ANIMAL KINGDOM (ANIMAL DIVERSITY)

TAXONOMY :

Taxonomy is the branch of science which deals the study of nomenclature, classification and principles of classification. Taxonomy word was given by "Candolle" (Taxis- arrangements. Nomia-distribution)

Aristotle :- He is known as the "father of zoology". (Book: Historia Animalium)

He is also known as the father of ancient taxonomy. He classified animals into two groups on the basis of the colour of blood.

(1) Anaima- Those animals which don't have red blood or in which RBC are absent. e.g. Invertebrates like Sponges, Cnidaria, Mollusca, Arthropoda, Echinodermata.

(2) Enaima :- These animals have red blood. This group includes all vertebrates and it has been further divided into two sub groups.

(a) Vivipara :- It includes animals which give birth to young-ones. e.g. Mammals.

(b) Ovipara :- It includes animals which lay eggs. e.g. Pisces, Amphibians, Reptiles, Aves etc.

IMPORTANT PHYLA

1. Protozoa (Included in kingdom - Protista)	-	Amoeba, Paramoecium etc.
2. Porifera (Kingdom - Animalia)	-	Sponges (Leucosolenia, Sycon)
3. Coelenterata/Cnidaria	-	Hydra, Jellyfish etc.
4. Ctenophora (minor phylum)	-	Pleurobrachia, Ctenoplana
5. Platyhelminthes	-	Flat worms (eg : Tape worm)
6. Nemathelminthes/ Aschelminthes	-	Round worm (eg : Ascaris)
7. Annelida	-	Earthworm, Leech etc.
8. Arthropoda	-	Insects, Scorpion , Fly etc.
9. Mollusca	-	Snail, Pila, Octopus etc.
10. Echinodermata	-	Starfishes
11. Hemichordata	-	Balanoglossus
12. Chordata	-	Fish, Snake, Birds, Monkey etc.

BASIS OF CLASSIFICATION

1. Level of body organization :-

Protoplasmic level → In protozoans, unicellular body performs all biological activities

↓

Cellular level → In sponges, cells are arranged as loose cell aggregates and division of labour occurs among cells (Tissues absent)

↓

Tissue level → In coelenterates and ctenophores, cells performing the same function are arranged into tissues

↓

Organ level → In platyhelminthes tissues are grouped together to form organs.

↓

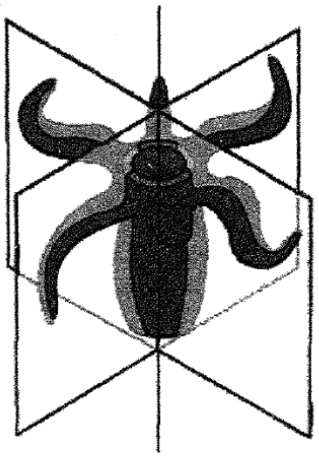
Organ system level → In higher animals, organs further organise to form organ systems e.g. Aschelminthes, Annelida, Arthropoda, Mollusca, Echinodermata and Chordata

2. Symmetry :

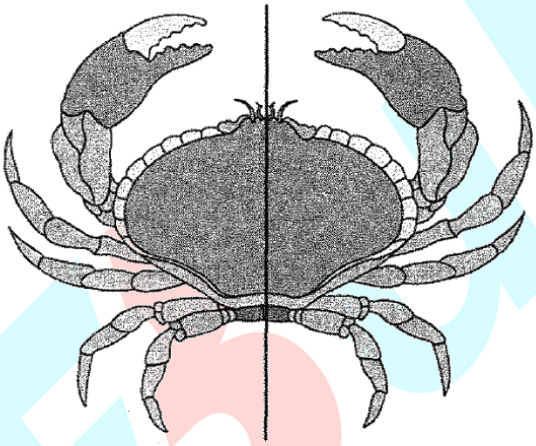
(a) **Asymmetry :-** When any plane that passes through the centre does not divide the body of animals into two equal halves.
e.g : most of the sponges are asymmetrical.

(b) **Radial symmetry :-** When any plane passing through the central axis of the body divide the animal into two identical halves.
eg : Coelenterates, Ctenophores and Echinoderms (adult)

(c) **Bilateral symmetry :-** When the body can be divided into identical left & right halves in only one plane.
e.g : Platyhelminthes to Chordates.



Radial symmetry

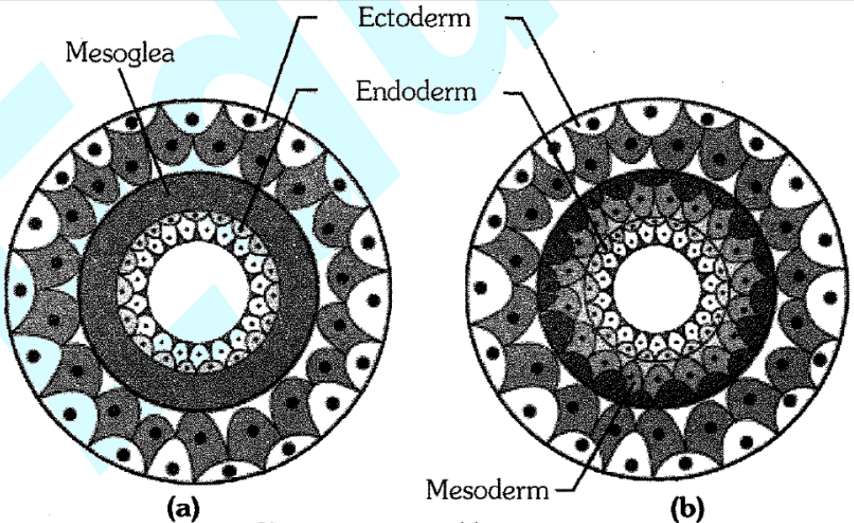


Bilateral symmetry

3. Germinal layers :-

(a) **Diploblastic :-** Animals in which the cells are arragned in two embryonic layers ectoderm and endoderm with an interveining undifferentiated mesoglea e.g. Coelenterates and Ctenophores.

(b) **Triploblastic :-** Those animals in which the developing embryo has a third germinal layer- Mesoderm in between the ectoderm and endoderm e.g. Platyhelminthes to Chordates.



Showing germinal layers:
(a) Diploblastic (b) Triploblastic

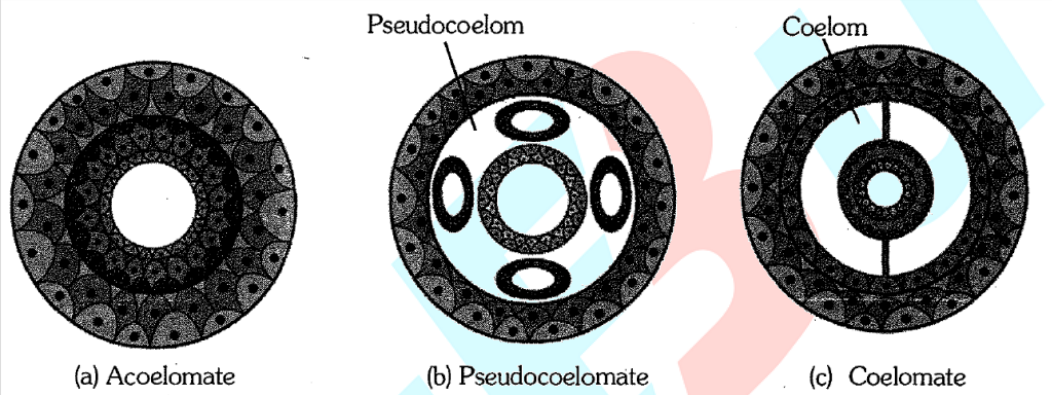
4. **Body Cavity or Coelom :-** Presence or absence of a cavity between the body wall and gut wall is very important in classification.

(a) **Acoelomates :-** Animals in which the body cavity is absent
e.g. Porifera. Coelenterata. Ctennophora, Platyhelminthes

(b) **Pseudocoelomates :-** In same animals body cavity is not lined by mesoderm, instead, the mesoderm is present as scattered pouches in between the ectoderm and endoderm. Such a body cavity is called pseudocoelom.
e.g. Aschelminthes.

(c) **Coelomates :-** Animals possessing coelom i.e. the body cavity which is lined by mesoderm on all sides

♦ On the basis of embryonic development, the coelom is of two types
(i) Schizocoel - Coelom formed by splitting of a mesodermal mass
e.g. Annelida, Arthropoda, Mollusca.
(ii) Enterocoel - Coelom formed by fusion of gut pouches during embryonic stage
e.g. Echinodermata, Hemichordata and Chordata.



5. **Body plan :**

(a) **Cell-aggregate type :-** e.g. Sponges

(b) **Blind Sac type :-**Animals in which digestive system is incomplete, it has only single opening to the outside of the body that serves as both mouth and anus.
e.g. Coelenterates to Platyhelminthes

(c) **Tube-within-tube type :-** Found in those animals having complete digestive tract i.e. with separate openings mouth and anus.
e.g. Nemathelminthes to Chordates

6. **Segmentation :-**

(a) **Pseudometameric :-** e.g. Tapeworms

(b) **Metameric :-** In Annelids, Arthropods and Chordates.
In these animals, the body is externally and internally divided into segments with a serial repetition of atleast some organs, this is called metameric segmentation and the phenomenon is known as Metamerism.

7. **Notochord :-** It is a mesodermally derived rod-like structure formed on the dorsal side during embryonic development in some animals.

(a) **Non-chordates :-** Animals without notochord e.g. Porifera to Hemichordata

(b) **Chordates :** - Animals with notochord. eg. Chordata

8. **Circulatory system :-**

(a) **Open type :-** In which the blood is pumped out of heart and the cells & tissues are directly bathed in it.
e.g. Arthropods, Molluscs, Echinoderms, Hemichordates and some lower Chordates like tunicates

(b) **Closed type :-** In which the blood is circulated through a series of vessels of varying diameters i.e. arteries. veins and blood capillaries
e.g. Annelids, Cephalopod molluscs, Vertebrates etc.

9. **Embryonic development :-** On the basis of fate of blastopore, animals can be divided into two categories :

(a) **Protostomiates :-** Animals in which mouth is formed first (Blastopore → Mouth)
e.g. Platyhelminthes to Mollusca

(b) **Deuterostomiate :** Animals in which anus is formed earlier than mouth (Blastopore → Anus)
e.g. Echinoderms, Hemichordates and Chordates.

BEGINNER'S BOX-1

1. Which of the following phylum have radially symmetrical organisms ?
(1) Coelenterata (2) Platyhelminthes
(3) Aschelminthes (4) Annelida

2. Which of the following phylum possess true coelom ?
(1) Aschelminthes (2) Annelida
(3) Ctenophora (4) Platyhelminthes

3. Loose cell aggregate type body plan is found in __ .
(1) Protozoa (2) Porifera (3) Coelenterata (4) Platyhelminthes

4. Which of the following phylum is pseudocoelomate ?
(1) Aschelminthes (2) Arthropoda (3) Annelida (4) Platyhelminthes

5. When any plane passing through the central axis of body and divides the animal into two identical halves. It is called as
(1) Asymmetry (2) Radial symmetry
(3) Bilateral symmetry (4) Biradial symmetry

6. Which of the following phylum have "Tube within tube" body plan ?
(1) Platyhelminthes (2) Coelenterata
(3) Porifera (4) Nemathelminthes

7. Which of the following phylum has closed circulatory system ?
(1) Arthropoda (2) Annelida (3) Mollusca (4) Echinodermata

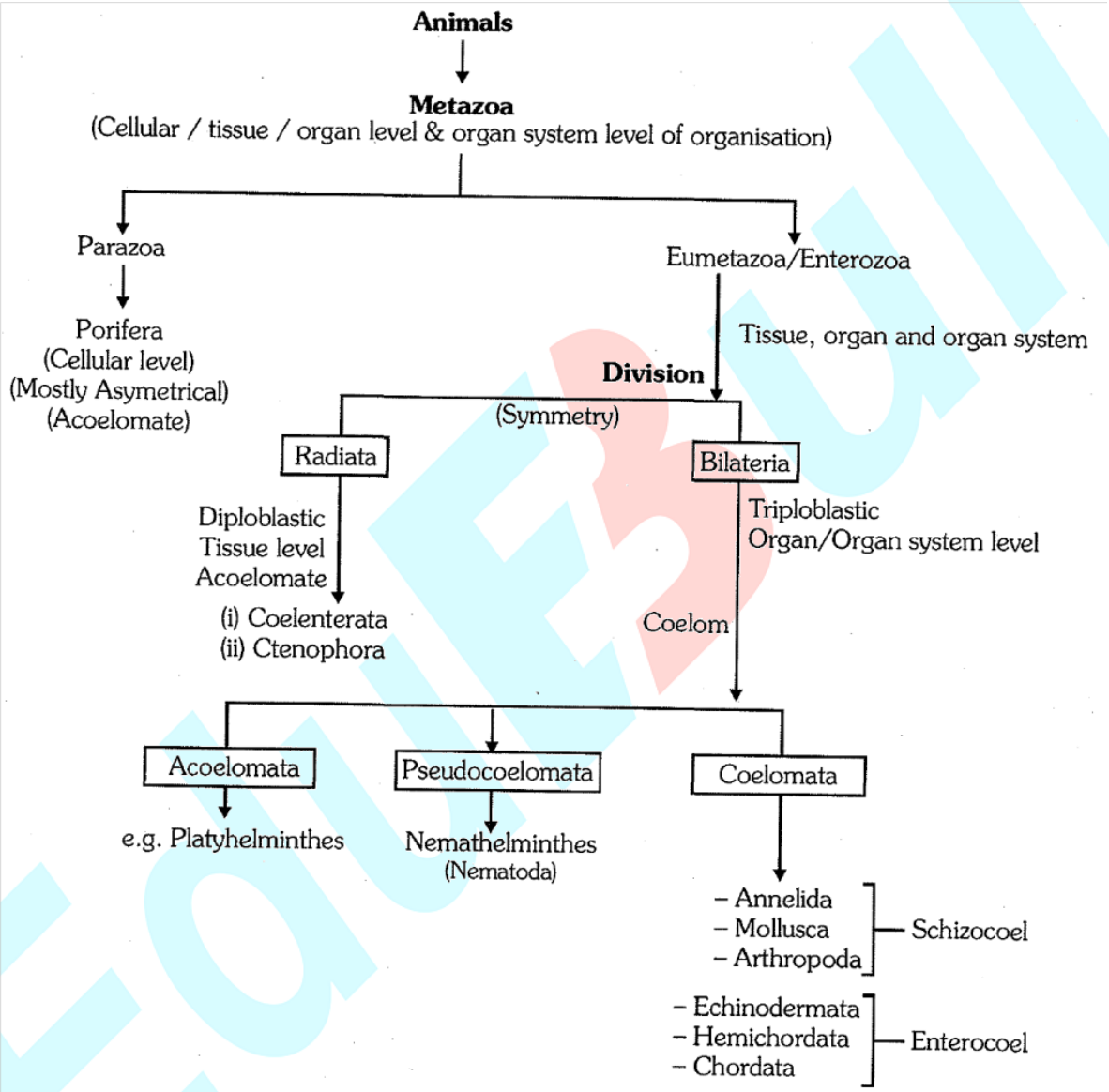
8. Segmentation is found in :-
(1) Annelida, Arthropoda, Mollusca (2) Arthropoda, Mollusca, Echinoderms
(3) Annelida, Arthropoda, Chordata (4) Arthropoda, Echinoderms, Chordata

9. Which of the following group is Deuterostome
(1) Annelida, Arthropoda, Mollusca (2) Echinodermata, Hemichordata, Chordata

(3) Annelida, Mollusca, Chordata (4) Arthropoda, Mollusca, Echinodermata

10. Incomplete digestive tract found in -
(1) Platyhelminthes and Aschelminthes (2) Platyhelminthes and Ctenophora
(3) Aschelminthes and Annelida (4) Coelenterates and Aschelminthes

OUTLINE OF ANIMAL CLASSIFICATION



PHYLUM – PROTOZOA (KINGDOM-PROTISTA)

1. It is 3rd largest phylum. In includes unicellular eukaryotes where one celled body performs all the biological activities like multicellular animals. So they are termed as "Acellular" organisms, proposed by Dobell.

2. They are cosmopolitan, microscopic, mostly aquatic, free living (Amoeba) or parasitic (Plasmodium), solitary or colonial (Proterospongia). These cause serious diseases.

3. They have varying body shapes and are mostly asymmetrical.

4. Body level of organisation is Protoplasmic level Their protoplasm is uninucleated or multinucleated. Few show nuclear dimorphism. e.g. Paramoecium.

5. Some are naked, some have body bounded by delicate membrane or a firm pellicle/Test/shell. In few groups of protozoa Silica shell & CaC03 exoskeleton is found. e.g. Radiolarian group (silica) & Foraminiferan group ($CaCO_3$). (eg : Globigerina)

6. Locomotory structures are
(i) Finger-like Pseudopodia e.g. Amoeba, Entamoeba
(ii) Whip-like Flagella e.g. Trypanosoma
(iii) Hairy Cilia e.g. Paramoecium
(iv) Absent in sporozoan parasites eg. Plasmodium

7. Nutrition in Protozoans is mainly holozoic (Amoeba) and Parasitic (Plasmodium). Digestion is intracellular takes place in food vacuole.

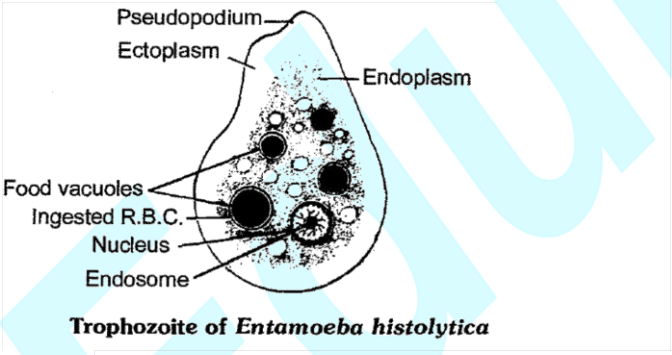
8. Respiration and Excretion take place by general body surface. Some excretion may occur through contractile vacuole. Nitrogenous waste is Ammonia. Some fresh water protozoans get rid of excess water through contractile vacuole by the process known as Osmoregulation.

