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CHORDATA

(Subject: Zoology)

M.Sc. II SEM

- Brief and Intensive Notes
- Multiple Choice Questions

Based On NEP 2020

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CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY, KANPUR

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Unit- I

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Origin and general characters of Chordata:

- All the chordates possess three outstanding unique characteristics at some stage in their life history. These three fundamental morphological features include :

(1) A dorsal hollow or **tubular nerve cord**

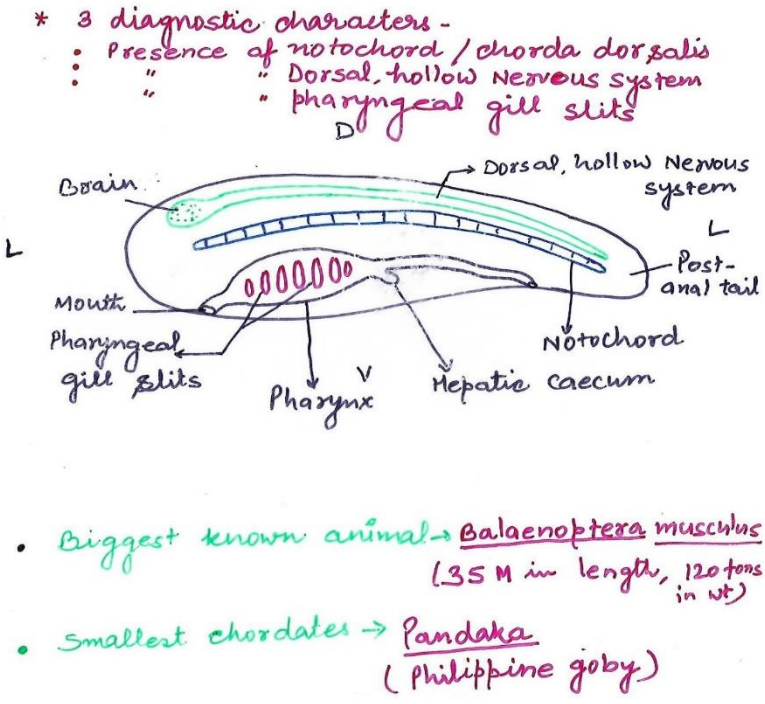
(2) A longitudinal supporting rod-like **notochord**

(3) A series of **pharyngeal gill slits**

- **Dorsal hollow nerve cord.** The central nervous system of the chordates is present dorsally in the body. It is in the form of a longitudinal, hollow or tubular nerve cord lying just above the notochord and extending lengthwise in the body. The nerve cord or *neural tube* is derived from the dorsal ectodermal **neural plate** of the embryo and encloses a cavity or canal called neurocoel. There are no distinct ganglionic enlargements. The nerve cord serves for the integration and coordination of the body activities.
- In vertebrates, the anterior region of nerve cord is specialized to form a cerebral vesicle or brain which is enclosed by a protective bony or cartilaginous cranium. The posterior part of nerve cord becomes the *spinal cord* and protected within the vertebral column.
- **Notochord or chorda dorsalis.** The notochord is an elongated rod-like flexible structure extending the length of the body. It is present immediately beneath

the nerve cord and just above the digestive canal. It originates from the endodermal roof of the embryonic archenteron.

- Structurally, it is composed of large vacuolated *notochordal cells* containing a gelatinous matrix and surrounded by an outer fibrous and an inner elastic sheath. Tht notochord is the prime diagnose feature of the Phvlum Chordata which derives its name from it, it serves as a support or internal skeleton and is not to be confused with the nerve cord.
- Protochordates have a typical notochord. In adult vertebrates, it is surrounded or replaced by the vertebrate Column.
- **Pharyngeal gill slits.** In all the chordates, at some stage of their life history, a series of paired lateral *gill clefts* or *gill slits* perforate through the pharyngeal wall of the gut behind the mouth. These are variously termed as pharyngeal, branchial and visceral clefts or pouches. They serve primarily for the passage of water from the pharynx to outside, thus bathing the gills for respiration. The water current secondarily aids in filter feeding by retaining food particles in the pharynx.



- In protochordates (e.g. *Bronchia stoma)* and lower aquatic vertebrates, the gill slits are functional throughout life. But, in higher vertebrates, they disappear or become modified in the adult with the acquisition of pulmonary respiration.

Other Characters of Chordates:

- These include bilateral symmetry, three germinal layers, segmentation, organ-system level of organization, cephalization, coelom, endoskeleton, complete digestive tract, special organs for respiration and excretion, closed circulatory system, separate sexes, gonads with gonoducts and without asexual reproduction.
- Phylum Chordata can be divided into two groups: A. Acrania (Protochordata) and B. Craniata (Euchordata) which show contrasting characters.
- Group A. **Acrania (Protochordata)**: (Gr., a = absent; kranion = head or Gr., protos = first; chorde = cord). All are marine, small, primitive or lower chordates. No cranium, jaws, vertebral column, paired appendages. About 2,000 species.
- The Acrania is divided into three subphyla- Hemichordata, Urochordata and Cephalochordata.
- **Subphylum I. Hemichordata:** (Gr., hemi = half; chorde = cord). Body divided into **3 regions**- proboscis, collar and trunk. Notochord doubtful, short confined to proboscis and non-homologous with that of chordates.
- **Class 1. Enteropneusta**: (Gr., enteron = gut; pneustos = breathed). Body large and worm-like. Gill-slits numerous and paired. Alimentary canal straight. Acorn or tongue worms. Enteropneusts include 3 families, 15 genera and 70 species. Examples- *Balanoglossus, Saccoglossus, Ptychodera*.
- **Class 2. Pterobranchia**: (Gr.,pteron = feather; branchion = gill). Body small and compact. Gill-slits one pair or none, never U shaped. Alimentary canal U-shaped. Pterobranchs include 2 orders, 3 genera and 20 species. Examples- *Cephalodiscus, Rhabdopleura*.
- **Class 3. Planctosphaeroidea**: Transparent, round and specialised tornaria larva possessing extensively branched ciliary bands. Alimentary canal L-shaped. *Planctosphaera pelagica* is a representative of this class. This form is supposed to be specialized tornaria larva of some unknown hemichordate.

- **Class 4. Graptolita:** The fossil graptolites (e.g., *Dendrograptus*) were abundant in Ordovician and Silurian periods. These are often considered as an extinct colonial class of Hemichordata. Their tubular chitinous skeleton and colonial habits show an affinity with *Rhabdopleura.*
- **Subphylum II. Urochordata or Tunicata:** (Gr., oura = a tail; L., chorda = cord). Notochord and nerve cord in tail only in minute free-swimming tadpole larva. Adult sac-like, covered with tunic (test) often transparent; usually no notochord nerve cord reduced to ganglion; no coelom, segmentation or nephridia.
- **Class 1. Ascidiacea:** Sessile tunicates with scattered muscles in tunic. Solitary, colonial or compound. Gill-slits many; tunic well developed, permanent. **Ascidians or sea squirts**. Include 3 orders, 12 families, 37 genera and 1,200 species. Examples- *Herdmania, Ciona* and *Molgula.*
- **Class 2. Thaliacea:** Free-swimming or pelagic tunicates with circular muscle bands in tunic. Salpians and chain tunicates. Include 3 orders, 5 families, 9 genera and 30 species. Examples- *Salpa, Doliolum, Pyrosoma.*
- **Class 3. Larvacea or Appendicularia**: Tiny transparent, free-floating. Adults retain many larval features including tail. Only two gill-slits. Tunic not persistent. Include 2 orders, 2 families, 5 genera and 3 species. Examples- *Oikopleura, Appendicularia.*
- **Subphylum III. Cephalochordata:** (Gr., kephale = head; L., chorda = cord). Notochord and nerve cord present throughout life along entire length of body. Include 1 class, 1 family, 2 genera and 30 species. Class Leptocardii: Body fish-like, segmented with numerous gill-slits. Free-swimming and burrowing. Lancets. Examples- *Branchiostoma* (= *Amphioxus*), Asymmetron.
- **Group B. Craniata:** Aquatic or terrestrial, usually large-sized, higher chordates or vertebrates with distinct head, a vertebral column, jaws and brain protected by a cranium or skull.
- The craniata includes a single subphylum Vertebrata.

- **Subphylum IV. Vertebrata:** (L., vertebratus = backbone). Notochord supplemented or replaced by a vertebral column or backbone comprising of overlapping vertebrae. Body divisible into head, neck, trunk and tail. Usually dioecious. Vertebrata is the largest chordate subphylum including about **45,000 species**.
- The Subphylum Vertebrata is divided into two divisions: 1. Agnatha and 2. Gnathostomata
- **Division I. Agnatha:** (Gr., a = not; gnathos = jaw). lawless fish-like vertebrates without true jaws and paired limbs.
- **Class 1. Ostracodermi:** (Gr., ostrakon = shell; derma = skin). Several extinct orders of ancient primitive heavily armoured. Palaeozoic, world's first vertebrates, collectively called the ostracoderms. Examples – *Cephalaspis, Pteraspis, Birkenia, Thelodus.*
- **Class 2. Cyclostomata:** (Gr., cyclos = circular; stoma = mouth). Body eel-like, long, cylindrical, skin smooth; without scales, jaws and lateral fins. Mouth rounded and suctorial. Gills 5 to 16 pairs. Heart 2-chambered. Parasites and scavangers. About 50 species. Examples- *Lampreys* (*Petromyzon*) and hagfishes (*Myxine*).
- **Division II. Gnathostomata:** (Gr., gnathos = jaw; stoma = mouth). Jawed vertebrates having true jaws and paired limbs. Gnathostomata has been further divided into two superclasses: 1. Pisces and 2. Tetrapoda. All the fishes and fish-like aquatic gnathostomes in the superclass Pisces, whereas all the four-footed terrestrial gnathostomes in the superclass Tetrapoda.
- **Superclass 1. Pisces:** (L., piscis = fish). Fishes or fish-like aquatic forms with paired as well as median fins, gills and scaly skin.
- **Class 1. Placodermi:** Several extinct orders of primitive earliest jawed fishes of Palaeozoic with bony head shield. Placoderms. A full-sized functional gill-arch precedes hyoid arch. Examples – *Climatius, Dinichthys.*
- **Class 2. Chondrichthyes:** (Gr., chondros = cartilage; ichthys = fish). Mostly marine. Cartilaginous endoskeleton. Skin with minute placoid scales. Gill-slits not covered with operculum. Mouth and 2 nostrils ventral. Males with claspers.

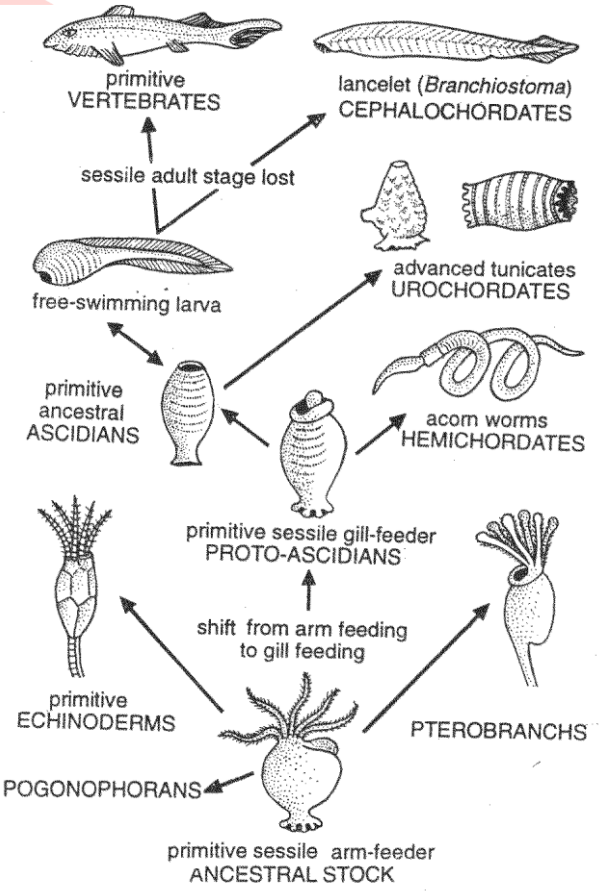
Cartilaginous fishes. Approximately 600 species. Examples-: *Scoliodon* (dogfish), *Chimaera* (ratfish).

- **Class 3. Osteichthyes:** (Gr., osteon = bone; ichthys = fish). Freshwater and marine. Bony endoskeleton. Skin having various types of scales (cycloid, ctenoid) other than placoid. Gill-slits covered with operculum. Males without claspers. Bony fishes. Approximately 20,000 species. Examples – *Labeo* (rohu), *Protopterus* (lungfish), *Hippocampus* (sea horse). Superclass
- **2. Tetrapoda:** (Gr., tetra = four; podos = foot). Land vertebrates with two pairs of pentadactyle limbs, comified skin with lungs.
- **Class 1. Amphibia:** (Gr., amphi = both; bios = life). Larval stage usually aquatic and breathes by gills. Adults typically terrestrial and respires by lungs. Living forms with moist glandular skin, no external scales. Typically 2 pairs of limbs, nostrils connecting mouth cavity. Heart 3-chambered. Amphibians. Approximately 2,500 species. Examples- *Rana* (frog), *Bufo* (toad), *Ambystoma* (salamander).
- **Class 2. Reptilia:** (L., reptilis = covering). Terrestrial and aquatic tetrapods. Skin dry covered by ectodermal horny scales or scutes. Limbs typically 4, each with 5 clawed toes. Skeleton bony. Heart incompletely 4-chambered. Cold blooded. Respiration by lungs. Approximately 7,000 species. Examples- *Hemidactylus* (wall lizard), *Uromastix* (spiny-tailed lizard), *Naja* (cobra), *Sphenodon* (tuatara), *Crocodilus* (crocodile).
- **Class 3. Aves:** (L., avis = bird). Body covered with feathers. Forelimbs modified as wings usually adapted for flight. Hindlimbs for walking, perching or swimming. No teeth in beak. Heart 4-chambered. Lungs compact, with air-sacs. Warm blooded. Birds. About 9,000 species. Examples- *Struthio* (African ostrich), *Columba* (pigeon), *Gallus* (fowl).
- **Class 4. Mammalia:** (L., mamma = breast). Body usually covered with hair. Skin with various glands. Female with mammary glands which secrete milk for suckling the young. Heart 4-chambered. Warm blooded, air breathing

vertebrates. Mammals. Approximately 4,500 species. Examples- *Echidna* (spiny anteater), *Macropus* (kangaroo), Rattus (rat), *Homo* (man).

Origin of Chordates:

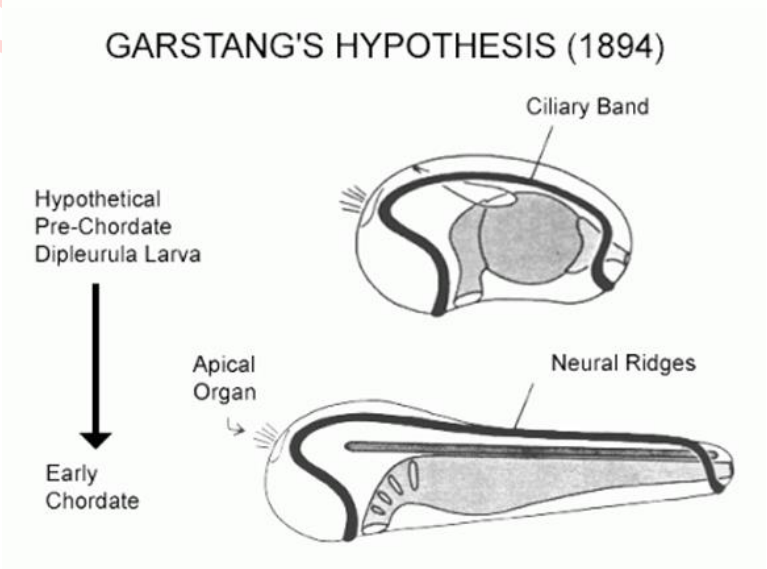
- The earliest known truly vertebrate animals were freshwater forms, abundant during the late Silurian and middle Devonian periods. Their fossils are collectively known as *ostracoderms.* They are placed with living cyclostomes (lampreys, hagfishes), in the jawless group called *Agnatha.*
- As their name refers to, 'their body was covered by a dermal bony armour forming an elaborate rounded solid shield on the head. Like cyclostomes, they had presumably a persistent notochord and no vertebrae.
- The mouth was anterior, ventral and lacked jaws and teeth. They had no paired appendages homologous with those of vertebrates. Paired eyes, median nostrial and pineal eye were present. A variable number of pharyngeal gill pouches opened by lateral common or separate gill openings. They were adapted for filter feeding.
- The oldest fragmentary fossils belonging to ostracoderms occur in the late Cambrian and middle Qrdovician. Absence of any vertebrate fossils in rocks older than the Cambrian, permits only speculation about the earlier history of the vertebrates. Which group was ancestral to the first tree vertebrates (ostracoderms)? In fact there have been no fossils intermediate between the ostracoderms, which are already vertebrates, and any other earlier group of animals.



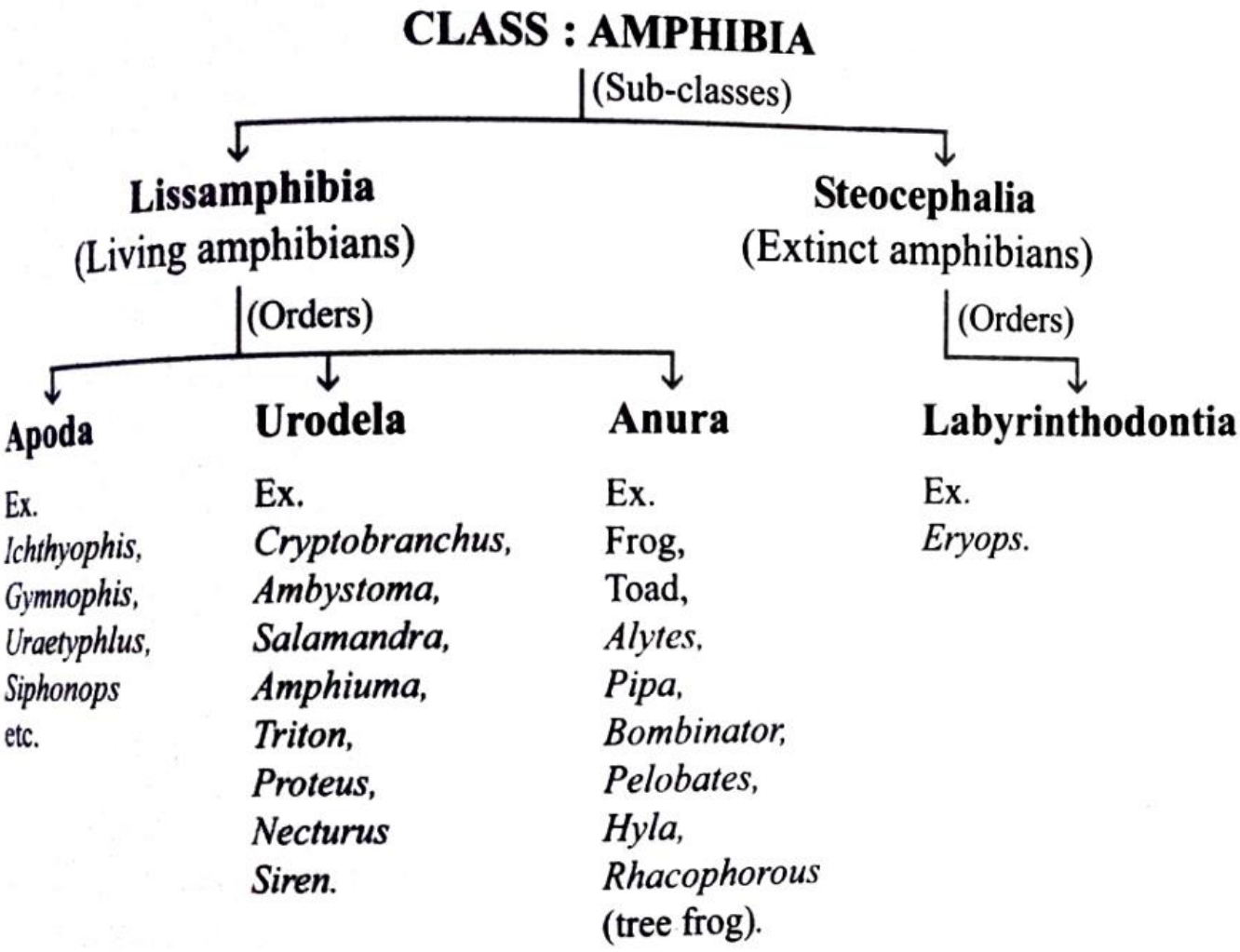
- As a result, there has been a great deal of speculation about the time of origin and the early progenitors of the vertebrates (chordates). Probably the vertebrate organisation had been evolving for several millions of years before the appearance of the first, late Cambrian fossils.
- The American geologist Chamberlain gave the idea of **freshwater origin of vertebrates, in 1900**. It was also supported by Romer and Homer Smith. They argued that dilute body fluids, compared to sea water, and the glomerular kidney to get rid of excess water evolved as adaptations to freshwater conditions.
- However, evidence for a marine origin of vertebrates is also overwhelming. The protochordates and deuterostome invertebrate phyla are exclusively marine forms. All known Cambrian and Ordovician vertebrates also occur as marine fossils.
- **THEORIES ABOUT ORIGIN OF CHORDATES**: It is believed that Chordates have originated from invertebrates. It is difficult to determine from which invertebrate group the chordates were developed. Chordate ancestors were soft bodied animals. Hence they were not preserved as Fossils. Many biology theories were put forward to explain the Origin of Chordates.
- **1. COELENTRATE THEORY** - According to this theory chordates were developed from coelenterates. Radial symmetry, coelenteron, cnidoblasts etc, presence of these characters indicated that coelentrates give rise to chordates. This theory infers that chordates might have acquired higher characters independently. It is not correct and hence this theory is not acceptable.
- **2. ANNELID THEORY -** This theory suggests that the chordates have evolved from an annelid stock. The annelids show bilateral symmetry, metamerism, head, lateral Coelom complete digestive tract, closed circulatory system, hemoglobin, etc., like chordates. Difference like Coelom is schizocoelic in annelids and enterocoelic in lower chordates. Haemoglobin is dissolved in the plasma in annelids but it is present in the red blood corpuscles in chordates. Annelid nerve cord is double, and, ventral in contrast to single, hollow, dorsal

nerve cord of chordates. Some striking differences exist between the annelids and the chordates in their embryology. Hence this theory is not acceptable.

- **3. ECHINODERM - HEMICHORDATE THEORY -** This theory infers origin of chordates, hemichordates and echinoderms from a common ancestor. This is the **Garstang's theory**. It proposes that the origin of chordates, which took place about 570 million years ago during the Precambrian, must be from some deuterostomes (animals in which the mouth is not formed from the blastopore of the early stages of development and that includes echinoderms, hemichordates and chordates).
- It is based on the following facts-
- a) EMBRYOLOGICAL EVIDENCE - Both echinoderms and chordates have enterocoelic coelome, mesoderm and deuterostomous mouth. There is resemblance between the bipinnaria larva of certain echinoderms and the tornaria larva of hemichordates. In echinoderms chordates the central nervous system develops from a dorsal strip of ectoderm.
- b) SEROGICAL EVIDENCE - A close similarity exists between the proteins of the body-fluid of chordates and echinoderms. Hence the chordates are more related to echinoderms. The generalised chordate ancestry is as follows: This was suggested by **N. J. Berrill**, (1953) in his book "The origin of Vertebrates".
- ECHINODERM - AURICULARIA - HEMICHORDATA - TORNARIA - PROTO CHORDATE - ASCIDIAN TADPOLE - FREE SWIMMING CHORDATE
- Hyman (1959) and others concluded that all the three groups have a common ancestor, Echinoderms and hemichordates branched off from a common evolutionary line which ended in the chordate group.



Classification of class Amphibia:



- The amphibians are the **first vertebrate** to become adapted for terrestrial and aquatic life. But they are not fully terrestrially adapted and however between aquatic and land environments.
- The name of class also indicate this double life (Gr; amphi= dual, double + bios= life). Structurally, Amphibia are between the fish on one hand and reptiles on the other.
- General Characters - Aquatic or semiaquatic (fresh water), air and water breathing, carnivorous, cold blooded (poikilothermal), oviparous, tetrapod vertebrates.

- **Head** distinct, trunk elongated. Neck and tail may be present or absent. Limbs usually two pairs (tetrapod), some limbless. Toes 4-5 (pentadactyle) or less. Paired fins absent. Median fins if present, without fin rays.
- **Skin** soft, moist and glandular. Pigment cells (chromatophores) present. Exoskeleton absent. Digits clawless. Some with concealed dermal scales.
- **Endoskeleton** mostly bony. Notochord does not persist. Skull with two occipital condyles.
- Mouth large. Upper or both jaws with small homodont teeth. Tongue often protrusible. Alimentary canal terminal into cloaca.
- **Respiration** by lungs, skin and mouth lining. Larvae with external gills which may persist in some aquatic adults.
- **Heart** 3-chambered (2-auricle and 1-ventricle). Sinus venosus present. Aortic arches 1-3 pairs. Renal and hepatic portal systems well developed. Erythrocytes large, oval and nucleated.
- **Kidneys** mesonephric. Urinary bladder large. Urinary ducts open into cloaca. Excretion ureotelic.
- **Brain** poorly developed. Cranial nerves 10 pairs. Nostrils connected to buccal cavity. Middle ear with a single root like ossicle, columella.
- Larval forms and some aquatic adults with lateral line system. Sexes separate. Male without copulatory organ. Gonoducts opens into cloaca.
- **Fertilization** mostly external. Females mostly oviparous. Development is indirect. Cleavage is holoblastic but unequal. No extraembryonic membranes. Larva a tadpole which metamorphosis into adult.
- The living amphibians are represented by about 2500 species. They dominated the world during carboniferous, but most of them have become extinct since long.
- **G. Kingsley Noble (1924)** recognized 3 orders of extinct and 3 orders of living amphibians.
- **Subclass I: Stegocephalia (Extinct)** Limbs pentadactyle. Skin with scales and bony plates. Skull with a solid bony roof, living openings for eyes and nostrils. Permian to Triassic.

- Order 1: Labyrinthodontia - Oldest known tetrapod called stem Amphibia. Fresh water or land forms. Salamander or crocodile like. Teeth large with characteristically much folded dentine similar to their crossopterygian ancestors.Carboniferous to Triassic. Example: *Eryops.*
- Order 2: Phyllospodyli- Small salamander-like. Head large, flat. Vertebrae tubular. Notochord and spinal cord housed in common cavity. Believed to be ancestors of modern salientia and urodela. Carboniferous to Permian. Example: *Branchiosaurs* (*Ichthyostega*).
- Order 3: Lepospondyli - Small salamander or eel-like. Vertebrae cylindrical, each made of a single piece. Neural arch and centrum continuous. Ribs articulating intervertebrally. Regarded ancestral to modern caecilians (Gymnophiona). Carboniferous to Permian. Example: *Diplocaulus, Lysorophus.*
- **Subclass II: Lissamphibia (living)** Modern Amphibia lacking dermal bony skeleton. Teeth small simple.
- **Order 1: Gymnophiona or Apoda** (Gr; gymnos= naked + ophioneos= serpent-like) or (Gr; a= without + podos= foot) Limbless, blind, elongated worm like, burrowing tropical forms known as caecilians. Tail short or absent, cloaca terminal. In some dermal scales embedded in skin which is transversally wrinkled. Skull compact, roofed with bone. Limb girdle absent. Males have protrusible copulatory organs. Example: About 55 species. *Ichthyophis, Uroaeotyphlus.*

Caecilians

- **Order 2: Urodela or Caudata** (Gr; Ura= tail + delos= visible) or (L; cauda= tail) Lizard like amphibians with a distinct tail. Limbs 2 pairs, usually weak, almost

equal. Skin devoid of scales and tympanum. Gills permanent or lost in adults. Males without copulatory organs. Larvae aquatic, adult-like, with teeth.

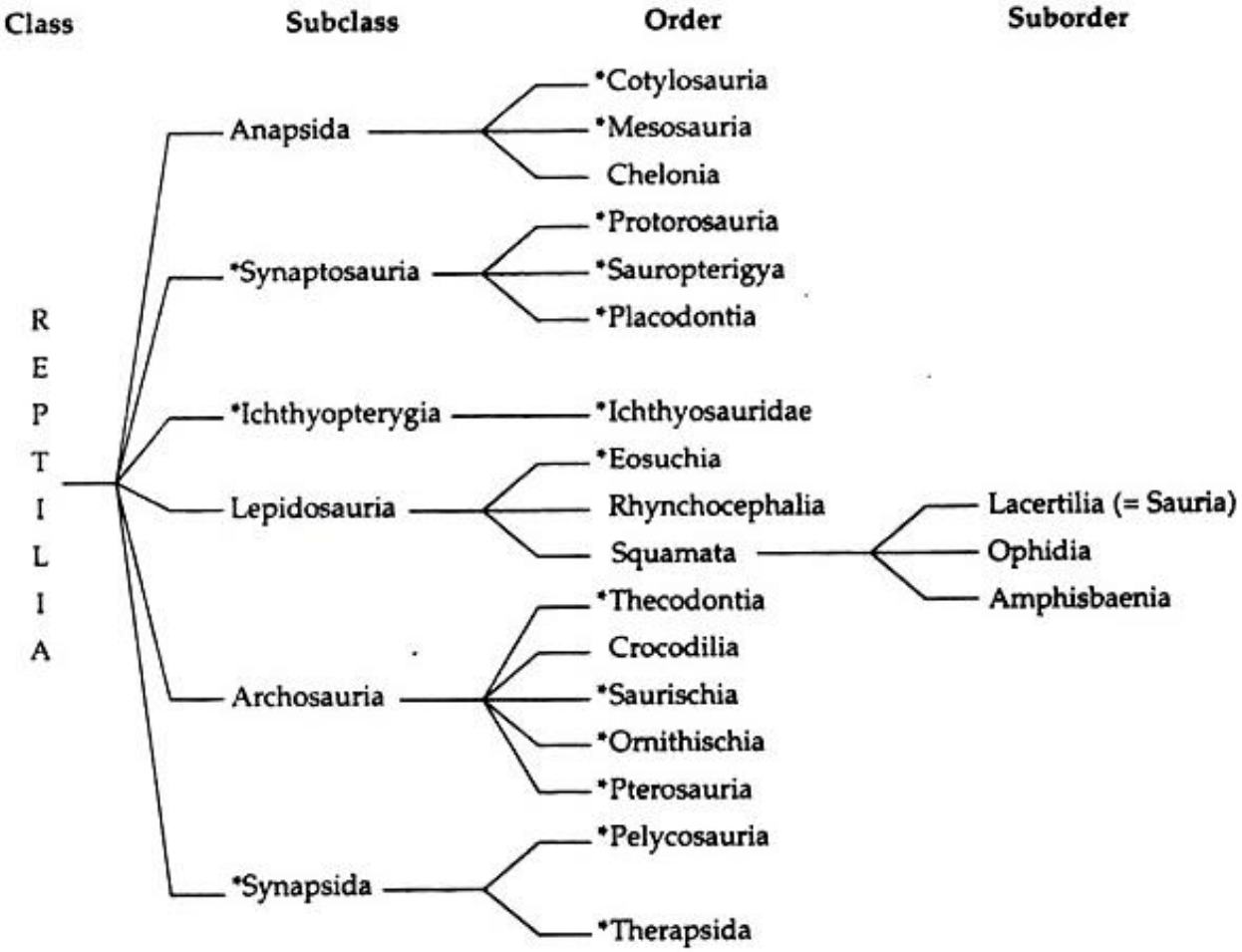
- About 300 species in 5 suborders. Suborder 1: Cryptobranchoidea Most primitive. Permanently aquatic. Adults without eyelids and gills. Angular and prearticular separate. Premaxillary spine is short. Fertilization external. Example: *Cryptobranchus, Megalobranchus.*
- Suborder 2: Ambystomatoidea - Adult terrestrial with two eyelids. Angular fuse with prearticular. Premaxillary spine short. Vertebrae amphicoelous. Fertilization internal. Example: *Ambystoma.*
- Suborder 3: Salamandroidea Vertebrae opisthocoelous. Teeth on palate and prevomers. Three sets of cloacal glands. Fertilization internal. Example: *Triton* and *Triturus* (newts), *Salamandra* (Salamander), *Desmognathus, Amphiuma* (Congo eel), *Plethodon.*
- Suborder 4: Proteidae- Aquatic bottom dwellers representing permanent larval forms, without eyelids. Adults with 3 pairs of external gills and 2 pairs of gill slits. Skull cartilaginous, without maxillae. Jaws with teeth. Example: *Proteus* (Olm), *Necturus* (Mud-puppy)
- Suborder 5: Meantes - Aquatic representing permanent larvae. Fore limbs small, hind limbs absent. Three pairs of external gills. Jaws with horny covering. Example: *Siren* (mud eel), *Pseudobranchus.*

Salamanders and Newts

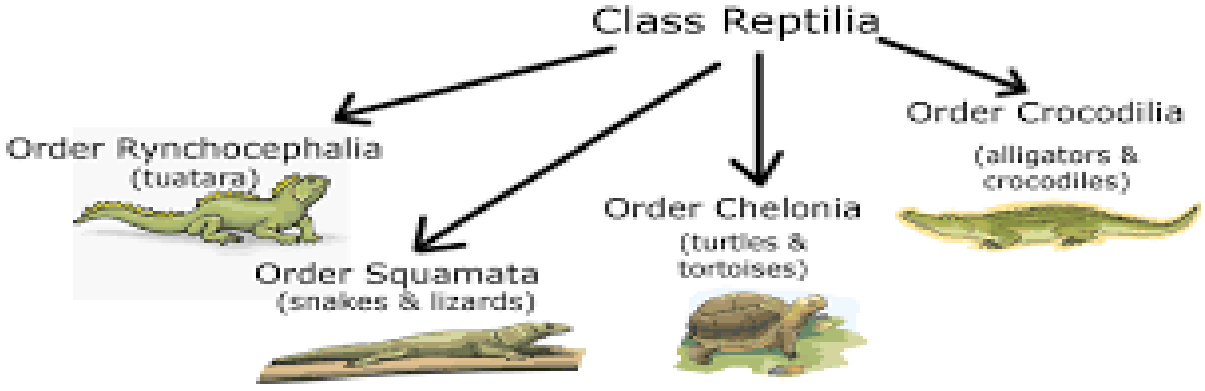
- **Order 3: Salientia or Anura** (L; saliens= leaping) or (Gr; an= without + aura= tail) Specialized Amphibia without tail in adults. Hind limbs usually adapted for leaping and swimming. Adults without gills or gill openings. Eyelids well-formed. Tympanum present. Skin loosely-fitting, scaleless. Mandible toothless.

- Pectoral girdle bony. Ribs absent of reduced. Vertebral column very small of 5-9 presacral vertebrae and a slender urostyle. Fertilization always external. Fully metamorphosed without neotenic forms.
- About 2200 species of frogs and toads in 5 suborders. Suborder 1: Amphicoela Vertebrae amphicoelous. Presacral 9. Free ribs and 2 relict tail muscles. Fertilization internal. Example: *Leopelma, Ascaphus.*
- Suborder 2: Opisthocoela- Vertebrae opisthocoelous. Scapula small. Ribs free in adult or larva. Example: *Alytes* (midwife toad), *Bombinator, Discogiosus, Pipa, Xenopus.*
- Suborder 3: Anomocoela - Vertebrae procoelous or amphicoelous. Free ossified ribs absent. Upper jaw with teeth. Example: *Pleobates, Scaphiopus.*
- Suborder 4: Procoela - Vertebrae procoelous. Presacral 5-8. Urostyle with two condyles. No free ribs. Example: *Bufo* (common toad), *Rhinoderma, Dendrobates, Hyla* (tree toad), *Gastrotheca* (marsupial frog).
- Suborder 5: Diplasiocoela - First 7 vertebrae procoelous, 8th vertebrae amphicoelous sacral or 9th vertebrae convex anteriorly and bears 2 condyles. Pectoral girdle usually fuse to sternum (firmistrnal) Ribs absent. Example: *Rana* (common frog), *Polypedates* or *Rhacophorus* (tree frog).

Classification of Class Reptilia:



❖ **ONLY 4 ORDERS are LIVING**

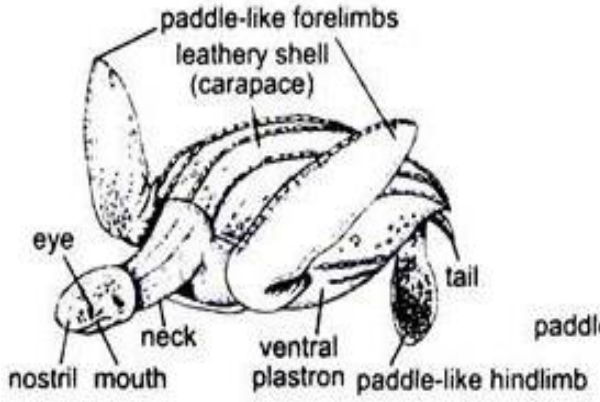


- Reptile represent the first class of vertebrates fully adapted for life in dry place on land. The characters of reptiles are in fact a combination of characters that are found in fish and amphibians on the one hand and in birds and mammals on the other.
- The class name refers to the mode of locomotion- (L; repere or reptum= to creep or crawl), and study reptiles is called Herpetology (Gr; herpeton= reptiles). Predominantly terrestrial, creeping or burrowing, mostly carnivorous, air breathing, cold blooded, oviparous and tetrapodal vertebrates.
- Body bilaterally symmetrical and divisible into 4 regions- head, neck, trunk and tail.
- Limbs 2 pairs, pentadactyle, digits provide with horny claws. However, limbs absent in a few lizards and all snakes.
- Exoskeleton of **horny epidermal scales**, shields, plates and scutes. Skin dry, cornified and devoid of glands.
- Mouth terminal, jaws bear simple conical teeth. In turtles teeth replaced by horny beak. **Alimentary canal** terminates into a cloacal aperture. Endoskeleton bony. Skull with occipital condyle (monocondylar). A characteristic T- shaped interclavical present.
- **Heart** usually 3 chambered, 4 chambered in crocodiles. Sinus venosus reduced. 2 systemic arches present. Red blood corpuscles oval and nucleated. Cold blooded (poikilothermal).
- **Respiration** by lungs throughout life.
- **Kidneys** metanephric. Excretion uricotelic.
- **Brain** with better development of cerebrum than in amphibia. Cranial nerves 10 pairs.
- Lateral line system absent. Jacobson's organs present in the roof of mouth.
- Sexes separate. Male usually with muscular copulatory organ.
- Fertilization internal. Mostly oviparous. Large yolky meroblastic eggs, covered with leathery shells, always laid on land. Embryonic membranes (amnion, chorion, yolk sac and allantois) appear during development. No metamorphosis. Young resembles adults. Parental care usually absent.

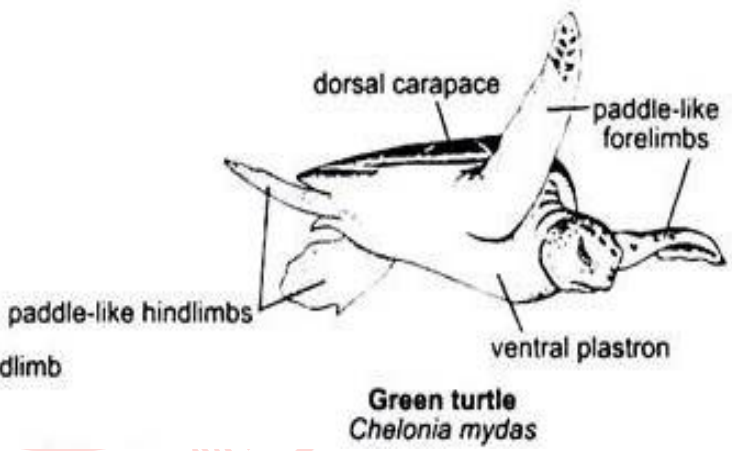
- Class Reptilia is further classified into **6 Subclasses**:
  1. **Anapsida - living**
  2. **Synaptosauria**
  3. **Ichthyopterygia**
  4. **Lepidosauria - living**
  5. **Archosauria - living**
  6. **Synapsida**
- Reptiles (Reptilia) are a diverse group of Vertebrates that includes creatures such as Snakes, Amphisbaenians, Lizards, Alligators, Caimans, Crocodiles, Tortoises, Turtles, and Tuataras.
- There are approximately 7900 species of Reptiles alive today that inhabit a wide range of temperate and tropical habitats including deserts, forests, freshwater, wetlands, mangroves and Open Ocean.
- Reptiles are cold-blooded vertebrates which, unlike Amphibians, possess thick, impermeable skin covered by scales. The Reptilian skeleton differs from other Vertebrates in various ways. For example, Mammals have a single lower jawbone called the mandible but Reptiles have several bones in their lower jaw that enable them with greater bite mobility.
- Also, Reptiles have only one bone in each ear (the stapes) whereas Mammals have three small bones in each ear (the malleus, incus and stapes).
- Reptiles also have only one occipital condyle, a protrusion on the skull that forms a joint that enables movement of the head, while Mammals and Amphibians have two occipital condyles.
- They have lungs, not gills, and usually a three-chambered heart, except for Crocodilians, whose hearts have four chambers. Their eggs are covered with watertight shells; thus they have severed the Amphibians link to water and fully conquered land.
- **Sub-class 1: Anapsida** ("no opening"); 1. Solid roof of the skull 2. No temporal vacuity or fossa in the skull 3. Quadrate is connected to the otic bones. 4. Limbs are generally strong. 5. Body is enclosed in the carapace and plastron.

❖ **Order 1: Chelonia**. Permian to Recent Turtles are distinguished by their large shells, which consist of an outer carapace and a breast-covering plastron. They live throughout the world, in the ocean, in fresh water, and on land in which case they are called Tortoises. Some Turtles are believed to live for more than 150 years. Only distantly related to other living Reptiles, turtles have changed little in the last 300 million years. Described living species are 260.

1. They are terrestrial or aquatic
2. Tetrapoda pentadactyle with walking limbs or paddles.
3. Trunk is enclosed in a bony shell-dorsal carapace and ventral plastron, which may or may not be covered with horny shield.
4. Tail is always present.



Leather back turtle or luth



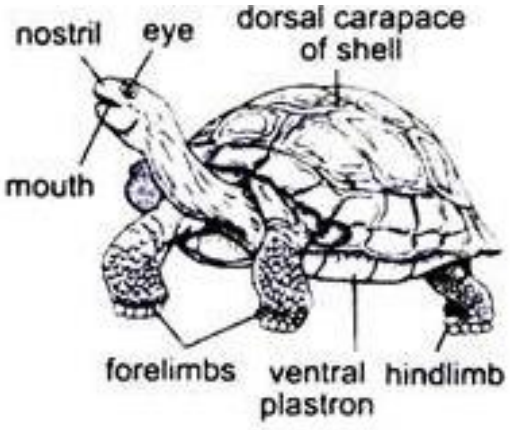
Green turtle
Chelonia mydas

5. Jaws covered with horny epidermal plates, no teeth.
6. Quadrate bone is fixed.
7. Thoracic vertebrae and ribs modified along with epidermal plates usually fused to form the shell.
8. Two sacral vertebrae.
9. Ribs with capitulars portion only.
10. Girdles inside the ribs
11. Humerus with entepicondylar foramen.
12. Pubis and Ischia form symphysis.
13. Copulatory organ is unpaired.
14. Cloacal opening is longitudinal.

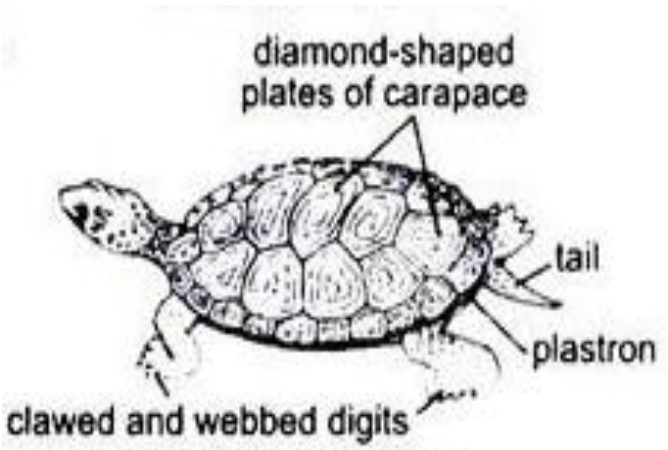
15. Oviparous.

16. Little change since Triassic and are the **oldest living reptile** in the world.

Examples: Chelus, Emys, Chelonia, Testudo.



Galapagos Giant tortoise
Testudo abingdoni



Diamond-back terrapin
Malacolemys

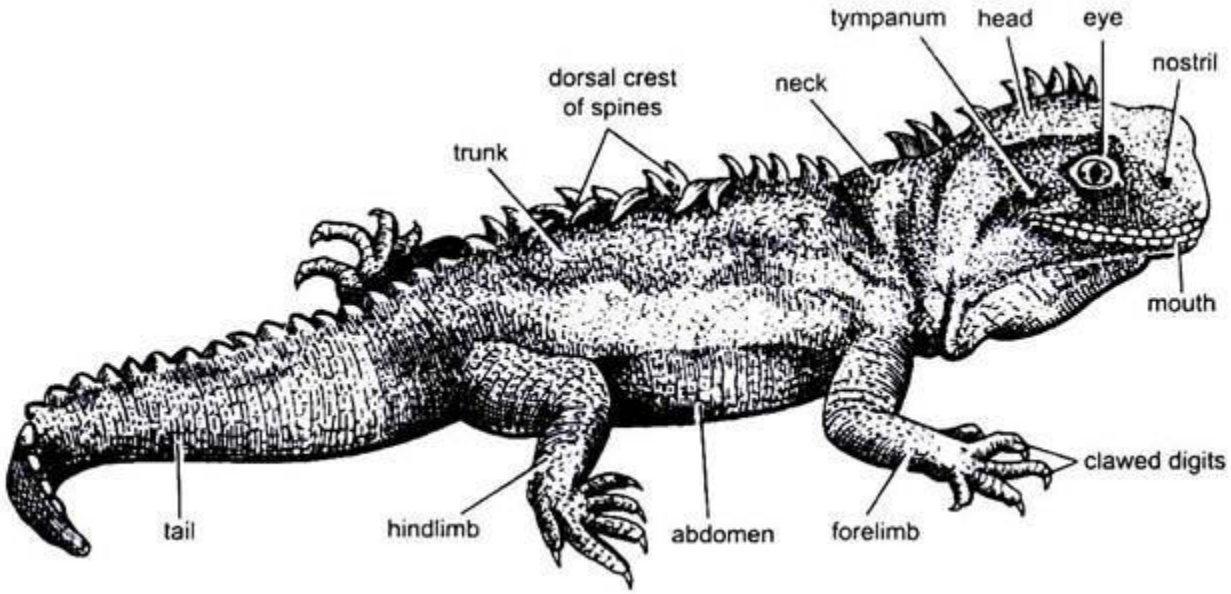
❖ **Sub-class 2: Lepidosauria (Scaly Lizards):** The main feature of the period of Reptilian dominance, the Diapsid skull is found in these animals and which is present in all living Reptiles except the Chelonia and in the birds. The Lepidosauria which includes Sphenodon, the Lizards and Snakes.

1. Two temporal vacuities are present.
2. Anterior orbital vacuities are absent.
3. Post-temporal fenestrae are usually present.
4. Humerus with two foramina.

Order 1: Rhynchocephalia : Triassic to Recent. Only two species remain of this ancient line of Lizard-like Reptiles, which now live only in certain parts of New Zealand.

