Animal Kingdom

Animal Kingdom

INTRODUCTION

There is a vast diversity in the number and types of animals in nature. They range from unicellular to multicellular. They are found in the deepest of the oceans, in snow-covered mountains, from the poles to the equator. There are differences in the structure and forms of the different animals. But there are some fundamental features in them which show resemblance such as arrangement of cells, body plan, symmetry, segmentation, coelom, germ layer, body temperature, skeleton and notochord, types of digestive, respiratory, circulatory, excretory, and reproductive systems. We need to classify organisms to make our study easier and to study the interrelationship between different groups.

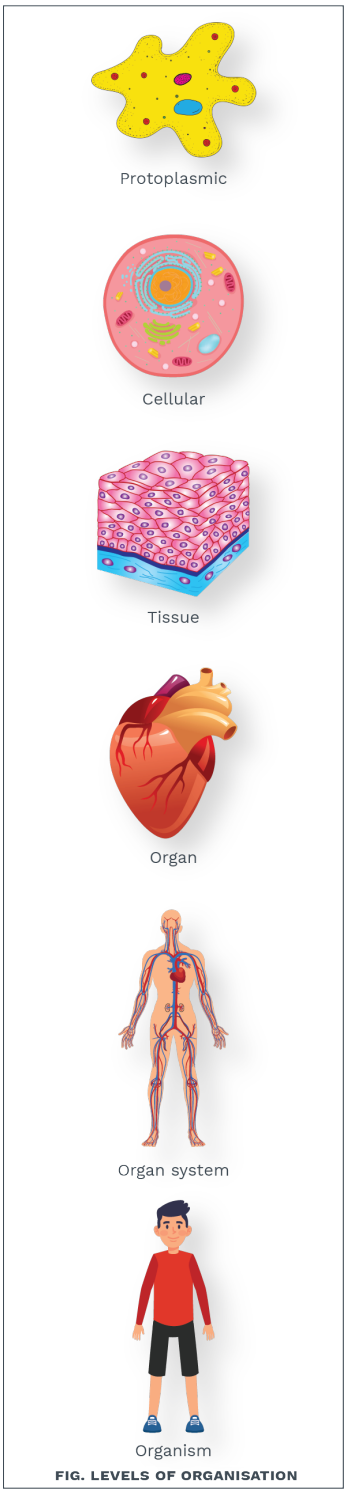


FIG. LEVELS OF ORGANISATION

BASES OF CLASSIFICATION

Habitat

- On the basis of habitat, animals are divided into the following types:

  Aquatic-Organisms that are found in water. They can be:
  - Marine-Echinoderms, many sponges and coelenterates.
  - Fresh water-Prawns, some fishes and molluscs.

  Terrestrial-Organisms that are found on land. They can be:
  - Fossorial animals (found in burrows) - Earthworm, snake, rabbit.
  - Arboreal (found on trees) - Birds, bats, monkeys.
  - Scansorial (climb the walls) - House lizards, squirrels.

Gray Matter Alert!!!

Marine phyla: Phylum Echinodermata, Ctenophora and phylum Hemichordata are three exclusively marine phyla.

Levels of Organisation

- Animals are divided into five types, on the basis of their level of organisation:

  Protoplasmic level of organisation: A cellular body performs all the biological activities.
  Example: Protozoa
  Cellular level of organisation: The cells of the body are present in loose aggregates and together perform all the functions.
  Example: Sponges
  Tissue level of organisation: The cells of the organism unite together to form a tissue system which helps the organism to perform different functions.
  Example: Coelenterata
  Organ level of organisation: The tissues combine together to form organs which perform different functions.
  Example: Platyhelminthes
  Organ-system level of organisation: The organs of an organism combine together to form different organ-systems which help in the functioning of the whole organism.
  Examples: Aschelminthes to Chordata.

Symmetry

It is the arrangement of the body organs on either side of the main axis of the body. It is of two types – Asymmetry and symmetry.

- **Asymmetry:** When the body of an organism cannot be divided into two identical halves in any plane.
  Examples: In some sponges and snails.
- **Symmetry:** When the body of an organism can be divided into two identical halves in one or more planes. On the basis of the plane involved, it is of two types:

  Radial:

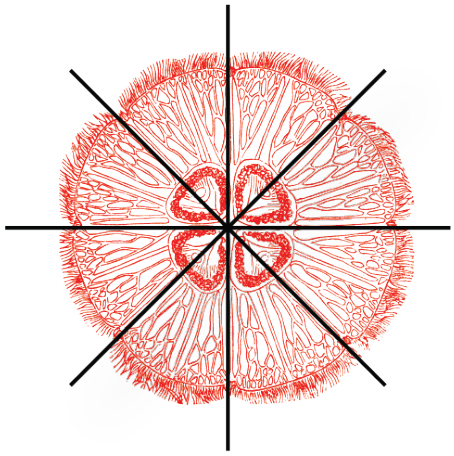
  - When the body of an organism can be divided into two identical halves by **any**

plane passing through the central axis of the body.

- For sessile animals, radial symmetry was useful as it helped them in food gathering from all sides. They might have developed appendages all around to capture the prey.
  Examples: Coelenterates, Ctenophores, Echinoderms

Bilateral:

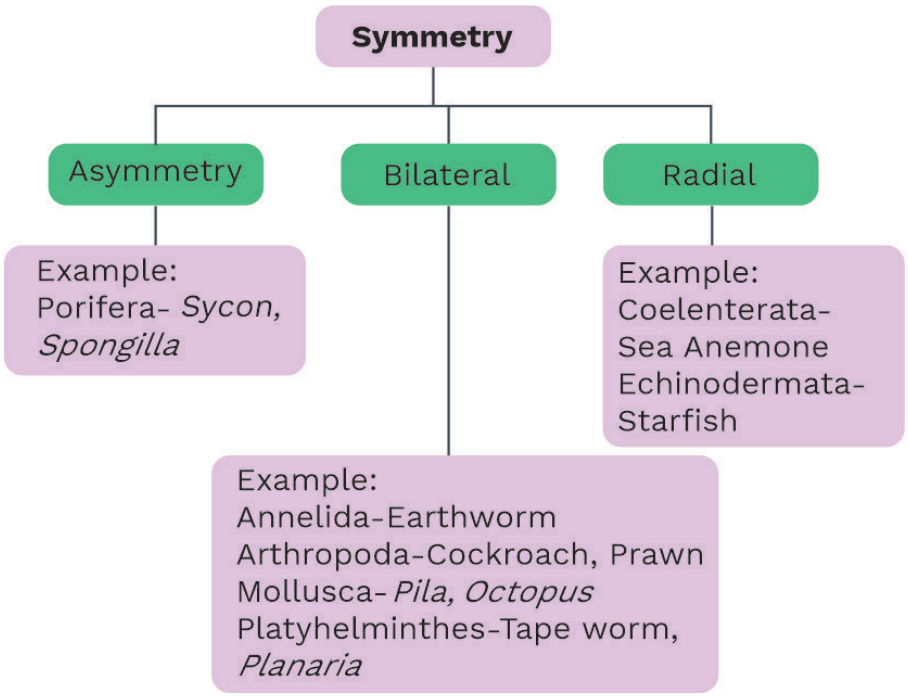
- When the body of an organism can be divided into two identical halves by only **one plane**, passing through the longitudinal axis of the body.
- It arose when animals on the ocean floor became mobile. A crawling animal will encounter food with the end that moves first.
- So, mouth developed at this end. Sensory organs and a coordinating brain developed at the front end.
- These organs helped in sensing food. So, the head enclosing the brain became associated with the mouth end. This is cephalization.
  Examples: Annelids, Arthropods.



Radial symmetry in Jelly fish

Bilateral symmetry in Spider

FIG. TYPES OF SYMMETRY



Body Plan

Animals show three different types of body plan:

- **Cell aggregate plan:** In this case, the body is just an aggregate of cells.
  Example: Sponges
- **Blind sac plan:** In this case, the multicellular organism has tissue or organ level of organisation. The organism has only one opening for intake of food as well as it is through this pore, the waste is thrown out of the body.
  Example: Platyhelminthes
- **Tube within the tube plan:** In this case, the body consists of two tubes. One tube is formed by the wall of the body and the second is formed by the digestive tract. It has two openings. One at the anterior for intake of food and the other at the posterior end for egestion of undigested food. It is of two types – Protostomes and Deuterostomes.

Protostomes: 'Proto' means first and 'stoma' means mouth. Thus, in protostome organisms, the development of the mouth in the embryo takes place first followed by the anus.
Examples: Platyhelminthes, Aschelminthes, Annelida, Mollusca
Deuterostomes: 'Deutero' means second, and 'stoma' means mouth. Thus, in deuterostome organisms, the development of the anus takes place first and development of mouth in the embryo takes place after it.
Examples: Echinodermata, Hemichordata, Chordata

Germ Layers

The layer of the gastrula which gives rise to the different parts of the body is called the germ layers. On the basis of the number of the layers, there are two categories:

- **Diploblastic:** Two germ layers i.e., **ectoderm and endoderm** give rise to the different parts of the body. In between the two layers is present a non-cellular layer known as mesoglea.
Examples: Sponges, Coelenterate, Ctenophores

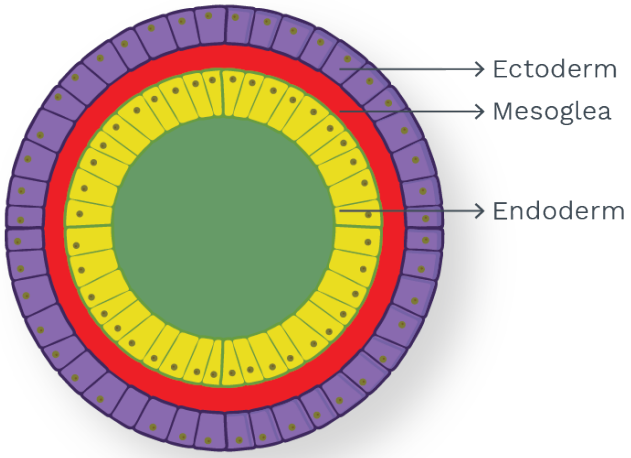


FIG. DIPLOBLASTIC (GERM LAYERS)

Definition

Cephalization: Differentiation of head at the anterior end during embryonic development.

