K N Govt Arts College for Women (A), Thanjavur.

Department of Zoology

I M.Sc Zoology

CC2: Functional Morphology and Palaeontology of Chordates

-18KP1Z02

I: Unit — Origin of chordates

Introduction:-

Chordata is a group of animals having three important salient features, namely a dorsal tubular nerve cord, a notochord and gill slits. It comprises about 49,000 species including Balanoglossus, Ascidians, Amphioxus, Petromyzon, fishes, reptiles, birds and mammals.

Systematic position:-

* The animal kingdom is divided into above 30 or more phyla.
* of these, the last phylum is called Chordata and the first one being Protozoa.
* All the phyla of the animal kingdom other than Chordata are together called non-chordates or invertebrates.

Place of origin:- It is belived that the first Chordata originated in the sea.

Time of origin:-

* The oldest fossils of vertebrates have been collected from the cambrian beds of palaeozoic era.
* Hence it is belived that the first chordate might have originated prior to Cambrian period that is about 600 million years ago.

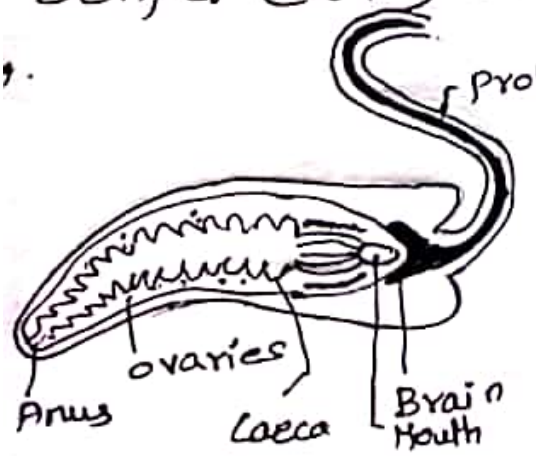
First chordate: It is belived that fixed Ascidians are the first chordates formed on the earth. The larvae of Ascidians developed into Amphioxus and fishes by neoteny.

First Probable Ancestor:- Though there are several theories for the ancestry of chordates, the view of Barrington (1965) is convincing.

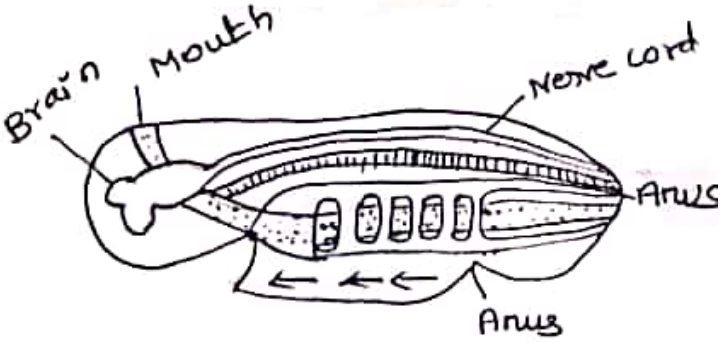
Theories of origin of chordata: There are several theories for the origin of chordates. The last three theories are convincing.

1. Coelenterate theory
2. Nemertean theory
3. Annelid theory
4. Insect theory
5. Arachnid theory
6. Echinoderm theory
7. Ascidian theory
8. Lophophorate theory.

1. Coelenterate theory:- This theory suggests that the chordates evolved from coelenterates. coelenterates are at a very low level of metazoan grade of organization. But this theory is not unjustified.
2. Nemertean theory:- Kafoid and Hubrecht suggested that the chordates originated from marine nemertine worms. But this theory is not accepted.
3. Annelid Theory:- The Annelid theory was proposed by Semper (1876) and Minot (1897). Considering all these



A Nemertine, the ancestor



The derivation of chordate from an annelid.

objections. The phylogenetic relationship between the annelids and the chordates cannot be established.

4. Insect theory:- According to Hilaire (1818) the vertebrates might have been evolved from the insects. The insect theory is not accepted because the points of resemblances between insects and chordates are mostly imaginary.

5. Arachnid theory :- According to patten (1912), an arachnid similar to limulus might be the ancestor of the chordates. This theory is based on the superficial resemblances between limulus and the astracoderms, the earliest known vertebrate fossils. The probable line of ancestry is:

6. Echinoderm theory:- The origin of chordates from echinoderms was proposed by Bateson and Garstang (1886). Garstang and De Beer suggested that the auricularia larva of echinoderm gave rise to chordates by neotony. This theory is supported by embryological, palaeontological and biochemical evidences.

a) Embryological Evidences:- The tornaria larva of hemichordata and the larvae of echinoderm show close resemblance.

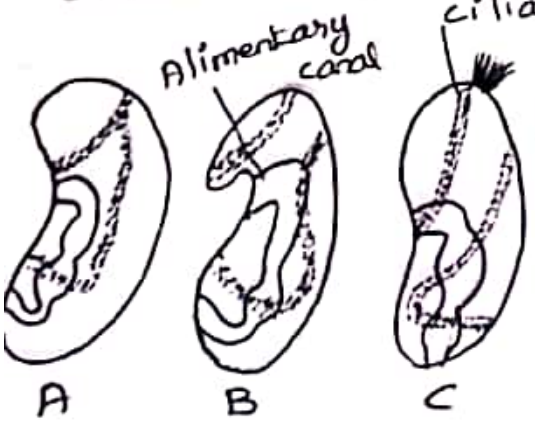


Fig: The Larvae of Echinoderms and Hemichordates resemble each other.
A- Larva of Balanoglossus
B- Larva of Starfish
C- Larva of sea cucumber.

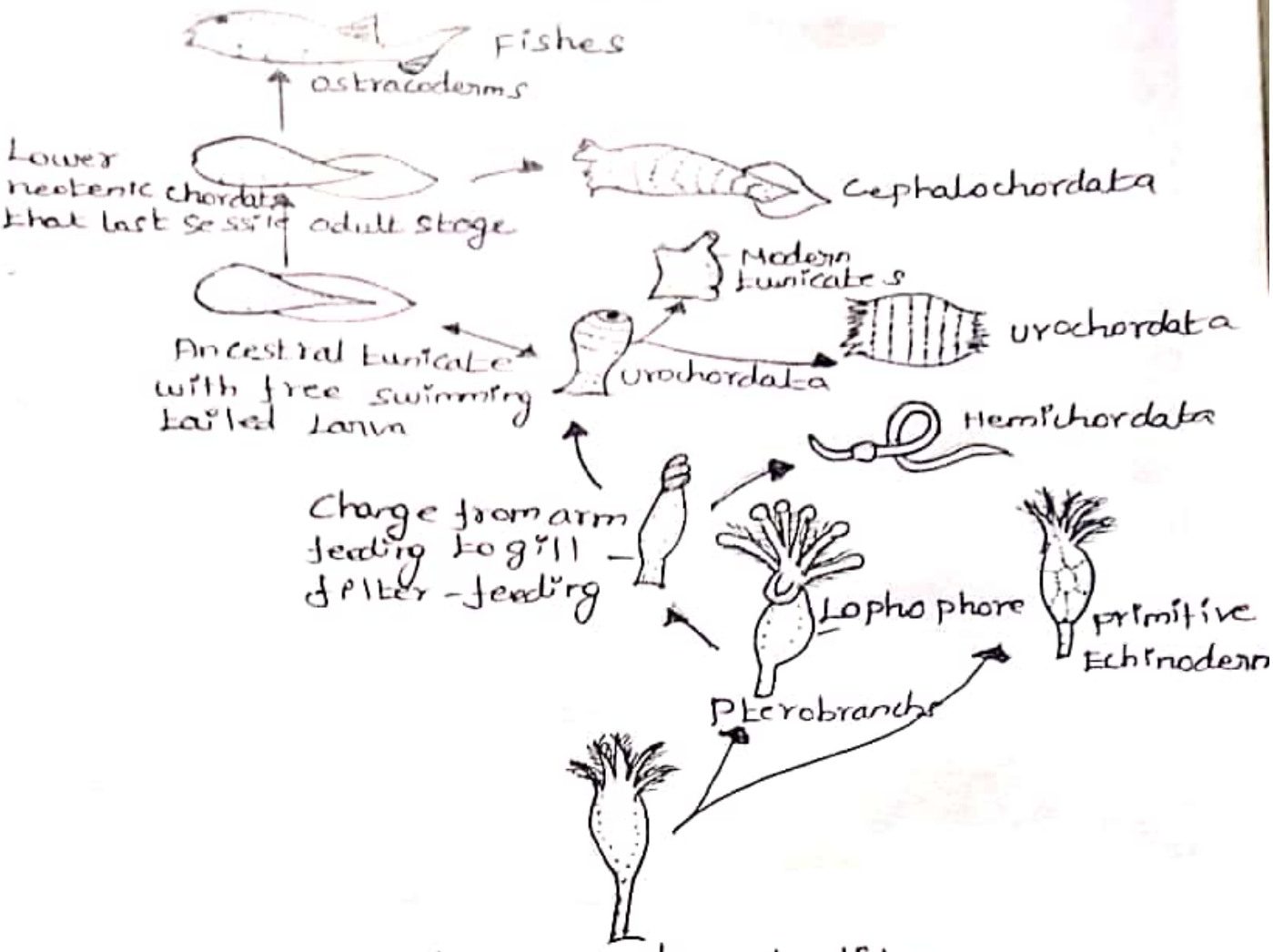


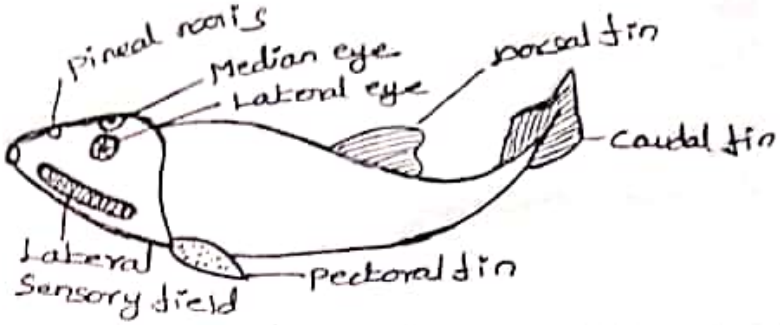
Fig: phylogenetic tree suggesting the possible mode of origin of vertebrates.

Ostracoderms

Ostracoderms are popularly called armoured fishes or bony skin. They are the first vertebrate appeared on the earth. They are the jawless vertebrates. Jamoytius is the primitive and typical ostracoderms.

Systematic position

Phylum : Chordata
Subphylum : Vertebrata
Superclass : Agnatha
class : Ostracodermi



Occurrence: Ostracoderms originated about 500 million years ago in the late Cambrian period of Palaeozoic era. They lived upto the Devonian period dora period of 200 million years and they became extinct completely about 300 million years ago.

Habitat:- Ostracoderms were freshwater forms. They were buttom dwellers.

origin:- Barrington suggested that Urochordate was the ancestor for ostracoderms.

Salient Features of ostracoderms: The astracoderms possessed the following salient features :

- Ostracoderms were the first vertebrates.
- They were commonly called armoured fishes.
- They originated about 500 million years ago, lived for about 200 million years and disappeared from the earth completely about 300 million years ago.
- The did not possess jaws and hence they were called Jawless vertebrates.
- They lived in freshwater and they were bottom dwellers.

- The bony skull was developed
- The body was fish-like.
- Paired fins were absent from ostracoderm. Median and caudal fins were present. The caudal fin was heterocercal.
- The head had a pair of lateral eyes and a median pineal eye
- They were small in size and did not exceed 30cm.
- They were filter feeders.
- The endoskeleton was either bony or cartilaginous.

Outline classification:-

Each class ostracodermi is also classified into four orders. They are:

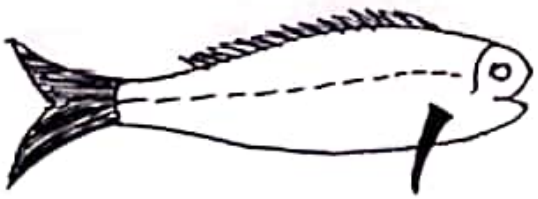
Order: 1. Euphanerida, eg. Jamoytius.

order: 2. pteraspidomorphi, eg. pteraspis.

order: 3. cephalaspidomorphi, eg cephalaspis

order: 4. Anapsida. eg. pterolepis.

Affinities:- The astracoderms resembled the cyclostomes in the presence of a single median naris, pineal eye, jawless mouth and the absence of paired fins. Hence the two groups are placed together in the superclass Agnatha.



pterolepis

Anglaspis

The ostracoderms were provided with bony skeleton but the [illegible] with cartilaginous skeleton. Hence it

character and cartilage is an advanced character. As per this conclusion cyclostomes are degenerate forms, having lost the bone from their skeleton.

It is believed that the armoured ostracoderms originated from the unarmoured Jamoytius. The ostracoderms were the ancestors of Gnathostomes. They gave origin to placoderms which inturn gave rise to modern fishes. The ostracoderms disappeared completely from the earth after giving origin to the placoderms.