1. The presence of Two vacuities.
2. Teeth acrodont.
3. An epipterygoid is present.
4. Quadrate bone is fixed or immovable.
5. Parietal foramen is present.
6. Vertebrae amphicoelus.
7. External copulatory organs are entirely absent.

Example: Sphenodon.



Order 2: Squamata: Triassic – Recent

1. Body covered with horny epidermal scales.
2. Single (supra or upper) temporal vacuity in Lizards and no temporal vacuity in Snakes.
3. Skull has lost one or both temporal regions
4. Teeth set in sockets- pleurodont.
5. Quadrate is movable.
6. Vertebrae are usually procoelous.
7. Abdominal ribs usually greatly reduced or absent
8. Limbs present or absent.
9. Cloacal opening transverse.
10. Male possesses a pair of eversible copulatory organs.
11. Contains most modern reptiles.

- There are three groups of Reptiles evolved comparatively recently means in the Jurassic period, so that even today they share certain anatomical similarities and are all put in the same order.
- Examples: Snakes (known from Cenozoic), Lizards (from Cretaceous) and Amphisbaenians (from Eocene).

- Described living species are 6,847.
- **Suborder 1: Lacertilia-** Triassic to Recent The most successful of all the Reptiles, Lizards represent about 54% of Reptilian species. Extremely diverse as well, Lizards live on every continent except Antarctica, and in nearly every conceivable habitat, from deserts to tundras, mountains to oceans

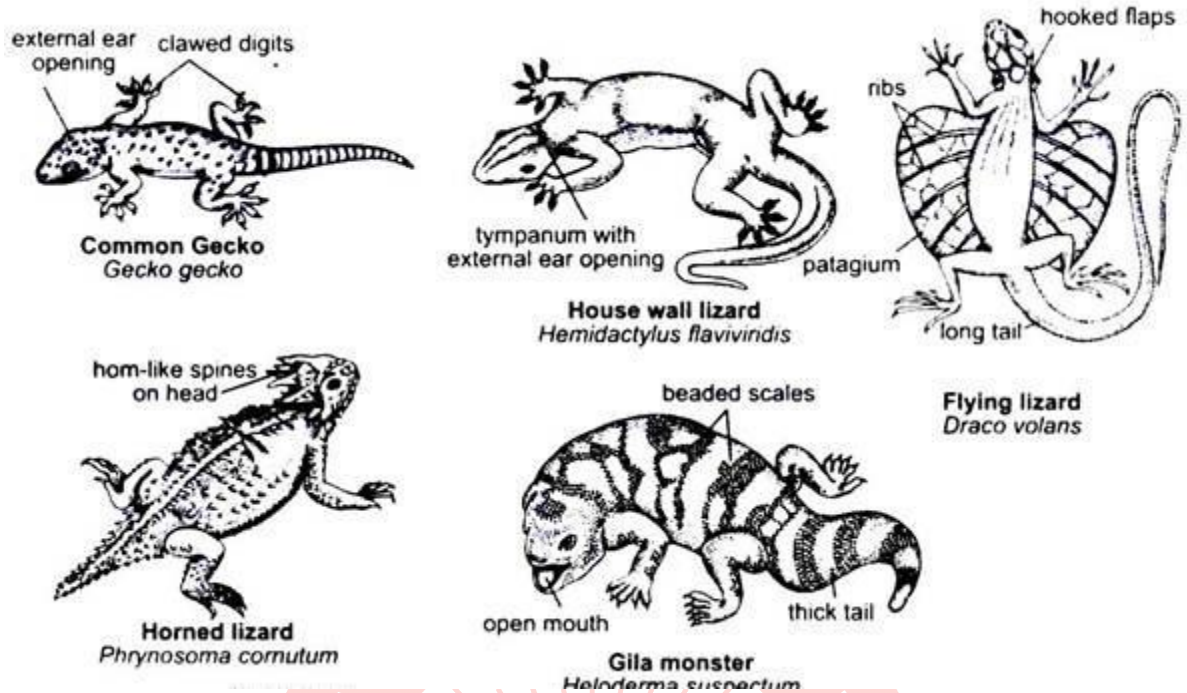
  1. Terrestrial, arboreal or burrowing forms have slender body.
  2. Single (supra or upper) temporal vacuity is present.
  3. Limbs are usually present Tetrapoda and Pentadactyle
  4. The rami of mandibles are fused in front.
  5. Sternum present.
  6. Eyelids movable.
  7. Tympanum present. Familiar examples include Chameleons, Iguanas, Geckos, Skinks, Monitor Lizards & many more.

  Infraorder 1: Gekkota. Mainly Recent Examples: Gekko, Pygopus, Hemidactylus, Ptychozoon

  Infraorder 2: Iguania. Cretaceous to Recent Examples: Iguana, Anolis, Phrynosoma, Draco, Lyrocephalus, Agama, Chamaeleo, Amblyrhynchus, Calotes

  Infraorder 3: Scincomorpha. Eocene to Recent Examples: Lacerta, Scincus

  Infraorder 4: Anguimorpha. Cretaceous to Recent Examples: Varanus, Anguis



Suborder 2: Ophidia: Cretaceous to Recent Snakes: Of all the tetra pods that have lost their limbs (including Caecilians, Sirens, Worm-lizards, and a variety of Lizards), Snakes are by far the most successful. They are exclusively carnivores, and often-fearsome predators. Their muscles have adapted for swift movement; their digestive systems allow them swallow the whole prey and their bodies have adapted to an extremely wide range of environments. They live on every continent except Antarctica.

Described living species are 2647.

1. Terrestrial or aquatic, arboreal or burrowing.
2. Temporal vacuities are entirely absent.
3. Limbs absent.
4. The rami of mandibles are united by a ligament.
5. Sternum absent.
6. Eyelids immovable.
7. Tympanum absent.
8. Tongue is bifid or protrusible.
9. Zygosphene and zygantra are present in the vertebra. Examples: Python, Natrix, Naja, Vipera

Suborder 3: Amphisbaenia or Worm lizards: Recent They are unique. Not only are they limbless, like Snakes; they are also, among living Reptiles, the only specialized burrowers, and live exclusively underground. They inhabit in South America, Africa, Spain, and the Middle East. Described living species are 133. Examples: Amphisbaena

Sub-class 3: Archosauria (The Ruling Reptiles)- They were the dominant land animals during Mesozoic. Crocodiles are the only descendants of this group. The Birds, which are also undoubtedly descendants of this group, give us in some ways a better idea of characteristic structure.

1. Skull with closed upper temporal vacuity but possesses both temporal arches means Diapsid skull.
2. Anterior orbital vacuities are usually present.
3. Teeth are thecodont.
4. Humerus with foramina
5. Vertebrae are amphicoelous or procoelous.
6. Some lines had the tendency to walk on the hind legs like Dinosaurs and Pterosaurs where the hind legs were much longer.

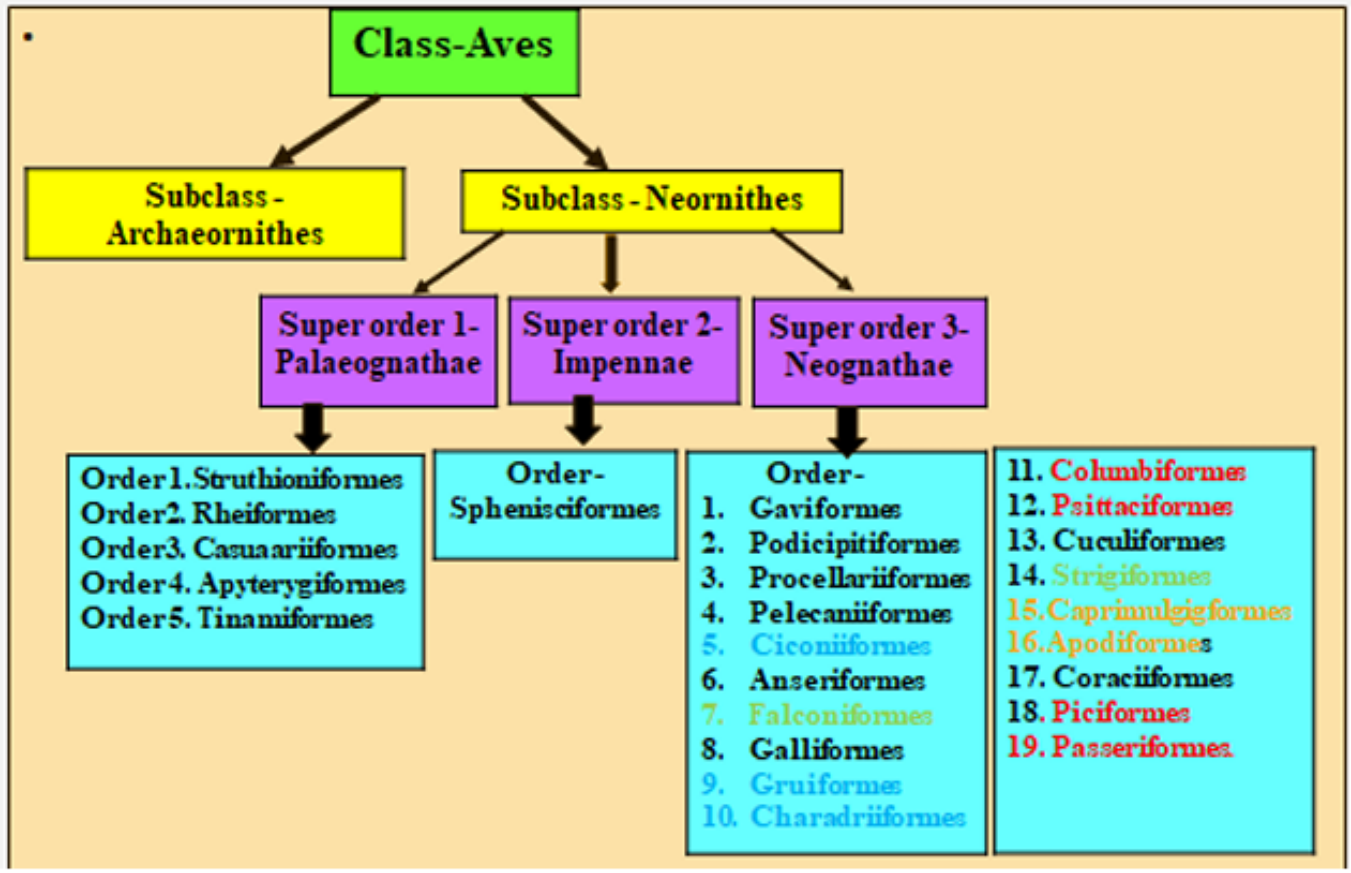
Order 1: Crocodilia: Triassic to Recent

1. They are fresh water or predatory forms.
2. Body is covered with an exoskeleton of thick horny epidermal scales.
3. Bony plates embedded in epidermis
4. Tail is long and laterally compressed.
5. Maxillae, palatines and pterygoids are united along the middle to form a secondary palate.
6. Teeth set in sockets-thecodont.
7. Quadrate immovable- fixed.
8. Both supra and infra arches are present.
9. Vertebrae procoelous.
10. Sternum is present.

11. Cervical vertebrae with two headed ribs.
12. Thoracic ribs possess uncinate process.
13. Abdominal ribs present in Gastralia
14. Prepubis present. Pubis does not share in the formation of acetabulum.
15. Heart is four chambered and Ventricles completely separated into two septum.
16. Lungs are spongy.
17. Cloacal opening longitudinal.
18. "Crop" similar to birds.

Examples: Crocodylus, Alligator, Caiman, Gavialis

Classification of Aves:



- The class Aves (birds) is primarily divided into two subclasses:
- Archaeornithes (extinct, Jurassic birds) and
- Neornithes (modern and some extinct birds).

- ❖ Neornithes is further divided into four superorders, including Palaeognathae (flightless birds like ostriches) and Neognathae (most modern birds). Neognathae contains numerous orders, such as Passeriformes (songbirds), Psittaciformes (parrots), and Galliformes (chickens).

1. Subclasses:

Archaeornithes: Extinct, includes the earliest known bird, Archaeopteryx.

Neornithes: Includes all living birds and some extinct post-Jurassic birds.

2. Superorders (within Neornithes):

Palaeognathae: Mostly flightless birds, like ostriches and emus.

Neognathae: Includes the vast majority of modern bird species.

3. Orders (within Neognathae, examples):

Passeriformes: Songbirds, the largest order of birds.

Psittaciformes: Parrots, lorikeets, etc.

Falconiformes: Diurnal birds of prey, like hawks and falcons.

Galliformes: Chicken-like birds, including turkeys and pheasants.

Anseriformes: Waterfowl, like ducks and geese.

Struthioniformes: Ostriches.

Columbiformes: Pigeons and doves.

Charadriiformes: Gulls, sandpipers, etc.

Piciformes: Woodpeckers and toucans.

Apodiformes: Swifts and hummingbirds.

Coraciiformes: Kingfishers and hornbills.

Strigiformes: Owls.

Procellariiformes: Seabirds like albatrosses.

Ciconiiformes: Herons and storks.

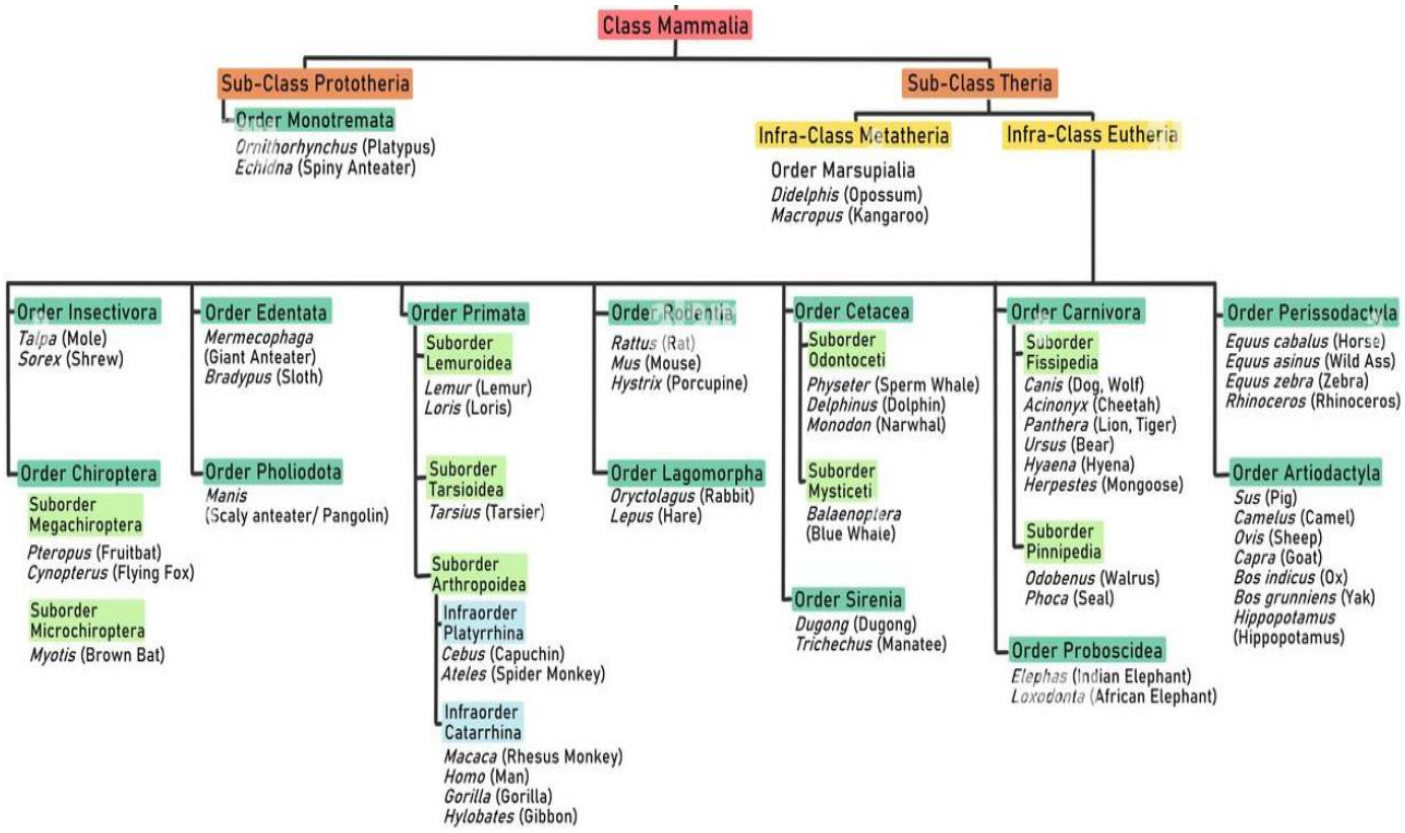
Pelecaniformes: Pelicans and cormorants.

Sphenisciformes: Penguins.

Gaviiformes: Loons.

Tinamiformes: Tinamous.

Classification of class Mammalia:



- All mammals are warm-blooded, and all female mammals possess mammary glands (mammae), which are used to suckle the young with milk.
- Mammals are further distinguished by the possession of hair or fur, although this is limited to early developmental stages in the Cetacea (whales and dolphins).
- The vast majority of mammals give birth to live young, the exception being the egg-laying Monotremata (a small group of mammals including the duck-billed platypus and the echidnas or spiny anteaters). Monotremes are found exclusively in Australia and New Guinea.
- Mammals are found in a wide variety of habitats, including terrestrial, freshwater, and marine systems. They occur from the deserts to the dense forests, from the deep seas to the highest mountains, and from the

tropics to the polar ice caps. Only one group of mammals, the Chiroptera (bats) is adapted to flight; other taxa such as flying squirrels or flying possums can glide effectively but are not capable of true flight.

1. Mammals are air breathing, warm blooded animals (homeotherms).
2. Most of them are viviparous (giving birth to young ones) with few exceptions being oviparous (prototherians).
3. Mammals are hair-clad organisms (skin covered by hair or fur) except Cetacea (whales and dolphins).
4. The skin has sudoriporous glands (i.e., sweat glands), sebaceous glands (oil) and sometimes scent glands.
5. Females have mammary glands with teats (nipples) which secret milk for the nourishment of young. Hence the name Mammalia.
6. These have 2 pairs of limbs either with plantigrade or digitigrade or unguligrade of organization.
7. Each limb has 5 or fewer digits. (Cetaceans are hind-limbless).
8. External ear pinnae are present to protect ear.
9. Exoskeleton includes epidermal hair, horns, spines, scales, claws, nails, hoofs and bony dermal plates.
10. Endoskeleton (bones) completely ossified.
11. Skull with two occipital condyles present. Skull is pretty reduced to make room for the large brain.
12. The lower jaw is composed of single bone on each side. 13. Ribs or bones of ribs are bicephalous i.e., with two heads.
13. There is presence of prominent muscular diaphragm between the thoracic and abdominal cavities.
14. Buccal cavity is separated from nasal passage by a hard plate formed of premaxillae, maxillae and palatine bones
15. Dentition is heterodont (differentiated into incisors, canines and molars), thecodont (embedded in the alveolar pockets of jaw bone) and diphyodont (only two sets of teeth, a milk set replaced by permanent set).
16. Respiration by lungs (pulmonary respiration). Larynx has vocal cords. Heart is 4 chambered with only a left aortic arch.
17. Complete double circulation is striking character with no mixing of oxygenated and de-oxygenated blood.
18. RBCs are small and non-nucleated or anucleate (except in Camel).

19. Brain has 4 optic lobes. Cerebrum and cerebellum are large and convoluted.
20. Presence of 12 pairs of cranial nerves.
21. A pair of metanephros kidneys present. Ureters open into urinary bladder.
22. Eyes are protected by lids and upper eyelids are movable. 25. Sexes are separate and males have erectile penis.
23. Eggs with very little yolk are seen.
24. Fertilization is always internal, after copulation. Young ones are born alive (except monotremes).

General Organization of Hemichordata:

- Hemichordates are a phylum of marine invertebrates characterized by a body divided into three regions: a proboscis, collar, and trunk. They are bilaterally symmetrical, triploblastic, and have an organ-system level of organization. While traditionally considered close to chordates, they are now classified as a separate phylum within the deuterostomes.
- Body Plan:
- **Proboscis:**

  The anterior, muscular, and ciliated proboscis is used for movement, gathering food, and transporting it.

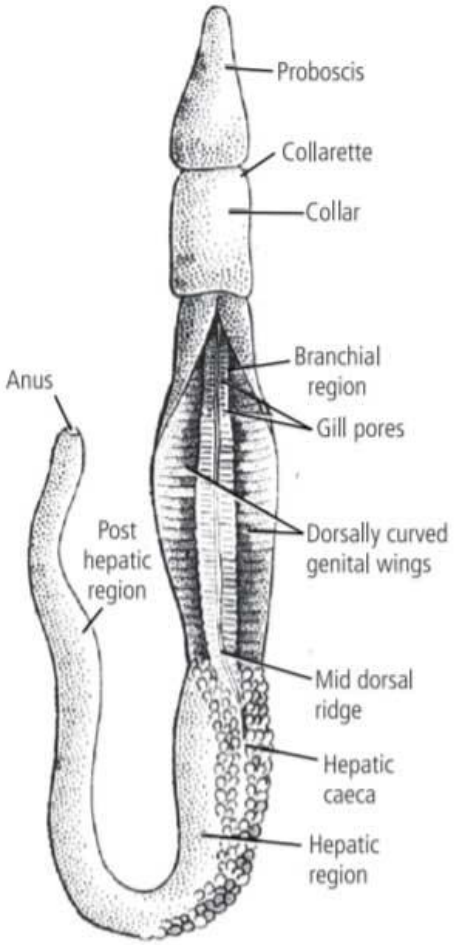
- **Collar:**

  Located behind the proboscis, it houses the mouth and sometimes contains a hollow buccal diverticulum (formerly thought to be a notochord).

- **Trunk:**

  The longest body region, containing the pharynx with gill slits (or pharyngeal slits), digestive system (esophagus and intestine), and gonads. In some species, a post-anal tail is present.

- Coelom:
- Hemichordates possess a true coelom (enterocoel), which is divided into protocoel, mesocoel, and metacoel.
- Digestive System:
- The digestive tract is typically a straight or U-shaped tube.
- Food is transported through the digestive tract using cilia, as the musculature is poorly developed.
- Circulatory System: Hemichordates have a simple, open circulatory system.
- It includes a dorsal heart vesicle (a contractile sinus), dorsal and ventral blood vessels, and sinuses.



- Nervous System: The nervous system is typically a diffuse, intra-epidermal nerve plexus.

- ❖ Some species have a hollow neural tube, particularly in early life, which is considered a primitive trait.
- ❖ Reproduction: Hemichordates are typically dioecious (separate sexes) with external fertilization.
- ❖ Development can be direct or indirect, with a free-swimming tornaria larva in some cases.
- ❖ Asexual reproduction (budding) occurs in some species.
- ❖ Other Characteristics: They are exclusively marine and often live in burrows. Some are solitary, while others are colonial. Gill slits are present in the pharynx, used for respiration. An excretory organ, the glomerulus, is located in the proboscis.

General organization of Urochordata:

- ❖ Urochordates, also known as tunicates, are marine animals characterized by a simple, sack-like body structure with two siphons for water intake and outflow.
- ❖ They are filter feeders, and their bodies are enclosed in a tunic made of tunicin and cellulose. Urochordates exhibit chordate characteristics, like a notochord and dorsal nerve cord, primarily during their larval stage.

❖ **Tunic:**

A tough, outer covering composed of tunicin (a protein) and cellulose (a polysaccharide).

❖ **Siphons:**

Incurrent and excurrent siphons for water intake and expulsion, respectively.

❖ **Pharynx:**

A large, perforated pharynx used for filter feeding.

❖ **Circulatory System:**

Open circulatory system with a simple, tubular heart that periodically reverses its pumping direction.

❖ **Nervous System:**

A simple, dorsal nerve cord, particularly prominent in the larval stage.

❖ **Larval Stage:**

A free-swimming tadpole larva with chordate characteristics (notochord, dorsal nerve cord, pharyngeal slits) that are lost during metamorphosis into the adult form.

❖ **Reproduction:**

Primarily hermaphroditic, with both sexual and asexual reproduction possible.

❖ **Habitat:**

Exclusively marine, with adults typically sessile (attached to a substrate) and larvae free-swimming.

❖ **Filter Feeding:**

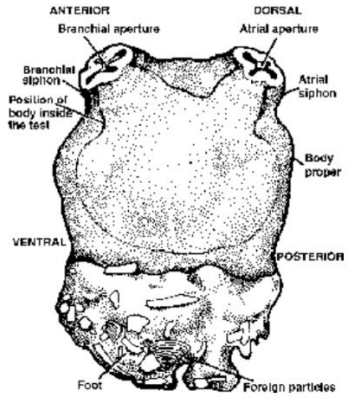
Water is drawn in through the incurrent siphon, passes through the pharynx where food particles are trapped, and exits through the excurrent siphon.

❖ **Excretion:**

Waste is excreted through various body parts, including the gills and intestine.

❖ **Classes:**

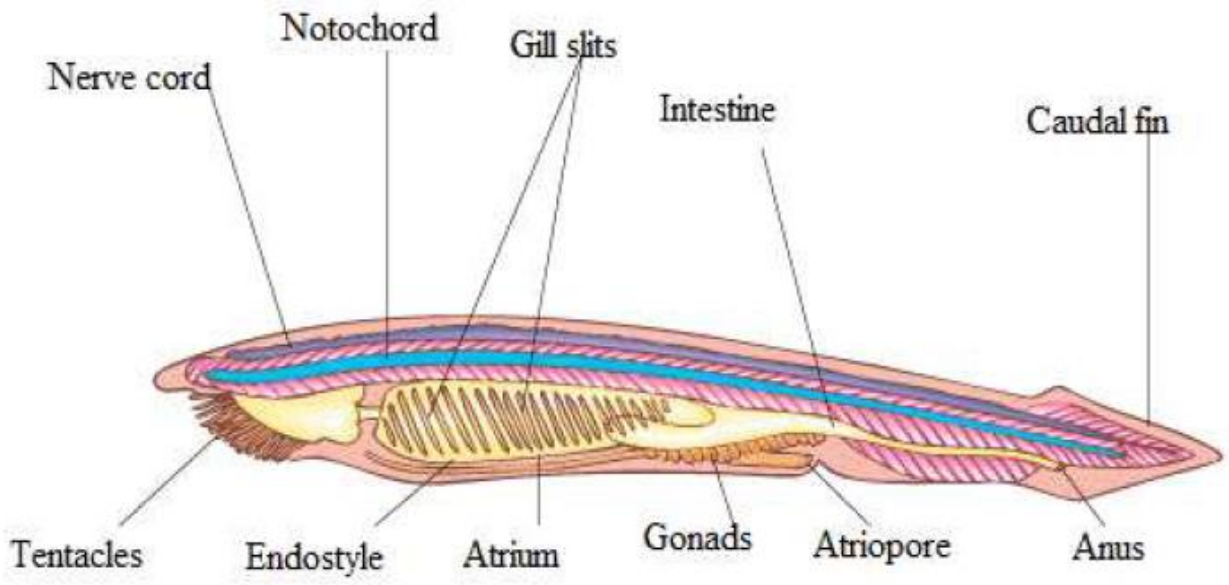
Urochordata is divided into three classes: Ascidiacea (sea squirts), Thaliacea (salps, doliolids, pyrosomes), and Larvacea (appendicularians).



General organization of Cephalochordata:

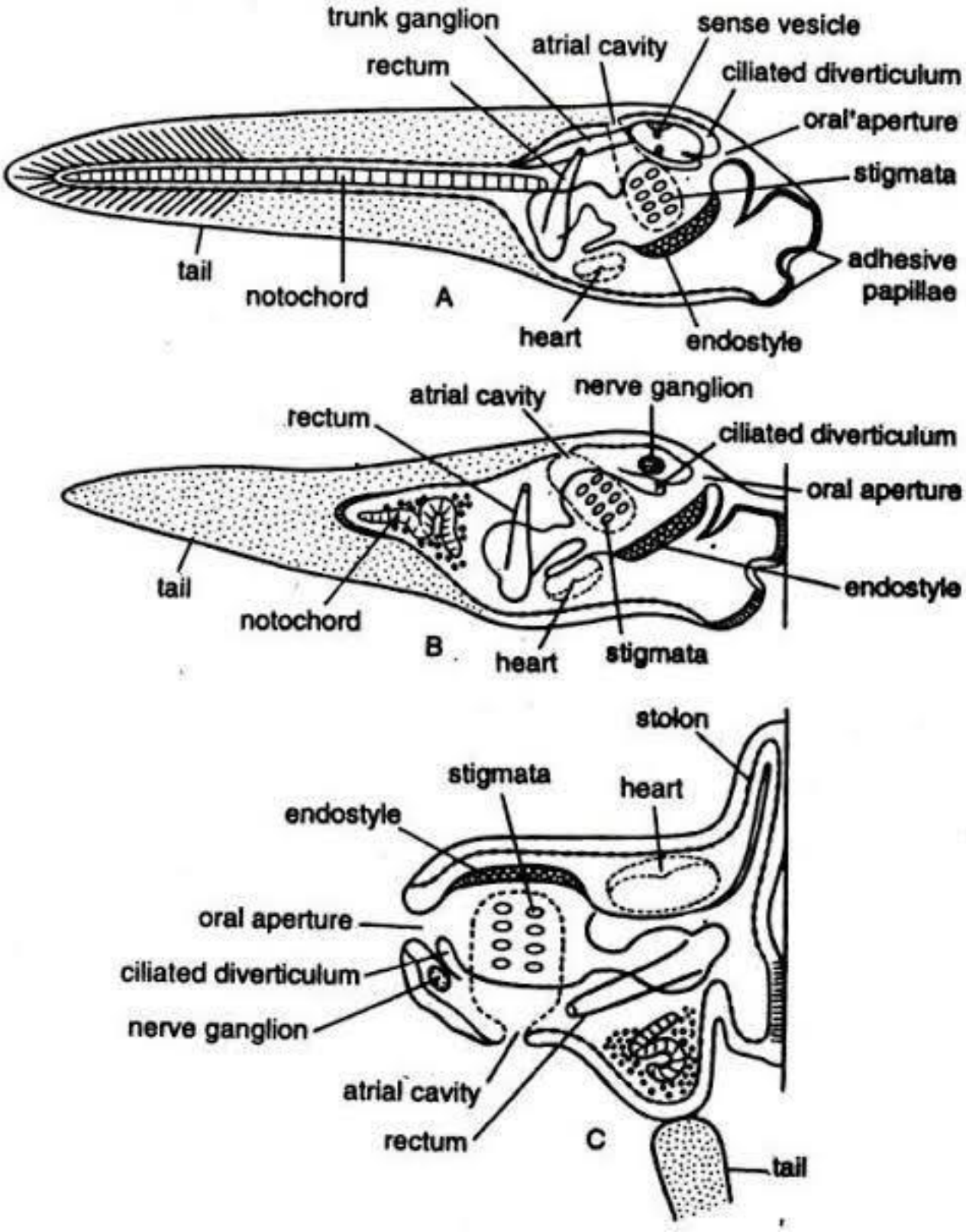
- Cephalochordates have all the typical chordate features. The dorsal nerve cord is supported by a muscularized rod, or notochord. The pharynx is perforated by over 100 pharyngeal slits or "gill slits", which are used to strain food particles out of the water.
- The musculature of the body is divided up into V-shaped blocks, or myomeres, and there is a post-anal tail. All of these features are shared with vertebrates. On the other hand, cephalochordates lack features found in most or all true vertebrates: the brain and the sense organs are very small and poorly developed, and there are no true vertebrae.
- Today, Amphioxus may be extremely common in shallow sandy environments: at Discovery Bay, Jamaica, up to five thousand individuals per square meter of sand have been reported. In some parts of the world, Amphioxus is eaten by humans or by domestic animals; they are important food items in some parts of Asia, where they are commercially harvested.
- Body is fish-like and is useful for burrowing and swimming. It has a head. It shows a tail. Appendages are absent. Dorsal, caudal and ventral fins are present.
- Body- wall shows one- cell thick, non-ciliated epidermis, dermis, connective tissue, striated muscle and parietal peritoneum.
- It has no exoskeleton. Notochord extends from the anterior end to posterior end. Enterocoelic coelom is present; however, it is reduced in the pharyngeal region by atrium.
- Alimentary canal is long. It includes a large pharynx with many gill-slits. Ciliary mode of feeding is developed.
- Gills perform respiration. Circulatory system is closed. Heart and respiratory pigments are absent. Hepatic portal system is present.
- Excretory system shows paired protonephridia with solenocytes.
- Brain is not present. Two pairs of cerebral and several pairs of spinal nerves are present.

- Sexes are separate. Gonads are metamerically arranged and are without gonoducts. Asexual reproduction never occurs. Fertilization is external.



Retrogressive Metamorphosis:

- Urochordates, also known as tunicates or sea squirts, are a diverse group of marine animals belonging to the subphylum Tunicata within the phylum Chordata.
- One of the most intriguing phenomena observed in urochordates is retrogressive metamorphosis, a unique developmental process with significant evolutionary implications.
- Retrogressive metamorphosis is a type of development where an organism undergoes a regression or degeneration of certain structures during its transition from the larval to the adult stage.
- Unlike typical metamorphosis, where animals develop more complex features, retrogressive metamorphosis involves the loss or reduction of specific organs.
- Urochordates have a biphasic life cycle with distinct larval and adult stages. The larval stage, called the tadpole larva, possesses a notochord, dorsal nerve cord, and a tail, which are characteristics of chordates.


trunk ganglion
sense vesicle
atrial cavity
rectum
ciliated diverticulum
oral aperture
stigmata
adhesive papillae
tail
notochord
A
heart
endostyle
atrial cavity
nerve ganglion
rectum
ciliated diverticulum
oral aperture
endostyle
tail
notochord
B
heart
stigmata
stolon
stigmata
heart
endostyle
oral aperture
ciliated diverticulum
nerve ganglion
atrial cavity
rectum
C
tail

- Retrogressive metamorphosis occurs during the transition from the larval to the adult stage. Metamorphosis of the ascidian larva is unique and begins almost explosively.
- It involves transformation of an active non-feeding, pelagic, lecithotrophic (i.e., that feeds on its own yolk reserves) and tailed larva having many advanced features such as axial notochord, dorsal neural tube and special sense organs, into an inert, sedentary or sessile, simple (primitive) and plankotrophic filter feeding adult with only a pharynx with stigmata and endostyle, both indicating the chordate features of adult ascidian.
- In retrogressive metamorphosis the larva possesses advanced characters which are lost during the development and the adult is either sedentary or degenerated with primitive characters.
- Retrogressive Metamorphosis is a characteristics of Ascidian or Tunicates of Urochordate. Ascidians are sac-like marine invertebrate filter feeders which composed of a tough outer "tunic" made of the polysaccharide cellulose, so they are also called Tunicates.
- Urochordate adults, being sedentary show degenerative characters while the free swimming tadpole larva shows advanced chordate characters which are lost during metamorphosis.
- **Retrogressive Changes:** It involves degeneration or destruction of larval tissues and some structures such as follows:
- a) The long tail with caudal fin starts reducing and finally disappear.
- b) Caudal muscles, nerve cord and notochord disappear as they break down and are consumed by phagocytes.
- c) Larval sense organs (the ocellus and the otolith) are lost and sensory vesicle is transformed into an adult cerebral ganglion.
- d) Adhesive papillae and ectodermal ampullae disappear completely.
- e) Anterior region between point of attachment (adhesive papillae) and mouth shows rapid growth, while original dorsal side with atriopore stops growth.

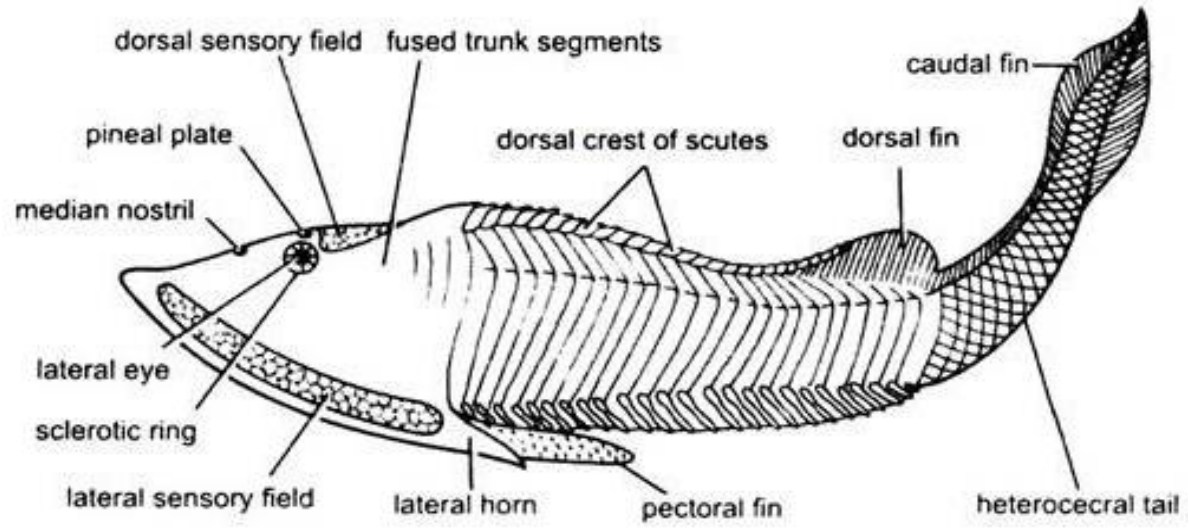
- This causes shifting of mouth through 90°. Therefore, the final branchial and atrial apertures in the adult represent the original anterior and dorsal sides of the larva.
- As a result of retrogressive metamorphosis the free swimming photo-positive and geo negative ascidian tadpole larva changes in to fixed, inactive geo-positive and photo negative adult. The chordate characters of larva like notochord, nerve cord and sense organs are completely lost in adult.
- **Importance of Retrogressive Metamorphosis-** Retrogressive metamorphosis in urochordates is thought to reflect evolutionary adaptations to sessile, filter-feeding lifestyles. It represents a reduction in locomotion-related structures as these animals transition from free-swimming larvae to sedentary adults.
- **Ecological Significance** - The adult urochordate form is specialized for filter-feeding, where water is drawn through a filtering apparatus to extract food particles. This feeding strategy is well-suited for stationary organisms and allows urochordates to thrive in various marine environments.
- **Evolutionary Implications** - Retrogressive metamorphosis is considered an example of paedomorphosis, where an organism retains juvenile characteristics in its adult form. It provides insights into the evolutionary processes that shape the diversity of life forms and the adaptation to specific niches

General Organization of Ostracoderms:

- Ostracoderms encountered first as fragmented fossils. Occurs in the rocks of late Cambrian and middle Ordovician periods. Quite abundant during the upper Silurian and Devonian periods. Fossils were preserved in the bottom sediments of freshwater streams.
- Characteristics:
    1. Ostracoderms were the first vertebrates. They were popularly called armoured fishes. They were jawless vertebrates. They lived in freshwater. They were bottom dwellers.
    2. Their body was fish-like and did not exceed 30 cm in size. Paired fins were absent. Median and caudal fins were present. The caudal fin was of

heterocercal type. The head and thorax were covered by heavy armour of bones. It protected ostracoderms from the giant scorpion like arthropods, eurypterids.

3. Bony skull was well developed. Mouth was mostly present on the ventral side. They were having large number of gill slits. The nervous system had 10 pairs of cranial nerves. The head had a pair of lateral eyes, and a median pineal eye. They were filter feeders, feeding like a vacuum cleaner.
4. The endoskeleton was either bony or cartilaginous.



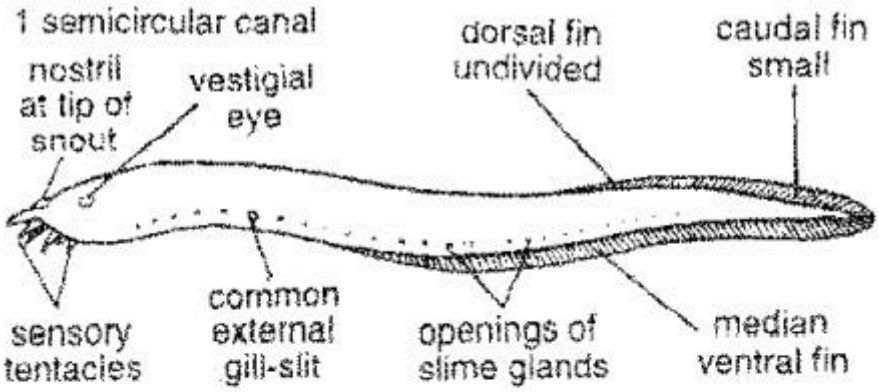
- Class ostracodermi (extinct Agnathans) is divided into following four orders: 1. Euphanerida. Example – Jamoytius. 2. Pteraspidomorphi. Example – Pteraspis, Thelodus, Lanarkia and Coelolepsis. 3. Cephalaspidomorphi. Example – *Cephalaspis, Hemicyclaspis, Ateleaspis.* 4. Anaspida. Example – *Birkenia, Pterolepis* and *Rhyncholepis.*
- General organization- Small to medium sized. Body form was fishlike, flattened dorso-ventrally. Huge head and gill region. Tapering but muscular trunk.
- Jaws and pectoral fins are absent, median fin present, Very bony and heavily armoured

- The head was encased in a solid shield made up of broad bony dermal plates, Separate pharyngeal gill pouches along the side of the head, which were permanently open with no protective operculum.
- Body is surrounded by a series of smaller plates- Dermal scales, Large lateral eyes and median pineal eye on the top of the head is present, Single median nostril was located anterior to pineal eye
- Ostracoderms internal anatomy- No axial endoskeleton or vertebrae, Mouth was anteroventral, small and without jaws or teeth, Sensory fields on head was part of lateral line system, Internal ear with two semicircular canals were present
- **Affinities of ostracoderm**- According to Lankester, pteraspids were related to cephalaspids – both are jawless – Have a large cephalic shields – Occurs in same beds.
- As per Prof. Eric Stensio (1927) pteraspids gave rise to myxinoids and the cephalaspids to lampreys.
- White, suggested that, the earliest vertebrates had straight or diphycercal tails. From these evolved pteraspids with hypocercal tails, as well as cephalaspids with heterocercal tails.
- The modern cyclosotomes have been probably evolved from the cephalaspids The ostracoderms have close affinities with modern cyclostomes:- Absence of biting jaws, Single nasal opening, Pineal eye, Structure of brain and cranial nerves, Similar auditory capsules, Unpaired olfactory organs, Pouch like branchial sacs.
- Stensio (1927) believes that cyclostomes have descended from ostracoderms by the evolution of sucking type mouth, loss of bony exoskeleton and paired limbs and development of cartilage.

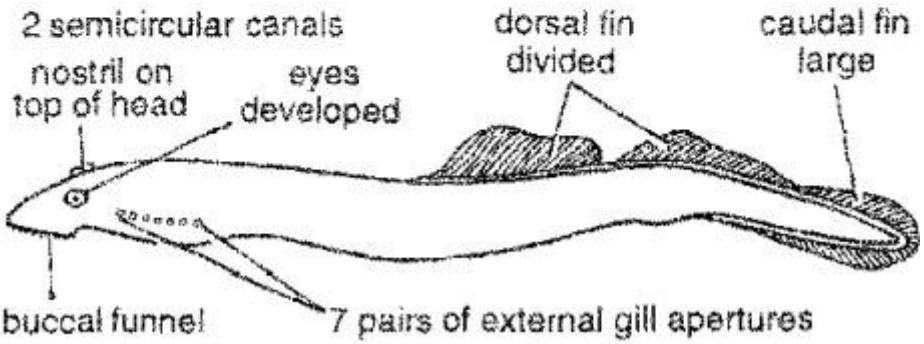
General Organization of Cyclostomes:

- Cyclostomata is a group of chordates that comprises the living jawless fishes: the lampreys and hagfishes. Both groups have round mouths that lack jaws but have retractable horny teeth.

- The name Cyclostomata means "round mouths". Their mouths cannot close due to the lack of a jaw, so they have to constantly cycle water through the mouth.
- Cyclostomes are jawless primitive vertebrates. They may be marine or fresh water. They include hag fishes and lampreys. The body is long, eel like. It has a trunk and a compressed tail. Paired fins are absent. Median fin is supported by cartilaginous fin-rays.
- The skin i.e soft and smooth. It is slimy. It is scale less. Z-shaped myomeres are present in the trunk and tail. Protractor and retractor muscles move the tongue. In this group a true coelom is seen. These vertebrates do not have jaws, hence called Agnatha. The mouth is circular. It works like a sucker and is surrounded by tentacles.



Myxine (hagfish).

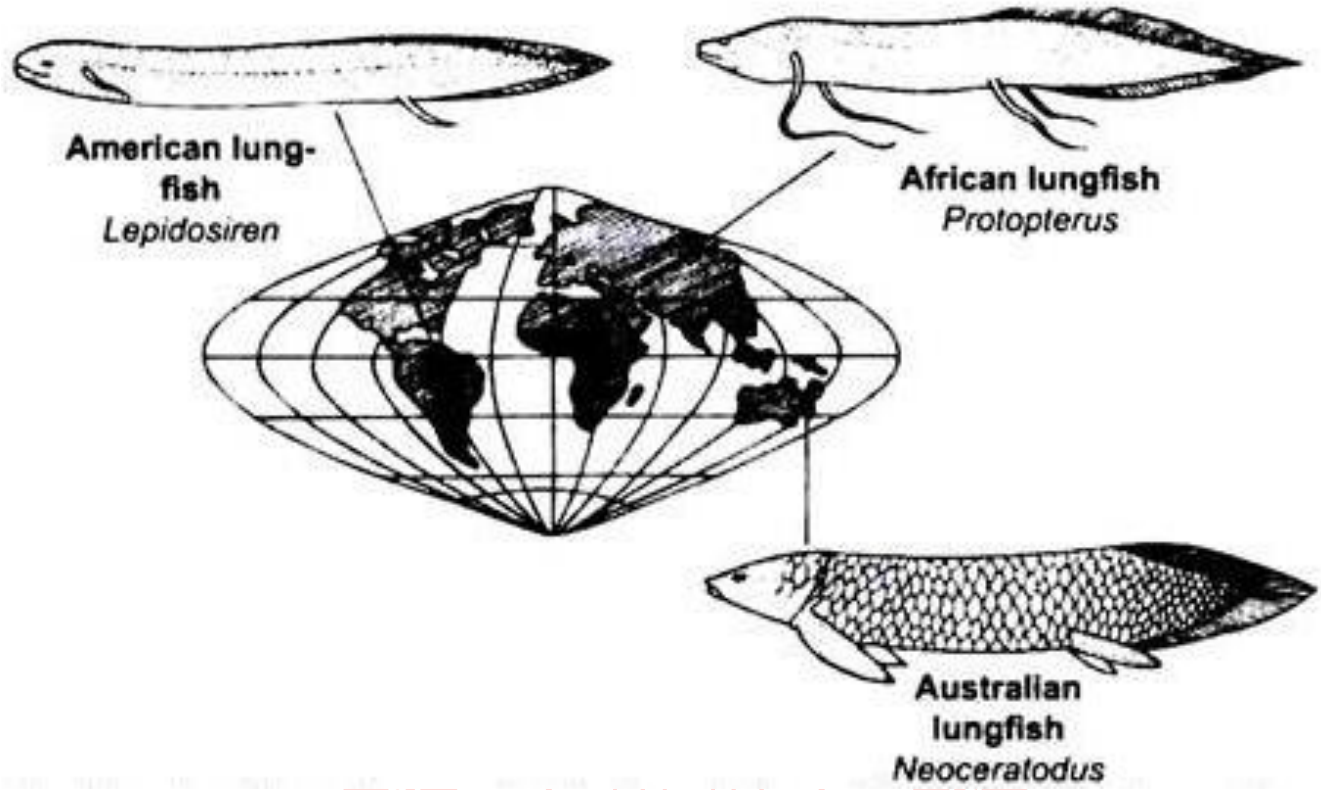


Petromyzon (lamprey).