Definitions

Protostomes: Organisms in which the mouth is developed first in the embryo, followed by the anus.
Examples: *Planaria*, *Ascaris*, earthworm, *Pila*, wasp

Deuterostomes: Organisms in which the anus develops first in the embryo, followed by the mouth.
Examples: Starfish, *Balanoglossus*, rohu, snake, pigeon, deer

- **Triploblastic:** Three germ layers i.e., **ectoderm, mesoderm and endoderm** give rise to the different parts of the body. **Examples:** Flatworm to mammals

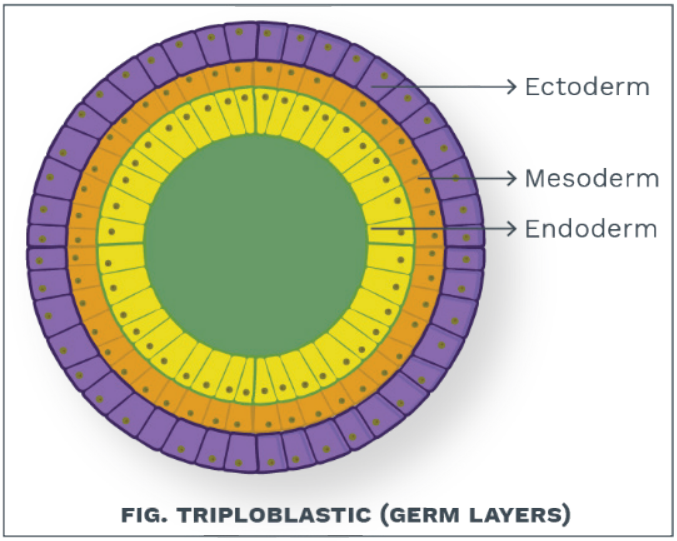


FIG. TRIPLOBLASTIC (GERM LAYERS)

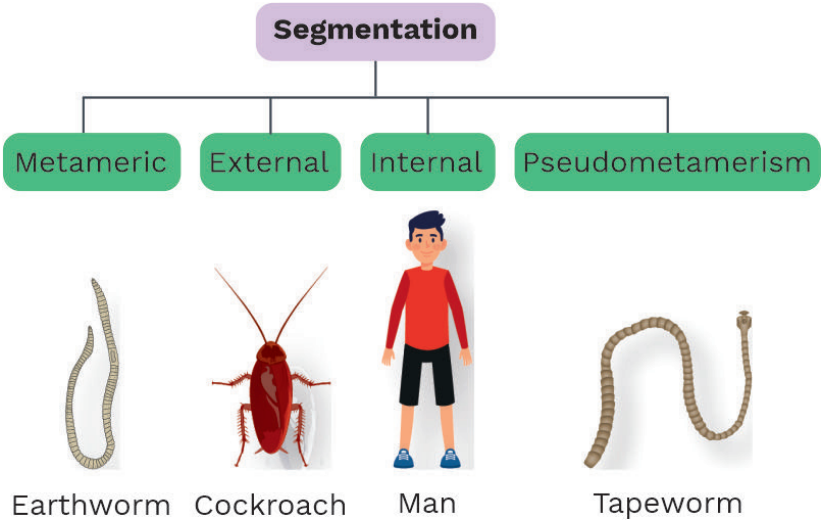
Segmentation

Segmentation is the division of a body into portions known as segments. It is of four types:

- **Metameric segments (True segmentation):** The body is divided into segments; internally and externally.
  Example: Annelida
- **External Segmentation-** Arthropoda
- **Internal Segmentation-** Chordata
- **Pseudometameric segments (False segmentation):** The segments of the body are not formed from the embryo and thus are known as pseudometamerism.
  Example: Tape worm

Previous Year's Question

Which one of the following kinds of animals are triploblastic?
(1) Flatworms
(2) Sponges
(3) Ctenophores
(4) Corals



Coelom

The space between the body wall and the gut wall is known as coelom. On the basis of the nature of coelom, organisms are of the following types:

- **Acoelomates:** Organisms do not have any cavity or coelom and thus are called as acoelomates.
  Examples: Platyhelminthes, porifera, coelenterata, ctenophora

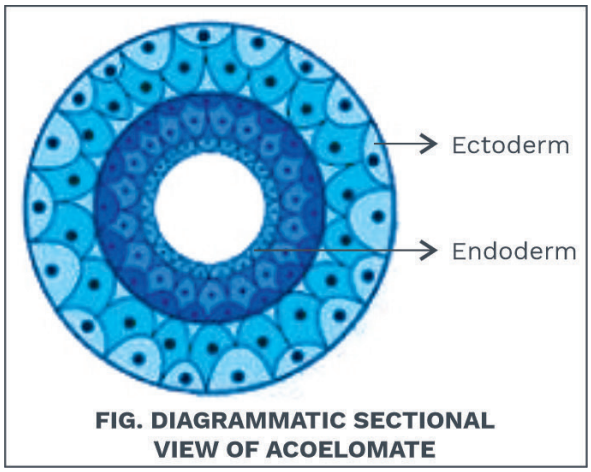


FIG. DIAGRAMMATIC SECTIONAL VIEW OF ACOELOMATE

- **Pseudocoelomates:** The mesoderm is present in form of small pouches between the ectoderm and endoderm.
  Example: Aschelminthes

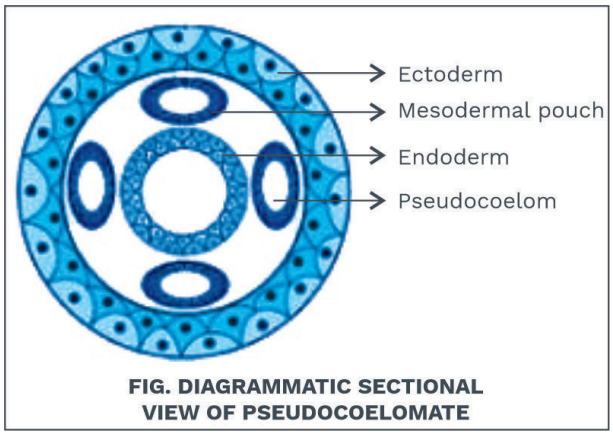


FIG. DIAGRAMMATIC SECTIONAL VIEW OF PSEUDOCOELOMATE

Definition

Pseudocoelomate: In these organisms, mesoderm is present in form of small pouches in between the two layers ectoderm and endoderm.

- **Coelomates (Eucoelomates):** It is a body cavity which arises from the mesoderm. It is of three types:

  Schizocoelom: It develops due to the split in the mesoderm sheet.

  Examples: Arthropods, molluscs, annelids

  Enterocoelom: The mesoderm arises from the wall of the embryonic gut as a hollow outgrowth and forms the coelom.

  Examples: Echinoderms, chordates

  Haemocoelomates: In Arthropods and Molluscs, the true coelom is reduced and filled with blood and known as haemocoel.

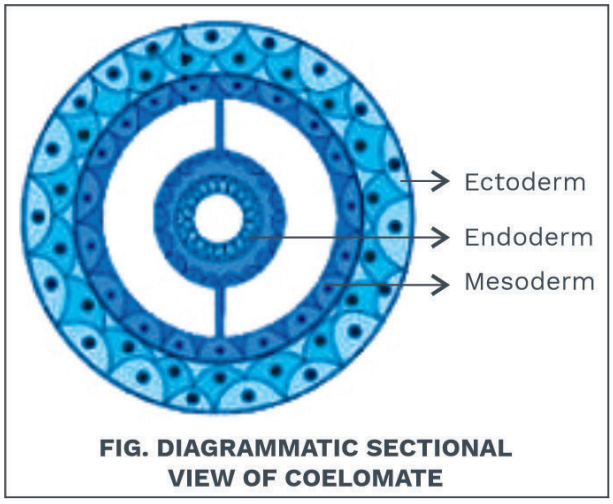


FIG. DIAGRAMMATIC SECTIONAL VIEW OF COELOMATE

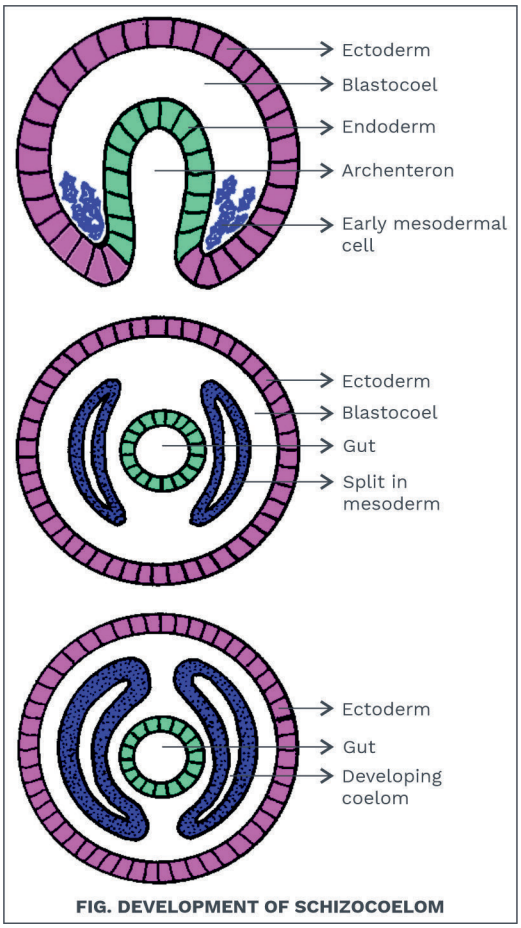


FIG. DEVELOPMENT OF SCHIZOCOELOM

Skeleton

The framework of the body that gives shape and protection to the animals is known as skeleton. It is of two types on the basis of their position:

- **Endoskeleton:** Hard structure that is present inside the body.
  Examples: Bones present inside the body, like humans.