— x —

Unit-1

Part-A

1. Notochord
2. Echinoderm theory
3. Cyclostomata
4. Petromyzon.

Part-B.

1. Draw and Explain the scheme of lophophorate theory of for the origin of chordates.
2. Tabulate the key characters of ostracoderms and cyclostomes.
3. Compare the petromyzontia and Myxinoidea

Part-C

1. List out the theories of origin of chordata and Explain it.
2. Explain Agnatha with suitable examples?

FUNCTIONAL MORPHOLOGY AND PALAEONTOLOGY OF CHORDATES

Subcode - 18KP1ZO2

Unit - II

Evolutionary significance of placoderms, crossopterygians Labyrinthodants and Dinosaurs - Adaptive radiation of Reptiles.

Placoderms existed throughout the Devonian period (about 416 million to 359 million years ago). but only two species persisted into the succeeding Carboniferous period. During the Devonian they were a dominant group, occuring in all continents except South America in a variety of marine and freshwater sediments.

The new analyses reveal that placoderms, which lived from about 420 million years ago to about 360 million years ago, had true teeth with dentine and pulp cavities, the researchers report online today in Nature. It was thought for a time that placoderms became extinct due to competition from the first bony fish and early sharks, given a combination of the supposed inherent superiority of bony fish and the presumed sluggishness of placoderms.

Placoderms were the first fishes appeared on the earth. They had plate skin (derr plates - plate, derma = skin).

They had a bony armour, flattened body and paired fins. They lived during silurian and Devonian periods of Mesozoic era.

they were credited as the first vertebrates having jaws.

Romer Stated that perhaps the greatest of all advances in vertebrate history was the development of jaws and consequent revolution in the mode of life of early fishes

Systematic position :-

Phylum : Chordata
Sub phylum : vertebrata
Superclass : Gnathostomata
Class : Placodermi

Placoderms originated in the freshwater and lived in the freshwater. Later forms invaded the sea.

It is believed that placoderms (Gnathostomes) Originated from ostracoderms (Agnatha). Smith (1960) Stated that placoderms maybe the derivatives of ostracoderms.

Salient features :-

1. placoderms were the first true fishes
2. They were called plate-skinned fishes and they had a bony armour like that of ostracoderms.
3. They appeared in the Silurian period about two million years ago, flourished well in the Devonian period and disappeared completely in the permian period about 230 million years ago.
4. They lived in the freshwater, later they invaded Sea.
5. They were bottom dwellers
6. They had a dorsoventrally flattened body.
7. The head and thorax were covered by bony Shields.
8. They had paired fins which were absent from ostracoderms.

9. They had jaws. The jaws developed from the first pair of gills arches.
10. They developed an internal ear with Semicircular canals.
11. Their Size ranged from a few centimeters to 10 meters. Dunkleosteus grew to about 10 meters.
12. Males had pelvic claspers.

CROSSOPTERYGIANS:-

The crossopteryggians, lobbed finned fishes, played an important role in the Orcadian Basin and in the evolution of man.

In the lake, these fast Swimming fishes with their strong teeth were the top predators. They evolved to form the first land animals during the Upper Devonian.

Crossopteryggian (subclass Crossopteryggii) any member of a group of primitive, lobe-finned, bony fishes believed to have given rise to the amphibians and all other land vertebrates.

Trout, gold fish, tuna, clown fish, and Cat fish are all kinds of bony fishes. They live in both Salt and freshwater. Their bodies are covered with Scales. Their gills are inside a pocket on the sides of their head.

To trace the direct line of evolution from fishes to land living vertebrates, it is necessary to consider the Crossopteryggian fishes.

The Crossopterygian fishes were choanate fishes ~~wi~~ with lobe fins. They had well developed internal nostrils. Their nasal passages, as in the higher land living vertebrates, went direct from the external nostrils through the internal nostrils into the mouth or pharynx.

The teeth to the crossopterygians were of the labyrinthodont type, i.e., the enamel had number of infoldings.

The bone arrangement in the paired fins of Crossopterygian could form the starting point for the evolution of the pentadactyl limb of land living animals.

The fins had a single proximal bone which can be compared with the humerus in the fore limb and the femur in the hind limb of vertebrates. The next two bones of the fin can be compared with the radius and ulna of the fore limb and the tibia and the fibula of the hind limb in the land living vertebrates.

Thus the early crossopterygian fishes had the characters that we might expect in the ancestors of land living animals.

RHIPIDISTIAN CROSSOPTERYGIANS:

During the Devonian Period Crossopterygians evolved in two lines, one being represented by the suborder Rhipidistia, the other by the suborder Coelocanthini.

The coelocanthini were not on the mainline' towards the evolution of amphibians. But the Rhipidistians were on the 'main line' towards the evolution of amphibian.

The Eusthen- opteron was a typical genus of Rhipidistians. These fishes were on the direct line towards the early amphibians.

Eusthenopteron was an elongated, carnivorous fish which had a skull patteren similar to the skull pattern of early amphibians.

In the Eusthenopteron, the paired fins possesse skeletal elements that could be compared with the pentadactyl limb. It was indeed but a short step from Eusthenopteron to a land living vertebrate.

LABYRINTHODONTS :-

Labyrinthodontia is an extinct group of amphibians. They were also called Stegocephalia. They were aquatic. They had Labyrinthodont teeth. The wall of the pulp cavity showed complex infoldings. The surface of the tooth had serrations.

They had dermal scales.

The vertebrate were complex with a neural arch, an anterior intercentrum and a posterior pleurocentrum.

The common examples are Ichthyostega, Eryops, etc.

Labyrinthodontia (Greek, 'maze-toothed') is an extinct amphibian subclass, which constituted some of the dominant animals of late paleozoic and early Mesozoic eras (about 340 to 150 million years ago). The group evolved from lobe-finned fishes in the Devonian and is ancestral to all extant land-living vertebrates.

The early labyrinthodonts possessed well developed internal gills as well as primitive lungs, derived from the swim bladders of their ancestors. They could breath air, which would have been a great advantage for residents of warm shoals with low oxygen levels in the water.

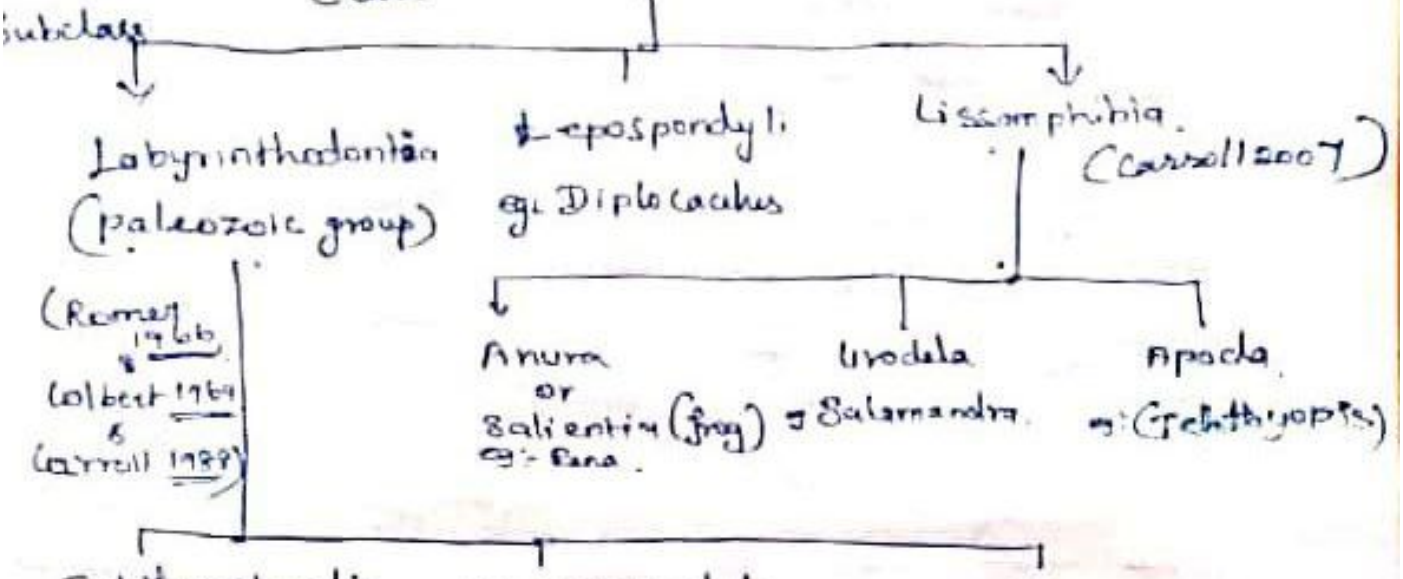
The amphibians that lived in the paleozoic traditionally were divided into the two subclasses of Labyrinthodontia and Lepospondyli based on the character of their vertebrae (Panchen 1967).

Labyrinthodonts could be up to four meters long. They were short-legged and large headed. Their skulls were deep and massive, and their jaws were lined with small, sharp, conical teeth. Also, there was a second row of teeth on the roof of the mouth. In their way of living, Labyrinthodonts were probably similar to fishes – it is speculated that they laid eggs in the water, where their larvae developed into mature animals.

Characteristically labyrinthodonts have vertebrae made of four pieces: an intercentrum, two pleurocentra and a neural arch/spine. The relative sizes of these pieces distinguishes different groups of Labyrinthodonts.

CLASSIFICATION:

Phylum : Chordata.
Sub phylum : Vertebrata.
Superclass : Gnathostomata.
Class : Amphibia



EVOLUTION:

Platyposaurus: The Labyrinthodontia evolved from a bony fish group, the crossopterygii rhipidistia.

Now a days only a few living representatives of these fish remains, two species of coelacanth and three species of lung fish.

The most diverse group of the labyrinthodonts was the Batrachomorpha. Though these animals looked more like crocodiles, they most probably

give rise to the order Anura, the amphibians without tails, which include, in particular, the modern frogs. Batrachomorphs appeared in the Late Devonian, but they had worldwide distribution in the Continental Shallow basins of the Permian (Platyoposaurus, Melosaurus) and Triassic periods (Thoosuchus, Benthosuchus, Eryosuchus). Some batrachomorphs existed until the end of the Cretaceous.

DINOSAURS – ADAPTIVE RADIATION OF REPTILES:

A striking example in the radiation, beginning in the paleogene period (beginning 66 million years ago) of basal mammalian stock into forms adapted to running, leaping, climbing, swimming, and flying. Other examples include Australian marsupials, cichlid fish and ~~the~~ Darwin's finches (also known as Galapagos finches).

For example, dinosaurs are reptiles, a group that also includes turtles, crocodiles and snakes. Although they split off pretty early on dinosaurs and these animals share common ancestors. that means that animals that were almost identical to the ones you can see today existed alongside dinosaurs.

The evolution of a single group of animals in different directions invading different habitats with different types of adaptations is called adaptive radiation. It is also called divergent evolution.

In the history of the earth, Reptiles appeared in the palaeozoic era, played a heroic role during Mesozoic era and disappeared from the Scene in the Cenozoic era leaving only a few representatives. They ruled over the earth for a very long duration of about 130 million years in the Mesozoic era.

When man's duration of life on the earth (only 2 to 4 million years) is compared with that of reptiles, the duration of reptiles was very long.

In the Mesozoic era, the reptiles were represented by 16 orders, But today they were represented by only 4 orders of living reptiles.

The first reptiles were cotylosauria since all the other reptilian orders have arisen from this basal stock, Cotylosaurs are considered as the stem reptiles

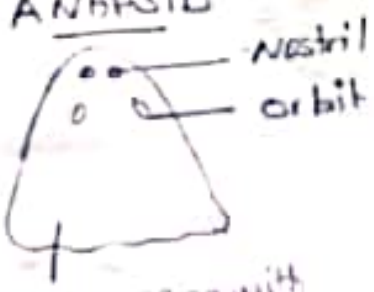
Seymouria has been considered by some authorities as a basic member of cotylosauria. But Romer (1962) considered Seymouria as a reptile - like amphibian and Colbert (1969) considered Seymouria as a 'connecting link' between amphibians and reptiles

The typical cotylosaur genus was Limnoscelis. It was a reptile with five feet in length. The skull was solidly roofed. On the skull roof there was a well developed pineal opening, a character inherited from amphibian ancestor.

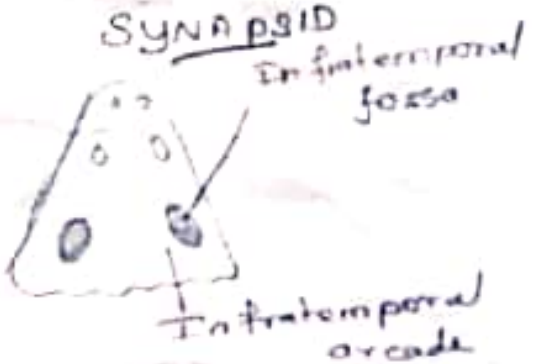
The stem reptiles rise to 5 main lines. These lines are named based on their skull roofing. They are

1. Anapsid line
2. Synapsid line
3. Euryapsid line
4. parapsid line
5. Diapsid line.

1. Anapsid line



Temporal region with complete roof



The anapsid line has a skull resembling the stem reptiles. They have no vacuity in the skull. They arose as an early offshoot of stem reptiles. They have remained uncharged since 1 carnillion years.

eg:- Turtles and tortoises.

