:

- The brain of shark is more advanced than that of protochordates. The brain is enclosed in a chondocranium of the skull. The brain of shark is elongated and flattened.
- The brain is surrounded and protected by single membrane called meninx primitiva.
- The brain of shark consists of fore brain, mid brain and hind brain.
- **Fore brain consists of olfactory lobe, cerebrum and diencephalon**.
- From anterolateral sides of cerebrum arises olfactory peduncle which terminates into bilobed olfactory lobe having olfactory sac. The olfactory lobe helps in detecting sense smell.
- Cerebrum is not divided into cerebral hemispheres.
- Diencephalon is short, small covered dorsally by cerebellum
- Pineal body is found on the dorsal roof of the diencephalon and ventral to it is pituitary gland.
- Optic chaisma is found in front of the infundibulum.
- **Mid brain consists of two hollow large optic lobes covered by cerebellum**.
- **Hind brain consists of cerebellum and medulla oblongata**.
- Cerebellum is large and consists of three lobes which over lap mid brain and diencephalon.
- Medulla oblongata forms the last part of the brain which continues posteriorly as spinal cord.
- The brain of shark provided with 10 pairs of cranial nerves and the number of spinal nerves corresponds to number of vertebra.

BRAIN OF FROG

- The brain of frog is elongated and flattened. The brain is enclosed in a cranium of the skull.
- The brain is surrounded and protected by meninges called outer duramater and inner piamater. The space between these two membranes filled with cerebrospinal fluid.
- The brain of frog consists of fore brain, mid brain and hind brain.
- **Fore brain consists of olfactory lobe, cerebral hemisphere and diencephalon**.
- The olfactory lobes are placed in front of the cerebral hemispheres and fused in the median line.
- Cerebrum is large and divided into right and left cerebral hemispheres by median fissure.
- Diencephalon is rhomboidal in shape, but cerebellum does not cover dorsally.

- Pineal body is found above the skull. Pituitary gland found on the ventral region of the Diencephalon.
- Optic chaisma is found in front of the infundibulum.
- **Mid brain consists of two hollow large optic lobes which are uncovered**.
- Below the optic lobes there is crura cerebri.
- **Hind brain consists of cerebellum and medulla oblongata**.
- Cerebellum is small narrow and undivided.
- Medulla oblongata forms the last part of the brain which continues posteriorly as spinal cord.
- The brain of frog provided with 10 pairs of cranial nerves and nine pairs of spinal nerves.

BRAIN OF PIGEON OR BIRD

- The brain of bird is comparatively larger and more complex. The brain is enclosed in a cranium of the skull.
- The brain is surrounded and protected by meninges called outer duramater and inner pia arachniod membrane. The space between these two membranes filled with cerebrospinal fluid.
- The brain of bird consists of fore brain, mid brain and hind brain.
- **Fore brain consists of olfactory lobe, cerebral hemisphere and diencephalon**.
- The olfactory lobes are placed in front of the cerebral hemispheres and poorly developed.
- Cerebrum is large and divided into right and left cerebral hemispheres by sagittal fissure.
- Diencephalon is covered by cerebral hemisphere and cerebellum.
- Pineal body is small. Pituitary gland found on the ventral region of the Diencephalon.
- Optic chaisma is found in front of the infundibulum.
- **Mid brain consists of two hollow large optic lobes**.
- The optic lobes are connected by transverse optic commissure**.**
- **Hind brain consists of cerebellum and medulla oblongata**.
- Cerebellum is large and divided into median vermis and two lateral flocuuli.
- Medulla oblongata forms the last part of the brain which continues posteriorly as spinal cord.
- The brain of bird provided with 12 pairs of cranial nerves and the number of spinal nerves corresponds to number of vertebra.

BRAIN OF MAMMAL [RABBIT]

- The brain of mammal is larger and more complex and highly specialized. The brain is enclosed in a cranium of the skull.
- The brain is surrounded and protected by meninges called outer duramater, middle arachnoid mater and inner pia mater. The space between arachnoid mater and pia mater filled with cerebrospinal fluid.
- The brain of mammal consists of fore brain, mid brain and hind brain.

- **Fore brain consists of olfactory lobe, cerebral hemisphere and diencephalon**.
- The olfactory lobes are placed in front of the cerebral hemispheres. Each olfactory lobe consists of olfactory bulb and olfactory tract.
- Cerebrum is large and divided into right and left cerebral hemispheres by median longitudinal fissure. Each cerebral hemisphere further divided into frontal and temporal lobe by sylvian fissure. The cerebral hemispheres are held ventrally by corpus callosum.
- Diencephalon is narrow, triangular and covered by the extension of cerebral hemisphere.
- Pineal body is small and round. Optic chaisma is found in front of the infundibulum.
- **Mid brain consists of optic lobes**.
- There are four optic lobes which are called corpora quadrigemina. A pair of thick nervefibres called crura cerebri found on ventral region of the optic lobes which is connecting diencephalon with medulla oblongata.
- **Hind brain consists of cerebellum and medulla oblongata**.
- Cerebellum is large, elongated and divided into five lobes median vermis, two lateral lobes and two flocuuli.
- Medulla oblongata forms the last part of the brain which continues posteriorly as spinal cord.
- The brain of mammal provided with 12 pairs of cranial nerves and 31 pairs of spinal nerves.

Unit:7.2 TYPES OF RECEPTORS

Receptors or Sense organs are present in the body to detect the environmental changes and internal changes. All animals have sense organs for touch, smell, taste ,sight and hearing. Internal receptors detect temperature, pain, hunger, thirst etc.

Following are different types of receptors.

- Tango receptors
- Gusto receptors
- Olfactory receptors
- Stato receptors

Tango receptors (Organ of touch):

Tango receptor receives the stimulus of touch, they are also called the organ of touch **or** they are called as cutaneous receptors.it includes

1. Free nerve endings
2. Basket nerve endings
3. Encapsulated nerve endings

Free nerve endings: They are fine branches of the nerve cells (neuron), occurs in the skin in the hairy parts of the body, especially in the epidermis.

Basket nerve endings: these are the fine branches of neurons and these branches form a network of basket around the hair follicles. They receive the stimuli when a hair is touched or bent. They are present in the hairy parts of the skin.

Encapsulated nerve endings: these are found in the hair less parts of the skin. Especially on dermis. Each encapsulated nerve ending consists of an axon with its branches surrounded by a connective tissues capsule.
The encapsulated nerve endings are of various types. They are Merkles capsule, Meissner's capsule, Paccinian corpuscles.
Working of tango receptors: when the hair or the skin comes to contact with an object the nerve endings are stimulated, it creates impulse in the nerves. The impulses carried by the nerves to the cerebral hemisphere. Tango receptors receive the humidity, temperature, chemicals, pressure and pain.

Gusto receptors (organs of taste)

Gusto receptors receive the taste stimuli. They are situated on the tongue and soft palate. The taste receptor cells are arranged in groups called taste buds. Each taste bud is situated on the papilla of tongue. A taste bud is oval in shape, and consists of two types of cells namely receptor cells and supporting cells.
The receptor cells are long, narrow and spindle shaped. The outer free end of the receptor cell contains a sensory hair and the inner end of the receptor cell is connected to the nerve fibres which are connected to VII or IX cranial nerve.

The supporting cells are long and narrow but lack of sensory hairs and nerves. Each tongue bud open out by a taste pore on the surface of the tongue.

Working of gusto receptors: when the taste bud comes in contact with food, the hairs in the taste buds are stimulated. In the nerve fibres the stimuli are converted into impulse which is carried to the cerebral hemisphere .

Olfactoreceptors (Organ of stimuli)

Olfactoreceptors are chemoreceptor consists of a pair of olfactory sacs and a pair of jacobsons organs. The receptor cells for smell lies at the roof of the olfactory sacs. The roof

of the olfactory sacs has a layer of epithelium. The epithelium consists of two types of cells namely olfactory cells and the supporting cells.
The olfactory cell is a long narrow spindle shaped cells. The outer end of the cells bears numerous olfactory hairs. The inner end is connected to a nerve fibre which is connected to the olfactory lobe of brain.The supporting cells are columnar cells occurring between the olfactory cells.