9. Reproduction takes place by

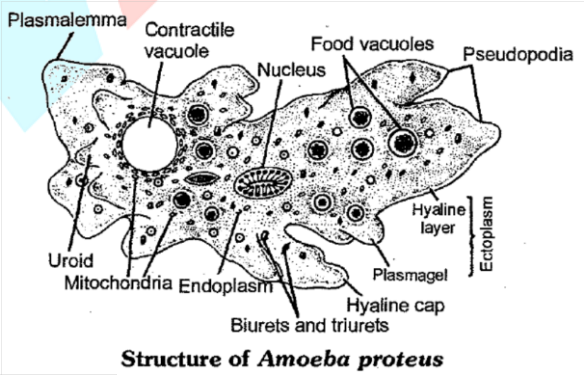
	Asexual		**Sexual**
(1)	Binary fission	**(1)**	Syngamy (Plasmodium)
	(a) Simple fission (Amoeba)		
	(b) Transverse fission (Paramoecium)		
	(c) Longitudinal fission (Trypanosoma)		
(2)	Multiple fission (Plasmodium)	**(2)**	Conjugation (Paramoecium)
(3)	Budding (Ephelota/ Sessile protozoan)		

10. They do not have natural death because in unicellular animals there is no differentiation of somatoplasm & germplasm, hence these are considered immortal.

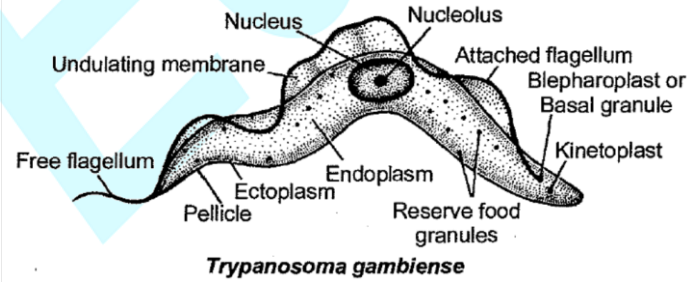
FEW COMMON PROTOZOANS



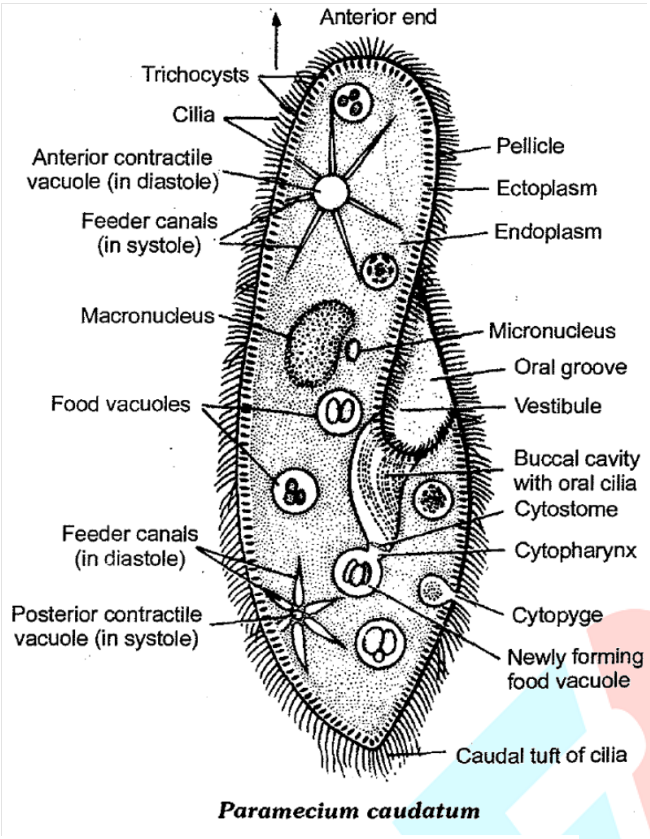
Trophozoite of *Entamoeba histolytica*



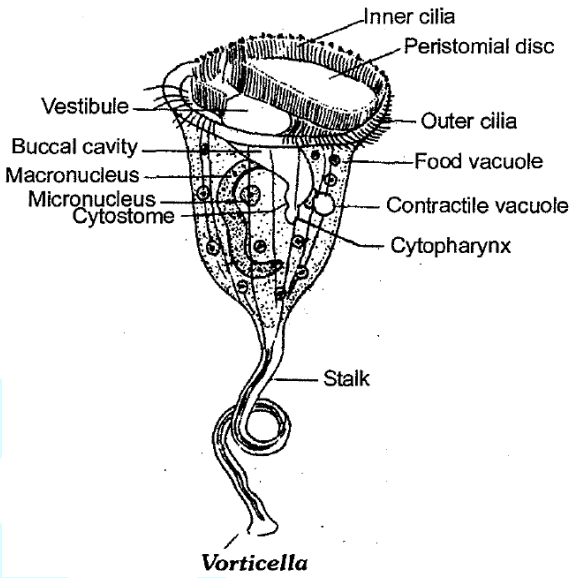
Structure of *Amoeba proteus*



Trypanosoma gambiense



Paramecium caudatum



Vorticella

PROTOZOA

4 Classes (on the basis of locomotory organs)

(1) Mastigophora or Flagellata

* Free living (aquatic) or parasitic
* Locomotion by 1 or 2 or many thread like flagella
* Body covered by pellicle
* Reproduction- Asexual by binary fission but sexual absent

e.g. 1. *Proterospongia* - Connecting link between protozoa and porifera.

2. *Leishmania donovani* – Dimorphic and digenetic parasite, causes **Kala azar / Dum-dum fever /Leishmaniasis** in humans, carrier-sandfly (*Phlebotomus*)

3. ***Trypanosoma gambiense*** - Polymorphic and Digenetic parasite, causes **Sleeping sickness or African trypanosomiasis**, Carrier-Tse tse fly *(Glossina)*

4. *Giardia intestinalis* - (Grand old man of intestine) monogenetic that causes "Diarrhoea / Giardiasis" and infection through contaminated food and water.

5. ***Trichomonas vaginalis*** - Vaginal parasite of woman that causes "**Leucorrhoea disease**"

6. ***Trichonympha*** - Symbiont in intestine of termite and Cockroach

(2) Sarcodina / Rhizopoda

* Free living (aquatic) or parasitic
* Locomotion by different types of pseudopodia
* Body-naked or with shell
* Reproduction-Asexual by binary fission but sexual absent

e.g. 1. *Amoeba* - finger-like pseudopodia called lobopodia

→ Cytoplasm differentiated into ecto-plasm and endoplasm

2. *Pelomyxa* - Chaos-chaos

→ Largest and multinucleated amoeba

3. ***Entamoeba histolytica*** - Dimorphic and monogenetic parasite, causes **"amoebic dysentry"**, infection through contaminated food and water

4. *Entamoeba gingivalis* - Increases infection of **pyorrhoea** (Causative agent *Trichomonas tinax*)

5. ***Entamoeba coli*** - Found in colon as commensal

6. *Actinophrys* - Sun animalcule

→ Pseudopodia supported with axial fila-ments called ***axopodia***

(3) Ciliata

* Free living (aquatic) or parasitic
* Locomotion by numerous cilia
* Body covered by pellicle
* Binucleated, **meganucleus** for somatic functions and **micronucelus** for reproductive function.
* Reproduction - Asexual by binary fission and Sexual by conjugation

e.g. 1. *Paramoecium* - slipper animalcule

→ Cytostome (cell-mouth) and cytopyge (cell-anus) are present

→ Trichocyst for offence and defence

2. *Vorticella* - Bell animacule

3. *Balantidium coli* - Found in colon of man

(4) Sporozoa

* All are endoparasite and pathogenic
* Locomotory organelles absent
* Thick pellicle for protection
* Reproduction - Asexual by multiple fission and Sexual by syngamy

eg 1. *Plasmodium*

→ Digenetic blood parasite(malaria)

→ Carrier is female anopheles

2. *Babesia* - Digenetic and causes "Texas cattle fever / Red water fever/ Tick fever" in cattle

→ Spread by ticks

3. *Monocystis* : Monogenetic, found in seminal vesicle of earthworm.

4. *Nosema* : Causes pebrine disease in silk worm

KINGDOM – ANIMALIA

PHYLUM – PORIFERA (sponges)

1. Members of this phylum are commonly known as" Sponges". Study of sponges is known as Parazoology.

2. All are aquatic and Sessile, mostly marine but few are found in fresh water also. They are solitary or colonial. Entire body with pores i.e. numerous small Ostia for entry and one large opening Osculum for exit of water.

3. Sponges have various body form and shapes with irregular shape mostly Asymmetrical. (Radial symmetry in Sycon and Leucosolenia)

4. Sponges are primitive multicellular acoelomate animals and have cellular level of organisation.

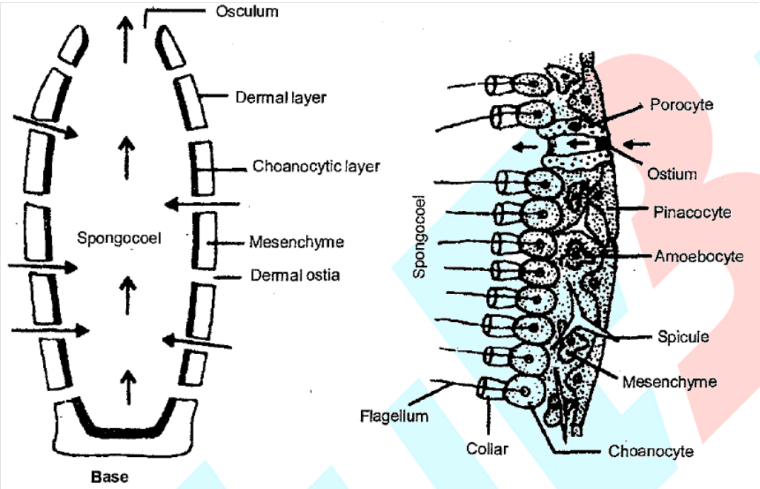
- Body wall consists of-

(i) **Outer Pinacoderm** - Consists of
(a) Pinacocytes (Flat cells)
(b) Porocytes (oval cells)

(ii) **Inner Choanoderm**
Consists of flagellated collar cells or choanocytes (Unique Characteristic of Porifera)

(iii) Between these two layers a gelatinous material Mesenchyme is present which contains certain Amoebocytes cells like -
Scleroblasts - For formation of skeleton elements
Archaeocytes - Totipotent cells (Formation of ova & spermatazoa)

5. Body wall encloses a large central cavity the spongocoel or paragastric cavity with small hollow canals.



BODY WALL OF A SPONGE (*LEUCOSOLENIA*)

6. **Canal system or water transport system :-** It is unique feature of sponges, water enters through ostia in the body wall into spongocoel and goes out through osculum. This pathway of water transport is helpful in food gathering (Nutrition), respiratory exchange and removal of Wastes (excretion).

7. **Choanocytes** forms lining of Spongocoel and canals. Ceaseless beating of flagella helps in maintaining flow of water current.

8. **Nutrition is holozoic :-** Digestion is intracellular and occurs in food vacuoles of choanocytes.

9. Skeleton is internal, consist of tiny calcareous spicules or siliceous spicules or fine spongin fibre located in mesenchyme. Scleroblast secretes spicules and spongioblast secretes spongin fibres.

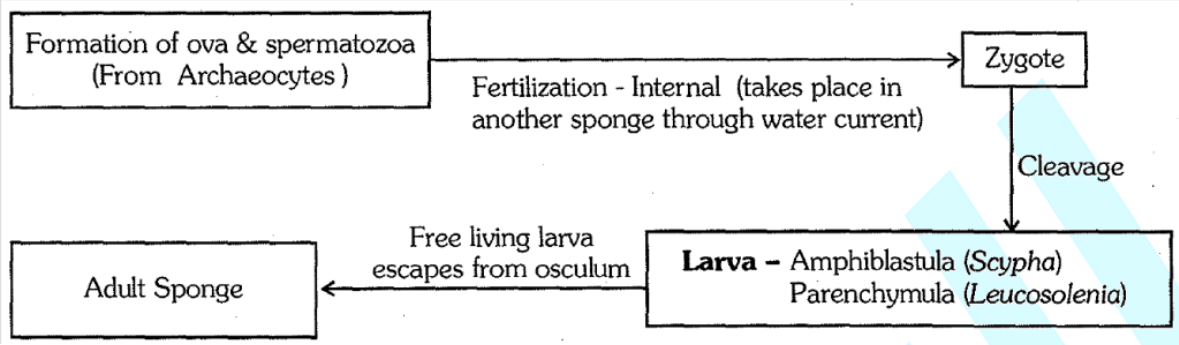
10. Respiration and Excretion takes place by diffusion of gases through body surface. Excretory matter is Ammonia.

11. **Reproduction takes place by means of :-**

(A) Asexual :- By Budding or Fragmentation or by Spedal cell mass Gemmules containing Archaeocytes.

• Endogenous buds of asexual reproduction in sponge are known as Gemmules (In unfavourable condition).

(B) Sexual :- Sponges are Hermaphrodite, fertilization is internal and cross due to Protogynous condition and development is indirect having a larval stage which is morphologically distinct from adult.

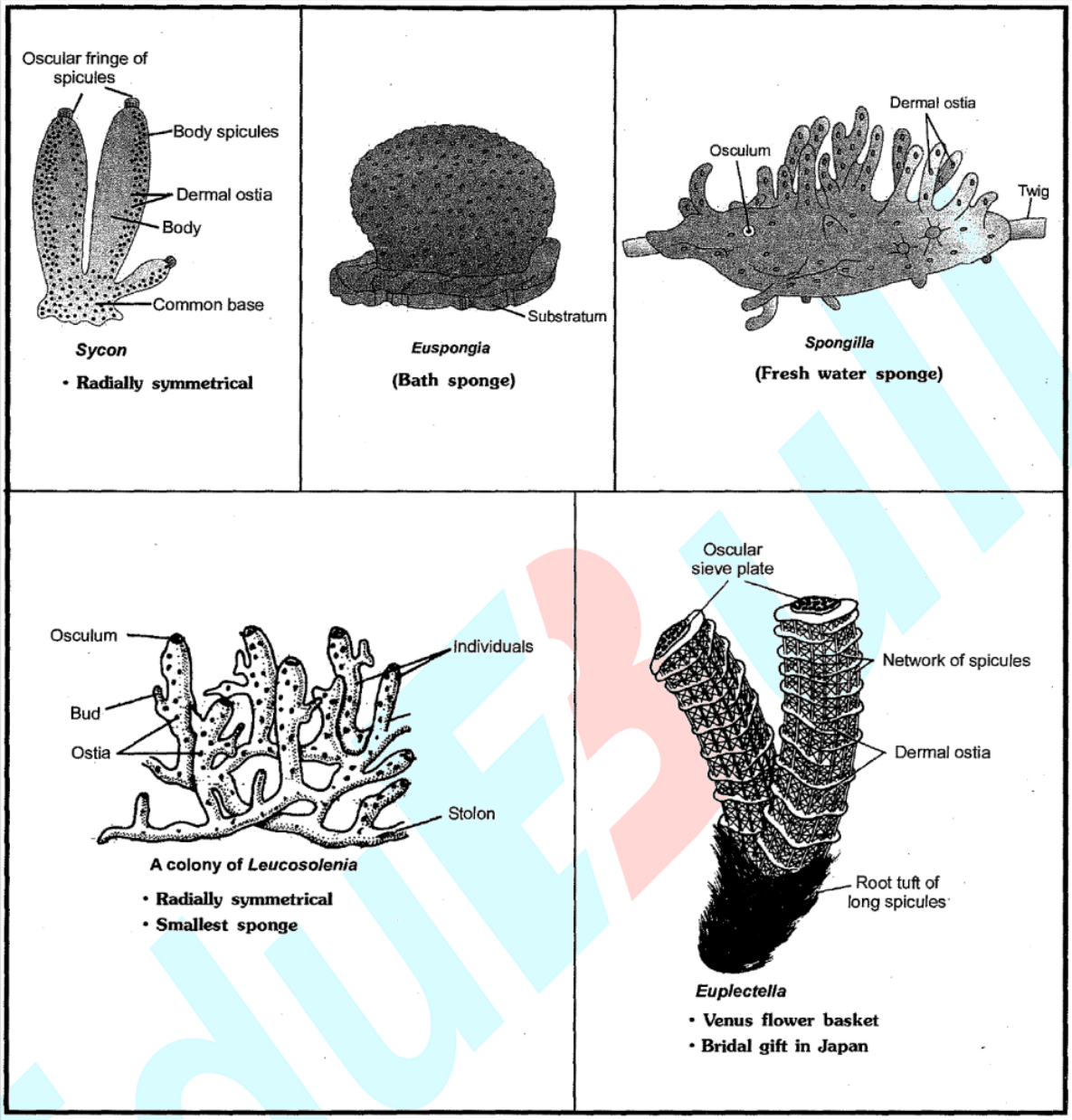


PORIFERA

(3 classes – On the basis of Skeleton)

	Calcarea	Hexactinellida	Demospongia
Skeleton	Calcareous spicules	6-rayed siliceous spicules (Glass sponge)	1 or 4 rayed siliceous spicules or sponging fibre or both
Habitat	All marine and found in shallow water	All marine and found in deep sea water	Marine or fresh water sponges
e.g.	**1.** Leucosolenia-smallest sponge **2. Scypha (Sycon)** - Urn sponge	**1.** Euplectella - Venus flower basket, Bridal gift in japan, Shrimps (Spongicola) crustacean, shows commensalism with it **2.** Hyalonema - Glass rope sponge	**1. Euspongia** - Bath sponge **2. Spongilla** - Fresh water sponge **3. Cliona** - Boring sponge (harmful to Oyster)

FEW COMMON SPONGES



BEGINNER'S BOX-2

1. The vector for causing sleeping sickness in man is :
(1) House fly (2) Mosquito (3) Tse-tse fly (4) Sand fly

2. In which of the following protozoans locomotory structure are absent?
(1) Sarcodina (2) Sporozoans (3) Ciliata (4) Mastigophores

3. Kala azar disease in man is caused by:
(1) Leishmania donovani (2) Trypanosoma gambiense
(3) Trichomonas (4) Giardia

4. "Bell- animalcule" is :

(1) Vorticella (2) Paramecium (3) Nyctotherus (4) Noctiluca

5. Which of the following pair is correctly matched?
(1) Leishmania- kala azar (2) Giardia - sleeping sickness
(3) Entamoeba – Malaria (4) Plasmodium- Dysentery

6. Which of the following cells of Porifera act as totipotent cells and responsible for high power of regeneration?
(1) Pinacocytes (2) Choanocytes (3) Collenocytes (4) Archeocytes

7. Larval form found in sponges is :
(1) Planula (2) Parenchymula (3) Cysticercus (4) Glochidium

8. Fertilization in Leucosolenia is :
(1) Internal & Cross (2) External & Self (3) Internal & Self (4) External & Cross

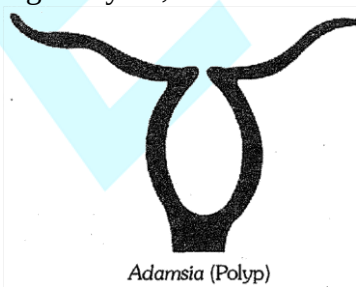
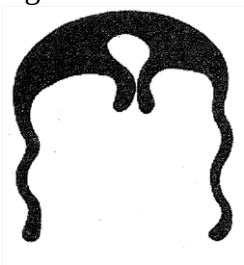
9. Boring sponge is :
(1) Cliona (2) Spongilla (3) Euspongia (4) Hyalonema

10. "Venus' flower basket" is :
(1) Hyalonema (2) Euplectella (3) Sycon (4) Euspongia

PHYLUM – CNIDARIA

- Coelenterates are also known as Cnidarians due to presence of stinging cells called Cnidoblast or Cnidocytes.