2. Synapsid line.

The synapsid line has a single temporal fossa on each side of the skull. The fossa was situated ventral to postorbital and squamosal. This line comprised of mammal-like reptiles.

eg:- Dimetrodon (Theromorpha) and Cynognathus (Therapsida).

3. Euryapsid line.

The euryapsid line of reptiles had also a

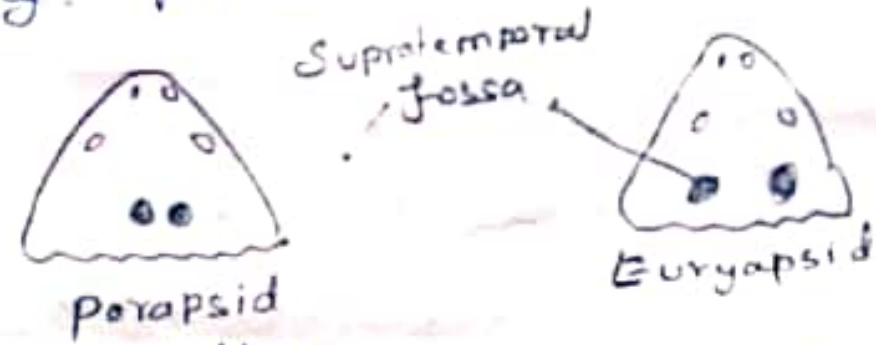
Single fossa. It was situated dorsal to postorbital and squamosal. They were marine, heavy bodied fish eaters.

eg:- plesiosauria.

4. Parapsid Line:

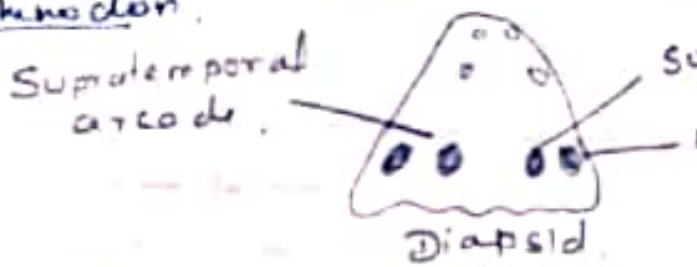
The parapsid line of reptiles had also a Single fossa on each side of the skull. It was far high so that postorbital and squamosal meet far below. Postfrontal and supratemporal lie immediately ventral to the fossa.

eg:- protosauria, Ichthyosauria, Mesosauria.



5. Diapsid Line:

The diapsid line of reptiles had two fossae, namely Supratemporal fossa and infratemporal fossa. This group includes extinct reptiles like Thecodonts, Pterosaurs and Dinosaurs and most of the living reptiles like lizards, snakes, Crocodiles and Sphenodon.



The earliest diapsids divided into two lines, namely lepidosauria and Archosauria.

Lepidosauria gave origin to modern Squamata (Lizards and snakes) and Rhynchocephalia (Sphenodon)

The Archosauria were the ruling reptiles dominating the mesozoic era. They gave rise to Pterosauria, Dinosaurs, Crocodiles and Birds.

Dinosaurs were the terrible lizards. They were of two types, namely Saurischia and Ornithischia. Saurischia means 'reptile-hips' They had reptilian type of pelvic girdle.

They were flesh eating bipedal carnivores. eg:- Struthoomimus, Ornithomimus etc.

Ornithischia means 'bird-hip'. They had avian pelvic girdle. They were herbivores. eg: Iguanodon, Triceratops, Stegosaurus, etc.

DIFFERENT WAYS OF LIFE:-

Adaptive radiation is not only seen in the skull pattern, but also in the ways of life. During Mesozoic era they had a world wide distribution. They inhabited all the available habitats. On the basis of the way of life, the reptiles were classified into the following types.

1. Cursorial Reptiles:-
2. Aquatic Reptiles
3. Flying reptiles
4. Carnivorous reptiles
5. Herbivorous reptiles.

1. Cursorial Reptiles:— Most of the reptiles were cursorial in habit. They lived on the land. eg:- Ankylosaurus.
2. Aquatic Reptiles:- They were successful marine reptiles. eg:- Ichthyosaurus, Pliosaurus, etc.

3. Flying Reptiles: A group of reptiles were successful in flight - eg: Rhamphorhynchus, pteranodon etc

4. Herbivorous Reptiles —
Certain reptiles fed on vegetable matter
eg. Iguanodon.

5. Carnivorous Reptiles: — These reptiles were the flesh eaters. eg: Allosaurus.

Dianosaurs are mesozoic reptailes. Term dinosaur was coined by Richard Owen in 1842. Dinosaur means terrible lizard. It is not a species name, but a group name It includes more than 1000 species.

DINOSAURS ARE FOSSIL ANIMALS:

Dinosaurs are not living today. They became Completely extinct. Not even a single individual is living today.

Dinosaurs are known from their fossils, the remains of their bones on the rocks. Thy Coloured figures of dinosaurs are only reconstructions of fossil bones, teeth, plates, etc.

Dinosaurs were believed to be warm blooded animals.

Though they were large their brain was as small as a hen's egg.

The first dinosaurs lived about 225 million years ago. The last dinosaurs lived about 65 million years ago. It lived in the Mesozoic era. During the Mesozoic era they were the dominant animals Owing to this Mesozoic era is called the Golden Age of Reptiles.

All the best

Dr. P. REXI.
Department of Zoology

Answer the following Questions :-

2marks.

① Mesozoic era
② Ornithischia
③ Crossopterygian
④ Labyrinthodontia.
⑤ Placoderms.

5marks.

① Write short notes on placoderms?
② Why did placoderms go extinct?
③ Are reptiles related to dinosaurs
④ What is the evolutionary significance of the crossopterygians?
⑤ What are the 3 types of bony fish?

10marks.

① Describe the adaptive radiation of Reptiles.
② Give a detail account on evolutionary significance of Labyrinthodonts and crossopterygians.

Dr. P REXI
Department of Zoology
Kunthavai Nachiyar Govt. Arts College
Thanjavur.

Unit-III

Birds are glorified reptiles.

In the 18th century Darwin's theory of organic Evolution brought a new line of thoughts and scientists began to search afresh for the stocks of all the living organisms.

How did the birds originate? and what was their ancestor looking like? The probable answer was, birds originated either from reptiles or they took to the air through a parallel line of evolution directly from life in water.

It was during 1861 that a fossil was discovered in Europe, which gave convincing clues about the ancestors of birds. The fossil was named Archaeopteryx. It showed admixture of characters of both the reptiles and the birds. Even the modern birds have still retained reptilian characters: their egg laying habit, scales on their legs strongly support their link with reptiles.

It was, a little more than a century ago man discovered a fossil of a creature which perhaps 100,000,000 yrs before had died in the muddy bottom of a long vanished sea in Europe which is known as 'Bavaria'. This strange looking animal-remain was given a name 'Archaeopteryx' which means primitive wing and considered by scientists as one of the oldest birds on earth. The most important feature of this bird-like animal was that it had feathers.

In addition, its wings, breast bone, legs and feet were like those of modern birds. However, those who considered it a feathered reptile, it had a long jointed bony tail and short, blunt and rounded head, resembling a lizard's snout than to a birds beak. Further it had teeth in both the jaws and bones resembling those of reptiles and had three free fingers on each wing.

The modern birds have no teeth in their jaws, but teeth were found in certain fossils which every one agrees.

During the course of study more and more fossils of birds were found, many of them have close resemblance with existing birds.

The long extinct Archaeopteryx can be seen as a reptile-bird, sharing characters both with reptiles and birds. This suggests that birds and reptiles evolved from a common ancestor. Even the modern birds have reptilian characters. their egg laying habit, presence of scales on their legs, presence of thumb bone, and even claws on thumb and index finger. This suggests that birds at a certain stage evolved from a reptile-like creature.

The admixture of avian characters, on one hand and the reptilian on the other justifies Archaeopteryx a connecting-link between the reptiles and birds.

Palaeontological Evidences.

The palaeontological studies of fossil birds and reptiles give strongest support to the reptilian ancestry of birds.

Similarities between fossil birds and modern reptiles:

The earliest known fossil birds, such as Archaeopteryx, Griphosaurus, Hesperornis, Baptornis Ichthyornis, Apatornis, etc, show many reptilian characters/features.

1. The Axis of the body was elongated & lizard-like.
2. The vertebrae had amphicoelous centra.
3. Long tail was present with 18-20 caudal vertebrae
4. Fore limbs with three-clawed digits.
5. pectoral girdle had T-shaped interclavicle and 'V' shaped furcula.
6. Each hind limb had four-clawed digits.
7. The shape of the skull was more reptilian.
8. Well developed short and blunt beak with well formed conical teeth lodged in sockets.

Similarities between fossil reptiles & modern birds.

Many fossil reptiles were adapted to aerial mode of life and showed many avian features. (eg) Dinosaurs, pterosaurs etc

1. The skull was long & skin suggesting the existence of a beak-like structure.
2. The hind limbs were longer and the ostrich-dinosaur was bipedal reptile and walked on three toes.
3. The digits of the forelimbs became reduced to three and were possibly modified for grasping.

The cumulative evidences from all sides added that reptiles and birds are phylogenetically related with one another.

The following evidences favour the reptilian origin of the birds

Anatomical Evidences

1. Both reptiles and birds have well formed exoskeleton. Scales in reptiles and feathers in birds. The hind limbs in most of the birds are covered with scales.
2. Exoskeletal structures including the horny covering of the beak in birds are shed.
3. Both cervical and thoracic ribs are present.
4. The wings of some birds contain one or two digits ending in claws.
5. The gizzard is present in birds and crocodiles.
6. The caecum and cloaca are present in both.
7. Avian heart is 4-chambered. The heart of crocodiles is almost 4-chambered.
8. Kidneys are elongated
9. Urinary bladder is absent in birds and snakes.
10. Both reptiles and birds are oviparous.
11. The pecten is present in the eye of birds and crocodiles.

Embryological Evidences.

1. The sperms are similar in size and eggs are large, albuminous, covered with hard shell, development is by incubation.
2. The segmentation is meroblastic.
3. Development of scales and feathers is similar

Adaptive radiation - birds.

In evolutionary biology, adaptive radiation is a process in which organisms diversify rapidly from an ancestral species into a multitude of new forms, particularly when a change in the environment makes new resources available, alters biotic interactions or opens new environment niches. The prototypical example of adaptive radiation is finch speciation on the galapagos (Darwin's finches), but examples are known from around the world.

Characteristics.

Four features can be used to identify an adaptive radiation

1) A common ancestor of component species:
2) A phenotype-environment correlation.
3) Trait utility.
4) Rapid speciation.

Adaptive radiations are thought to be triggered by an ecological opportunity or a new adaptive zone. Sources of ecological opportunity can be the loss of antagonists (competitors or predators), the evolution of a key innovation or dispersal to a new environment. Any one of these ecological opportunities has the potential to result in an increase in population size and relaxed stabilizing selection.

Example: Darwin's finches

Darwin's finches are a group of about 18 species of passerine birds. They are well known for their remarkable diversity in beak form and function. Darwin finches helped to show how the species adapted from generation to generation, different birds were all finches that looked different from one another.

~~2018-2019 (onwards)~~

~~M.Sc. MICROBIOLOGY~~

Beaks in birds: Beaks are the horny projections of the jaws of birds, also called bills, beak is covered by a horny covering called rhamphotheca.

The beak is formed of an upper jaw and lower jaw. the beak function as the hand and mouth of the birds. They do the following functions: To obtain food, handle food, To preen the feathers, To collect nest materials, To build nest, To feed the young ones, for defense, for courtship.

Types: Seed eating beaks (ex: Sparrow

2. cutting beaks (ex: crow
3. Fruit eating beaks (ex: parrots
4. Insect eating beaks (ex: swallows
5. Prey eating beaks (ex: kingfisher
6. pouched beaks (ex: pelicans
7. Mud straining beaks (ex: Ducks, Geese
8. Wood chiselling beaks (ex: Wood pecker
9. Mud probing beaks (ex: Sand-piper
10. Flower probing beaks (ex: Humming bird.

(11) piercing and tearing Beak (ex: Eagles, owls and vulture.

X. Adaptive Radiation of modern birds.

Modern birds are classified in Neornithes, which are split into paleognaths and neognaths

The paleognaths include the tinamous and the ratites, which nowadays are found almost exclusively on the southern hemisphere.

The ratites include, it is a flightless birds, include ostriches, rheas, kiwis and emus.

The available data regarding their evolution is still very confusing, because there are no uncontroversial fossils from the mesozoic.

The basal divergence from the remaining Neognathes was that of the Galloanserae, the superorder containing the Anseriformes (ducks, geese and swans) and Galliformes (chickens, turkeys and their allies)

Connecting Link / Fossil evidences of birds.