Working: Olfactory organ is very sensitive compared to taste buds. It can receives the stimulus produced by any chemicals.

Jacobson's Organs: It is present in the roof of buccal cavity of Amphibians, Reptiles etc. It is lined with olfactory epithelium and effectively smells the content of the mouth.

Stato receptors (Organ of equilibrium)

Stato receptors are called as organs of equilibrium because it helps to maintain the balance and posture of the body. This equilibrium is maintained by all vertebrates and is brought about by the maculae and cristae of internal ear.

Maculae: are sensory spots present inside the vestibule of internal ear. There are two maculae in each ear, they are Macula utriculus and Macula sacculi.
Each macula consists of a group of receptor cells and supporting cells. One end of the receptor cell is connected to the auditory nerve. The free end of the receptor cell bears frw hairs like non-vibrate sensory processes. The sensor process of receptor cells are partly embedded in gelatinous mass called cupule, secreted by the supporting cells. A tiny calcareous particle called Otolith occurs among the sensory hairs. Whenever the position of the head is changed the Otolith exerts pressure on the sensory hairs.

Working: when the body is tilted, the otolith of the inner ear stimulates the hairs. Thus an impulse produces and carried to the brain through VIII cranial nerve. The brain responds by causing appropriate muscles to contract thus bringing the body back to its original position.

Implantation of Embryo:

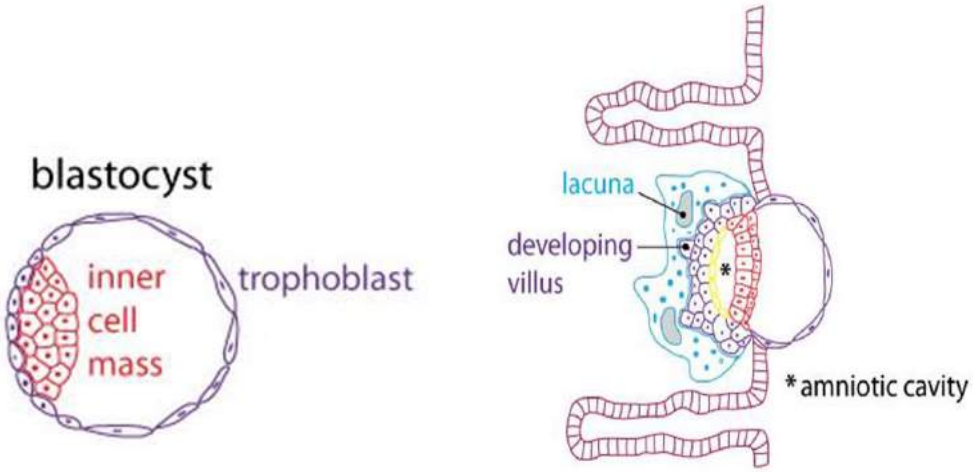
The process of attachment of the blastocyst to the wall of the uterus (endometrium) is called implementation. It occurs about 7th day after fertilization. During implantation the trophoblast cells of blastocyst producess certain proteolytic enzymes which dissolves a small area of the endometrium, this creates a depression in the endometrium.

During its transit in the fallopian tube, the bastocyst remains embeded within the zona pellucida. The zona pellucida protects the embryo and prevents implantation in the fallopian tube. An important step that allows implantation is the release of the embryo from the zona pellucida .

During this first week before implantation, the blastula undergoes cleavage, that is, cell divisions without growth. The implantation stage is known as a blastocyst. A blastocyst consists of roughly 70-100 cells, which have differentiated into two cell types:

Trophoblast--a tightly adherent layer of cells forming the outside of the blastocyst,inner cell mass--a group of rounded, internally located cells.

The trophoblast will give rise to extra-embryonic structures, notably the chorion, which is the fetal part of the placenta. The inner cell mass will give rise to the embryo.



Once the blastocyst is released from the zona pellucida, it very readily implants because the trophoblast is quite sticky. Implantation is initiated when the trophoblast adheres to the surface of the endometrium. This stimulates proliferation of the trophoblast cells, which will divide into two parts: a syncytial trophoblast and a cellular trophoblast. The syncytial trophoblast is a syncytium, meaning there are multiple nuclei but no cell membranes. The syncytial trophoblast is invasive, secreting proteolytic enzymes that allow the blastocyst to penetrate into the endometrium. Digestion of the endometrial tissue creates spaces known as lacunae. The proliferating cellular trophoblast forms branched structures, known as chorionic villi (singular: chorionic villus). Note that the developing embryo forms a disc that pulls away from the proliferating trophoblast to create a new space. This will eventually develop into the amniotic cavity, a fluid-filled space that will surround the developing fetus.

The syncytial trophoblast produces the hormone chorionic gonadotropin. Detection of this hormone in the urine is the basis for pregnancy tests. Chorionic gonadotropin is an analogue of luteinizing hormone (LH), meaning it binds and stimulates the LH receptor. Chorionic

gonadotropin is necessary to stimulate and maintain the corpus luteum, which is the primary source of estrogen and progesterone in the first trimester of pregnancy.Once trophoblast completely embedded in endometrium and villi , implantion is completed.

Hormonal control of Implantation :

- **Role of oestrogen**: these are the group of hormones mainly secreted by follicular epithelial cells of graffian follicle of Ovary. Secretion of oestrogens is stimulated by **FSH** of anterior lobe of pituitary gland, stimulates the uterine endometrial epithelium to enlarge become more vascular and more glandular.
  The stimulation by the oestrogen on the uterus generally occurs on the 4th day of implementation.
  Estrogen regulates the synthesis of specific proteins, which acts as a enzymes to activate the blastocyst for implementation. Oestrogen stimulates the uterine endometrium to undergo decidual cell reaction essential for implementation.

- **Progesterone:** it is secreted by the yellow coloured gland called corpus luteum .The secretion is stimulated by **LH** of anterior lobe of pituitary gland.
  Progesterone stimulates the proliferation of endometrium of uterus and prepare it for implantation. It also helps in implantation, placenta formation and normal development of the foetus in uterus.

Formation of Human Placenta:

Placenta is a special kind of tissue connection between the uterine wall of the mother and foetal membranes of the embryo. It takes place in two processes.

a. Pre-villous stage

b. Villous stage

During Pre-villous stage, the trophoblast cells of the blastocyst which are in connect with the uterine wall secrete proteolytic enzymes these enzymes destroy the endometrium of the uterine wall. The embryo slowly move down into the connective and vascular tissues of uterus.The opening of the lining of uterus is closed by blood clot & then by the overgrowth of epithelial cells. The trophoblast multiply to form 2 layers the inner **cryptotrophoblast** and outer **Syncytial trophoblast.** The enzymes of trophoblast destroy the maternal capillaries.The blood from these capillaries comes in direct contact with trophoblast and provides nutrition.

During Villous stage, the extra embryonic membrane called **Chorion** that surrounds the trophoblast produces finger like projections called **villi** that penetrate into the uterine wall. Later on the villi penetrated from **Allantois** form connective tissues & blood vessels of the

foetal placenta. These Allanto-Chorionic villi become highly vascular and connect with uterine wall. This finger like structure of embryo and the uterine wall of the mother is called **placenta** and the process of formation of placenta is known as **placentation.**

Hence Human placentas consist of foetal blood capillaries, foetal connective tissues, chorionic & allantois villi, uterine epithelium, Uterine Connective tissues & maternal blood capillaries.