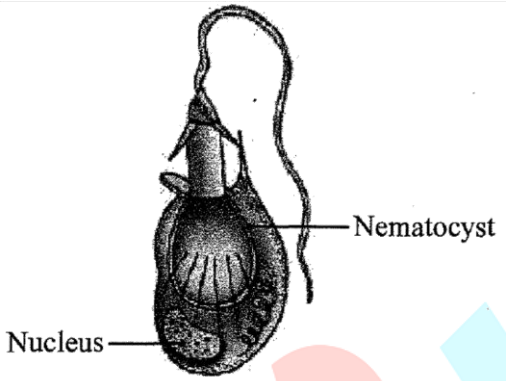
1. Mostly marine, few fresh-water (Hydra) Carnivorous, sessile or free swimming.
2. Radial symmetry.
3. Tissue level of organisation, acoelomate animals.
4. They develop from two germinal layers (1) Ectoderm (2) Endoderm i.e. they are Diploblastic (mesogloea between two layers) Interstitial cells are totipotent cells found in both layers of body wall.
5. Coelenterates have two basic body forms (Dimorphic)

(1) Polyp	(2) Medusa
- Cylidrical and sessile form - May be solitary or Colonial - Mouth directed upwards e.g. – Hydra, Adamsia  *Adamsia* (Polyp)	- Umbrella shaped and free swimming - Always solitary - Mouth directed downwards e.g. – Aurelia  *Aurelia* (Medusa)

- Either or both zooids may occur in a species .

- If both are found in a spedes, two forms alternate in life cycle. Polyps produce medusae asexually and medusa form the polyps sexually, this alternation of generation is called Metagenesis eg :- Obelia
- Group of different types of zooids in polyp or medusa shows polymorphism.

6. Cnidoblast or Cnidocyte (contains stinging capsule as Nematocyst) present on the tentacles and body, which are used for anchorage (Attachment), defence and for the capture of Prey (Offence).



Diagrammatic view of Cnidoblast

- Body of some coelenterates may be covered by exoskeleton of calcium carbonate. eg :- Corals

7. A large central cavity called Coelenteron is having single aperture on hypostome i.e. Incomplete digestive tract (Blind sac).

8. Digestion is extracellular as well as Intracelluar i.e. takes place in Caoelenteron as well as in food vacuole. Mouth serves both purposes.

- Coelenteron is also responsible for distribution of food besides partly digesting it. Due to this dual role it is named as coelenterons or Gastrovascular cavity.

9. Respiration and Excretion takes place by diffusion of gases through body surface. Excretory matter is Ammonia.

10. Nervous system diffused type and consists non-polar neurons (Nerve net).

11. Reproduction
- Asexual by budding
- Sexual by production of gametes
- Development is indirect with larval stages
- Larva of Obelia-Planula (free living).
- Larva of Aurelia - Ephyra.

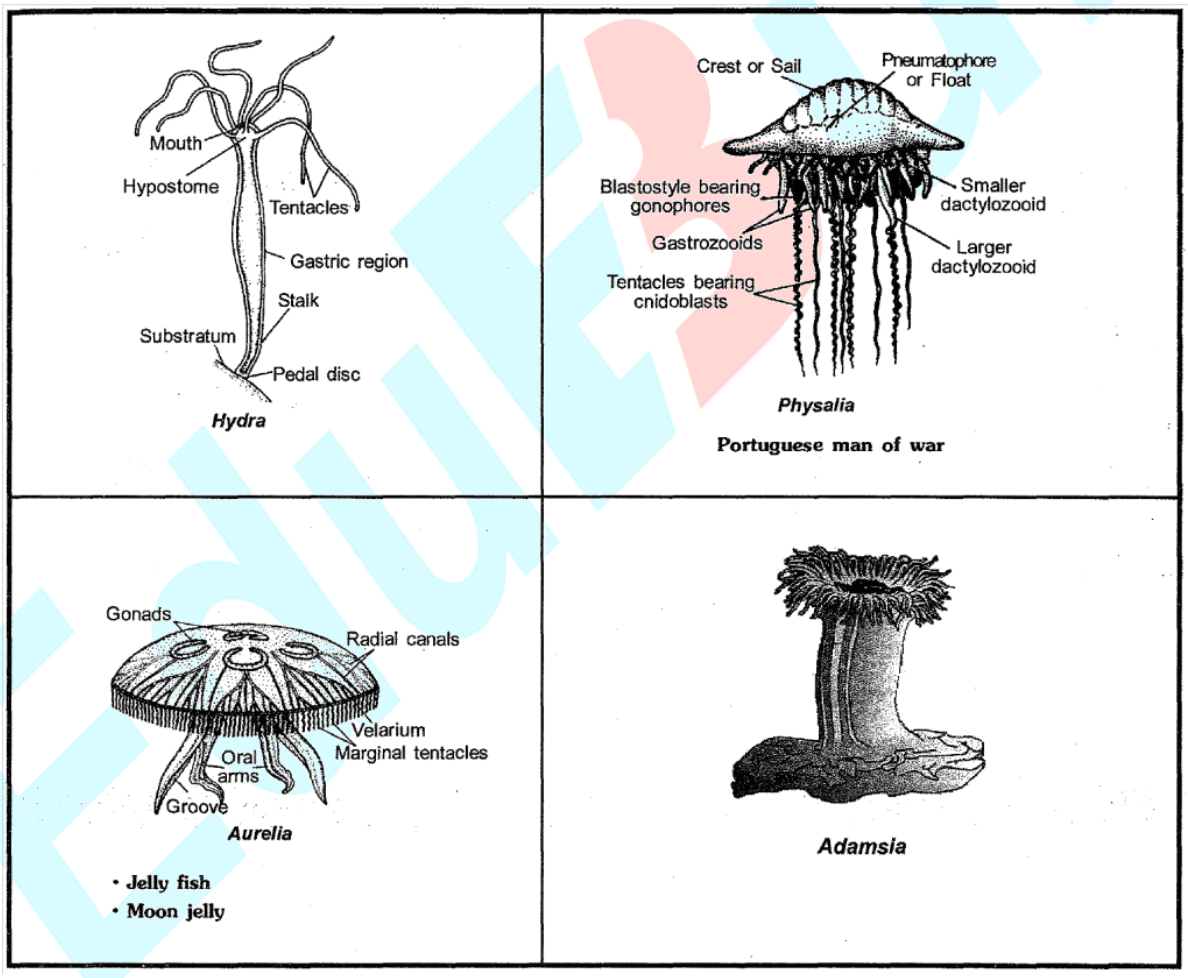
Classification : 3 classes

(On the basis of dominance of polyp and medusa)

Hydrozoa	Scyphozoa	Anthozoa
- Polyp & medusa often show metagenesis e.g. 1. Hydra – Frest water polyp (medusa absent) 2. Obleia – Sea fur 3. Physalia – Portuguese man-of-war. (Neurotoxic,	- Medusa form is more common, polyp may be reduced or absent e.g. 1. Aurelia – jelly fish, Moon jelly.	- Only polyp form dominant, medusa may be reduced or absent. - This class has two types of animals (A) Sea Anemones (Skeleton absent)

gas gland present)		e.g. 1. Adamsia 2. Metridium - Sea anemones show commensalism with Hermit crab (B) Corals ($CaCO_3$ Skeleton) 3. Pennatula - Sea) pen 4. Gorgonia - Sea fan 5.Meandrina-Brain coral 6. Tubipora- Organ pipe coral 7. Alcyonium -Dead man's finger (Soft coral) 8. Corallium - Red coral (Moonga)

FEW CNIDARIANS



PHYLUM – CTENOPHORA

1. Ctenophores are known for their beauty and delicate nature. In sunlight their comb-plates give the effect of a rainbow. They are commonly known as "Sea-gooseberries" or "Comb-jellies" or "Sea-walnuts".
2. Nematoblasts are absent, so they are also called “acnidarians”.
3. They are exclusively marine.
4. Bioluminescence (fhe property of a living organism to emit light) is well marked.
5. Body is soft transparent jelly like. They are radially symmetrial.
Diploblastic organism with tissue grade body organisation.
6. Locomotion takes place by the presence of 8 ciliary comb plates on the body surface.
7. Digestion is both extracellular and intracelluar.
8. Skeletal, Excretory and Respiratory systems are absent.
9. They are carnivorous. A pair of long solid tentacles are present. In place of nematoblasts, special type of cells are present on tentacles, called Lasso cells (Colloblasts) which help in catching the prey.
10. Sexes are not separate. Reproduction takes place only by sexual means. Fertilization is external.
11. Development is of indirect type. Life cycle involves a free living Cydippid larval stage.
e.g. 1. Pleurobrachia
2. Ctenoplana
3. Beroe- Swimming eye of Cat.
4. Cestum- Venus's girdle

BEGINNER’S BOX-3

1. Which one of the following animals is diploblastic ?
(1) Pennatula (2) Paramoecium
(3) Taenia solium (4) Ascaris

2. The function of nematoblast in coelenterate is :
(1) Locomotion (2) Offence & defence
(3) Reproduction (4) Nutrition

3. "Corals" belong to the phylum :
(1) Porifera (2) Coelenterata (3) Mollusca (4) Echinodermata

4. A radially symmetrical diploblastic animal is :
(1) Ascaris (2) Earth worm (3) Liver Ruke (4) Hydra

5. Medusa stage is not found in the coelenterate of class :
(1) Hydrozoa (2) Scyphozoa (3) Sporozoa (4) Anthozoa

6. "Portuguese man of war" is -
(1) Obelia (2) Physalia (3) Euplectella (4) Meandrina

7. The characteristic larva of Ctenophora is :
(1) Cydippid (2) Veliger (3) Nauplius (4) Trochophore

8. "Comb jellies " or "Sea Walnuts" belong to the phylum :

(1) Coelenterata (2) Ctenophora (3) Mollusca (4) Echinodermata

9. Lasso cells are present in :
(1) Coelenterata (2) Ctenophora (3) Porifera (4) Protozoa

10. Which one of the following is coelentrate-
(1) Sea cow (2) Sea cucumber (3) Sea fan (4) Sea horse

PHYLUM – PLATYHELEMINTHES

1. They have dorsoventrally flattened body hence are called flat worms.
2. These are mostly endoparasites found in animals including human being but some are Free living (aquatic).
3. Study of worms causing parasitic infestation in human is called Helminthology.
4. Body is Bilaterally symmetrical and body organisation is of organ /organ system grade.
5. Body is Triploblastic i.e. body is formed from three germinal layers i.e. Ectoderm, Endoderm & Mesoderm.
6. Locomotary organs are absent in these animals but adhesive organs like suckers, hooks etc are present in parasitic form.
7. Epidermis is sometimes ciliated. On the body wall of parasitic animals a thick cuticle is present i.e. Tegument.
Thick cuticle protects the parasite from the digestive enzymes of the host.
- Muscles in the body-wall are mesodermal. Below the epidermis, longitudinal, circular and oblique muscles are present.
8. These are acoelomate. In between various organs a solid, loose mesodermal tissue called Mesenchyma or Parenchyma is present.
9. Digestive system is incomplete (Blind sac body plan) and without anus but in Tapeworm digestive system is completely absent. They absorb nutrients from the host directly through their body surface.
10. Skeleton, respiratory and circulatory systems are absent.
11. They respire through body surface. Anaerobic respiration is found in internal parasites like Taenia.
12. Excretion occurs through specialised cells called flame cells or Solenocytes (Protonephridia). They also help in osmoregulation.
13. Nervous system is ladder like, consist of a nerve ring and longitudinal nerve cords.
14. They are Bisexual. Reproductive system is complex and well developed. Fertilization is internal. Development indirect through many larva stages.
15. Some members like Planaria possess high regeneration capacily.

Divided into three classes

Turbellaira	Trematoda	Cestoda
- Fresh water/ Marine water - Mostly free living, called Eddy worms 1. Dugesia or Planaria	- Mostly Endoparasite - Body is flat and leaf like so called flukes 1. Fasciola – Sheep liver flukes 2. Schistosoma – the blood flukes 3. paragonimus – Lung	- Endoparasite, mostly intestinal parasite - Body is ribbon-like and segmented so called tape worms 1. Taenia solium – Pork tapeworm 2. Taenia saginata – Beef

	fluke worm in lungs of man and pig 4. Opisthorchis – Human liver fluke or Chinese liver fluke	tapeworm 3. Echinococcus – Dog tapeworm 4. Hymenolepis – Smallest tapeworm in man's intestine – 200 proglottids (monogentic)

(1) **Planaria** - Found in fresh water, nocturnal, cannibalic, slow creeping, omnivorous. Reproduce sexually as well as asexually (Transverse binary fission), good power of regeneration. Pharynx can be everted.

(2) **Fasciola hepatica (Liver fluke)**

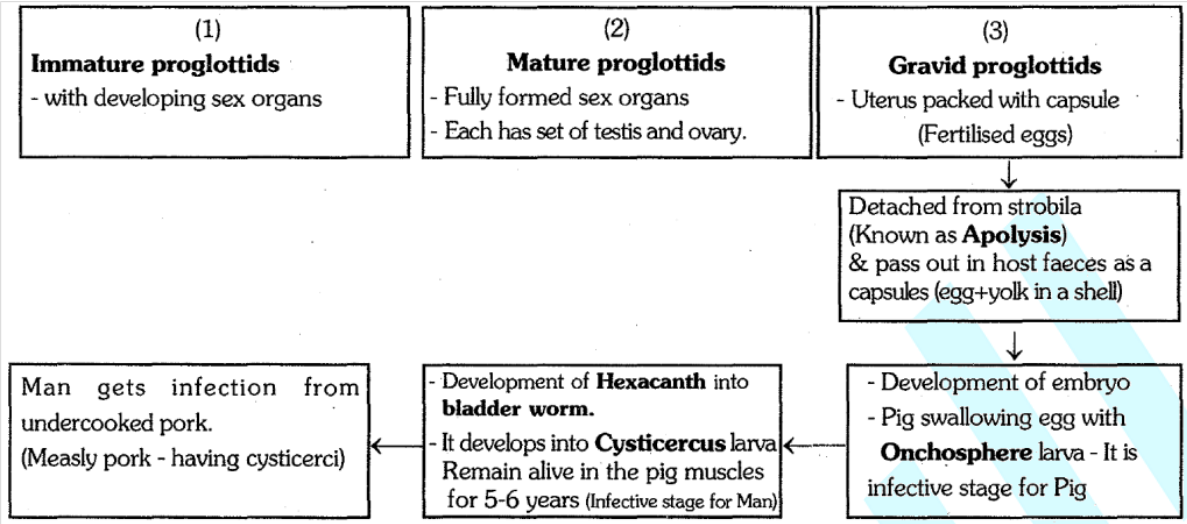
- Life history involves two hosts (Digenetic parasite)
  (1) Primary host- Sheep & Goat
  (2) Secondary host - Garden snail (Planorbis, Lymnea)
- Adult fluke is found in the bile ducts and liver of Sheep and causes Liver-rot or Cirrhosis disease.
- Shows many larval stages namely Miracidium (enters into snails body) → Sporocyst → Redia → Cercaria → Metacercaria ~ Eaten by sheep and develops into adult fluke.
- Infective stage for Primary host (Sheep)- Metacercaria
- Infective stage for Secondary hos_t (Snail) - Miracidium (Free swimming)

(3) **Schistosoma (Blood fluke) :-** Found in veins of human bladder and intestine. Unisexual, Large male carries female in a groove gynaecophoric canal on ventral side. It shows sexual dimorphism.

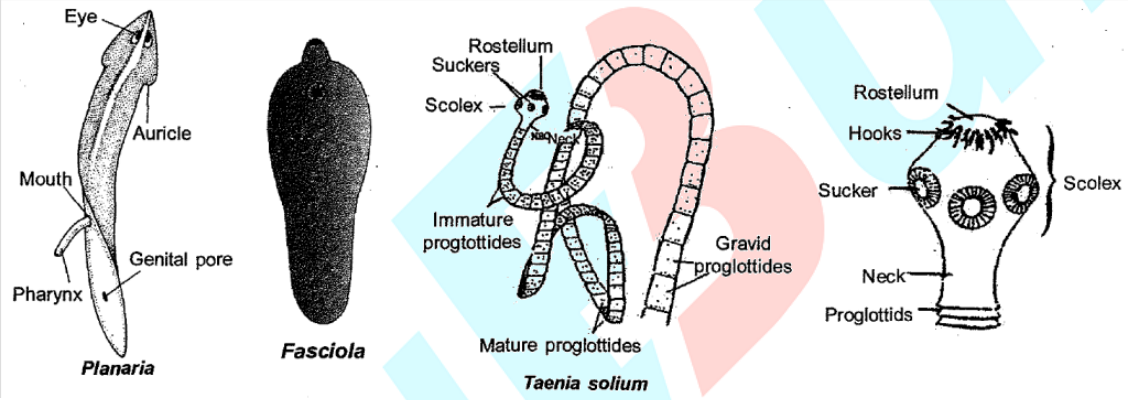
- Life history involves two hosts (Digenetic parasite)
  (1) Primary host- Man
  (2) Secondary host - Garden snail (Planorbis, Lymnea)
- Miracidium → Sporocyst → Cercaria larvae are found.
- Larva enters human body by boring in skin while bathing in ponds.
  It damages the liver & causes intestinal disorder - Schistosomiasis or Bilharzia disease.