The origin and evolution of major groups of animals are well documented by connecting links.

The origin of birds from reptiles is evidenced by a connecting link called Archaeopteryx. It is a fossil animal. Hence it is called a missing link. It is considered as the first bird originated on the land.

Though it is a bird, it retains many reptilian characters. Hence it is intermediate between reptiles and birds.

a) Reptilian characters:

1. Jaws are provided with homodont teeth.
2. The tail is long, lizard-like and with 20 free caudal vertebrae.
3. Bones are not pneumatic.
4. cervical vertebrae are fewer, 9 or 19.
5. The vertebrae are amphicoelous as in sphenodon
6. cervical and abdominal ribs are present in addition to thoracic ribs. Ribs are single headed and without uncinate process.
7. Sternum is weak or absent.
8. Eyes are provided with sclerotic ossicles.
9. Scales are present.
10. Fore limbs are provided with three free fingers tipped with claws. The phalangial formula is 2, 3 and 4 in I, II and III fingers.
11. Carpels and metacarpels are free: there is no carpometacarpus.
12. pelvic girdle has an elongated ilium and a backwardly directed pubis.

b) Avian characters:

The following are the avian characters of Archaeopteryx.

1) presence of feathers. If the feathers of Archaeo-pteryx were not preserved in the fossil, it would have been taken for some bipedal diapsid reptile.
2. fore limbs are modified as wings.
3. Tail bears two rows of feathers.
4. Rounded brain case.
5. Bones in the skull are intimately fused
6. Beaks are present.
7. Bones of limbs and girdles are bird like.
8. V-shaped furcula is present. 9) Tibia and fibula are seperate. (10) A keel is present on the Sternum.

Part-A

1. Archaeopteryx
2. feathers.
3. Air Sacs.

Part-B.

1. write an account of Beaks in birds
2. Explain the fossil history of birds.
3. What are the similarities between fossil reptiles and modern birds.

Part-C

1. the birds are glorified reptiles - Discuss.
2. Write an essay on the Adaptive radiation of birds.

Unit IV :-

Origin of Mammals

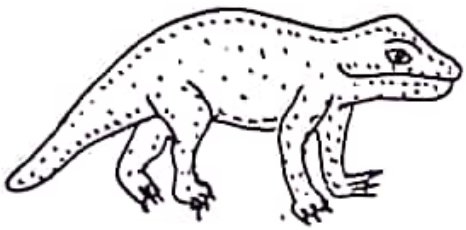
Mammals are the final product of evolution. They occupy the top of the evolutionary tree. Man also comes under this group. Mammals are identified from other animals by the presence of mammary glands, hair and by giving birth to their youngones.

Time of origin :- The mammals originated in the Triassic period of Mesozoic era about 200 million years ago.

First Mammals :- The first mammals are coming under the order Docodonta. The common examples were Morganucodon and Megazostrodon. The lived in the upper Triassic Period of Mesozoic era about 200 million years ago.

- They were tiny creatures not bigger than rats and mice.
- They were nocturnal in habit.
- They were either burrowing or arboreal in habit.
- They were homoeothermic and endothermic animals.
- They had hair.
- They carried their youngones in pouches for further development after birth.

Probable Ancestor :- It is strongly believed that mammal-like reptiles were the ancestors for mammals. Among the mammal-like reptiles cynognathus was believed to be the ancestor of mammals. It is included in the suborder Theriodonta, order Therapsida and subclass. Synapsida. It lived during the early Triassic period of Mesozoic era about 230 million years ago.



The ancestor of mammals possessed both mammalian and reptilian characters. The mammalian characters were the following:-

- The skull was dicondylic
- The skull had a temporal fossa
- The dentary of lower jaw was enlarged.
- The dentition was heterodont with incisors, canines, premolars and molars.

The reptilian characters of the ancestor of mammals were the following:

- Ear had a single bone instead of three
- The Lower jaw had many bones.

Evolutionary Trends:- When the ancestor of mammal transformed into mammals, the following changes occurs:-

- Hair developed. The ear developed a pinna.
- Mammary glands appeared.
- Adiaphragm appeared. Homoeothermy developed.
- The three ear ossicles, namely malleus, incus and stapes developed.
- The heart became completely four chambered.
- Dentition heterodont and thecodont, the male developed a scrotal sac.
- oviparous condition was transformed into viviparous condition. The brain developed a corpus callosum.

Theories of the origin of Mammals:-

There are three theories to explain the origin of mammals. They are the following:

1. Amphibian ancestry 2. Reptilian ancestry
3. polyphyletic theory.

1. Amphibian Ancestry:- J.H. Huxley (1880). This theory is based on the presence of two occipital condyles both in amphibians and mammals. However, this theory is not acceptable because condyles are derived from basioccipitals in mammals

2 Reptilian Ancestry:-

Among the reptiles, the order Therapsida of the Subclass Sympsida is closest to mammals. They possessed many mammalian characters. Hence they were called mammal like reptiles.

3 Polyphyletic Theory:-

Though the Theriodonts are regarded as the ancestors of mammals, it is difficult to pinpoint the exact mammalian ancestor among the advanced Theriodonts. Therefore it seems wise to conclude that mammals had a polyphyletic origin. That is, several groups of mammals-like reptiles contributed to the early ancestry of mammals.

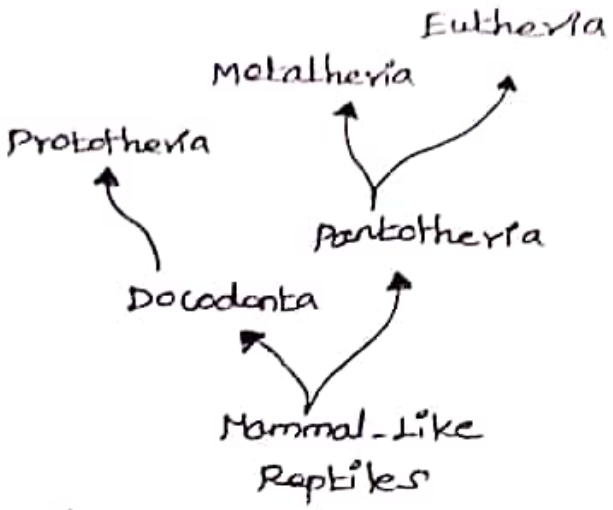


Fig: polyphyletic origin of Mammals.

* It is generally assumed that the present mammals originated from at least two ancestors.
* The prototheria originated from docodonts, while Metatheria and Eutheria originated independently from the pantotherians. Docodonts and pantotherians were Jurassic mammals.

—— × ——

b Paleontological Evidences:- The Lower Silurian carpoid echinoderms had the calyx perforated by a series of 16 small apertures.

c Biochemical Evidences:- The phylogenetic relationship between the echinoderms and the chordates has been shown by biochemical studies also.

7. Ascidian theory:- This theory was proposed by Garstang (1928) supported by Berrill (1955) and Romer (1959) some of these neotenous forms re-entered the sea and became Amphioxus.

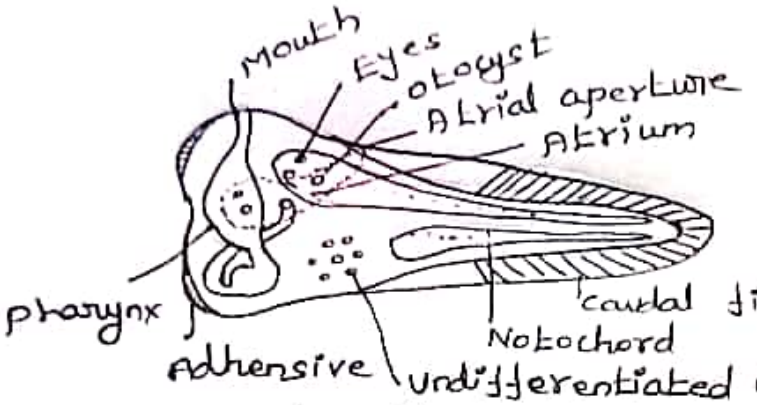


Fig:- A free living Ascidian Larva

8. Lophophorate theory:- The lophophorate theory was proposed by Barrington (1965). According to this theory, a lophophorate or arm feeding creature was the ancestor for echinoderm chordates.

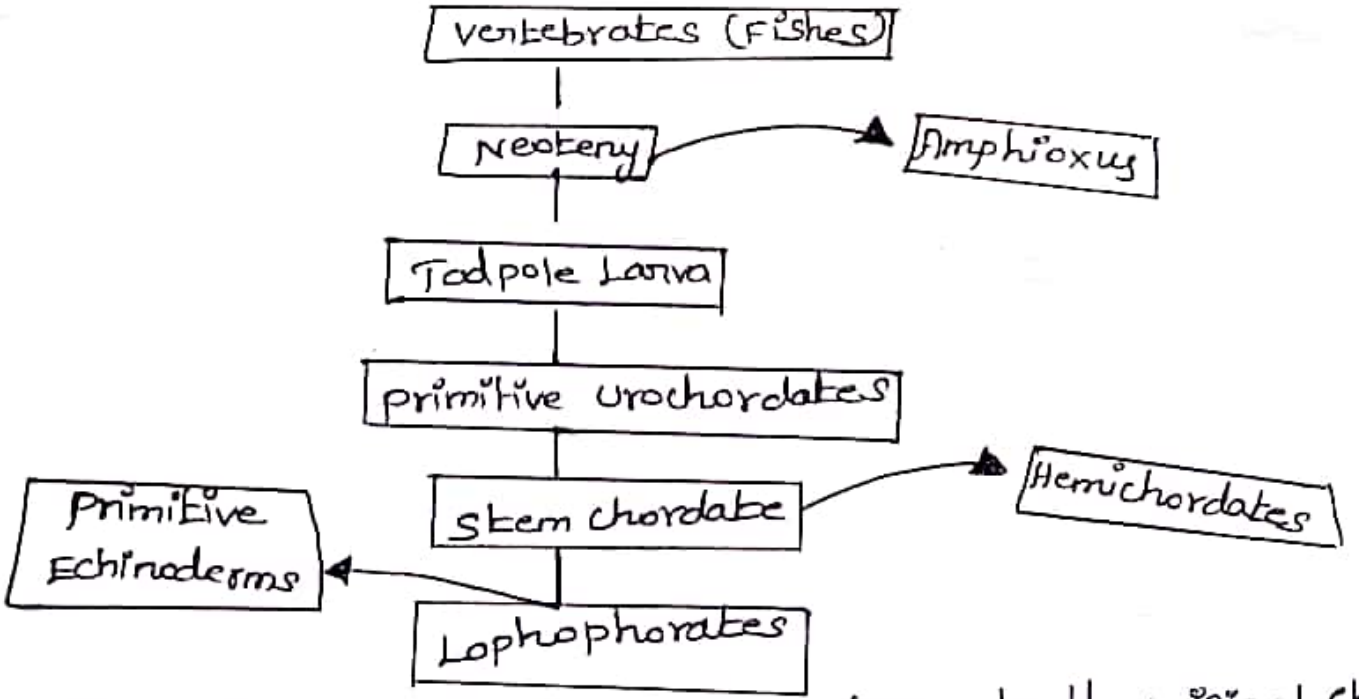


Fig:- Scheme of Lophophorate theory for the origin of Chordate

Limbs:

- The humerus has a little developed olecranon process. The centrale is not separated.

Girdles:

- The pectoral girdle is built on a reptilian pattern. The scapula is without a spine. The acromion process is well developed. The coracoid is large. T-shaped interclavicle is present.
- In the pelvic girdle, the acetabulum is perforated. An epipubic bone is present.

Internal organs:-

- The tongue is long and sticky.
- The anus is absent but a cloaca is present.
- Sweat and sebaceous glands are present.
- The chordae tendinae are absent.
- The brain has no corpus callosum.
- The RBCs are non-nucleated. There is no vagina.
- They are oviparous.
- The eggs are cleidoic and megalecithal.
- The cleavage is meroblastic.

Origin:- Prototheria originated about 200 million years ago in the Triassic period of the mesozoic era. The ancestor of Prototheria was the mammal-like reptile.

Classification:- Prototheria is a subclass included under the class Mammalia. It is subdivided into three orders. They are the following:-

order 1. Triconodonta

order 2. Symmetrodonta

order 3. Monotremata.

Affinities: Prototheria exhibits relationship with Reptiles, Aves, Metatheria and Eutheria.

Affinities with Reptiles:-

Prototheria resembles reptiles in the following features.

- The pinna is absent. The cochlea is simple
- The cloaca is present
- The body temperature is low and not constant.
- The skull contains an ectopterygoid.
- A prevomer is present.
- The tympanic bulla is absent.
- The corpus callosum, uterus and vagina are absent.
- An abdominal vein, A T-shaped interclavicle is present.
- They are oviparous

Affinities with Aves:- Prototheria resembles aves in the following characters:

- The beak of platypus resembles the beak of birds.
- The teeth are absent. The digits are webbed.
- Sutures of the skull are obliterated.
- In both the groups, an oil gland is present.
- A spur is present in the tarsal region.