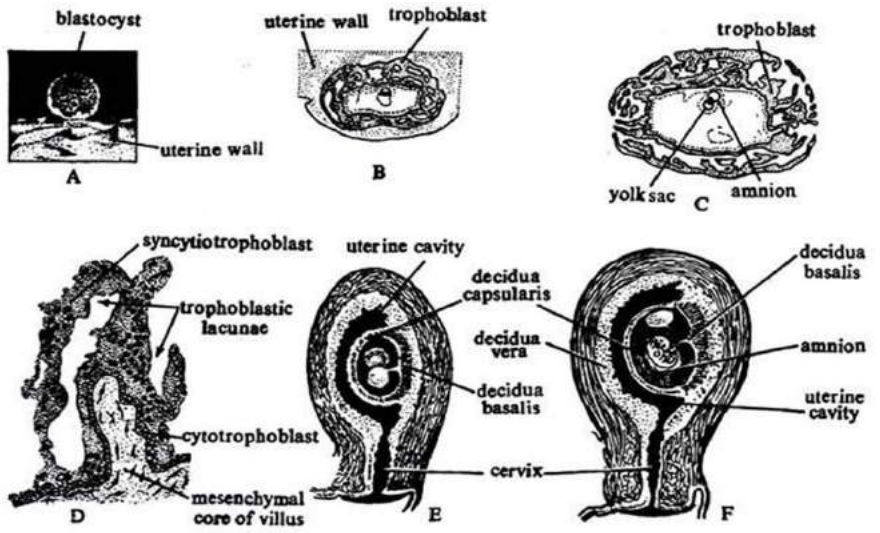


Fig. 5.46. Showing the development of placenta in human (contd.). A. Surface view of the implantation site of a human blastocyst. B. Sectional view of blastocyst of about 12 days which is engulfed completely inside the endometrium. C. Sectional view of embryonic vesicle of about 13–15 days. Note the presence of trophoblastic lacunae. D. Formation of secondary villus. E. Sectional view of uterus along with the developing embryo of 4 weeks old. F. Sectional view of six weeks old embryo. Note the disappearance of villi at one side and elaboration of villi on chorion frondosum (after various sources).

Metamorphic events in frog life cycle:

Metamorphosis is the gradual transformation of larva into an adult .It involves changes in habit, habitat, morphology, Physiology and behaviour of larva.

In anuran, progressive metamorphosis takes place. During metamorphosis the larva(tadpole) undergoes various ecological, morphological and biochemical changes.

1. Ecological changes -

The tadpole is an aquatic larva, the adult is a terrestrial being. So during the metamorphosis there is a transition from aquatic to terrestrial life. The Tadpole is herbivorous but the adult is carnivorous.

2. Morphological changes –

During metamorphosis tremendous changes take place on the structural organization of the tadpole. There are 3 types changes can found in morphological

changes. They are a) Regressive changes b) progressive changes and c) some organs which exist in both in larva and adult.

a) Regressive changes – certain structures of the tadpole are not essential for the adult. Hence they degenerate and disappear. These changes are the regressive changes. The following are the regressive changes in tadpoles:

- The tail and fin-folds are completely reabsorbed.
- The gills are reabsorbed
- The lateral line sense organ disappears.
- The ventral suckers disappear.
- The mouth changes its shape.

b) Progressive changes – Certain structures develop and become functional only during and after metamorphosis. These constitute progressive changes.

- The limbs develop progressively and undergoes differentiation.
- The middle ear develops. The tympanic membrane and tympanic cartilage also develop.
- The eyes protrude out and they develop eyelids and the nictitating membrane.
- The tongue develops.
- Heart become three chambered

C) Organs which exist in both in larva and adult – The organs which function both in larva and adult, but change their differentiation during metamorphosis are primarily the skin, the intestine and the brain.

- During metamorphosis the skin thickens and an insoluble protein called keratin develops in its outer layer. The skin becomes less sensitive to evaporation and to mechanical injury.

-Intestine, which is very long in tadpoles, as the tadpole changes into a carnivores adult, the intestine becomes shortened and straight.

3. Biochemical changes and physiological changes – during metamorphosis, tremendous physiological and biochemical changes take place. They are summarized as follows:

a) Excretion – the tadpole is **ammonootelic.** The adult frog is **ureotelic**.

B) **Haemoglobin** – the tadpole's haemoglobin binds oxygen more readily while the frog haemoglobin binds with oxygen less readily. The haemoglobin in the tadpole does not contain **cysteine,** while the frog haemoglobin contains cysteine. So cysteine is added to the haemoglobin during metamorphosis. Etc.

Hormonal control of amphibian metamorphosis

Secretions of the two hormones **thyroxine (T4)** and **tri-iodothyronine(T3**) cause metamorphic changes. Hormones have different effects depending on location in body. These hormones act on the tissue directly causing the degeneration and necrosis of some cells and stimulating the growth and differentiation of others.

The initial signal for metamorphosis is given by hypothalamus present in the brain. It contains certain specialised nerve fibres called **neurosecretory nerve fibres.**

The nerve fibres secrete a chemical substance called **neurosecretion**. It contains a factor called **thyrotropin releasing factor (TRF).** It is transported to the pituitary gland through the **median eminence** present between hypothalamus and the pituitary gland.

The TRF of neurosecretion stimulates the **pituitary gland** to secrete another hormones called **thyroid stimulating hormone (TSH).** This hormone acts on the thyroid gland to secrete another hormones called **thyroxine(T4)** and **Tri-iodothyronine(T3).** These hormones acts on the tissues directly causing the degeneration and necrosis of some cells and stimulating the

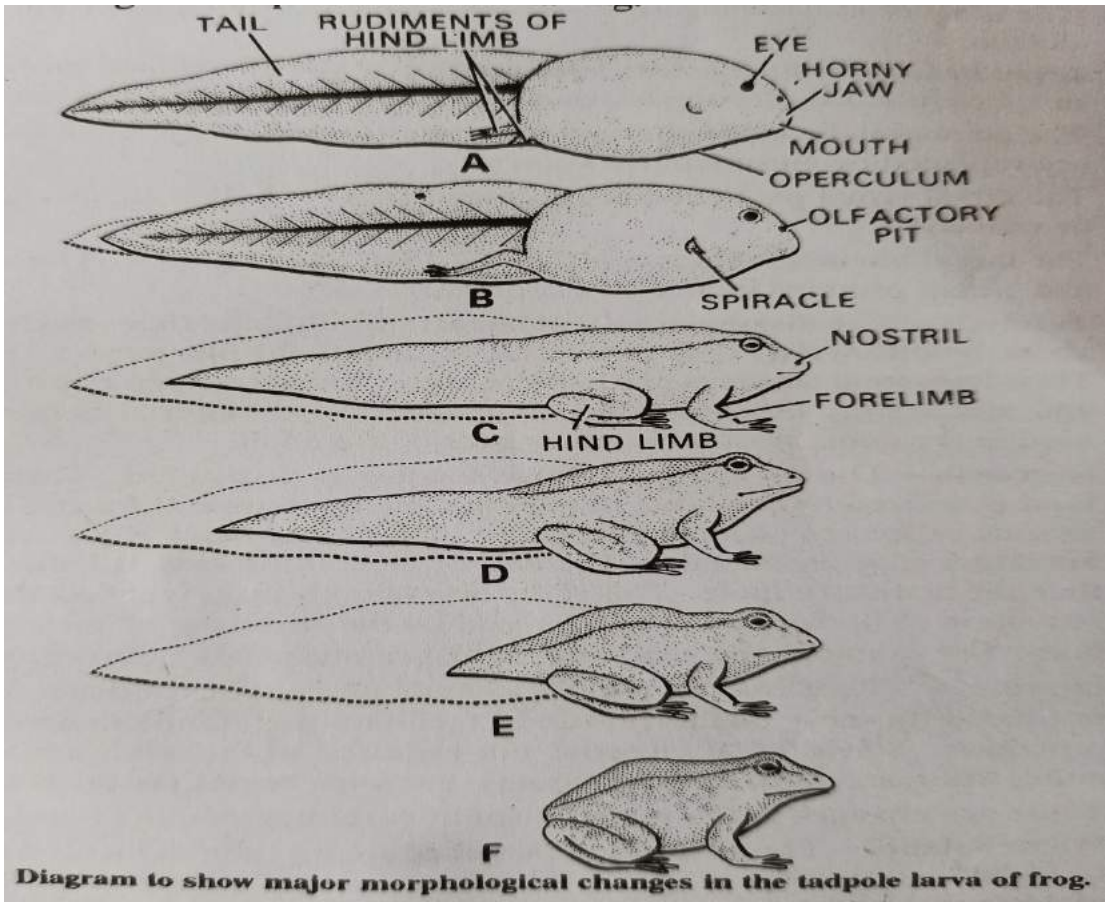


Diagram to show major morphological changes in the tadpole larva of frog.

growth and differentiation of others.