- **Exoskeleton:** It is present outside the body. It is of different types like-
  Calcareous shells in Mollusca.
  Epidermal scales in reptiles.
  Feathers in birds.
  Hair, nails, claws, horns in mammals.

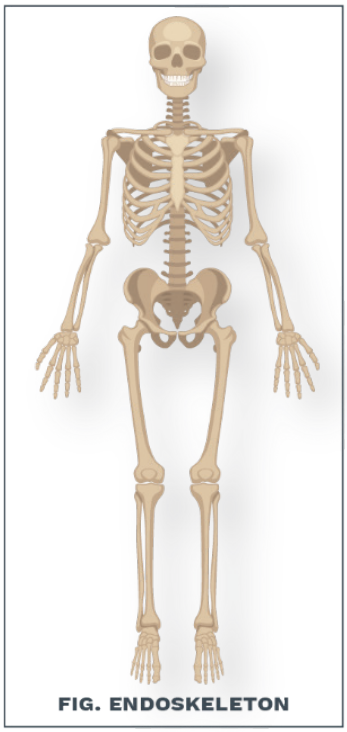


FIG. ENDOSKELETON

FIG. EXAMPLES OF EXOSKELETON

Notochord

It is a solid, unjointed and mesodermal rod, present on the dorsal side of the body. Depending upon its presence or absence, there are two groups of animals:

- **Non-Chordates:** Organisms that do not have the notochord are known as non-chordates.
  Examples: Poriferans to Hemichordates

- **Chordates:** Organisms that have the notochord are known as chordates.
  Examples: Pisces to mammals

Cleavage

It is of two types:

- **Mosaic (Determinate) Cleavage:** Complete embryo is formed from the whole blastomere. If any of the blastomere gets detached accidentally then the embryo formation will cease.
  Example: Annelids
- **Non-Mosaic (Non-determinate) Cleavage:** On separation of some of the blastomeres in the early stage, the leftover blastomeres will give rise to the complete embryo.
  Example: Chordates

Development

- **Indirect:** The young one does not resemble the parent. It undergoes **metamorphosis** through a number of larval or nymphal stages to develop into an adult.
  Examples: Mosquito, frog, tape worm

Definition

Notochord: A solid, unjointed mesodermal rod present on the dorsal side of the body. In some animals, it develops into a vertebral column in later stages of their life.

Keywords

- Diploblastic
- Triploblastic
- Coelomate
- Pseudocoelomate
- Protostomes
- Deuterostomes

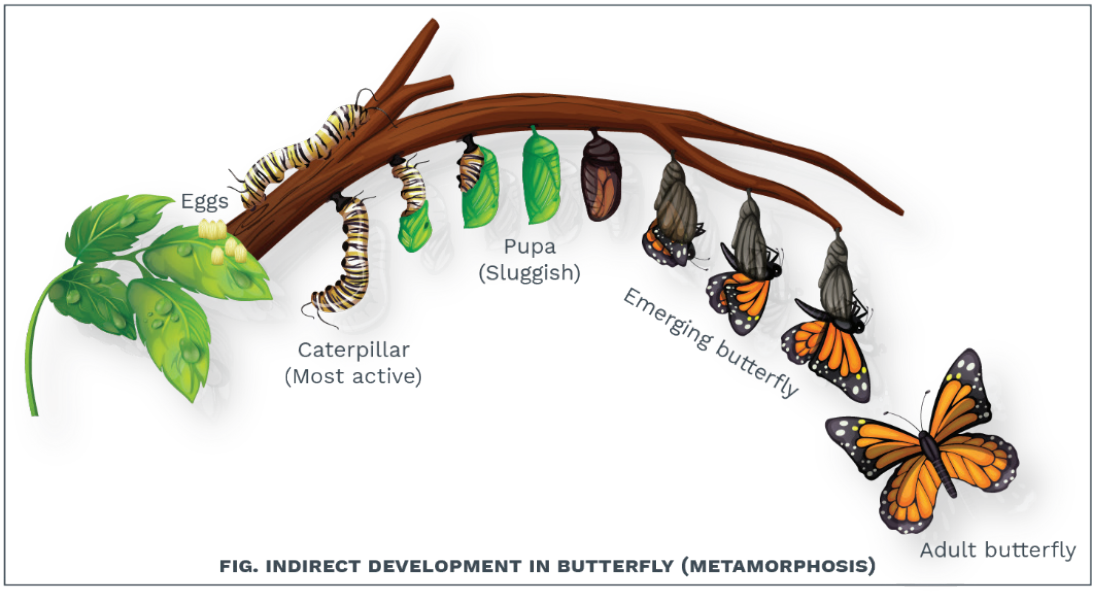
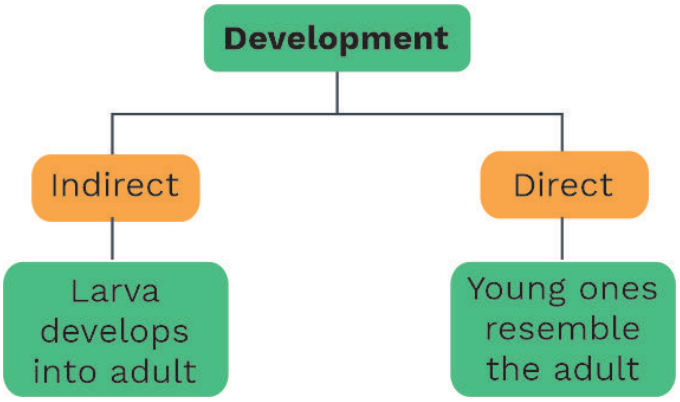


FIG. INDIRECT DEVELOPMENT IN BUTTERFLY (METAMORPHOSIS)

- **Direct:** The young one resembles the adult and it does **not undergo metamorphosis**.
  Examples: Humans, birds



Types of Eggs

Based on the quantity of yolk, they are of three types:

- **Microlecithal:** The amount of yolk in the egg is less.
  Examples: Eggs of *Herdmania*, Sea Urchin
- **Mesolecithal:** The amount of yolk in the egg is moderate.
  Examples: Eggs of frog, fish, toad
- **Macrolecithal:** The amount of yolk in the egg is high.
  Examples: Eggs of birds, reptiles, bony fishes.

Based on the distribution of yolk in the cytoplasm of egg, they are of three types:

Homolecithal: Yolk is uniformly distributed.
Examples: Eggs of Annelids, molluscs, protochordates

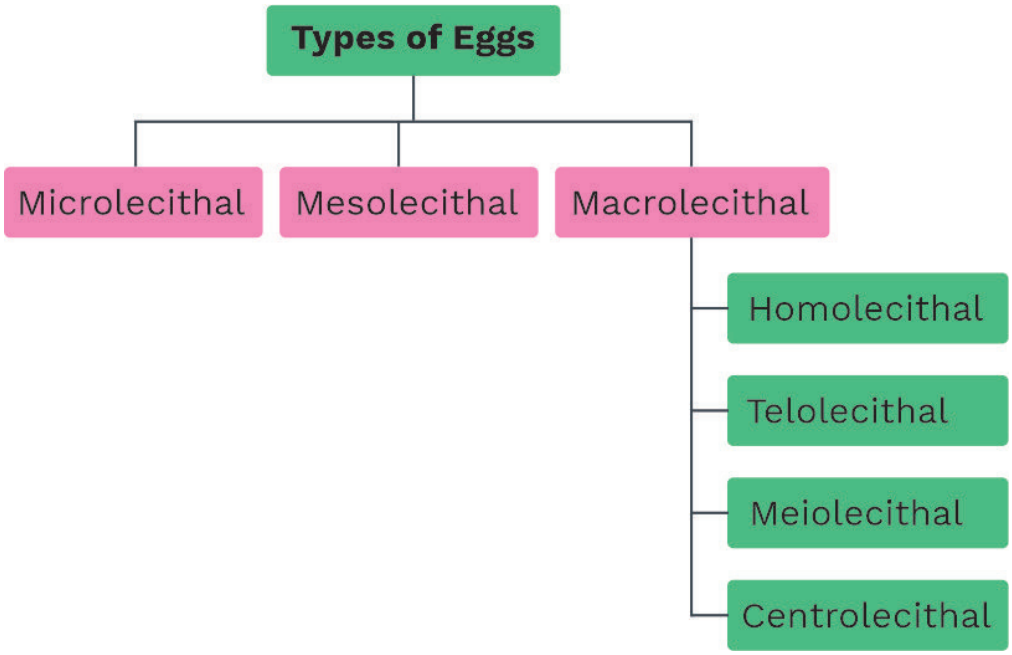
Telolecithal: Yolk is concentrated in the vegetal half.
Examples: Eggs of Amphibians