- Tongue bears teeth. Stomach is absent and oesophagus leads into the intestine. Endoskeleton is present.
- Skull is simple and primitive. Notochord persists throughout life. Vertebrae are represented by neural arches, around the notochord. Five to sixteen pairs of gills are present in sac like pouches, the heart is two chambered. Sinus venosus is present, but conus arteriosus is absent. Blood contains leucocytes and irregular nucleated erythrocytes.
- Brain is seen. Ten pairs or less number of cranial nerves are present. Nasal sac is single and median. Lateral line sense organ is present.
- Excretory system includes a pair of mesonephric kidneys.
- Sexes are separate. Gonad is single and without a gonoduct. Development may be direct or with a long larval stage.
- **CLASSIFICATION:** The class Cyclostomata is divided into two orders: 1) Petromyzontia and (2) Myxinoidea
- **Order 1: Petromyzontia** - This includes Lampreys. The buccal funnel is suctorial and shows horny teeth. The mouth is present in the buccal funnel. The nasal sac is dorsal. It has no connection with the pharynx.
- A well-developed dorsal fin is present. Branchial basket is complete. Brain is well developed. Pineal eye is well developed. Ear has two semicircular canals. Example: Petromyzon (Sea-lamprey).
- **Order 2: Myxinoidea** - It includes the hag-fishes or slime eels. Buccal funnel is absent. The nasal sac opens into pharynx through a canal. Eyes are vestigial. Dorsal fin is absent or very small. Branchial basket is poorly developed. Brain is primitive. Pineal eye is reduced. Ear has only one semicircular canal. The hag-fishes are all marine. Examples: 1. Myxine glutinosa (Hag-fish or slime eel). 2. *Eptatretus*

General organization of Dipnoi:

- The dipnoans, belonging to the order Dipnoi of the subclass Sarcopterygii of Osteichthyes, are generally called “lung fishes”. The name Dipnoi (Gr; di= two + pnoe= breathing) means “double breather”, as they respire through gills as well as lungs.
- **DISTRIBUTION-** Fossil dipnoans appeared in mid-Devonian probably as an offshoot of the crossopterygian stem. They flourished moderately in Permian and Triassic and later became rare. The earlier recorded fossil lungfish is Dipterous of mid-Devonian.
- From this genus, dipnoan evolution led directly to the Triassic form Ceratodus, having a wide distribution over earth. Dipnoans have remained conservative and changed very little since that time.
- There are only 3 living genera of lung fishes, one in each of the 3 continents of the Southern Hemisphere:-
- 1. *Neoceratodus* (=Epiceratodus):- Single species *N. forsteri* found in Burnett and Marry Rivers in Queensland (Australia). A direct descendant of ancient lungfish. Attains a length of 1.5 meters and a weight of 45 kg.
- 2. *Protopterus*:- Four or so species in certain lakes and rivers of tropical Africa (rivers Senegal, white Nile and Zambesi and Lake Tanganyika). Grow up to 1 or 2 meters and weigh about 40 kg.
- 3. *Lepidosiren*:- Single species *L. paradoxa* in river Amazon and its tributaries of tropical South America.
- **HABITS AND HABITAT** - Lungfishes are large, bizarre fishes, inhabiting semi-permanent freshwater and swamps in Africa, South America and Australia.
- They probably survive because they live in habitats where no actinopterygians can successfully compete.



- All can survive extremely stagnant waters, periodically coming to the surface and gulping air into their lungs. Neoceratodus respires exclusively via gills and use its single lung only under stress.
- *Lepidosiren* and Protopterus have weakly developed gills and will draw if prevented from reaching the surface to use their paired lungs. All are sluggish bottom dwellers and predaceous carnivores feeding on worms, molluscs, crustaceans, frogs, small fishes and even members of their own species.
- Besides swimming in water by undulating body movements, they also crawl on the bottom using their paired fins like legs. *Lepidosiren* and African *Protopterus* species survive drought by aestivating in a mucous cocoon buried in the bottom mud of their dried-up habitats.
- During aestivation the air bladder is constantly used as a lung. When mud softens again during rains, they resume their normal life like fish. Male *Protopterus* vigorously guards eggs laid by female in an oval muddy pit or nest,

after fertilizing them. Parental care is even more pronounced in male *Lepidosiren* whose pelvic fins develop vascular tufts during breeding season.

- The male periodically leaves the nest to engulp atmospheric air and Oxygen diffuses from freshly aerated blood of pelvic fins to the vicinity of eggs or young for respiration and growth.
- **PECULIARITIES EXTERNAL FEATURES**- Lungfishes are slender fish-like or eel-like creatures, 1 to 2 meters in length. Paired pectoral and pelvic fins, often designated as limbs, are narrow lobe-like or filamentous, with a central axis of flesh and bone.
- Dorsal anal and caudal fins are fused into a continuous, symmetrical, diphycercal tail, supported by partly calcified fin rays.
- Snout is depressed bearing external nostrils enclosed within upper lip. Mouth is subterminal or ventral. Gills are covered on either side by an operculum leaving a single slit-like gill slit. Spiracles are absent. Anus, urinary and genital apertures and one or two abdominal pores lie within a small mid-ventral cloaca.
- Eyes are small. Lateral line system is will developed, especially on head. Skin is covered by an exoskeleton of thin, bony, overlapping cycloid scales.
- **INTERNAL FEATURES** - Endoskeleton is mostly cartilaginous. Notochord is persistent with cartilaginous vertebral arches but lacking vertebral centra. Anterior vertebrae are fused with skull. Primary cranium persists with little ossification and with or without fontanelles. Premaxillae and maxillae absent and teeth modified as crushing plates. There are 4 to 6 cartilaginous branchial arches. Jaw suspension is autostylic. Pectoral girdle is a stout cartilage with a pair of investing bones on either side. Pelvic girdle is will developed and cartilaginous.
- Intestine has a spiral valve. Glottis may be protected by an epiglottis. Internal nares may open into mouth cavity much like those of Amphibia. Air bladder (swim bladder) forms a single or double lung with internal alveoli as in higher vertebrates.

- Gills may be well developed or reduced. Auricle and ventricle of heart and sinus venosus are imperfectly divided. The large atrioventricular opening is filled by a fibrous plug, there being no true valves.
- Ventral aorta is very small. Conus arteriosus is partly fully partionated. A spiral valve is present. A pulmonary artery is given off on either side from efferent branchial system. A pulmonary veins opens into left side of auricle. There are two precavals (ductus cuvieri) and a large posterior venacava (posterior cardinal vein) as in tetrapods.
- Mid-brain is almost undivided into optic lobes. Pallium of cerebral hemispheres has a layer of nerve cells. Paired oviducts open anteriorly into coelom in female. Vasa efferentia carry sperms through excretory part of kidney in male.
- Fertilization is external. Development includes metamorphosis. Larvae may develop suckers and external gills.
- **AFFINITIES OF DIPNOI -** With special features of their own, the Dipnoi combine characteristics in which they resemble different group of fishes as well as Amphibia.
- I. **AFFINITIES WITH FISHES (GENERAL) -** Lungfishes are true fishes beyond doubt as they resemble them in general in the following features;-
  1. Body spindle-shaped and stream lined.
  2. Locomotory appendages fins.
  3. Diphycercal caudal fin.
  4. Largely ossified, slender dermal fin rays.
  5. Body covered by overlapping cycloid scales.
  6. Notochord persistent.
  7. Vertebrae without centra.
  8. Skull with little ossification and with several investing bones.
  9. Branchial arches 4 to 6 pairs present.
  10. Aquatic respiration by gills.
  11. Lateral line sensory system.
- **II. AFFINITIES WITH AMPHIBIA** - Dipnoans resemble amphibians in several features, such as:-

1. Semiaquatic or marshy habitat.
2. Internal nostrils piercing roof of mouth cavity.
3. Multicellular skin glands.
4. Dermal scales present in Gymnophiona.
5. Lungs capable of pulmonary respiration.
6. Spiracles lacking.
7. Vomerine teeth present.
8. Auricle and sinus venosus partially divided into right and left halves.
9. Conus arteriosus spirally twisted and longitudinally partitioned.
10. Ventral aorta short.
11. Presence of anterior abdominal vein, posterior venacava, pulmonary artery and vein.
12. Pericardium is thin-walled.
13. Jaw suspension autostylic.
14. Brain similar in structure of cerebrum and cerebellum.
15. Sperms carried through excretory part of mesonephric kidney.

CONCLUSION- This close similarity led early workers to conclude that lungfishes gave rise to amphibians, a view no longer held now-a-days. According to Dolo, these similarities probably were due to convergent evolution on account of similar habits and habitat.

General organization of Fishes:

- The general organization of fishes includes their body structure, which is typically streamlined for aquatic life, with a head, trunk, and tail. Key features include fins for locomotion and a lateral line system for sensing water movement.
- Fishes can be broadly classified into jawless fish (Agnatha), cartilaginous fish (Chondrichthyes), and bony fish (Osteichthyes).

❖ **Body Shape:**

Most fish have a streamlined, spindle-shaped body, which minimizes water resistance.

❖ **Fins:**

Fins are essential for swimming and balance. They can be paired (pectoral and pelvic) or unpaired (dorsal, anal, and caudal).

❖ **Lateral Line System:**

This sensory system detects water movement and vibrations, helping fish navigate and locate prey.

❖ **Skin and Scales:**

Fish skin is often covered in scales, which can be placoid (cartilaginous fish), cycloid, or ctenoid (bony fish).

❖ **Gills:**

Gills are the primary respiratory organs, extracting oxygen from the water.

❖ **Skeleton:**

Fish have either a cartilaginous skeleton (Chondrichthyes) or a bony skeleton (Osteichthyes).

❖ **Swim Bladder:**

Many bony fish have a swim bladder, a gas-filled sac that helps with buoyancy.

❖ **Digestive System:**

Fish have a relatively simple digestive system, with a stomach (in some), intestines, and associated organs like the liver and pancreas.

❖ **Reproductive System:**

Fish can be oviparous (egg-laying), ovoviviparous (eggs hatch inside the body), or viviparous (live birth).

Classification of Fishes:

- **Agnatha (Jawless Fish):** Includes lampreys and hagfish, characterized by the absence of jaws and paired fins.
- **Chondrichthyes (Cartilaginous Fish):** Sharks, rays, and chimaeras, with a cartilaginous skeleton.
- **Osteichthyes (Bony Fish):** The most diverse group of fish, with a bony skeleton.

Swim Bladder and Their functional significance:

- ❖ Swim bladder is an endodermal outgrowth from the oesophagus, shortly behind the pharynx. It resembles a lung in structure and function in some primitive fishes.
- ❖ However, it is not called a lung because in most of the cases, its primary roll is not respiratory. A swim bladder may be single or double. It may open into the oesophagus, dorsally or ventrally or not at all. It may be very small or quite large, extending through the entire length of the coelom. It often lies above the gut, directly beneath the vertebral column.
- ❖ It is retroperitoneal, i.e., the peritoneum is present only on the ventral side. The swim bladder generally opens by a pneumatic duct into the oesophagus through an aperture called glottis.
- ❖ The fishes with such an open swim bladder are described as physostomous. In fishes where the swim bladder is closed, they are described as physoclistous.
- ❖ The swim bladder in teleosts is divided into two chambers- the anterior chamber and the posterior chamber, demarcated by a constriction with a sphincter.
- ❖ The blood capillaries may uniformly vascularise the entire swim bladder or they may form tightly packed localized mass called retia mirabillus. In some teleosts having physostomous swim bladder, the retia mirabillus are further specialized to form red bodies near the anterior end of the swim bladder.
- ❖ In the teleosts with physoclistous swim bladder, the epithelial lining of the swim bladder, covering the red bodies is glandular and folded. Red bodies so modified

are called **red gas glands**. Swim bladder receives blood from the coeliaco mesenteric artery and returns blood to the hepatic portal vein. The red bodies or red glands can transfer oxygen, carbon dioxide and nitrogen from the blood to the swim bladder.

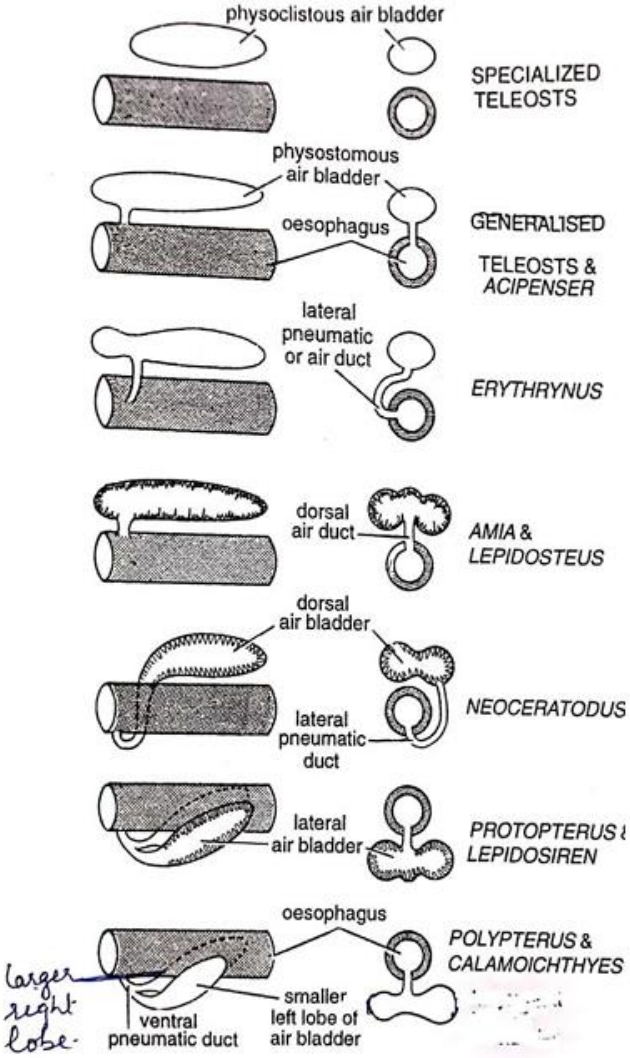
- Any excess gas secreted into the swim bladder by the red bodies or the red glands is passed out through the pneumatic duct in the physostomous fishes but is absorbed by the capillaries forming the retia mirabillus at the anterior end in physoclistous fishes.

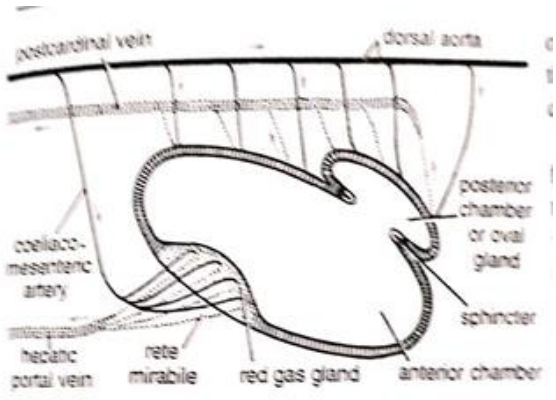
- **Functions of Air Bladder**

1. Respiration: In lower or intermediate fishes such as ganoids and lung fishes, the air bladder serves as a lung. These fishes come to water surface regularly to gulp air. In teleosts, the swim bladder plays some role in respiration. If the carbon dioxide content of water rises, the swim bladder supplies stored oxygen during this time of deficiency.

2. Hydrostasis: Swim bladder in teleosts functions chiefly as a hydrostatic organ and helps to keep the weight of fish body equal to the volume of water displaced by fish. Secretion of more gases means lower specific gravity so that the fish rises in water. Reabsorption of gases means increased specific gravity and the fish sinks. Thus, the fish is able to rise or sink and maintain its equilibrium in water without any muscular effort.

3. Sound Production : In some fishes, sound is produced by expelling the air from the swim bladder through the pneumatic duct and mouth. Sound may be produced by the compression of the muscles of the swim bladder. Polypterus, Protopterus and Lepidosiren produce sound during the forceful expulsion of gas from the swim bladder.





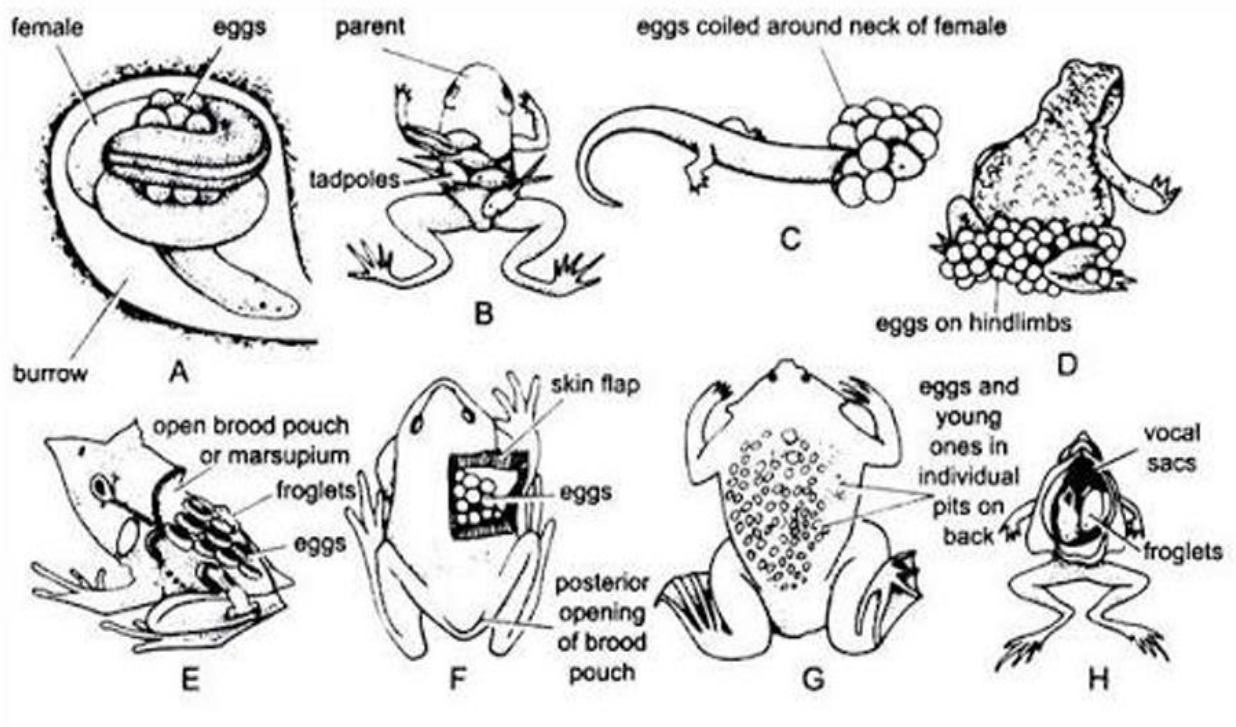
Parental Care:

- Parental care refers to any behavior on the part of either or both parents that help their offspring to survive. In many animals, parental care includes building a nest and feeding the young. Mammals teaches the young ones important skills that they will need when they are older and no longer cared for by the parents.
- Parental care in Fishes & Amphibians: Many species of fishes do not care for their eggs and fingerlings. They leave the spawning grounds after fertilization. For such species of fishes the lacking parental care behavior is compensated by

the production of large number of eggs. Such fishes lay over 300 million eggs at a time.

- Parental care can be provided by various means-
  A. Depositing Eggs in Suitable Places: A number of fish species have developed some design of depositing their eggs in suit-ably protected places. They do not build nests.
- Deposition of eggs in sticky cove-ring: (i) In carps, eggs are usually laid with some special sticky covering by means of which they are attached to each other or to stones, weeds etc. (ii) In yellow perch (*Perca flavescens*) eggs are deposited in a rope-like structure. The eggs are held together by a long floating membrane.
- Eggs scattered over aquatic plants: Eggs of fishes such as pikes (*Esox lucius*), carps (*Cyprinus carpio*), *Carrassius auratus* etc., are scattered over aquatic plants to which they remain attached.
- Deposition of Eggs into Self-Made Nest: Some species of fishes prepare nests of different types for the safe deposition and protection of eggs, and for the development of their young ones.
- A large tree frog (*Hyla faber*) protects its progeny by building a basin-shaped nest or nursery in shallow water on the border of the pond.
- Some tree frogs like *Phyllomedusa* in South America, *Rhacophorus malabaricus* in India, and *Chiromantis* in tropical Africa glues the eggs to foliage hanging over water, and after hatching, the tadpoles drop straight into the water.
- Small South American frogs *Phyllobates* and *Dendrobates* and tropical African frogs *Arthroleptis* and *Pelobates* lay their eggs on ground. The hatched tadpoles adhere by their sucker-like lips and flattened abdomen to the back of one of their parents and, thus, they are carried from one place to the other.
- In Obstetric toad (*Alytes obstetricans*) of Europe, the male winds the strings of eggs-formed by adhesion of their gelatinuous investment-round his body and hindlegs. Here they are retained until the tadpoles are ready to be hatched.

- In *Plethodon* (urodele) the eggs are laid in small packages of about five beneath the stones or in the hollow of rotten log, and the mother coils round them. In *Megalobatrachus maximus* (urodele) the male coils round the eggs.
- Concealing eggs and young's in or on their body - In *Pipa pipa*, the eggs are carried by females on the back. Similar phenomenon is observed in *Cryptobatrachus evansi.*
- During breeding season, the dorsal skin of the females becomes soft, spongy and gelatinous. The male place the eggs on the back of the female where each egg sinks into a small pit.



Migration:

- Migration in chordates, particularly fish and birds, refers to the seasonal movement of populations, often for breeding or feeding purposes.
- Fish migration can be broadly classified into potamodromous (freshwater), oceanodromous (saltwater), and diadromous (freshwater to saltwater or vice versa).
- Bird migration, on the other hand, encompasses various types like latitudinal, altitudinal, cyclic, and daily migrations.

Fish Migration:

- **Potamodromous:** Fish migrate entirely within freshwater systems.
- **Oceanodromous:** Fish migrate within saltwater environments.
- **Diadromous:** This category includes:
  - **Anadromous:** Fish migrate from saltwater to freshwater to spawn (e.g., salmon).
  - **Catadromous:** Fish migrate from freshwater to saltwater to spawn (e.g., eels).
- **Other types:** Vertical migration (movement up and down in the water column) and shoreward migration (temporary movement towards the shore).
- **Factors influencing fish migration:** Factors like salinity, pH, water temperature, and the availability of food and suitable spawning grounds play a crucial role.

Bird Migration:

- **Latitudinal migration:** Seasonal movement between breeding and wintering grounds, often north and south.
- **Altitudinal migration:** Movement between high and low altitudes.
- **Cyclic migration:** Recurring migrations at specific intervals.
- **Daily migration:** Vertical movement in the water column, also seen in some fish species.
- **Factors influencing bird migration:** Food availability, breeding conditions, and weather patterns are significant drivers.

General Considerations:

- **Advantages of Migration:**

  Migration allows animals to exploit abundant food resources, find suitable breeding grounds, and access better climatic conditions.

- **Disadvantages of Migration:**

  Migration can be energetically expensive, expose animals to predators, and increase the risk of disease spread.

- **Influencing Factors:**
  Migration is driven by a complex interplay of physical, chemical, and biological factors.

MCQ based on Unit I:

Q. 01. Heart in vertebrates is-

a. Dorsal, Skeletal

b. Ventral, Skeletal

c. Ventral, Muscular

d. Dorsal, Muscular

Ans. d

Q.02. In vertebrates, the pharyngeal gill slits are not more than-

a. 9 pairs

b. 8 pairs

c. 7 pairs

d. 6 pairs

Ans. c

Q. 03. The ostracoderms are grouped into-

a. Agnatha

b. Tetrapoda

c. Gnathostomata

d. Pisces

Ans. A

Q. 04. In Lampreys, paired appendages are-

a. 3 pairs

b. Absent

c. 8 pairs

d. 2 pairs

Ans. b

Q. 05. Anticoagulant in Petromyzon is excreted by-

a. Mucous Glands

b. Zymogen Glands

c. Oxyntic Glands

d. Salivary Glands

Ans. d

Q. 06. A urinogenital papilla in Petromyzon is present-

a. Near the caudal fin

b. Protrudes through the cloaca

c. Near the anus

d. Absent

Ans. b

Q. 07. In Petromyzon, the sucking action of the buccal funnel is operated by-

a. Radial Muscles

b. Circular muscles

c. Longitudinal Muscles

d. Skeletal Muscles

Ans. a

Q. 08. Fistularia is commonly known as

a. Flute fish

b. Dog fish

c. Sword fish

d. Saw fish

Ans. a

Q. 09. Lung fishes are included in the order-

a. Acipenseriformes

b. Polypteriiformes

c. Dipnoi

d. Crospterygii

Ans. c

Q. 10. Brood pouches are developed in Hippocampus on the-

a. Back of female

b. Back of male

c. Belly of female

d. Belly of male

Ans. b

Q. 11. In frogs, the sexual embrace between male and female is called-

a. Amplexus

b. Swarming

c. Spawning

d. Aplexus

Ans. a

Q. 12. The third eyelid in frog is called-

a. Nictating membrane

b. Upper eyelid

c. Lower eyelid

d. Pineal eye

Ans. a

Q.13. The endoskeleton of chordate animals is

a. Non- living structure

b. Living structure

c. Living structure with growth

d. Living structure without growth

Ans. c

Q.14. First jawed vertebrates belong to class-

a. Chondrichthyes

b. Placodermi

c. Cyclostomata

d. Ostracodermi

Ans. d

Q. 15. Which of the following is a chordate but not vertebrate?

a. Amphioxus

b. Catla

c. Frog

d. Rat

Ans. a

Q. 16. Notochord is restricted to head region only in

a. Chordata

b. Cephalochordata

c. Urochordata

d. None of these

Ans. b

Q.17. Which of the following is anamniote animal?

a. Rattus

b. Columba

c. Crocodilus

d. Labeo

Ans. d

Q. 18. Balanoglossus is commonly known as

a. Earthworm

b. Acorn worm

c. Snake worm

d. Corn worm

Ans. b

Q. 19. Musculature in Balanoglossus is-

a. Cardiac

b. Striated

c. Smooth

d. Transverse

Ans.c

Q. 20. Coelom in Balanoglossus is-

a. Enterocoel

b. Schizocoel

c. Holocentric

d. Heterocoel

Ans. a

Q. 21. Digestive system in Hemichordates is-

a. U shaped

b. Y shaped

c. H shaped

d. V shaped

Ans. a

Q. 22. The aperture of siphons in *Herdmania* is guarded by-

a. One lip

b. Two lips

c. Three lips

d. Four lips

Ans. d

Q. 23. Most tunicates, except Herdmania are able to extract rare metal

a. Silver

b. Vanadium

c. Gold

d. Copper

Ans. b

Q. 24. Reverse circulation can be seen in-

a. Branchiostoma

b. Balanoglossus

c. Herdmania

d. Catla

Ans. c

Q. 25. In Branchiostoma, the no. of myotomes on either side are-

a. 30-32

b. 40-42

c. 50-52

d. 60-62

Ans. d

Q. 26. Liver in Branchiostoma is

a. Ilio Colic ring

b. Midgut diverticulum

c. Lateral ciliary tract

d. Rectum

Ans. b

Q. 27. Wheel organ is a part of

a. Pharynx

b. Oral hood

c. Velum

d. Mouth

Ans. d

Q. 28. In Branchiostoma, gill slits open-

a. Into the Pharynx

b. Into the Atrium

c. Into the Coelom

d. Direct to the outside

Ans. b

Q. 29. Atrium in Branchiostoma is formed by

a. A pair of meta pleural folds

b. Folding of mesoderm

c. folding of ectoderm

d. Folding of Endoderm

Ans. a

Q. 30. Endostyle in Branchiostoma concentrates on of the following in itself-

a. Radioactive Chlorine

b. Radioactive Iodine

c. Radioactive Fluorine

d. Radioactive Bromine

Ans. b

Q. 31. In Branchiostoma, Ductus cuvieri is another name for-

a. Aorta

b. Parietal veins

c. Sinus Venosus

d. Cardinal veins

Ans. d

Q. 32. Neoteny refers to

a. Reproduction in larva

b. Metamorphosis

c. Presence of rudimentary organ

d. Retention of larval characteristics in adults

Ans. d

Q. 33. Caecilians belong to the order-

a. Gymnophiona

b. Apoda

c. Both a and b

d. Urodela

Ans. c

Q. 34. The part of archenteron connected to yolk sac-

a. Mid gut

b. hind gut

c. Fore gut

d. Primitive gut

Ans. d

Q. 35. In ruminants, true stomach is represented by-

a. Reticulum

b. Omasum

c. Rumen

d. Abomasum

Ans. d

Q.36. Muscles are –

a. Mechanoreceptors

b. Photoreceptors

c. Chemoreceptors

d. Thermoreceptors

Ans. a

Q. 37. Bipolar neurons are found in

a. Lens

b. Choroid

c. Retina

d. Cornea

Ans. c

Q. 38. Spiny anteaters are included in the family-

a. Notorvetidae

b. Ornithorhynchidae

c. Didelphidae

d. Tachyglossidae

Ans. d

Q. 39. Marsupials with true allantoic placenta-

a. Opossum

b. Kangaroo

c. Bandicoots

d. None of these

Ans. a

Q. 40. Baleen is present in-

a. Elephants

b. Horses

c. Bos

d. Whales

Ans. d

Q. 41. Involuntary activities of body are controlled by-

a. Spinal cord

b. Cerebellum

c. Cerebrum

d. Pons and Medulla oblongata

Ans. d

Q. 42. True vocal cords are absent in-

a. Cat

b. Dog

c. Hippopotamus

d. Human

Ans. c

Q. 43. Ptyalin is present in

a. Saliva

b. Bile uice

c. Gastric uice

d. Pancreatic Juice

Ans. a

Q. 44. Renal columns of Bertini are formed by-

a. Capsule

b. Medulla

c. Cortex

d. Pelvis

Ans. b

Q. 45. Which is the connecting link between reptiles and birds?

a. Archaeopteryx

b. Columba

c. Ostrich

d. None of these

Ans. a

Q. 46. Apteryx is the scientific name of-

a. Ostrich

b. Emu

c. Kiwi

d. Rhea

Ans. c

Q. 47. Ostrich belongs to

a. Apterygiformes

b. Struthioniformes

c. Causiriiformes

d. Rheiformes

Ans. b

Q. 48. Flightless birds belong to order

a. Ratitae

b. Odontognathae

c. Neornithes

d. Archaeonithes

Ans. a

Q. 49. Which of the following lizard is poisonous?

a. Gila Monster

b. Horned Lizard

c. Flying Lizard

d. Monitor lizard

Ans. d

Q. 50. Loreal pit in pit vipers is a-

a. Cold sensitive organ

b. Heat sensitive organ

c. Current sensitive organ

d. None of these

Ans. b

Q. 51. Boas are-

a. Oviparous

b. Viviparous

c. Ovo-viviparous

d. None of these

Ans. c

Q. 52. Four chambered heart is present in-

a. Lizard

b. Turtles

c. Tortoises

d. Alligator

Ans. d

Q. 53. In Turtles, teeth are-

a. Homodont

b. Pleurodont

c. Horny beak

d. Heterodont

Ans. c

Q. 54. Which is considered as living fossil?

a. Cobra

b. Turtles

c. Lizards

d. Sphenodon

Ans. d

Q. 55. In class Reptilia, the interclavicle bone is-

a. H shaped

b. A shaped

c. Z shaped

d. T shaped

Ans. d

Q. 53. In the head of Cobra-

a. 3rd supra-labial shield large

b. 4th Infra labial shield large

c. 5th Infra labial shield large

d. 6th infra labial shield large

Ans. a

Q. 54. Hexagonal mid-dorsal vertebral scales are present in-

a. Krait

b. Cobra

c. Viper

d. None of these

Ans. a

Q. 55. Snakes are sensitive to-

a. Birds' noise

b. Thunder

c. Earth borne vibrations

d. Air borne vibrations

Ans. c

Q. 56.Which of the following is NOT a characteristic feature of all chordates?

a. Notochord

b. Dorsal hollow nerve cord

c. Ventral heart

d. Pharyngeal gill slits

Ans. c

Q. 57. In which subphylum of Chordata is the notochord present only in the larval tail?

a. Urochordata
b. Cephalochordata
c. Vertebrata
d. Hemichordata

Ans. a

Q. 58. Which of the following is a feature unique to cephalochordates?
a. Presence of a vertebral column
b. Presence of a bony skeleton
c. Notochord extending from head to tail and persistent throughout life
d. Metamorphosis
Ans. c

Q.59. which of the following is a characteristic of vertebrates?

a. Notochord is replaced by a bony vertebral column in the adult
b. Notochord is present throughout life
c. No notochord is present
d. Notochord is replaced by a cartilaginous vertebral column

Ans.a

Q. 60. Which of the following is a characteristic of urochordates?

a. Notochord is present throughout life
b. Notochord is only present in the larval tail
c. Notochord is replaced by a vertebral column
d. No notochord is present

Ans. b

Q. 61. Which of the following is a typical example of a cephalochordate?

a. Amphioxus
b. Salpa
c. Herdmania
d. Tunicate

Ans. a

Q. 62. Which of the following is a characteristic of the subphylum Vertebrata?

a. Notochord is replaced by a vertebral column
b. Notochord is present throughout life
c. No notochord is present
d. Notochord is replaced by a cartilaginous vertebral column

Ans. a

Q.63. Which of the following is a feature of the phylum Chordata?

a. Dorsal, solid, and single nerve cord
b. Ventral, solid, and single nerve cord
c. Dorsal, hollow, and single nerve cord
d. Ventral, hollow, and single nerve cord

Ans. c

Q. 64. Ammocoete larva is found in:

a. Myxine

b. Petromyzon

c. Cephalochordata

d. Amphioxus

Ans. b

Q. 65. The term "typical chordate" is often associated with:

a. Amphioxus

b. Salpa

c. Herdmania

d. Tunicate

Ans. a

Q. 66. Which among the following is incorrect about chordates?

a. They must have notochord at every point of their life

b. They have a post anal tail

c. They have hollow dorsal nerve cord

d. They have a ventral heart

Ans. a

Q. 67. Which among the following is incorrect about chordata?

a. They have paired muscles

b. Post anal tail must be present in chordates

c. Their notochord vanishes after certain period of time

d. Pharyngeal gill slits are present

Ans. b

Q. 68. Which among the following is odd?

a. Urochordata

b. Cephalochordata

c. Vertebrata

d. Agnatha

Ans. d

Q. 69. Which among the following is not correct about Urochordata?

a. They are a classification under Protochordates

b. They have post anal tail only till their larval stage

c. Most of these are marine and almost extinct

d. They don't contain gill clefts

Ans. d

Q. 70. Which among the following is incorrect about Vertebrata?

a. All chordates are vertebrates

b. In vertebrates, notochord is replaced by vertebral column in adults

c. They might not have post-anal tail after a certain period of time

d. Notochord is present during embryonic period

Ans. a

Q.71. Agnatha is an example of _____

a. Sub-phylum

b. Phylum

c. Super-class

d. Class

Ans. c

Q. 72. Which among the following is incorrect about Agnatha?

a. These are also called as jawless fishes

b. Scales and fins are present

c. They adopt parasitic mode of nutrition

d. They have a circular mouth that acts as sucker

Ans. b

Q. 73. Which among the following is incorrect about Cyclostomata?

a. Their vertebral column is made of cartilage

b. Lamprey and hagfish are examples of this class

c. Their digestive system is complete with stomach, food pipe and intestines

d. Their circulatory system is closed with a 2 chambered heart

Ans. c

Q. 74. Which among the following is incorrect about Gnathostomata?

a. These are vertebrates with jaws

b. This super class is classified into Pisces and tetrapods based on their type of blood

c. Pisces use fins for their movement

d. Tetrapods use limbs for their movement

Ans. b

Q. 75. Which among the following is incorrect about Pisces?

a. They have a streamlined body and a muscular tail that helps them in their movement

b. They are cold-blooded animals and can regulate the body temperature

c. Their heart is 2 chambered

d. Their skeleton is made of cartilage and bone

Ans. b

Q. 76. Which among the following is an incorrect statement about circulatory system in Pisces?

a. Their circulatory system is of closed type

b. They have two-chambered heart i.e. they have an auricle and a ventricle

c. They have a single circulatory system with gills i.e. oxygenated blood is pumped to body parts only once

d. Auricle is also called receiving chamber and ventricle is also called as pumping chamber

Ans. c

Q. 77. Which among the following is the main difference between Chondrichthytes and Osteichthytes?

a. Endoskeleton composition

b. Fins

c. Type of blood

d. Type of jaws

Ans. a

Q. 78. Which among the following is not correct about Chondrichthyes?

a. Chondrichthyes are jawless fishes

b. They have stream-lined body

c. Notochord is present throughout their life

d. Their skin is covered with pointed denticles

Ans. a

Q. 79. Which among the following is incorrect about Osteichthyes?

a. Swim bladder helps them retain buoyancy

b. Many of them are edible

c. Gills are separate without operculum

d. Skin covered with cycloid/ ctenoid scales

Ans. c

Q. 80. Which among the following is incorrect about Tetrapoda?

a. Lobe-finned fishes were ancestors of tetrapods

b. Tetrapoda are classified into 4 sub-classes i.e. Amphibia, Reptilia, Aves and Mammalia

c. The word tetrapoda means those that have four chambered heart

d. Most of them are terrestrial

Ans. c

Q. 81. Which among the following is incorrect about Mammals?

a. They are mostly terrestrial and feed their young ones with milk

b. Scales are absent, instead hairs, sweat and oil glands on skin

c. They respire through lungs and their heart is four-chambered

d. Bats are the only mammals that lay eggs and feed their young ones with milk

Ans. d

Q. 82. Which among the following is incorrect about Aves?

a. Scales are absent and skin is dry except at the one end there is an oil gland

b. Endoskeleton is made of bones and they respire through lungs

c. They have cold-blooded animals

d. They are dioecious and oviparous

Ans. c

Q. 83. Which among the following is incorrect about Reptilia?

a. These are cold-blooded animals with scales on them

b. All of them have a three-chambered heart

c. Kidneys are present for excretion

d. These are oviparous

Ans. b

Q. 84. Which among the following is incorrect about organ system in Amphibia?

a. In amphibians, blood passes the heart twice

b. Left auricle deals with deoxygenated blood

c. Ventricle deals with both oxygenated and deoxygenated blood

d. Tympanum represents ears in amphibians

Ans. b

Q. 85. Which among the following is incorrect about Amphibia?

a. They can live both on land and water

b. They are warm-blooded animals

c. They have three chambered heart

d. They have gills/ lungs to respire

Ans. b

Q. 86. Which of these characteristics of frog is the reason for its short alimentary canal?

a. Carnivorous

b. Sexual dimorphism

c. Amphibian

d. Chordate

Ans. a

Q. 87. Where are the copulatory pads in male frog present?

a. Second digit of the hindlimbs

b. First digit of the hindlimbs

c. First digit of the forelimbs

d. Second digit of the forelimbs

Ans. c

Q. 88. Which of this is not a distinguishing feature of a male frog?

a. Narrow abdomen

b. Copulatory pad

c. Vocal sacs

d. Moist, slippery skin

Ans. d

Q. 89. How many digits does the forelimb and hindlimb of frog have respectively?

a. 3, 4

b. 5, 4

c. 4, 5

d. 4, 3

Ans. c

Q. 90. Which of these structures in frog receive sound signals?

a. Webbed feet

b. Skin

c. Nictitating membrane

d. Tympanum

Ans. d

Q. 91. Which of these structures protects the eyes of the frog in water?

a. Nictitating membrane

b. Tympanum

c. Bidder's canal

d. Cloaca

Ans. a

Q. 92. Which of these are the divisions of the body of a frog?

a. Head, trunk, abdomen

b. Head, thorax, abdomen

c. Head, trunk

d. Head, thorax, trunk

Ans. c

Q. 93. Which of these describes the skin of frog?

a. Thick, leathery

b. Smooth, slippery

c. Hard, dry

d. Thin, membranous

Ans. b

Q. 94. Which of these statements is false about frogs?

a. They do not aestivate

b. They change color

c. They live in burrows

d. They hibernate

Ans. a

Q. 95. Which of these methods are utilized by frogs for protection?

a. Speed

b. Spikes

c. Mimicry

d. Playing dead

Ans. c

Q. 96. Frogs are _____

a. homeothermic

b. warm-blooded

c. poikilothermic

d. heterothermic

Ans. c

Q. 97. Which of these statements is true about frog?

a. It lives both on land and in sea water

b. They cannot survive in freshwater

c. *Rana tigrina* is a rare species

d. They belong to class Amphibia

Ans. d

Q. 98. Which of the following is NOT a characteristic feature of Reptilia?

a. Scales or scutes

b. Ectothermic (cold-blooded)

c. Viviparous (giving birth to live young)

d. Dry, rough skin

Ans. c

Q. 99. Reptiles are primarily classified based on the structure of:

a. their limbs

b. their hearts

c. their skulls (especially temporal fossae)

d. their scales

Ans. c

Q. 100. Which of the following is NOT an order within Reptilia?

a. Testudines
b. Crocodilia
c. Squamata
d. Amphibia

Ans. d

Q. 101. Which of the following is considered a "living fossil" among reptiles?

a. Snakes
b. Lizards
c. Tuatara
d. Crocodiles

Ans. c

Q. 102. Reptiles are typically found in:

a. Aquatic environments
b. Terrestrial environments
c. Aerial environments
d. Both aquatic and terrestrial environments

Ans. d

Q. 103 Which of the following is NOT a characteristic feature of Phylum Hemichordata?

a. Presence of pharyngeal slits
b. Dorsal nerve cord

c. Atriopore for excretion

d. Possession of a proboscis

Ans. b

Q. 104 .Hemichordates have a rudimentary structure in the collar region called:

a. Notochord

b. Stomochord

c. Dorsal tubular nerve cord

d. Post-anal tail

Ans. b

Q. 105 Which of the following is true about the circulatory system in Hemichordata?

a. It is a closed type

b. It is an open type

c. It is absent

d. None of these

Ans. b

Q. 106. Development in Hemichordates is typically:

a. Direct

b. Indirect with a larval stage

c. Asexual

d. Both direct and indirect

Ans. b

Q. 107. Examples of Hemichordates include:

a. Ascidia and Salpa

b. Branchiostoma (Amphioxus) and Lancelet

c. Balanoglossus and Saccoglossus

d. Fish, amphibians, reptiles

Ans. c

Q. 108. Which of the following is characteristic of Urochordata?

a. Notochord present throughout life

b. Dorsal, tubular nerve cord present only in larval stage

c. Exclusively freshwater habitat

d. Segmented body

Ans. b

Q. 109. Urochordata are also commonly known as:

a. Sea stars

b. Sea anemones

c. Sea squirts

d. Sea urchins

Ans. c

Q. 110. Which of the following describes the adult stage of most Urochordates?

a. Free-swimming and planktonic

b. Sessile and filter-feeding

c. Predatory and motile

d. Parasitic and internal

Ans. b

Q. 111. The protective outer covering of adult Urochordates is called the:

Shell

b) Cuticle

c) Tunic

d) Exoskeleton

Ans. c

Q. 112. In Urochordata, the process where the larval form transforms into a simpler adult form is known as:

a. Anamorphism

b. Neoteny

c. Retrogressive metamorphosis

d. Progressive metamorphosis

Ans. d

Q. 113. Which of the following is a characteristic feature of Cephalochordata?

a. Notochord present only in larval tail

b. Notochord extends from head to tail and persists throughout life

c. Notochord is replaced by a bony vertebral column in adults

d. Exclusively freshwater animals

Ans. b

Q. 114. Which of the following is a common example of a Cephalochordate?

a. Ascidia
b. Salpa
c. Branchiostoma
d. Doliolum

Ans. c

Q. 115. Cephalochordates are characterized by:

a. A closed circulatory system with red blood cells
b. An open circulatory system with colorless blood
c. A closed circulatory system with colorless blood
d. Absence of a circulatory system

Ans. c

Q. 116.The notochord in Cephalochordates is:

a. Present only in the larval stage
b. Replaced by a vertebral column in adults
c. A supportive structure extending from head to tail and present throughout life
d. Absent

Ans. c

Q. 117. Cephalochordates are typically:

a. Terrestrial
b. Aquatic, specifically marine

c. Amphibious

d. Parasitic

Ans. b

Q. 118. Retrogressive metamorphosis is characteristic of which of the following animals?

a. Amphioxus

b. Balanoglossus

c. Herdmania

d. All of the above

Ans. c

Q. 119. Which of the following best describes ostracoderms?

a. An ancient group of spiny echinoderms

b. A group of primitive protochordates

c. Primitive fishes without jaws

d. One of the first terrestrial vertebrates

Ans. c

Q. 120. Which of the following is a characteristic feature of cyclostomes?

a. Presence of jaws

b. Presence of paired fins

c. Presence of a sucking and circular mouth

d. Presence of bony skeleton

Ans. c

Q. 121. Cyclostomes are typically:

a. Herbivores
b. Carnivores
c. Parasites
d. Omnivores

Ans. c

Q. 122. What type of circulatory system do cyclostomes have?

a. Closed circulatory system
b. Open circulatory system
c. Both open and closed circulatory systems
d. No circulatory system

Ans. a

Q. 123. Cyclostomes are known for their:

a. Well-developed limbs
(b) Protective scales
(c) Cartilaginous skeleton
(d) Bony skeleton

Ans. c

Q. 124. Where do cyclostomes typically migrate for spawning?

a. From freshwater to salt water
b. From saltwater to freshwater
c. From one freshwater location to another
d. From one saltwater location to another

Ans. b

Q. 125. What is the primary function of the gills in cyclostomes?

a. Digestion
b. Excretion
c. Respiration
d. Circulation

Ans. c

Q. 126. Which of the following is an example of a cyclostome?

a. Shark
b. Hagfish
c. Frog
d. Snake

Ans. b

Q. 127. Cyclostomes belong to the subphylum:

a. Vertebrata
b. Cephalochordata
c. Urochordata
d. Hemichordata

Ans. a

Q. 128. What is the primary distinguishing feature of cyclostomes within the vertebrates?

a. Presence of a vertebral column
b. Absence of jaws
c. Presence of paired limbs
d. Presence of bony skeleton

Ans. b

Q. 129. How do cyclostomes typically feed?

a. Filter feeding
b. Active hunting
c. Parasitic attachment and feeding
d. Herbivorous grazing

Ans. c

Q. 130. Fishes belonging to the subclass Dipnoi are commonly known as:

a. Catfish
b. Lungfish
c. Ratfish
d. Starfish

Answer: b

Q. 131. A distinguishing characteristic of Dipnoi, enabling them to survive during droughts, is the presence of:

a. Gills only
b. Scales and fins only
c. Gills and lungs
d. External gills

Answer: c

Q. 132. The heart of lungfishes is:

a. Two-chambered
b. Three-chambered
c. Four-chambered
d. Absent

Answer: b

Q. 133. Which of the following is an example of a lungfish?

a. Exocetus
b. Lepidosiren
c. Clarias
d. Pristis

Answer: b

Q. 134. The scales present in Dipnoi are typically:

a. Placoid scales

b. Cycloid scales

c. Ctenoid scales

d. Ganoid scales

Answer: b

Q. 135. Which of the following is a characteristic feature of Dipnoi (lungfish)?

a. They primarily breathe through gills, with lungs being vestigial.

b. They possess a single-chambered heart.

c. They have crushing tooth plates instead of typical teeth.

d. They exhibit a constricted notochord in adults.