GASTRULATION IN FROG

The process of transformation of blastula into gastrula is called Gastrulation.

During gastrulation single layered blastula converts into three layered blastula by a series of dynamic cellular movements

MORPHOGENETIC MOVEMENTS

The dynamic cellular movements involving the reorganization and rearrangement of cells (blastomeres) during gastrulation are called morphogenetic movements. These movements leads to the formation of future or presumptive germ layers like ectoderm, mesoderm, endoderm

Types of morphogenetic movements occurs during Gastrulation

1. **Epiboly :-** it is a type of morphogenetic movement where the cells of epidermal ectoderm(micromeres) multiply and spread all over the embryo and covering the macromeres, except at the blatopore. Due to the epiboly some of the yolk filled macromeres projecting out of the blastopore temporarily, this is called yolk plug and stage is called yolk plug stage.

Or

It is also defined as the process of overgrowth of micromeres on the macromeres.

2. **Emboly:-** it is a type of marphogenetic movement occur during gastrulation where cells(blastomerers) move into the interior from the surface.

Emboly represents inward movement of blastomeres or ingrowth

Invagination – It is defined as the active infolding or inpushing of blastomeres (macromeres) on one side of the blastula.

In frog, invagination takes place just below the grey cresent invagination results in the development of a new cavity called archenteron or gastrocoel. The invaginated cells occupy the floor and lateral side of archenteron, which forms endodermis.

The gastrocoel opens outside through the opening called blastopore. The margins of the blastopore are called lips, the dorsal margin is called dorsal lip, ventral margin is called ventral lip and lateral margin is called lateral lip

- **Convergence:-** it is defined as the directional movement of micromeres towards a particular point that is towards the dorsal lip of the blastopore.

During convergence micromeres at the animal pole proliferated and migrate towards the dorsal lip.

- **Involution ("rolling in" movements):-** It is inward rolling or rotation of the micromeres near the dorsal lip of blastomere into the gastrocoel. The involuted micromere occupy the roof

of the gatrocoel and forms chorda mesoderm. The involution of micromeres enlarges the size of the gastrocoel . as the gastrocoel enlarges, the size of the blastocoels reduces, finally the blastocoels disappear.

- **Divergence :-** it is the spreading movement of involuted blastomeres(micromeres) from the point of involution(i.e tip of the blastopore) with in the wall of the archenteron.
- **Extension :-** It is the stretching of the converging notochordal and mesodermal cells in the gastrula.

Due to epiboly, some of the yolk filled macromeres projecting out of the blastopore temporarily. This is called yolk plug and the stage is called yolk plug stage.

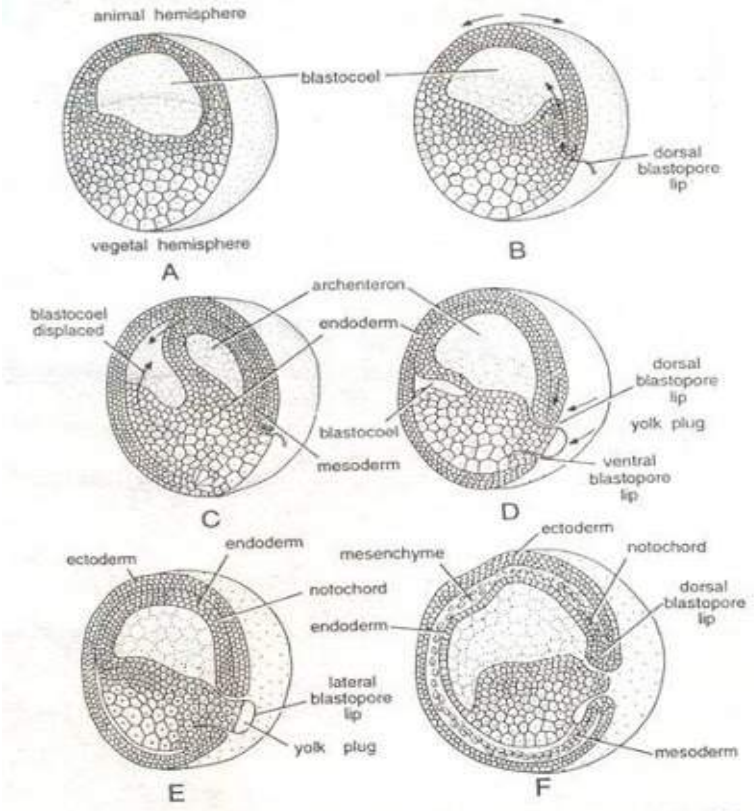


Fig. 15. Gastrulation in frog. A-Late Blastula, B-Beginning of gastrulation, C & D-middle gastrula stages, E & F-Late gastrula stages.

Gastrulation Process in Frog

STRUCTURE OF GASTRULA

Gastrula is a three layered embryo consists of 3 germ layeres namely Ectoderm, Mesoderm and Endoderm

A mature gastrula is oval in shape.

The cavity of gastrula is called Archenteron.

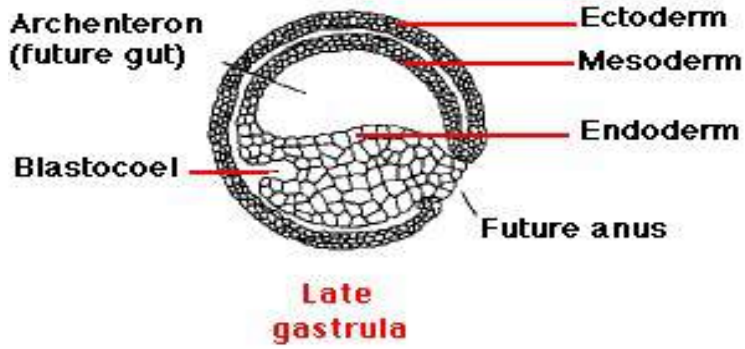
The archenteron opens exterior by blastopore, the blastopore has dorsal, ventral and lateral lip.

The blastopore is plugged by the yolk plug. It is composed of yolky macromeres.

The surface of gastrula is composed of micromeres this forms the ectoderm. The mid dorsal line of micromeres forms the neurectoderm and the remaining ectoderm forms epidermal ectoderm.

The roof of the archenteron is composed of micromeres which forms the chorda mesoderm. The floor of the archenteron composed of yolky macromeres which forms ectoderm.

In between the ectoderm and endoderm there is a layer of mesoderm is present. It is formed by the cells which involuted at the ventral and lateral lip of the blastopore.



GATRULATION IN CHICK

Gatrulation in chick is highly prolonged and modified due to the presence of large amount of yolk. Gastrular movement (morphogenetic movement) are responsible for formation of embryonic membranes

- **Formation of endoderm or Hypoblast**

Presumptive endoderm or hypoblast is formed during gastrulation by the delamination of large yolk cells from the inner surface of epiblast. These form a distinct layer in the subgerminal cavity above the yolk

- **Formation of Mesoderm**

The cells of notochord and mesoderm migrate inward and form a layer in between the epiblast and hypoblast. These movements are leads

in the form of primitive streak. Thus the three embryonic layers are established the uppermost or epiblast now forms the ectoderm, the median layer mesoderm and the lower one endoderm.

- **Formation of primitive streak**

The endoderm is migrated to the definite position, the central area of blastoderm is left with prospective somatic mesoderm, prechordal mesoderm, neurectoderm and the epidermal ectoderm.

- **Formation of initial primitive streak**

Later mesoderm begins to converge towards the middle line from a point about a quarter of the way from the anterior end of area pellucida (epiblast) towards the growth centre in the posterior quadrant to initiate in the formation of a thickening called the primitive streak

By the twelth hour the intermediate streak is formed is about one half the length of the circulared area pellucida, it continoues to grow in length, elongated backward and its posterior end. The oval area pellucid becomes pear shaped to accommodate the lengthening streak.

- **Formation of definite primitive streak**

By the 19^{th} hour of incubation there is forward stretching of primitive streak.