Affinities of Metatheria:- Prototheria resembles Metatheria in the following characters:-

- A marsupial bone is present. A cloaca is present.
- The corpus callosum and true allantoic placenta is absent.
- The clavicle is well developed.

Affinities with Eutheria:- Prototheria resembles Eutheria in the following salient features:

- A body is covered by hairs.
- Mammary gland, oil glands, sweat glands, palate and diaphragm is present.

* The heart is four chambered. The RBC is non-nucleate
* They are warm blooded animals.
* The fertilization is internal.

Conclusion:- Protherians are the only "hair" animals laying eggs. Laying eggs is a reptilian character. At the same time, Prototherians feed their young ones with milk like higher mammals. Hence prototheria is regarded as a connecting link between reptiles and higher mammals.

Prototheria originated as a side line from the mammal-like reptile ancestor. It continued to survive in isolation retaining primitive characters. It is still on the line of evolutionary path. Hence prototheria is described as unfinished mammals. It is not the ancestor for Metatheria and Eutheria.

---

(6)

Metatheria (Marsupialia)

Metatheria is a subclass of the class mammalia It includes pouched mammals The females have a pouch called marsupium on the ventral side. Hence the Metatherians are also called Marsupials The well known example of Metatheria is the kangaroo. It is the National emblem of Australia.

Salient features of Metatheria :-

- They have isolated distribution.
- They have marsupial pouch or brood pouch on the ventral side.
- They are terrestrial, arboreal burrowing or aquatic
- They are herbivorous or carnivorous.
- They are viviparous, warm blooded animals.
- The body is covered by hair. The pinna is well developed.
- The mammary glands have teats. The skull is dicond
- The palate is perforated
- The dentition is heterodont, the codont & monophyd
- The dental formula is $\frac{5,1,3,4}{4,1,3,4}$.

Distribution:- Metatheria were widely distributed till the Miocene period for about 90 million years. But now they are confined to Australia and America.

Classification:-

The class Mammalia is divided into three subclasses, namely Prototheria, Metatheria and Eutheria.

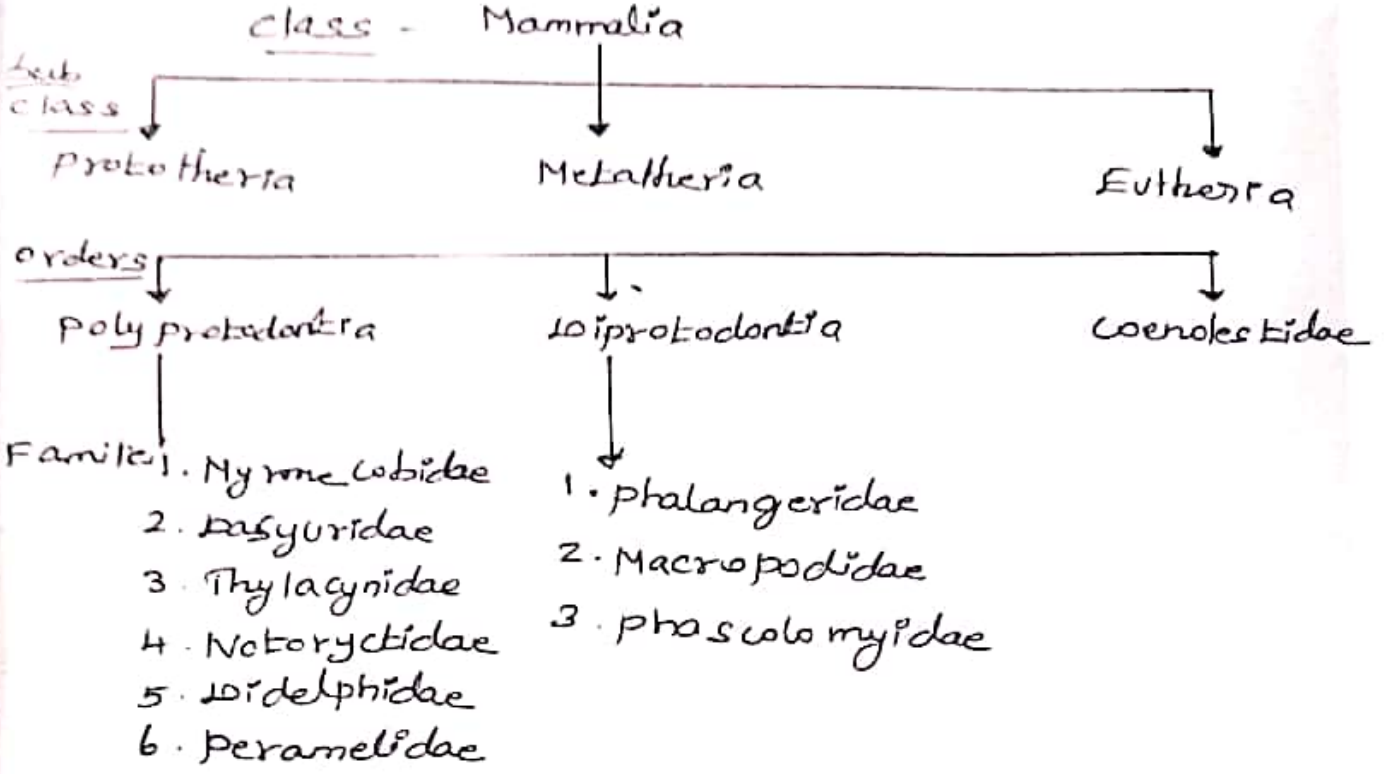


Fig: Synoptic classification of Metatheria.

Adaptive Radiation of Metatheria:-

Metatheria are restricted to Australia and America.

1. Cursorial Metatherians
2. Fossorial "
3. Arboreal "
4. Flying "
5. Aquatic "

1. Cursorial Metatherians.

These Metatherians are well developed to fast running. Eg. Kangaroos

Kangaroo

Kangaroos are also good swimmers and good diggers.

2. Fossorial Metatherians:.

These are the burrowing Metatherians Eg: Wombat. They have adaptations for burrowing

Wombat

3. Arboreal Metatherians:-

They have adaptations to live on trees.

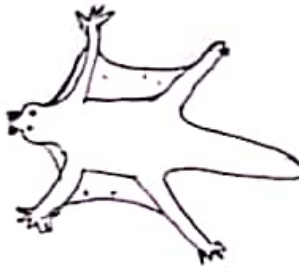
Eg. Koala

Koala -

4. Flying Metatherians.

They can fly in the air. Eg. Petaurus

They have patagium between the fore limbs and the hind limbs.



5. Aquatic Metatherians:

They live in water. They have webbed feet.

Eg. Chironectes

webbed hind limb

Parallel Evolution in Metatherians:

Similar changes undergone by two groups of related animals constitute parallel evolution. A very good example for parallel evolution is provided by metatherian.

Affinities:- Metatheria exhibits relationship with prototheria and Eutheria.

Affinities with prototheria:-

1. A cloaca. Clavicles and Anterior commissure is prese

* Corpus callosum is absent.
* Epipubic bones or marsupial bones are present.
* The olfactory lobes are larger.
* A true allantoic placenta is not found.

Affinities with Eutheria:-

* A pinna is present
* The cochlea is coiled.
* A scrotum and a penis are present.
* The dentition is heterodont. A placenta develops
* The development is internal. Uterus and vagina are present.
* They are viviparous.

Conclusion:-

Among mammals, the prototherians are the most primitive and they contain more reptilian characters. The metatherians are a little more advanced than the prototherians and they contain more mammalian characters, the Eutherians are highly developed ~~amm~~ mammals.

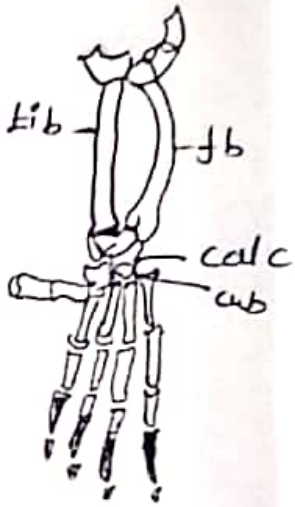
Prototherians are oviparous and they lay eggs The eggs are hatched outside. In metatherians the development is internal by but the entire development of the embryo is not completed inside the mother.

Eutheria

Eutheria is one of two mammalian clades with extant members that diverged in the Early Cretaceous or perhaps the Late Jurassic. All placental mammals that diverged in the Early Cretaceous or ~~p~~ indigenous to Europe, Africa, Asia the Americas, Australia and Antarctica are eutherians. Extant eutherians, their last common ancestor, and all extinct descendants of that ancestor are members of placentalia.

Characteristics:

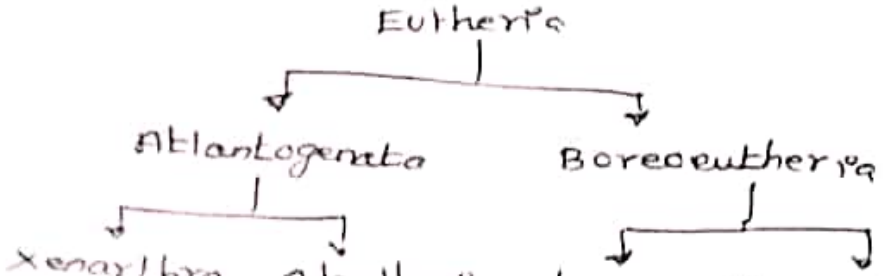
- An enlarged malleolus at the bottom of the tibia, the larger of the two shin bones.
- The joint between the first metatarsal bone and the entacuneiform bone in the foot is offset farther back than the joint between the second metatarsal and middle cuneifor bones- in metatherians these joints are level with each other.



Evolutionary History:-

Eutheria contains several extinct genera as well as larger groups, many with complicated taxonomic histories still not fully understood. Members of the Adapisoriculidae, Cimolesta and Leptictida have been previously placed within the outo-dated placental group Insectivora, while zhelestids have bo been considered primitive ungulates. However, more recent studies have suggested these enigmatic taxa

represent stem group eutherians, more basal to Placentalia.



Adaptive Radiation in Mammals

Introduction:-

Where do new species come from? This is the key question that biology have been asking for more than 200 years. Charles Darwin gave us part of the answer in his exploration of natural selection. Now we know that new species are formed by evolution. Evolution occur in 2 different patterns.

1. Successive Speciation
2. Adaptive Radiation

It is the evolutionary divergence of members of a single phyletic line to a series of different niches.

In evolutionary biology, adaptive radiation is a process in which organisms diversify rapidly from an ancestral species.

1. Radiation in Limb structure of Mammals:

Mammalian Limbs are the modifications of the pentadactyl limb. primitive ancestral mammals are believed to have been short legged five fingered creatures living on the ground.

From these terrestrial mammals the different lines radiated in the following manner:-

* one evolutionary line radiates to form arboreal forms which have adapted limbs for life in trees eg. squirrels, monkeys, etc.,
* Another line leads to aerial representing mammals adapted for flight eg. bats
* Third line of radiation gave rise to cursorial forms eg. horses
* Fifth line of radiation leads to the aquatic mammals:

(i) Whales and porpoises having limbs strongly adapted for aquatic life, but they cannot move about on land.

(ii) While seals, sea lions and walruses have also strongly modified limbs for aquatic life but they are also able to move about land.

Evolutionary Relationships:-

All the mammals included in the diagram have modified pentadactyl limbs, hence, they must be related to each other. possession of this common limb pattern indicates close relationship not only among mammals but also by birds, reptiles and amphibians. by all vertebrates except fishes.

Tooth Radiation in mammals:-

The mammals with few exceptions possess heterodont dentition i.e., the teeth in contrast

those of reptiles, are differentiated into different forms with very distinct functions. The different types of teeth are incisors for biting, canines for grasping, tearing or for defence or offence, premolars and molars are for griding.