Meiolecithal: Yolk is present in the entire ooplasm, except for a little disc-shaped space in the cytoplasm for the nucleus.
Examples: Eggs of Reptiles

Definition

Metamorphosis: Drastic changes through which the larva of an organism, structurally and morphologically modifies into the adult.
Examples: Development of butterfly and frog

Centrolecithal: Yolk is present in the centre of the cell.
Examples: Eggs of insects



Body Temperature

On the basis of body temperature, organisms are of two types:

- **Homeotherms (Warm-blooded animals):** The body temperature does not change with the change in ambient temperature.
  Examples: Birds, mammals.
- **Poikilotherms (Cold-blooded animals):** The body temperature changes with the change in the ambient temperature.
  Examples: Amphibians, pisces, reptiles

Digestion

Based on where the digestion takes place, it is divided into two types:

- **Intracellular:** Digestion takes place within the cells of the body.
  Examples: *Amoeba*

Previous Year's Question

Temperature changes in the environment affect most of the animals which are
(1) poikilothermic
(2) homeothermic
(3) aquatic
(4) desert living

- **Extracellular:** Digestion takes place outside the cell, in a cavity of an organ.
  Examples: *Hydra*

Digestive System

It is of two types:

- **Incomplete:** A single opening that functions both as a mouth and anus.
  Example: Platyhelminthes
- **Complete:** Two openings, i.e. mouth and anus are present.
  Examples: Arthropoda, annelida, aschelminthes, chordata

Respiration

Organisms follow two modes of respiration:

- **Aerobic respiration:** Organisms respire in the presence of oxygen.
  Examples: Mammals, reptiles, coelenterates
- **Anaerobic respiration:** Organisms respire in the absence of oxygen.
  Example: Flatworms

Definitions

Aerobic Respiration: Respiration that occurs in the presence of oxygen. High amount of energy is generated.

Anaerobic Respiration: Respiration that occurs in the absence of oxygen. Less amount of energy is generated.

Table. Different modes of respiration in animals

Modes of Respiration	Respiratory Organs	Animals
• Body surface	Body surface	Sponge, sea anemone
• Branchial	Gills	Garden snail, rohu
• Cutaneous	Skin	Earthworm, frog
• Tracheal	Trachea	Cockroach
• Booklung	Booklungs	Spider, scorpion

Modes of Respiration	Respiratory Organs	Animals
• Buccopharyngeal	Buccopharyngeal cavity	Frog, toad
• Pulmonary	Lungs	Toad, snake, crocodile, pigeon, deer

Circulation

It is of two types:

- **Open circulation:** In such a circulation, the blood flows through a space called sinuses. The sinuses are known as Haemocoel.
- There is **no capillary system**.
- The blood flows at **low pressure**.
- Body tissues and important organs exchange respiratory gases, nutrients and waste products directly from blood.

Examples: Arthropoda, Mollusca.

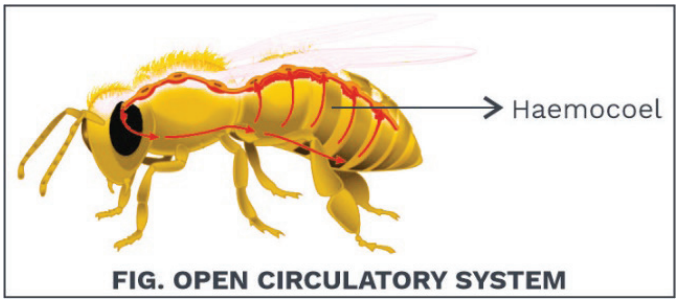


FIG. OPEN CIRCULATORY SYSTEM

- **Closed circulation:** In such a circulation, the blood flows through the **blood vessels**.
- The blood flows at **high or low pressure**.

Examples: Annelids, mammals.

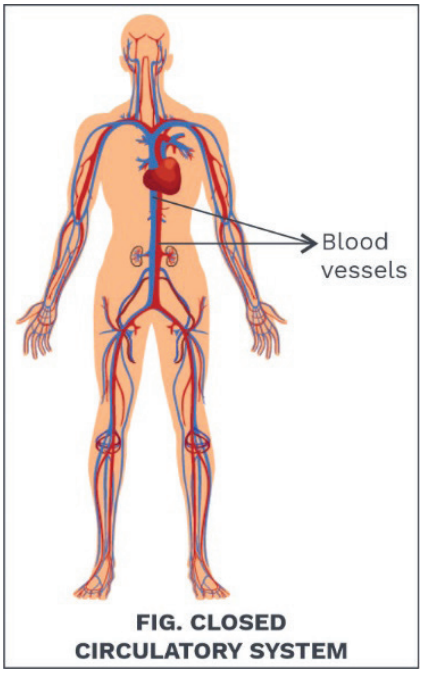
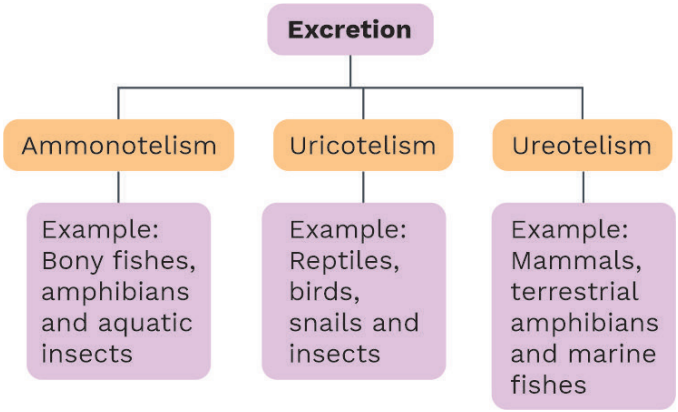


FIG. CLOSED CIRCULATORY SYSTEM

Excretion

The process by which the nitrogenous waste is thrown out of the body is known as excretion. It is of following types, on the basis of the main nitrogenous waste:

- **Ammonotelism:** When the main nitrogenous waste is ammonia. Such animals are known as ammonotelic.
  Examples: Sponges, coelenterates, ctenophores, echinoderms
- **Ureotelism:** When the main nitrogenous waste is urea. Such animals are known as ureotelic.
  Examples: Some amphibians, mammals
- **Uricotelism:** When the main nitrogenous waste is uric acid. Such animals are known as uricotelic.
  Examples: Birds, reptiles, insects.



Previous Year's Question

Which of the following does not have an open circulatory system?
(1) Frog's tadpole
(2) Prawn
(3) *Chelifer*
(4) Cockroach

Gray Matter Alert!!!

Dual Excretion: Some animals have dual mode of excretion. Examples: In normal condition, earthworm secretes urea but it secretes ammonia when sufficient water is available.

Excretory Organs	Animals
• Body surface	Sponges, sea anemone, starfish
• Protonephridia (flame cells)	Flatworms
• Intracellular tubes	Roundworms
• Nephridia	Earthworm
• Antennary/green glands	Prawn

Excretory Organs	Animals
• Malpighian tubules	Cockroach
• Coxal gland	Scorpion and spider
• Kidneys	Garden snails, alligator

Nervous System

- System that helps the organism to coordinate all of its function. Different organisms have different types of nervous system.
- Sponges do not have any nerve cell.
- Coelenterates have diffused type of nervous system.
- Flatworms and roundworms have a ladder-type nervous system.
- Echinoderms have two ring nervous system.

Reproduction

The process by which an adult organism gives rise to a young one of its own kind is known as reproduction. It is of two types:

- **Asexual reproduction:** In this type of reproduction, **only a single parent** is involved. Gametes are not formed.
  Examples: *Hydra, Penicillium*
- **Sexual reproduction:** In this type of reproduction, **two parents** are involved. Gametes are formed and fertilisation and meiosis take place.
- Organisms can be unisexual (as in humans) or bisexual (as in earthworm) where both the sexes are present in the same organism.
- Fertilisation can be internal (as in mammals) or external (as in fishes and amphibians).

Previous Year's Question

Uricotelism is found in
(1) mammals and birds
(2) fish and fresh water protozoans
(3) birds, land reptiles and insects
(4) frogs and toads

Definitions

Asexual Reproduction: The process by which a single parent gives rise to a new individual. Examples: *Amoeba, Hydra*

Sexual Reproduction: The process by which the gametes of two parents fuse to give rise to an offspring.

CLASSIFICATION IN ANIMALS

- On basis of the above-given characteristics, animals were classified into different groups by the different scientists.
- **Aristotle:** He divided animalia into two groups:
- **Anaima:** It included animals without red blood cells.
  Examples: Sponges, Arthropoda, Mollusca.
- **Enaima:** It included animals with red blood cells.
  Example: Chordates
  Many scientists later tried to classify organisms into different groups but the finally accepted classification is of Robert Whittaker.