This primitive streak contains the presumptive lateral plate mesoderm, prechordal mesoderm and notochordal materials. The movements in the blastoderm leading to the formation of primitive streak may be called pregastrulation movements.

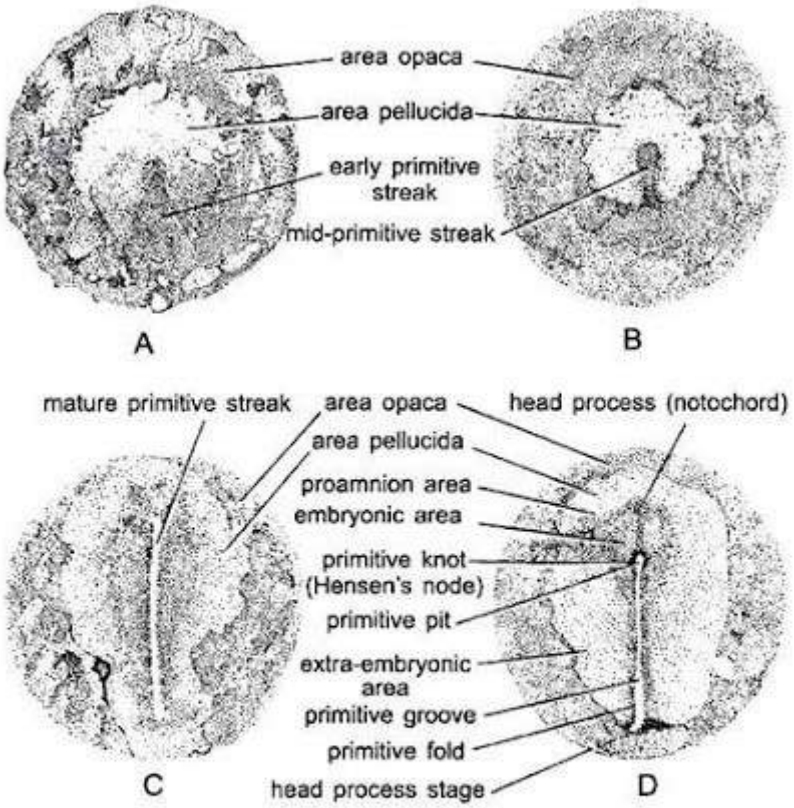


Fig. 38.5. Surface view of chick blastoderm showing development of primitive streak (gastrulation) and head process (neurulation). A–Initial streak (stage 2); B–Intermediate streak (stage 3); C–Definitive streak (stage 4); D–Head process stage (stage 5 embryo of 19 to 22 hours of incubation).

NEURULATION IN FROG EMBRYO

The formation of neural tube (neutralization) and its further differentiated into brain, spinal cord and different sensory organs such as olfactory (nose), optic(eye) and auditory(ear) organs, are collectively included in the process of neurogenesis.

The process of neurulation, specifically is the process of neural tube formation. In frog it includes following processes all of which occur in a simultaneous manner

Neural tube formation

At the end of gastrulation, when the yolk plug finally disappear and the blastopore closes to a dorso ventral slit soon afterward the presumptive area of the nervous system become differentiated from

the rest of ectoderm in the form of pear shaped medullary or neural plate

The ectodermal epithelium moves towards the dorsal side of the embryo, at the same time the cells of neural plate changes its shape become elongated and arranged them selves into a columnar epithelium

During this process the embryo lengthens along its anteroposterior axis, at the same time the edges of the neural plate become thickened and raised above the general level as ridges called neural fold.

The neural folds become higher, so that the neural area contained between them forms a wide neural groove. Subsequently, the neural folds meet each other in dorsal middle line and fuse, in this way the neural tube is formed.

Finally some regionalization becomes visible in the neural tube with sub division of the brain into prosencephalon (fore brain) mesencephalon (mid brain) rhombencephalon(hind brain).

- **Tabulation of chorda- mesoderm**

At the time of the closure of the blastopore the chorda – mesodermal mantle seperates itself from the endoderm and the mesoderm attains its definite position between the endoderm and ectoderm.

Formation of Notochord

After the speration prechordal plate from endoderm a narrow rod of cells, the remainings of notochord seperates from the rest of the chorda-mesodermal mantle.

Shortly after fluid- containing vacuoles appears in the notochordal cells.

- **Differentiation of mesoderm**

Simultaneously the tip of mesoderm at each side of the notochord thickens and subdivides in transverse plane beginning at the end into a series of cell masses or somites.

- **Tubulation of Endoderm**

As neurulation begins the free margin of the endoderm unite in the dorsal middle line beneath the notochord to complete the formation of the definitive gut (enteros). The floor of the enteron has thick yolk filled cells. Later the lungs, liver and pancreas develop from evaginations from the gut.

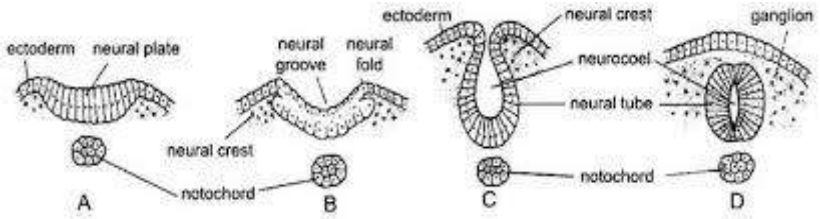


Fig. 37.7. Stages in the formation of neural tube in amphibians.

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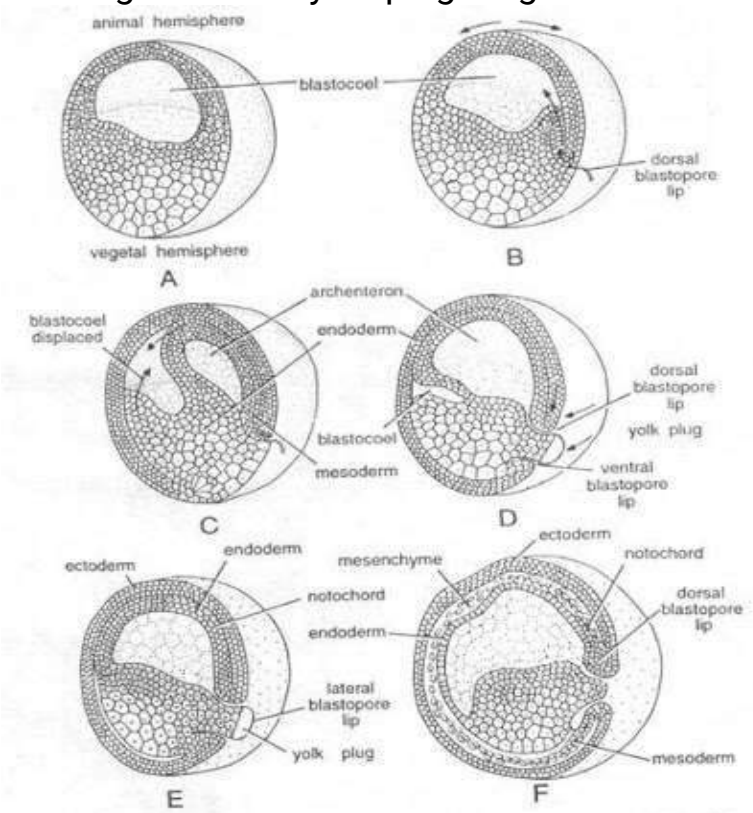

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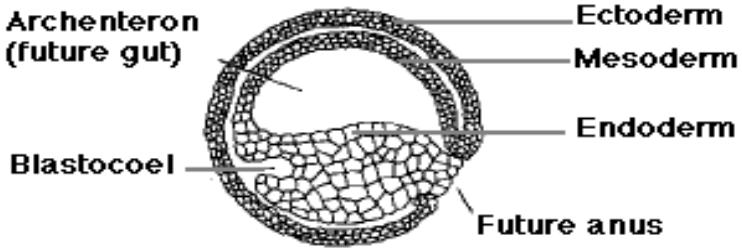
The roof of the archenteron is composed of micromeres which forms the chorda mesoderm. The floor of the archenteron composed of yolky macromeres which forms ectoderm.