Answer: c

Q. 136. The swim bladder is found in:

a. Cartilaginous fish (sharks, rays)

b. Bony fish (most common types)

c. Echinoderms (starfish, sea urchins)

d. Both a and c

Answer: b

Q. 137. The main function of the swim bladder is to:

a. Excrete waste products

b. Aid in digestion

c. Maintain buoyancy

d. Circulate blood

Answer: c

Q. 138. Which of the following is NOT a function of the swim bladder?

a. Maintaining depth in the water
b. Assisting with respiration in some species
c. Producing and receiving sound
d. Collecting urine

Answer: d

Q. 139. What type of fish lacks a swim bladder?

a. Freshwater fish
b. Bony fish
c. Cartilaginous fish
d. Fish with oily livers

Answer: c

Q. 140. In some primitive fish, the swim bladder can also function as a:

a. Heart
b. Lung
c. Kidney
d. Brain

Answer: b

Q. 141. Which of the following is NOT an example of a fish with a swim bladder?

a. Common carp

b. Cattlefish

c. Bowfin

d. Shark

Answer: d

Q. 142. The swim bladder is derived from an outpocketing of the:

a. Digestive tube

b. Respiratory system

c. Excretory system

d. Nervous system

Answer: a

Q. 143 The primary function of the swim bladder in most bony fish is:

a. Respiration

b. Buoyancy control

c. Sound production

d. Waste excretion

Ans. b

Q. 144 Fish that have a swim bladder directly connected to their esophagus are classified as:

a. Physoclistous

b. Cartilaginous

c. Physostomous

d. Deep-sea dwellers

Ans. c

Q. 145 Which of the following fish lacks a swim bladder?

a. Carp

b. Shark

c. Eel

d. Catfish

Ans. b

Q. 146. The network of capillaries in the swim bladder responsible for gas secretion is called the:

a. Gill slits

b. Weberian apparatus

c. Rete mirabile

d. Oval

Ans. c

Q. 147. Swim bladder disorders can be caused by:

a. Overfeeding

b. Poor water quality

c. Infections

d. All of the above

Ans. d

Q. 148. Which of the following best describes parental care in amphibians?

a. Care of the young only after they hatch.

b. Behaviors that protect eggs and offspring to increase survival.

c. Only protecting eggs from predators.

d. Directly feeding the young amphibians.

Ans. b

Q. 149. What is a common method of parental care in amphibians?

a. Building elaborate nests like birds.

b. Directly feeding the developing young.

c. Guarding eggs and keeping them moist.

d. Migrating with the young to find food.

Ans. c

Q. 150. Which of the following amphibians is known for parental care by coiling around its eggs?

a. Rana temporaria

b. Ichthyophis

c. Ambystoma maculatum

d. Bufo bufo

Ans. b

Q. 151. How do tree frogs often protect their eggs?

a. By laying them directly in water.

b. By building mud nests.

c. By creating foam nests.

d. By burying them in the soil.

Ans. c

Q. 152. Which of the following is an example of direct parental care in amphibians?

a. Choosing a safe egg-laying site.
b. Carrying eggs on the body or in pouches.
c. Building a nest out of leaves.
d. All of the above.

Ans. b

Q. 153. What is the main benefit of parental care in amphibians?

a. Increased mating success.
b. Enhanced survival of eggs and young.
c. Improved camouflage for offspring.
d. More efficient locomotion for young.

Ans. b

Q.154. Which of the following fish species exhibits parental care by males?
a. Seahorse (Hippocampus)
b. Anabas
c. Labeo
d. Synaptura

Answer: a

Q. 155. Which of the following is NOT a type of parental care observed in fishes?

a. Guarding eggs

b. Cleaning nests

c. Providing food for the young

d. Internal fertilization with no parental care

Answer: d

Q. 156. In which fish species is the male known as the "pregnant male" due to his role in parental care?

a. Anabas

b. Labeo

c. Seahorse (Hippocampus)

d. Scoliodon

Answer: c

Q. 157. What is the primary function of the brood pouch in male seahorses?

a. To store food for the female

b. To provide a place for the female to lay eggs

c. To fertilize the eggs

d. To protect and nourish the developing embryos

Answer: d

Q. 158: Which of the following is an example of viviparity in fish, where the young develop internally?

a. Seahorse

b. Anabas

c. Dogfish (Scoliodon)

d. Labeo

Answer: c

Q. 159. Which of the following describes anadromous fish migration?

a. Migration within freshwater habitats

b. Migration from freshwater to saltwater for spawning

c. Migration from saltwater to freshwater for spawning

d. Migration entirely within saltwater habitats

Answer: c

Q 160. Which of these fish is a classic example of anadromous migration?

a. European Eel

b. American Eel

c. Salmon

d. Tuna

Answer: c

Q. 161. Catadromous fish are characterized by which of the following migratory patterns?

a. Living and migrating entirely within freshwater

b. Living and migrating entirely within saltwater

c. Migrating from freshwater to saltwater for spawning

d. Migrating from saltwater to freshwater for spawning

Answer: c

Q. 162 A prominent example of a catadromous fish is:

a. Salmon

b. Sturgeon

c. European Eel

d. Herring

Answer: c

Q 163. Potamodromous fish migrate:

a. Between freshwater and saltwater

b. Only within freshwater habitats

c. Only within saltwater habitats

d. From freshwater to saltwater for feeding

Answer: b

Q. 164 Oceanodromous fish migrations take place:

a. Between freshwater and saltwater environments

b. Entirely within freshwater systems

c. Entirely within marine (saltwater) environments

d. From saltwater to freshwater for spawning

Answer: c

Q. 165. A key reason for many fish migrations is:

a. Avoiding predators

b. Finding suitable spawning grounds

c. Escaping from extreme weather conditions

d. All of the above

Answer: d

Q 166. The ability of salmon to return to their natal stream (birthplace) for spawning is primarily attributed to:

a. Visual cues

b. Geomagnetic field detection

c. Olfactory senses (smell)

d. Tidal currents

Answer: c

Q 167. The main physiological challenge faced by fish migrating between freshwater and saltwater is:

a. Maintaining body temperature

b. Maintaining salt and water balance (osmoregulation)

c. Adapting to changes in water pressure

d. Coping with varying levels of dissolved oxygen

Answer: b

Q 168. Human activities can significantly impact fish migration by:

a. Improving water quality

b. Reducing the presence of predators

c. Creating barriers like dams and weirs

d. Increasing the availability of food sources

Answer: c

Q 169. Bird migration refers to:

a. Random movement of birds within a limited area.

b. Irregular, short-distance movements in search of food.

c. The regular seasonal movement of birds, often north and south, between breeding

and wintering grounds.

d. A sudden, unpredictable shift in bird populations due to environmental changes.

Ans. c

Q 170. What is the primary reason why birds migrate from colder regions to warmer regions during winter?

a. To enjoy the scenic beauty of different locations.

b. To escape harsh weather conditions and find better food resources.

c. To socialize with different bird species.

d. To avoid predators in their breeding grounds.

Ans. b

Q 171. Which of the following navigation cues do migratory birds use to find their way during long journeys?

a. Following the scent of other birds.

b. Relying solely on memory and experience from previous migrations.

c. Using the Earth's magnetic field, the sun's position, and the stars.

d. Utilizing echoes to locate their destinations.

Ans. c

Q. 172. The longest recorded migratory journey belongs to the:

a. Ruby-throated Hummingbird

b. Bar-tailed Godwit

c. Arctic Tern

d. Snow Goose

Ans. c

Unit- II

Amphibia: Origin of tetrapods, General organization of Anura, Neoteny, Peculiarities of Urodela, Peculiarities and affinities of Apoda, Adaptive Radiation

Reptilia:

Skull in Reptiles, Origin and evolution, Adaptive radiation, General organization and affinities of Chelonia, Crocodilia, Squamata, Rhynchocephalia

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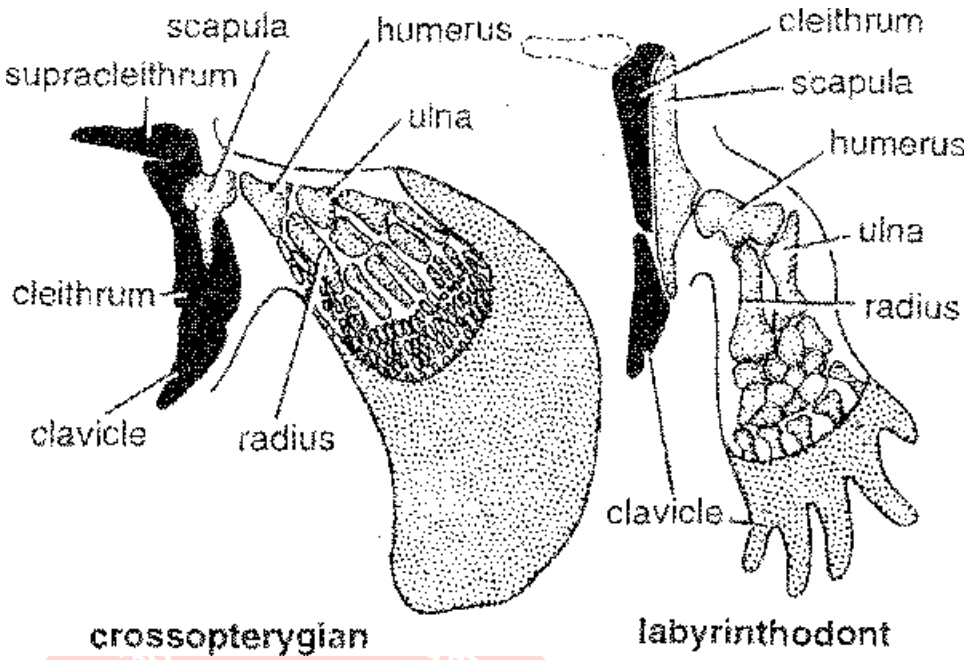
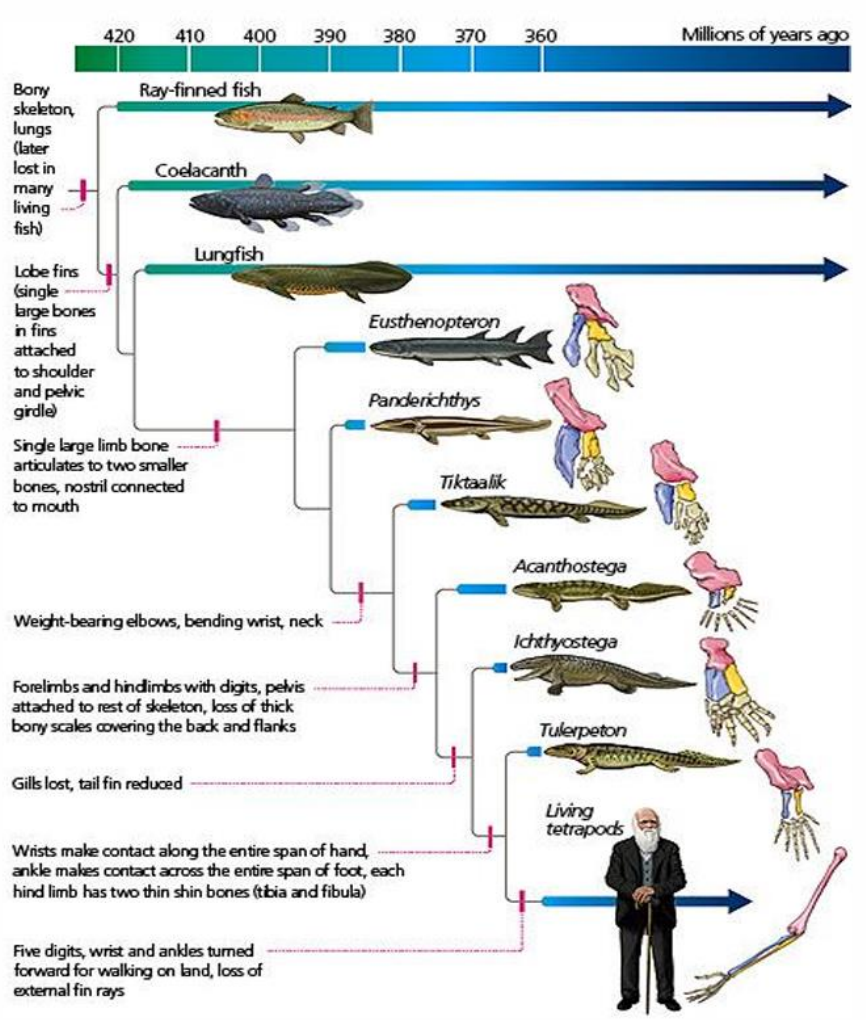
Origin of Tetrapods:

- Tetrapods are a group of vertebrates that includes amphibians, reptiles, birds, and mammals. The first tetrapods evolved during the Devonian period from crossopterygian fishes, which were adapted to shallow, marshy environments. These fishes already possessed some features that made their transition to land possible. The transition from aquatic to terrestrial life involved several anatomical changes.
- The first tetrapods were amphibians that evolved from the Devonian crossopterygian fishes which lived in shallow marshy locations and already possessed lungs for respiration and lobed fins to support their bodies on muddy banks of ponds, rivers and marshland. The anatomical changes that took place during transformation from fishes to amphibia were as follows:
- A tetrapod limb evolved to support the body out of water as on land the entire body weight fell on the four limbs, whereas in fishes body weight is supported by water and fins have to just propel it forward.
- Gills were lost in the adult stage as lungs became more and more efficient air breathing organs and air contained more oxygen as compared to water.
- The hyomandibular bone of the second visceral arch transformed into columella to transmit sound vibrations from air to the inner ear.
- Loss of scales permitted cutaneous respiration which evolved as an alternative method of respiration in the absence of gills while the animal lived and swam in water.
-

- The skull developed two occipital condyles that fitted in an atlas vertebra so that skull could move upward and downward for locomotion as well as for better visibility.



- In terrestrial environment vertebral column must be strong to support the body weight and hence centra of vertebrae transformed from amphicoelous to procoelous type.
- The lateral line system that was not useful in terrestrial environment simply disappeared.
- Adipose tissue that stores fat and provides insulation developed under the skin to stop loss of water by evaporation on land.
- **FOSSIL ANCESTORS OF TETRAPODS-** Labyrinthodonts were ancestors of all tetrapods and they had evolved from crossopterygian fishes. These ancestors had large teeth with labyrinthine folds on enamel that traversed deep into dentine. They still carried dermal scales on body and functional lateral line system. They had strong girdles and limbs. They diversified from Devonian to Permian periods and were dominant predators on land.
- *Osteolepis*. It was a lobed-finned fish belonging to Crossopterygii that lived about 375 million years ago and breathed with gills as well as lungs. Fins had bony elements homologous to humerus, radius, ulna and digits of tetrapod limbs. Eusthanopteron. This was another crossopterygian fish of Devonian period with lobed fins having bones arranged in the pattern of a tetrapod limb, even though the fish was completely aquatic.



- *Tiktaalik roseae* (Order Ichthyostegalia). The fossils of this labyrinthodont from Devonian (375 million years) were discovered from the river delta on Ellesmere Islands in Arctic Canada by Edward Daeschler of the Academy of Natural Sciences and Neil Shubin of the University of Chicago in 2006, who nicknamed it as "fishapod".

- It had 2.75 m long, scaly body with broad, 20 cm long skull and a flexible neck. Snout was long and flat with nostrils located near the base that suggests that it breathed air by sticking its head out of water and probably also caught terrestrial prey by hauling itself onto land.

- It had a big interlocking rib-cage to protect lungs while it dragged its body on muddy shores. Limb bones had typical tetrapod arrangement with 5 digits and primitive wrist bones. But the limb bones were wrapped in a fish-like fin which enabled it to swim and walk in shallow waters but incapable to confer locomotion on land.
- *Acanthostega* (Order Ichthyostegalia). It is more aquatic and better known animal than *Ichthyostega* and anatomically intermediate between fish and

tetrapods. Fore limbs were more paddle-like with 8 digits, and hind limbs had 6 digits but the elbow and knee joints did not bend and could not support animal's body on land and definitely were not capable of carrying out an effective terrestrial locomotion.

- Vertebrae were less ossified and ribs were short and straight and not overlapping and incapable to prevent collapse of the chest cavity out of water. *Ichthyostega* (Order Ichthyostegalia). The earliest fossils were discovered in 1932 from Greenland from the late Devonian (360 mya) deposits.
- Skull was flat and fish-like. Teeth had labyrinthine folds around dentine. Body was covered with dermal scales and lateral line system was present. Although tail carried fin rays, there is no indication of the presence of gills and respiration was carried entirely through lungs.
- Limbs were paddle-like, suggesting aquatic mode of life and were probably also used to drag the body on land. Digits were 5 or 6 in the hind limb but in fore limb the hand part is missing in fossil.
- ***Eryops, Cacops*** & *Amphibamous* (Suborder Rhachitomi). They are also called stem animals that evolved from stegocephalians, developed terrestrial adaptations, grew to become giants and became dominant terrestrial carnivores of Carboniferous and Permian.
- They had massive bodies and some reached a length of five feet and had strong limbs with four digits in the front leg and five in the hind leg. Tail was massive that contained a chevron bone in vertebrae and perhaps assisted in locomotion on land. Body was covered with dermal scales for protection.
- ***Buettneria*** (Suborder Stereospondyli). They were aquatic animals having secondarily simplified vertebral column in which intercentra expanded and became ring-like. They were the largest amphibians of their time that attained a length of up to 6 feet and were perhaps aquatic as suggested by the flattened tail and came on land briefly to feed or escape from predators.
- ***Eogyrinus*** (Suborder Embolomeri). They were small lizard-like, pentadactyle labyrinthodonts that had 5 digits in each limb. Each vertebra had two disc-

shaped centra. They were ancestors of Anthracosauria which later evolved into reptiles.

- ***Microbrachis*** & ***Sauropleura*** (Subclass Lepospondyli). They were ancestral to limbless caecilians and lived from Carboniferous to Permian periods. Vertebrae were ossified around the notochord and neural arch was continuous with centrum.
- ***Branchiosaurus*** (Subclass Phyllospondyli). They were small amphibians with large flat head and short tail and are believed to be ancestors of urodeles and anurans. The transverse process of the vertebrae and ribs were stout. Pectoral girdle was made of coracoid, scapula, cleithrum and clavicle. Limbs had four fingers and five toes.
- **ORIGIN OF AMPHIBIANS** - Amphibians evolved in specialized situations during Devonian period, just after the Devonian mass extinction when climate became warm and humid, and huge swamps and marshlands appeared on land. By Carboniferous period there were dense gymnosperm forests all over the land areas.
- Advancement of forests on land attracted insects, worms and molluscs that had already achieved the capability to inhabit terrestrial forests and which were part of fish and amphibian diet. Swamps of Devonian period were inhabited by highly specialized lobe-finned fishes that were already equipped with lungs to obtain oxygen from air as the marshland water was low in oxygen content.
- These fishes also had lobed fins with strong bony elements to support the body in muddy water or on submerged vegetation. Perfection of these two anatomical features, that is, lungs and lobed fins transforming into tetrapod limbs must have taken place in marshy conditions, which later proved to be important adaptations to conquer land, as seen in labyrinthodonts, such as *Tiktaalik*, *Acanthostega* and *Ichthyostega*.
- As forests started invading land, followed by invertebrates, these primitive labyrinthodonts also tried to venture on land in pursuit of abundant prey or to escape predators. They soon mastered terrestrial living and became the

dominant predators on land in Carboniferous and Permian periods, e.g. Cacops, Eryops and Buettneria. Large amphibians were wiped out by the Permian mass extinction, when over 70% of tetrapod families and almost 90% of species vanished.

General organization of Anura:

- The order **Anura** includes the **frogs** and **toads**. They are one of the most successful living amphibia, judged by number of species. There are about 7400 different species of amphibians, and about 6500 are in the Anura.
- There is no fundamental difference between frogs and toads. Frogs have a short body, webbed digits (fingers or toes), protruding eyes, forked tongue and no tail. They are exceptional jumpers: many of their features, particularly their long, powerful legs, are adaptations to improve jumping performance. They often live in semi-aquatic or humid areas.
- A popular distinction is often made between frogs and toads on the basis of their appearance. The warty skin of toads is an adaptation for making their toxic slime. Apart from these glands, their skin is dry, and that is an adaptation to drier habitats.
- These features have evolved a number of times independently: convergent evolution. The distinction has no taxonomic basis: the Anura are not divided into frogs and toads. The only family exclusively given the common name "toad" is the Bufonidae (the "true toads"), but many species from other families are also called "toads".
- Frogs have smooth (soft) skin, while toads have rough (hard) skin. Frogs need their skin to be wet in order for them to get oxygen. Frogs and toads have broad heads and plump bodies. They have short fore limbs and long webbed hind feet. This helps them to move and swim in water. They can

also use their legs to crawl, hop and leap. Frogs are good jumpers, and some can leap up to six feet in the air.

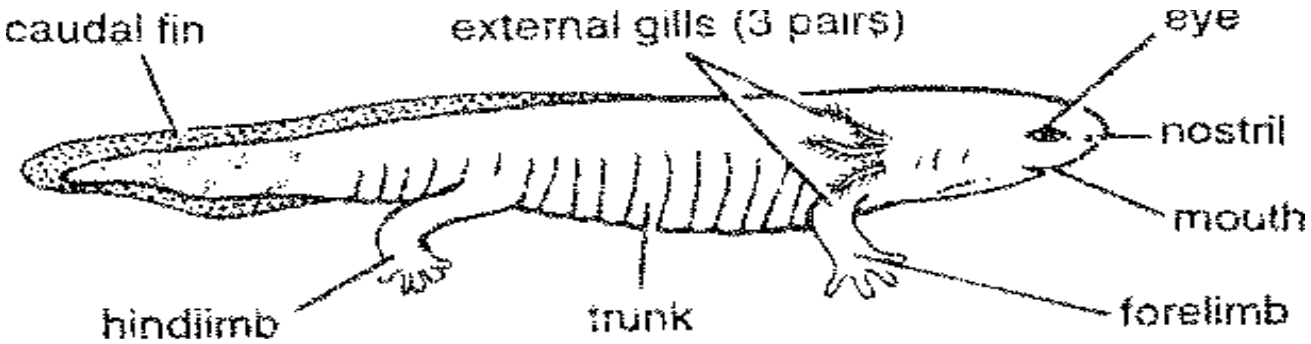
- Tree frogs can climb on any surfaces, they use their sticky hands to do this. The tympanum membrane can only be seen on frogs. The tympanum membrane can be found between the frog's ears and eyes.

- Frogs have tiny teeth inside their mouths. They are found on the lower jaw. The African bullfrog is the only species where the males are longer than the females. Males can reach up to 24.1 cm-25.4 cm in length, while the female only grows up to 11.4 cm.

- Frogs belonging to the suborder Neobatrachia, such as the poison dart frogs and Mantellinae frogs, can kill humans. Like most poisonous animals, they get their toxin from their food.

NEOTENY:

- *Neoteny* refers to the retention of a larval or embryonic trait in the adult body. Familiar examples are retention of embryonic cartilaginous skeleton in adult in Chondrichthyes; and the larval gills in some adult salamanders.
- *Paedogenesis* or *paedomorphosis* refers to development of gonads and/or production of young ones by an otherwise immature, larval or preadult animal. The examples are scattered in several groups or animals (e.g. gall fly, liver fluke, salamanders).
- Thus, whereas neoteny emphasizes the retention of embryonic or larval features in the *adult* body, paedogenesis stresses precocious development of gonads in *larval body.*



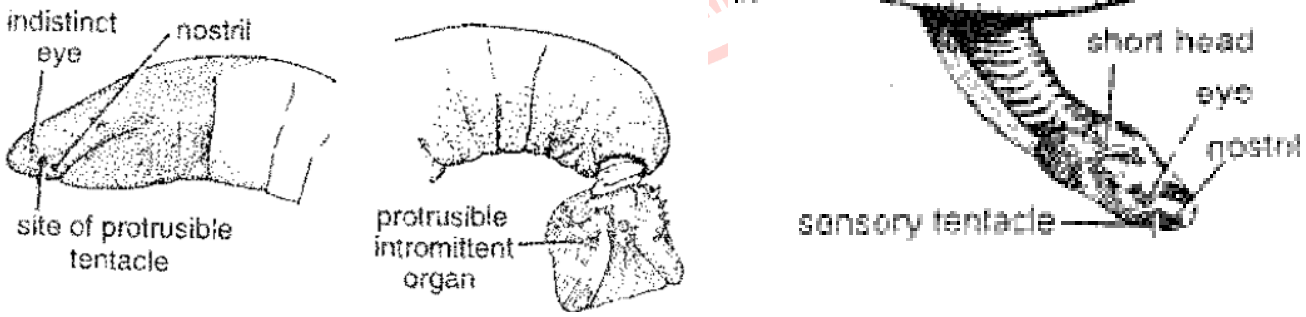
- **Axolotl.** Classical and most informative examples of neoteny and paedogenesis among Amphibia (vertebrates) are furnished by *Ambystoma* (or *Ambly stoma). A. maxieanum* lives in Lake Xochimilco in the highlands of Mexico and the closely related. *A. tigrinum* (tiger salamander) in high altitudes of Colorado (North America).
- Ordinarily they go through typical gilled aquatic larval stages, then metamorphosis, to transform into adult air-breathing land forms. However, under certain circumstances, the larvae do not metamorphose, retain their gills and aquatic habitat but become sexually mature.
- This sexually mature but morphologically immature, larval stage with external gills is called an *axolotl.* The name was given by natives of Mexico who captured them for food.
- In Aztec axoiotl means "servant of water". At one time axolotls were considered a separate genus, *Siredon, S. axoiotl, S. mexicanum, S. pisciformis* etc. (Wagler, 1830).
- However, in 1865, some axolotls brought to'' Paris in France discarded their gills and fins and underwent metamorphosis to become adult terrestrial salamanders. Axolotls have been important laboratory experimental animals for a century, for most of them now used worldwide have descended directly from those sent to Paris in 1864 and 1868.
- **Significance** : Weismann (1875) thought neoteny to be a case of retarded evolution or *atavism,* that is, reversion to ancestral condition. However, this is now regarded to be of secondary specialization, a physiological adaptation of advantage. This is also proved by the great heterogeneity of all neotenous perennibranchiate forms.

Peculiarities of Apoda:

- The limbless amphibians or caecilians, sometimes called blindworms, belong to the order Gymnophiona or Apoda. They mostly inhabit the tropical and subtropical regions of America, Africa and Asia. Except few aquatic forms, they

are strictly burrowing. They burrow in moist ground with their strong heads, feeding mostly on worms and other small invertebrates.

- They have long slender, worm like body with much reduced tail so that vent or cloaca is almost terminal. They have neither girdles nor limbs but possess' minute dermal scales buried in the skin. They may have as many as 250 vertebrae. Their eyes are rudimentary, concealed and practically functionless, hence the common name blindworms.
- However, they can feel their way about by means of a protrusible sensory tentacle, lying in a groove between the eyes and nose. Male copulates with female by a protrusible cloaca and fertilization is internal.
- Large eggs are usually laid in masses in moist ground near water. Female of *Ichthyophis,* common form in southeast Asia including India, shows parental care by carefully coiling her body around eggs till they hatch.
- The larval stage passed inside egg has 3 pairs of external gills which are lost when it hatches. *Uraeotyphlous* is another oviparous form also found in India in Malabar and Cochin. Some types of Apoda are viviparous or ovoviviparous, such as the South American aquatic form, *Typhlonectes.*

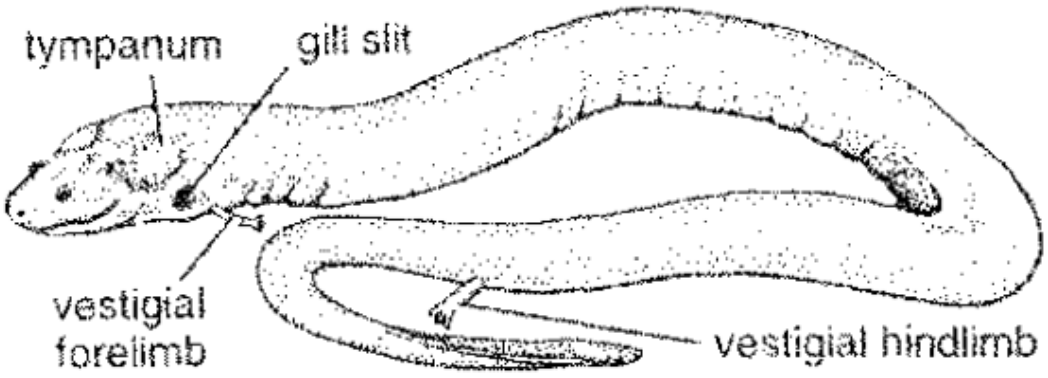


Peculiarities of Urodela:

- Tailed amphibians, belonging to the order Caudata or Urodela, include salamanders, newts and allied forms. Lizard-like amphibians with a distinct tail. Limbs 2 pairs, usually weak, almost equal.
- Skin devoid of scales and tympanum. Gills permanent or lost in adult. Males without copulatory organs. Larvae aquatic, adult-like, with teeth.
- These are elongated, lizard-like forms more generalized than frogs and undergo less profound changes in structure and habits at metamorphosis than do frogs.
- All possess a well developed tail and a lateral line system in adult as well as larval condition. Limbs are usually weak and subequal and terminal mouth is bounded by jaws with or without teeth. Eyelids and tympanum are lacking.
- Their skin is close-fitting unlike that of frogs and toads. They live on worms, small arthropods and small molluscs.
- Urodeles show a gradual transition from aquatic to terrestrial life and generally fall in two groups

  1. Perennibranchs. These forms retain gills and are aquatic throughout life. Examples : *Necturus, Proteus, Siren.*

  2. Caducihranchs. These forms lose their gills upon becoming adults that generally assume a terrestrial mode of life



Amphiuma or Congo eel

Adaptive radiation in Amphibians:

- It refers to the diversification of amphibian species from a common ancestor into various ecological niches, often driven by environmental changes or the availability of new resources.
- This process leads to the evolution of diverse forms with specialized traits that enable them to thrive in different habitats and lifestyles. Examples include the diversification of frogs in the Philippine archipelago or the shrub frogs in Sri Lanka.

❖ Diversification from a Common Ancestor:

Amphibians, like other groups, can undergo adaptive radiation when a single ancestral species gives rise to multiple descendant species with distinct characteristics.

❖ Ecological Niches:

These descendant species adapt to different ecological niches, such as different types of vegetation (tree-shrub, leaf-litter, etc.), or specific microhabitats within a region.

❖ Morphological and Physiological Adaptations:

Adaptive radiation often results in noticeable differences in body size, limb structure, skin texture, and other physical features, as well as variations in physiological processes related to feeding, reproduction, and other functions.

Examples:

Philippine Kaloula frogs: A study of microhylid frogs in the Philippines identified three primary habitat specialists or ecotypes (tree-dwelling, ground-dwelling, and burrowing) within the genus Kaloula, demonstrating adaptive radiation.

Sri Lankan shrub frogs: Another example is the diversification of Pseudophilautus shrub frogs in Sri Lanka, where five ecomorphological

categories (Tree-shrub, Rock-boulder, Leaf-litter, Habitat Generalists, and Canopy) have evolved, with body size being a key factor in separating species.

- **Driving Forces:**

Adaptive radiation in amphibians can be triggered by:

- **Ecological Opportunities:** When new habitats or resources become available, such as after a mass extinction event or due to geological changes.
- **Acquisition of Novel Traits:** Evolutionary innovations or pre-adaptations can lead to new ways of exploiting the environment and driving diversification.
- **Climate Change:** Fluctuations in climate can also play a role, as seen with the Sri Lankan shrub frogs, where cold climatic periods influenced the diversification of ecomorphs.
- **Research Focus:**

Studies on adaptive radiation in amphibians often combine phylogenetic analyses (studying evolutionary relationships) with ecological and morphological data to understand the patterns and processes of diversification.

SKULL IN REPTILES:

- Reptiles are ectothermic animals whose body is covered by epidermal scales. They possess monocondylic skull that rests on a long neck made of atlas, axis and other cervical vertebrae.
- They have two sacral vertebrae, which are fused together to transfer the weight of body onto the hind limbs. Pentadactyle limbs bear sharp claws which help the animal in creeping and climbing. Reptiles were the first vertebrates that laid a large, shelled, cledoic egg that could develop on land.
- The egg has three membranes, amnion, allantois and yolk sac which help in the development of the embryo on land in dry conditions. Generally in reptiles with big jaws and large head, the skull becomes too heavy for the neck to support it. Therefore vacuities or fossae developed in reptiles to lighten the skull and also to provide space for accommodating powerful jaw muscles.
- The skull names come from the word "**apse**," which means "**arch**." The number and types of arches, or enclosed fenestrae or windows, give the skull

types their names. These openings actually give the skull extra space for the attachment of jaw muscles, allowing animals to snap their jaws more forcefully.

- Temporal fenestrae have been used to classify amniotes by Osborn, 1903. Taxa such as **Anapsida, Diapsida, Euryapsida, and Synapsida** were named after their type of temporal fenestration. Temporal fenestrae are large holes on the sides of the skull. The function of these holes has long been debated (Case, 1924).
- Many believe that they allow muscles to expand and lengthen, resulting in greater bulk of jaw musculature. The longer muscle fibres allow an increase in the gape of the jaw to handle larger prey (Pirlot, 1969).

ANAPSID SKULL (Ex. Cotylosauria and Chelonia)

- This is the most primitive type of skull of reptiles that occurred in primitive labyrinthodont amphibians and then in primitive reptiles like ***Seymoria.*** The anapsids were the first reptiles to appear in the Carboniferous Period (345 to 280 million years ago).
- "**Anapsid**" means "**without arch**", meaning that they have no fenestrae in their skulls. The anapsids were first represented by small, herbivorous Procolophonids, and the much larger, herbivorous Pareiasaurs.
- Chelonia that today includes tortoises and turtles, still possess this type of skull, which has complete skull roofing, without temporal vacuities or fossa. As the skull is completely covered by bones, this type of skull is heavy but strong.
- Turtles have small head and jaws without teeth and hence the weight of the skull can be borne by the neck, but other reptile that evolved massive jaws and head, must evolve lighter skulls so that it could be supported by the neck and also larger and stronger jaw musculature.
- This is achieved by developing vacuities or empty spaces in the temporal area of the skull and sometimes before the eye orbit.

EURYAPSID SKULL (Ex. ***Plesiosaurus)***

- **Euryapsid** means "**wide arch**". They have one fenestra high on both sides of the skull. The euryapsids are represented by the marine reptiles such as the icthyosaurs, plesiosaurs, and placodonts, which are all completely extinct groups. The euryapsids arose from the diapsids which had two fenestrae, but sealed one of the openings to strengthen their skulls for life under water.
- ***Plesiosaurus*** was aquatic giant reptile with a long neck, small skull and fish-eating jaws. Its limbs were modified into paddles for swimming and there was no tail fin but a small tail. Skull had a single pair of temporal vacuities bordered by parietal, postorbital and squamosal bones. Maxilla and premaxilla had sharp teeth for fish catching.

PARAPSID SKULL (Ex. ***Ichthyosaurus)***

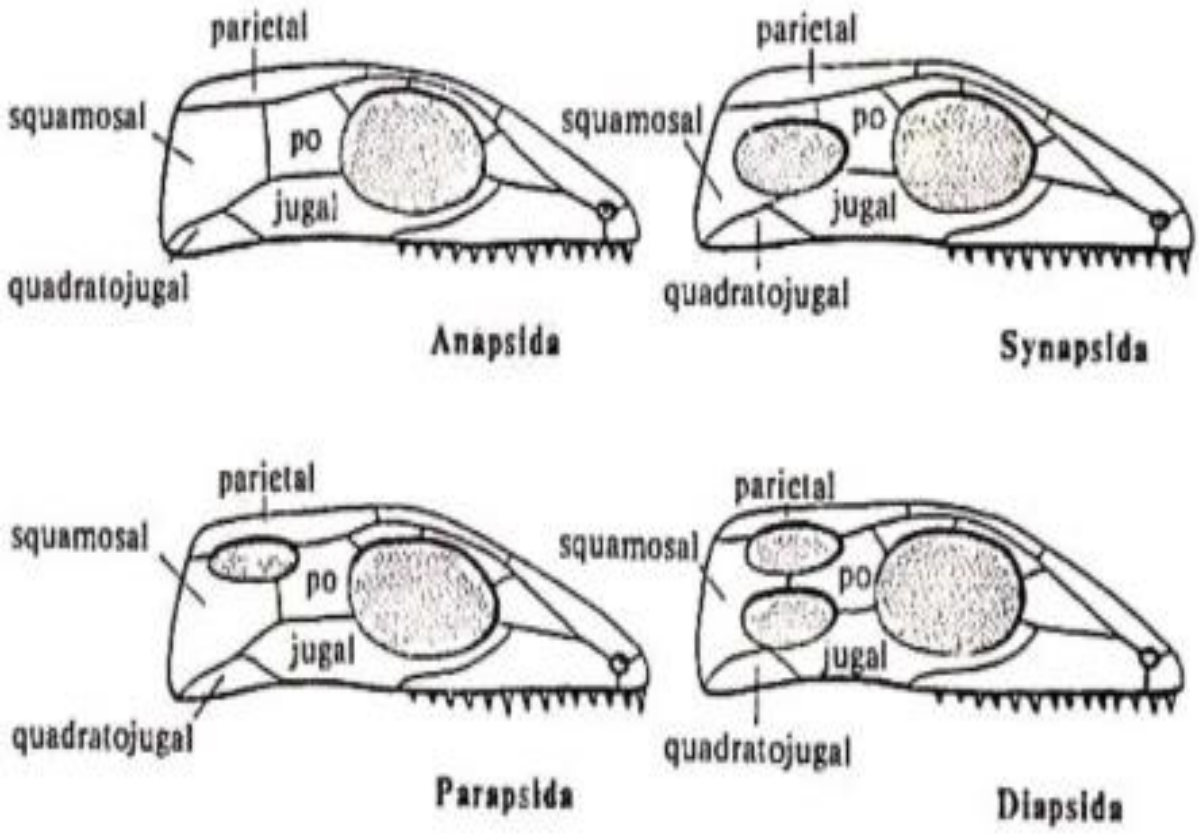
- This type of skull evolved in ***Ichthyosaurus,*** which included dolphin-like aquatic reptiles that preyed upon fishes or other aquatic animals. This skull also had only one pair of temporal vacuities on the upper side, guarded by two additional bones, namely, postfrontal and supratemporal, which push the postorbital and squamosal bones towards the lower side.
- The vacuities are guarded by parietal bones above. The condition found in ***ichthyosaurs*** is distinguished from the euryapsid condition because their temporal fenestrae are only bordered by the parietal, postfrontal, and supratemporal (Pirlot, 1969). This condition has been called parapsid, but it only represents a minor variation from the euryapsid pattern.

DIAPSID SKULL (Ex. *Sphenodon*, snakes, lizards, crocodiles and dinosaurs)

- This type of skull has two temporal vacuities on either side of the skull. The superior temporal vacuity is surrounded by parietal above and postorbital and squamosal below. The inferior temporal vacuity is guarded by the postorbital and squamosal above and jugal and quadratojugal below.
- This type of skull is lighter and has more space for the attachment of jaw muscles. It is found in a large number of living reptiles and also in extinct dinosaurs. Dinosaurs and crocodiles also have a pair of preorbital vacuities anterior to the eye orbits.

SYNAPSID SKULL (Ex. Pelycosauria and Therapsida)

- This type of skull was found in ***Dimetrodon*** (Pelycosauria) and the mammal-like therapsid reptiles ***(Cynognathus)***, in which there was only one inferior temporal vacuity on each side of the skull but it was guarded by postorbital and squamosal bones above and jugal and quadratojugal below.
- "Synapsid" means "together arch." The synapsids were the dominant land vertebrates from the Late Carboniferous Period (280 to 230 million years ago) to the end of Triassic Period (230 to 195 million years ago). Although the syanpsids were reptiles, they later gave rise to mammals.



Origin and Evolution of Reptiles:

- Amphibian origin. It is generally agreed that primitive reptiles originated from some primitive lahyrinthodont Amphibia, in the beginning of Carboniferous period. The labyrinthodonts possessed characteristically folded or labyrinthine teeth, similar to their crossopterygian ancestors.
- They flourished through Carboniferous and Permian periods before extinction in the Triassic. Probably they arose polyphyletically along a dozen or more independent lines.
- **Stem reptiles (Cotylosauria),** During Carboniferous period of late Palaeozoic Era, about 250 million years ago, some labyrinthodont amphibians gradually took on reptilian characters.
- These earliest reptiles are called the stem reptiles. They belong to the order Cotylosauria of the subclass Anapsida. The transition was so gradual that often it is difficult to decide whether some fossil skeletons are those of advanced amphibians or primitive reptiles.
- One of the members of the Cotylosauria was *Seymouria,* found in the Lower Permian of Texas (U.S.A.), perhaps 250 million years old. It was a lizard—like animal about 60 cm long, with a comparatively thick body, relatively small pointed head with dorsally placed nostrils, and a short tail. Structure of *Seymouria* was intermediate between the amphibians of that time and the early reptiles.
- *(a)* **Amphibian affinities.** *Seymouria* resembled early Amphibia or Labyrinthodontia in many features, (i) Skull is flat with reduced ossification, (ii) An intertemporal bone is present, (iii) Palate is primitive, (iv) Teeth are labyrinthine and also found on vomers and palatines, (v) Position of fenestra ovalis below the basal level of brain is amphibian, (vi) There are traces of lateral line canals in head region, (vii) Vertebrae show little differentiation, (viii) One pair of sacral ribs are present, (ix) Neck is short so that pectoral girdle lies close behind skull.

- **(b) Reptilian affinities-** *Seymouria* had several characteristically reptilian features, (i) Limbs are muscular and arise mid-ventrally. (ii) Skull is anapsid and monocondylic. (iii) Pelvic girdle is attached to vertebral column by sacral vertebrae, (iv) Number of phalanges 2 : 3 : 4 : 5 : 3 or 4 is more reptile like.
- **Conclusions-** *Seymouria* leads us to certain logical conclusions. It is not directly ancestral to all reptiles. At the time it was living, the reptiles had already been present for some 50 million years. It is so perfectly intermediate between an amphibian and a reptile that its true position remains uncertain.
- Romer treats it as a reptile under the order Cotylosauria, whereas others classify it with primitive Amphibia under the order Seymouria-morpha. Perhaps *Seymouria* is a connecting link between Labyrinthodontia and Cotylsosauria.

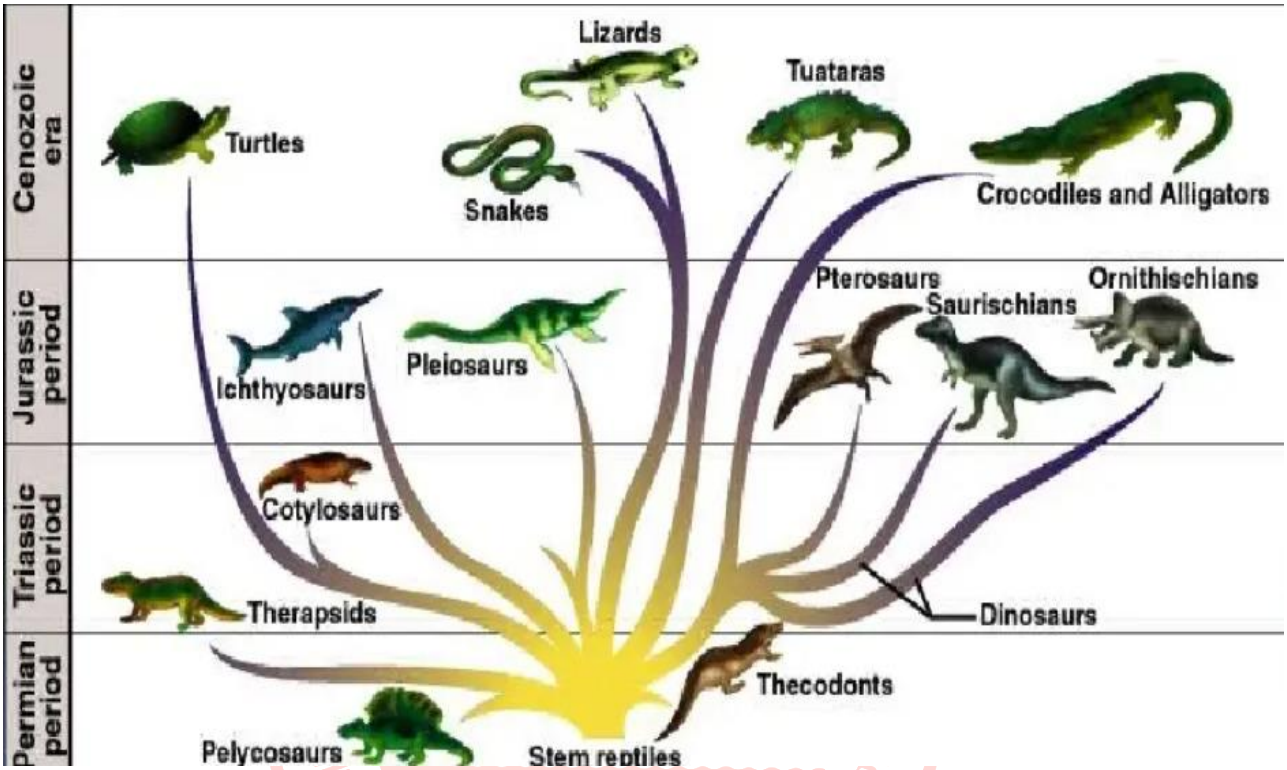
Adaptive Radiation in Reptiles:

- The class Reptile first appeared in the fossil record in Pennsylvanian times around 250 million years ago. The ancestral reptilians initiated one of the most spectacular adaptive radiations in the history of life. Adaptive radiation of the reptiles occurred between Permian and Cretaceous times.
- The living reptiles are derived from Cretaceous ancestors. The Mesozoic era, during which the reptiles thrived, is often termed as the "**Age of Reptiles**". The initial success of the reptiles stem resulted into a mega-evolutionary shift from aquatic to completely terrestrial development. i. e. the cleidoic or amniotic eggs of reptiles, like bird eggs, do not need to be immersed in water to survive.
- The basic stock of reptiles included the Cotylosauria from which a variety of reptiles were blossomed. The most inspiring and famous dinosaurs ruled over the lands until the close of the Mesozoic era before they suffered extinction. Dinosaurs were remarkably diverse in terms of their size, body forms as well as habits.
- Some of the dinosaurs were carnivorous, such as the gigantic Tyrannosaurus; whereas others were vegetarians, such as the feeble-toothed but elephantine Brontosaurus. The bulky body of Brontosaurus weighed approximately 30 tons and measured nearly 70 feet in length. Not all dinosaurs were huge; some were

no bigger than chickens also. Some dinosaurs strode on two feet, while others had reverted to four. The exceedingly long necks of certain dinosaurs were adaptations for feeding on the foliage of tall coniferous trees.