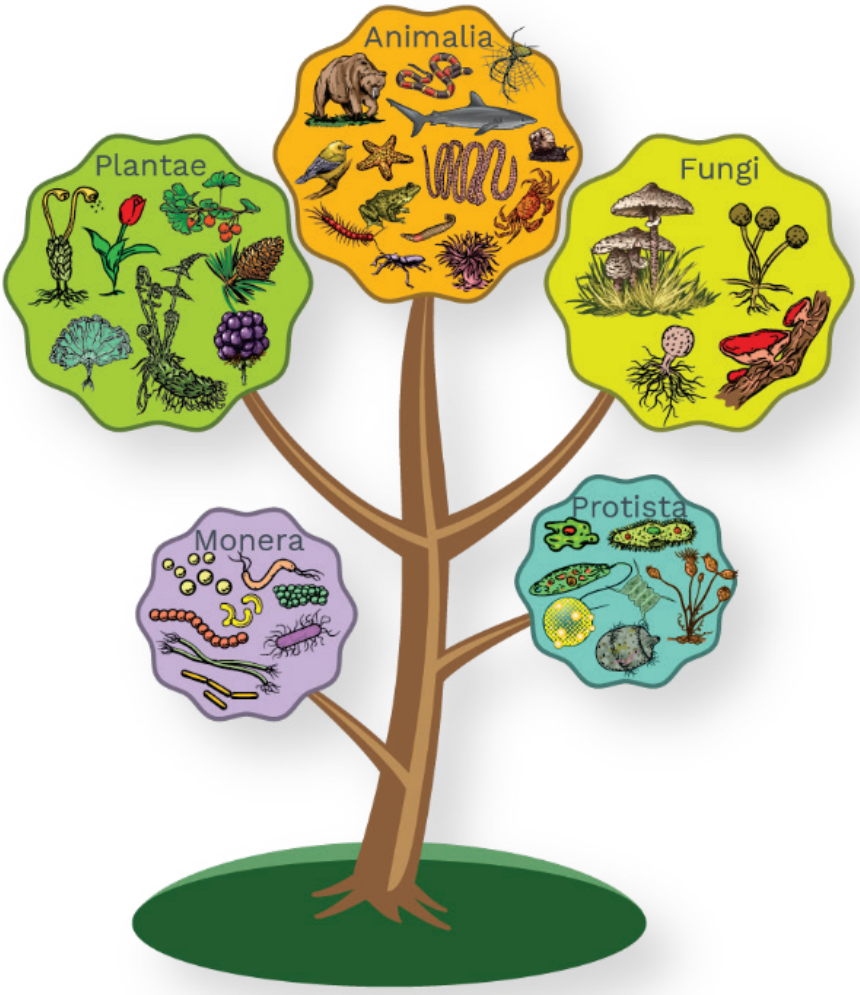


FIG. FIVE KINGDOM CLASSIFICATION

- **Robert Whittaker's five kingdom classification (1969):** Whittaker divided the living organisms into five kingdoms:
  Monera
  Protista
  Fungi
  Plantae
  Animalia.

  In 1969, Robert Harding Whittaker proposed this system. He argued that fungi, which had been previously placed along with plants, had a unique method of obtaining food. So he proposed Kingdom Fungi and separated it from plants. Now, living organisms are divided into five kingdoms; Monera, Protista, fungi, Plantae and Animalia.

  Criteria used by Whittaker for his classification scheme were:
- **Cell structure**
- **Body organisation**
- **Mode of nutrition**
- **Reproduction**
- **Phylogenetic relationships**

  This system placed all prokaryotes in Kingdom Monera and unicellular eukaryotes were placed in the kingdom Protista. Fungi were elevated to the level of kingdom.
- Kingdom Animalia is divided into 31 phyla, 11 of which are considered to be major ones.
- Animal kingdoms have organisms which are multicellular, eukaryotic, heterotrophic. They lack a cell wall.
- They depend upon plants or plant products for their food.
- They digest food inside a cavity.
- They store digested food as Glycogen and fats.
- They respond to stimuli and have a nervous system. Exception-Sponges do not have nerve cells.

Keywords

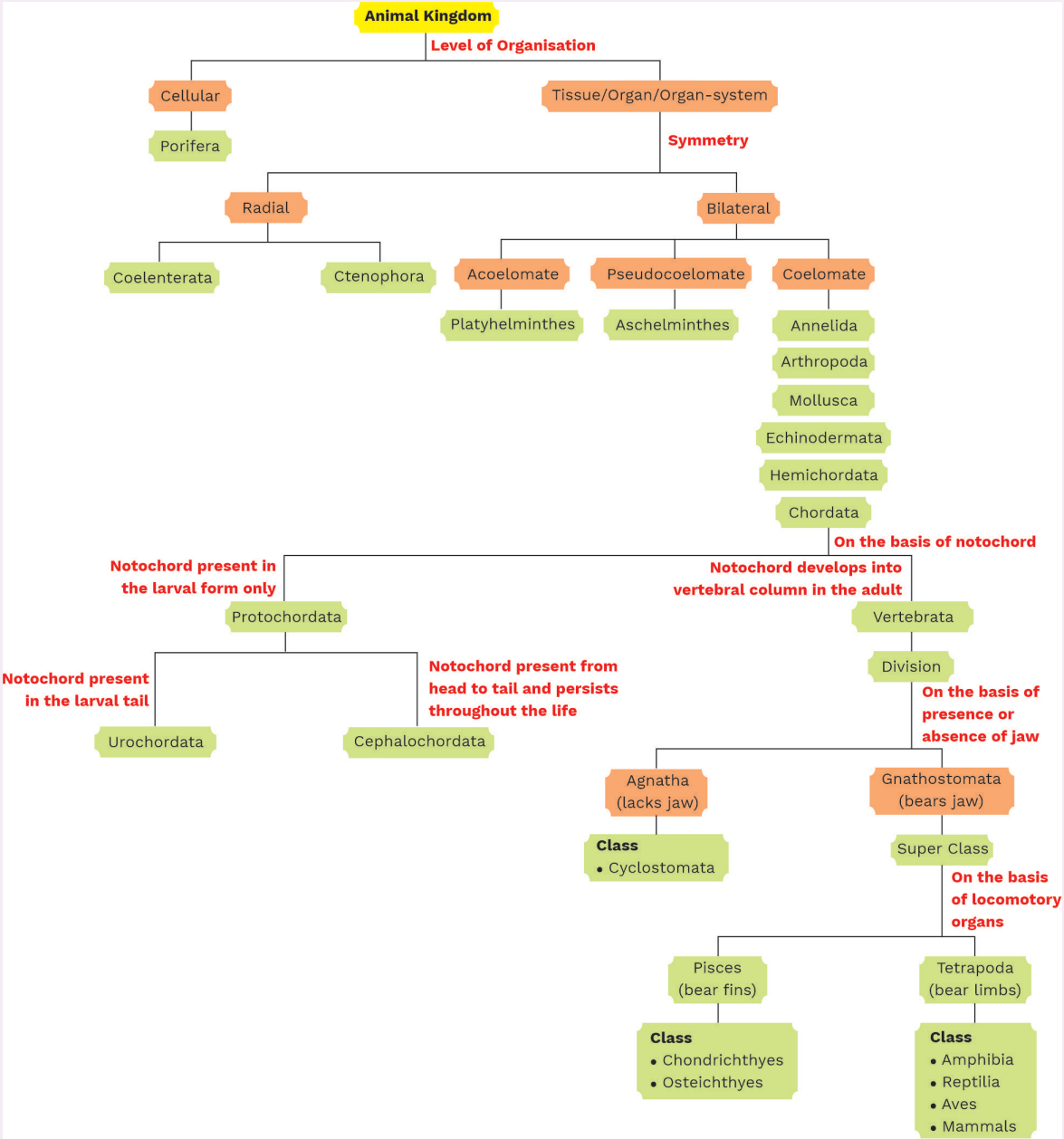
- Cell structure
- Body organisation
- Mode of nutrition
- Reproduction
- Phylogenetic relationship

Previous Year's Question

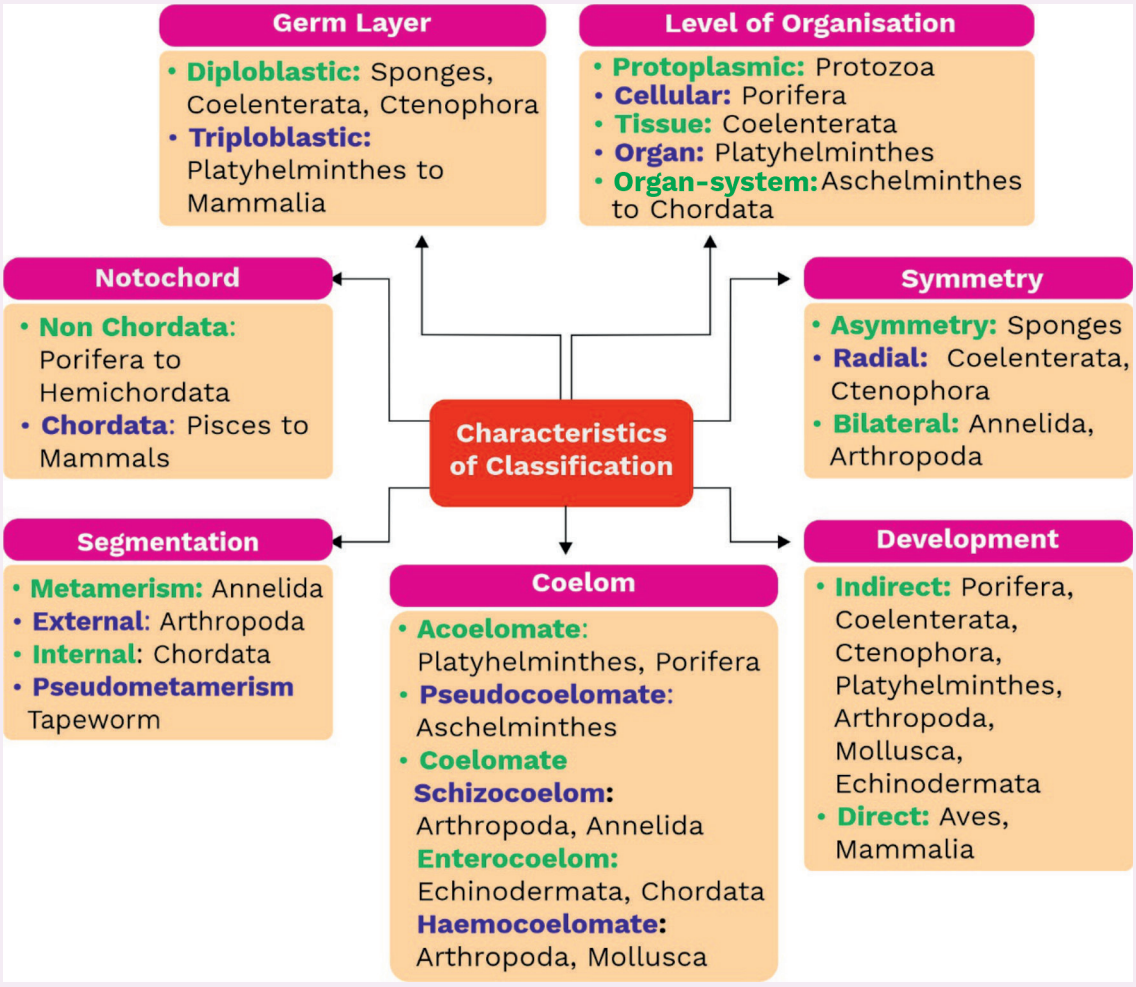
Five kingdom system of classification suggested by R.H. Whittaker is not based on
(1) presence or absence of a well defined nucleus
(2) mode of reproduction
(3) mode of nutrition
(4) complexity of body organisation