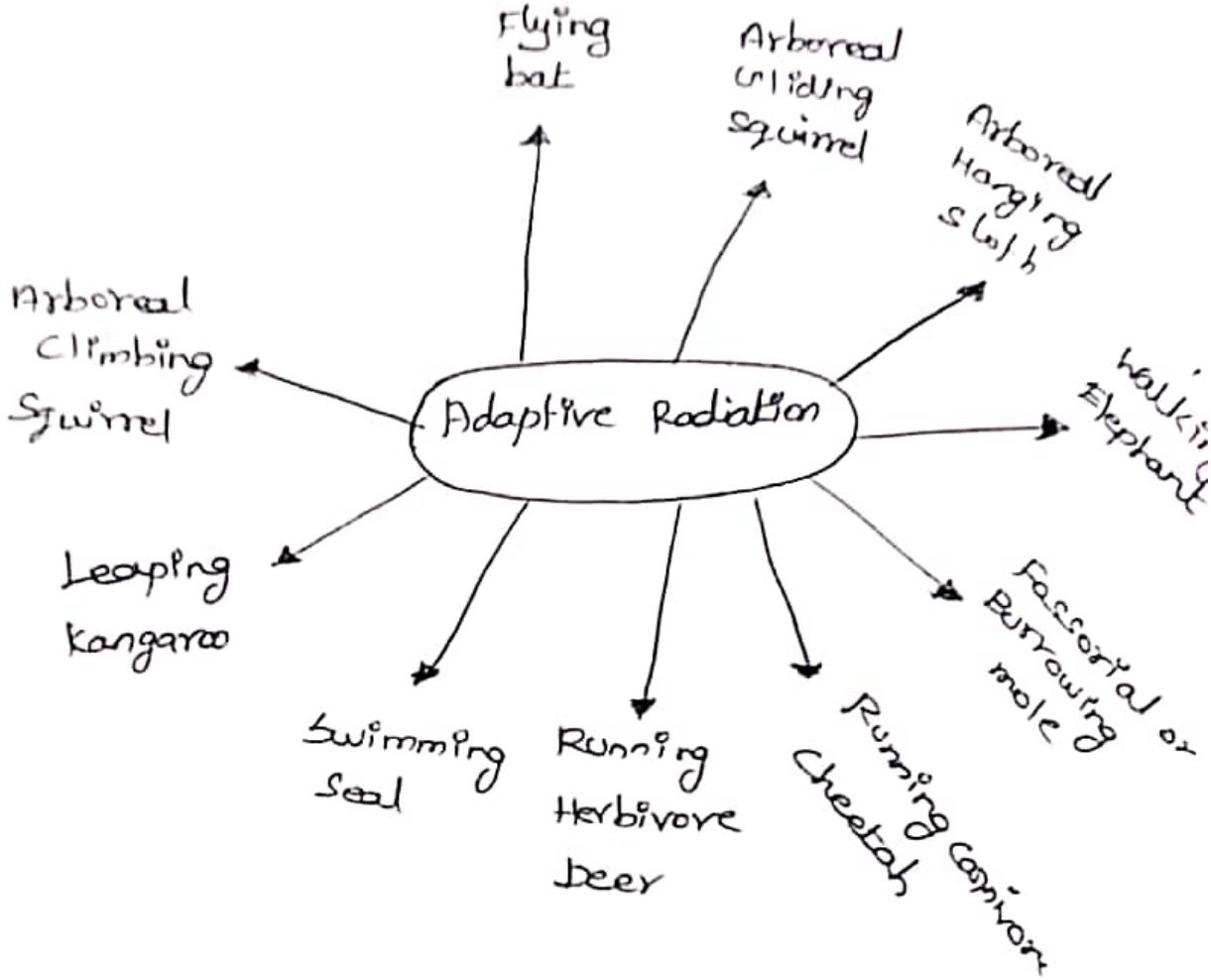


Fig: Adaptive radiation or divergent evolution in mammals, based on locomotion.

-x-

Unit - IV

Part-A

1. pleurodont
2. Aquatic mammals.
3. Diphyodont dentition

Part-B

1. Write down the theories of origin of mammals?
2. Give an account of Metatheria
3. Briefly explain the placenta.
4. write the important characters of mammals?

Part-C

1. 'prototheria is an unfinished mammal' - Discuss.
2. Describe the Adaptive radiation of mammals.

—

Respiratory system – (Pisces) (shark)

Respiratory system is formed of five pairs of gill pouches. they are located on the lateral wall of the pharynx.

They open into the pharynx by an internal branchial aperture and outside by the external branchial aperture.

The mucous membrane of gill pouches is produced into a series of leaf like structures called bronchial lamellae. they are highly vascularized. Each gill pouch has two sets of branchial lamellae. One is anterior wall and other is on its posterior wall.

The lamellae of one side of each gill pouch constitute a demibranch or hemibranch. Two hemibranchs constitute a holobranch.

The gill pouches are separted by interbranchial septa. Each interbranchial septum is supported by a cartilaginous rod called visceral arch. the visceral arches at their inner end bear combs like gill rakers to protect internal branchial aperture.

The visceral arch lying infront of the first gill pouch is called hyoid arch. It bears only one gill. Hence it is hemibranch. the remaining arches are called I, II, III, IV and V branchial arches. Last branchial arch is without any gills. Hence it is a branch.

Mechanism of Respiration: Respiration is aquatic, with the help of gills. During respiration mouth is opened and buccal and pharyngeal cavities are enlarged water is drawn in through the mouth.

Water enters the gill pouches through the internal branchial aperture. The entry of food particles into the gill pouches is prevented by the gill rakers. From the gill pouches, the water passes out through the external branchial apertures after washing the branchial lamellae. The O_2 from the water diffuses into the blood and CO_2 diffuses into the water.

Urinogenital System (Pisces) (Shark)

It consists of excretory & Reproductive System.

Excretory System: It includes a pair of kidneys, a pair of ureters and an urinogenital sinus.

The kidney is mesonephros. It is long and flattened. It extends from the cloaca to the oesophagus. It has two parts, namely slender anterior part and thicker posterior part.

In the male, the anterior part is called genital kidney. The posterior part is called renal kidney. It carries out the excretory function. The kidney is formed of thousands of tubules called Uriniferous tubules or nephron. One end of the each uriniferous tubule has a malpighian corpuscle. It is formed of a cup-like structure called Bowman's capsule and a network of capillaries called glomerulus. The other end is connected to a collecting tubule which receives many uriniferous tubules the collecting tubule open into the ureter, it open into urino-genital sinus, which open to the cloaca.

Reproductive system.

Male Reproductive System: Male has two testes. They are elongated. They are attached to the dorsal body wall by a membrane called mesorchium. From each testis arise several vasa efferentia. It opens into vas deferens. It remains much coiled, it is called epididymis. It comes out of the kidney and posteriorly it dilates to form a sac called Seminal vesicle.

The seminal vesicle open into the urino-genital sinus which inturn opens into the cloaca. Two sperm sacs of unknown function are attached to the urinogenital sinus.

Female Reproductive system: It consists of pair of ovaries, oviducts, shell glands and uteri. Ovaries are located behind the oesophagus attached to the dorsal body wall by a membrane called mesovarium. Oviducts are long and they open into the body cavity by oviducal funnels.

Posteriorly the oviduct dilates to form a sac like uterus. The two uteri join together to form a vagina. The vagina opens into the cloaca. The sperms are introduced into the vagina. fertilization is internal. It occurs in oviduct

Respiratory system (Frog) (Amphibia)

Frog exhibits aerial respiration. There are 3 types of respiration. They are

1) cutaneous respiration
2) Buccopharyngeal respiration
3) pulmonary respiration.

1) Cutaneous respiration: It is the skin respiration. The skin is used as the respiratory organ. Skin is kept moist by the mucous secreted by the mucous glands.

The skin is permeable to gases. The skin has abundant blood supply. The O_2 from outside diffuses into blood and the CO_2 from the blood diffuses out through the skin.

Cutaneous respiration takes place both in H_2O and on Land.

2) Buccopharyngeal Respiration

Respiration occurring inside the buccal cavity and the pharynx is called buccopharyngeal respiration. It is terrestrial respiration where air is used.

The buccal cavity and the pharynx are lined with thin mucous membrane which is moist with mucous, permeable to gases and richly supplied with blood vessels.

The buccopharyngeal cavity communicates through a pair of respiratory tracts. Each respiratory tract consists of an internal nostril, a nasal chamber and external nostril

buccopharyngeal respiration is brought about by the raising and lowering of the throat alternately.

Now exchange of gases takes place between the blood of the mucous membrane and the air of the buccopharyngeal cavity. Now the throat is raised. This increases the pressure of air in the cavity. Hence the air goes out from the buccopharyngeal cavity through the respiratory tract. This process is repeated regularly.

3) Pulmonary Respiration.

In pulmonary respiration, the lungs are used. It is a terrestrial respiration where air is used. It consists of respiratory tracts and lungs.

There are two respiratory tracts. Each respiratory tracts starts from an external nostril → opens into nasal chamber → opens into buccopharyngeal cavity → leads into the glottis.

The lungs are thin walled over sacs. the walls are elastic and highly vascular. the inner lining of the lungs has a number of ridges called Septa. The septa enclose cavities called alveoli. the alveoli lined with epithelium rich in blood capillaries.

Mechanism of Respiration.

1) Aspiration 2) Inspiration 3) Expiration.

1) Aspiration: the entry of the air into the bucco-pharyngeal cavity is called aspiration

2) Inspiration: The passage of air from the buccopharyngeal cavity into the lungs is called inspiration.

O_2 from the air diffuses into the blood of alveoli. From the blood of alveoli Co_2 diffuses into the lungs.

3) Expiration: The passage of impure air from the lungs to the exterior is called expiration.

Urinogenital system. (Amphibia)

The excretory system consists of a pair of kidneys. The functional kidney of amphibians is mesonephros.

From each kidney arises a tube called ureter. the ureter is the mesonephric duct. Or wolffian duct. The Uteres run backwards and open into the cloaca. urinary bladder is connected with the cloaca.

A testis, an adrenal gland and a tuft of fat body are attached to each kidney. kidney is composed of many minute tubules called uriniferous tubules or nephrons. They are the functional units of kidney.

Each nephron is a coiled tubule. one end of the nephron is formed of a cup-like structure called Bowmans capsule. the cavity of the cup contains a network of capillaries called glomerules. the Bowman's capsule and the glomerulus are together called Malpighian corpuscle. It leads into a neck which is followed by a coiled tubule. It opens into a large tubule called collecting tube. Each collecting tube receives many uriniferous tubules.

The uriniferous tubule of frog has no henle's loop. The uriniferous tubule receives blood from the renal artery and the renal portal vein. the renal artery divides into small branches called afferent arterioles. they supply blood to the glomerules. The efferent arterioles divides into capillaries around the coiled tubule.

The ventral side of the kidney has several ciliated funnel-like openings called nephrostomes. The function of the kidney is to produce Urine.

Reproductive System.

Male Reproductive system:

The male frog has a pair of Testes. Each testis is connected to the kidney by a membrane called mesorchium. Each testis is composed of many fine coiled sperm producing seminiferous tubules.

Numerous fine tubules called Vasa efferentia arise from the testis. The Bidder canal is a longitudinal tube situated along the median edge of the kidney. It is connected with the ureter by collecting tubules.

The ureter receive sperms through the vasa efferentia and urine from the urinigerous tubules. The ureter is known as urinogenital duct in the male frog. The urinogenital duct passes backward and opens into the cloaca.

Female Reproductive System.

There are two ovaries attached to the kidney by a membrane called mesolarium. Ovary wall is made of an outer epithelium, inner epithelium and a layer of flat cells or stroma in between. The ova develops inside the ovarian follicles.

The oviduct (Mullerian ducts) are long, white, much coiled ducts extending upto the base of the lungs. Anteriorly each oviduct has a funnel-like structure called oviducal funnel. It opens into coelom by the ostium.

Posteriorly each oviduct dilates to form a thin walled sac, the ovisac. The inner wall of the oviduct is glandular and secretes the jelly coat of the egg. The oviducts from both sides open separately into the cloaca.

During the breeding season the ova are released into the body cavity. The ova enter the oviduct through the ostium and get collected in the ovisac. Later they are released into the water through the cloacal aperture.

Respiratory System (Reptiles)

Rana uromastix exhibits aerial respiration. It is a lung breather. The respiratory system includes the respiratory passages and two lungs. It starts from two external nostrils located at the tip of the snout.

The external nostrils lead into nasal passages the nasal passages open into the buccal cavity by the internal nostrils.

The buccal cavity opens into a larynx through a slit like glottis. The larynx is box shaped and its wall is supported by 3 cartilages. a pair of arytenoid and a single cricoid cartilage.

The larynx opens into a long tube called trachea. The wall of the trachea is supported by cartilaginous tracheal rings. the tracheal rings are Complete. The trachea divides into two bronchi. Each bronchus leads into a lung. The lungs are elongated sacs. The lungs are similar in size.

Each lung is internally divided by incom-plete septa into many chambers called alveoli. The posterior one third of the lung is devoid of alveoli. this part of the lung is considered as the reservoir for the residual air.

The exchange of gases takes place in the alveoli.

Mechanism of Respiration.

Respiration involves two steps, namely inspiration and expiration. During inspiration air is taken into the lungs. At this time, thoracic cavity increases in volume by the raising of the ribs. raising of the ribs is caused by the relaxation of the inter coastal muscles. During expiration air is sent out from the lungs. It is caused by the lowering of the ribs. It is caused by the contraction of the intercoastal muscles.

Urino-genital system (Reptiles). (8)

Excretory system: This system is concerned with the removal of nitrogenous waste products. It consists of a pair of kidneys, a pair of ureters, an urinary bladder and an urinary aperture.

Kidneys are metanephric and dark red in colour. They are situated in the abdominal cavity. Kidney is formed of two lobes. Kidneys are united posteriorly but free anteriorly. Kidney has a peri-pheral region called cortex and a central portion called medulla. Medulla contains numerous urini ferous tubules or nephron. One end of the nephron contains a Malpighian corpuscle. The other end gets connected with a collecting duct. Collecting duct open into an ureter, ureter open into cloaca, cloaca contains an urinary bladder. Urine of Uromastix is semisolid, it contains uric acid. It is a Uricotelic acid.