- The dinosaurs were descended from the thecodonts which were slender, fast-running lizard-like creatures. The thecodonts gave rise also to bizarre reptiles that took to the air, the pterosaurs. These so called 'dragons of the air' possessed highly expansive wings and dis-proportionately short bodies. The winged pterosaurs became extinct before the end of Mesozoic era.
- Another independent branch of the thecodonts led to exceptionally more successful flyers, the birds. The origin of birds from reptiles is revealed by the celebrated Archaeopteryx, a Jurassic form. The feathered creatures possessed a slender lizard-like tail and scaly head equipped with reptilian teeth. Certain mesozoic reptiles returned to water also.
- The streamlined, dolphin like ichthyosaurs and long necked, short-bodied plesiosaurs were marine, fish-eating reptiles. The ichthyosaurs were expert swimmers. Their limbs were fin-like and tails were forked.
- The plesiosaurs were efficient predators and capable of swinging their heads 40 feet from side to side and seizing fish in their long, sharp teeth. These aquatic reptiles breathed by means of lungs. They did not redevelop the gills of their very descendant fish ancestors.
- Indeed, it is axiomatic that "A structure once lost in the long course of evolution cannot be regained". This forms the basis for the doctrine of "Irreversibility of Evolution or Dollo's Law" which was proposed by eminent Belgian paleontologist Louis Dollo (1895).
- Further, among the early reptiles present before Mesozoic days (i.e. Permian of Palaezoic era), were the pelycosaurs (For e. g. Dimetrodon), notable for their peculiar sail like extensions of the back. It appears that the sail of pelycosaurs was a functional device to achieve some degree of heat regulation. Pelycosaurs gave rise to an important group of reptiles, the therapsids.
- These mammal-like forms bridged the structural gap between the reptiles and the mammals. The history of the reptiles attests to the ultimate fate to many

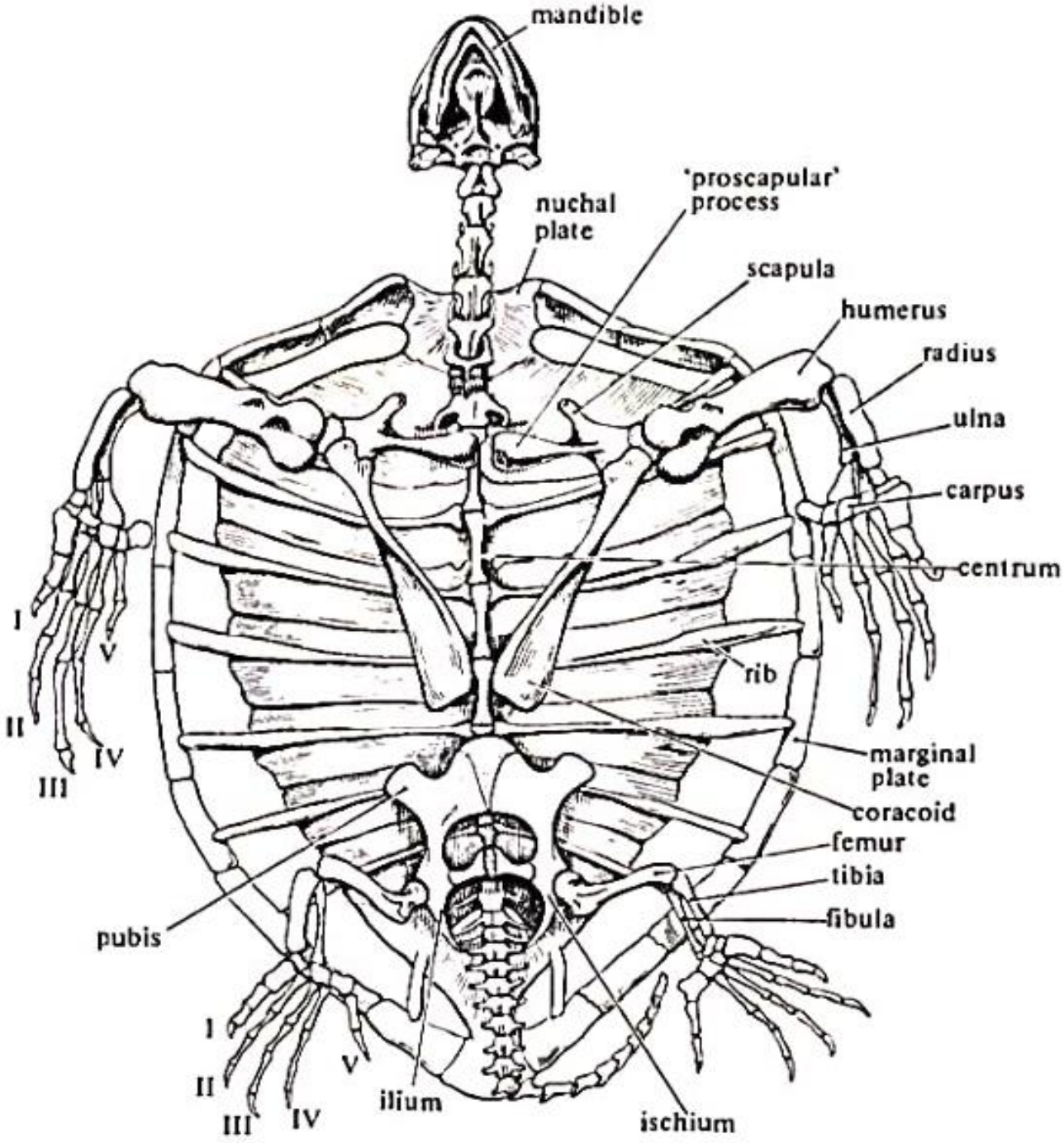
groups of organisms extinction. Of the vast host of Mesozoic reptiles, relatively few have survived to modern times; the ones that include the lizards, snakes, crocodiles and turtles.



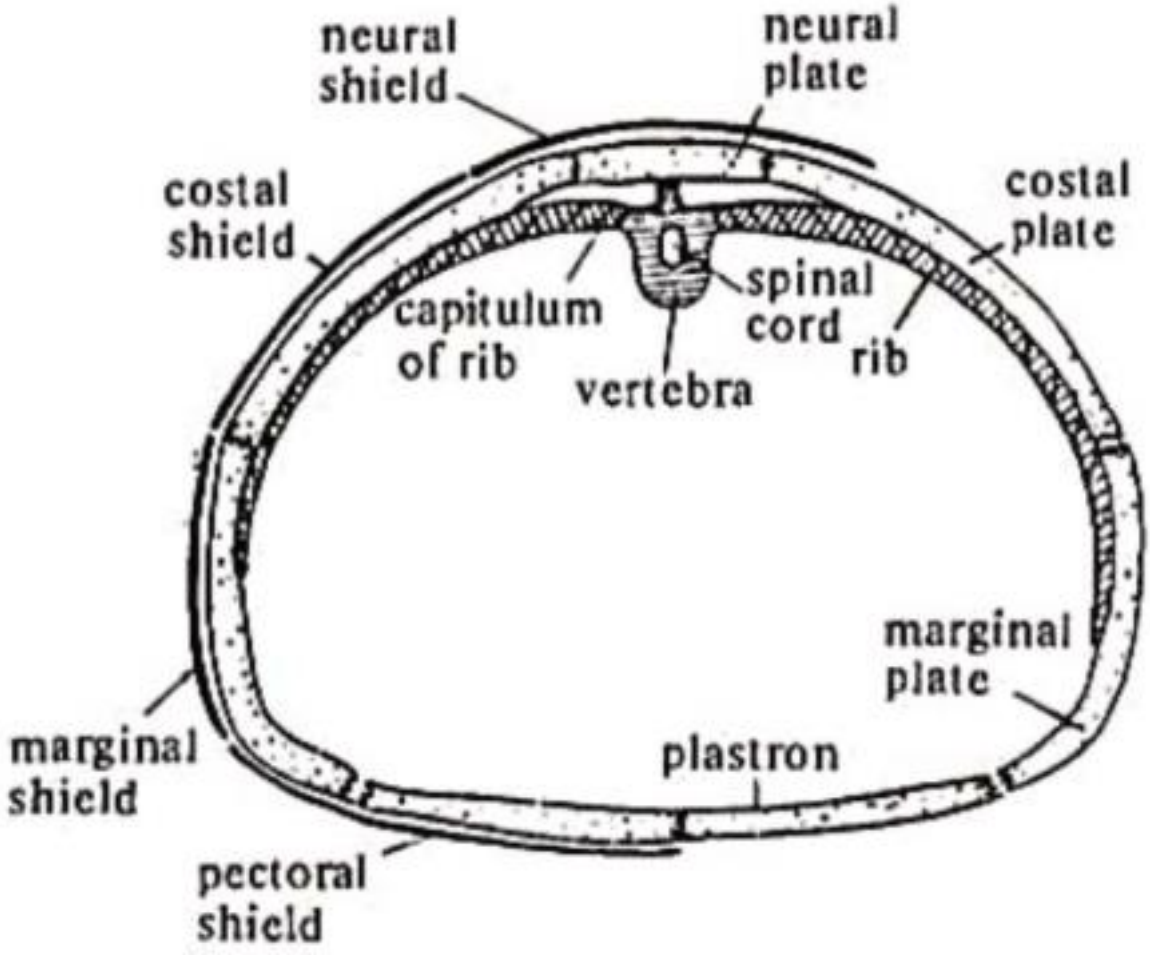
General organization of Chelonia:

- The names 'turtles' and 'tortoises are often used interchangeably. However, the term *turtle* is usually applied to the aquatic or semiaquatic forms and *tortoise* to land forms, whereas *terrapin* is reserved for some edible freshwater species. They are ancient reptiles that have remained relatively unchanged for 175 million years since Triassic.
- They show the greatest departure from the typical reptilian plan. However, they are easily identified by their armoured *shell* of bony plates consisting of a dorsal *carapace* and a ventral *plastron.* Their limbs are heavy as required for carrying about the unusually heavy body.
- When the animal is threatened with danger, the head and neck, limbs and tail are withdrawn into the shell. Teeth are absent in all turtles being replaced by a

horny beak-like structure. Although they breathe by lungs, they may remain under water for a considerable time. Air is pumped into lungs by movements of neck and legs.



- Some aquatic forms *(Emys)* have vascular thin-walled cloacal sacs for aquatic respiration when submerged. In temperate climates, all turtles hibernate during colder days but in tropical countries, they aestivate during hotter months All turtles are oviparous and the eggs, nearly spherical with calcareous shells, are deposited in nests in ground.



- Aquatic forms have reduced shells and limbs modified as flippers or paddles without claws for swimming. Sea turtles also reach a large size due to buoyant character of environment.
- The leatherback turtle, *Dermochelys coriacea,* also found along the coast of Kerala, is the largest of all. It may reach a length of 2.5 meters. The green or edible sea turtle, *Chelonia mydas,* also common in Bay of Bengal, may grow to 1.2 meters and weigh 200 kg. It is greatly prized for soup.

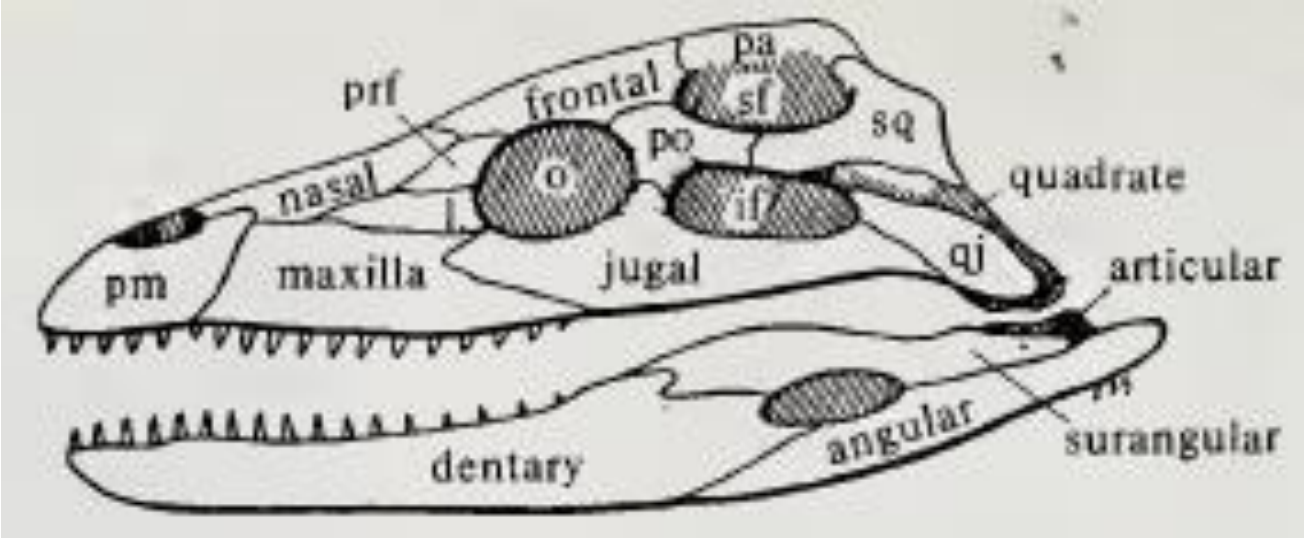
- The characteristic of **chelonian organization** is the shortening and broadening of the body, together with the development of bony plates, forming a box into which the head and limbs can be withdrawn.
- The total number of segments is only about 8 in the neck, 10 in the trunk, and a series of reduced caudals; the body is therefore morphologically shorter than in any other vertebrate except the frog. Probably this shortening and broadening is the result of some quite simple change in morphogenesis.
- The brain shows well developed cerebral hemispheres, with not only the basal regions (striatum) but also the pallium quite large. This was therefore probably true also of the earliest reptiles, as it is of amphibians.
- In the mammals, also derived from cotylosaur ancestors, there has been still further development of the dorsal regions of the hemispheres to form the cerebral cortex, whereas in the remaining reptile groups and in the birds, the ventral portion has become large, the dorsal thin. Only part of the hemispheres of Chelonia receives olfactory fibres. There are also visual, auditory, and somatic sensory inputs from the thalamus.
- The eyes are probably the chief receptors of chelonians. The retina consists largely of cones, many containing oil droplets of various colours. There are three photo pigments in turtles, with different absorption maxima.
- The olfactory system is well developed and Pseudemys can be trained to avoid olfactory (or visual) cues. Some turtles produce liquid with a strong smell when disturbed. The musk glands also play a part in courtship. Turtles return to their birthplace to breed.
- Perhaps they are imprinted on the odour of its water (as in salmon), but the homing mechanism has not been identified. The tympanum is often covered with ordinary skin and hearing is probably only for low tones.
- In some species there are mating calls as part of their elaborate courtship. Chelonians are capable of learning considerable feats of maze learning, discrimination, and operant conditioning. They show several forms of homing behaviour, some, including time compensated solar orientation, presumably involving an internal clock.

- The shell is usually considered to include a dorsal carapace and ventral plastron. Each of these is made up of inner plates of bone, covered by separate outer plates of horny material, comparable to the scales of other reptiles.
- The carapace includes five rows of bony plates, namely median neurals, and paired costals and marginals.
- These plates are ossifications in the dermis, attached to the vertebrae and ribs, but not actually formed from the latter. The plastron is developed from the expanded dermal bones of the pectoral girdle, together with dermal ossifications comparable to the abdominal ribs found in crocodiles and other reptiles.
- The whole is covered in most chelonians by rows of special smooth epidermal plates forming the 'tortoise' shell. A new and larger layer is added to each of these plates each year, the old one remaining above it, thus making a number of 'growth rings' from which some indication of the age of the tortoise can be calculated, though the outer members often become rubbed off.
- The aquatic soft-shelled turtles *(Trionyx, Amyda)* also have smooth leathery shells without shields. Their snout forms a short proboscis. *Trionyx gangeticus* is common in the rivers of N. India, while *T. leithi* in S, India.
- The snapping turtles *(Chelhydra serpentina)* and alligator turtles *(Macrolemys)* are carnivorous predators feeding on fish, frogs, waterfowls, etc. with powerful jaws. They are dangerous to handle for they strike with lightening speed and hold on with fierce tenacity.
- The painted turtle or terrapin *(Chrysemys picta),* with bright yellow, black and red colours, feeds on insects near the surface of water in ponds. The diamond-back terrapin *(Malaclemys)* is famous as food for man. It derives its common name from the markings on its shell.
- In *Kachuga* represented by several species in Indian rivers, the carapace bears spinous plates. The snake turtles have extremely long necks. In the side-necked turtle of Australia (*Chelodina longicollis),* the neck is folded in a lateral S-shaped bend. The matamata *(Chelus)* of America and Africa is the most

bizarre side-necked freshwater turtle. A common land tortoise is *Testudo.* The giant land tortoise *(Testudo abingdoni)* of Galapagos Islands in Pacific Ocean.

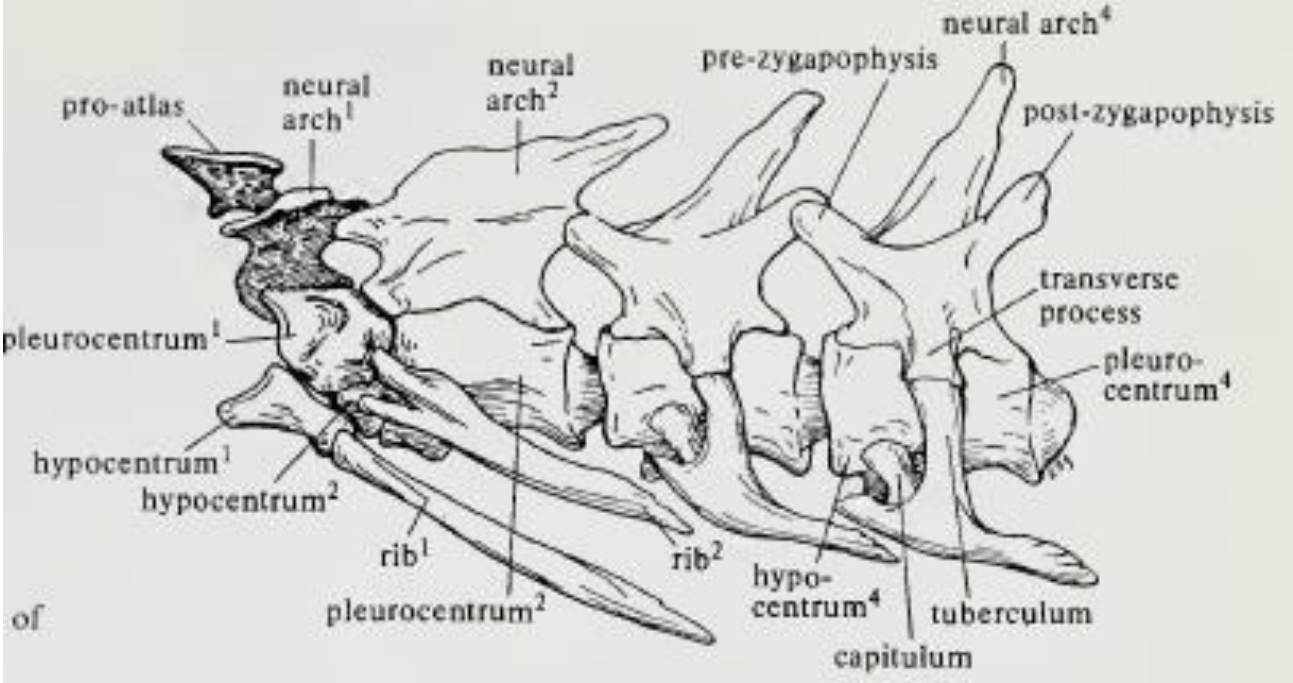
General organization of Crocodilia:

- The true crocodiles first appeared in the late Triassic and are modified for amphibious life. The nostrils are at the tip of the snout and the air is carried back in a long tube, the maxillae, palatines, and pterygoids forming a bony secondary palate, as in mammals.
- There is a flap behind the tongue, which, with **a fold of the palate**, enables the mouth to be closed off from the respiratory passage and hence kept open under water. The nostrils can also be closed by a special set of muscles, and the ear drums are protected by scaly movable flaps.
- The Eustachian tubes are very complicated and there is a large lagena. They have acute hearing and eyesight. Parts of the skull are pneumatized by extensions from the middle-ear cavity, as in birds.



- The teeth are sharp but can only hold the prey and not cut or chew. They are continually replaced. The oesophagus can be distended to store food. The stomach consists of a thick-walled muscular gizzard containing stones (gastroliths) and a glandular pyloric region. There are canals leading from the peritoneal cavity to the exterior at the cloaca ('abdominal pores').
- Crocodiles have a social organization in which the males defend territories by fighting and roaring. There is a complex courtship and fertilization is in the

water by insertion of the penis. The female has a clitoris. The Nile crocodile buries her eggs in a nest, then stays near them throughout incubation, helps the young to hatch, and escorts them to the water.

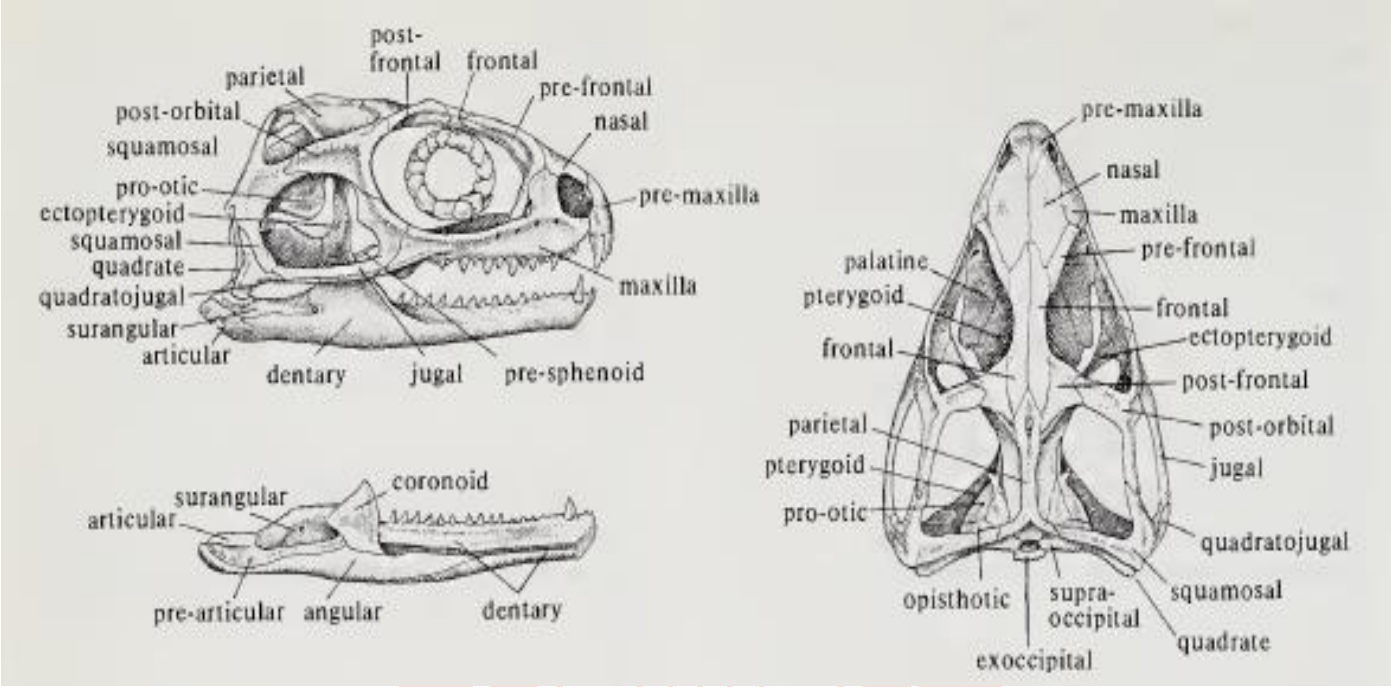


- The crocodiles use all four limbs in walking, but the front are shorter than the hind, suggesting bipedal ancestry. The pelvis of the crocodiles shows signs of the typical propubic structure, but there are only two sacral vertebrae.
- Rapid swimming is produced by lateral movements of the tail, but when moving slowly the partly webbed feet are used to push the animal along. The ribs are two headed and there is a **proatlas** element between the skull and atlas.
- As in the earlier thecodonts there are dermal plates (osteoderms) along the back and belly underneath horny scales. There are well developed abdominal ribs (**gastralia**).
- The soft parts of the crocodiles are of special interest because crocodiles are, except the birds, the only living creatures closely related to the great group of dinosaurs.
- The lungs are well developed, having a system of tubes ending in sacs. A transverse partition separates off a thoracic from the main abdominal cavity.

- This 'diaphragm' is not itself muscular, but is continued into a diaphragmatic muscle attached to the abdominal sternal plates.
- This muscle, innervated by abdominal spinal nerves, presumably assists in respiration. It is a development for this purpose quite distinct from the mammalian diaphragm. It is not impossible that the dinosaurs possessed further developments of this arrangement of the heart and lungs.
- The nine genera of the modern crocodiles represent only the survivors of a once much more abundant group. *Crocodylus* is the most widespread genus, occurring in Central America, Africa and Asia, Malaya and East Indies, and North Australia. Alligator, with each fourth lower tooth penetrating into a hole in the maxilla, is found in North America and in China.
- Caiman of Central and South America is related to Alligator. The length of the snout varies considerably in different species, and is extremely long and slender in the fish eating *Gavialis*, the Indian gharial, and *Tomistoma* of the East Indies. Crocodiles lay hard shelled eggs in large clutches, depositing them in the sand or in nests composed of vegetation.

General organization of Rhynchocephalia:

- *Sphenodon* (= Hatteria), the tuatara of New Zealand, is the oldest surviving lepidosaurian reptile; it still remains in essentially the eosuchian condition. Very similar Mesozoic fossils (e.g. Homoeosaurus from the Jurassic) show the continuity of the type.
- Among the many primitive features that this race has preserved unchanged for 200 Ma are the two complete temporal fossae the well developed pineal eye (the pineal foramen is marked in the early diapsid fossil skulls), and the amphicoelous vertebrae with intercentra.
- *Sphenodon*, alone of surviving reptiles, has no copulatory organ. As in some lizards the teeth are of acrodont type, fused with the jaws. They are not replaced and become much worn down in later life.
- The name *Sphenodon* means 'wedge-toothed' and refers to the shape of the large premaxillary teeth. There is a beak on the upper jaw.



- The tuatara was once widespread throughout New Zealand but became much reduced and in danger of extinction. Recently rigid conservation measures seem to have allowed it to recover in numbers on some small northern islands.
- The animals are up to 60 cm long and are insectivorous and carnivorous. They are mostly nocturnal and may be active with a body temperature of 8°C, at which most reptiles would be immobile. They live in burrows, often in association with petrels. The eggs take over a year to hatch, much longer than other reptiles.
- *Sphenodon* evidently shows us a type that has departed relatively little from the condition of diapsids in the late Permian, yet its appearance, habits, and soft parts are very like those of lizards, and provide us with evidence that these animals remain in essential rather close to the original amniote populations.
- The rhynchosaurs such as *Scaphonyx* were herbivorous rhynchocephalians very common in the Middle Triassic. They were up to 2 m long with a huge beak and sharp edge to the lower jaw which cut into a groove between rows of teeth on the upper jaw.

Lacertilian characters.

- Tuatara *resembles* a lizard in (i) general body form, (ii) elongated compressed tail, (iii) clawed pentadactyle limbs, (iv) pineal eye, (v) single-headed ribs, (vi) chevron bones as caudal vertebrae, and having (vii) similar heart, lungs and brain.
- it differs from lizards in having (i) an extra temporal vacuity (postemporal) in skull, (ii) mandibular rami united by an elastic ligament, (iii) immovable quadrate, (iv) amphicoelous vertebrae, (v) proatlas between skull .aid atlas, (vi) persistent notochord, (vii) uncinate processes on ribs, (viii) abdominal ribs, (ix) ten bones in carpus, and (x) in the absence of pecten in eye and copulatory sacs in male.

Crocodilian characters.

- Tuatara resembles crocodiles (also Chelonia and dinosaurs in most features) in the possession of (i) palate, (ii) immovable quadrate, (iii) proatlas, (iv) uncinate processes, (v) abdominal ribs, and (vi) chevron bones.
- It *differs* from them in the absence of (i) thecodont teeth, (ii) procoelous vertebrae, (iii) 4-chambered heart, (iv) pecten in eye, (v) copulatory organ, and (vi) in the presence of clavicles.

Systematic position.

- *Sphenodon* is appropriately referred to as a 'living fossil' because it has retained many primitive characteristics of fossil or stem reptiles belonging to the Permian period and has changed little through the past 200 million years.
- **Primitive characters** are : (i) median pineal eye, (ii) widely roofed mouth, (iii) three temporal bridges in skull, (iv) forward extension of pterygoid to meet vomer as in stegocephalians, v) amphicoelous vertebrae with persistent vestiges of notochord vi. Abdominal ribs vi. Emergence of 3 aortic arches from a short common trunk comparable to conus arteriosus of Amphibia, (viii) retention of ductus caroticus as well as ductus arteriosus, and (ix) absence of copulatory organs in male.
- *Sphenodon* is neither a degenerate nor an ancestral form. Rather, it is a highly modified type that has persisted from earlier times (Permian) as such. It

resembles as well as differs from orders Squamata and Crocodilia in many respects. Therefore, it is quite reasonable to place it under a separate order of its own, the *Rhynchocephalia.*

General organization of squamata:

- The order Squamata includes the modern **lizards and snakes**. The lizards are the most typical of the modern reptiles, showing the least modification in body form. They usually have an elongate body, a long tail and 4 well-developed clawed pentadactyle limbs adapted for running, climbing and digging.
- The skin is usually covered with small scales. The tail of most lizards is easily broken off when threatened or seized by a predator. This ability is known as *autotomy.* A new tail is soon regenerated which, however, does not possess vertebrae. The fact that tail breaks up easily is of great survival value. While the predator is attracted to and eats the wriggling tail, the lizard quietly escapes. The majority of lizards are carnivorous, feeding largely on insects, worms and other small animals.
- Most lizards are oviparous. Their eggs, protected by thin shells with little lime, are laid on land.
- Snakes with their limbless elongated form represent one of the most specialized groups of animals in the world. They are found in almost every kind of habitat. While snakes resemble lizards in many anatomical features, they differ from them in several ways.
- A notable difference is the ability of snakes to swallow preys several times larger than their own diameter. The long slender body of snakes is highly muscular with internal organs arranged along the narrow cylindrical trunk.
- There is little or no external evidence of paired limbs. The scales on the head are so regular that they are used in their taxonomy. The large ventral scutes are used in locomotion. The scaly epidermis of skin is periodically shed usually in one piece. The process is termed *moulting* or *ecdysis.*
- Their long, slender and bifid tongue is sensitive both to **odours and vibrations** so that it is protruded out of mouth as a sense organ. Most snakes are not

poisonous to human. Rather they are of definite value as destroyer of harmful rodents, insects and so forth.

MCQ based on Unit II:

Q. 1. Lateral undulation are used by snakes in :

a. Serpentine locomotion

b. Forward locomotion

c. Locomotion in' burrows

d. Locomotion in sand

Ans. a

Q. 2. Snakes are sensitive to :

a. Noises made by birds

b. Earth borne vibrations

c. Thunder

d. Air borne vibrations

Ans. b

Q. 3. Which of the following is incorrect for snakes:

a. The two rami of the lower jaw joined together by elastic ligament permit lateral expansion

b. Bones of palate are movable

c. Pectoral girdle is present

d. Ribs are free ventrally

Ans. c

Q. 4. Solenoglyphous condition is found in :

a. Family Colubridae

b. Cobras and Kraits

c. Coral snakes and sea snakes

d. Viper and rattle snake

Ans. d

Q. 5. The precavals are formed by the anion of :

a. Pulmonary veins

b. Azygous vein and juglar vein

c. Internal and external juglar and subclavian vein

d. Caudal vein and subclavian vein

Ans. c

Q.6. In *Calotes* tunica media of heart is made of :

a. Ligaments

b. Skeletal muscles

c. Visceral muscles

d. Cardiac muscles

Ans. d

Q. 7. Which of the following is not a name of *Calotes* :

a. Wall lizard

b. Garden lizard

c. Girgit

d. Blood sucker

Ans. a

Q.8. Teeth in *Calotes* are :

a. Hetrodont and monodont

b. Homodont and pleurodont

c. Hetrodont and acrodont

d. Hetrodont and thecodont

Ans. 2

Q. 9. In *Uromastix* cloaca is divided into :

a. Coprodaeum and Urodaeum

b. Coprodaeum and Proctodaeum

c. Coprodaeum. Urodaeum and Proctodaeum

d. Urodaeum and Proctodaeum

Ans. c

Q. 10. Walls *of* larynx are supported by :

a. Arytenoid cartilage

b. Cricoid cartilage

c. Coracoid cartilage

d. Arytenoid and cricoid cartilage

Ans. d

Q. 11. Right and left systemic arches communicate through :

a. Foramen of Panizae

b. Foramen of Monero

c. Foramen magnum

d. Fenestra ovalis

Ans. a

Q. 12. Fertilized egg is provided with shell in :

a. Oviducal funnel

b. Ovisac

c. Ostium

d. Vagina

Ans. b

Q. 13. The body of *Uromastix* is divisible into :

a. Head, neck, trunk and tail

b. Head, trunk and tail

c. Head, neck and trunk

d. Head, neck and tail

Ans. a

Q. 14. *Uromastix* is commonly known as :

a. Girgit

b. Spiny tailed lizard

c. Flying lizard

d. Wall lizard

Ans. b

Q. 15. Shedding of scally covering periodically in flakes is :

a. Moulting

b. Metamorphosis

c. Ecdysis

d. Pupation

Ans. c

Q. 16. Lips guarding mouth in *Uromastix* are :

a. Thin and movable

b. Fleshy and movable

c. Thin and immovable

d. Fleshy and movable

Ans. d

Q. 17. In *Uromastix* pharynx leads to oesophagus through a aperture the :

a. Gullet

b. Glottis

c. Nares

d. Cloaca

Ans. a

18. In *Uromastix* liver is attached to the body wall by peritoneal fold called :

a. Mesogasler

b. Hepatic omentum

c. Pyloric sphincter

d. Temporal fossae

Ans. b

Q. 19. Tuatara belongs to the order

a. Chelonia

b. Squamata

c. Rhynchocephalia

d. None of these

Ans. c

Q. 20. Vestigeal hind limbs and pelvic girdle are present in ;

a. Cobra

b. Krait

c. Boa

d. Turtles

Ans. c

Q. 21. Ophiosaurus belongs to :

a. Chelonia

b. Ophidia

c. Crocodilia

d. Lacertilia

Ans. d

Q. 22. Heart in crocodiles is :

a. Completely 4 chambered

b. Incompletely 4 chambered

c. 3 chambered

d. None of these

Ans. a

Q. 23. Study of reptiles is

a. Herpetology

b. Ornithology

c. Ichthyology

d. None of these

Ans. a

Q. 24. Turtles have :

a. Homodont teeth

b. Heterodont teeth

c. Horny beak

d. None of these

Ans. c

Q. 25. Interclavical in reptiles is

a. H shaped

b. T shaped

c. W shaped

d. A shaped

Ans. b

Q. 26. Embryonic membranes present in reptiles are :

a. Amnion and chorion

b. Chorion and yolk sac

c. Yolk sac and allantois

d. Amnion, chorion, yolk sac and allantois

Ans. d

Q. 27.Direct development is shown by :

a. *Rhacophorus*

b. *Ram clumitans*

c. *Hylodes*

d. *Leptodactylus*

Ans. c

Q. 28. Which of the following does carry eggs in its back pouches :

a. *Nototrema*

b. *Hylambates breviceps*

c. *Pipa*

d. None of these

Ans. b

Q. 29. Partial neoteny refers to :

a. Sexual reproduction in larvae, capable of metamorphosis under suitable conditions

b. Delayed metamorphosis due to ecological or physiological changes in environment

c. Animal remains larval throughout

d. Animal fails to hibernate

Ans. b

Q. 30. Paedogenesis refers to :

a. Precocious development of gonads

b. Retention of larval characters by adults

c. Retention of rudimentary characters in adults

d. Retrogressive metamorphosis

Ans. a

Q. 30. Extinct amphibians are placed in the subclass ;

a. Stegocephalia

b. Lissamphibia

c. Lepospondli

d. Cyptobranchoidea

Ans. a

Q. 31. Caecilians belong to the order :

a. Urodela

b. Gymnophiona

c. Anura

d. Opisthocoela

Ans. b

Q. 32. Neoteny refers to :

a. Retention of rudimentary organs

b. Metamorphosis

c. Retention of larval characteristics in adults

d. Reproduction in larvalforms

Ans. c

Q. 33. In *Plethodon* the nasolabial grooves help in :

a. Clearing pharynx

b. Clearing buccal cavity

c. Clewing eyes

d. Clearing nostrils

Ans. d

Q. 34. In Amphibians respiration takes place by :

a. Culls, lungs, skin and buccal lining

b. Gills and lungs

c. Skin and gills

d. Gills, Lungs and buccal lining

Ans. a

Q. 35. Erythrocytes in Amphibians are :

a. Oval and enucleated

b. Oval and nucleated

c. Convex and nucleated

d. Convex and nucleated

Ans. b

Q. 36. Excretion in amphibians is :

a. Ammonotelic

b. Aminotelic

c. Ureotelic

d. Uricotelic

Ans. c

Q. 37. Ear-ossicle present in the middle ear of frog is :

a. Iris

b. Coliumella auris

c. Auris

d. Columella

Ans. d

Q. 38. Which of the following is not an intestinal hormone in frog :

a. Entcrogasterone

b. Cholecystokinin

c. Secretin

d. Gastrin

Ans. d

Q. 39. Which of the following is not a function of bile :

a. Hydrolysis of carbohydrates

b. Neutralizing acidity of chyme

c. Emulsification of fat

d. Activation of pancreatic lipase

Ans. a

Q. 40. During buccal respiration in frog :

a. Nostrils remain closed and glottis remains open

b. Nostrils remain open and glottis remains closed

c. Both nostrils and glottis remain closed

d. Both nostrils and glottis remain open

Ans. b

Q.41. The auricles in frog are marked off externally from the ventricle by ;

a. Interauricular groove

b. Interventricular groove

c. Coronary sulcus

d. Auriculo-ventricular septa

Ans. c

Q. 42. Sinus venosus in frog is formed by the union of :

a. 2 precavals and 2 post cavals

b. I precaval and 2 post cavals

c. 1 precaval and 1 post caval

d. 2 precavals and 1 post cavals

Ans. d

Q. 43. The third eyelid in frog is called :

a. Pineal eye

b. Upper eyelid

c. Lower eyelid

d. Nictitating membrane

Ans. d

Q. 44. The number of voluntary muscles in frog is about:

(a) 200

(b) 300

(c) 400

(d) 500

Ans. a

Q. 45. Salivary glands in frog are:

a Absent

b. 1 pair

c. 2 pairs

d. 3 pairs

Ans. a

Q. 46. The teeth in frog are meant for :

a. Chewing

b. Preventing prey from slipping

c. Tearing

d. Cutting

Ans. b

Q. 47. Stomach in frog is attached to the dorsal body wall by means of a mesentery called :

a. Oxygaster

b. Bodogaster

c. Mesogaster

d. Megagaster

Ans. c

Q. 48. The hepatopancreas duct opens into :

a. Buccal cavity

b. Oesophagus

c. Stomach

d. Duodenum

Ans. d

Q. 49. Common bile duct in frog is :

a. Combined cystic ducts from gall bladder and hepatic ducts from liver

b. Combined cystic ducts from gall bladder

c. Combined hepatic ducts from liver

d. Combined hepatic and pancreatic ducts

Ans. a

Q. 50. The gastric glands are activated for the secretion of HCl by

a. Enterogastrone

b. Gastrin

c. Insulin

d. Renin

Ans. b

Q. 51. The liquefied semi digested acidic food in stomach is known as :

a. Bolus

b. Bile

c. Chyme

d. Rhyme

Ans. c

Q. 52. The crocsopterygian fishes gave rise to :

a. Labyrinthodontia

b. Anura

c. Urodela

d. Apoda

Ans. a

Q. 53. *Rana tigrin*a member of the order :

a. Lepospondyli

b. Anura

c. Apoda

d. Urodela

Ans. b

Q. 54. The frogs swim in water by :

a. Powerful forward thrusts of its forelimbs

b. Powerful backward thrusts of its forelimbs

c. Powerful backward thrusts of its hind limbs

d. forward thrusts of its hind limbs

Ans. c

Q. 55. The tongue of frog is

a. Short, protrusible and attached at the front end

b. Short, protrusible and attached at the distal end

c. Long, protrusible and attached at the front end

d. Long, protrusible and attached at the front end

Ans. d

Q. 56. During hibernation or aestivation frog lives upon :

a. Stored Glycogen and fat

b. Stored Glucose and fat

c. Water and fat

d. Fat only

Ans. a

Q. 57. In frogs, the sexual embrace between male and female is called :

a. Aplexus

b. Amplexus

c. Spawning

d. Swarming

Ans. b

Q. 58. The three rectal ciliates in frog are :

a. *Nyctotherus, Balantidium* and *Trichomonas*

b. *Balantidium, Opalina* and *Entamoeba*

c. *Opalina, Nyctotherus* and *Balantidium*

d. *Opalina, Balantidium* and *Amoeba*

Ans. c

Q. 59. What type of fish are considered the ancestors of tetrapods?

a. Ray-finned fishes

b. Lobe-finned fishes

c. Cartilaginous fishes

d. Hagfishes

Answer: b

Q 60. Which geological period is known for the emergence of the earliest tetrapods?

a. Cretaceous

b. Jurassic

c. Triassic

d. Devonian

Answer: d

Q 61.Which of the following was a significant adaptation that allowed early tetrapods to survive in oxygen-poor marshy waters?

a. The evolution of gills

b. The development of fins

c. The presence of lungs

d. The loss of scales

Answer: c

Q 62. *Tiktaalik* is considered an important transitional fossil because it possesses features of both fish and tetrapods, such as:

a. Gills and a tail

b. Fins and lungs

c. A body without limbs

d. Scales and gills

Answer: b

Q 63. What is the primary function of the bony elements found in the lobed fins of tetrapod ancestors?

a. To propel them through open water

b. To provide support for movement in shallow water and on land

c. To aid in filter-feeding

d. To attract mates

Answer: b

Q. 64. Tetrapods evolved from which group of fishes?

a. Ray-finned fishes (Actinopterygii)
b. Cartilaginous fishes (Chondrichthyes)
c. Lobe-finned fishes (Sarcopterygii)
d. Jawless fishes (Agnatha)

Answer: c

Q. 65. Which of the following is considered a key transitional fossil in the evolution of tetrapods, showcasing both fish-like and tetrapod-like features?

a. Eusthenopteron
b. Ichthyostega
c. Tiktaalik
d. Acanthostega

Answer: c

Q. 66. Early tetrapods likely developed limbs and digits primarily for what purpose?

a. Terrestrial locomotion (walking on land)
b. Escaping predators
c. Supporting their body in shallow water environments
d. Hunting terrestrial prey

Answer: c

Q. 67. One significant anatomical change that occurred during the transition from fishes to tetrapods was the transformation of the hyomandibular bone into the:

a. Vertebral column

b. Shoulder girdle

c. Columella (stapes)

d. Pelvic girdle

Answer: c

Q. 68. What key innovation in amniotes (a group of tetrapods that includes reptiles, birds, and mammals) enabled them to lay their eggs on land?

a. More efficient lungs

b. Stronger limbs

c. Amnion (a protective membrane within the egg)

d. Scaly skin

Answer: c

Q. 69. Frogs and toads belong to the order:

a. Urodela

b. Apoda

c. Anura

d. None of the above

Answer: c

Q. 70. Which of the following is a key characteristic of the order Anura?

a. A long, segmented backbone

b. Presence of external gills in the adult stage

c. Absence of a tail in the adult form

d. Smooth, scaly skin

Answer: c

Q. 71. What is the primary function of the nictitating membrane in frogs?

a. To protect the eye from bright light

b. To aid in sound reception

c. To protect the eye while submerged in water

d. To change the colour of the eye

Answer: c

Q. 72. How do adult frogs primarily exchange gases with the air and water?

a. Through gills

b. Exclusively through lungs

c. Through lungs, skin, and the lining of the mouth

d. Only through gills and the mouth

Answer: c

Q. 73. Which term describes frogs that live in a state of dormancy during hot, dry periods?

a. Hibernation

b. Aestivation

c. Diapause

d. Metamorphosis

Answer: b

Q. 74. The order Anura is named for the absence of a tail in the adult form, meaning "without tail." Which term describes this characteristic?

a. Apoda

b. Urodela

c. Anura

d. None of the above

Answer: c

Q. 75. What is a defining feature of the limbs in adult anuran frogs?

a. Padded forelimbs and webbed hind limbs

b. Padded hind limbs and webbed forelimbs

c. Long, webbed hind limbs for swimming and leaping

d. Shorter, webbed forelimbs for digging

Answer: c

Q. 76. How many chambers are present in the heart of an anuran frog?

a. Two

b. Three

c. Four

d. Five

Answer: b

Q. 77. Frogs belong to the class Amphibia and are poikilothermic. What does poikilothermic mean?

a. They have a constant internal body temperature.

b. Their body temperature fluctuates with the environment.

c. They are warm-blooded.

d. They cannot survive in water.

Answer: b

Q. 78. What is the function of the tympanum in a frog?

a. It is the site of gas exchange.

b. It acts as the frog's ear.

c. It helps in the absorption of water.

d. It is part of the respiratory system.

Answer: b

Q. 79. Which of the following is NOT a method of respiration in frogs?

a. Through the lungs

b. Through the skin

c. Through the mouth lining

d. Through the gills

Answer: d

Q 80. Frogs and toads belong to the order:

a. Urodela

b. Apoda

c. Anura

d. Caudata

Ans. c

Q 81. The term "Anura" means:

a. "with a tail"

b. "without a tail"

c. "four legs"

d. "lives on land and water"

Ans. b

Q 82. Which of the following is a characteristic feature of Anura?

a. Presence of a tail in adulthood

b. Absence of limbs

c. Four limbs, with the front limbs modified for jumping

d. Gills for breathing in adulthood

Ans. c

Q. 83. Frogs are able to swim rapidly with the help of:

a. Padded forelimbs

b. Webbed long hind limbs

c. Both a and b

d. Webbed forelimbs

Ans. c

Q 84. The skin of a frog is:

a. Thick, leathery

b. Smooth, slippery

c. Dry and bumpy

d. Scaly

Ans. b

Q 85. The larval stage of a frog is called a:

a. Pupa

b. Caterpillar

c. Nymph

d. Tadpole

Ans. d

Q 86. Frogs are classified as:

a. Homeothermic

b. Warm-blooded

c. Poikilothermic

d. Heterothermic

Ans. c

Q. 87. Which of these statements is true about frog?

a. It lives both on land and in sea water

b. They cannot survive in freshwater

c. *Rana tigrina* is a rare species

d. They belong to class Amphibia

Answer: d

Q. 88. Which of the following best defines neoteny?

a. The development of sexual maturity before physical maturity.

b. The retention of larval or juvenile features in an adult organism.

c. The complete loss of a larval stage during development.

d. The process of metamorphosis in amphibians.

Answer: b

Q. 89. The Axolotl is a classic example of neoteny because:

a. It completes its entire life cycle on land.

b. It loses its gills and develops lungs for a terrestrial life.

c. It retains its aquatic features like gills and fins into adulthood and can reproduce

in its larval form.

d. It undergoes a rapid metamorphosis into a flying amphibian.

Answer: c

Q 90. Which of the following is a common cause of neoteny in some amphibians?

a. An increase in thyroid hormone production.

b. A delay or failure of the organism to metamorphose into its adult form.

c. An absence of gonads in the larval stage.

d. A genetic mutation leading to increased growth.

Answer: b

Q 91. Neoteny is characterized by:

a. Early development of adult somatic features and delayed sexual maturity.

b. Delayed development of somatic cells and sexual cells.

c. Delayed development of somatic cells while sexual cells develop at a constant rate.

d. Retaining larval features but also losing the ability to reproduce.