Summary: Classification of Animal Kingdom

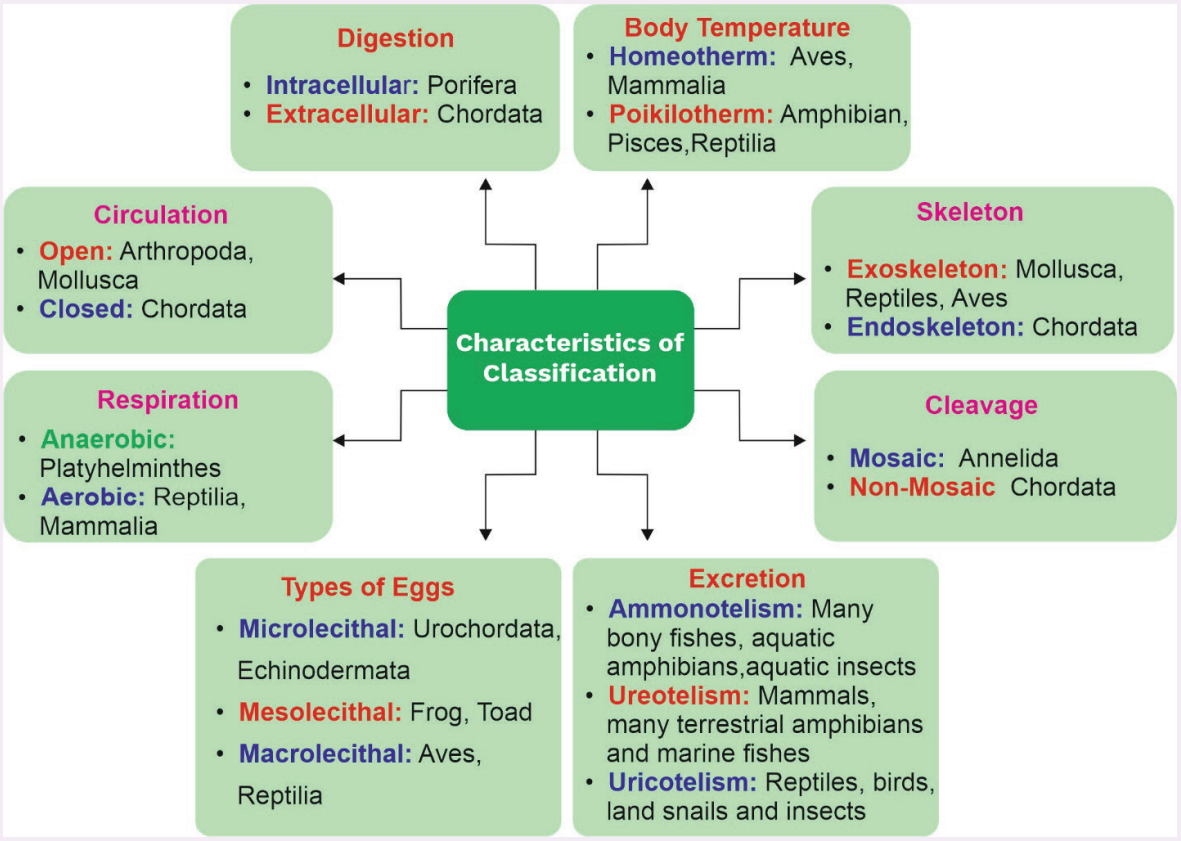
Broad classification of kingdom Animalia based on common fundamental characters



Summary: Characteristics of Animal Kingdom



Summary: Characteristics of Classification



Non-Chordata

Phylum Protozoa

- Initially, it was placed in animal kingdom but they could not be called as animals as they showed characteristics of both plants and animals like *Euglena*. Thus finally Haeckel placed them in a separate kingdom Protista and later Robert Whittaker maintained its status as a kingdom in his five kingdom classification. But here we will keep in mind the traditional concept and study it here as a phylum of Non-Chordata.
- Microscopic one-celled organism performs all the metabolic activities, and thus known as 'Acellular' organisms.
- **Habitat:**
  Aquatic
  Terrestrial
  Free living -*Amoeba*
  Parasitic -*Plasmodium*
  Solitary or colonial -*Proterospongia*
  Pathogenic -*Entamoeba histolytica*, *Leishmania*
- **Level of body organisation: Protoplasmic level**.
- Consists of protoplasm with a single or more than one nucleus.
- Maybe enveloped by plasmalemma, pellicle, cyst, theca, lorica or shell.
- **Locomotion:** By means of-
  Pseudopodia-*Amoeba*
  Flagella-*Euglena*
  Hairy cilia-*Paramoecium*
  No locomotory organelles-*Plasmodium*
- **Nutrition**
  Holozoic-*Amoeba*
  Mixotrophic-*Euglena*
  Parasitic- *Plasmodium*
  Digestion is intracellular, takes place in food vacuole.
- **Respiration:** By exchange of gases through body surface.
- **Excretion:** Takes place by contractile vacuole.
  Nitrogenous waste is Ammonia.
  Some fresh water protozoans get rid of excess water through contractile vacuole and the phenomenon is known as osmoregulation.
  Amoeba has one vacuole and *Paramoecium* has two vacuoles.

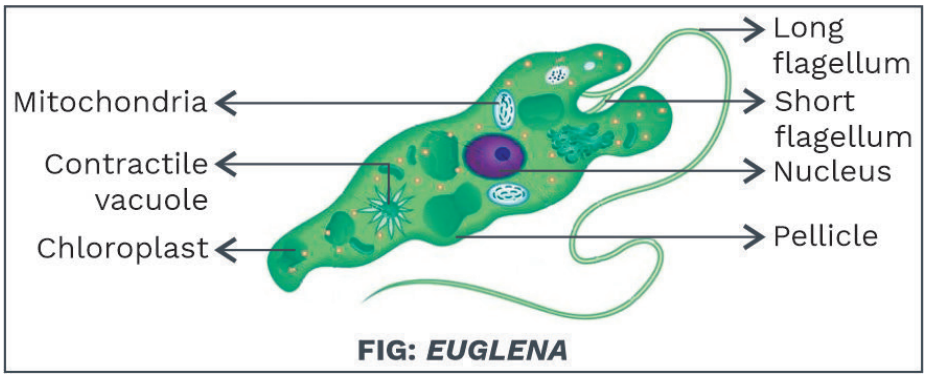


FIG: *EUGLENA*

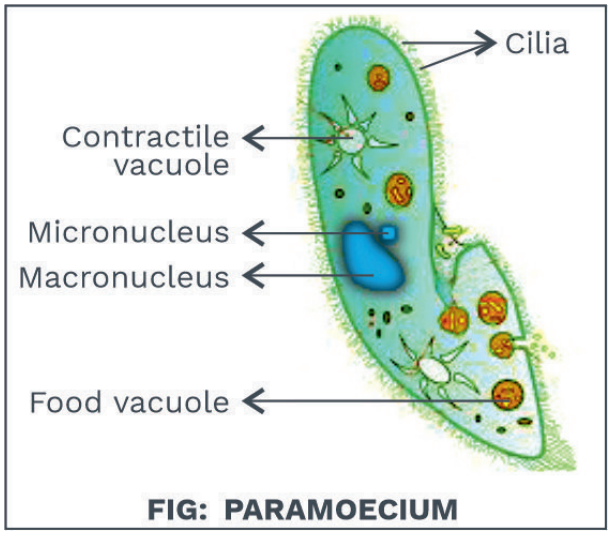


FIG: PARAMOECIUM

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Paramoecium-It is heterokaryotic i.e possesses two nuclei, macronucleus and micronucleus.
Macronucleus is polyploid and is the somatic nucleus that controls the metabolic activities.
Micronucleus is diploid and controls the reproductive activities of the organism.

- **Reproduction:**
  - **Asexual**
    - Binary fission -*Amoeba*
    - Transverse fission -*Paramoecium*
    - Longitudinal fission - *Euglena*
    - Multiple fission -*Plasmodium*

Definition

Binary fission-A mode of asexual reproduction in which a unicellular parent cell divides to form two daughter cells.