Male Reproductive system: Uromastix have two testes. Each testis arise numerous vasa efferentia. They are connected together to form an epididymis. It is coiled and runs backwards as the vas deferens.

The ureter open into the cloaca. It has a pair of penes. enclosed by copulatory sacs. A longitudinal groove extends all along the hemipenis. During copulation the hemisphere are introduced into the cloaca of the female and the semen flows through the groove into the cloaca of the female.

Female Reproductive system: Female uromastix has a pair of ovaries. It is attached to the body wall by a membrane called mesovarium. There are two oviducts one on each side. Anterior end opens into the body cavity near the ovary. This opening is called oviducal funnel.

The posterior part of the oviduct is called uterus. Anterior part of the oviduct contains albuminous glands and posterior part contains shell glands. Oviducts open into the cloaca. Fertilization is internal. megalecithal egg. Lays eggs. It is oviparous.

Birds

Respiratory System.

Pigeon exhibits pulmonary respiration. It starts from external nostrils. They open into the pair of olfactory sacs. olfactory sacs open into the buccopharyngeal cavity by a pair of openings called internal nostrils. Buccopharyngeal cavity containing a slit-like opening called glottis. The glottis opens into a tube called trachea. trachea is a long tube running the entire length of the neck. The anterior end of the trachea is enlarged into a chamber called larynx. Larynx is supported by a cricoid cartilage and a pair of arytenoid cartilage The larynx does not produce sound. Trachea divides into two branches called primary bronchi

The primary bronchi are supported by a incomplete cartilaginous rings. The primary bronchus remaining inside the lung is called mesobronchus. The mesobranchus gives a number of lateral branches called secondary bronchi.

The secondary bronchi are connected with each other by numerous thin small tubes called tertiary bronchi or parabronchi. The tertiary bronchi give out small branches called bronchioles or air capillaries.

Pigeon has a pair of lungs. lungs are very small. they are not elastic. Solid & spongy. The main substance of the lung is formed of a net-work of capillaries. air capillaries are connected to the bronchi.

The lung of birds is beset with air sacs. The air sacs are thin walled membranous sacs. Pigeon has nine sacs

1. A pair of cervical air sas
2. A median interclavicular air sac.
3. A pair of anterior thoracic air sacs.
4. A pair of posterior thoracic air sacs and
5. A pair of of abdominal air sacs

The air sacs communicate with the pneumatic cavities of the bones.

All the air sacs are connected to the Secondary bronchi. From the proximal end of each air sac, except the cervical air sacs, a small tube arises. It is called recurrent bronchus or Saccobronchus.

Air sacs do the following functions.

1. They act as reservoirs of air. They assist in respiration.
2. They are also helpful in thermoregulation. They help to remove the excess of temperature from the body.
3. They reduce weight.

Mechanism of Respiration.

It is unique in birds. It exhibits double respiration. they are inspiration and expiration.

Sound producing organ.

In birds, sound is produced by the Syrinx. It is the sound box in birds. It is an unique feature of birds and is absent from other vertebrates.

Excretory system: It consists of a pair of kidneys. metanephric type. Each kidney is a flattened dark red body. It is divided into three lobes. from the ventral surface of each kidney a tube arises. It is called ureter. The ureter runs backward and it opens into the urodaeum. Each kidney is made of thousands of fine tubules called uriniferous tubules or nephrons.

The uriniferous tubules are like that of rabbit. Each tubules consists of malphigian corpuscle and Henle's loop.

The excretory product of birds is uric acid. Hence the birds are called uricotelic animals.

The Henle's loop and the cloacal wall reabsorb water from the urine & faces. Hence the urine is semisolid. It is excreted along with the faeces. Uric acid remains as a white coat on the dropping of birds. The uric acid and the faeces of bird together constitute guano.

Reproductive system.

In birds sexes are separate. They exhibit sexual dimorphism.

male Reproductive system.

It consists of a pair of testes: Testes is attached to the kidney by a membrane called mesorchium.

The Vasdeferens runs backward and opens into the Urodaeum of the cloaca.

Female Reproductive System.

It consists of a single ovary lying on the left side. It is attached to the kidney by a membrane called mesovarium. Birds also Contain only one oviduct lying on the left side. The anterior end of the oviduct opens into the body cavity by a funnel-like opening called oviducal funnel or ostium. The remaining part is much coiled. The vagina opens into the cloaca.

Exoskeleton.

The exoskeleton in birds is epidermal in origin like that of reptiles. Birds have 4 exoskeletal structures. 1) Beaks 2) claws 3) Scales 4) feathers.

1. Beaks: Beaks of are horny structures covering the upper & lower jaws. They help in feeding, preening & fighting.
2) Claws: claws are horny structures present on the tip of the toes. They are used for perching and walking.
3) Scales: The scales of birds are epidermal in origin. They cover the lower part of hind limbs. They are of reptilian type.
4) Feathers: It is epidermal exoskeleton of birds. The arrangement of feathers on the body is called pterylosis.

arranged in the tracts called pterylae. Between the pterylae, there are featherless areas called apteria.

A typical feather has a central axis and an expanded portion called vane or vexillum. The central axis has a basal portion called quill or calamus and distal portion called rachis or shaft.

The free end of the quill has an opening called inferior umbilicus. A small conical projection of the dermis projects into the inferior umbilicus. It is called dermal papilla. There is another opening located at the junction of the quill and rachis. It is called Superior umbilicus. It is surrounded by a tuft of soft feathers called aftershaft or hyporachis.

Pigeon have 4 main types of feathers. They are

1) Quill feathers
2) Filoplumes
3) Down feathers.

1) Quill feathers: Large feathers found in the wing, tail and on the body are called Quill feathers.

2) Filoplumes: Small hair-like feathers which cover all over the body. Clearly seen in plucked birds.

3) Down feathers: It is present in the nestlings. Smaller in size.

Urinogenital System (Rabbit) ①

It Consists of two systems namely the urinary (or) Excretory system and the genital (or) reproductive system.

- In the Embryos, they develop independently.
- But in the adult they become connected with each other.

urinary (Excretory System).

- This System is Concerned with the removal of nitrogenous waste products.

It is similar in both sexes.

It Consists of a pair of kidneys, a pair of ureters, an urinary bladder and an urinogenital aperture.

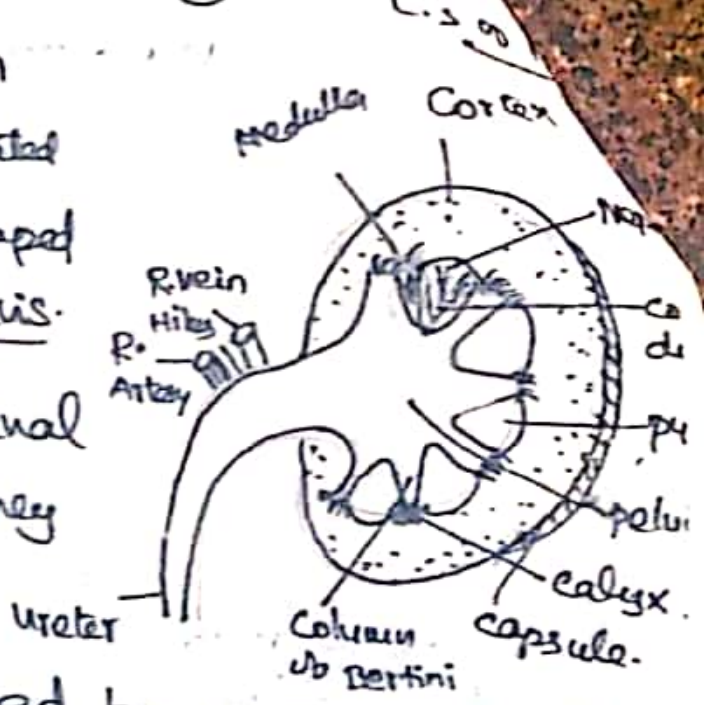
the kidneys are situated in the abdominal cavity. They are bean shaped.

Each kidney has a Convex outer surface and a concave inner surface.

The centre of the inner surface has a notch called hilus.

From the hilus the ureter arises and it runs backwards to open into the urinary bladder.

(15) → At the point of origin the ureter becomes dilated to form a funnel-shaped structure called pelvis.



→ A renal artery and a renal vein pass into the kidney through the hilus.

→ The kidney is covered by a capsule of connective tissue.

→ Each kidney is formed of two layers, namely an outer cortex & an inner medulla.

→ The medulla is formed of several conical lobes called pyramids.

→ The pyramids project into a cup-like structure called calyx.

→ Each pyramid has thousands of tubules called uriniferous tubules or nephrons.

→ In each pyramid, many uriniferous tubules join together to form a common tubule called collecting tubule or collecting duct.

→ Each nephron is coiled tubule having a length of 3 cms.

→ One end of the nephron is formed of a cup like structure called Bowman's capsule.

The cavity of the cup containg a network of capillaries called glomerulus.

The Bowman's capsule and the glomerulus are together called Malpighian Corpuscle.

The Malpighian corpuscle leads into a tubular portion.

It is turned into many coils called proximal Convoluted tubule.

> It leads into a U-shaped portion called Henle's loop.

=> It has three regions, namely a proximal descending limb, a middle thin segment and a distal ascending limb.

-> the ascending limb leads into another coiled portion called distal convoluted tubule.

-> It opens into the collecting tubule.

-> The entire uriniferous tubule is closely associated with a network of capillaries.

(17)

Female Reproductive System (F

The female reproductive system consis
of a pair of ovaries.

-> They are located behind the kidney in the abdominal cavity.

-> They are attached to the dorsal body wall by a double fold of peritoneum called mesovarium.

-> The ovary contains many button-like projections called Graffian follicles.

-> Each Graffian follicle encloses an egg

-> A pair of oviducts starts by the side of the ovaries.

-> The oviduct opens into the abdominal cavity of the ovary by a funnel like st called oviducal funnel. The opening is called ostium.

-> The oviducal funnel leads into a coiled tube called fallopian tube.

-> The fallopian tube leads into a wider tube called uterus.

Respiratory system - Mammals.

Rabbit is a terrestrial animal. So it exhibits aerial or pulmonary respiration where atmospheric air is used by lungs.

The respiratory system consists of two components (i) Respiratory tract & (ii) Respiratory organs.

Respiratory tract.

Respiratory tract is the passage through which air passes from the atmosphere to the lungs and back. It consists of following parts.

The respiratory system communicates to the exterior by a pair of openings called external nares. They are situated at the tip of the snout.

The ext. ~~cha~~nares lead into two chambers called nasal chambers or olfactory chambers.

They are situated above the buccal cavity and are seperated from ~~by~~ the " by the ~~pla~~ plate.

The nasal chamber has three functions.

The nasal chamber functions as the organ of smell.

It brings up the temperature of the inhaled air to that of the body.

(19) The hairs present in the nasal chamber function as a sieve to filter the dust particles of the air.

The two nasal chambers opens into the pharynx by a pair of openings called internal nares.

Where the internal opening nares open is called nasopharynx.

The floor of the pharynx has a slit-like opening called glottis.

The glottis leads into a chamber called Larynx. It serves as the voice box.

The wall of the larynx is supported by 4 cartilages, namely a thyroid cartilage, a cricoid cartilage, two arytenoid cartilages.

Respiratory organs or Lungs

Lungs are the aerial respiratory organs.

Rabbit has a pair of lungs like other vertebrates.

They lie inside the thoracic cavity one on either side of the heart.

Each lung is enclosed by two membranes called pleura. The outer membrane is called parietal pleuron. Inner membrane is called visceral pleuron.

A narrow space lies between the two pleura. It is called pleural cavity.

- It is filled with a lubricating watery fluid called pleural fluid.
- It lubricates the pleura and prevents friction when the lungs expand and contract.
- The lungs are soft, spongy, elastic organs.
- They are pink in colour. The left lung is divided by a cleft into two lobes, namely a left anterior lobe and a left posterior lobe.
- The right lung is divided into 4 lobes.

(1) Anterior azygos lobe ③ right anterior lobe
(2) posterior " " ④ right posterior "

- In each lung, the bronchioles divide into fine tubules called alveolar ducts.
- Each alveolar duct opens into a chamber called alveolar sac or infundibulum.
- The alveolar sac gives out several small pouches called alveoli or air sacs. A group of alveoli looks like a bunch of grapes.
- The wall of alveolus is extremely thin and is made up of elastic connective tissue fibres and surrounded by a fine network of capillaries.

Mechanism of Respiration.

Respiration is taking in of oxygen and giving out of Co_2. It occurs in two stages, namely inspiration & expiration.

Inspiration.

Inspiration is a stage of respiration where atmospheric air is brought into the lungs and from the lungs O_2 diffuses into the blood and Co_2 diffuses into the lungs. It is an active process.

During inspiration the atmospheric air takes the following route:

External nostril → Nasal chamber → Internal nostril → Nasopharynx → Glottis → Larynx → Trachea → primary bronchi → secondary bronchi → Tertiary bronchi → Bronchioles → Alveolar ducts → Infundibulum → Alveoli → Blood.