(4) **Taenia solium (Pork tapeworm) :-** Flat, white ribbon like.

- Body divided into (1) head or scolex with hooks & suckers (2) Neck-for forming new proglottides (3) long strobila approx 850 proglottides. T. solium is human gut parasite, Attached to intestinal wall by hooks & suckers. Anaerobic respiration. Hermaphrodite, Self fertilization.
- Life history involves two hosts (Digenetic)
  (1) Primary host- Man
  (2) Secondary host - Pig
- Development through many larval stages namely : Onchosphere, Hexacanth, Bladder wonn and Cysticercus
- Man gets infection from undercooked pork containing encysted larvae cysticerci.
- Infective stage for primary host (Man) - Cysticercus.
- Infective stage for secondary host (Pig) - Onchosphere
- It causes the disease Taeniasis and Cysticercosis
- There are three types of Proglottids (segments).



FEW COMMON FLATWORMS



PHYLUM- NEMATHELMINTHES (ASCHELMINTHES)

1. Phylum includes round wonns which appear circular in cross section.
2. Nematods are found everywhere, they may be free living (aquatic and terrestrial) or parasite in plants and animals.
3. They have long, cylindrical body with tapering ends and without segmentation.
4. Symmetry - Bilateral. Germ layer - Triploblastic, Level of organisation - Organ-system level and having tube within tube body plan.
5. Anterior end does not show distinct head (Cephallsation absent).
6. Body wall consists of
   (i) Cuticle -Non living, thick and resistant to digestive enzymes of host.
   (ii) Epidennis - Syncytial i.e. a continuous layer of cytoplasm having scattered nuclei.
   (iii) Muscle layer- Only Longitudinal muscle fibres present
7. They are Pseudocoelomate animals, body cavity is there between body wall and digestive tract which is not lined by mesodermal epithelium i.e. Pseudocoel (developed from embryonic blastocoel)
8. Skeleton is absent but fluid pressure in the pseudocoelom maintains body shape. It is called Hydroskeleton.
9. Digestive tract is complete and differentiated into mouth, pharynx, intestine and anus.
   Pharynx is muscular and well developed. It is used to suck the liquid food. Intestine is non muscular.

10. Respiration is through body surface by diffusion.

11. Excretory system is H-shaped and consists of excretory canals (Protonephridia) which removes body wastes from body cavity through excretory pores. They develop from an embryonic "Renette cell".
Excretory matter is ammonia.

12. Nervous system comprises of a nerve ring (Brain) and longitudinal nerve cords. Sense organs like Papillae (tangoreceptors), Amphids (chemoreceptor) are present on lips while Phasmids (chemoreceptor) are found on tail.

13. Reproduction system is developed and sexes are separate (Dioecious). Fertilization· is internal and development may be direct or indirect. ~·

14. Sexual dimorphism is present.
In Ascaris male is smaller than female and curved from its caudal end. Male has Pineal setae for copulation. Genital tract joins with digestive tract to form cloaca. Female is larger than male and straight at both ends. Genital and digestive tract open independently (Cloaca absent).

Eg.

(1) **Ascaris** - Round worm (in small intestine), larva- Rhabditiform/Rhabditoid

(2) **Ancylostoma** - Hookworm (in small instestine)

(3) **Wuchereria** - Filarial worm (Viviparous)
- Digenetic parasite that causes Filariasis/Elephantiasis disease.
- Carrier host is female Culex mosquito.
- Adult mainly infects lymph vessels and lymph nodes in humans.

(4) **Dracunculus** - Guinea worm (madina worm) or Fiery serpent (Digenetic- Cyclops as intermediate host)

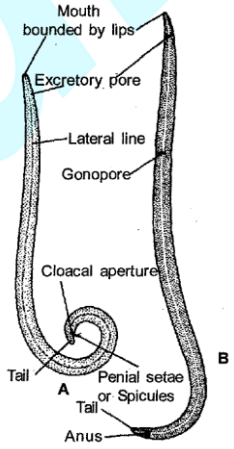
(5) **Enterobius** - Pin worm or seat worm (in large intestine)

(6) **Trichuris** - Whipworm (in intestine)

(7) **Rhabditis** - Free living nematode

(8) **Trichinella** - Infection in intestine and striated muscles (viviparous)

SOME ROUNDWORMS THAT PRARASITIZE MAN



Ascaris : (A) Male, (B) Female

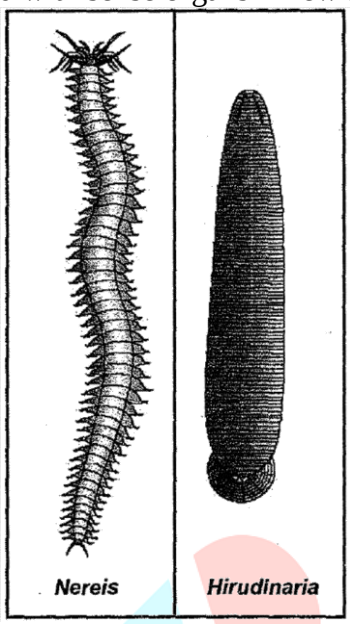
PHYLUM – ANNELIDA

1. Free living found in moist soil ITerristriall, fresh water or marine but few are parasite.

2. Body is soft elongated, cylindrical and divided into segments or metameres by ring like grooves called Annuli.

3. They are bilaterally symmetrical. triploblastic and have organ system level of organisation with tube within tube body plan.

- They are metamerically segmented and coelomate animals.
- Anterior end has a distinct head with sense organs in few annelids. (eg : Nereis)



4. They have Chitinous Setae and lateral muscular appendages called Parapodia for locomotion.

5. Body wall consist of
(i) Cuticle - Moist and elastic
(ii) Epidermis - Uving layer that secretes dead cuticle outside
(iii) Muscle layer- Contains circular and longitudinal muscles which help in Locomotion

6. Body cavity is true coelom lined by mesodermal coelomic epithelium. (Schizocoel/First Eucoelomate).
It is filled with coelomic fluid that serves as a hydrostatic skeleton.

7. Digestive tract is complete, straight and extends through entire body. Digestive glands are developed for the first time in Annelida.

8. Respiration is through moist skin (Cutaneous respiration), Some have gills (branchial respiration).

9. Circulatory system is closed type and pulsatile heart present.

- The blood is red with haemoglobin like pigment which remains dissolved in plasma (Erythrocruorin). It has amoeboid corpuscles only. (RBCs absent)

10. Excretory organ is Nephridia (sing. nephridium). They also help in osmoregulation.
Excretory matter (1) Ammonia in aquatic form (2) Urea in land form

11. Nervous system consists of a nerve ring (Brain) and a solid. double and ventral nerve cord with ganglia.

12. Reproduction is sexual, Nereisis dioecious but earthworms and leeches are monoecious.

- Development is direct or indirect with free swimming ciliated trochophore larva.

GOLDEN KEY POINTS

During course of evolution metameric segmentation, true coelom, closed circulatory system and pumping heart appeared first in annelids.

e.g

1. **Nereis** - Sandwarm/ Ringworm
(a) Cephalisation is present.
(b) Parapodia helps in locomotion.

(c) Unisexual
(d) Larva is trochophore

2. **Pheretima** - Earthworm
(a) Cephalisation absent
(b) Setae for locomotion
(c) Bisexual or hermaphrodite

3. **Hirudinaria** - Fresh water leech (Blood sucking leech)
(a) Cephalisation and setae absent
(b) Parapodia and setae absent
(c) Bisexual
(d) Hirudin (anticoagulant) present

4. **Aphrodite** - Sea mouse

BEGINNER'S BOX-4

1. Platyhelminthes are :
(1) Diploblastic, radially symmetrical and coelomate
(2) Diploblastic, radially symmetrical and acoelomate
(3) Triploblastic, bilaterally symmetrical and acoelomate
(4) Triploblastic, bilaterally symmetrical and pseudocoelomate

2. Parapodia are locomotary structures in :
(1) Scolopendra (2) Nereis (3) Centipede (4) Earth worm

3. Animals showing metameric segmentation are :
(1) Poriferans (2) Annelids (3) Tape-worms (4) Aschelminthes

4. The gravid proglottids having fertilized eggs in uterus of Tape worm are regularly detached, this process is known as:
(1) Apolysis (2) Proliferation (3) Strobilization (4) Topolysis

5. Aphrodite, commonly known as "sea mouse" is an :
(l) Annelid (2) Mollusc (3) Insect (4)Mammal

6. Which of the following endoparasite of man is viviparous ?
(1) Ascaris (2) Wuchereria (3) Taenia (4) Enterobius

7. The correct sequence of various larvae in liver fluke is ?
(1) Miracidium, sporocyst, cercaria, redia, metacercaria
(2) Miracidium, sporocyst, redia, cercaria, metacercaria
(3) Sporocyst, redia, miracidium, cercaria, metacercaria
(4) Cercaria, sporocyst, redia, miracidium, metacercaria

8. Which of the following is pseudocoelomate animal ?
(1) Whip worm (2) Sand worm (3) Flat worm (4) Tape worm

9. Protonephridia or flame cells of fresh water platyhelminthes help in :
(1) Excretion and osmoregulation (2) Nutrition and excretion
(3) Reproduction and respiration (4) Secretion and nutrition

10. Which one of the following has mesoderm but no coelom ?
(1) Flatworm (2) Earthworm (3) Roundworm (4) Leech

ARTHROPODA (7 CLASSES)

Merostomata
- Includes primitive aquatic arthropods
- Respiration - **Book gills**
- Excretion - **Coxal gland**
- Development-indirect

e.g.
1. ***Limulus*** King crab or Horse shoe crab (living fossil)

Arachnida (Octapoda)
- Cephalothorax bears 1 pair of Chelicerae, 1 pair of Pedipalps for feeding & 4 pairs of walking legs
- Antennae absent
- Respiration - **Trachea** or **book lungs**
- Excretion - **Coxal gland** or **Malpighian Tubules** or **both**
- Development- Direct

e.g.
1. ***Palamnaeus*** - Scorpion (viviparous and last segment modified into poison sting)
2. *Lycosa/Agelena*– Spider
3. Ticks and Mites

Crustacea
- Exoskeleton harden by impregnation of Ca salt. (Chitin + $CaCO_3$)
- Body has two division cephalothorax and abdomen
- Antennae -Two pairs
- Each segment bears a pair of **biramous (forked)** appendages modified for swimming, feeding (5 pairs)
- Respiration- **body surface** or **gills**
- Respiratory pigment is Haemocyanin
- Excretion- **Green glands**
- Development - indirect

e.g.
1. ***Palaemon*** - Prawn
2. *Cancer* - Crab
3. *Eupagurus*-Hermit crab
4. *Daphnia*-Water flea
5. *Cyclops* - Husband of 100 wives, single eye, No heart
6. *Astacus* - Cray fish

Diplopoda
- Worm like body with head, thorax and abdomen
- Each abdominal segment with 2 pairs of legs and poison claws absent
- Excretion - **Malpighian tubules**

e.g.
1. ***Julus*** - Millipede (Thousand leggers)

Chilopoda
- Body worm like and divisible into head and trunk
- Each segment with one pair of legs and poison claws present
- Excretion - **Malpighian tubules**

e.g.
1. ***Scolopendra*** - Centipede (Hundred leggers)

Insecta (Hexapoda) (75%)
- Body - Head, thorax, abdoman
- Head - 1 pair of antennae, compound eyes and mouth parts present
- Thorax - 3 pair of legs & one or two pairs of wings
- Abdomen - lacks appendages
- Respiration-**Tracheal system**
- Excretion - **Malpighian tubules**

Sub-class

Apterygota (Wingless insects)

e.g.
1. *Lepisma* - Silver fish
2. *Pediculus* - louse
3. *Cimax* - Bed bug
4. *Xenopsylla cheopsis* -Rat bug Transmits *Pasteurella* or *Yersina pestis* (Plague)

Pterygota (Winged insects)

e.g.
1. ***Bombyx*** - Silkworm
2. ***Apis*** - Honey bee
3. **Mosquitoes**
4. *Kalotermes* - Termite (Social insect)
5. ***Laccifer*** - Lac insect
6. ***Periplaneta*** - Cockroach
7. ***Musca*** - Indian house fly
8. ***Locusta*** - Locust (gregarious pest)

Onychophora

e.g.
1. ***Peripatus*** - Walking worm (Connecting link between Annelida & Arthropoda, Living fossil)
2. **Excretion** - **Nephridia**

USEFUL INSECTS

Honey bee (*Apis*) - Honey, Wax
Silk worm (*Bombyx*) - Silk
Lac insect (*Tachardia lacca/Laccifer*) - Lac
Dragon flies - Larvivorous (Mosquitoes)

HARMFUL ARTHROPODS (VECTOR FOR DISEASES)

Anopheles - Malaria
Culex - Elephantiasis
Aedes - Dengue/Yellow fever
Tse-Tse fly - African sleeping sickness
Sand fly - Kala-azar
House fly - Cholera, Diarrhoea, Dysentery, Gangrene, Intestinal fever
Bed-bug - Relapsing fever/Typhus
Louse - Trench fever

Larvae & Pupae

Caterpillar - Silkworm and Butterfly
Grub - Honey bee
Maggot - House fly
Wriggler - Mosquito
Zoea or **Megalopa** - Crab
Nauplius - Prawn

PHYLUM - ARTHROPODA

1. Arthropoda is the largest phylum of animalia which includes insects. Over two-thirds of named species on earth are arthropods.
2. They may be aquatic (marine and fresh water) or terrestrial, free living and sometimes parasitic.
3. Body is Bilaterally symmetrical Triploblastic with organ system level of organisation
4. They are metamerically segmented and coelomate animals.
5. Body is divided into three region Head. thorax & abdomen, but in some head and thorax fused to form cephalothorax (Prosoma)
6. Unique features

(i) They have jointed appendages for different functions. (arthro- jointed, poda - foot/appendages).
(ii) The body of Arthropods is covered by Chitinous exoskeleton.

7. Body cavity around viscera contains blood and the coelom filled with blood is called the haemocoel.

8. Digestive Tract is complete and they can feed upon all kind of food substances.

9. Respiration by gills (e.g. Prawn), Book-gills (e.g. King crabs). Tracheal system (e.g Insects), Book-lungs
(e.g. Scorpion), Trachea carry oxygen directly to the body cells.

10. Circulatory $!Jstem is Open type i.e. blood flows in open tissue spaces and hoemocoel instead of blood vessels. Blood is colourless called Haemolymph (e.g. Insect).Respiratorypigment absent. Copper containing pigment haemocyanin is found in some arthropods (e.g. Prawn).

11. Excretory organs are- Antennary or green glands (e.g. Prawn), Coxal gland (e.g. Scorpion), Malpighian tubules (e.g. Insects) opening into the gut.

12. Excretory matter is Ammonia in aquatic animals and Uric acid in land animals.

13. Nervous system comprises of a nerve ring and a double, solid and ventral nerve cord bearing ganglia.

14. Head is distinct [High digree of cephalization]

15. Sensory organs like simple eyes, or compound eyes or both, antennae, statocyst and anal cerci are found.

16. They are mostly dioecious. Fertilization is usually internal but few aquatic form has external fertilization. Gonads have ducts. Sexual dimorphism may be present. They are mostly oviparous.

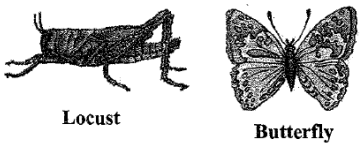
17. Development may be direct or indiret.

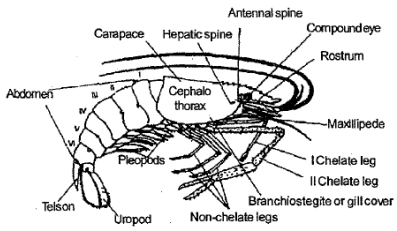
18. Animals of Arthropoda are most successful invaders of terrestrial enviornment among invertebrates due to presence of (i) Cuticle (ii) Appendages (iii) Wings

Examples:-

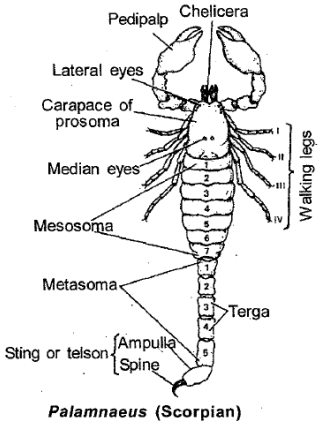
- Economically important insect- Apis (Honev bee), Bombyx {Silk worm), Laccifer (Lac insect)
- Vectors- Anopheles. Culex and Aedes {mosquitoes)
- Gregarious pest - Locusta (Locust)
- Living Fossil- Limulus (King crab)
- Others- Butterfly, Scorpion, Prawn, Spider, Cyclops, Centipede, Millipede, Peripatusetc.

FEW ARTHROPODS





Palaemon (Prawn)



Palamnaeus (Scorpian)

GOLDEN KEY POINTS

- **MOUTH PARTS IN INSECTS**
  (i) Biting and chewing - Grasshopper, Cockroach, Termites, Caterpillars.
  (ii) Piercing- sucking - Mosquitoes, Bugs, Tse-tse fly
  (iii) Chewing- lapping type - Honey Bee
  (iv) Sponging type - Housefly.
  (v) Siphoning type - Butterflies, moths
- Muscles are stripped/striated/voluntary (first time devepoled in Arthropods)
- Due to presence of joints, muscles are separate or arranged in bundles in them.

BEGINNER'S BOX-5

1. Biramous appendages are best represented in :-
(1) Insects (2) Crustaceans
(3) Annelida (4) Arachnida

2. The phylum Arthropoda is characterised by :-
(1) Chitinous exoskeleton, external segmentation and paired appendages
(2) Chitinous exoskeleton and antennae
(3) Chitinous exoskeleton, antennae and compound eye
(4) Chitinous exoskeleton, external segmentation and paired jointed appendages

3. Excretion in Arthropod animals takes place by:
(1) Malpighian tubules (2) Green glands
(3) Coxal glands (4) All of the above

4. Book -lungs are found in:-
(1) Scorpion (2) Prawn (3) Limulus (4) Cockroach

5. Which one of the following is most important feature of insects :-
(1) Compound eyes (2) Long abdomen
(3) Three pairs of legs (4) Two pairs of wings

6. Number of walking legs in a spider are :-
(1) Three pairs (2) Four pairs (3) Six pairs (4) Two pairs

7. Which of the following is a wingless insect?
(1) Lepisma (2) Termite (3) Moth (4) Apis

8. Book gills for respiration are found in ?
(1) House - fly (2) Termites (3) Ant (4) King-Crab

9. Members of phylum Arthropoda lack one of the following features :-
(1) External skeleton made of chitin (2) Compound eyes
(3) Excretion by malphigian tubules (4) Usually a close type of blood vascular system

10. Which of the following animal is not an Insect ?
(1) Tick (2) Honey bee (3) Beetle (4) Silkworm

PHYLUM – MOLLUSCA

1. It is second largest phylum which includes "Soft bodied and shelled" animals.

2. They are aquatic (marine or fresh water) or terrestrial.

- Study of molluscs is known as Malacology & study of shells of molluscs is known as Conchology.