In between the ectoderm and endoderm there is a layer of mesoderm is present. It is formed by the cells which involuted at the ventral and lateral lip of the blastopore.



Late gastrula

GATRULATION IN CHICK

Gatrulation in chick is highly prolonged and modified due to the presence of large amount of yolk. Gastrular movement (morphogenetic movement) are responsible for formation of embryonic membranes

- Formation of endoderm or Hypoblast

Presumptive endoderm or hypoblast is formed during gastrulation by the delamination of large yolk cells from the

inner surface of epiblast. These form a distinct layer in the subgerminal cavity above the yolk

- Formation of Mesoderm

The cells of notochord and mesoderm migrate inward and form a layer in between the epiblast and hypoblast. These movements are leads in the form of primitive streak. Thus the three embryonic layers are established the uppermost or epiblast now forms the ectoderm, the median layer mesoderm and the lower one endoderm.

- Formation of primitive streak

The endoderm is migrated to the definite position, the central area of blastoderm is left with prospective somatic mesoderm, prechordal mesoderm, neurectoderm and the epidermal ectoderm.

- o Formation of initial primitive streak

Later mesoderm begins to converge towards the middle line from a point about a quarter of the way from the anterior end of area pellucida (epiblast) towards the growth centre in the posterior quadrant to initiate in the formation of a thickening called the primitive streak

By the twelth hour the intermediate streak is formed is about one half the length of the circulared area pellucida, it continoues to grow in length, elongated backward and its posterior end. The oval area pellucid becomes pear shaped to accommodate the lengthening streak.

- o Formation of definite primitive streak

By the 19^{th} hour of incubation there is forward stretching of primitive streak.

This primitive streak contains the presumptive lateral plate mesoderm, prechordal mesoderm and notochordal materials. The movements in the blastoderm leading to the formation of primitive streak may be called pregastrulation movements.

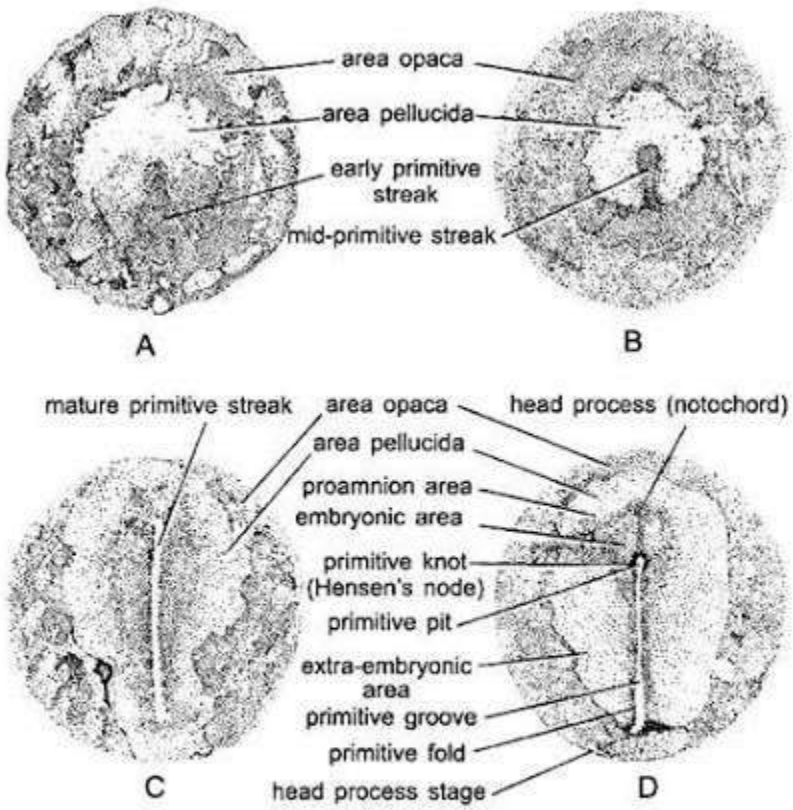


Fig. 38.5. Surface view of chick blastoderm showing development of primitive streak (gastrulation) and head process (neurulation). A–Initial streak (stage 2); B–Intermediate streak (stage 3); C–Definitive streak (stage 4); D–Head process stage (stage 5 embryo of 19 to 22 hours of incubation).

NEURULATION IN FROG EMBRYO

The formation of neural tube (neutralization) and its further differentiated into brain, spinal cord and different sensory organs such as olfactory (nose), optic(eye) and auditory(ear) organs, are collectively included in the process of neurogenesis.

The process of neurulation, specifically is the process of neural tube formation. In frog it includes following processes all of which occur in a simultaneous manner

Neural tube formation

At the end of gastrulation, when the yolk plug finally disappear and the blastopore closes to a dorso ventral slit soon

afterward the presumptive area of the nervous system become differentiated from the rest of ectoderm in the form of pear shaped medullary or neural plate

The ectodermal epithelium moves towards the dorsal side of the embryo, at the same time the cells of neural plate changes its shape become elongated and arranged them selves into a columnar epithelium

During this process the embryo lengthens along its anteroposterior axis, at the same time the edges of the neural plate become thickened and raised above the general level as ridges called neural fold.

The neural folds become higher, so that the neural area contained between them forms a wide neural groove. Subsequently, the neural folds meet each other in dorsal middle line and fuse, in this way the neural tube is formed.

Finally some regionalization becomes visible in the neural tube with sub division of the brain into prosencephalon (fore brain) mesencephalon (mid brain) rhombencephalon(hind brain).

- **Tabulation of chorda- mesoderm**

At the time of the closure of the blastopore the chorda – mesodermal mantle seperates itself from the endoderm and the mesoderm attains its definite position between the endoderm and ectoderm.

Formation of Notochord

After the speration prechordal plate from endoderm a narrow rod of cells, the remainings of notochord seperates from the rest of the chorda-mesodermal mantle.

Shortly after fluid- containing vacuoles appears in the notochordal cells.

- **Differentiation of mesoderm**

Simultaneously the tip of mesoderm at each side of the notochord thickens and subdivides in transverse plane beginning at the end into a series of cell masses or somites.

- **Tubulation of Endoderm**

As neurulation begins the free margin of the endoderm unite in the dorsal middle line beneath the notochord to complete the formation of the definitive gut (enteros). The floor of the enteron has thick yolk filled cells. Later the lungs, liver and pancreas develop from evaginations from the gut.

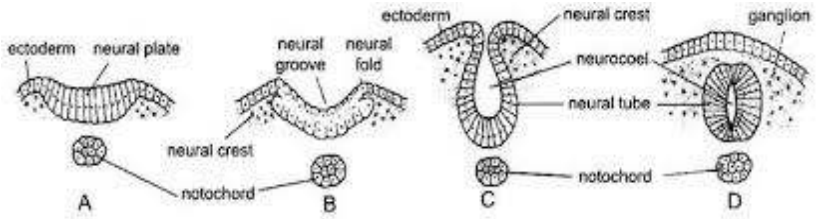


Fig. 37.7. Stages in the formation of neural tube in amphibians.

Unit-8 Dairy

A dairy is a business enterprise established for the harvesting or processing of animal milk mostly from cows or goats, but also from buffaloes, sheep, horses or camels for human consumption. With industrialization and urbanization the supply of milk become a commercial industry with specialized breeds of cattle being developed for dairy as distinct from beef or draught animals.

Most countries produce their own milk products, the structure of the dairy industry where is in different parts of the world in major milk producing countries most milk is distributed through whole sale markets.

Composition of milk and nutritive value of milk

Milk is produced by mammary gland. Its secretion is stimulated by prolactin in the mother at the time of birth of a calf (young one) adrenal hormone is also essential for lactation.

Milk is an emulsion of fat in a continuous phase. The dispersed phase consists of fat globule of varied diameter. Fat content varies from 0.1 to 10%.

The fat globules are surrounded by layers of protein phospholipids carotenes and cholesterol. This layer prevents the globules from coalescing together into large globules, protective layer may be broken by churning when the fat globules coalesce to form butter.

Milk /fat/ butter consists of glycerides of butyric caproic acid and capric acids. Which posses characteristic odour. The continuous aqueous phase consists of Carbohydrates(lactose) and a colloidal suspension of casein, stabilized by lactalbumin and lactoglobulin.