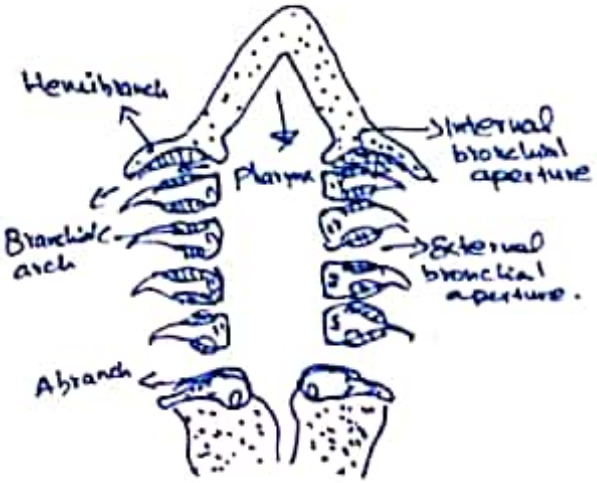
The inspiration is brought about by the breathing movement.

Expiration:

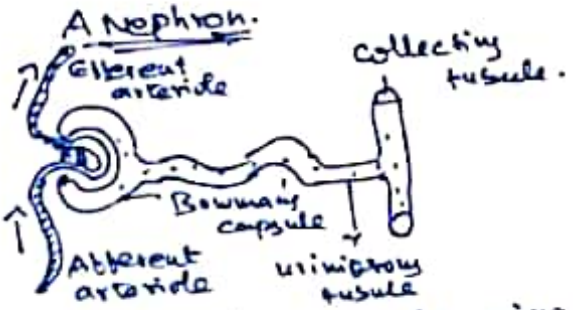
Expiration is a stage of respiration where air from the lungs passes out through the external nare. It is a passive process.

PISCES

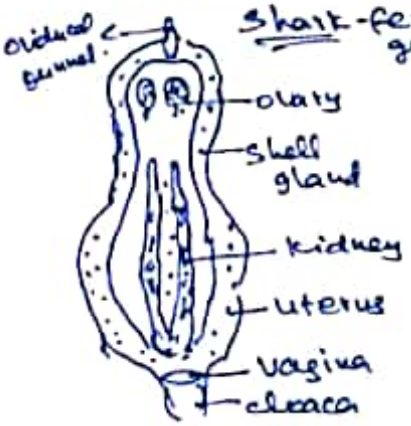
Shark - Respiratory System.



A Nephron.

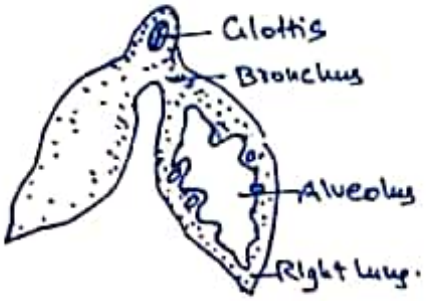


Shark - female urino genital system

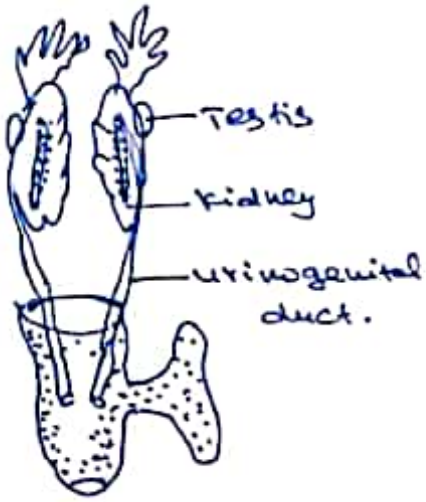


(Amphibia)

Frog: LUNGS

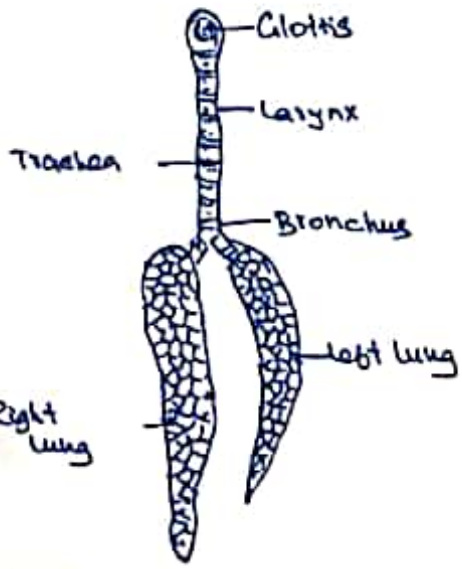


Male urinogenital system: Frog.

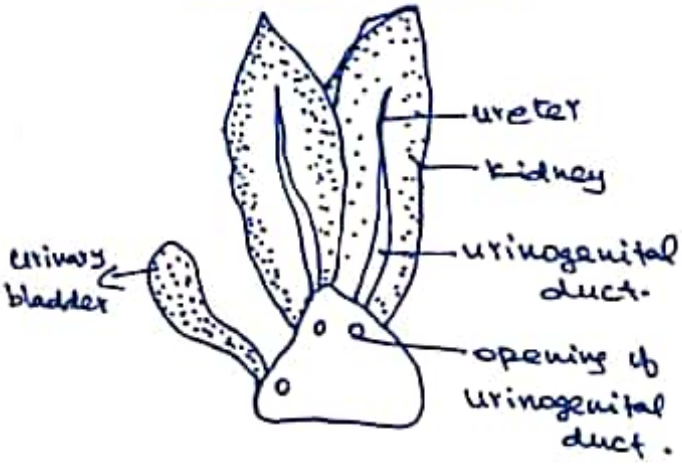


REPTILIA

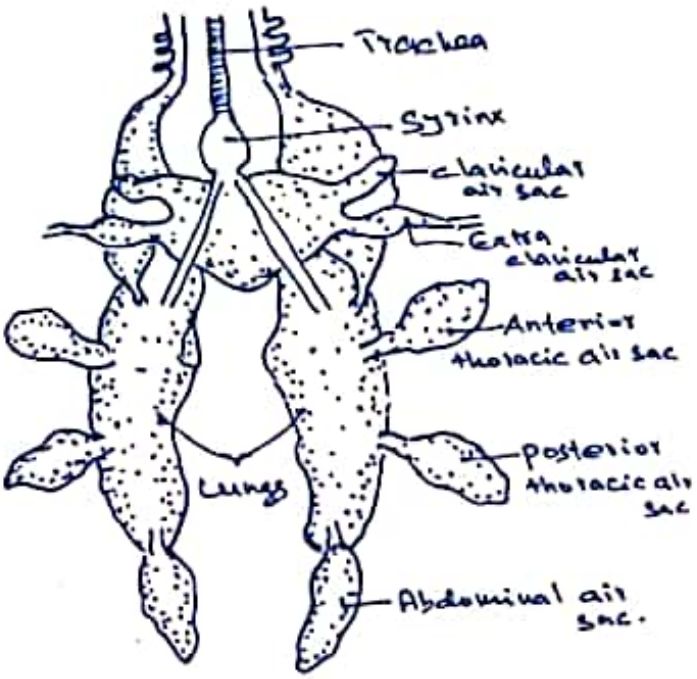
Calotes - Respiratory System



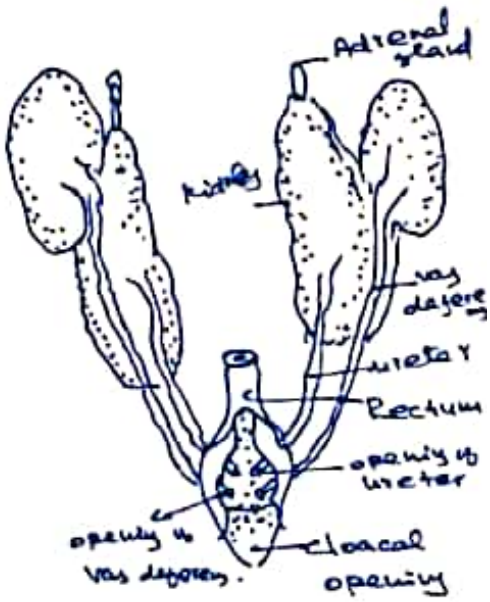
Urinogenital System.



Pigeon- Respiratory system

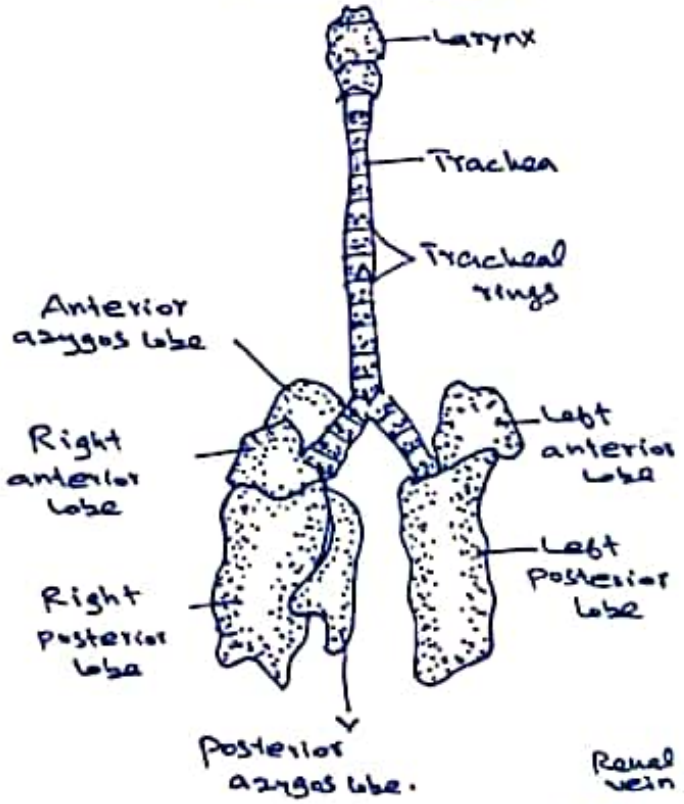


Pigeon
Male Reproductive system.

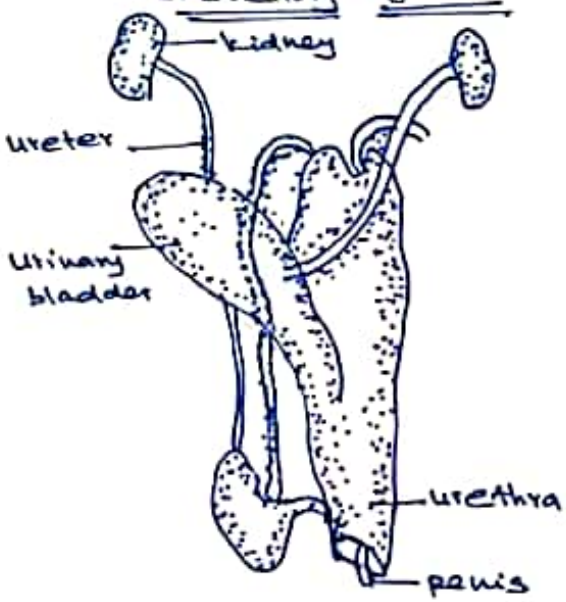


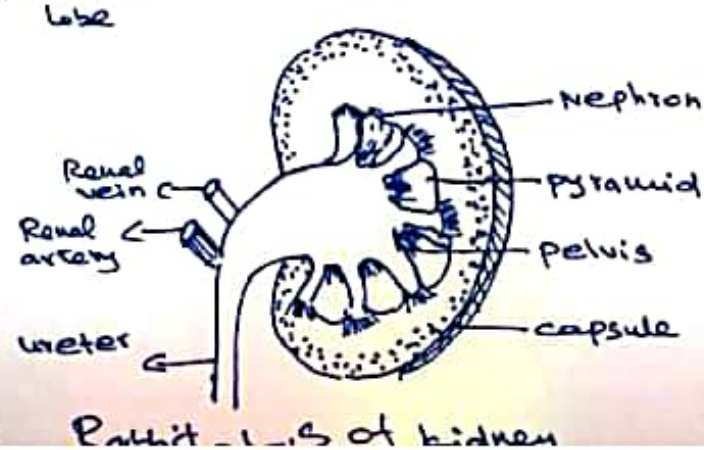
Rabbit

Respiratory System.



Excretory system.





Rabbit - L.S of kidney

Unit - V

Part - A

1) Gills of shark
2) Buccopharyngeal respiration.
3) Malpighian corpuscle
4) Air Sacs

Part - B.

1) Give a brief account of Exoskeleton of birds?
2) Give an account of Respiratory system of shark.
3) What is pulmonary Respiration? Explain the mechanism of pulmonary Respiration in Amphibia?
4) Describe the urinogenital system of cololes.

Part - C

1) Compare the Exoskeleton of fishes with that of pigeon.
2) Compare the Respiratory system of birds with that of mammals (Rabbit).
3. Explain the urinogenital system of frog.