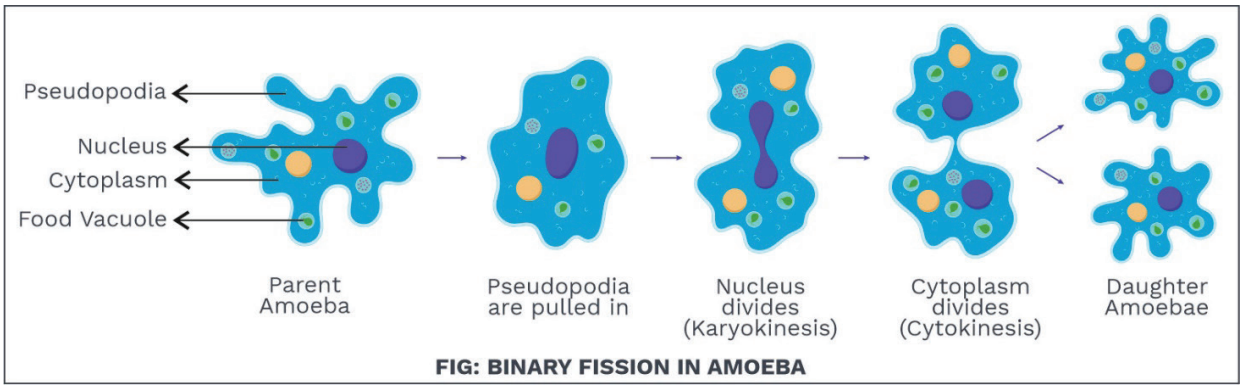


FIG: BINARY FISSION IN AMOEBA

Sexual :

- Syngamy -*Plasmodium*
- Conjugation -*Paramoecium*

- Some also form cyst which helps in reproduction in unfavorable conditions. They do not have natural death because in unicellular animals, growth is always followed by binary fission. The parent cell divides and forms two daughter individuals and thus, loses its identity.
- **Examples:**
  Amoeba
  Plasmodium
  Euglena
  Leishmania

Rack your Brain

Which organisms are considered to be immortal?

Classification of Protozoa

Phylum Protozoa is classified into the following four classes on the basis of modes of locomotion-

- **Mastigophora or Flagellata:** Locomotion is by flagella.
  Examples: *Trypanosoma gambiense, Giardia intestinalis*
- **Sarcodina:** Locomotion by pseudopodia.
  Examples: *Amoeba, Entamoeba histolytica*
- **Ciliata:** Locomotion by cilia.
  Example: *Paramoecium*
- **Sporozoa:** Locomotory organs absent.
  Example: *Plasmodium*

PHYLUM PORIFERA (Sponges or pore bearing)

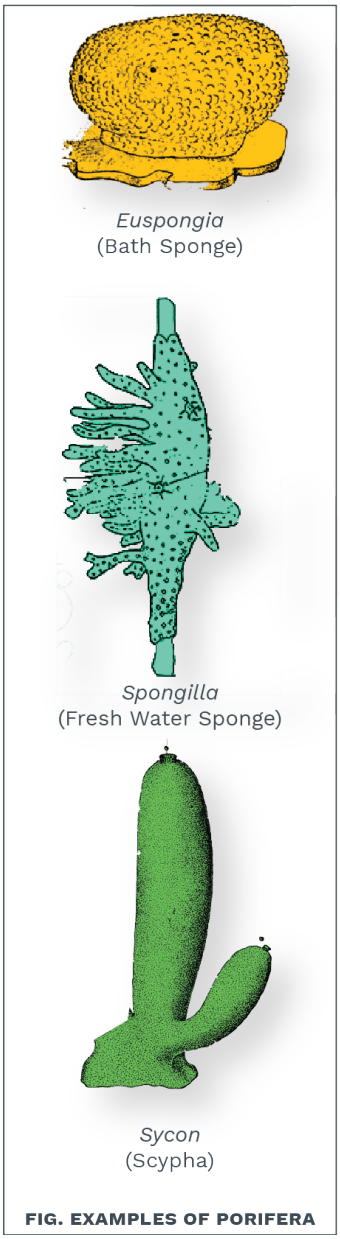
- Robert Grant gave the term 'Porifera'. They are commonly known as Sponges.
- **Shape:** tubular, vase-like, cylindrical and branched.
- **Habitat:** Aquatic, mostly marine and a few are found in fresh water (*Spongilla).* They are solitary or colonial. They are attached to the substratum and hence are sessile.
- **Level of body organisation:** They are multicellular, having a **cellular level** of organisation.
- **Symmetry:** Mostly asymmetrical.
- **Germ Layer:** They are **diploblastic**, having two layers namely dermal layer and gastral layer.
- **Body layers:** The body wall of sponges consists of three layers Pinacoderm, Choanoderm and Mesenchyme lining the central cavity called the spongocoel.

Pinacoderm:

- The layer present externally is known as epidermis or pinacoderm. It is a single layer of cells which are polygonal in shape, known as pinacocytes.
- Pinacocytes have nucleus in the center.
- The cells show contractility, which helps the sponges to increase and decrease in size.
- This layer also contains tubular cells known as pore cells or porocytes. They are the modification of pinacocytes.
- The space present in the porocytes is known as ostia or incurrent pore. Each porocyte allows water to move to the spongocoel.

Choanoderm:

- The layer that lines the spongocoel is the gastrodermis or choanoderm. It consists of flagellated collar cells, known as choanocytes.
- The choanocyte consists of ovoid cell with a transparent collar which surrounds the flagella.



Euspongia
(Bath Sponge)

Spongilla
(Fresh Water Sponge)

Sycon
(Scypha)

FIG. EXAMPLES OF PORIFERA

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Connecting link: *Proterospongia* is a connecting link between Protozoa and Porifera.

- The flagella beat and ensure the flow of water within the body of the animal.

Mesenchyme:

- The non-cellular layer present between the pinacoderm and choanoderm is mesenchyme.It consists of gelatinous matrix known as mesoglea.
- The matrix contains many amoeba-shaped cells called amoebocytes and minute skeletal elements made up of calcium known as spicules.
- Amoebocytes are modified into many different types namely-
  - **Archaeocytes** give rise to totipotent cells.
  - **Trophocytes (nurse cells)** provide nutrition to the cells.
  - **Thesocytes** store food.
  - **Chromocytes** contain the coloured pigments which provide colour to the sponges.
  - **Scleroblasts** secrete spicules. The calcareous spicules are present between the pinacoderm and choanoderm and form the skeleton of the sponges. They can be made up of calcium or silicon calcoblasts are the calcareous spicules.
  - **Gland cells** are the cells that secrete slimy substance.
  - **Germ cells** are the cells that form the sperms and ova.

- **Coelom:** Acoelomate
- **Canal System:** A distinguishing feature of the sponges is the presence of a canal system in the body.

  This system helps the organism to obtain food and oxygen from the surrounding medium whereas harmful substances and reproductive bodies are carried out of the body. There are three types of canal system-

Definition

Choanocytes- Flagellated cells have a collar of protoplasm at the base of the flagellum. They line the canal chambers of sponges.

Keywords

- Spongocoel
- Choanocyte
- Hermaphrodite
- *Ascon, Sycon, Leucon*
- Cell structure

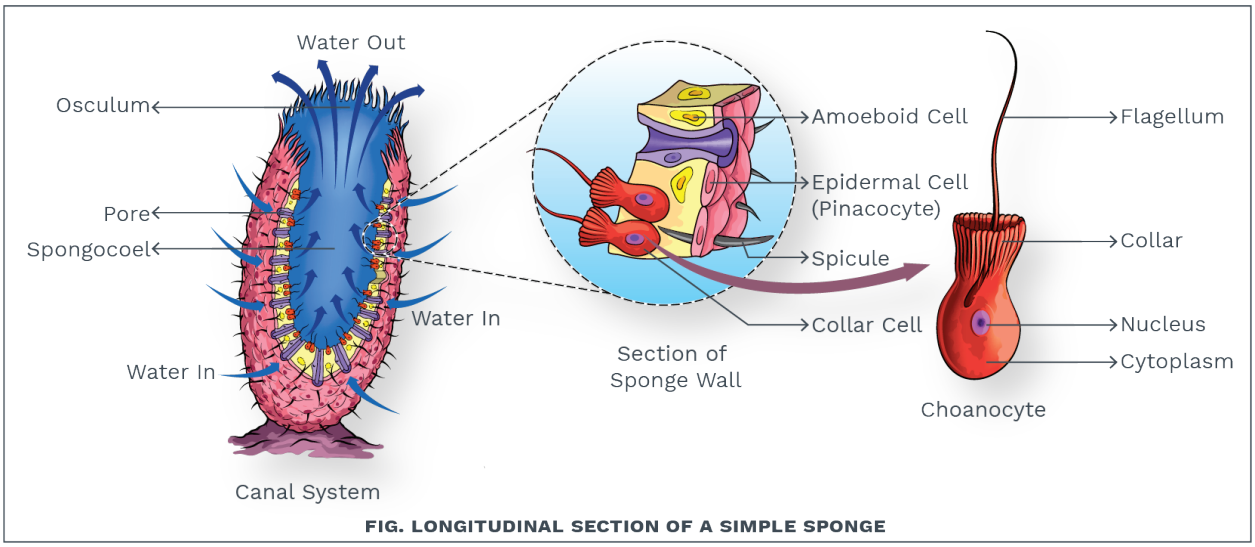

FIG. LONGITUDINAL SECTION OF A SIMPLE SPONGE

- **Ascon:** It is the simplest type of canal system, found in asconoid sponges like *Leucosolenia.* The body consists of minute pores called as incurrent pores which lead to the single large cavity known as spongocoel**. Spongocoel** opens into the outside by a circular opening known as osculum.