3. Molluscs are bilaterally symmetrical. Few are secondarily asymmetrical (snail) due to twisting /Torsion during growth. They are triploblastic and coelomate animals with Organ system level of organisation.

4. Body is unsegmented with variety of shapes and covered with calcareous shell.

5. Body is divisible into three parts :
(i) Head with sense organs like eyes and sensory tentacles.
(ii) Dorsal visceral mass/ hump containing all visceral organs of body.
(iii) Ventral muscular foot for locomotion.

6. Soft and spongy layer of skin form a mantle or pallium over the visceral hump.

- The space between hump and mantle is called mantle cavity .
- The mantle usually secretes an external calcareous shell. Shell is made up of Calcium carbonate and Concheolin protein.

7. Digestive tract is complete. Buccal cavity contain a file-like rasping organ for feeding called Radula, with transverse rows of teeth. Anus opens into the mantle cavity.

8. Respiration is usually by feather like gills (Ctenidia) located in the mantle cavity which also helps in excretion. Pila respire by pulmonary sac on land and by gills in water.

9. Circulatory system is open type. It includes dorsal pulsatile heart and a few arteries that open into sinuses. (Cephalopoda has closed type of circulatory system eg Octopus, Sepia, Loligo)

- Coelom is greatly reduced. Spaces among the viscera contain blood and form haemocoel.
- Blood usually has a copper containing respiratory pigment called haemocyanin (Blue or green).

10. Excretory system includes 1 or 2 pairs Keber's organs or Organ of Bojanus, which open into the mantle cavity. Excretory matter is ammonia or uric acid.

11. Nervous system comprises three 3 or 4 pairs of ganglia.

12. Senses organs : (1) Eye - present over a stalk called ommatophore in some molluscs.
(2) Statocyst/Lithocyst - for body equilibrium in foot
(3) Osphradium- chemoreceptor/olfactory receptor for testing chemical nature of water (pH).

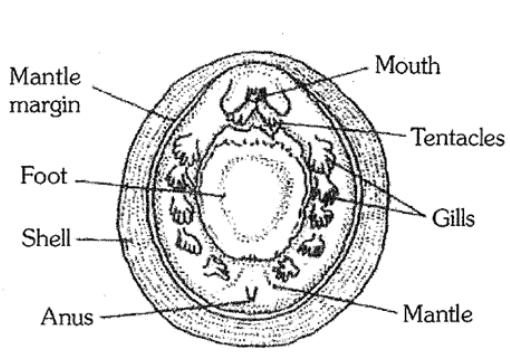
13. They are usually dioecious, they are mostly oviparous. Fertilization may be external or internal.

- Development is mostly indirect. Trochophore is very common latva of Molluscs, Glochidium (Larva of Unio) and Veliger (larva of Pila).

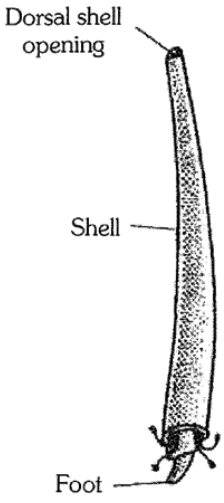
EXTRA POINTS :

- Precious pearl of the size of tennis- ball is made by a giant mollusc- Tridecna
- "Nacre layer" is called "Mother of Pearl" : This layer is made up of $CaCO_3$ and choncheolin protein.
- Molluscs are classified on the basis of shell and foot into six classes.

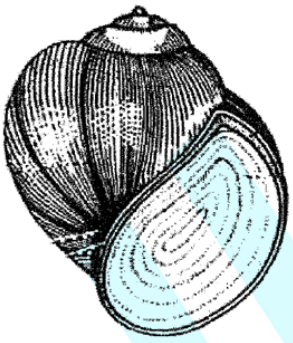
FEW MOLLUSCS



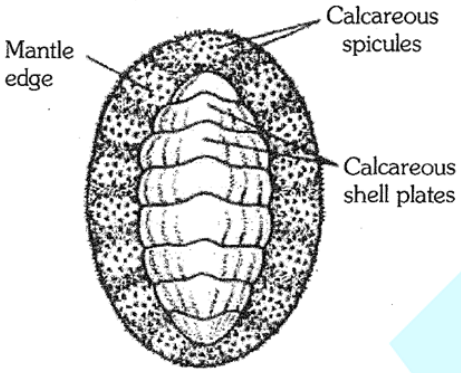
Neopilina



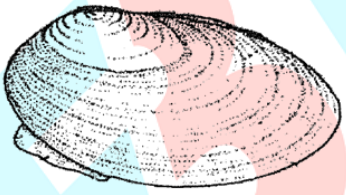
Dentalium



Pila



Chiton



Unio

Octopus

E.g.

1. Neopilina- Living fossil (Connecting link between Annelida and Mollusca)

2. Chaetopleura(Chiton) - "Coat of maU shell" or Sea-mica

3. Dentalium -Tusk- shell (Respire by mantle)

4. ***Pila*** - Apple-snail
5. ***Aplysia*** - Sea hare
6. *Doris* - Sea lemon
7. *Turbinella*- Shankh
8. *Planorbis* -Land snail
9. *Lymnea* - Land snail

] Shell is spirally coiled so animals becomes asymmetrical

10. Pinctada- Pearl oysters

11. Unio- fresh water mussel

12. Teredo- Ship worm

13. ***Octopus*** - Devil fish (8 arms) - Shell is absent
14. ***Sepia***-Cuttle fish (10 arms) - Shell is internal
15. ***Loligo*** - Squid (Radula absent)

] Belongs to class cephalopoda in which closed blood vascular system is present

PHYLUM - ECHINODERMATA

1. All are Marine. Generally live at bottom and slow moving.

- Body shape is star like, cylindrical, melon-like or disc-like.

2. The adult Echinoderms are radially symmetrical but larvae are bilaterally symmetrical.

3. They are triploblastic and coelomate animals with organ- system level of organisation. Echinoderms have true Coelom
- They do not have distinct head.

4. Skin of echinoderms contains calcareous spines, pedicellariae and endoskeleton consists of calcareous plate (dermal ossicle).
- Minute pincer like structure pedicellariae comes out through skin. They keep body surface clear of debris.

5. The most distinctive feature of echinoderms is presence of water filled ambulacral or water vascular system with tube feet to help in locomotion. capture and transport of food. excretion and respiration. A perforated plate madreporite permits entry of water into ambulacral system, Structures like- Tube feet, radial canals, tiedmann body and stone canal are also found in water vascular system.
6. Digestive tract is complete with mouth on lower side (ventral) and anus on the upper side (dorsal).
7. Respiration takes place by body surface or gills called dermal branchiae or papulae in most of Echinoderms like Starfish.
8. Circulatory system is reduced and open type. No heart or pumping vessel.
9. There is no excretory system. Nitrogenous waste ammonia diffuses out through body surface.
10. Nervous system is simple and less developed includes a Nerve ring and radial nerves with simple sense organ. They don't have head and brain.
11. Reproduction is sexual, sexes are separate (unisexual).
12. Fertilization is usually external and development is indirect with free swimming larva.

GOLDEN KEY POINTS

- Echinoderms have some chordate like characters like enterocoelic coelom, mesodermal skeleton and deuterostomic embryonic development.
- Few echinoderms (star fish) have great power of regeneration. They break off their arms for defence purpose. This phenomenon is known as Autotomy.
- Sea cucumbers in angry or frightened state vomits out viscera (internal organ). This phenomenon is known as Evisceration.

e.g.

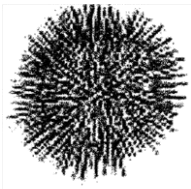
1. **Asterias** – star fish

STAR FISH

2. **Ophiura** -Brittle star
3. **Ophiothrix** - Brittle star

BRITTLE STAR

4. **Echinus** - sea urchin (arms are absent)
Mouth- with Aristotle's lantern i.e. Masticating apparatus with 5 teeth.



SEA URCHIN

5. **Cucumaria** (Sea rucurnber)
6. Holothuria (Sea cucumber) (Arms are absent)

SEA CUCUMBER

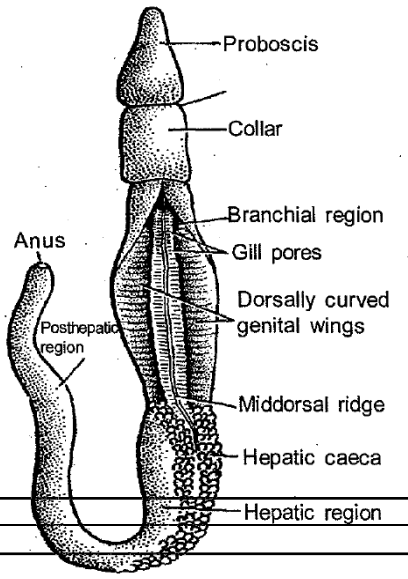
7. **Antedon** – (Sea lily)

SEA LILY

PHYLUM – HEMICHORDATA

Hemichordata is a connecting link between Non- chordata & Chordata.

1. Hemichordata was earlier considered as a sub-phylum of chordata. But now it is placed as a separate phylum under non-chordata.
2. This phylum consists of a small group of worm like marine animals with organ system level of organisation.
3. They are bilaterally symmetrical. triploblastic and coelomate animals.



Balanoglossus :
External features in dorsal view

4. The body is cylindrical, unsegmented and divided into three parts : anterior proboscis, middle collar and a posterior long trunk.

- Body cavity is enterocoelus, which is divided into Protocoel, Mesocoel and Metacoel.

5. Mostly ciliary feeders, digestive tract is complete.

6. A notochord like structure is found in their buccal cavity, that is called "Buccal diverticulum" or "Stomochord" (outgrowth of buccal cavity) but true notochord is absent.

7. Respiration takes place through gills.

8. Circulatory system is open type. Blood is colourless with amoeboid corpuscles. Respiratory pigment vanadium is present in some cases. Heart is situated dorsally.

9. Excretion occurs through a single glomerulus or proboscis gland.

10. Central nervous system is just like non chordates.

11. Reproduction is sexual and Mostly animals are unisexual

- Fertilization is external.
- Development is indirect with tornaria larva which is similar to bipinnaria larva of echinodermata in their developmental stages.

eg. **1. Balanoglossus :**-Tongue worm or Acorn worm
2. Saccoglossus

BEGINNER'S BOX-6

1. The connecting link between annelida and mollusca is:-
(1) Peripatus (2) Hirudinaria (3) Neopilina (4) Bonellia

2. Organ of Bojanus are found in :-
(1) Chordata (2) Echinodermata (3) Annelida (4) Mollusca

3. Molluscan which form hole in wood of ships is?
(1) Doris (2) Chiton (3) Teredo (4) Limax

4. Which animal becomes assymetrical due to torsion in body and shell :-
(1) Gastropods (2) Cephalopods (3) Pelecypods (4) All of the above

5. Which of the following is a mollusc ?
(1) Sea-horse (2) Sea-mouse (3) Sea-hare (4) Sea-cow

6. Water vascular system is found in:-
(1) Sycon (2) Leech (3) Fish (4) Star-fish

7. The animal with tube-feet is :-
(1) Star-fish (2) Jelly-fish (3) Silver-fish (4) Cray-fish

8. Which is the characteristic feature of Echinodermata?
(1) Smooth skin and radial symmetry
(2) Spiny skin and radial symmetry
(3) Spiny skin and bilateral symmetry
(4) Smooth skin and bilateral symmetry

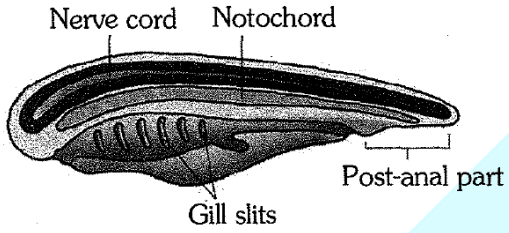
9. Excretory organ of Balanoglossus is :

(1) Protonephridia (2) Supra neural gland
(3) Solenocytes (4) Proboscis gland

10. The larval form of Hemichordata is called :-
(1) Trochophore (2) Tornaria (3) Tadpole (4) Ammocoete

PHYLUM CHORDATA

- The term chordata is originated by the two words of Greek language the 'Chorda' and the 'Ata'. Meaning of 'Chorda' is 'a thick string' and meaning of 'ata' is 'to have' and over all meaning of chordata is animals having notochord.
- So, chordates are the animals in which notochord is present in any stage of their life - span.
- According to taxonomists, 90 - 95% animals are non-chordates of the total animals present on earth, and rest of the 3 - 5% animals are chordates.
- In chordates, species with maximum living animals belong to Pisces group and with minimum living species belong to Mammalia group.



Chordata characteristics

Fundamental Characters of Chordates :
These are as follows :-

1. **Presence of notochord/Chorda dorsalis :-** In the embryonic stage of chordates there is a solid rod like structure (Just below the nerve cord and above the alimentary canal), this is called notochord.

- Notochord is extended from anterior end to posterior end of the body at the dorsal surface.
- Notochord is mesodermal in origin. It forms a primary endoskeleton which gives support to body.
- In - Protochordata group , notochord is not replaced by vertebral column but in vertebrata, it is replaced by back bone or vertebral column in adults.

2. **Presence of Dorsal Hollow Nerve Cord :-**
In chordates central nervous system is situated at the dorsal surface of body.

- In these animals, single, hollow, tubular nerve cord is present beneath the bodywall and just above the notochord.
- Nerve cord is ectodermal in origin.

3. **Presence of paired pharyngeal gill - slits :-**

- In each chordate there are present paired lateral gill clefts in the walls of pharynx for respiration in any stage of its life span.
- In aquatic chordates (pisces) and lower chordates, pharyngeal gill clefts are present throughout their life span for respiration.
- In terrestrial chordates, gill clefts are found only in embryonic stage and are absent in adults, because main respiratory organs are lungs in them.

4. **Post anal tail :-** In chordates tail if present is the post anal part of the body. Tail is reduced or absent in many adult chordates.

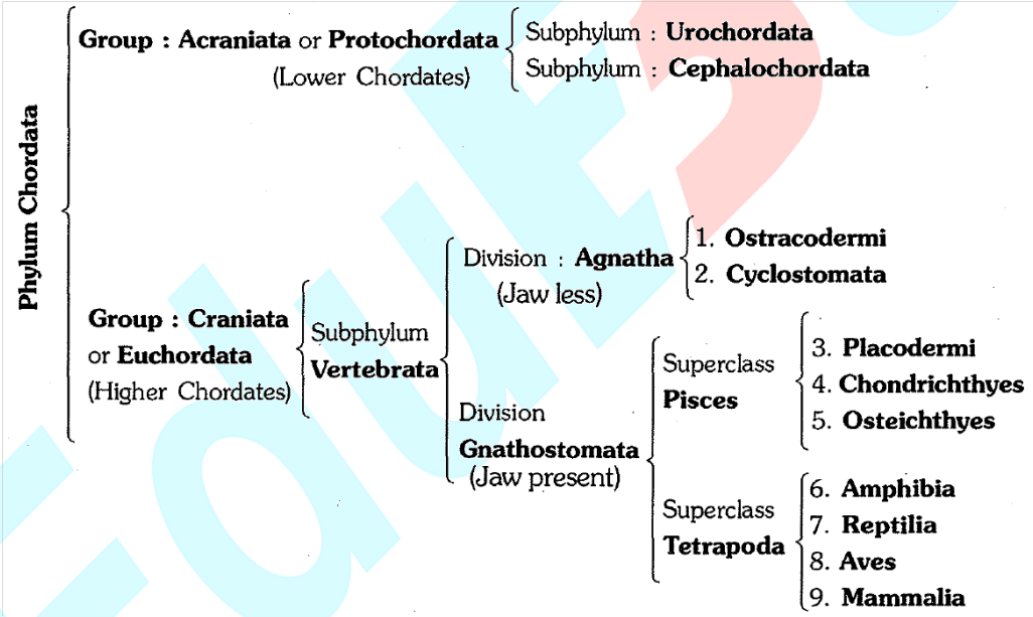
S. No.	Chordates	Non-chordates
1.	Notochord present.	Notochord absent.
2.	Central nervous system is dorsal, hollow and single.	Central nervous system is ventral, solid and double.
3.	Pharynx perforated by gill slits.	Gill slits are absent.
4.	Heard is ventral in position.	Heart is dorsal or lateral in position. (if present).
5.	A post-anal part (tail is present.	Tail if present is pre anal part (Post-anal tail is absent)

- Chordates are bilaterally symmetrical, triQloblastic, coelomate with organ system level of organisation. They have a closed circulatonz system.