Lactose form the largest constituent of milk next only two water, fat soluble vitamins and water soluble minerals are present along the milk.

Amylase, catalase, peroxidase, lipase, phosphotase, galactase, lactase and aldehydase are important for the enzymes. These enzymes are destroyed due to pasteurization.

The white appearance of milk in reflected light and its opacity in transmitted light is due to emulsified fat and the colloidal calcium phosphate and caseinate.

Creamy colour is due to the presence of Keratin in the dispersed phase and of riboflavin in aqueous phase.

The flavour of milk is pleasant and sweet. Milk containing 3.5% fat and rich in lactose has a butter flavour.

constituent	Sindhi	Buffalo
Water	86.07	83.63
Fat	4.90	6.55
Protein	3.42	3.38
Lactose	4.91	5.23
Minerals	0.70	1.21

Nutritional value of milk

Milk is a complete food for infants up to 6 months of age. After which acts as a supplement to other food. Milk is a good source of phosphorus calcium and vitamins.

Cow milk is easily digestible, 50% of its caloric value is contributed by fat, 20% by lactose and 21% by protein. Milk is rich in vitamin A, D, B1 and B2.

Milk is rich in enzymes like amylase, catalase, peroxidase, lipase, phosphotase, galactase, lactase and aldehydase.

Proteins like lactalbumin, lactoglobulin which are also antibodies are Richey present. The additives like phospholipids, carotene, cholesterol are present.

Milk sugar like lactose a disaccharide constituents about 4 to 7% of milk, its hydrolysis gives glucose and galactose.

Milk consists of fat of about 4 to 7% called butter fat composed of triglycerides. Milk protein like cascin , globulins, immunoglobulins, proteases and peptones.

salts like, calcium chloride, citrate, sulphate and bicarbonate of sodium and potassium are present there are also traces of iron and copper.

Cattle breeds

A breed is group of one species of animals, which have the same descent and are similar in body shape, size and structure.
Examples: Amrithmahal, Kangayan, Malvi, Siri, Hallikar, Khillari etc..

Indigenous Draught breeds of cattle

Draft breed:

Hallikar:- They are breeds mainly meant for transport and field work.

- Originated from the former princely state of
- Vijayanagaram, presently part of Karnataka.
- The colour is grey or dark grey.
- Compact, muscular and medium size animal with prominent forehead, long horns and strong legs.
- The breed is best known for its draught capacity and especially for its trotting ability.
- Both bulls and cows have horns.
- The cows are average milk producers and an average can produce about 542kg of milk/lactation.
- Green fodder, chiefly comprises finger millet, grass sorghum or pearl millet.

uses

- The bulls are known for their strength and endurance and are primarily used for draft purposes.
- Along with normal draught purpose, the Breed is also used for cart racing.
- It is considered as one of the premier draft cattle breeds in India. That cows are always milkers.

Red Sindhi (Milch breed)

Examples: Gir, Red sindhi, Sahival and

Deoni.

They are breeds mainly meant for milk production.

- This breed is otherwise called as Red Karachi and Sindhi and Mahi.
- Originated in Hyderabad and Karachi (Pakistan) regions of undivided India and also reared in certain organized farms in our country.
- Colour is red with shades varying from dark red to light, strips of white.
- Milk yield ranges from 1250 to 1800 kgs per lactation.
- Bullocks despite lethargic and slow can be used for road and field work.
- They having short, curved, lyre shaped horns.
- The bulls are usually of a darker colour than the cows.
- The heritability for milk yield is 0.30 to 0.35.
- Age of first calving is 39 to 50 months. Calving interval is 425 to 540 days.

Uses

- It has been used to improve beef and dual purpose cattle in many tropical countries.
- High milk production helps give a fast growing cough which is ready for market at 1year.
- Cross breeding method is commonly used for improving cattle breeds. It is used for producing more yield of milk

Ongole (dual purpose breeds)

Examples: Hariana, ongole,etc..

They are used for both work and production of milk.

- Otherwise known as Nellore.
- Home tract is Ongoletaluk in Guntur district of Andhra Pradesh.
- Large muscular breed with a well developed hump.
- Suitable for heavy draught work.
- White or light grey in colour.
- Average milk yield is 1000 kgs per lactation.
- Animals of the Ongole breed were extensively exported to USA for beef production and also Brazil for beef and milk, Sri Lanka for drought etc..
- The Breed produces moderate milk with an average of 798 kg per lactation.
- In average fat percentage is about 3.79 percent.

uses

- The bulls commonly used in bull fight due to their strength and aggressiveness in Mexico.
- Tthey are also used for traditional fight in Andhra Pradesh and tamilnadu.
- Angole cattle were the first Indian breed of cattle to gain worldwide recognition.
- Ongole cows stay close to their calves to protect them from Predatory animals.

Exotic dairy breed:

They are breeds originated outside india and then imported to our country.
Examples: Holstein, Ayrshire and Redden etc..

Holstein Friesian

- Originated from the northern parts of Netherlands, especially in the province of Friesland.
- Largest dairy breed and ruggedly built is shape and possess large udder.
- Breeds have typical marking of black and white that make them easily distinguishable.
- The average milk production of cow is 6000 to 7000 kg per lactation.
- The adult males and females about 800 to 900 kg and 500 26 50 kg respectively.
- The healthy calf weighs 40 to 50 kg or more at birth.
- Generally breeders plan for HF to calve for the first time between 21 and 24 months of age.
  The gestation period is about 9 and half month.
  Breeders important specialised Dairy holstein from the United States to cross with the European black and whites.
  Uses
  It is an adult purpose breed, used for both dairy and beef.
  The exotic breed of cattle are high milk production.

Red Dane (Danish red)

Orginated in Denmark.

- Body colour of this Danish breed is red, reddish brown or even dark brown.
- It is also a heavy breed.
- The lactation yield of Red Dane cattle varies from 3000 to 4000 kg.
- They having great heat tolerance.
- It having fat content is about 4% and above.
- The calving interval 13 months.
- Both bulls and cows usually may have small horns.
- This breed is disease resistant and we'll adopted to varying climates.
- Mature males weighing up to 950kg and mature female is about 600kg.

Uses

The Danish red cattle are a dual purpose animal.

They are raised for both milk and meat production.

Buffalo breeds

Examples: Murray, Jaffrabadi, Bhadawari, Niki Ravi, surti, Nagpur.

Surti: Also known as Deccani, Gujarati, Talabda, Charator and Nadiadi.

- The breeding tract of this breed is Kaira and Baroda district of Gujarat.
- Coat colour varies from rusty brown to silver-grey.
- Tail is fairly long and back is straight.
- The horns are sickle shaped, moderately long and flat.
- The peculiarity of the breed is two white collars, one round the jaw and the other at the brisket region
- The milk yield ranges from 1000 to 1300 kgs per lactation.

The peculiarity of this breed is very high fat percentage in milk (8-12%)

Uses

They are mainly used for milk production purpose.

The bullocks are used for good light work.

Nagpuri

- This breed is also called as Elitchpuri or Barari.
- The breeding tract of this breed is Nagpur, Akola and Amarawati districts of Maharashtra.
- These are black coloured animal with white patches on face, legs and tail.
- The horns are long, flat and curved, bending backward on each side of the back. (Swaord shaped horns).
- The bullocks can be used for heavy work.
- The milk yield ranges from 700 to 1200 kgs per lactation.
- The age at first calving is 45 to 50 months with an intercalving period of 450 to 550 days.
- It is an central Indian breed.
- They having 7.7% of fat soluble in milk.
- These breeds are slow movement and less active.
  Uses
  It is very good for milk production.
  Male animals are used for draft purposes but it works slow than bull.

Diseases in Cattle

Mastitis is the inflammation of the memory gland and udder tissue and is a major endemic disease of dairy cattle.

It is most often transmitted by contact with the milking machine and through contaminated hands or other materials.

causes

It is a multifactorial disease, since the infectious infection depends on germs, environmental conditions and the characteristics of the cow. The microorganisms invade the tissue breast causing on inflammation of the gland.they are caused by two types of mastitis,

1)contagious mastitis:

This is caused by microorganisms Streptococcus agalactiae and staphylococcus aureus. They are transmitted during milking through contaminated milking machinery. the caof or the improper handling by the workers it caused a reduced to level of milk.