Answer: c

Q 92. Besides the Axolotl, which other amphibians are known for being permanently neotenous?

a. Frogs and toads

b. *Proteus* and *Necturus*

c. Newts and salamanders

d. All amphibians

Answer: b

Q 93. What is the definition of neoteny?

a. Accelerated development to adulthood

b. Retention of juvenile traits in adult organisms

c. Reproduction at a faster rate

d. None of the above

Ans. b

Q 94. Which of the following organisms is a classic example of neoteny?

a. Frog

b. Axolotl

c. Butterfly

d. Human

Ans. b

Q 95. What is the main cause of neoteny in axolotls?

a. Genetic mutation

b. Lack of thyroid stimulating hormone (TSH) production

c. Abundant food resources

d. All of the above

Ans. b

Q 96. How can metamorphosis be induced in axolotls?

a. Reducing the water level

b. Injecting thyroxine hormone

c. Both a and b

d. Neither a nor b

Ans. c

Q 97. What are the different types of neoteny?

a. Partial, Intermediate, and Total

b. Facultative and Obligate

c. Inducible obligate and Facultative

d. All of the above

Ans. d

Q. 98. Which of the following is NOT a characteristic of Urodela?

a. Elongated body

b. Presence of a tail

c. Limbs of equal size

d. Hind limbs significantly larger than front limbs

Ans. d

Q. 99. Urodela are also known as:

a. Anura

b. Apoda

c. Caudata

d. Gymnophiona

Ans. c

Q. 100. Neoteny, the retention of larval features in the adult, is commonly observed in:

a. Anura

b. Apoda

c. Urodela

d. Reptiles

Ans. c

Q. 101. Which of the following is an example of an animal belonging to the order Urodela?

a. Frog

b. Toad

c. Salamander

d. Snake

Ans. c

Q. 102. Unlike frogs, salamanders typically:

a. Have dry, scaly skin

b. Are strictly terrestrial

c. Breathe only through lungs

d. Have moist, permeable skin

Ans. d

Q 103. Which of the following amphibians belong to the order Urodela?

a. Frogs

b. Toads

c. Salamanders

d. Caecilians

Answer: c

Q 104. A key characteristic of most Urodela species is:

a. Dry, scaly skin

b. Absence of a tail in adulthood

c. Lizard-like appearance with a tail

d. External fertilization

Answer: c

Q 105. Salamanders, unlike frogs, are capable of regenerating which body parts?

a. Eyes

b. Gills

c. Limbs and tails

d. Lungs

Answer: c

Q 106. Where do most Urodela typically lay their eggs?

a. On trees

b. In crevices

c. In water

d. In dry soil

Answer: c

Q 107. The larval stage of Urodela, unlike anuran tadpoles, typically has:

a. No limbs

b. External gills and four limbs

c. Lungs for breathing

d. A short, non-functional tail

Answer: b

Q 108. Which of the following is a defining characteristic of the order Apoda (Caecilians)?

a. Four well-developed limbs

b. A tail present throughout their life cycle

c. Limbless, worm-like body with scales in the skin

d. External fertilization

Answer: c

Q 109. The term "Apoda" translates to:

a. "With legs"

b. "With eyes"

c. "Without legs"

d. "With a tail"

Answer: c

Q. 110. What is the primary function of the tentacles found on the heads of caecilians?

a. Locomotion

b. Vision

c. Reproduction

d. Chemosensory detection for finding prey underground

Answer: d

Q 111. Apoda is an order within which class of vertebrates?

a. Pisces

b. Reptilia

c. Amphibia

d. Aves

Answer: c

Q 112. Which of the following is an example of an organism belonging to the order Apoda?

a. Newt

b. Frog

c. Salamander

d. Ichthyophis (a limbless amphibian)

Answer: d

Q 113. Apoda are amphibians that are characterized by:

a. Having tails and smooth skin

b. Being limbless and having concealed eyes

c. Having elongated front limbs adapted for jumping

d. Having visible gills throughout their life cycle

Ans. b

Q 114. Apoda are often referred to as "blind-worms" because:

a. Their vision is excellent, allowing them to hunt effectively in the dark

b. They live in dark environments and are completely eyeless

c. Their eyes are concealed by skin or bone

d. They resemble worms and burrow extensively

Ans. c

Q 115. Which of the following is a characteristic feature of Apoda's head?

a. Presence of large, prominent eyes

b. Absence of sensory organs

c. Presence of tentacles which are chemosensory organs

d. Skull is lightly built and flexible

Ans. c

Q 116. The diet of Apoda primarily consists of:

a. Small vertebrates and large insects

b. Plant matter and fruits

c. Earthworms and other small subterranean invertebrates

d. Large aquatic animals and fish

Ans. c

Q 117. In Apoda, fertilization is typically:

a. External

b. Internal

c. Both external and internal

d. Not well understood

Ans. b

Q 118. Apoda are primarily found in:

a. Temperate regions and cold climates

b. Tropical regions of South America, Africa, and Southern Asia

c. Desert and arid environments

d. High mountains and snowy areas

Ans. b

Q 119. Some species of Apoda exhibit parental care, including:

a. Males guarding the eggs

b. Females providing nourishment to the offspring through their skin

c. Both parents participating in raising the young

d. Abandoning the eggs after laying them

Ans. b

Q. 120. What is the significance of the dermal scales in some Apoda species?

a. They indicate a close relationship to fish

b. They are thought to be a primitive amphibian trait

c. They are essential for breathing underwater

d. They are used for camouflage and defense

Ans. b

Q 121. The term "Apoda" literally translates to:

a. "Blind Ones"

b. "Legless"

c. "Snake-like"

d. "Burrowing"

Ans. b

Q 122. What unique adaptation do caecilians have to detect prey?

a. Excellent eyesight

b. Highly sensitive hearing

c. A retractable sensory tentacle between the nostril and the eye

d. Powerful sense of smell

Ans. c

Q 123. Which of the following is a characteristic feature of a diapsid skull, found in most reptiles?

a. A solid skull roof without any holes

b. Two holes (temporal fenestrae) behind each eye

c. A single occipital condyle

d. A jaw that is fused to the skull

Ans. b

Q 124. Which group of reptiles possesses an anapsid skull, a type of skull with a solid roof and no temporal openings?

a. Lizards and snakes
b. Crocodiles
c. Turtles (Chelonia)
d. Tuataras

Ans. c

Q 125. How many occipital condyles (bony knobs connecting the skull to the vertebral column) are typically present in the skull of a reptile?

a. Two
b. Zero
c. One
d. Four

Ans. c

Q 126. In a diapsid skull, the presence of two temporal fenestrae (holes) on each side of the head is a key feature. What does "di-" mean in "diapsid"?

a. Single
b. Two
c. Large
d. Empty

Ans. b

Unit- III

Aves

Origin and evolution, Flightless birds, Palate in birds and their importance, Modification of beaks, feet in birds, Migration in Birds, Adaptations for flight, Parental care, Adaptive radiation

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ORIGIN AND EVOLUTION OF BIRDS:

- Birds evolved from theropod dinosaurs during the Jurassic period, with the earliest known bird fossil being Archaeopteryx. This creature, which lived about 150 million years ago, displayed both reptilian and avian characteristics, indicating a transitional form.
- Bird evolution involved gradual changes in features like feathers, wings, and skeletal structure over tens of millions of years, rather than a sudden transformation.
- **Dinosaur Ancestry:**

Birds are now widely accepted as descendants of theropod dinosaurs, a group that also includes iconic creatures like Tyrannosaurus Rex.

Transitional Fossils:

Archaeopteryx is a crucial fossil, exhibiting features like feathers, a wishbone (furcula), and a long tail with reptilian features, showcasing the transition from dinosaurs to birds.

Feather Evolution:

Feathers, initially thought to be solely for flight, likely evolved for other purposes like insulation and display before being adapted for flight.

Flight Development:

The evolution of flight is a complex topic, with theories including the "arboreal" (from the trees down) and "cursorial" (from the ground up) hypotheses.

Diversification:

Birds diversified significantly during the Cretaceous and Cenozoic periods, with various groups like Enantiornithes and Ornithurae emerging, leading to the diverse bird orders we see today.

Modern Bird Features:

Many avian features, such as the pygostyle (a fused tailbone), carpometacarpus (fused wrist and hand bones), and perching feet, evolved in later stages of bird evolution, indicating adaptations for flight and perching.

Extinction Event:

The end-Triassic extinction event played a role in shaping bird evolution by eliminating many other archosaurs, allowing the bird lineage to flourish

Diphyletic origin of birds

The earliest known fossil birds include both flying *(Archaeopteryx, Ichthyornis)* as well as flightless *(Hesperornis, Diatryma)* types.'The recently extinct Moas and Elephant birds were also flightless. The most primitive living - birds or Ratitae (Ostrich, Rhea, Cassowary, etc.) and Penguins are also flightless.

- This led some authors, notably PR. Lowe, to believe in the *diphyletic* (two-lines-of-descent) origin of birds. They maintain that the flightless and flying birds of today have descended from different flightless ancestors.
- According to Lowe, the present-day flightless birds were never capable of flight, and their wings are not degenerate now, but better developed than at any time in their past history.

Monophyletic origin of birds

- In Ratitae, the legs are well-developed and powerful, the wings vestigial, and the feathers arefluffy.
- But a recently discovered fossil of *Eleuherornis,* a probable ancestor of the present-day ostrich from the Eocene of Switzerland, shows closer affinities to flying forms than does the present-day ostrich, and poses a serious blow to the concept of diphyletic origin of birds.

- Today most palaeonotologists believe that the Carinatae are more primitive. Presumably the Ratitae evolved from flying ancestors but readapted to a terrestrial mode of life in areas with abundant food and few competitors or enemies.
- The more usually accepted view today maintains that birds have a *monophyletic* (one-line-of-descent) origin, i.e., all birds have evolved from a single ancestor, perhaps close to *Axchaeopteryx.* Accordingly, the flightless birds have evolved by loss of flight from flying ancestors. The weight of the known evidence also favours this view.

FLIGHTLESS BIRDS:

- The living wingless or flightless birds belong to the superorder Palaeognathae (or Ratitae) of the subclass Neomithes.
- They are characterized by having a palaeognathous palate, a keeless raft like sternum and curly feathers.
- Ratitae are represented by several species on earth today and have persisted over a long period of geological time. These birds are much alike and all are ground-dwelling. They are usually very large, some reaching as much as 4 metres in height. They have well-developed powerful legs, small heads and rudimentary wings with fluffy feathers which are useless for flight.
- In fact, they depend on their fleetness for security. An interesting fact is that all modern flightless birds live in parts of the world where there are no carnivores, that is no members of the cat or wolf tribes.

Orders of flightless birds

- The living flightless birds belong to the following 4 orders of the superorder Palaeognathae :

Order 1. Struthioniformes. Ostriches of Southwest Asia and Africa.

Order 2. Rheiformes. Rheas of South America.

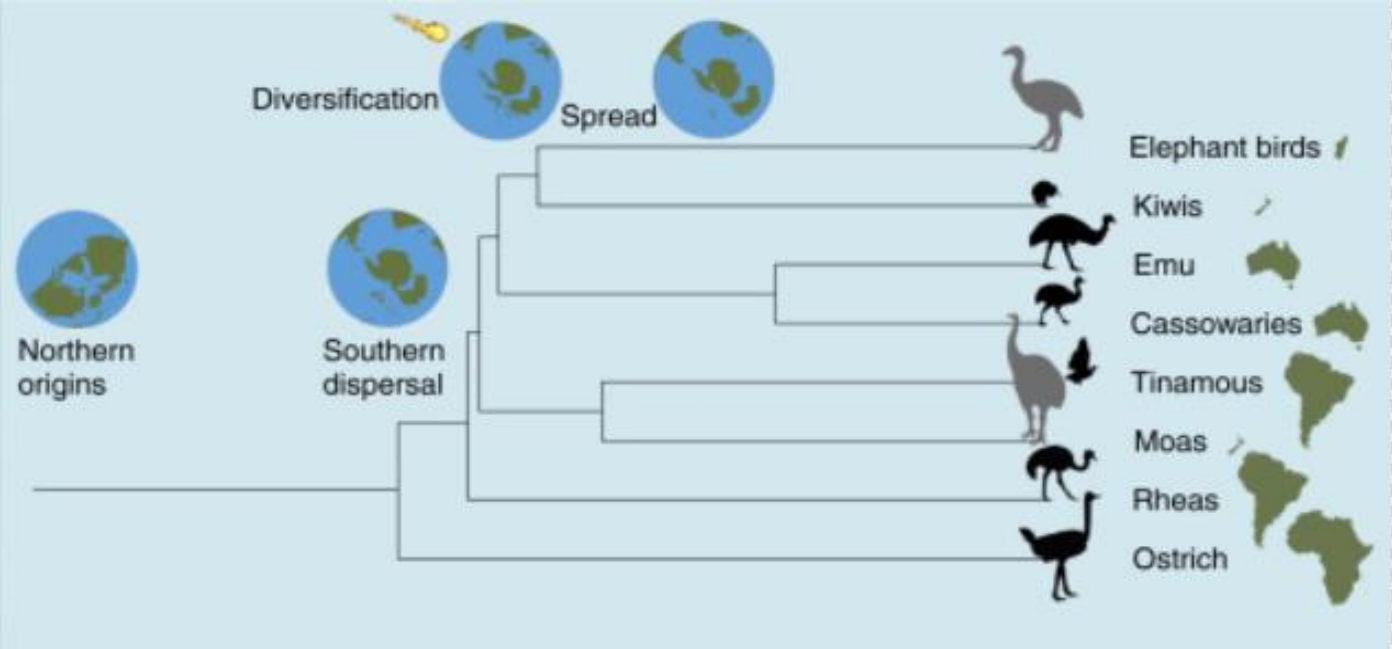
Order 3. Casuariformes, Cassowaries and emus of Australia and adjacent islands.

Order 4. Apterygiformes. Kiwis of New Zealand.

- A remarkable example of discontinuous distribution is furnished by the flightless birds. Taking into consideration the living forms only, each of the

great Southern land masses contains one order of Ratitiae (or Palaeognathae) not found elsewhere.

- ❖ They are distributed in far flung areas such as South America (rheas), Africa and Asia (ostriches), Australia (cassowaries and emus) and New Zealand (kiwi).



- ❖ It is indeed very remarkable that two genera so closely allied as are *Rhea* and *Struthio,* should occupy areas so distantly removed from each other as South America and Africa.
- ❖ The living members are entirely wanting in Europe and North America. But the existence of their fossils in North America and Europe only proves that the flightless birds were once not confined to their present limits alone and possibly pervaded the greater part of the earth.

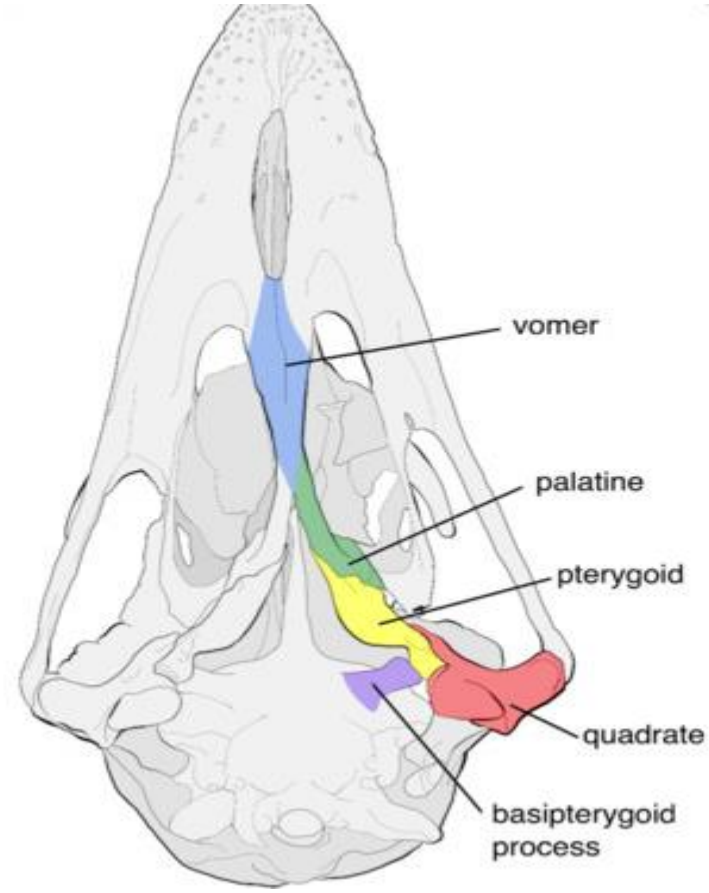
PALATE IN BIRDS:

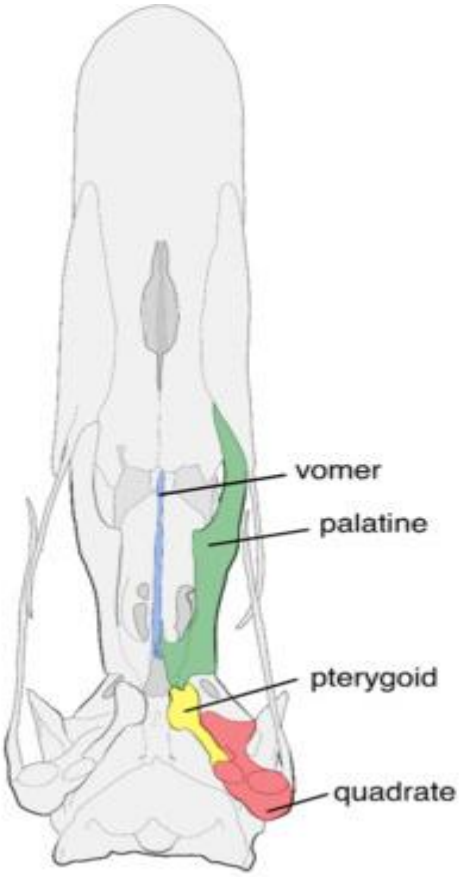
- ❖ The skull in various birds does not show much variation. Amongst some of the universal skull characters of birds are ; an early ankylosis of bones except in Ratitae, rounded and spacious cranium, a single small rounded occipital condyle formed by basioccipital, the upper beak composed mainly by the two premaxillae united into a large triradiate bone, the slender maxillo-jugal arch,

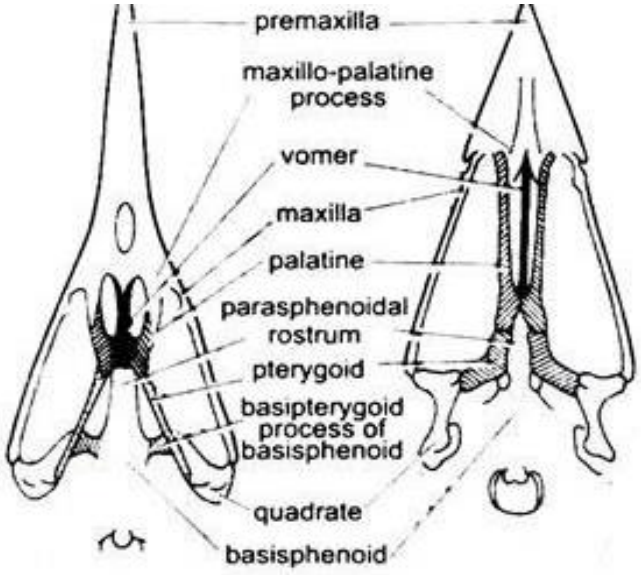
the large parasphenoidal rostrum, the freely articulated quadrate and the absence of the reptilian post-frontals.

- Orbits are large, separated by a thin interorbital septum formed by the mesethmoid which is continued anteriorly with cartilaginous internasal septum.
- **Importance of palate in classification.** There are, however, marked differences in the structure of the palatal region of skull in birds which provides an important character for their classification.
- The living birds are classified in two super-orders-Palaeognathae and Neognathae.
- In the *Palaeognathae* or *Ratitae* are included all the flightless birds. They have a *dromaeognathous* type of palate in skull in which the large vomer is extended posteriorly, so that the two palatines do not meet with one another and with the rostrum.
- On the other hand, in *Neognathae* or *Carinatae* are included all the modern flying birds. They have a *neognathous* type of palate with three sub-kinds (*schizognathous, desmognathous* and *aegithognathous),* in which the vomer is small or absent, so that the palatines meet the rostrum.
- Huxley, in 1887, pointed out the following **four types** of plate in birds based on the relations of vomer, palatines, pterygoids and maxillo-palatine processes.

1. **Palaeognathous or dromaeognathous palate-** This type of palate is characteristic of Ratitate, such as the ostrich, rhea, kiwi and tinamous, etc.
2. **Schizognathous palate-** This type of palate is common in a variety of birds, such as pigeons, fowls, gulls, plovers, cranes, woodpeckers, trogons, etc.
3. **Desmognathous palate-** This type of palate is common in most of the wading and swimming birds, such as storks, herons, ducks and geese, besides parrots, birds of prey, cuckoos, etc.
4. **Aegithognathous palate-** This is similar to the schizognathous type of palate and occurs in passerine birds, such as crows, swifts, bulbuls, etc.

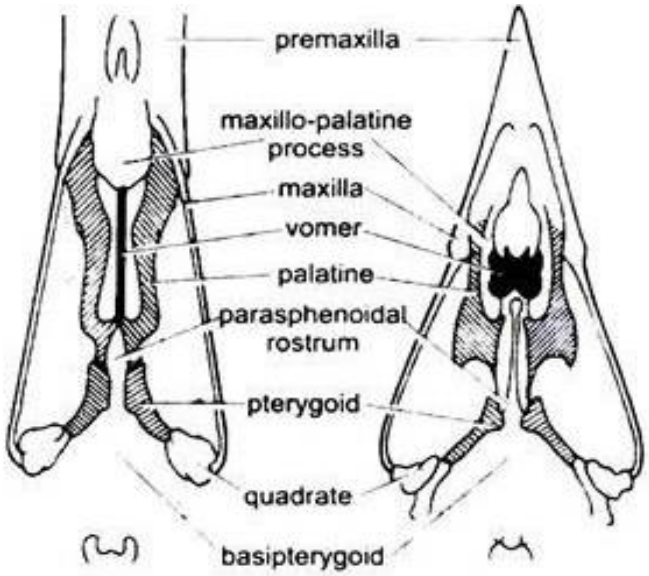






Dromaeognathous
Tinamous
(*Rhynchotus*)

Schizognathous
(*Megacephalum*)

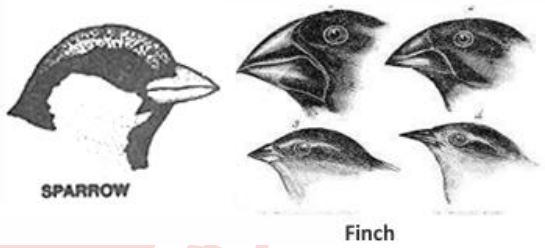


Desmoganthous
Anser
(*Cygnus*)

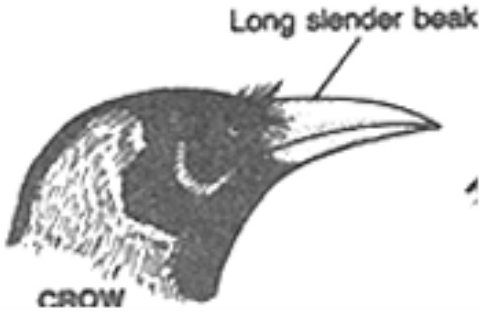
Aegithognathous
Crow
(*Corvus*)

MODIFICATION OF BEAK IN BIRDS:

- The entire modern avian world is characterized by the absence of teeth. The upper and lower jaw bones become elongated to form a peculiar beak or bill covered by a horny sheath called *rhamphotheca,*
- The modification of forelimbs into wings deprived birds of some of their normal functions which had to be taken over by the beaks and teeth. Thus beaks serve both as mouth and hands.
- Beak plays very important role in: i) Obtaining and handling food, ii) Preening feathers, iii) Gathering and arranging nest materials, iv) Offence and defence and v) Feeding the young ones. Beaks shows great variations in shape, size and structure.
- Some important modifications and types are-
- 1. **Seed eating beak:** The granivorous or seed eating birds exhibit very strong, stout, short and conical beaks. e.g., sparrow, finches and cardinals. Strong and powerful beaks are also used for crushing the large and hard seeds. Smaller and weaker beaks are used for picking up small seeds which are either swallowed or crushed. Finch

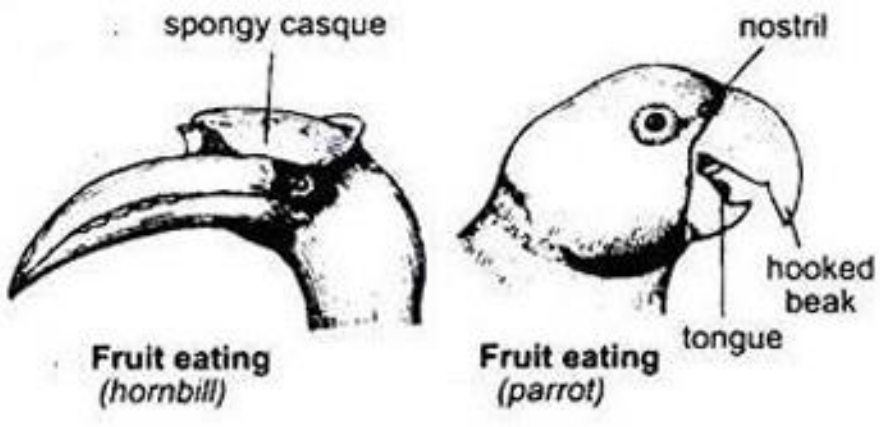


- 2. **Cutting Beaks:** Some birds possess long, sharp and slender beaks with cutting edges. It is used for various purposes like cutting, breaking eggs, cutting fruits etc. e.g., Crow.

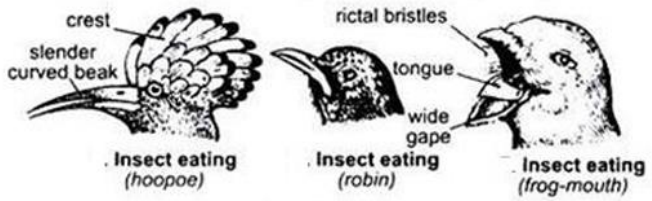


3. **Fruit Eating Beak:** Many birds feed on fruits, hence their beaks are adapted for breaking hard fruits, nuts and hard seeds. E.g., Parrot, Hornbill. In Parrot beak is very sharp, massive and deeply hooked and extremely strong. It is useful for breaking open hard seeds and nuts.

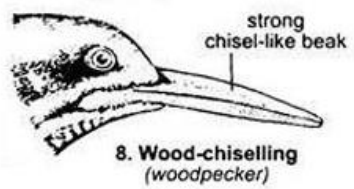
In hornbill beak is very large, enormous, heavy and cumbersome. But it is very light and these acts as resonators which enable the bird to produce exceptionally loud cry.



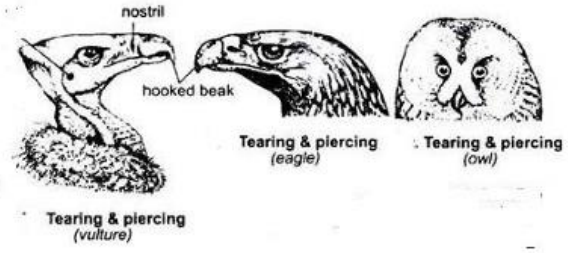
4. Insectivorous Beak: Many birds are insectivorous hence the beaks are adapted for catching the insects when they are flying. The beak is small, wide and delicate. e.g., Hoopoe, Robin, King birds. In Hoopoe the beak is long, slender and slightly curved and used for turning leaves or probing into soil for insect grubs and pupae. In fly catchers (King birds), the beak is short and strong with numerous rectal bristles at the base.



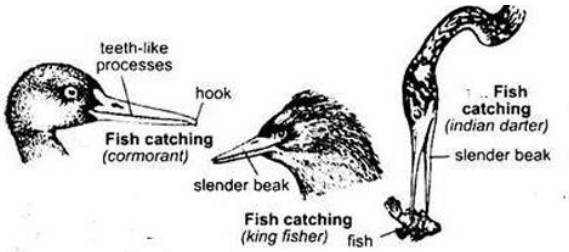
5. Wood Chiselling Beak: This type of beak is long, straight and stout chisel-like which is useful for drilling into the bark or wood for insect larvae or nest building. e.g., Woodpecker.



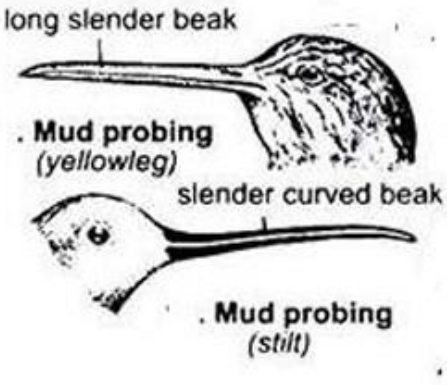
6. Tearing and Piercing Beak: The carnivorous birds which feed on flesh such as eagles, owls, kites, hawks, vultures, have short, pointed sharp-edged, powerful, hooked beaks for tearing and piercing flesh. These beaks are operated by well-developed mandibular muscles. e.g., Vultures, Hawks, Eagles, Owls, Kites etc.



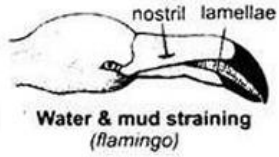
7. Fish Catching Beak: The aquatic birds have long, powerful and sharply pointed beaks to capture fish, frogs, toads and aquatic animals. e.g., Herons, Kingfishers. In cormorants, the beak is long and narrow with the edges armed with sharp backwardly directed teeth like processes for capturing fishes.

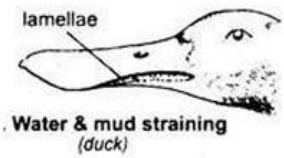


8. Mud Probing Beak: The birds with mud probing beaks are lapwing, sand piper, stilt, shipe. Their beaks are extremely long and slender. These are used as a long probe for thrusting far down into water and mud in search of worms and larvae. e.g., Lapwing, Sand piper, Stilt, Shipe etc.

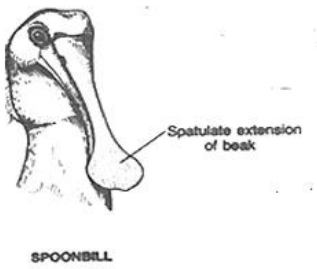


9. Water and Mud Straining Beak: The type of beak is broad and flat. The edges of the jaws are modified into horny serrations or transverse lamellae. These lamellae act as sieves or strainer. Through these sieves water and mud can easily pass out and food remains in the mouth. e.g., Ducks, Teals, Geese and Flamingo.



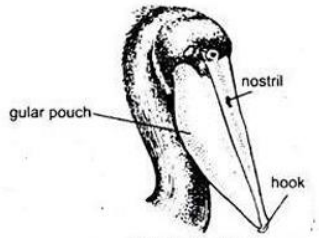


10. Spatulate Beak: The Spoonbill possess a very specialized form of beak. It is flattened beak throughout its length, but terminates in a broad spoon like expansion. It is developed for dabbling in water and mud in search of insects, fish, worms and molluscs etc.



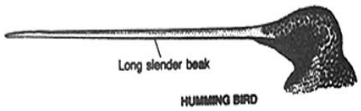
SPOONBILL

11. Pouched Beak: The birds like pelicans require large quantity of food (Fishes). Therefore, their beak is large with large gular pouch of extensible skin attached to the lower mandible. This pouch serves as a fishing net.



Pouched *(pelican)*

12. Flower probing beak: The birds feeding on the nector of flowers. develops such type of beaks. They develop long and pointed beak for sucking nector and insects. e.g., Humming birds, Sun birds.



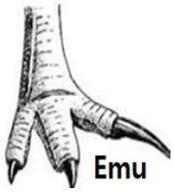
HUMMING BIRD

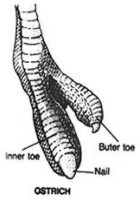

Sunbird

FEET MODIFICATION IN BIRDS:

- ❖ The feet of the birds are modified to fulfil several needs of birds. They are modified according to the character of the environment and the manner of locomotion. The normal number of toes in birds is four to five.
- ❖ The first toe is pointing backwards called hallux and remaining 2nd to 4th toes are pointing forwards. Some important feet modifications are-

1. Running or Cursorial Feet: These feet found in birds which are adapted for running. The legs are very strong

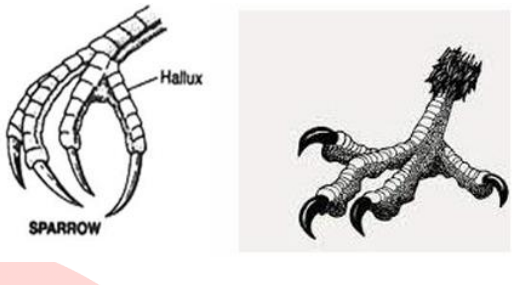

Emu



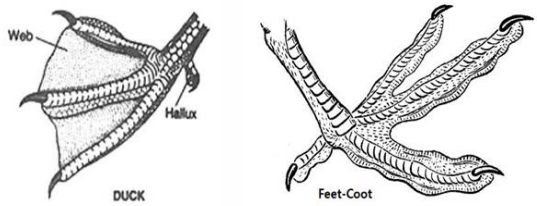
OSTRICH

and powerful and number of toes is reduced. e.g., Ostrich has only two toes, outer toe is smaller and bears no nail. In Bustards, Emu, Rhea and Cassowary only three toes are present and they are directed forwards.

2. Perching Feet: Many birds show perching type of feet In this type, three toes are directed forward and they are slender. While one toe i.e., hallux is long, strong and opposable to other three. This arrangement helps for securely fastening the foot to a branch. e.g., Crows, Sparrows, Robins, Bulbuls, Mynahs etc.



3. Swimming Feet: In swimming birds, the toes are webbed, partially or completely. The feet are modified as propellers or steering organs. In diving birds (e.g., Coots and Grebes) the web is lobate and the toes are free. In case of swimming and paddling birds (e.g., Ducks and Teals), only the anterior three toes are united by webs. In Pelicans and Cormorants all the four toes are united by web.



4.Climbing Feet: In many birds, the feet are used as organs of grasping and they are also adapted for climbing on vertical surfaces. In these birds, the second and third toes are pointed forward, while the 1st and 4th toes are pointed backwards. e.g., Parrot, Woodpecker.

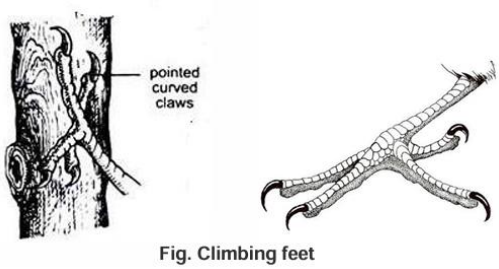
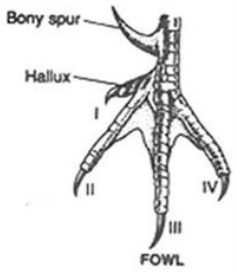
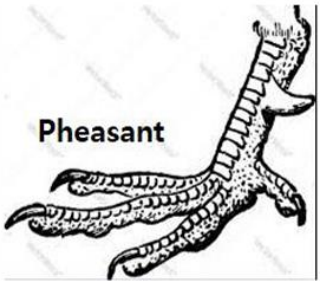


Fig. Climbing feet

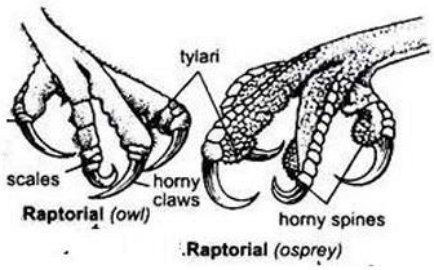
5. Clinging Feet: In this type of feet all four toes are pointed forwards and serves to cling to steep faces of cliffs or under curves of houses etc. e.g., Swifts, Martinets, Humming birds.

6. Scratching feet: The feet of this type are strong, stout with strongly developed claws. These are adapted for running as well as scratching the earth. In male birds, the foot is usually provided with a pointed bony spur for offence and defence. e.g., Fowls, Quails, Pheasants etc.

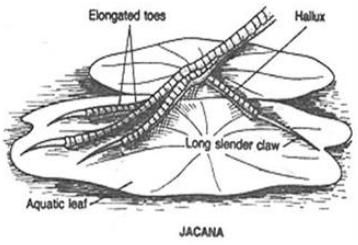




7 .Raptorial Feet: These feet are found in carnivorous, predatory birds. These birds have strong feet for striking and grasping their prey. The toes are armed with strong, sharp and curve claws. e.g., Kites, Eagles, Vultures, Hawks, Owls etc. In hawks and owls, the underside of toes shows presence of large and fleshy bulbs called tylari. In osprey and ketupa, tylari are absent but horny spines are present. These spines are useful in gripping slippery preys such as fish and frog.



8. Wading Feet: These are found in birds which feed in marshy, muddy places. The birds are also called wading or marshy birds. In these birds, the legs and toes are exceptionally long and slender. Thus, the bird can easily walk over aquatic vegetation or marshes. The web is generally absent and if present it is poorly developed. e.g., Herons, Snipes, Jacana, Lap wing etc.



MIGRATION IN BIRDS:

- The word migration has been derived from the Latin word "migrare" which means movement from one spatial unit to another.
- Any position occupied by an organism at a moment in time is considered as the spatial unit. Migration is viewed as an annual trek of an individual or group between a specific breeding and a non-breeding places in order to avail the benefit of the favourable condition.
- According to Cahn (1935) migration can be defined as, "a periodic passing of animals from one place to another." In birds the migration means a two way journey- from a breeding and nesting nesting place (called home) to a feeding and resting place (called new place) and back journey from the new place to the home.
- The movement occurs during the particular period of the year and the birds usually follow the same route.

KINDS OF MIGRATION

- Migration is broadly divided into following 3 kinds.

1. Return migration:- Migration to a previously known place which has been visited earlier is called return migration.

2. Exploratory migration:- Migration to a completely unknown space which has not been visited earlier is called exploratory migration. Although ability to return to return to the known place is retained but is not exploited.

3. Removal migration:- Migration to a comparable spatial unit which is not followed by a reversal to the original spatial unit is called removal migration. Depending upon the plane of movement of the migrants, migration is divided into 3 types:-

1. Horizontal migration:- Migration occurring on a path perpendicular to the gravitational force of the earth is called horizontal migration. Depending upon the directions of path, horizontal migration is further divided into following two kinds:-

(a) Latitudinal migration:- Horizontal migration occurring from north to south or vice-versa is called latitudinal migration. Usually it occurs from north to south and it

occurs from south to north in few cases only. Cuckoo breeds in India and spends the summer at South-East Africa. Thus it covers a distance of about 7250 km. Ruff breeds at Siberia and travels to Great Britain, Africa, India and Srilanka covering a distance of about 9650 km.

(b) Longitudinal migration:- It takes place in East- West direction. They starting moves from towards the Atlantic coast to avoid the Continental winter. The Pentagonian plover visits the Folkland Island and South Pentagonia in September and October for breeding.

2. Vertical migration:- Migration occurring in a plane parallel to the gravitational pull of the earth is called vertical migration.

3. Altitudinal migration:- This involves both horizontal and vertical components. Birds fly up and down over mountain and hills. Generally migration occurs at relatively low altitudes. Small passerine birds fly at a height 60 meters. Some birds have been found to fly at an altitudes of 4000 meters. A no. of birds in India migrate from planes to the slopes of Himalayas ascending thousands of feet above sea level during summer and return to the planes on commence of winter. These movements in birds are included under altitudinal migration.

Migration is also divided into two types on the basis of time of flight which occurs during migration:-

1. Diurnal migration:- Many large birds fly in day. These are crows, swallows, robin, hawks, cranes, pelicans etc. These may stop to forage in suitable places. However swallows and swifts capture their insect food in the air during flight. Diurnal migratory birds usually travel in flock which may be well organized.

2. Nocturnal migration:- Majority of small sized birds like sparrows, warblers, thrushes etc. prefer to fly at night, under the protection cover of darkness to escape their enemies. They feed and rest during day. However some birds like Geese and Ducks fly by day and night while migrating.

On the basis of reasons of migration, migration is categorized into following 3 types:-

1. Climatic migration:- It occurs in response to change in the climate of the environment. North-South migration of many ducks and geese is a good example of climatic migration.

2. Alimental migration:- It occurs due to shortage of water food. It may occur at any time in a year.

3. Gamatic migration:- It occurs in a need to certain environment for successful completion of the some parts of the reproductive process. Majority of the birds perform this type of migration.

On the basis of seasons during which birds migrate they are categorized into following types:- 1. Summer visitors:- These birds arrive in spring from the south to breed and leave for the south in autumn. e.g., Swifts, Swallows, Nightingales, Cuckoos etc.

2. Winter visitors:- These birds migrate Southward and South-West in winter and go back to North in spring. e.g., Field fare, Snow bunting, Red wig etc.

3. Birds of passage:- Some birds are seen for a short time twice in a year on their way to colder or warmer countries in spring and autumn e.g., Sand pipers, Spines etc.

CAUSES OF MIGRATION

- Various factors causing migration put forward by different workers include followings:-
- 1. Environmental stimulus for migration:- It is believed that decline in temperature and food availability might trigger off migration. With less hours of light during autumn in temperate and Northern hemisphere, the time for food gathering is lessened. It initiates autumnal migration. Similarly increasing day length causing elevated temperature in Southern hemisphere during spring acts as initiator of migration. However, the sensitivity of migratory birds to changes in the weather is species specific.
- 2. Physiological stimulus for migration:- Scientists are busy today to assess the role of endocrine glands such as pituitary, gonad, thyroid, adrenal and pineal in migration. The pituitary regulates the development of gonads and influences all metabolic processes by way of its action on thyroid gland. It has been demonstrated in a passerine migrant that thyroid hormones may play an important role in the initiation of migratory deposition. Gonadal hormones are also responsible for the deposition of fat in many migratory birds.

ADVANTAGES OF MIGRATION- Migratory birds avail the facility of better breeding and feeding ground. As a result of arrival at warm places from cold places, the birds get longer day time to search their food. By migration birds escape unfavourable conditions.

ADAPTATIONS FOR FLIGHT:

- Flight adaptations in birds Bird flight is the primary mode of locomotion used by most bird species in which birds take off and fly. Flight helps birds in feeding, breeding, avoiding predators, and in migration.
- The flight motion compromises of hovering, taking off, and landing, involves many complex movements. Birds adapted over millions of years through evolution for specific environments, prey, predators, and other needs.
- Flight adaptations in birds are divided into two categories:
- A. Morphological Adaptations
- B. Anatomical Adaptations
- **Morphological Adaptations**

1. **Body shape** - The birds have a spindle-shaped body to offer less air resistance during flight. This helps the birds to conserve energy and become more efficient at flying.

2. **Compact body** - The body of a bird is compact, dorsally strong and ventrally heavy to maintain equilibrium in the air. Their wings are attached on the thorax, the light organs like lungs and sacs are positioned high, the heavy muscles placed centrally are other features that help in flight.

3. **Body covered with feathers** -The feathers are smooth, directed backwards, and closely fitting which make the body streamlined and reduce friction during flight. It lightens the body weight and protects it from the effect of environmental temperature. They also have a wide surface area for striking the air. Feathers add to the body buoyancy. It insulates the body and prevents any loss of heat from the body. This helps the birds to bear low temperatures at higher altitudes.

4. **Forelimbs modified into wings**- The forelimbs are modified into wings which is the only organ of flight. These consist of a framework of bones,

muscles, nerves, feathers, and blood vessels. The wings have a large surface area. They also support the bird in the air. The wings have a thick strong leading edge with a concave lower surface and a convex upper surface. This helps in increasing the air pressure below and reducing the air pressure above. Thus the bird can fly upward and forward during flight.

5. **Mobile neck and head**- The birds have a long and flexible neck which helps in the movement of head important for various functions. They possess a horny beak which helps them to pick the grains and insects while feeding.

6. **Bipedal locomotion** - The anterior part of the body of a bird helps in taking off during flight. The anterior part of the body also helps birds to land. The hindlimbs help in the locomotion on land. They can support the entire body weight of a bird.

7. **Perching** - When a bird sits on the branch of a tree, its toes wrap around the twig. This is known as perching. The muscles are so well-developed that a bird can sleep in that position without falling.

8. **Short tail** - The tail bears long feathers that spread like a fan and function as a rudder during flight. They also help in balancing, lifting, and steering while flying and perching.

Anatomical Adaptations

1. **Flight muscles** - The well-developed muscles control the action of the flight muscles. It weighs about 1/6th of the entire bird. The flight muscles are striated. The muscles on the wings are large. Other muscles help the above muscles in functioning.

2. **Light and rigid endoskeleton** - The birds have a very stout and light skeleton. The bones are hollow, filled with air sacs. They are provided with a secondary plastering to increase their rigidity. The bones are fused and lack bone marrow. The birds lack teeth. The thoracic vertebrae are fused except for the last one. This plays an essential role in the action of wings striking the air.

3. **Digestive system** - The birds have a very high rate of metabolism. Therefore, food digests rapidly. The length of the rectum is reduced because of

the minimum undigested waste. They have no gall bladder which reduces the weight of the bird.

4. **Respiratory system** - The respiratory system of birds is designed in such a manner that the food is oxidised rapidly and a large amount of energy is liberated. Since the metabolism rate is higher, a large number of oxygen molecules are required by the body. For this, the lungs are provided which occupy the entire space between the internal organs.

5. **Circulatory system**- Rapid supply of oxygen is required by the blood due to rapid metabolism rate in birds. Therefore, birds require an efficient circulatory system. Birds have a four chambered heart that performs double circulation. This prevents the mixing of oxygenated and deoxygenated blood. Also, the birds contain a large amount of haemoglobin in their red blood cells which helps in the quick aeration of body tissues.

6. **Warm blooded** - The temperature of the body of a bird remains high and does not change with the change in the environment. This facilitates the birds to fly at very high altitudes.

7. **Excretory system** - The nitrogenous waste is converted to less toxic organic compounds such as uric acid, and urates. They have no urinary bladder. The uriniferous tubules efficiently absorb water.

8. **Brain and sense organs** - Eyes are large and the large optic lobes correspond to the great development of sight. The eyes occupy a large portion of the head, and both eyes together are often heavier than the brain. The ability to accommodate rapidly is also well developed for birds must change quickly from a distant to a near vision in flight. The much developed and convoluted cerebellum indicates the delicate sense of equilibrium and the great power of muscular co-ordination belonging to birds. The enormous development of corpus striata in the cerebrum also adds to the extraordinary manoeuvreability to attain stability in flight.

9. **Single ovary** - Presence of a single functional ovary of the left side in the female bird also leads to reduction of weight which is so essential for flight.

Parental Care in Birds

- All birds show parental care with 90% involved in bi-parental care, 9% maternal and 1% paternal care. The parental care in birds can be divided into **three** main stages.
- **Nest Building:** Nests are the homes built by male birds that is used for egg laying and incubation. It is one of the ways male attract females and also take care of eggs and young ones. In nature there are many variety of bird nests. Some birds use crevices among rocks or a cavity in the tree as nest and lay their eggs there.
- But most birds build elaborate nests with variety of material available to them. Many decorate it with pebbles and flowers to make it attractive. Members of the same species build similar nests utilizing same material.
- Weaverbirds and tailorbirds are named for their astonishing nest building skills. Tailorbird sews the edges of a large single leaf to design beautiful home out of it. Weaverbird constructs a suspended pendant shaped nest out grass and plant fiber.

A male village weaver (*Ploceuscucullatus*), building his nest

- Woodpeckers hollow out cavity in the tree and kingfisher excavates riverbank to use it as nest. Some birds build colonial nest as in case of social weaverbird where multiple birds build nests on the same tree or European bee-eater that lives in colonial burrow nest.

- **Incubation of Eggs:** Fertilized birds egg need to be kept at optimal temperature constantly till they hatch. This is mostly done by sitting on eggs by the parent birds. In most species both parents take turns to keep eggs warm, in others its either male or female that incubate eggs.
- In case of emperor penguin, male incubates single egg in harsh winter for around two months. He keeps egg on the top of his feet and keeps it warm till it hatches. In case of Greylag goose and many species of ducks it's the mother who incubates the eggs, but the father remains close by and guards them. In case of doves, pigeons and sandpipers both female and male take turns to incubate eggs. Period of incubation varies in different species of birds being 13 days in a canary to 67 days in emperor penguins.