CLASSIFICATION OF CHORDATA

- Phylum chordata is divided into two groups on the basis of cranium, vertebral column and paired appendages :-

[A] Acraniata or Protochordata [B] Craniata or Euchordata



Grooup : Acraniata or Protochordata

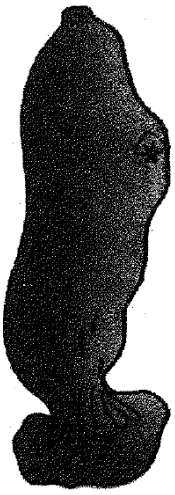
- Protochordates are exclusively marine.
- Pharyngial gill clefts are found throughout the life for respiration.
- Notochord is present in larval stages or persists throughout the life, but skull, brain and vertebral column is absent in them.
- Notochord is not replaced by vertebral column, hence they are chordate but not vertebrate.
- Protochordata is divided into two subphylum :-

  Subphylum - 1-Urochordata

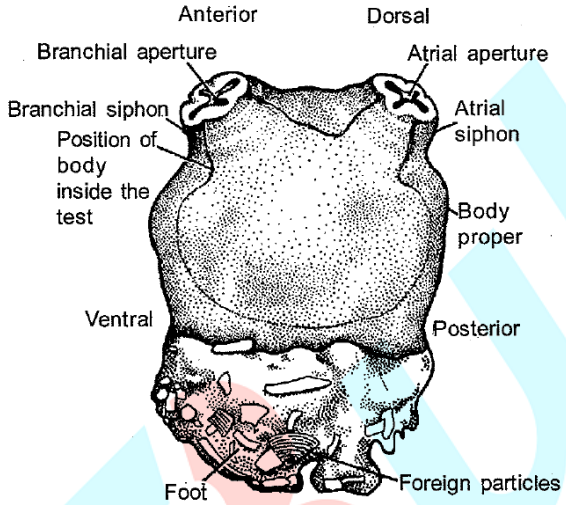
Subphylum - 2-Cephalochordata

SUB-PHYLUM - UROCHORDATA OR TUNICATA

- All the members of this subphylum are exclusively marine, free swimming or attached with rocks.
- Adults are normally fixed but larva is free swimming.



Ascidia



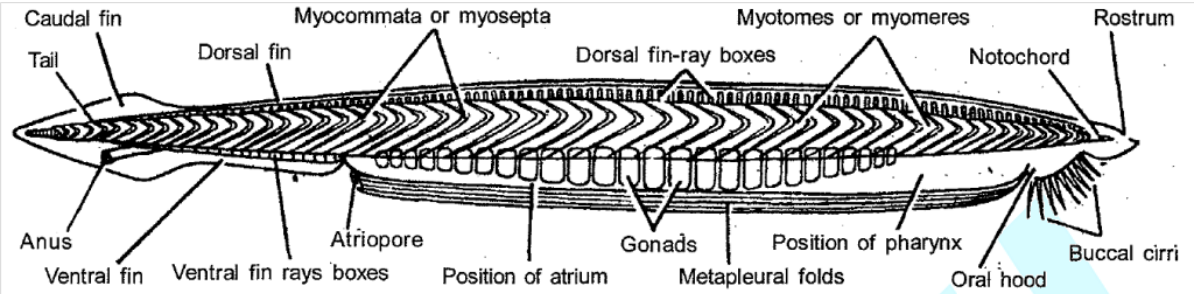
Herdmania

- All the adult members have test all over their body, made up of a cellulose like substance called tunicin so these animals are also called .tunicates.
- Notochord is found only in tail of larva which is lost during metamorphosis. Since chordate characters are found only in the tail region of tadpole larva, so the name Urochordata was given to this subphylum.
- Dorsal tubular nerve cord is found only in larval stage. In adult stage, this nerve cord is replaced by a neural ganglion.
- All chordate characters are found in larva. Only one chbrdate character is found in adults i.e. pharyngeal gill clefts.
- They are ciliary feeder.
- Blood vascular system is open type, heart is situated at ventral surface of body.
- Excretion is by supra neural gland/pyloric gland and nephrocytes.
- Most of the animals are bisexual.
- Fertilisation is external and mostly cross-fertilisation.
- A free swimming larval stage is found in this group, just like tadpole of Frog, it is also called tadpole larva.
- All the members of this subphylum show "Retrogressive metamorphosis". During this metamorphosis, a well developed free swimming larva is changed into less developed adult. Endostyle absorbs iodine from water and is homologous to thyroid gland of mammals.

e.g.:

1. Ascidia
2. Doliolum
3. Salpa
4. Herdmania - Sea - potato or sea - squirts.

SUB-PHYLUM – CEPHALOCHORDATA



***Branchiostoma* : Entire animal in right side view**

- They all are found in shallow sea water.
- Both larva and adult are free swimming forms.
- Animals form burrows in sand and are nocturnal.
- Body is laterally compressed like fish, and is segmented.
- Notochord and nerve cord remain extended from anterior to tail region. Notochord persists throughout life.
- Alimentary canal is complete. Buccal opening is covered by oral hood and this collectively termed as "Wheel organ" or "Ciliated organ of Muller". This organ helps in the ingestion of food by producing circular currents in water (Ciliary feeder).
- Blood vascular system is closed type and respiratory pigment absent.
- For excretion protonephridia are present in the form of flame cells or solenocytes. Hatschecks nepheridium (single) is present which helps in excretion.
- Fundamental chordate characters remain throughout life. Larva and adult both show chordate characters.
  Therefore, they are considered as first complete chordate animals or typical chordates.
- These are unisexual animals.
- Fertilisation is external.
- Development is indirect i.e. larval stage is found.
  e.g. :- Branchiostoma or Amphioxus (Lancelet)

SUB-PHYLUM - VERTEBRATA

- The members of subphylum Vertebrata possess notochord during the embryonic period. The notochord is replaced by a cartilaginous or bony vertebral column in the adult. Thus all vertebrates are chordates but all chordates are not vertebrates. Besides the basic chordate characters. vertebrates have a ventral muscular heart with two, three or four chambers, kidneys for excretion and osmoregulation and paired appendages which may be fins or limbs.

Subphylum vertebrata is divided into two divisions :-

(i) Agnatha = Jaws absent (ii) Gnathostomata = Jaws present

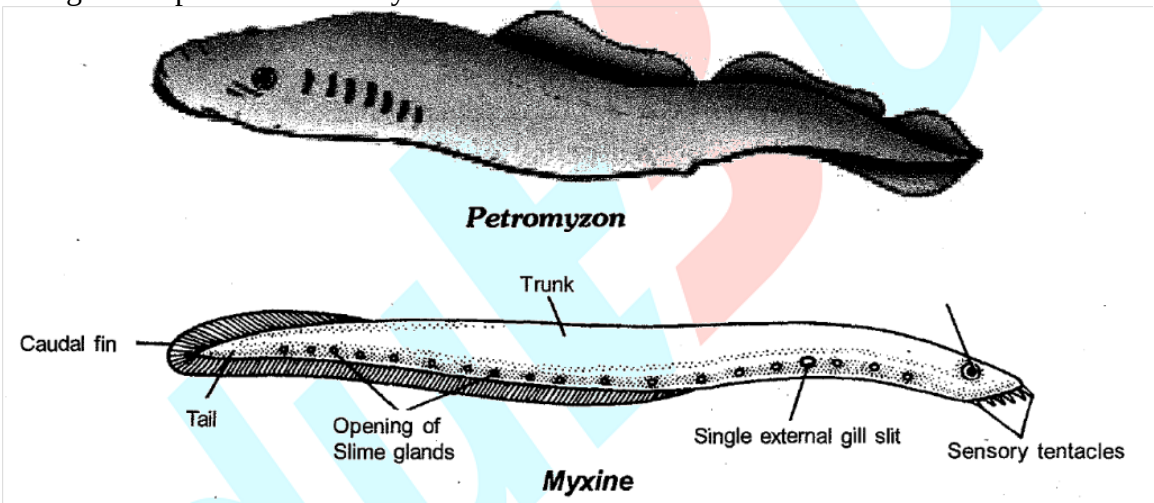
- Group Agnatha is divided into two classes.
  [A] Ostracodermi [B] Cyclostomata

Class [A] - Ostracodermi

- All the members of this class are extinct. These were freshwater fishes which were first vertebrates ..
- Their body was covered by a protective covering made up of hard scales.
  e.g. :- Cephalaspis.

Class [B] - Cyclostomata

- This class includes Jaw less fishes (false - fishes).
- Most of the members of this class are marine but migrate for spawning to fresh water. After spawning within few days they die. Their larvae, after metamorphosis, return back to Ocean.
- These fishes are ectoparasite as well as scavanger.
- They have elongated body bearing 6-15 pairs of gill slits for respiration.
- They have a sucking and circular mouth without jaws.
- Scales and paired fins are absent.
- Notochord and vertebral column both are present. Cranium and vertebral column are cartilaginous. Bones are absent.
- Circulation is closed type, Heart is two - chambered. It is called Venous - heart.
- Kidneys are protonephric or mesonephric type.
- Three eyes are found on the head, one median pineal eye and two lateral eyes.
- Only one Nostril is present (Monorhynous).
- Internal ear contains one or two semicircular canals. Internal ear works as statoreceptor only. (For balancing)
- Animals unisexual, fertilization external, larval stage absent. Except Ammocoete larva is found during development of Petromyzon.



e.g. 1. Petromyzon or Lamprey :- It is an ectoparasite (Sanguivorous) on true fishes. Many teeth are found in mouth and it shows Anadromous migration. Its larva is Ammocoete. This Ammocoete larva is considered as connecting link between Cephalochordata and Cyclostomata.

2. Myxine or Hag fish :-It has wrinkled lips just like an old woman. It usually remains attached with the gills of host.

BEGINNER'S BOX-7

1. Which one of the following is a chordate but not a vertebrate :
(1) Scoliodon (2) Hag fish (3) Amphioxus (4) Star fish

2. Bioluminiscent chordate is :-
(1) Pyrosoma (2) Doliolum (3) Salpa (4) Botryllus

3. "Wheel organ" is found in :-
(1) Herdmania (2) Amphioxus (3) Balanoglossus (4) All the above

4. "Sea - squirt" is common name of :-
(1) Balanoglossus (2) Herdmania (3) Amphioxus (4) Ascidia

5. Chordates are distinguished from non chordates by the presence of :-
(1) Brain (2) Dorsal hollow tubular nerve cord
(3) Ventral nerve cord (4) Dorsal nerve cord

6. In which one of the following group, brain box is absent :-
(1) Cyclostomata (2) Pisces (3) Amphibia (4) Urochordata

7. Which of the following is the larva of Petromyzon ?
(1) Ammocoete (2) Bipinnaria (3) Tadpole (4) Tornaria

8. Circular and suctorial mouth is present in :-
(1) Labeo (2) Petromyzon (3) Scoliodon (4) All the above

9. Jaw less fishes are included in :-
(1) Chondrichthyes (2) Osteichthyes (3) Cyclostomata (4) Lung fishes

10. Notochord is found only in the tail of Larva in -
(1) All chordata (2) Hemichordata (3) Urochordata (4) Cephalochordata

Super Class – Pisces

- This super class includes true fishes.
- "Devonian period" is called as "Golden period of fishes"
- Study of fishes is Icthyology.
- They are cold blooded {Poikilothermous) animals i.e. they lack the capacity to regulate their body temperature.
- They are aquatic, may be fresh water or marine.
- Body is long, boat shaped and stream lined, which is divided into head, trunk and tail. Neck is absent.
- Body is covered by dermal scales. But Cat fish, Torpedo & Wallagonia fishes are scale less.
- Paired fins are present for swimming. e.g. Pectoral and pelvic fins. Along with these unpaired fins are also found on the body e.g. mid dorsal fin and caudal fin.
- External nares are one pair. (Dirhynous condition)
- External and middle ears are absent, only internal ear is present which works as statoreceptor. (For balancing)
- Respiration by JJills, which are naked or covered by operculum.
- Teeth are Acrodont.
- Heart is two chambered. known as "Venous heart", because it contains only impure blood, which goes to gills for purification from heart, pure blood is then distributed to all parts of body directly from gills. i.e. single circulation of blood.
- RBC are nucleated. Sinus venosus, renal and hepatic portal systems are found in circulatory system.
- In the skull of fishes only one occipital condyle is present, so their skull is called monocondylar type.
- Cranial nerves are 10 - pairs.

- Lateral line sensory system is present in the body of all fishes and tadpole larva which includes many receptor organs which can detect vibrations (Rheoreceptor) and Electric field.
- Kidneys in fishes are mesonephric type, Urinary bladder is absent.
- Cartilagenous fishes excrete Urea, marine bony fishes excrete Trimethyl amine oxide and fresh water bony fishes excrete Ammonia.
- Fishes are unisexual.
- Fertilization is internal or external.
- Development is direct i.e. larval stage is lacking during development.
- Baby fishes are called Fry or Hatchling.
- Super class pisces classified into three classes :-
  (A) Placodermi (B) Chondrichthyes (C) Osteichthyes

[A] Class - Placodermi

- In this class, extinct fishes (Fossil fish) are included, which lived from devonian period to permian period. So these were the first fresh water true fishes.
- Their body was covered by bony plates, so these are called "Armoured fishes"
  e.g. :- Climatius - First jawed fish

[B] Class - Chondrichthyes or Elasmobranchi

- This class includes cartilaginous fishes.
- They are exclusively marine.
- Endoskeleton is made up of cartilage. Notochord is persistent through out the life.
- Exoskeleton over the skin is made up of placoid scales. Teeth are modified placoid scales, which are backwardly directed.
- In these fishes. 5 - 7 pairs of gills are present, which open directly outside the body by gill slits. Operculum is normally absent in these fishes.
- Mouth is present at the ventral surface of head. Jaws are vety powerful. These fishes are predaceous.
- Due to absence of air - bladder they have to swim constantly to avoid sinking .
- A spiral valve or scroll valve is found in intestine.(To increase absorptive surface area)
- Cloacal aperture is present. Genital ducts open into cloacal aperture.
- There is a special structure at the dorsal surface of head in these fishes, which is called "Ampulla of Lorenzini", which works as electroreceptor organ.
- Liver is bilobed
- Male fishes have "Claspers" as copulatoty organs. which are developed on pelvic fins.
- They bave internal fertilisation and many of them are Viviparous.

e.g. :-

1. **Scoliodon :-** Dog fish or common Indian shark - Dog like sense of smell. It is viviparous
2. **Pristis :-** Saw - fish
3. **Trygon :-** Sting ray - Its dorsal fin has poisonous spines.
4. **Torpedo :-** Electric ray - In this fish an electric organ is found which is a modified muscle, it can give shock averaging 100-400 volts.
5. **Carcharodon :-** Great white shark
6. **Chimaera :-** "Rat fish" or "King of herrings" or Ghost fish. Connecting link between bony & cartilaginous fish. Operculum present and cloaca absent like in bony fishes.\

[C] Class - Osteichthyes or Teleostomi

- This class includes Bony fishes.
- They are found in fresh water as well as marine water.
- Endoskeleton is made up of bones, so these fishes are called 'b!>ny- fishes"
- Their exoskeleton is made up of scales, which may be cycloid or ctenoid organoid Jype. (Placoid scales absent).
- Respiration by 4 - pairs of gills. These gills are covered by operculum at each side of body.
- Mouth is normally terminal.
- Helping respiratory organs "air bladders" are present. These air bladders are hydrostatic i.e. help in maintaining balance of body and provide Buyoncy.
- Scroll valve in intestine is absent.
- Cloaca absent, in place of cloacal aperture anus is present. Genital ducts open outside the body through separate apertures.
- Ampulla of Lorenzini is absent.
- Liver is Trilobed
- Fertilization is usually external, claspers are absent in male fishes.
- They are mostly oviparous.

Examples:-

1. **Hippocampus :-** "Sea- horse" or "Pregnant male" : It swims in sea water in vertical position. A pouch like structure is present at the abdomen of male fishes known as "Brood - pouch" in this pouch male collects the eggs. Secondary vivipary and parental care is found.
2. **Exocoetus (flying fish) :-** Its dorsal fin is long, it can fly (glide} over 400 metre in sea water with the help of enlarged pectoral fin.
3. **Labeo :-** "Rohu" or "Indian carp" (fresh water fish}.
4. **Clarias :-** "Cat fish" or Magur (Fresh water}
5. **Catla :-** Katla (Fresh water}
6. **Betta :-** Fighting Fish (Aquarium fish}
7. **Pterophyllum :-** Angel Fish (Aquarium fish}
8. **Latimeria or coelacanth :-** living fossll or oldest living vertebrate known till now.
9. **Gambusia :-** Larvivorous fish and is viviparous.
10. **Wallagonia :-** Lachi (scale less)

LUNG FISHSES (GROUP - DIPNOI) :- Uncle of amphibia

- These are freshwater bony fishes and have some amphibian like characters.
- Air bladder helps in respiration and can survive out of water.
- Three chambered heart is present.
- External and internal both the nares are present.
- Scales are cycloid type.

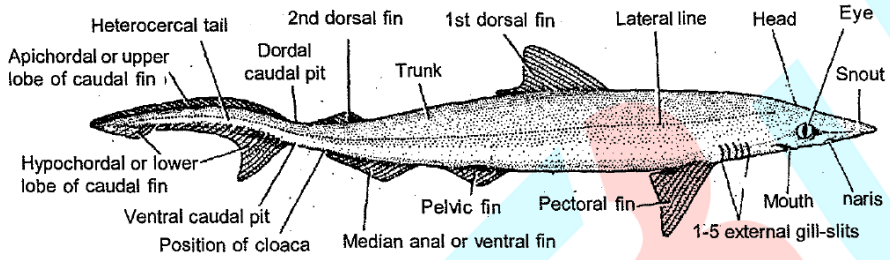
e.g. :-

- **Protopterus :-** African lung fish (living fossil)
- **Lepidosiren :-** South American lung fish

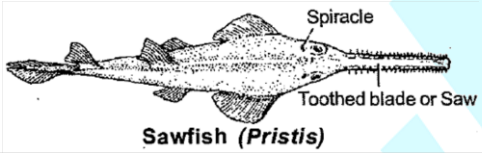
GOLDEN KEY POINTS

- Shagreen is dried skin of Cartilaginous fish (shark) .
- Cod liver oil is rich in Vitamin D,Shark liver oil is rich in Vitamin A
- Maltese cross is found in vertebrae of Shark for supporting vertebrae.

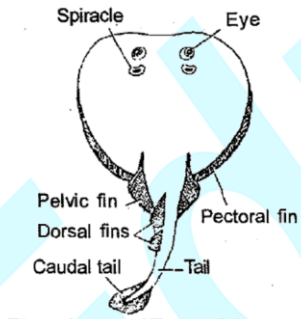
- Mermaid's purse refers to Egg capsule of Shark.
- Isinglass is a gelatinous product obtained from air bladder of certain fish and used for making cement, Jelly & for clarification of wine & beer.
- Smallest fish Mystichthyes- Goby fish- Pandaka (8-10 mm)
- Stone fish is the most poisonous fish.
- Fishes can change their direction suddenly, with help of caudal fin.
- Fishes show a seasonal migration in a particular season.
  - **[A] Catadromous migration :-** Migration of fishes from fresh water to marine water. e.g. Anguila
  - **[B] Anadromous migration :-** Migration of fishes from marine water to fresh water. e.g. (1) Salmon, (2) Sturgeon, (3) HiLsa
- Pyrosoma - Bioluminescence is found. (Strongest light among marine organism)
- Rhincodon :-Whale shark- It is the largest true fish. Its length is 13 - 14 meters.