2) environmental mastitis:

This is caused by microorganisms environmental streptococci and coliforms. They are transmitted between period of milling and dry periods when the gland does not produce milk.

Symptoms:

This is an inflammation of the affected udders the animals feel pain when touched.

The milk is altered and blood is sometimes seen as well as flakes, clots and colourless puas.

Fever, lower milk production and loss of appetite.

The microbial count and somatic cell is high.

Diagnosis:

The milk sample are collected and conducted the following tests,

Somatic cell count

Bacterial culture of milk and other test.

Treatment:

Treatment depends on the cause of the microorganisms and whether it is subclinical are clinical this can be done using intramammary antimicrobials.

Prevention:

Teat disinfection before and after milking

good hygiene during milk in period

good milking machine for also used

call out a veterinarian to take information

given a good nutrition, water and quality bedding to the cattles

good ventilation clean and dry tests

keeping cows standing after milking.

Anthrax:

Anthrax is an acute disease having rapidly fatal course. it is the oldest disease known in the cattle disease. It is characterized by septicemia and sudden death.

Causes

The causative agent of this disease is bacillus anthracis.

the organisms is a relatively large, rod-shaped and non motile.

the animals get infection by ingestion of food and directly from animal to animal.

Symptoms

Shivering fits with rise of temperature the temperature of animal body go up to 106 degree fahrenheit.

Rumination stops, eye become red, extremities get cold

breathing is difficult

abdominal pain and tympanites

dung is stained with blood and rectum protrudes

bloody discharge from mouth nostrils and rectum. the discharge is tarry in colour

the animal dies within 24 hours, if the disease is in acute form.

Treatment

The treatment is usually not possible in acute cases but subacute cases are treated with antibiotics and antianthrax serum.

Penillin and streptomycin in large doses are recommended

Annual vaccination of the animals recommended in the endemic areas.

Prevention:

Good hygiene is the most important single factor in the prevention of spread of Anthrax

destruction of contaminated material and disinfection of equipments and animal shed are is also necessary vaccination in endemic areas is very important to control the diseases

as the population of disease causing organisms takes place in the presence of oxygen, the vegetative forms present in the tissues and body Fluids will die if the caracass is not open but is burnt or buried deep with lime.

Septicemia:

It is also called hemorrhagic septicemia.

this is mainly occurs in cattle and buffaloes and also goats, camels, Horses and donkeys

it is a severe bacterial diseases.

Causes:

The causative agent of this disease is starting stains of pasteurella multicoda

the diseases is spread through contact with infected animals, contaminated clothing, equipments and through injection or inhalation of bacteria.

The animals under stress or with poor body condition are believed to be more susceptible to p.multicoda infection.

Symptoms:

The infected diseases swollen neck and lower jaw

leathArgy, reluctant to move

nasal discharge

painful or difficulty breathing

excesive salivation , fever and finally become death.

Treatment:

The antibiotics is only effective when administered early

several of the sulfonamides and antibiotics such as penicillin and the tetracyclines can be used successfully in the early stages.

animals with elevated temperatures are isolated and treated intravenously with a soluble sulfonamide.

Diagnosis:

Diagnosis on the basis of blood smear and clinical findings.

Prevention:

Maintaining hurts in good physical condition and bearing the entry of animals

vaccination for haemorrhagic septicaemia is available

when favourable conditions for outbreaks are known to recur periodically.

In endemic areas the only practical ways to protect animals are by an organised program of vaccination.

Foot and mouth diseases:

It is Viral disease and it is highly communicable disease affecting cloven footed animals. it is characterized by fever, formation of blisters in tile mouth, udder, teats and on the skin between toes and above the hoofs.

in India the diseases widespread and assumes a position of importance in livestock industry.

causes

the disease is caused by a virus called foot and mouth disease virus.

it is spread by direct contact or indirectly through infected water, mannure, hay and pastures.

it is also conveyed by cattle attendants

the virus and gains entry into the bloodstream of animals through injury to the lining membranes of tongue intestine, clefts of hoofs and other similar parts.

Symptoms:

Rise of body temperature, dry muscle, dullness, depression, shivering, staring coat, loss of appetite and stoppage of rumination.

slight constipation

dribbling of saliva from tile mouth.

formation of blisters on the tongue and cheeks.

shaking and kicking of legs and lameless.

Vesicles at the cleft of the hoof become ulcer like and may get fly blown.

the milk is comes down in quantity and quality and the milk coagulates on boiling

the infected animals cannot be put to hard work especially in the sun and it gasps from breath a condition known as panting.

Treatment:

No therapeutic agents have been found till now to cure foot and mouth disease

a common and inexpensive dressing for lessons of feet is a mixture of Coal Tar and copper sulfate in the proportion of 5:1 some other measures to treat the disease are given below

clean the wounds and ulcers in the mouth, udder, teats and feet with 2% potassium permanganate lotion or alum water

decoction of babool bark for gargling the mouth and washing the ulcers may also be effective.

apply boric acid mixed with glycerine to ulcers in the mouth.

foot bath with a disinfectant solution such as cresol or phenol (1:100) may be used.

Sores on the udder and teats of milch cows should be kept clean and dressed with boric ointment.

Management of dairy form

The building in which dairy cattle are dept is called dairy house.

Selection of sight should consists of dry place, elevated place drainage facility and

good water supply.

The dairy house should contain cowshed, suckling calves room, feeding Room, milkroom,washroom,loafingroom.

The cowsheds can be arranged in single room if the cows are less than 10 or in a double row if the cows are more than 10, in the middle there is a passage.

In the double row system the cows should be arranged face to face or tail to tail

MANAGEMENT OF COW

the cow has three stages in its Life. They are,

1.new born calf

2.heifer

3.milking cow

CARE OF NEW BORN CALF

As soon as the calf is delivered, the mucous is removed from the nose and mouth and it is cleaned.

If the calf does not start breathing artificial respiration should be given by pressing the chest .

Another method is to hold calf by the rear legs hand lift from the Flore with the head down, this may be respected several times.

The naval cord of the calf is tied about 2.5 cm away from the body and cut about 1 cm below the ligature. Appt tincture iodine and repeated it 2-3 days. This prevent infection.

Feed colostrum with in 15 minutes of calving .

Identification - metal ear tags or button with letters and numbers may be inserted in the year.

Dehorning- by use of hot iron to removal of horns with in the age 3 to 10 days.

* Note- colostrum = it contains low fat, high protein, vitamin s and minerals .this helps to protect the calf against various diseases as it contains antibodie.

MANAGEMENT OF HEIFER

Heifer is the stage of the cow which does not have yielded calf. It has got an age 15 to 18 months from the date of calving.

Usually heifers at kept in indoors up to 9 to 12 months, then they are raised outdoors and protection from adverse climatic conditions, rains, sun etc, are essential.

The heifer cow is still growing and as not reached her adult body weight. So, extra growth ration as to be provided to milking heifer cow, is through out first location.

Management of milk cow

1)Feeding management

Adequate quantity of roughages expecially greens are usually fed 4 to 5 times a day.

The concentrates her fed usually at the times of milling, this helps in, led down, of milk.

Concentrate feed should the given at the rate of 1.5 kg per animal as maintainance ration.

1 kg of concentrate feed should be given for every additional 2.5 kg of milk yield.

1.0 to 1.5 kg concentrate feed should given to the pregnant cows from 7th months of pregnancy.

A milking cow requires 15 to 25 kg of green fodder and 3 5 kg of paddy and straw per day in addition to the concentrate feed.

2)Breeding management

The heifer comes to heat at about 18 months of age .

A period in the oestrous cycle during which cow will mate is called the oestrum as heat period.

The oestrous cycle averages about 21 days in length.

The heat period will usually last from 14 to 18 Hours, but may vary and if ranges from 12 to 24 hours in length.

Dairy cows usually comes to heat about 30-40 days after calfving.

The gestation period of cow is about 280 daus.