Taking care of young ones: In case of most birds, chicks require extensive care post hatching. They need to be fed, cleaned and protected from the predators. precocial birds chick are born with feathers and they can swim, run post hatching and are fairly independent. Still they require parental presence to develop learned skills by observing adults.

While, altricial birds are born featherless, helpless and blind and remain inside the nest for few weeks before they become independent. In most cases, parental duties are shared between male and female in birds. In emperor penguin once eggs hatch female takes over the chick and parental duties, while male leaves for feeding. Both parents after that take turns, one brooding and other feeding and raise their chick together.

- Feeding in birds involve collection of food by parent and placing in the mouth of chicks. In pigeons, the epithelial lining of crop is shredded and fed to the young one as pigeon milk.
- **Crop milk** is a secretion from the lining of the crop of parent birds in some species that is regurgitated to young birds. It is found among all pigeons and doves where it is also referred to as pigeon milk.
- Many birds, especially raptors like osprey are very protective of their young ones. They aggressively defend their nest from predators. Birds have long term social bond with their hatchlings based on imprinting and offspring learn lots of skills from parents till they leave the nest.
- Imprinting is a type of innate learning in animals immediately after birth or hatching to recoginize their caregiver for food and protection. Birds after hatching visually imprint on their parents during a critical period of development.

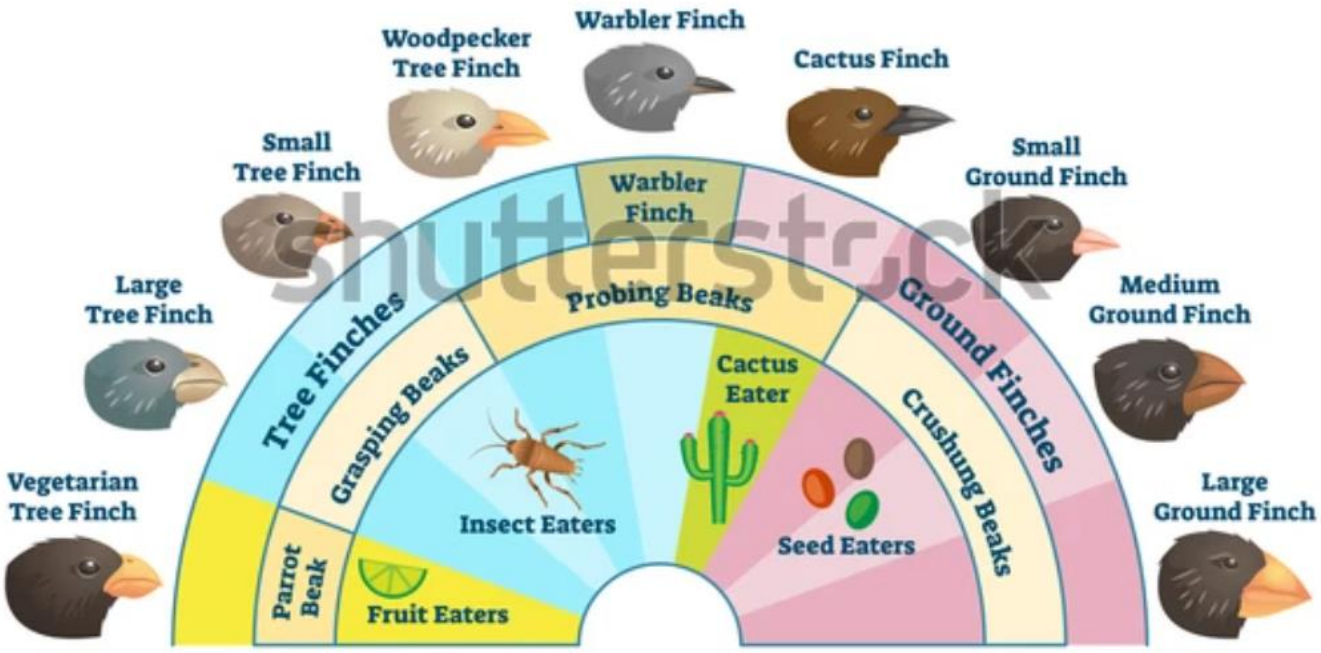
Adaptive Radiation

- It is the evolutionary divergence of members of a single phyletic line into a series of different niches. (Mayer,1931) OR
- Adaptive radiation is a process in which organism diversify rapidly from an ancestral species into a multitude of new forms.

Darwin's Finches:

- One of the classical examples of speciation involving the interplay of complex forces like isolation, competition, adaptation, etc. which lead to adaptive radiation at the species level, is provided by Darwin's finches. Darwin's finches are the small Sparrow-like dark birds belonging to family Fringillidae.
- In the archipelago, there are 5 large islands in the group; with 19 smaller ones and 47 rocks. The ancestors of Darwin's finches were early migrants to the Galapagos Islands in the Pacific Ocean and probably the first land birds to reach the islands.
- The present-day assemblages of Darwin's finches descended from these birds that once inhabited the mainland of South America, the Galapagos Islands which lie on the equator about 600 miles west of South America i.e., Ecuador. These early colonists have given rise to 14 distinct species, each well adapted to a specific niche. 13 of these species of Darwin's finches occur in the Galapagos and one is found in the small isolated Cocos Island, northeast of Galapagos.
- Not all 13 species are found on each island. These islands are of volcanic origin. They were never connected with the mainland of South America. The tugged shoreline cliffs are of grey lava and the coastal lowlands are parched, covered with cacti and thorn bushes. In the humid uplands, trees flourish in the rich black soil.
- Due to this geographical segregation, the finches on different islands could not interbreed, so the populations on the different island tended to become distinct.
- Significantly, the study of these birds in their native habitat gave Darwin his first insight into evolutionary processes. Darwin's finches were utilized as evidence for his theory of evolution.
- David Lack (1969) has evaluated the phenomenon of adaptive radiation of Darwin's finches very carefully. Darwin's finches occupy the fragmented landscape of the Galapagos Islands and are diversified into many varieties of species which differ in ecology, song pattern and morphology.

- The most conspicuous differences among these species are in the size and shape of their beaks, which are correlated with marked differences in their feeding habits (As per Wells, 2000). Six of these species are 'Ground finches', with heavy beaks specialized for crushing of seeds. Some of the ground finches live mainly on a diet of seeds found on the ground.
- For example, there are 3 seed-eater ground finches: (i) small-beaked (*Geospiza fuliginosa*), (ii) medium beaked (*Geospiza fortis*) and (iii) large-beaked (*Geosptiza magnirostris*) which occur together in the coastal lowlands of several islands.
- Each species, however, is specialized in feeding on a seed of a certain size. The small-beaked finch feeds on small grass seeds, whereas large-beaked finch eats large, hard fruit. Other ground finches feed primarily on the flowers of prickly pear cacti. The cactus eaters possess decurved, flower-probing beaks.
- Their beaks are thicker than those of typical flower eating birds. All other species are 'Tree finches', the majority of which feed on insects in the moist forests. One of the most remarkable of these tree dwellers is the 'woodpecker finch'. It possesses a stout, straight beak, but lacks the long tongue characteristic of the woodpecker. Like a woodpecker, it bores into wood in



search of insect larvae, but then it uses a cactus spine or twig to probe out its insect prey from the excavated crevice.

- Equally extraordinary is the 'Warbler finch' which resembles in form and habit the true warbler. Its slender, warbler-like beak is adapted for picking small insects of bushes.
- Occasionally, like a warbler, it can capture an insect in flight. Thus, the original ancestral stock of finches on the Galapagos diverged along several different paths. All the finches are related to one another, but the various species of ground finches evidently are more related by descent to one another than to the members of the tree-finch assemblage.
- As a measure of evolutionary affinities, the ground finches are grouped together in one genus (Geospiza) and the warbler finches are clustered in another genus (Camarhynchus).
- The diagram portrays different lineages of finches. As per Stanley, 1969, Darwin's finches like adaptive radiations, within ecologic islands of any sort are called 'eco-insular radiations'.
- Darwin's finches provide circumstantial evidence for the origin of a new species by means of geographical isolation.
- 2. **Adaptive Radiation in Penguins:** G. G. Simpson in the year 1953 has cited evidence that when a group of organisms enters a new adaptive zone previously unoccupied by the group, there may be rapid bursts of speciation and adaptive divergence into a variety of ecological niches.
- These zones were sequentially invaded by penguins during their evolution and they are now extinct in the aerial flight zone or subzone.

MCQ based on Unit IV

Q. 1. Exoskeleton in birds is epidermal and horny, represented by :

a. Feathers, forming a body covering

b. Scales, similar to those of fishes

c. Claws, on wings

d. Sheaths on toes

Ans. a

Q. 2. Centra of vertebrae in birds is ;

a. Procoelous

b. Heterocoelous

c. opisthocoelous

d. Amphicoelous

Ans. b

Q. 3. In birds the last 3 or 4 tail vertebrae are fused to form :

a. Synsacrum

b. Furcula

c. Pygostyle

d. Wish bone

Ans. c

Q. 4. In birds, sound is produced by :

a. Air sacs

b. Trachea

c. Larynx

d. Syrinx

Ans. d

5. Middle ear in birds contains :

a. 1 ossicle

b. 2 ossicles

c. 3 ossicles

d. 4 ossicles

Ans. a

Q.6. Flightless birds are included in :

a. Odontognathae

b. lmpennae

c. Ratitae

d. Carinatae

Ans. c

Q. 7. The fossil record of *Archaeopteryx* have been discovered

a. Britain

b. Germany

c. France

d. USA

Ans. b

Q. 8. Beak in sparrows is :

a. Cutting type

b. Seed eating type

c. Fruit eating type

d. Tearing and piercing type

Ans. b

Q. 9. Probable ancestors of present day Ostrich is ::

a. *Archaeopteryx*

b. *ktyornis*

c. *Eleuheromis*

d. *Hesperornis*

Ans.c

Q. 10. Skull in members of ratitae is

a. Schizognathous

b. Desmognathous

c. Dromaeognathous

d. Aegithognalhous

Ans. c

Q. 11. Champion long distance migrant is

a. European white stork

b. Arctic tern

c. Crow

d. Passer

Ans. b

Q. 12. Birds are glorified -

a. Vertebrates

b. Fishes

c. Amphibians

d. Reptiles

Ans. d

Q. 13. The most common mode of flight:

a. Gliding

b. Hovering

c. Flapping

d. None of these

Ans. c

Q.14. Pectoralis minor is a ;

a. Elevator muscle

b. Perching muscle

c. Visceral muscle

d. Depressor muscle

Ans. a

Q.15. In bird's gizzard is used for:

a. Chewing food

b. Grinding food

c Mixing food

d. Digesting food

Ans. b

Q. 16. What fraction of food stuff is converted into energy by birds?

a. Half

b. Two third

c. One third

d. One fourth

Ans. c

Q. 17. Coccygeo-mesentric vein collects blood from:

a. Kidney

b. Tail

c. Pelvis

d. Cloaca and rectum

Ans. d

Q. 18. Which of the following animal groups has richest blood

a. Birds

b. Mammals

c. Reptiles

d. Amphibians

Ans. a

Q.19. Bones of fowl are called :

a. Cartilaginous

b. Membranous

c. Replacing

d. Pneumatic

Ans. d

Q. 20. Skull of fowl is :

a. Monocondylic

b. Dicondylic

c. Acondylic

d. None of these

Ans. a

Q. 21. In fowl, cranium does not extend forward into orbital region. This condition of skull is called —

(a) Edentulus

(b) Tropibasic

(c) Autostylic

(d) Craniostylic

Ans. b

Q. 22. Jaw suspensorium in *Gallus* is said to be :

(a) Autostylic

(b) Craniostylic

(c) Monymdstylic

(d) Hyostylic

Ans. a

Q. 23. In fowl the skull palate is with short vomers permitting the palatines to meet. This type of palate is called:

a. Palaeognathus

b. Dromaeognathous

c. Desmognathous

d. Schizognathous

Ans. d

Q. 24. Strongest bone of Pectoral girdle is :

a. Clavicle

b. Coracoid

c. Scapula

d. Sternum

Ans. b

Q. 25. Furcula or Merry thought or Wishbone is a composite bone formed by the fusion of-

a. Clavicles and interclavicles

b. Coracoid and scapula

c. Coracoid and clavicles

d. Coracoid and interclavicles

Ans. a

Q. 26. One half of Pelvic girdle is called as :

a. Osinnominatum or innominate bone

b. Ilium

c. Synsacrum

d. Acetabulum

Ans. a

Q. 27. Which of the following is associated with Radius-ulna :

a. Obturator foramen

b. Olecranon process

c. Pneumatic foramen

d. Acromian process

Ans. b

Q. 28. Which of the following is a sesamoid bone :

a. Fibula

b. Phalanges

c. Furcula

d. Patella

Ans. d

Q. 29. Number of Cervical vertebrae in fowl is :

a. 14-16

b. 7

c. 10-12

d. 16

Ans. a

Q. 30. Keel is a component of :

a. Ribs

b. Pelvic girdle

c. Sternum

d. Hyoid apparatus

Ans. c

Q. 31. Number of thoracic ribs in fowl is :

a. 7

b. 11

c. 9

d. 8

Ans. a

Q. 32. The first toe of fowl is called :

a. Pollex

b. Hallux

c. Tarsal

d. Phalanges

Ans. b

Q. 33. Fighting spur is found in :

a. Tarso-metatarsus

b. Carpo metacarpus

c. Tibio tarsus

d. Tarsals

Ans. a

Q. 34. The meninges covering the brain of a bird are :

a. Duramater and piamater

b. Duramater and pia-arachnoid layer

c. Piamater and arachnoid layer

d. Duramater and arachnoid layer

Ans. b

Q. 35. The cavity of mid brain is called :

a. Diacoel

b. IV ventricle

c. Iter

d. Optocoel

Ans. c

Q. 36. In pigeons gray matter is internal in :

a. Olfactory lobes

b. Cerebral hemisphere

c. Cerebellum

d. Optic lobe and medulla oblongata

Ans. d

Q. 37. In birds voluntary movements are controlled by :

a. Cerebellum

b. Optic lobes

c. Crura cerbri

d. Medulla oblongata

Ans. a

Q. 38. In pigeons retina possesses :

a. Rods and cones equally

b. More cones than rods

c. More rods than cones

d. Only cones

Ans. b

Q. 39. Pecten is absent in which bird :

a. Pigeon

b. Peacock

c. Kiwi

d. Crow

Ans. c

Q. 40. The study of birds is termed as :

a. Ornithology

b. Oology

c. Herpetology

d. Icthyology

Ans. a

Q. 41. Study of birds eggs is

a. Ornithology

b. Oology

c. Herpetology

d. Icthyology

Ans. b

Q. 42. Which of the following is not true for birds?

a. Feathered

b. Flying

c. Quadraped

d. Possess wings –

Ans. c

Q. 43. The common rock pigeon does not nest on :

a. Fissures of rocks

b. Forts

c. Houses

d. Trees

Ans. d

Q. 44. Pigeon's milk is manufactured in :

a. Crop

b. Oesophagus

c. Buccal cavity

d. Stomach

Ans. a

Q. 45. Jaws in *Columba livia* are covered by :

a. Operculum

b. Rhamphotheca

c. Cere

d. Nictitating membrane

Ans. b

Q. 46. Nostrils in pigeons arc overhung by :

a. Feathers

b. Rhamphotheca

c. Operculum or cere

d. Nictitating membrane

Ans. c

Q. 47. The only cutaneous glands in pigeon:

a. Sweat glands

b. Sebaceous glands

c. Mammary glands

d. Preen glands or uropygial gland

Ans. d

Q. 48. The foot of birds is covered bv

a. Epidermal scales

b. Dermal scales

c. Dermal plates

d. Feathers

Ans. a

Q. 49. The arrangement and distribution of feathers on birds :

a. Plumage

b. Pterolysis

c. Pterylae

d. Apteria

Ans. b

Q. 50. The remiges attached to second digit of hand of birds are called :

a. Manuals

b. Metacarpals

c. Digitals

d. orbitals

Ans. c

Q. 51. Bastard wing is attached to :

a. Hand

b. Second digit

c. Fore arm

d. Pollex or thumb

Ans. d

Q. 52. Down feathers are present in :

a. Newly hatched pigeons

b. Male pigeons

c. Female pigeon

d. Adult pigeons

Ans. a

Q. 53. The coelom in birds is divided into thoracic and abdominal cavity by :

a. Transverse septum

b. Oblique septum

c. Longitudinal "septum

d. Diagonal septum

Ans. b

Q. 54. Which of the following is not a flight muscle

a. Pectoral muscle

b. Coraco-brachialis longus

c. Gastrocnemius

d. Coraco-brachialis

Ans. c

Q. 55. The foramen triosseum is an aperture between:

a. Clavicle and coracoid

b. Coracoid and scapula

c. Clavicle and scapula

d. Clavicle, coracoid and scapula

Ans. d

Q. 56. Which of the following is the primitive palate type found in flightless ratite birds like ostriches and emus?

a. Schizognathous

b. Aegithognathous

c. Desmognathous

d. Palaeognathous

Ans. d

Q. 57. In the aegithognathous palate, what is the state of the vomer?

a. It is large and broad from behind, connecting the palatines.

b. It is small and pointed.

c. It is short and broad, with the palatines meeting the rostrum.

d. It is abortive and disappears in the skeleton.

Ans. c

Q. 58. Which type of palate is characteristic of modern flying birds, and includes sub-types like schizognathous, desmognathous, and aegithognathous?

a. Palaeognathous

b. Neognathous

c. Dromaeognathous

d. None of the above

Ans. b

Q. 59. The desmognathous palate, where the palatines meet the rostrum, is common in which group of birds?

a. Ratites

b. Pigeons and fowls

c. Most wading and swimming birds like storks, ducks, and herons.

d. Passerine birds like crows and swifts.

Ans. c

Q. 60. What function does the palate serve in a bird's mouth?

a. It is the primary organ for vocalization.

b. It separates the oral and nasal cavities.

c. It helps in filtering food from water.

d. It acts as a sensory organ for taste.

Ans. b

Q 61. What is the primary function of the palate in birds for classification purposes?

a. Supporting flight muscles

b. Regulating body temperature

c. Aiding in digestion

d. Providing an important character for classification

Answer: d

Q 62. The soft part of a bird's feather on either side is known as:

a) Barb

b) Rachis

c) Barbules

d) Barbicels

Answer: a

Q. 63.Which fossil is considered a transitional form between reptiles and birds, showcasing both reptilian and avian characteristics?

a. *Hesperornis*

b. Archaeopteryx

c. Sinosauropteryx

d. Ichthyornis

Ans. b

Q. 64. The presence of feathers is a defining characteristic of which group?

a. Mammals
b. Reptiles
c. Birds (Aves)
d. Amphibians

Ans. c

Q. 65. Darwin's finches on the Galápagos Islands are a classic example of which evolutionary process, where a single ancestral species diversifies into many species adapted to different environments?

a. Convergent Evolution
b. Adaptive Radiation
c. Use and Disuse
d. Mass Extinction

Ans. b

Q. 66. What are the characteristic long, hollow bones in birds, which are also called pneumatic bones, known for?

a. Increasing weight for flight
b. Strengthening the skeleton for impact
c. Lightening the skeleton to assist in flight
d. Improving hearing in flight

Ans. c

Q. 67. What period is generally associated with the appearance of the earliest bird ancestors, the dinosaurs?

a. Cretaceous
b. Jurassic
c. Triassic
d. Permian

Ans. c

Q 68. Which of the following is considered a crucial transitional fossil between reptiles and birds?

a. Pterosaur

b. Ichthyornis

c. Archaeopteryx

d. Plesiosaurus

Ans. c

Q 69. Birds are believed to have evolved from which group of dinosaurs?

a. Sauropods

b. Stegosaurs

c. Theropods

d. Hadrosaurs

Ans. c

Q. 70. Which of these features in birds points towards their reptilian ancestry?

a. Presence of feathers

b. Four-chambered heart

c. Presence of scales on hind limbs

d. Pneumatic bones

Ans. c

Q 71. What is the term for the process where a single ancestral species diversifies into multiple species, each adapting to different ecological niches, like Darwin's Finches?

a. Convergent evolution

b. Divergent evolution

c. Adaptive radiation

d. Natural selection

Ans. c

Q 72. Which of the following is a key adaptation in birds for flight?

a. Solid bones

b. Thick bones

c. Hollow bones

d. Heavy bones

Ans. c

Q 73. The presence of both a beak with teeth and wings with claws in a fossil like *Archaeopteryx* suggests its importance as a:

a. Living fossil

b. Specialized bird

c. Connecting link

d. Primitive reptile

Ans. c

Q 74. In which geological era did the evolution of modern birds begin?

a. Paleozoic

b. Cenozoic

c. Mesozoic

d. Archaeozoic

Ans. c

Q 75. The wishbone of birds is formed by the fusion of which bones?

a. Hindlimbs

b. Clavicles

c. Skull

d. Pelvic girdle

Ans. b

Q 76. Which of the following is a key reason for the bird's high metabolism, necessary for sustained flight?

a. Efficient digestive system processing large amounts of food rapidly

b. Presence of pneumatic bones

c. Four-chambered heart

d. All of the above

Ans. d

Q 77. The similar streamlined bodies of dolphins and sharks, despite their different ancestry, is an example of:

a. Homology

b. Adaptive radiation

c. Convergent evolution

d. Divergent evolution

Ans. c

Q 78. Which of the following is a famous flightless bird found in New Zealand and known as a national symbol?

a. Emu

b. Ostrich

c. Kiwi

d. Penguin

Answer: c

Q 79. Which of the following birds, native to Africa, is the largest living flightless bird and can run at high speeds?

a. Emu

b. Kiwi

c. Ostrich

d. Rhea

Answer: c

Q 80. Penguins are well-adapted for an aquatic lifestyle. Which part of their body has evolved into flippers for swimming?

a. Legs

b. Wings

c. Tail

d. Beak

Answer: b

Q 81.Which of the following is NOT a flightless bird?

a. Cassowary

b. Crane

c. Penguin

d. Rhea

Answer: b

Q 82. Flightless birds, such as ostriches, emus, and kiwis, are a type of bird that belongs to which broad group?

a. Ratites

b. Passerines

c. Waterfowl

d. Raptors

Answer: a

Q 83. Which of the following is the largest living flightless bird?

a. Kiwi

b. Emu

c. Ostrich

d. Penguin

Answer: c

Q 84. Flightless birds primarily belong to which order?

a. Passeriformes

b. Struthioniformes

c. Sphenisciformes

d. Galliformes

Answer: b

Q 85. Which of the following is NOT a common physical characteristic of flightless birds?

a. Reduced wing structures

b. Denser bones

c. Hollow bones

d. Reduced keel on the sternum

Answer: c

Q 86. Why did some birds evolve to lose their ability to fly?

a. The advantages of flight were outweighed by its costs in certain environments.

b. They were specifically bred by humans for this trait.

c. They needed to adapt their wings for swimming in marine environments.

d. All of the above

Answer: d

Q. 87. Which flightless bird is endemic to New Zealand and known for its nocturnal habits?

a. Ostrich

b. Emu

c. Kiwi

d. Cassowary

Answer: c

Q 88. Which of the following is an extinct flightless bird?

a. Ostrich

b. Dodo

c. Penguin

d. Kiwi

Answer: b

Q 89. What is the primary function of a penguin's wings?

a. Flight

b. Running

c. Swimming

d. Digging

Answer: c

Q 90. What is a key reason for the vulnerability of many flightless bird species to extinction?

a. Lack of suitable habitats

b. Limited mobility and inability to escape predators quickly

c. Climate change

d. Disease

Answer: b

Q 91. What is the primary reason birds migrate?

a. To find new food sources and breeding grounds

b. To escape from other birds

c. To get exercise

d. To see new places

Answer: a

Q 92. Which is the longest-distance migratory bird?

a. Hummingbird

b. Blue Grouse

c. Arctic Tern

d. Common Cuckoo

Answer: c

Q 93. What internal factor helps birds navigate during migration?

a. Their strong sense of smell

b. An internal biological clock and navigation sense

c. Their ability to use the sun's heat to guide them

d. Their excellent hearing

Answer: b

Q 94. What external factor can prepare birds for migration?

a. A decrease in temperature

b. An increase in day length

c. A sudden increase in available food

d. More predators in their current habitat

Answer: b

Q 95. Which of the following is a type of migration where birds move between different elevations to avoid harsh winters?

a. Longitudinal migration

b. Nomadic migration

c. Altitudinal migration

d. Latitudinal migration

Answer: c

Q 96. What term is used for the "restlessness" birds exhibit before migrating?

a. Migratory fever

b. Zugunruhe

c. Wanderlust

d. Pre-flight jitters

Answer: b

Q 97. What is the main purpose of the "V" formation used by some migrating birds?

a. To make themselves a more intimidating target

b. To conserve energy by reducing wing drag

c. To keep warm as a group

d. To keep better track of each other

Answer: b

Q 98. A bird that does not migrate and stays in the same area year-round is called a:

a. Migratory bird

b. Resident bird

c. Nomadic bird

d. Non-migratory bird

Answer: b

Q 99. How does climate change impact bird migration?

a. It has no impact.

b. It causes birds to migrate earlier due to increased temperatures.

c. It disrupts traditional routes and timing.

d. Both b and c are correct.

Answer: d

Q. 100. Which of the following describes bird migration most accurately?

a. Random movement of birds seeking food.

b. Regular, seasonal movement, often north and south, between breeding and wintering grounds.

c. Birds leaving one country to move permanently to another.

d. Birds staying in one place until food resources are depleted.

Answer: b

Q. 101. What are the primary reasons birds migrate?

a. To escape boredom.

b. To find new friends.

c. To find food, suitable breeding locations, and avoid harsh weather.

d. To visit different landscapes.

Answer: c

Q 102. Which of the following is NOT a navigation mechanism birds use during migration?

a. Celestial cues (sun, stars)

b. Earth's magnetic field

c. Visual landmarks

d. Random exploration

Answer: d

Q 103. What is a common threat faced by migratory birds during their journeys?

a. Too many food sources.

b. Lack of predators.

c. Adverse weather conditions and exhaustion.

d. Easy availability of nesting sites.

Answer: c

Q 104. The type of migration where birds move up and down a mountain's elevation is called:

a. Latitudinal migration

b. Longitudinal migration

c.. Altitudinal migration

d. Nomadic migration

Answer: c

Q. 105. Which of the following features is NOT a flight adaptation in birds?

a. Pneumatic (hollow) bones
b. A streamlined, spindle-shaped body
c. Large, heavy teeth for chewing dense food
d. Modified forelimbs into wings with feathers

Answer: c

Q. 106. What is the primary function of feathers in a bird's flight?

a. Insulation and waterproofing only
b. Providing lift, control, and streamlining the body
c. Generating body heat for flight
d. Storing food for the bird

Answer: b

Q. 107. How does the bird's skeleton assist in flight?

a. It is dense and heavy to provide stability
b. It is light, rigid, and features hollow bones
c. It is highly flexible to absorb shock
d. It is composed of solid, fused bones with bone marrow

Answer: b

Q. 108. Which part of the bird's body is a large, powerful, and essential muscle for wing movement?

a. The leg muscles
b. The back muscles
c. The breast muscles
d. The neck muscles

Answer: c

Q. 109. What role does the bird's short tail serve during flight?

a. To store energy for take-off
b. To increase air resistance
c. To act as a rudder for steering and stabilization
d. To absorb water for hydration

Answer: c

Q 110. Which of the following is NOT a characteristic flight adaptation in birds?

a. Streamlined body

b. Hollow bones

c. Presence of teeth

d. Modified forelimbs (wings)

Answer: c

Q 111. What is the primary function of feathers in bird flight?

a. Provide insulation only

b. Aid in buoyancy and reduce air resistance

c. Protect the body from environmental temperature fluctuations

d. All of the above

Answer: d

Q 112. The bones of birds are often described as "pneumatic." What does this mean and how does it relate to flight?

a.. They are dense and heavy, providing strength for wing flapping.

b. They are filled with air sacs, making them lighter for flight.

c. They are flexible, allowing for intricate wing movements.

d. They are made of a different material than other vertebrates.

Answer: b

Q 113. How are the flight muscles of birds adapted for flight?

a. They are small and weak to reduce weight.

b. They are located in the wings for direct flapping.

c. They are large, striated and well-developed, attached to a keel on the sternum.

d. They are primarily responsible for perching and walking.

Answer: c

Unit- IV

Mammalia:

Origin of mammals, Adaptive radiation of Mammalia, Structural peculiarities and phylogenetic relations of Prototheria and Metatheria, Uterus modifications, Aquatic mammals, Stomach in ruminants

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ORIGIN OF MAMMALS:

- Mammals evolved from reptiles during the Triassic period, specifically from synapsid reptiles called therapsids. Key mammalian characteristics developed over time, including hair, specialized teeth, and a high metabolic rate allowing for warm-bloodedness.
- Early mammals, like Morganucodon, were small, mouse-sized creatures that diversified during the Jurassic and Cretaceous periods.
- **Reptilian Ancestry:**

Mammals are descendants of reptiles, specifically a group of synapsid reptiles called therapsids. These therapsids are distinct from other reptiles due to a single skull opening behind the eye socket, a feature that distinguishes them as synapsids.

- **Evolutionary Steps:**

The transition from reptile-like synapsids to mammals involved several key evolutionary changes:

- **Specialized Dentition:** Reptiles have polyphyodont teeth (many sets of teeth throughout life). Mammals evolved diphyodont teeth (two sets: milk teeth and permanent teeth).
- **Leg Position:** Mammals developed legs positioned under their bodies, unlike the sprawling legs of reptiles.
- **Increased Brain Size:** Early mammals had larger heads, suggesting a larger brain size.

- **Warm-Bloodedness:** Mammals evolved a high metabolic rate and the ability to maintain a constant body temperature (endothermy).
- **Hair:** The development of hair is a key characteristic of mammals.
- **Early Mammals:**

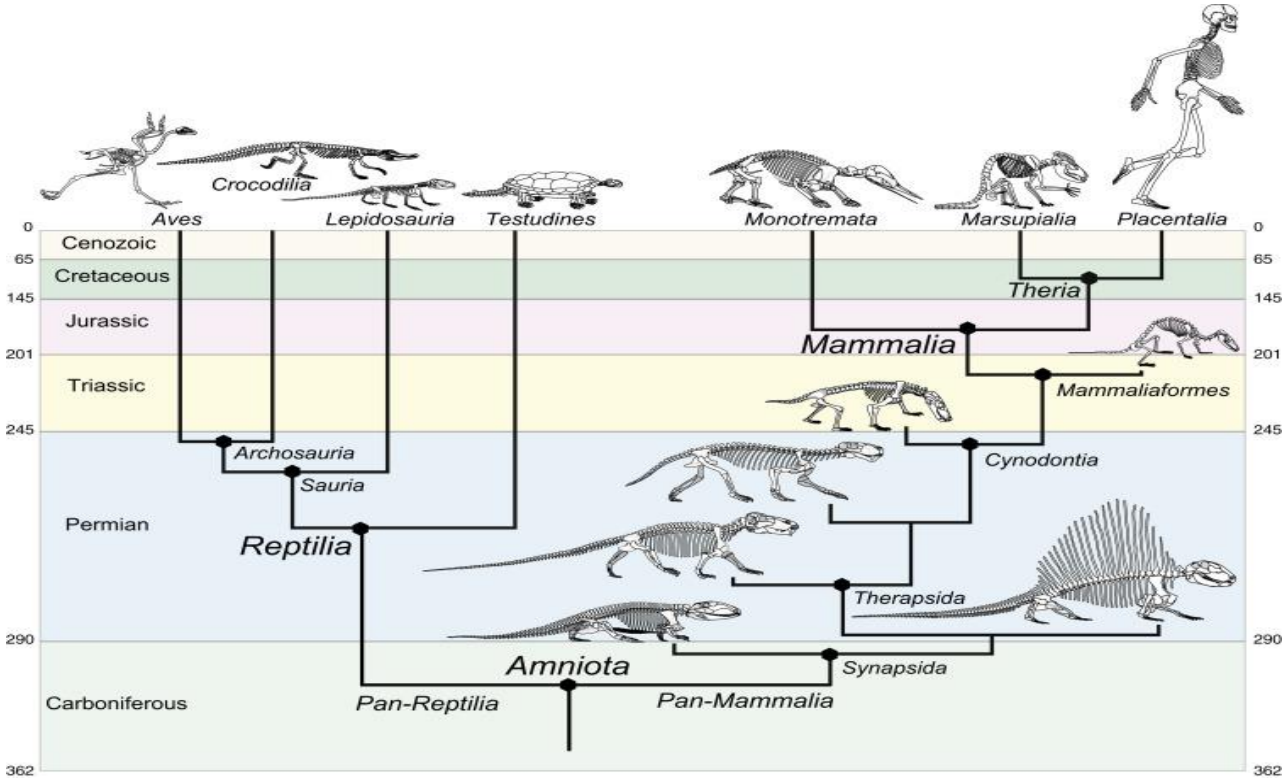
  The first true mammals, like Morganucodon, were small, likely mouse-sized, and appeared during the Late Triassic. These early mammals were part of groups like docodonts, triconodonts, symmetrodonts, pantotheres, and multituberculates.

- **Dominance in the Cenozoic:**

  Modern mammal groups, including those we see today, diversified and became dominant during the Cenozoic era.

- **The Reptile-Mammal Transition:**

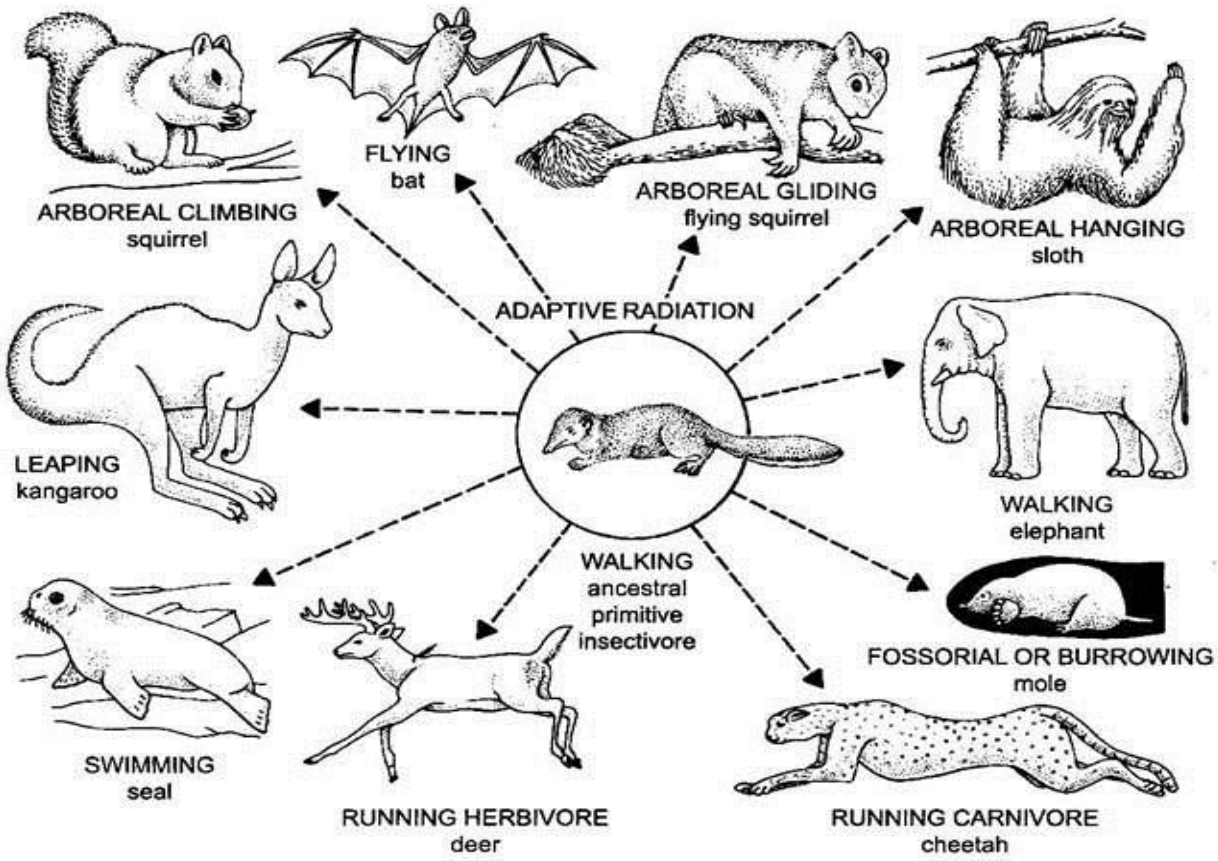
  The transition from reptiles to mammals is a fascinating area of study in paleontology. Researchers are still investigating the details of this transition, including the specific changes in skeletal structure, physiology, and behavior.



ADAPTIVE RADIATION:

- During Mesozoic Era. the age of reptiles (dinosaurs), mammals were small, generalized and rare. By the end of Mesozoic or beginning of Coenozoic, the dinosaurs vanished and the mammals suddenly expanded into varied evolutionary patterns.
- Early in Cretaceous period, placental mammals became distinct from marsupials. During Eocene and Oligocene, most of the orders of mammals originated moving into habitats and ecological niches vacated by the extinct dinosaurs.
    - This evolution from a single ancestral species to a variety of forms which occupy different habitats is called *adaptive radiation* or *divergent evolution.*
    - The concept of adaptive radiation in evolution was developed by H.F. Osborn in 1898. Examples often cited as evidence include Darwin's finches of the Galapagos Islands, varied limb structure of mammals, Australian marsupials, etc.
    - The primitive common ancestor was a land animal, like modern shrews, with short 5-toed plantigrade limbs with no particular specialization. From this stem mammal, various modern types have evolved by the modification of limbs and other structures adapted to a wide variety of habitats.
    - The five basic patterns of locomotion are running (cursorial), burrowing (fossorial), tree-climbing (arboreal), flying, and swimming. Their other modifications are walking, leaping, graviportal, hanging, gliding, amphibious,

etc.



Structural peculiarities and phylogenetic relations of Prototheria-

The subclass *Prototheria* includes primitive egg-laying mammals belonging to a single order, *Monotremata* or *Ornithodelphia.* They stand at the base of the mammalian stock and present many features in common with the *Sauropsida* (reptiles + birds).

Distinctive Characters

1. Distribution- Restricted wholly to the Australian region including Australia, Tasmania, New Guinea and sundry neighbouring islands.

2. Habits and habitat- Aquatic or terrestrial, burrowing, mainly insectivorous, nocturnal, air-breathing, incompletely warm-blooded, quadrupedal, oviparous or egg-laying mammals.

3. External features- Body small and covered by hairs and spines. Muzzle or snout produced into a beak. External ears inconspicuous or absent. Tail present or absent. Mammary glands are without teats or nipples. Male carries a hollow, horny, tarsal

spur on each hindleg, connected internally to a crural poison gland. A temporary mammary pouch, equivalent to teats, develops during breeding season on the abdomen of female.

4. Exoskeleton- Includes epidermal horny hairs, spines, beaks and claws. Skin glandular.

5. Body cavity- Divided by a typical mammalian diaphragm into an anterior thoracic and a posterior abdominal cavity.

6. Endoskeleton- Skull dicondylic. Skull sutures become obliterated. Orbits continuous with temporal fossae. Lacrimals and alisphenoids absent, but distinct pterygoids present. Tympanic ring-like and no tympanic auditory bulla formed. Ear ossicles three. Malleus and incus relatively large. Each half of mandible made by a single bone, the dentary. Mandibular symphysis weak and coronoid process small. Vertebral epiphyses indistinct or absent. Cervical vertebrae 7 and without zygapophyses. Ribs unicephalous, with only capitulum. Coracoids well developed. Spine of scapula present at its anterior border. A large T-shaped interclavicle similar to that of reptiles, present. Ischia and pubes fuse at a long ventral symphysis. A pair of small rod-like epipubic or marsupial bones present in ventral abdominal wall.

7. Digestive system- Teeth develop only in embryos, replaced by horny beak in adults. Rectum opens into a cloaca.

8. Respiratory system- Respiration pulmonary, by lungs.

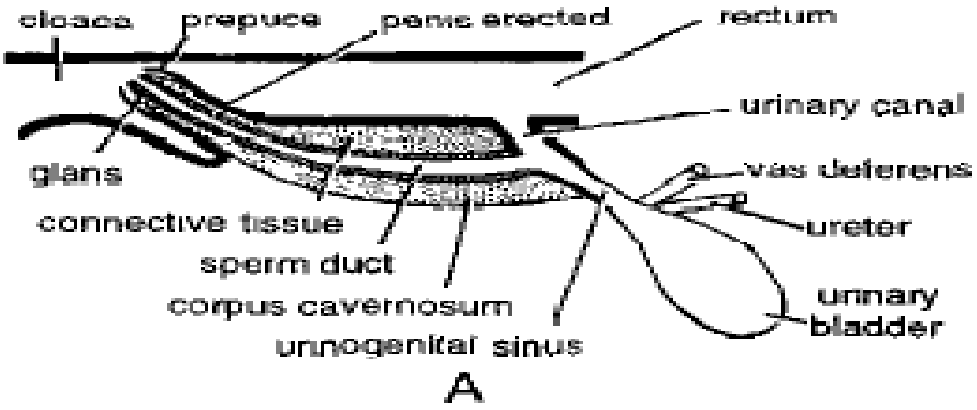
9. Circulatory system- Heart 4-chambered. Right auriculoventricular valve incomplete and fleshy. Right valve tricuspid, not bicuspid as in other mammals. Chordae tendineae absent. Single left aortic arch persists. Ventral abdominal vein or its mesentery present. R.B.C. small, circular and non-nucleated. Body temperature variable (25°-28°C).

10. Excretory system- Kidneys metanephric. Ureters open into a urinogenital sinus which terminates into common cloaca.

11. Nervous system- Brain relatively small, simple and without corpus callosum. Optic lobes four (corpora quadrigemina). Cochlea slightly bent and with a lagena.

12. Reproductive system- In male, testes abdominal and penis retractile passing out sperms but not urine. In female, right ovary reduced and oviducts lead separately into cloaca. There are no uterus and vagina.

13. Development- Females oviparous. Eggs large with much yolk and plastic shells. Cleavage meroblastic. No uterine gestation. Newly hatched young very immature, fed on milk in abdominal pouch till fully developed



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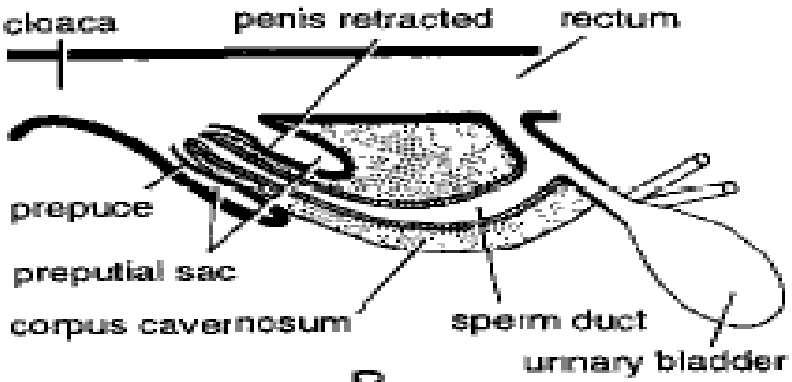

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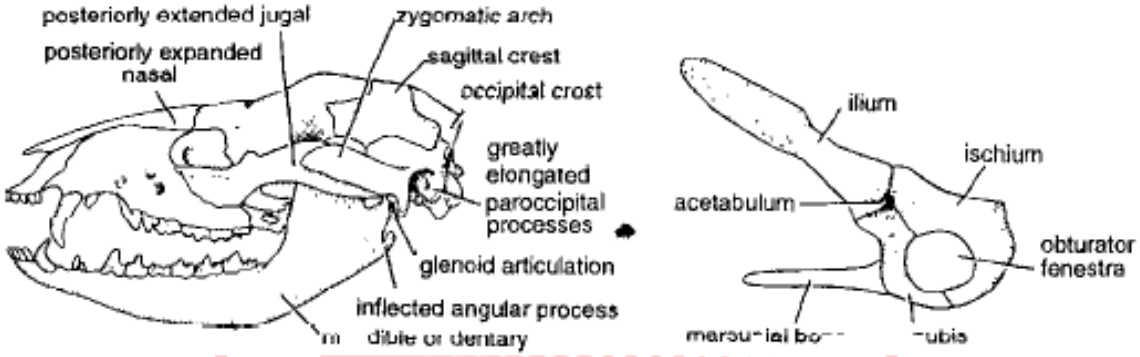
Structural peculiarities and phylogenetic relations of Metatheria

- Female Metatherians are provided with an integumentary pouch in the abdominal region. This pouch is called marsupium and for this reason these are called marsupials.
- These are primitive mammals in which youngs are born in an immature condition and undergo further development in the marsupium of the female.

Their mammary glands open in the **marsupium** by teats. These lack allantoic placenta.

- **GEOGRAPHICAL DISTRIBUTION**- Marsupials evolved completely during cretaceous period and enjoyed cosmopolitan distribution. But, presently they found mainly in Australia (except New Zealand), South America and in North America (only with a few species).
- Kangaroos, wombats, phalangers, koalas etc. are found in Australia. Thylacinus and Sarchophilus are found in Tasmania. South America is home for Cocholestes, Orolisters and Rhyncholisters. The best known North American member is Didelphis viginiana (opossum).
- Cenozoic era witnessed an enormous increase in number of placentals, so marsupials has to face competition with them. Unlikely they failed in competition and consequently become exterminated from many parts of world.
- **HABIT AND HABITAT-** Marsupials differ greatly among themselves in feeding and other habits. These may be diurnal or nocturnal, most of them are terrestrial, burrowing or arboreal, while aquatic forms are rare. These may be exclusively herbivorous (Kangaroos) or exclusively carnivorous (Thylacinus and Dasyures) or omnivorous.
- **EXTERNAL FEATURES** - Soft furs cover the body. Pinnae are well developed. Females have marsupium supported by two epipubic or marsupial bones (absent in Didelphis). Mammary glands open into marsupium by teats. Tail is well developed which help in balancing.
- The second and third toes of hind limbs are slender and remain enclosed in a sheath of skin. These two together are known as syndactylus digits which form a sort of two pronged comb. The fourth toe is largest. All digits end in claws. Hind limbs are longer than limbs.
- **ENDOSKELETON -** Dicondylic skull bears distinct sutures. Jugal participates in the formation of glenoid fossa. Tympanic bulla is partly formed by alisphenoid and is incompletely united with skull. Orbital and temporal fossae are continuous. Mandible is formed of a single dentary zygomatic arch is complete.

- Pterygoid is small. Palate is fenestrated. Dentition is thecodont, heterodont and monophyodont. Vertebrae with epiphysis. Vertebral column is divisible into five regions (cervical- 7, thoracic-13 with ribs, lumber- 7 devoid of ribs). Caudal vertebrae are with 'chevron bone' except in koala and wombat.
- Atlas is incomplete and is provided with cartilage in the ventral incomplete side. In pectoral girdle interclavicle is absent but a clavicle is present. The scapula is large and is provided with a spine, but the coracoid is reduced. In pelvic girdle, epipubic bones are present, projecting forward from the pubis, but is not homologous to reptilian epipubic bone.



DIGESTIVE SYSTEM - In kangaroos, the stomach is enlarged and sacculated. A gall bladder is always present. A large caecum is found in herbivores forms, sometines with a vermiform appendix. Caecum is absent in carnivorous forms.

CIRCULATORY SYSTEM - The fossa ovalis is absent in auricular septum. Each superior venacava receives an azygous vein. Auriculo-ventricular valves are membranous and remain attached by chordae tendineae to the papillary muscles.