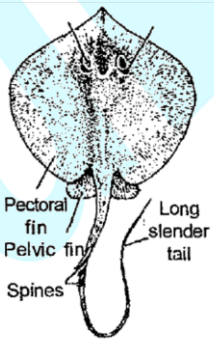
Female Indian dogfish shark (***Scoliodon***)



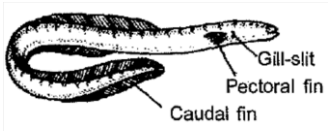
Sawfish (*Pristis*)



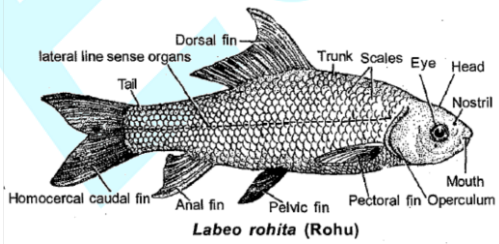
Electric ray (*Torpedo*)



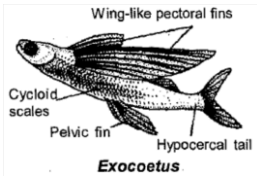
Sting ray (*Trygon*)



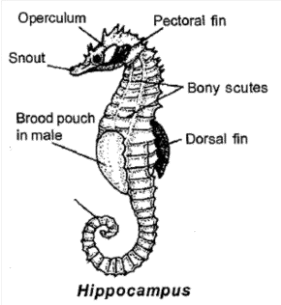
Anguilla



***Labeo rohita* (Rohu)**



Exocoetus



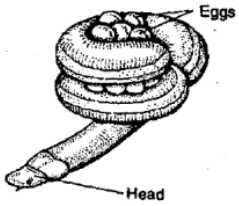
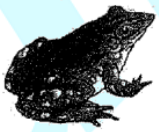
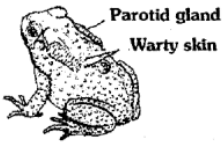
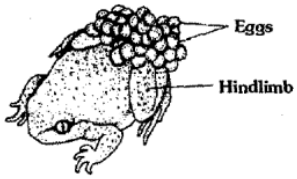
Hippocampus

Class - Amphibia

- Carboniferous period is the golden age of Amphibians
- Class amphibia includes animals which can live on both the places at ease i.e. - under water and on the land. (Never found in marine water).
- These are the first chordate animals which came out of water but these are not able to live on land permanently,
- They depend on water for their reproduction. Their eggs do not have protecting covering to check the evaporation.
- These animals undergo hibernation or aestivation to prevent themselves from extreme cold and heat and to overcome unfavourable conditions.
- Body is divided into head & trunk. Tail may be present in some. Neck is totally absent.
- Skin is moist. smooth and scale less .
- Numerous mucus glands are found in skin which help in the moistening of skin. So these animals respire mainly through moist skin (Cutaneous respiration).
- Most of them have two pairs limbs. Forelimbs have four fingers and hindlimbs have five fingers.
- Mouth is bigger in size. Upper or both the jaws have teeth. Teeth are pleurodont, homodont and polyphyodont. (Frog- Acrodont)
- A well developed and complete alimentary canal along with digestive glands are present in digestive system (Salivary glands are absent in frog).
- Alimentary canal, urinary bladder and genital ducts open into a common chamber called cloaca, which opens to the exterior.
- Respiration by gills, skin, lungs or buccopharyngeal cavity.
- These are cold blooded or poikilothermal animals.
- Heart is three chambered, 2 auricles and 1 ventricle (arteriovenous).-Sinus venosus and Truncus arteriosus are well developed.
- R.B.Cs are biconvex, oval and nucleated.
- Renal portal system and hepatic portal system are present.
- 1 pair of kidneys are mesonephric or opisthonephric type. They are mostly Ureotelic. But tailed amphibians and larvae are Ammonotellic.
- Skull has two occipital condyles (dicondylic skull).
- A tympanum represent the ear. Only one ear ossicle columella (stapes) is present in middle ear. External ear absent
- Eyes have eyelids.
- Cranial nerves are 10 - pairs.
- Sexes are separate.

- Fertilization is external and takes place in the water, but some animals show internal fertilization.
- These are oviparous, which lay their eggs in water.
- Development is indirect through larva
  i.e. **Tadpole larva** - In Frog,
  Axolotl larva - In Salamander

This class is divided into three orders :-
(A) Gymnophiona or Apoda
(B) Caudata or Urodela
(C) Anura or salientia

Gymnophiona (Apoda)	Caudata (Urodela)	Anura (Salientia)
e.g. ***Ichthyophis*** (limbs absent)  Wormlike Primitive Limbless Scales present Blind and deaf	Head, trunk and tail present (Tailed amphibia) e.g. 1. ***Salamandra*** -  Viviparous, Axolotl larva. Sometimes show neoteny 2. ***Amphiuma*** - Congo-eel Largest RBC is present.	e.g. 1. ***Rana tigrina*** -  Indian bull frog. 2. ***Bufo*** - Common toad  3. ***Hyla*** - Tree frog 4. ***Alytes*** - Midwife toad 

BEGINNER'S BOX-8

1. Air bladder is present in :-
(1) Dog fish (2) Flying fish (3) Hag fish (4) Electric fish

2. Ampulla of Iorenzini are found in :-
(1) Scoliodon (2) Labeo (3) Rattus (4) Hippocampus

3. Which of the following fish is a connecting link between cartilaginous and bony fishes

(1) Chimaera (2) Rhineodon (3) Latimaria (4) Whale

4. American lung fish is :-
(1) Scoliodon (2) Lepidosiren (3) Protopterus (4) Neoceratodus

5. Amphibians have:-
(1) Incomplete double circulation (2) Complete double circulation
(3) Open circulation (4) Single circulation

6. The amphibians are characterized by :-
(1) Only aquatic habit
(2) Monocondylar skull
(3) Scaleless, smooth moist and glandular skin
(4) Claws present at the tip of digits

7. Which of the following are viviparous usually :-
(1) Lung fishes (2) Frog (3) Sharks (4) Bony fishes

8. "King of Herrings" is a common name of:-
(1) Scoliodon (2) Chimaera (3) Torpedo (4) Neoceratodus

9. The fish that swims vertically :-
(1) Scoliodon (2) Hippocampus (3) Exocoetus (4) Syngnathus

10. "Water dog" is -
(1) Salamandra (2) Necturus (3) Alytes (4) Icthyophis

REPTILIA

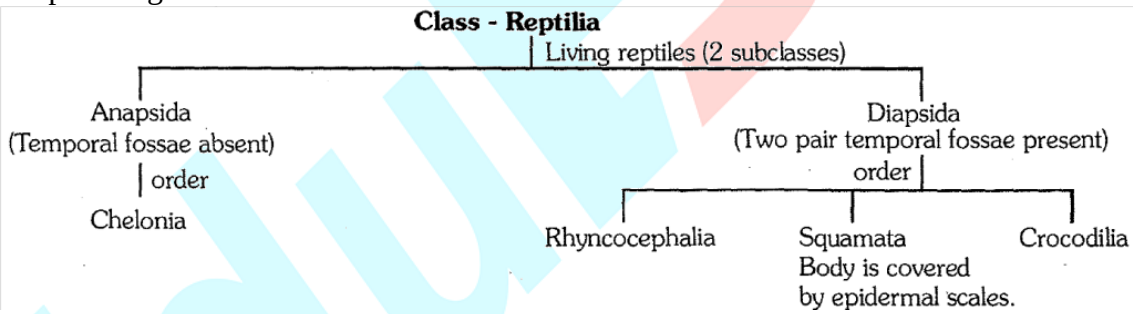
- Class name refers to creeping or crawling mode of Locomotion. (Latin reptum- To creep or Crawl)
- Mesozoic era was the Golden age of Reptiles.
- Study of reptiles is known as "Herpetology".
- These are Cold blooded/Poikilothermal animals.
- Reptiles were the first successful terrestrial vertebrates but some are also found in aquatic habitat.
- Body is divided into head. neck, trunk and tail.
- Exoskeleton is made up of horny epidermal scales or scutes.
- Skin is dry, cornified, rough and nonglandular. Snakes & Lizard shed their scales as skin cast.
- Limbs, when present are two pairs and each limb has five digits. Each digit has incurved nails. (Snakes are limbless)
- A complete alimentary canal is found in these animals, which opens into cloaca.
- Teeth are acrodont, pleurodent and thecodont type. Tounge is protrusible.
- Respiration occurs through lungs throughout the life.
- Heart is usually 3 chambered but 4 chambered in crocodiles, right and left both systemic arches are present.
- Sinus venosus is ill developed and trunkus arterious is absent. RBCs are oval and nucleated.

- Only one occipital condyle is present in skull,(monocondyler skull).
- Ribs are present in neck and thorax region.
- One pair of Metanephric kidneys are present for excretion and osmoregulation. These animals are uricotelic for water conservation.
- Brain is well developed and 12- pairs of cranial nerves are present. They do not have external ear opening. Tympanum represents ear.
- Lateral line system is absent. At the roof/cieling of buccal cavity Jacobson's organ (olfactory) is present.
- Ureters, genital ducts and alimentary canal open into a single cloacal aperture.
- These are unisexual animals. Fertilization is internal. One or two penis (Hemipenis) is found in male animals as copulatory organ.
- They are mostly oviparous.
- Eggs are leathery and cleidoic, i.e. eggs are covered by a shell made up of $CaCO_3$
- Development direct i.e. larva stage is absent.
- Parental care is often marked.

GOLDEN KEY POINTS

In reptiles, birds and mammals, All the three embryonic membranes amnion, chorion and allantois are present in the embryo. Yolksac is also attached with embryo these classes are grouped under Amniota group, so reptiles are first amniotes, while fishes and amphibians are grouped under Anamniota group because extra embryonic membranes are absent in them.

- Class Reptilia is classified on the basis of presence or absence of temporal fossae in the temporal region of skull and on their number.



Order – Chelonia

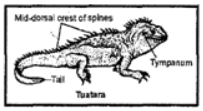
- They are terrestrial, marine and fresh water animals.
- Whole body is covered by firm bony shell, dorsal plate is called **carapace** and ventral plate called **plastron**.
- Jaws are horny **beak like** and **teeth less.**
- Scales are found on **neck**, **limbs** and **tail**. All these three organs can be pushed into the **carapace**.
- Thoracic vertebrae and **ribs** are attached with **carapace**.
- Cloacal aperture is vertical and it helps in respiration (cloacal respiration).
- **Single** copulatory organ is found in male animal.

e.g.

1. ***Testudo*** – Land tortoise
2. ***Chelone*** – Marine Turtles
3. *Trionyx* – Fresh water Terrapins (Edible)
4. *Kachhuga tactum* – Roofed tectum

Order – Rhynchocephalia

Sphenodon punctatum – Commonly called Tuatara in local language of **Newzealand. (living fossil)**



- Study of lizards is called **"Saurology"**
- Eyelids are **movable** Lizards have limbs, urinary bladder, tympanum, girdles and nictitating membrane in the eye.
- **Foramen of panizzae** is present in the heart of lizard.

e.g.

1. ***Hemidactylus*** - Common lizard/**wall lizard**. It can shed its own tail at the time of emergency. It is called **autotomy**. Power of regeneration is well marked.
2. ***Calotes*** - **Blood sucker/ Garden lizard/Girgit.** It can change its colour according to environment.
3. ***Chameleon*** - **Tree lizard** (Viviparous)
4. *Draco* - **Flying lizard.** It can glide from one tree to another tree with the help of lateral skin extensions called patagia.
5. *Varanus* - **Goh** or **Monitor lizard.** *Varanus komodoensis* (Komodo Dragon) is the **Largest living lizard**
6. *Ophiosaurus* - It is limbless lizard. It is also called glass - snake.
7. *Heloderma* - Gila - monster. It is the **only poisonous lizard**. Its poison glands are modified sublingual salivary glands (Mexico & USA).

- The study of snakes is called **ophiology** or **serpentology**.
- Girdles and limbs are absent **(Limbless)**.
- Eyelids are immovable and nictitating membrane in eyes are absent.
- Urinary bladder **absent.**
- Tympanum, middle ear absent.
- Tongue thin, long and **bifid** and sensitive to odour and vibration.
- Left lung is ill developed.

- These are amphibious in nature and live in lakes or rivers.
- These are **largest modern reptiles**.
- Skin is covered by **bony scutes/bony plates.**
- Body is solid and massive.
- Snout is long. External nares are situated at the distal end of snout and nares have cover also.
- They have some mammal like features - **diaphragm**, **thecodont teeth** and **4-chambered heart.**
- Urinary bladder **absent**.

e.g.

1. ***Crocodilus*** **(Crocodile)** - It is found only in Indian subcontinent.
2. ***Alligator*** - Maxican crocodile.
3. *Gavialis* - Gharial. Snout very long.

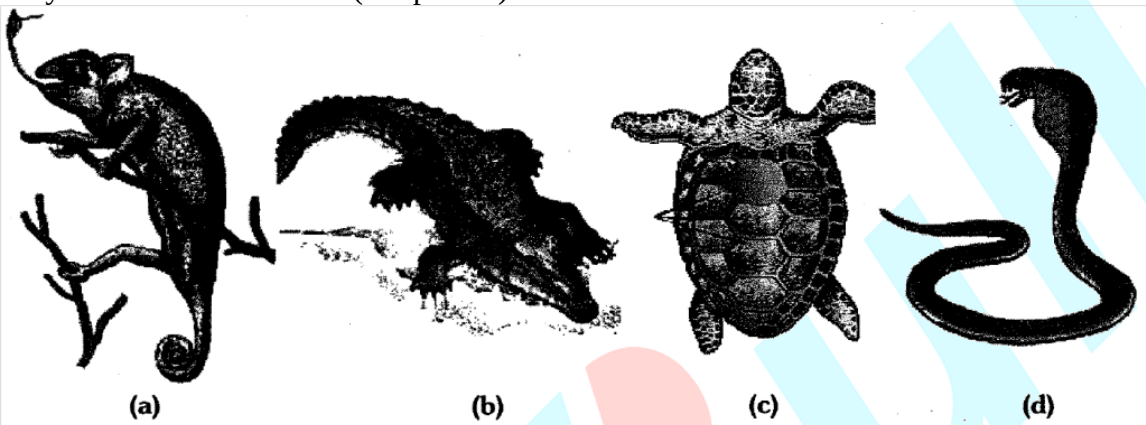
e.g.

1. **Vipera** - Viper snake : Head is differentiated from bcx:ly. Poisonous and viviparous snake. Its venom is haemotoxic/Cardiotoxic. Loreal pit is found which is a thermoreceptor.
2. **Bangarus** - Krait : Poisonous snake (neurotoxic).
3. **Naja naja** - Indian cobra. Poisonous snake (Neurotoxic).
4. **Naja bungarus or N.Hannah** - King cobra, poisonous snake. It is the largest snake among poisonous snakes (Head with one or two circular mark).
5. **Hydro phis** - Marine, deadly poisonous, tail is laterally compressed and viviparous snake.
6. **Crotalus** - It produces a characteristic rattling sound of "Rate - rate- rate", so it is called rattle snake. It is poisonous and ovoviviparous snake.
7. **Python molurus** - Ajgar, the largest non-poisonous snake (25 feet). Rudiments of hind limbs are found on the body.
8. **Ptyas mucosus or Zamenis** - Rat snake. It is commonly called Dhaman. It feeds on rats, so it is also called "Friend of farmers". It is a non-poisonous snake.
9. **Eryx Johni** - Sand boa, Dumuhi, a non-poisonous snake.

GOLDEN KEY POINTS

- Poison glands of poisonous snakes are modified labial glands. Probably these glands are homologous to parotid salivary glands of Mammals.
- Poisonous teeth (fangs) are modified maxillary teeth.
- Treatment of poisonous snake bite is done by antivenom dose. It is produced at
  (1) Central Research Institute, Kasauli- Shimla
  (2) Haffkine Institute, Mumbai.

- ♦ Biggest Serpentarium is located in India - Chennai
- ♦ Characteristic features of poisonous snakes :
  (1) Small scales are found on head or hood.
  (2) Laterally compressed tail is present in marine snake.
  (3) Ventrally placed scales of the body are broad.
  (4) Two deeper teeth mark is of poisonous snake. (A - shaped - Non posionous)
- ♦ Phrynosoma - Homed toad (viviparous)



Reptiles : (a) *Chameleon* (b) *Crocodilus* (c) *Chelone* (d) *Naja*

BEGINNER'S BOX-9

1. Only poisonous Lizard of the world is:-
(1) Heloderma (2) Ophiosaurus (3) Phrynosoma (4) Hemidactylus

2. Which of the following is a non poisonous snake:-
(1) Cobra (2) Eryx (3) Viper (4) Krait

3. Group amniota includes:
(1) Birds and mammals (2) Birds and reptiles
(3) Mammals and reptiles (4) Reptiles, birds and mammals

4. Which of the following pair is unmatched for the animals of Reptilia class :
(1) Temperature constant and external fertilisation
(2) Sexes seperate and lack of Metamorphosis
(3) 12 pairs cranial nerves and rough skin
(4) Skull monocondylic and skin with scales

5. In which of the following tympanum is absent:-
(1) Birds (2) Frogs (3) Lizards (4) Snakes

6. Number of cranial nerves in a reptile :-
(1) 8- pairs (2) 10- pairs (3) 12- pairs (4) 14- pairs

7. Chelone belongs to:
(1) Amphibia (2) Reptilia (3) Protochordates (4) Fishes

8. Rying lizard is:
(1) Chameleon (2) Draco (3) Exocetus (4) Varanus

9. Eggs are covered by leathery shell in:-
(1) Birds (2) Amphibians (3) Snakes (4) Mammals

10. The glass snake is a:-
(1) Limb less amphibian (2) Limbless lizard
(3) White snake (4) Limbless fish

CLASS – AVES

- All types of birds are included in this class.
- Study of birds is known as "Ornithology"
- Dr. Salim Ali was the great ornithologist of India and regarded as "Birdman of India"
- Birds are also known as "Feathered bipeds or glorified reptiles"
- Birds are warm blooded or Homeothermic or endothermic animals i.e. Body temperature remains almost constant. (Approx 102°F)
- Body is boat shaped. It is divided into head, neck, trunk and tail. Neck is long and flexible.
- The characterstic features of birds are presence of feathers all over the body and most of them can fly except flightless bird. Feathers keep them warm and also make body weight light. Feathers are modification of epidermal scales.
- Skin is dry and without glands. But oil glands or Preen glands are found on tail or Uropygium. These glands secrete oil, which lubricates feathers.
- Forelimbs are modified into wings. which help in flying.
- Hind limbs are best adapted for clasping the branches of trees or for perching or for walking swimming. Scales are found only on hind limbs.
- Digestive tract has additional chambers - the crop and gizzard.
- Oesophagus is modified into Crop for quick food ingestion and storage and Gizzard for crushing the food which is swallowed unmasticated. Pigeon or crop milk is secreted by both sexes (Crop product).
- A three chambered cloaca is present in the birds.
- Jaws are modified into horny beak, which is toothless.
- Spongy lungs are present for respiration Air sacs are also found. Air sac connected to lungs for supplement respiration.
- Sound producing organ at the junction of trachea and bronchi of birds is called syrinx.
- Heart is four chambered. Double circulation is found.
- Hepatic portal system is well developed in birds, but renal portal system is ill developed. Sinus venosus is absent. Only Right aortic arch is present. R.B.Cs are nucleated.
- Endoskeleton is bony. Long bones are hollow. with air filled cavities and these bones are called pneumatic bones. These make the body light in weight and help in flying.
- Skull is monocondylic.
- Last four caudal vertebrae fuse to form pygostyle. Which helps in wagging of tail.
- Sternum is large. Swollen basal part of sternum is called "Keel" This keel offers sites for attachment of flight muscles.
- Two bones, clavicle and interclavicle fuse to form V- shaped bone called furcula or Wish bone or Merry thought bone. Which Act as a spring between two pectoral girdles.