NERVOUS SYSTEM - Brain is small with little convolutions. Corpus callosum is absent or poorly developed. Cochlea of internal ear is spirally coiled. 8.

URINOGENITAL SYSTEM - Kidneys are metanephric. Ureters run between genital ducts in both sexes. In male testes are extra-abdominal and lie in scrotal sacs in front of penis. The glans penis is often bifurcated. Vesicular seminalis is absent. The opening of the urinogenital canal and anus are enclosed by a common sphincter muscle. In female, two oviducts open

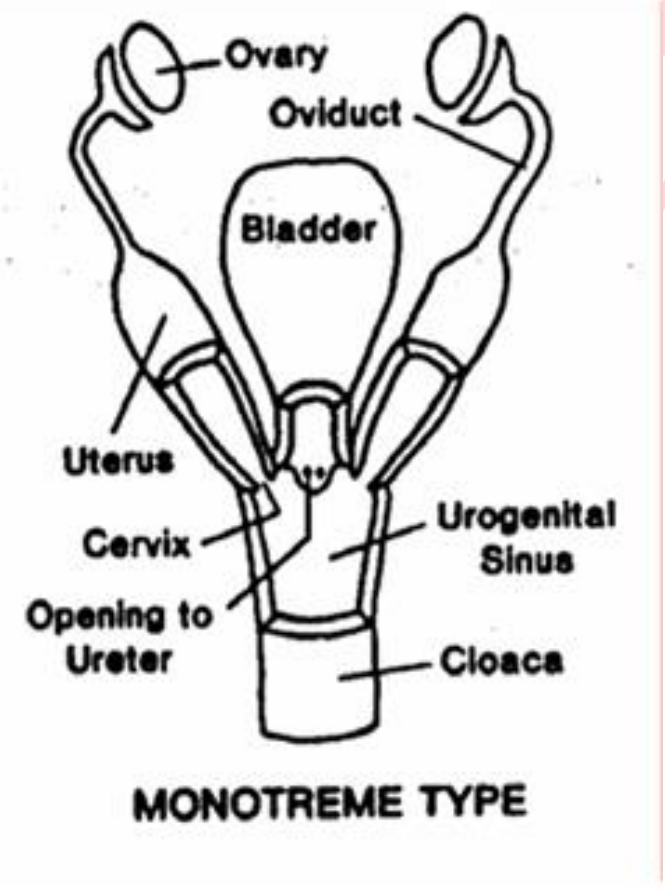
separately into urinogenital sinus hence there are two uteri and two vaginae.

DEVELOPMENT - Females are viviparous, give birth to immature youngs which are kept in marsupium where the embryos remain attached to the nipples of the mother. Gestation period is very short. Yolk sac placenta is common in all. But an allantoic placenta is formed in Parameles.

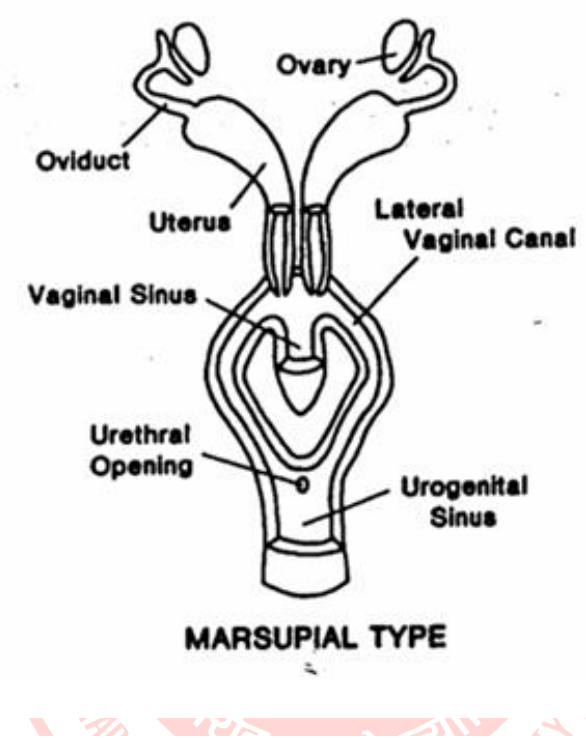
Phylogenetic consideration – Comparative study of organization of marsupial and placental mammals reveals that marsupial are "Ilnd grade mammals" and often regarded by zoologists as transitional step in the evolution of mammals and coenozoic placentals. But now it is believed that placental mammals and marsupials evolved independently from some common panthotherian ancestor in late Jurassic period side by side

Uterus Modification in Mammals:

The reproductive tract of a female monotreme



The reproductive tract of a female marsupial- The lateral vaginal canals receive the bifurcated penis of the male. The vaginal sinus opens and connects with the urogenital sinus to serve as a passageway for delivery of the young. Notice that the uteri are separate, the vaginae are paired, and that the urethral opening is separate from the urogenital opening.



- Uterus modification in mammals refers to the varied structures of the uterus across different species, ranging from the **duplex uterus** (two separate uteri, like in rabbits) to the simplex uterus (a single, fused organ, like in humans).
- These modifications, such as the development of caruncles in ruminants or the differences in uterine horns and cervices, are essential for hosting the developing conceptus and adapting to specific reproductive strategies.
- Mammals exhibit four main types of uterine modifications, classified by the degree of fusion of the Müllerian ducts:
- **Duplex uterus:**

Two entirely separate uteri, each with its own cervix. Found in animals like mice and guinea pigs.

❖ Bipartite uterus:

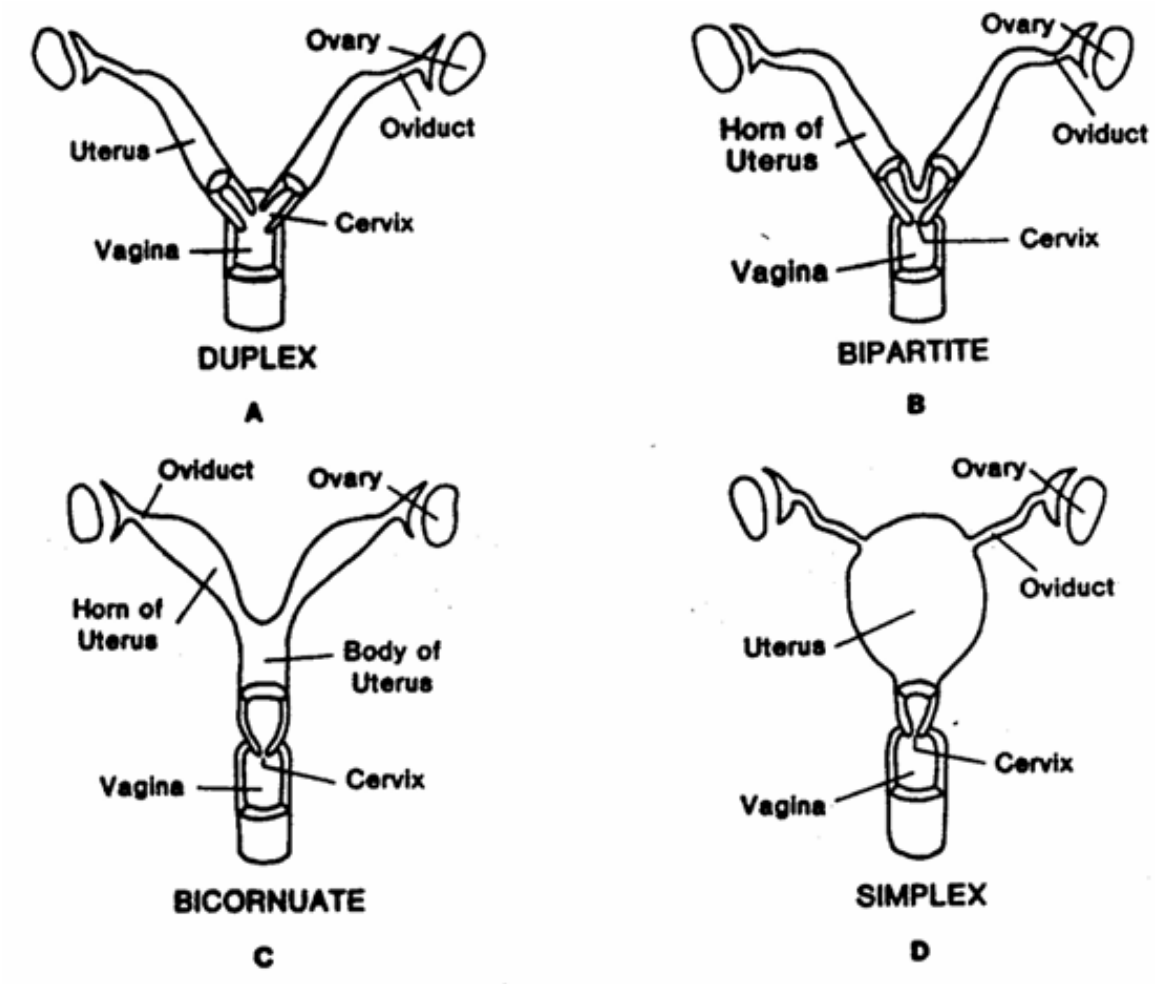
The upper parts of the two uterine horns remain separate, but the lower parts are fused into a single uterine body and cervix. This type is seen in species like cows and cats.

❖ Bicornuate uterus:

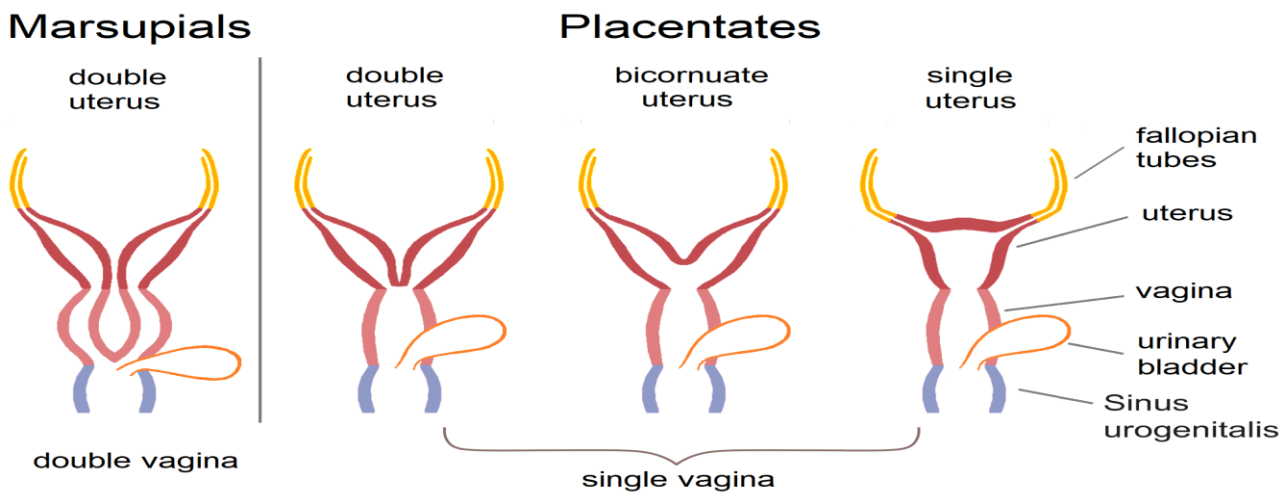
A result of incomplete fusion of the Müllerian ducts, leading to a more distinct body and prominent horns, as seen in pigs and dogs.

❖ Simplex uterus:

A completely fused uterus with a single, large cavity. This is the type found in higher primates, including humans, as well as in horses.



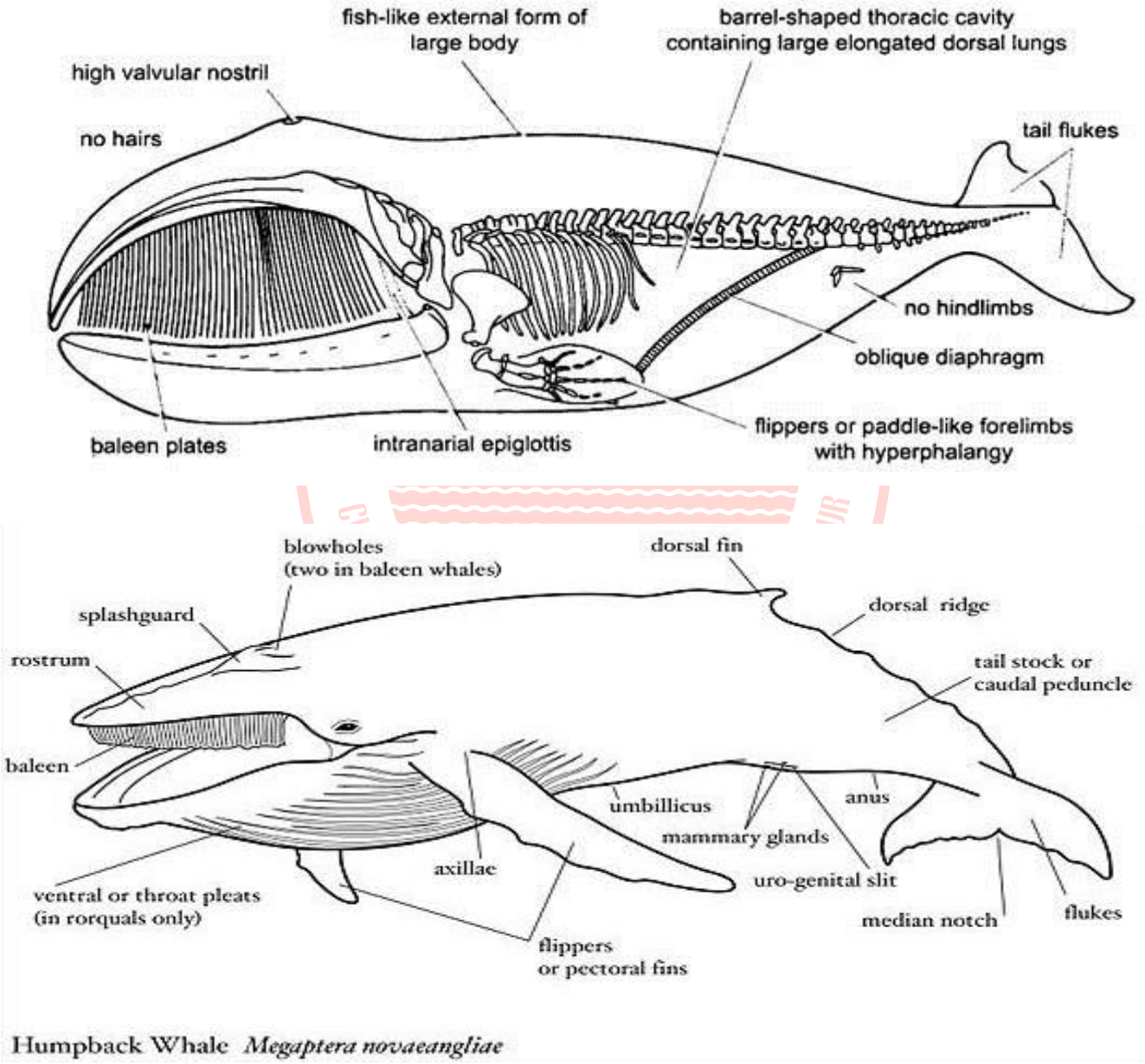
- In the **duplex uterus**, there are 2 uteri and 2 cervixes. The duplex uterus is found in the lagomorphs and rodents.
- In the **bipartite uterus**, there are 2 uteri and 1 cervix. The bipartite uterus is found in the cetaceans and carnivores.
- In the **bicornuate uterus**, the uterine horns are Y-shaped, being separated medially but fused distally, where they form a common chamber, the body, which opens into the vagina through a single cervix.
- The bicornuate uterus is found in insectivores, some bats, perissodactyls, and artiodactyls.
- In the **simplex uterus**, all separation between the uterine horns is lacking, and the single uterus opens into the vagina through one cervix. The simplex uterus is found in primates, some bats, and edentates.



AQUATIC MAMMALS:

- Aquatic mammals belong to several orders and may be put under two categories depending on their degree for aquatic adaptation.
- **Amphibious mammals-** These mammals do not live permanently in water. They live on land but go into water for food and shelter. They show only partial aquatic adaptations such as (i) small external ears, (ii) webbed feet, (iii) flattened tails, (iv) subcutaneous fat, etc.

- **Examples** are minks, seals, otters and walrus (Carnivora), beavers (Rodentia), hippopotamus (Artiodactyla), *Chironectes* (Marsupialia), *Ornithorhynchus* (Monotremata), etc.
- **Completely aquatic mammals.** Members of two orders, Cetacea (whales, dolphins and porpoises) and Sirenia, (manatees and dugongs), are essentially aquatic forms. They never come to land and are perfectly at home in water.



Humpback Whale *Megaptera novaeangliae*

- **Aquatic adaptations -** The specializations or adaptations of truly aquatic mammals (Cetacea and Sirenia) fall into 3 major categories : (i) modifications of

original structures, (ii) loss of structures and (iii) development of new structures.

Modifications of original structures-

- **Body shape-** Body shape is of primary importance in aquatic animals. The external fish-like form, elongated head, indistinct neck and tapering streamlined body offers little resistance and swims rapidly through water.
- **Large size and weight-** Whalebone whale may grow upto 35 metres in length and weigh about 150 tons. Large size reduces skin friction and heat loss, but creates no problem for support in water due to buoyancy.
- **Flippers-** Forelimbs are transformed into skin-covered, unjointed paddles or flippers, having no separate indication of fingers. They can move as a whole only at the shoulder joint. The broad and flattened flippers serve as balancers and provide stability during swimming.
- **Hyperdactyly and hyperphalangy-** Extra digits (hyperdactyly) and extra phalanges (hyperphalangy), upto 14 or more in some cases, serve to enlarge the surface area of flippers for greater utility for swimming in water.
- **High and valvular nostrils-** Nostrils are placed far back on top of head so that animal can breathe air without raising head much out of water. Nostrils can also be closed by valves during diving under water.
- **Mammary ducts-** During lactation, ducts of mammary glands dilate to form large reservoirs of milk, which is pumped directly into mouth of young by the action of a special compressor muscle. This arrangement facilitates suckling of young under water.
- **Oblique diaphragm-** Oblique diaphragm makes thoracic cavity larger, dorsal and barrel shaped, providing more space to lungs for expansion.
- **Large lungs-** Large unlobulated and highly elastic lungs ensure taking down maximum air before submergence. Like swim bladders of fishes, the dorsal lungs also serve as hydrostatic organs in maintaining a horizontal posture during swimming.

- **Intra-narial epiglottis-** Elongated, tubular and intranarial epiglottis, when embraced by the soft palate, provides a continuous and separate air passage, thus allowing breathing and feeding simultaneously.
- **Endoskeleton**- Cranium becomes small but wider to accommodate the short and wide brain. Facial part of skull projects forming elongated snout or rostrum (porpoise). Zygomatic arches are reduced. Cervical vertebrae are fused into a solid bony mass because of reduced neck. Zygapophyses are reduced. Sacrum is also reduced. Ribs become arched dorsally to increase thoracic cavity. Bones are light, spongy and in Cetacea, filled with oil.
- **Teeth-** In toothed whales, teeth are monophyodont, homodont and numerous, as many as 250. This helps in seizing prey, prevent its escape and swallowing it without mastication. Usually, the mobility of jaws is reduced as they have no function in mastication.

Loss of structures-

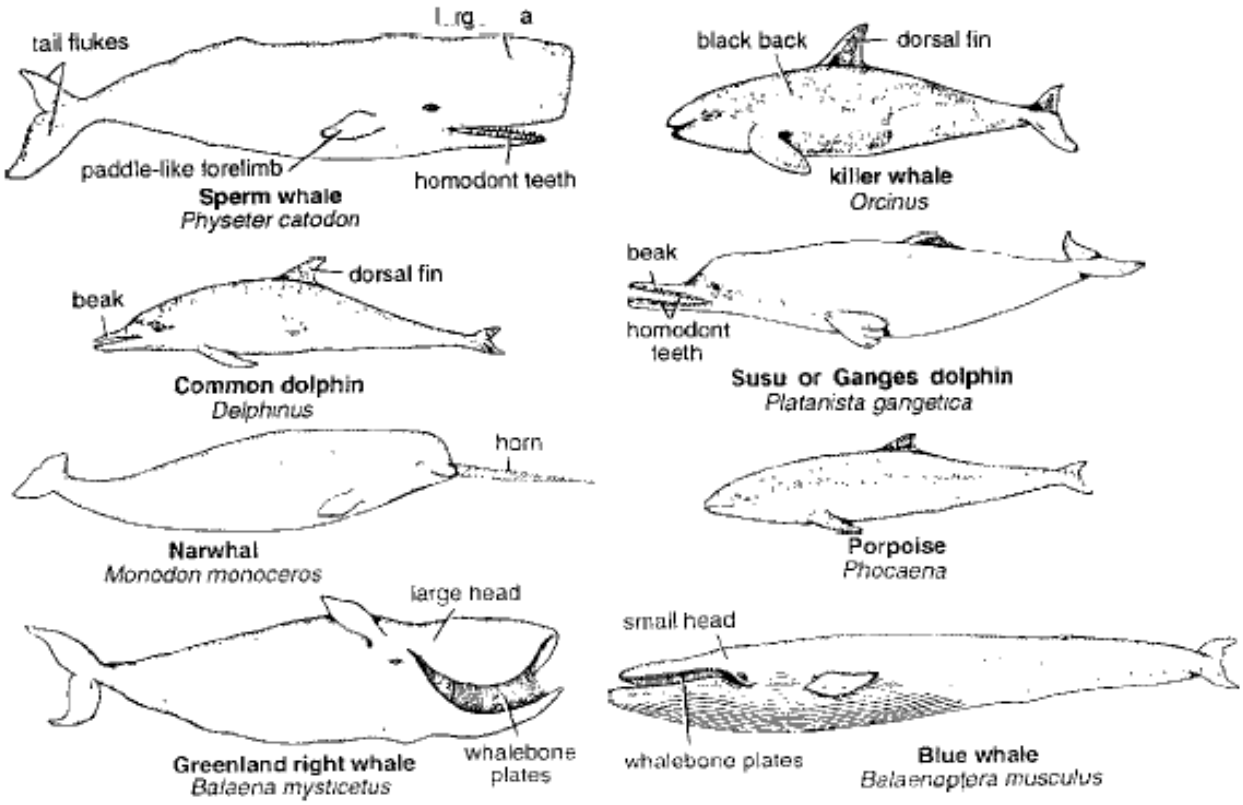
- Skin surface usually remains smooth and glistening due to loss of hairs except for few sensory bristles on snout or lips in some cases.
- Pinnae are also absent. Presence of hairs and pinnae may impede or obstruct the even flow of water over body surface and interfere with the speed and elegance of movement through water.
- Eye cleansing nictitating membranes, lacrimal glands and all kinds of skin glands (sweat and sebaceous) are also absent because they would have been useless under water. Due to thickening and immobility, skin loses its muscles and nerves.
- Hind limbs are represented only by button-like knobs in the foetus but disappear in the adult. Pelvis is also rudimentary. Fingernails are absent except for traces in foetus.
- Scrotal sacs are also absent and testes remain inside abdomen.

Development of new structures

- **Tail flukes**- Tail develops large, lateral or horizontal expansions of skin called *flukes.* These are not supported by fin rays. Their up and down strokes not only

propel the body through water but enable rapid return to the surface for breathing after prolonged submersion.

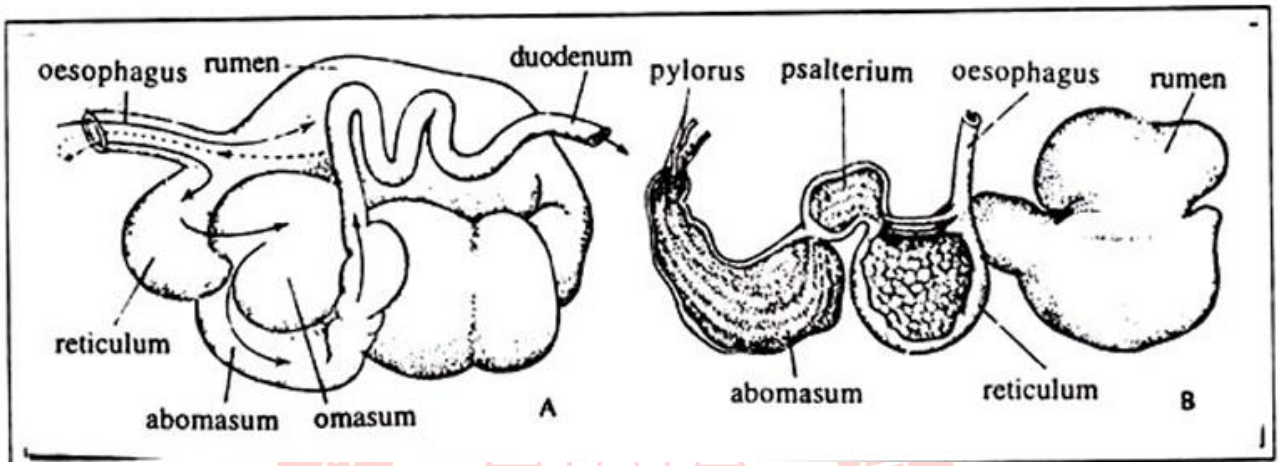
- **Dorsal fin-** Most Cetacea develop an unpaired adipose dorsal fin without internal skeletal support. It serves as a rudder or keel during swimming.
- **Baleen-** In whalebone whales, teeth are absent. Instead, the upper jaw carries two transverse rows of numerous triangular fringed horny plates of *baleen* or *whalebone.* These serve as an effective sieve for straining plankton (mostly krill) which forms their chief food.
- **Foam-** Each middle ear cavity sends an inner pneumatic prolongation, which meets with the fellow on the other side below the skull. These extensions contain foam which is a fine emulsion of fat, mucus and gas. It probably serves to insulate sound and improves audition or hearing under water.
- **Melon-** It is a receptor present in front of nostrils. It consists of a fatty mass traversed by muscle fibres. It possibly serves to detect pressure changes in water.
- **Harderian glands**. Eyes under water remain protected by a special fatty secretion of harderian glands.
- **Blubber-** Blubber is the thick subcutaneous layer of fat, which compensates for the lack of hairy covering. Acting as heat insulator, it not only retains the warmth of the body but also provides a ready reservoir of food and water during emergency. The fat also reduces the specific gravity of the animal, thus imparting buoyancy. Blubber also provides an elastic covering to allow changes in body volume during deep diving and also counteracts the hydrostatic pressure.



Stomach of Ruminating Mammals:

- It is very complex. The stomach is constituted of 4 separate chambers. They are rumen (= paunch), reticulum or honeycomb, omasum (= psalte rium or many plies) and abomasum (= reed)
- **Ruminant:** A group of placental mammals with a rumen, a specialised extensive digestive tract that processes plant material.
- Origin: The first three chambers — rumen, reticulum and omasum arise from the oesophagus and only the fourth chamber, the abomasum is the actual derivative of the stomach.
- **Rumen:** Rumen is the first and the largest chamber of the stomach. It is also called paunch. It has low muscular folds and mucus membrane is beset with numerous short villi. The internal lining is non-glandular and contains stratified epithelium.

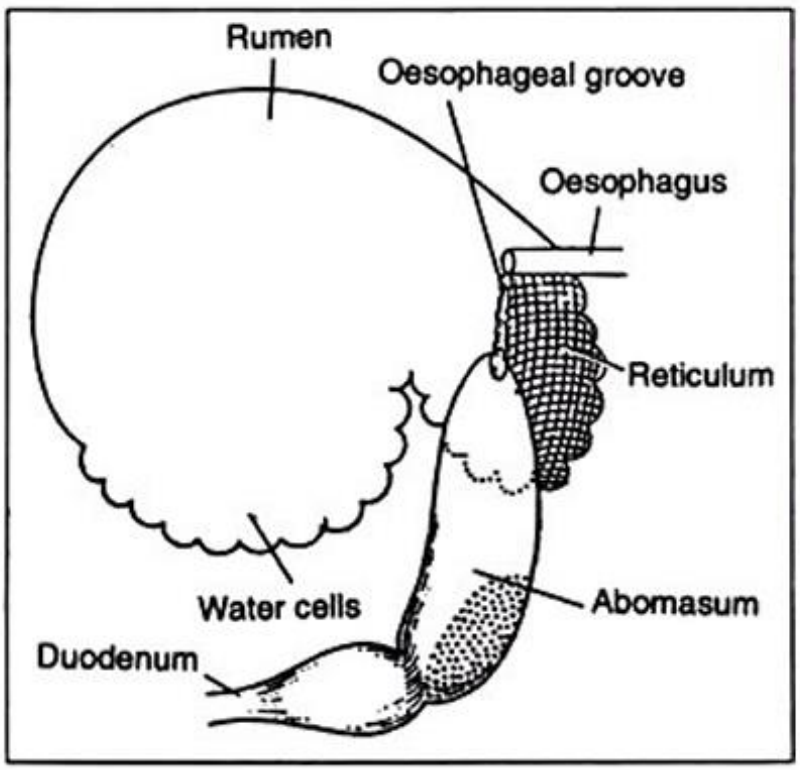
- E. M. structure of rumen epithelium consists of basement membrane between the epithelial and connective tissues.
- **Reticulum or Honey comb**: The chamber is much smaller than the first. Its mucous membrane has raised up into a number of anastomosing ridges, hence the name reticulum, also called honey comb because its walls are with a honey combed texture



- **Omasum or Psalterium**: The muscular ridges occur as overlapping leaves, hence the name resemble a book such as the psalter or book of psalms used in religious service. Omasum is lined by a stratified epithelium whose thin layer is keratinized.
- **Abdomasum or reed or true stomach or rennet:** The chamber is smaller than the rumen but larger than the reticulum. It possesses a smooth vascular and glandular mucous membrane with peptic glands. This chamber is the true stomach for its nature.
- Process of rumination: Rumination is the re-mastication of plant material together with microbial fermentation in ruminants. The rumen serves mainly as storage organ. The cattle feed fairly rapidly and fills the rumen with grain, grass and other herbage.
- The food within the rumen is churned by muscular contraction and undergoes certain bacterial fermentation during its stay in the rumen. Food from the rumen passes by degrees into the reticulum or directly to the oesophagus and hence to the mouth by a process of retro-peristalsis. Such food regurgitated into the mouth is called cud or bolus. When the cud is well masticated and

thoroughly mixed with the secretion of the salivary glands, it again passes into the rumen.

- A new bolus is again formed and chewed and sent back to the rumen. The process is repeated several times and when all the food is well-masticated it passes to the reticulum and then to the omasum and abomasum.
- The abomasum is provided with gastric glands. This chamber secretes a highly acidic, gastric juice whose pH is 1.05 to 1.32 and kills the microorganisms and initiates the process of digestion.
- **Camel's Stomach:** The true ruminant stomachs occur under the suborder Ruminantia. The Camel's stomach is different in anatomy and histology with the stomach of ruminants, but their rumination and fermentation are the same like the true ruminants.
- In camels the stomach is three-chambered, the omasum being absent. The rumen and reticulum parts of the stomach of camels are provided with pouch-like water cells. Their openings are guarded by sphincter muscles. At one time it was believed that the camels store water in their water cells and make prolonged journey without drinking water.
- The pouches can by no means hold as much water as would be required by the animal on a prolonged journey through the desert where no water is available.
- Later studies have shown that the camels get their water requirement



during journey by the breaking down of the glycogen of the muscles and fat of the hump.

- Physiologists have shown that for each 100 gm. of fat oxidised in the body 110 gm. of water is formed. They also have shown that the water cells do contain some metabolic water.
- The water is pure in nature and helps in moistening the food. The stomach of whales and hippopotamus is divided into several chambers.

MCQ based on Unit IV:

Q. 1. The dental formula of sub order Lemuroidea is :

a. 2133 /2133

b. 2123 /2023

c. 2133/ 1133

d. 2123 /2023

Ans. a

Q 2. Largest mammalian suborder :

a. Logomorpha

b. Rodentia

c. Cetacea

d. Sirenia

Ans. b

Q. 3. Largest living land animals are included in the suborder :

a. Perissodactyla

b. Artiodactyla

c. Proboscidea

d. Hyracoidea

Ans. c

Q 4. In mammals hind limbs arc absent in .

a. Cetaceans

b. Rodents

c. Marsupials

d. Chiropterans

Ans. a

Q. 5. Teeth in mammals are :

a. Thecodont, homodont, diphyodont

b. Thecodont, hetrodont, diphyodont

c. Acrodont, homodont, monophyodont

d. Acrodont, homodont, polyphyodont

Ans. b

Q. 6. Monotremates are confined to :

a. Oriental region

b. Ethiopian region

c. Australian region

d. Neotropical region

Ans. c

Q. 7. Marsupium is present in :

a. Monotremes

b. Insectivores

c. Chiropterans

d. Marsupialia

Ans. d

Q. 8. Spiny anteaters are included in the family :

a. Tachyglossidae

b. Ornithorhynchidae

c. Didelphidae

d. Notorvctidae

Ans. a

Q. 9. Which of the following is a Reptilian affinity of monotremes ?

a. Body covered with hair

b. T-shaped interclavicle

c. Pinnae present

d. Dicondylic skull

Ans. b

Q. 10. Typical prototherian character is :

a. Presence of cloaca

b. 4 chambered heart

c. Tarsal spur in males

d. Segmented sternum

Ans. c

Q. 11. Metatherian teeth are more than :

a. 32

b. 36

c. 40

d. 44

Ans. d

Q. 12. Marsupial with true alantoic placenta

a. Bandicoots

b. Opossum

c. Kangaroo

d. Petaurus

Ans. a

Q. 13. Marsupials present in America :

a. Opossom

b. Wombat

c. Kangaroo

d. Bandicoots

Ans. a

Q. 14. Milk dentition in mammals lack :

a. Molars

b. Premolars

c. Canines

d. Incisors

Ans. a

Q. 15. First teeth on maxillae :

a. Lower canines

b. Upper canines

c. Upper molars

d. Lower premolars

Ans. b

Q. 16. Baleen is present in :

a. Lizards

b. Frogs

c. Whales

d. Elephants

Ans. c

Q. 17. Pubis is separated from ischium by a foramen :

a. Foramen magnum

b. Foramen ovale

c. Obturator foramen

d. Pubic symphysis

Ans. c

Q. 18. Deltoid ridge is found in :

a. Humerus of frog

b. Humerus of rabbit

c. Femur of frog

d. Femur of rabbit

Ans. b

Q. 19. Olecranon process is formed by :

a. Proximal end of ulna

b. Distal end of ulna

c. Proximal end of radius

d. Distal end of radius

Ans. a

Q. 20. Longest bone in the body of rabbit is :

a. Humerus

b. Femur

c. Tibia

d. Ulna

Ans. b

Q. 21. Shortest bone in the body of rabbit is :

(a) Tibia

(b) Ulna

(c) Stapes

(d) Fibula

Ans. c

Q. 22. The two halves of the pelvic girdle of rabbit is united mid-ventrally at :

a. Ilium

b. Cotyloid bone

c. Pubic symphysis

d. Acetabulum

Ans. c

Q. 23. Signet ring like cervical vertebra of rabbit is :

a. First cervical vertebra (atlas)

b. Second cervical vertebra (axis)

c. First cervical vertebra (axis)

d. Second cervical vertebra (atlas)

Ans. a

Q. 24. The vertebrae of rabbit is :

a. Amphicoelous

b. Acoelous

c. Procoelous

d. Heterocoelous

Ans. b

Q. 25. Last sternebra is known as :

a. Xiphisternum

b. Manubrium

c. Capitulum

d. Tuberculum

Ans. a

Q. 26. Structure present in pectoral girdle which receives the head of the humerus :

a. Glenoid cavity

b. Coracoid process

c. Metacromian process

d. Suprascapula

Ans. a

Q 27. Toothless gap present in the jaws of rabbit is :

a. Dentary

b. Diastema

c. Thecodont

d. Maxillae

Ans. b

Q 28. Vomer and turbinals are parts of :

a. Auditory capsule

b. Olfactory capsules

c. Orbits

d. Ossicles

Ans. b

Q 29. Ear ossicles in the correct order of their appearance in the tympanic cavity :

a. Malleus, incus, stapes

b. Incus, stapes, malleus

c. Stapes, incus, malleus

d. Malleus, stapes, incus

Ans. a

Q. 30. Zygomatic arch is made up of :

a Maxilla, squamosal and jugal

b. Pterygoid, squamosal and jugal

c. Maxilla, palatine and jugal

d. Maxilla, palatine, pterygoid

Ans. a

Q. 31. Half of the jaw is known as :

a. Ramus

b. Os-innominatum

c. Ceratohyal

d. Hyoid

Ans. a

Q. 32. The skull of rabbit is :

a. Dicondylic

b. Tripobasic

c. Both a and b

d. None

Ans. c

Q. 33. The jaw suspensorium in rabbit is :

a. Craniostylic

b. Autostylic

c. Platibasic

d. All of the above

Ans. a

Q. 34. The floor of the brain-box is made by :

a. Supra-occipital

b. Basi-occipital

c. Exoccipital

d. Paroccipital process

Ans. b

Q. 35. A deep notch present posteriorly in alisphenoid :

a. Foramen magnum

b. Foramen ovale

c. Foramen lacerum anterious

d. Pituitary foramen

Ans. b

Q. 36. Lower jaw of rabbit is made up of :

a. Dentary only

b. Premaxillae, Maxillae and Dentaries

c. Premaxillae only

d. Maxillae only

Ans. a

Q. 37. In rabbit morula develops into fluid filled ball called :

a. Coeloblastula

b. Trophoblastula

c. Blastocyst

d. Gastrula

Ans. c

Q. 38. Cells of Rauber are found in :

a. Amphioxus

b. Frog

c. Chick

d. Rabbit

Ans. d

Q. 39. Yolk sac placenta where yolk sac wall is intimately connected to uterine wall is found in :

a. Rabbit

b. Opossum

c. Man

d. Rat

Ans. b

Q. 40. Chorio-allantois in case of mammals performs following functions:

a. Respiration

b. Excretion

c. Nutrition

d. All these

Ans. d

Q. 41. The egg of mammals are :

a. Alecithal

b. Mesolecithal

c. Telolecithal

d. Isolecithal

Ans. a

Q. 42. The cleavage in mammals is :

a. Holoblastic equal

b. Holoblastic unequal

c. Meroblastic

d. Apiblastic

Ans. c

Q. 43. The chorion is composed of :

a. Cytotrophoderm

b. Syncytial trophoblast

c. Ectoderm and mesoderm

d. All these

Ans. c

Q. 44. The cells destined to become the embryo proper in mammal constitute the :

a. Trophoblast

b. Cells of Rauber

c. Inner cell mass

d. Cellular capsule

Ans. a

Q. 45. The acrosome of the sperm in mammals produces an enzyme :

a. Androgammone

b. Gynogammone

c. Hyaluronidase

d. Acrozin

Ans. c

Q. 46. Haemochorial placenta is found in :

a. Man and monkeys

b. Lion and tiger

c. Cat and camel

d. Giraffe and horse

Ans. a

Q. 47. Eutherian mammals are

a. Oviparous

c. Ovoviviparous

c. Viviparous

d. None of the above

Ans. c

Q. 48. Attachment of developing embryo to the wall of uterus :

a. Implantation

b. Ovulation

c. Placentation

d. Orientation

Ans. a

Q. 49. Yolk sac placenta is derived from :

a. Allantois

b. Yolk sac and chorion

c. Chorion

d. Yolk sac and allantois

Ans. b

Q. 50. In chorionic placenta, allantois is limited to :

a. Chorionic villi

b. Uterine wall

c. Umbilical cord

d. Yolk sac

Ans. c

Q. 51. In pig, the placenta is :

a. Cotyledonary non deciduous

b. Diffuse non deciduous

c. Intermediate non deciduous

d. Deciduous

Ans. b

Q. 52. Syndesmochorial placenta lacks :

a. Chorionic epithelium

b. Uterine connective tissue

c. Uterine epithelium

d. Chorionic + Allantoic mesoderm

Ans. c

Q. 53. All six barrier tissues are present in :

a. Endothelio-chorial placenta

b. Haemochorial placenta

c. Epithelio-chorial

d. Haemoendothelial

Ans. c

Q. 54. Hormone secreted from the placenta at the time of parturition :

a. Progesterone

b. Estradiol

c. Relaxin

d. Lactogen

Ans. c

Q. 55. Functions of placenta include :

a. Exchange of substances between mother and foetus

b. Ultrafilter

c. Endocrine gland

d. All of the above

Ans. d

Q. 56. Viral or bacterial infection of placenta is known as :

a. Syphilis

b. Placentitis

c. Dermatitis

d. Appendicitis

Ans. b

Q. 57. Cotyledonary placenta is found in :

a. Cow and camel

b. Cow and deer

c. Camel and giraffe

d. Pig and horse

Ans. b

Q. 58. Contra-deciduous placenta is characteristic of :

a. Elephant

b. Bandicoot

c. Tiger

d. Cow

Ans. b

Q. 59. The egg laying mammals are :

a. Prototherians

b. Metatherians

c. Eutherians

d. Both prototherians and metatherians

Ans. a

Q. 60. Yolk sac placenta is found in :

a. *Macropus* and *Didelphis*

b. *Rattus rattus*

c. *Perameles*

d. *Talpa*

Ans. a

Q. 61. Yolk sac placenta is derived from :

a. Yolk sac and allantois

b. Yolk sac and chorion

c. Yolk sac and amnion

d. Yolk sac only

Ans. b

Q. 62. The type of placenta found in primates

a. Yolk sac placenta

b. Allantoic placenta

c. Allantochorionic placenta

d. Chorionic placenta

Ans. d

Q. 63. Following is the complete set of placenta of nondeciduous type :

a. Diffuse, cotyledonary, zonaiy

b. Diffuse, discoidal, intermediate

c. Diffuse, cotyledonary, intermediate

d. Diffuse, zonary, discoidal

Ans. c

Q. 64. True vocal cords are absent in :

a. Man

b. Lion

c. Dog

d. Hippopotamus

Ans. d

Q. 65. Fossa ovalis represents :

a. Foramen ovale

b. Musculi pectinati

c. Sinus venosus

d. Auricular appendix

Ans. a

Q. 66. The left auriculo-ventricular valve is known as :

a. Tricuspid valve

b. Mitral valve

c. Semilunar valve

d. Eustachian valve

Ans. b

Q. 67. Veins carrying oxygenated blood:

a. Aorta

b. Coronary veins

c. Pulmonary veins

d. Caval veins

Ans. c

Q. 68. Funnel shaped space towards the concavity of the kidney :

a. Capsule

b. Cortex

c. Medulla

d. Pelvis

Ans. d

Q. 69. Renal columns of Bertini are formed by :

a. Cortex

b. Medulla

c. Pelvis

d. Capsule

Ans. a

Q. 70. The volume of urine is controlled by :

a. Thyroxine

b. ADH

c. Insulin

d. Adrenalin

Ans. b

Q. 71. Involuntary activities of body are controlled by :

a. Cerebrum

b. Cerebellum

c. Pons and Medulla oblongata

d. Spinal cord

Ans. c

Q. 72. Contraction of melanophores is regulated by :

a. Noradrenalin

b. Serotonine

c. Aldosterone

d. Melatonin

Ans. d

Q. 73. Hormone controlling the contraction of uterine muscles at the time of child birth :

a. Oxytocin

b. Vasopressin

c. Prolactin

d. Gonadotropin

Ans. a

Q. 74. Removal of parathyroid glands leads to :

a. Diabetes melitus

b. Tetany

c. Diabetes insipidus

d. Myxoedema

Ans. b

Q. 75. Cells of islets of Langerhans responsible for the secretion of glucagon :

a. Gamma cells

b. T cells

c. Alpha cells

d. Beta cells

Ans. c

Q. 76. Addison's disease results from the under activity of :

a. Thymus

b. Parathyroid

c. Adrenal medulla

d. Adrenal cortex

Ans. d

Q. 77. The burrow of rabbit is called :

a. Warren

b. Form

c. Barren

d. Barrel

Ans. a

Q. 78. The burrow of hare is called :

a. Warren

b. Form

c. Barren

d. Barrel

Ans. b

Q. 79. The external nares in rabbit are surrounded by

a. Hare lip

b. Vibnssae

c. Rhinarium

d. None of these

Ans. c

Q. 80. The perineal pouch bears

a. Anus

b. Vulva

c. Both a and b

d. scent glands

Ans. d

Q. 81. The tail in rabbit serves as :

a. Balancing organ

b. Sensory organ

c. Decorative structure

d. Hearing aid

Ans. a

Q. 82. The glands and keratin structures in rabbit are derived from :

a. Stratum lucidum

b. Stratum germinativum

c. Stratum spinosum

d. Stratum granulosum

Ans. b

Q. 83. The secretion of sebaceous glands is :

a. Sweat

b. Tears

c. Sebum

d. Ear wax

Ans. c

Q. 84. Sweat glands are absent in the skin of :

a. Rabbit

b. Cat

c. Man

d. Rat

Ans. d

Q. 85. Mammary glands are modified :

a. Sebaceous glands

b. Sweat glands

c. Tear glands

d. Meibomian glands

Ans. a

Q. 86. Buccal cavity is divided into nasal and food passage by :

a. Tongue

b. Palate

c. Teeth

d. Vestibule

Ans. b

Q. 87. Dental formula of rabbit is :

a. 2123/ 2103

b. 2033 /2234

c. 2033 / 2103

d. 1033 / 2033

Ans. c

Q. 88. The wide toothless gap due to the absence of canines is :

a. Glottis

b. Epiglottis

c. Cheek

d. Diastema

Ans. d

Q. 89. Mucin is a mixture of :

a. Proteins

b. Fatty acids

c. Lipids

d. Carbohydrates

Ans. a

Q. 90. The duct of infra-orbital salivary glands opens near :

a. Upper incisors

b. Upper molars

c. Angles of mandibles

d. Tongue

Ans. b

Q. 91. Hormone insulin is secreted by :

a. Pancreatic acini

b. Cystic lobe of liver

c. Islets of langerhans

d. Gastric glands

Ans. c

Q. 92. Ptyalin is present in :

a. Gastric juice

b. Saccus entricus

c. Bile juice

d. Saliva

Ans. d

Q. 93. Bilirubin and biliverdin are derived by the disintegration of :

a. Haemoglobin

b. Globulin

c. DNA

d. Myosin

Ans. a

Q. 94. Rabbits re-eat the faeces produced during :

a. Evening

b. Night

c. Morning

d. Noon

Ans. b

Q. 95. Adam's apple in human neck is :

a. Glottis

b. Pharynx

c. Larynx

d. Trachea

Ans. c

Q 96. Which of the following is an exclusive characteristic of mammals?

a. The presence of a completely four-chambered heart

b. The presence of a muscular diaphragm

c. Homoiothermy (warm-blooded)

d. Internal fertilization

Ans. b

Q 97. The unique mammalian characteristics are:

a. Hairs, pinna, and mammary glands

b. Hairs, pinna, and indirect development

c. Pinna, monocondylic skull, and mammary glands

d. Hairs, tympanic membrane, and mammary glands

Ans. a

Q. 98. The primary function of hair and fur in mammals is:

a. Camouflage

b. Insulation and protection

c. Air-conditioning

d. Display and mating

Ans. b

Q. 99. Most mammals breathe using:

a. Gills

b. Spiracles

c. Lungs

d. Skin

Ans. c

Q. 100. Egg-laying mammals belong to which subclass?

a. Prototheria (Monotremata)

b. Metatheria (Marsupialia)

c. Eutheria

d. Theria

Ans. a

Q. 101. Pouched mammals, which give birth to immature young, belong to the group:

a. Monotremes

b. Marsupials

c. Eutherians

d. Prototherians

Ans. b

Q. 102. Bats are classified as mammals because:

a. They can fly

b. They possess pinnae (external ears)

c. They have hair

d. They have testes

Ans. c

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