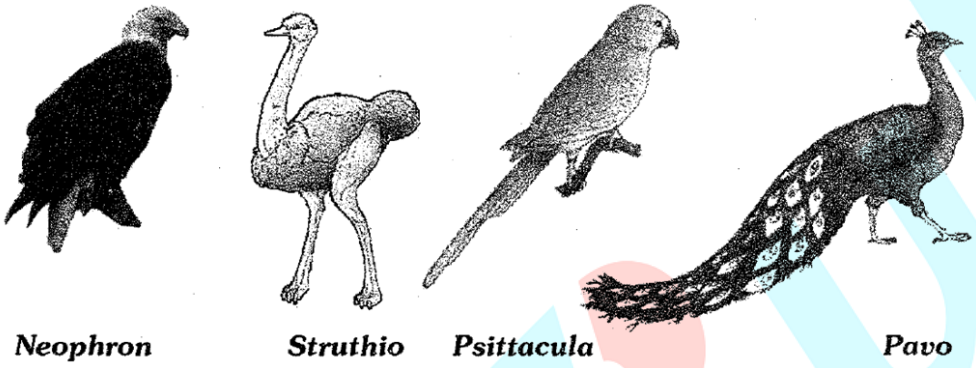
- Pygostyle, Keel and Furcula are absent in flight less birds.
- Kidneys are metanephric. Ureters open into cloaca. They are mostly Uricotelic.
- Most of the birds do not have urinary bladder and copulatory organ.
- Brain is large, smooth, highly developed. Cerebellum is well developed for aerial mode of life.
- Cranial nerves are 12 - Pairs.
- Eyes are large and nictitating membrane is present in eye. Vision is monocular.
- A specific comb like structure Pecten is found in the eyes of all birds except kiwi. Pecten helps in accomodation of eye and provides nutrition to eye balls. Acute vision and telescopic vision of birds is due to pecten.
- External ears are present but ear pinnae are absent. Only one ossicle columella (Stapes) is found in middle ear.
- Olfactory organs are less - developed.
- Birds are monodelphic i.e. only left ovary and left oviduct is functional in females.
- Birds are unisexual. Sexual dimorphism is well marked.
- Fertilization is internal. They are oviparous and development is direct.
- All the birds form nests. Parental care is well marked.

e.g.

1. **Archaeopteryx - Lizard bird**. (Extinct in Cretaceous period) Its fossil was discovered by Andreas Wagner in 1861 from Bavaria (Germany).
   (a) Bones were non-pneumatic.
   (b) Teeth were present in the jaws of skull.
   (c) They are considered as the connecting links between reptiles and birds.
   (d) Wings were ill developed, i.e. capacity of flying was very less.
2. **Aptenodytes** - Penguin, also called "sea bird of Antarctica"
   - Forelimbs are modified into flippers for swimming.
3. **Struthio** - African ostrich or Camel-bird - It is the largest living bird of modern period. It is almost 8 feet in height. Polygamous, male incubate the eggs (Largest eggs).
4. **Rhea** - American ostrich.
5. **Apteryx** - Kiwi - It is National bird of New zealand. It has hair like feathers all over its body. It is smallest flightless bird.
6. **Dromaeus** - Emu - It is a monogamous bird in which only males look after their young ones and eggs.
   - 3 to 6 are large and massive birds, which are flightless in nature.
   - These are able to run fast wings are reduced or absent.
   - Caudal vertebrae are free and pygostyle is absent.
   - Lacks Keel.
   - Oil glands or preen glands absent.
   - Sound producing organ syrinx is absent.
   - Usually urinary bladder and copulatory organ in males present.
7. **Pavo- cristatus** - Peacock - It is the national bird of India.
8. **Psittacula** - Indian parrot (Upper jaw movable)
9. **Columba Iivia** - Blue rock pigeon - Its crop glands secrete pigeon milk
10. **Neophron** - Vulture (Scavenger bird)
11. **Corvus splendens** - Crow
12. **Passer domesticus** - Sparrow - It shows commensalism with man.

13. **Helena** - Humming bird or sunbird. It is the smallest flying bird. It is found in cuba. It can fly in forward and backward both the directions .It can fly like helicopter. Its size is about 3 to 4 cm.

- For 7 to 13 small sized flight birds of modern era. Wings are well developed
- Pygostyle is present
- Keel in sternum is highly developed.
- Oil glands or preen glands are found.
- Sound producing organ syrinx is present.
- Urinary bladder and copulatory organ absent.



Neophron *Struthio* *Psittacula* *Pavo*

CLASS – MAMMALIA

- Coenozoic era (Recent) is golden era of mammals.
- Study of mammals is known as Mammology.
- The members of this class are cosmopolitan and found in a variety of habitats - polar ice. Deserts, mountains, forest, grasslands and dark caves. Some of them adapted to fly or live in water.
- Mammals are warm blooded or homeothermic or endothermic animals
- Body is divided into head, neck, trunk and tail.
- The most unique mammalian characterstic is the presence of milk producing glands (mammary glands) by which the young ones are nourished.
- A horizontal, diaphragm is present in between thorax and abdomen of all the members without any exception. Diaphragm helps in respiration, defaecation, micturition and parturition.
- The skin of mammals is unique in possessing hair.
- Skin of mammals is thick and glandular. So many types of glands are present in the skin as sweat glands, sebaceous glands and mammary glands. (Mostly modified sweat glands)
- Two pairs of limbs are present in trunk. Limbs are pentadactyl which help in swimming, walking, running
  etc. Hind limbs are absent in some aquatic mammals.
- Alimentary canal is complete. Anus and urinogenital apertures are separate. Cloaca is absent
- Teeth are Thecodont (embedded in bony sockets), Heterodont (different types) and mostly Diphyodont (comes twice).
- Respiration is by one pair of lungs (Enclosed in pleural cavity).
- Larynx or sound organ is found in the neck region for the production of sound.
- Heart four chambered. Double circulatory system is present. No sinus venosus. Only left aortic (systemic) arch present.
- RBCs small, circular and enucleated.

- Skull is dicondylic.
- Neck is having 7 cervical vertebrae except : Bradypus/Sioth has 9 or 10 cervical vertebrae and Sea- cow/Manatee has 6 cervical vertebrae.
- One pair of Metanephric kidneys are situated in abdominal cavity, They are ureotelic.
- Brain is comparatively large. Cerebrum and cerebellum are highly developed.
- A special structure is present for the connection of both the cerebral hemispheres of brain, that is called corpus- callosum. (Present only in higher mammals)
- Cranial nerves are 12 - pairs
- External ear is present in the form of ear pinna.
- Malleus, Incus and stapes are the three ear ossicles in middle ear.
- Mammals are unisexual animals. Testes of males are situated outside the abdominal cavity in the scrotal sacs. A distinct penis is present in males for copulation.
- Fertilization is internal and it takes place in fallopian tubes.
- Embryo is attached with the uterus of mother by placenta in higher mammals, so these animals are also called placental animals.
- Mostly mammals are viviparous, which give birth to their young ones. Some mammals are oviparous [Prototherians].
- Parental care is well marked in mammals. Mother feeds the child from milk secreted from her mammary glands and looks after her child.
- Livings mammals are classified into following 3 groups :-

(i) Prothotherians or Monotremes

- It includes primitive reptile like egg laying mammals.
- Mammary glands are without nipples.
- Gynaecomastism is found in these animals. Mammary glands are functional in males and females both.
- Cloaca is present.
- Testes in males are situated inside the body as their body temperature is low.
- These are partially homeothermic animals.
- Pinnae are absent.
- Corpus- callosum is absent in brain.
- A toothless horny beak is found in adult animals, but teeth are present in childhood only (Monophyodont).
- They are found in Australia, New Guinea and Tasmania.
- These are considered as Connecting links between reptiles and mammals.

e.g. **1.** Ornithorhynchus (Duck-billed platypus) :- Poison glands are present in the claws of male platypus.
2. Echidna/Tachyglossus (spiny ant-eater)

(ii) Metatherians or Marsupials

- An abdominal pouch called marsupium is found in these animals, in which immature young ones are kept after delivery.
- Mammary glands with nipples are situated in marsupium.
- Two vagina, two clitoris and two uteri are present in a female animal and bifid penis present in male.
- Yolk sac or false placenta are found.

- Corpus callosum is absent.

e.g.

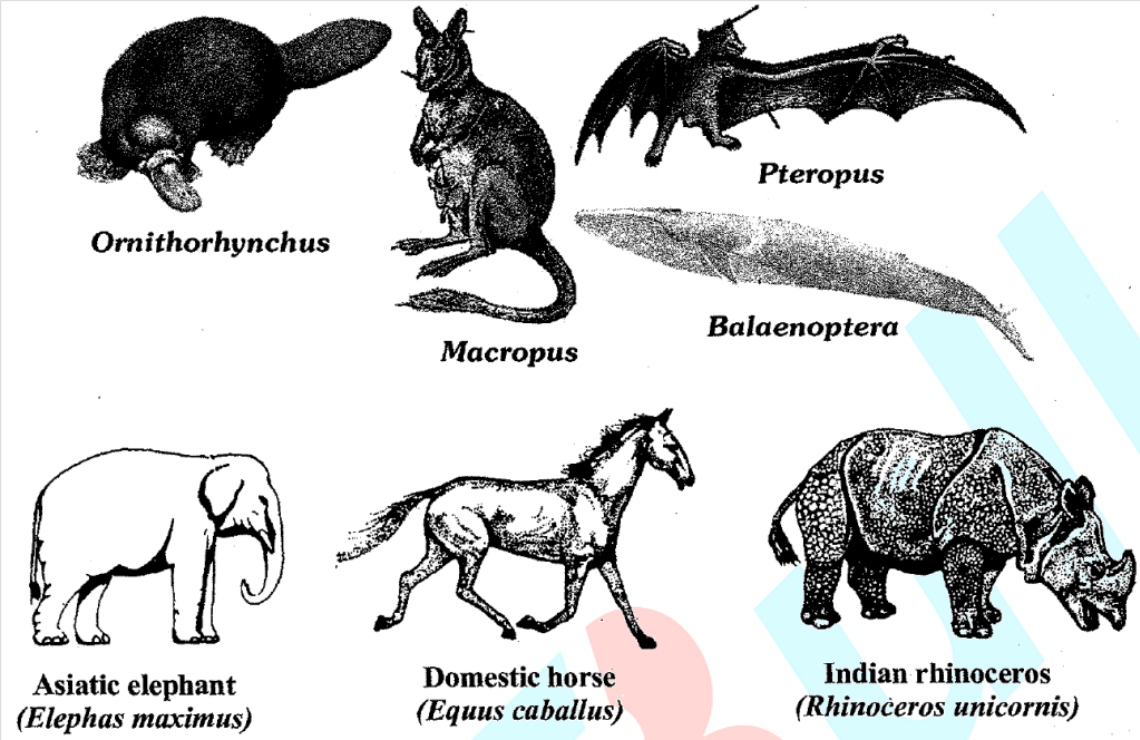
1. **Macropus** - Kangaroo- Found in Australia only. Saltatoriallocomotion.
2. **Didelphys** - Opossum - It has Shortest gestation period (12-13 days).

(iii) Eutherians

- These are true placental mammals, that give birth to a mature baby. A true placenta is found, which provides both attachment and nutrition to baby.
- Nipples are well marked in mammary glands.
- Uterus and vagina are single in female.
- Corpus callosum is found in brain.

e.g.

(1) **Pteropus (Flying fox) :** It is Frugivorous bat. These are true flying mammals. Ecolocation sensory system (Radar system) present. Their order is chiroptera.
(2) **Camelus (Camel)**
(3) **Macaca (Monkey)**
(4) **Rattus (Rat)**
(5) **Canis (Dog)**
(6) **Felis (Domestic cat)**
(7) **Panthera leo (Lion)**
(8) **Panthera tigris (Tiger)** - National Animal of India
(9) **Zalopus (Sea lion)**
[Order of carnivorous mammal is Carnivora. They have digitigrade locomotion and Carnassial Teeth. Their upper last premolar and lower first molar are modified for tearing the flesh, these are called carnassial Teeth.]
(10) **Delphinus (Common dolphin)**
(11) **Balaenoptera musculus (Blue whale)** - Found in Antarctic ocean. A Horny sheet called Baleen plate (for filtration) is found in upper jaw instead of teeth. Milk is squirted down to the throat of baby by the muscle contraction of mother. Retea mirabile is found in thoracic region which helps in respiration in under water.
[Order of fish like marine mammals is called Cetacea in which whale, dolphin are included. They have no hind limb, Hair and Ear Pinna.]
(12) **Elephas** (Indian elephant)
(13) **Loxodonta (African elephant)** - It is the largest living land animal.
(14) **Equus (Horse)**
(15) **Rhinoceros (Single horn Genda)** - It is found in Kaziranga national park, Assam.
(16) **Hippopotamus (River horse)**



BEGINNER'S BOX-10

1. Which of the following animal has poison glands:-
(1) Male platypus (2) Female lizard (3) Male rabbit (4) Male rat

2. External ear pinna is found in:-
(1) Reptiles (2) Mammals (3) Amphibians (4) Fishes

3. Respiratory organs of whale are:-
(1) Book lungs (2) Lungs (3) Gills (4) Skin

4. Characteristic of birds is:-
(1) Unisexual and sexual dimorphism absent
(2) Bisexual and sexual dimorphism absent
(3) Unisexual and sexual dimorphism present
(4) Bisexual and sexual dimorphism present

5. 'Pecten' is a structure found in the eyes of:-
(1) Reptilies (2) Fishes (3) Birds (4) Mammals

6. Furculum, synsacrum and pygostyle are characteristic of :-
(1) Snakes (2) Lizard (3) Birds (4) Monotremes

7. Which of the following group of animals have monocondylar skull:-
(1) Amphibia & mammals (2) Reptilia & mammals
(3) Aves & mammals (4) Reptilia & aves

8. Archaeopteryx shows the characters of:

(1) Reptiles and birds
(2) Reptiles and mammals
(3) Birds and mammals
(4) Fishes and amphibia

9. Character found only in mammals:-
(1) Homeothermy
(2) Viviparity
(3) Dicondylic skull
(4) Diaphragm

10. Birds differ from reptiles in which one -of the following character:-
(1) Skin has scales
(2) They lay eggs
(3) They are vertebrates
(4) There is regulation of body temperature

ANSWER KEY

BEGINNER'S BOX-1

1.	(1)	**2.**	(2)	**3.**	(2)	**4.**	(1)	**5.**	(2)	**6.**	(4)	**7.**	(2)
8.	(3)	**9.**	(2)	**10.**	(2)								

BEGINNER'S BOX-2

1.	(3)	**2.**	(2)	**3.**	(1)	**4.**	(1)	**5.**	(1)	**6.**	(4)	**7.**	(2)
8.	(1)	**9.**	(1)	**10.**	(2)								

BEGINNER'S BOX-3

1.	(1)	**2.**	(2)	**3.**	(2)	**4.**	(4)	**5.**	(4)	**6.**	(2)	**7.**	(2)
8.	(1)	**9.**	(1)	**10.**	(2)								

BEGINNER'S BOX-4

1.	(3)	**2.**	(2)	**3.**	(2)	**4.**	(1)	**5.**	(1)	**6.**	(2)	**7.**	(2)
8.	(1)	**9.**	(1)	**10.**	(1)								

BEGINNER'S BOX-5

1.	(2)	**2.**	(4)	**3.**	(4)	**4.**	(1)	**5.**	(3)	**6.**	(2)	**7.**	(1)
8.	(4)	**9.**	(4)	**10.**	(1)								

BEGINNER'S BOX-6

1.	(3)	**2.**	(4)	**3.**	(3)	**4.**	(1)	**5.**	(3)	**6.**	(4)	**7.**	(1)
8.	(2)	**9.**	(4)	**10.**	(2)								

BEGINNER'S BOX-7

1.	(3)	**2.**	(1)	**3.**	(2)	**4.**	(2)	**5.**	(2)	**6.**	(4)	**7.**	(1)
8.	(2)	**9.**	(3)	**10.**	(3)								

BEGINNER'S BOX-8

1.	(2)	**2.**	(1)	**3.**	(1)	**4.**	(4)	**5.**	(1)	**6.**	(3)	**7.**	(3)
8.	(2)	**9.**	(2)	**10.**	(2)								

BEGINNER'S BOX-9

1.	(1)	**2.**	(2)	**3.**	(4)	**4.**	(1)	**5.**	(4)	**6.**	(3)	**7.**	(2)

8. (2) **9.** (3) **10.** (2)

BEGINNER'S BOX-10

1. (1) **2.** (2) **3.** (2) **4.** (3) **5.** (3) **6.** (3) **7.** (4)
8. (1) **9.** (1) **10.** (4)