Ingressing water —Through dermal ostia→ **Spongocoel** —Through Osculum→ **To the outside**

Sycon: It is a complex type of canal system found in syconoid like *Sycon, Grantia.* It is formed by the folding of the wall of asconoid sponges. It includes two types of canals i.e., incurrent and radial, which alternate with each other. Both the canals are interconnected with a pore (known as prosopyle) between them. Water moves into spongocoel through the apopyles and then moves out by osculum.

Ingressing water —Through dermal ostia→ **Incurrent canals** —Prosopyles→ **Radial canals** —Apopyles→ **Spongocoel** —Through Osculum→ **To the outside**

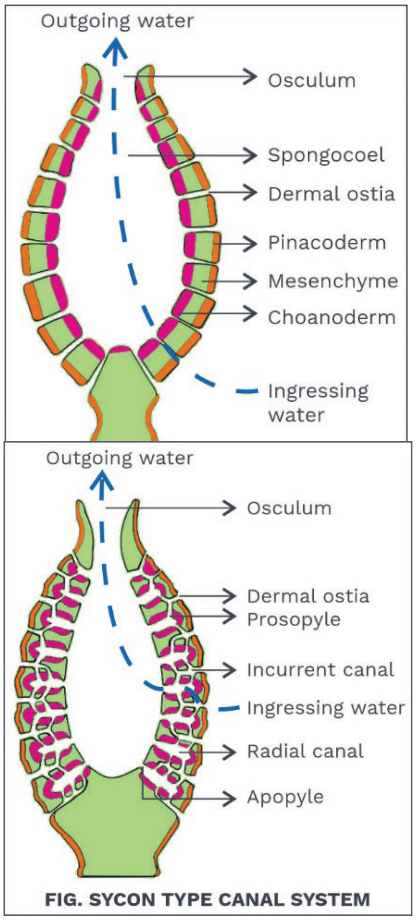

FIG. SYCON TYPE CANAL SYSTEM

Leucon: The walls of the leuconoid sponges show further folding, that leads to the complex leucon type of canal system. The incurrent canal enters into the flagellated chambers through the prosopyles, which lead into the excurrent canal through the apopyles. Excurrent canal is developed due to the shrinkage of the spongocoel.

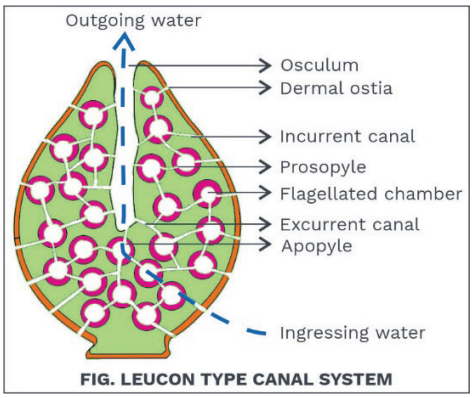

FIG. LEUCON TYPE CANAL SYSTEM

Ingressing water —Through dermal ostia→ **Incurrent canal** —Prosopyles→ **Flagellated chambers** → **Apopyles** → **Excurrent canal** —Through Osculum→ **To the outside**

- **Nutrition:** Digestion is intracellular, and food consists of microscopic plants and animals.
- **Respiration:** Takes place by diffusion through the water that moves into the canals.
- **Excretion:** Occurs through the canals.
- **Reproduction:** They reproduce asexually as well as sexually.

  Asexually, they reproduce by buds or by the gemmule formation.

  They are hermaphrodite and sperm and ovum are formed. The sperms are released into water, which move into another sponge and fuses with the ovum to form a zygote.

  Development is indirect and takes place by the formation of a ciliated larva known as amphiblastula.
- **Examples:**

  Euspongia: Bath sponge

  Euplectella: Venus flower basket

  Spongilla: Fresh Water sponge

Classification of Phylum Porifera:

- Phylum Porifera is classified into the following three classes on the basis of the types of Spicules-

Definition

Indirect development : The young one does not resemble the parent. It undergoes metamorphosis through a number of larval or nymph stages to develop into an adult.

Class Calcarea or Calcispongiae: Exoskeleton is formed of calcareous spines. Examples- *Leucosolenia, Scypha*

Class Hyalospongiae or Hexactinellida: Exoskeleton is formed of six-rayed siliceous spicules. Examples- *Euplectella, Hyalonema*

Class Demospongiae-Exoskeleton is either formed of spongin fibres or siliceous spicules or both. Examples- *Euspongia, Spongilla*

- **Distinctive Features Over Protozoa**
  Multicellular
  Presence of canal system
  Formation of gametes
  Development of larva

PHYLUM COELENTERATA OR CNIDARIA

- The term 'Coelenterata' was given by Leuckart while Hyman gave the term 'Cnidaria'.
- **Habitat:** They are aquatic and most of them are found in marine water except *Hydra* which is a freshwater cnidarian.
- They are solitary or colonial and may be sedentary or free swimming.
- **Level of organisation:** They are the first group of organisms that show tissue level of organisation.
- **Symmetry:** They show radial symmetry.
- **Germ Layer:** They are diploblastic animals.
- **The body wall:** The outer Epidermis and inner Gastrodermis. In between these two layers, a non-cellular layer called mesoglea is present.
- **Epidermis:** It is the outer-most layer and consists of small cuboidal cells. Its function is protective and sensory. Various cells that constitute this layer are:
  Epithelio-muscle cells: The muscle contracts and shortens the body and the tentacles.
  Gland cells: Secrete a sticky material which helps in capture and entanglement of the prey.

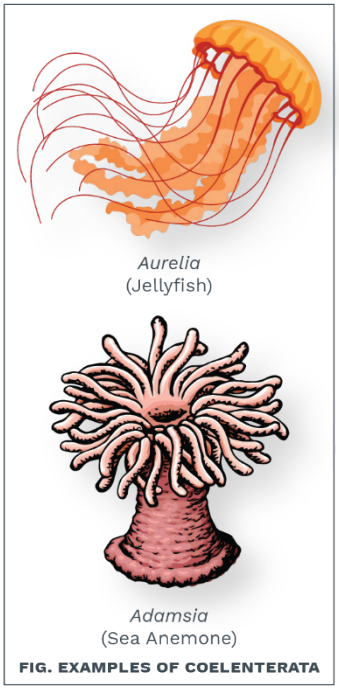

FIG. EXAMPLES OF COELENTERATA

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Hydra has power of regeneration. It was discovered by Trembley.

Interstitial cells: Ability of regeneration and hence also known as totipotent or reserve cells. These cells help in regeneration, budding and formation of other cells like the reproductive cells, glandular, stinging cells.

Sensory cells: Found specially on the tentacles, hypostome and pedal disc.

Nerve cells/Ganglia: They are present in the coelenterates (first one to have nerve cells). They are found in the epidermis layer and formed from the interstitial cells.

Germ cells: The interstitial cells in summer, differentiate and give rise to the gonads which differentiate into testes or ovaries.

Cnidoblasts: Many of the interstitial cells of the epidermis become specialized to form the stinging cells called cnidoblasts. When they are developed, they migrate to the tentacles through the mesoglea by the amoeboid movement.

- Cnidoblasts are oval in shape and consist of the **nematocyst (stinging organ)**.
- They act as an organ of defence. It is filled with a poisonous fluid known as hypnotoxin, which consists of proteins and phenols.
- The cnidoblast projects out of the epidermis as a tiny hair like structure known as the cnidocil.
- **Discharge of nematocyst takes place when the cnidocil is stimulated by the touch of the food and the prey**.
- Thus, mechanical and chemical stimulation is necessary for the discharge of the nematocyst.
- Once the nematocyst comes out, it cannot be used again. The cnidoblast of the nematocyst moves to the gastrovascular cavity and is digested.
- Discharged nematocysts are formed within 48 hours.

Gastrodermis: Inner layer of the body lining the gastrovascular cavity. It consists of the following cell:

Endothelio-muscular or nutritive cells: The cells consist of two flagella, which keep the liquid food inside the body cavity in moving state.

Endothelio-gland cells: Enzymatic gland cells secrete digestive enzymes into the cavity for digestion. Mucous glands secrete lubricants and paralyse the prey.

Interstitial cells: They are totipotent and can transform into any other types of cells when required.

Sensory cells: They are stimulated by the presence of a prey into the body.

Nerve cells: Similar to those that appear in the epidermis. Nematocysts are absent in the gastrodermis.

Mesoglea: A non cellular, thin layer present between the epidermis and gastrodermis.

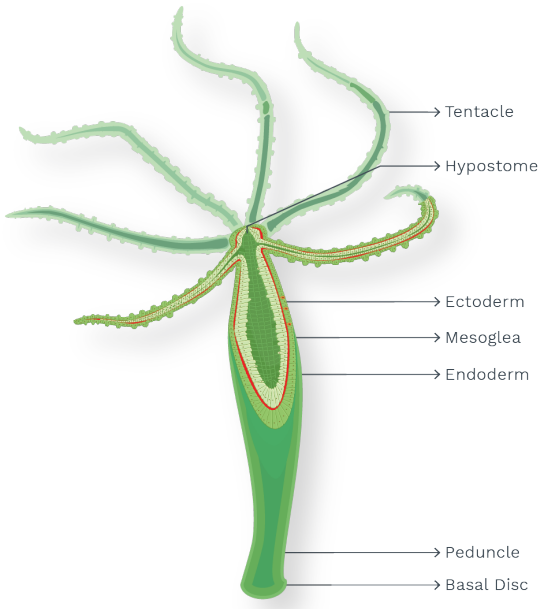


FIG. HYDRA

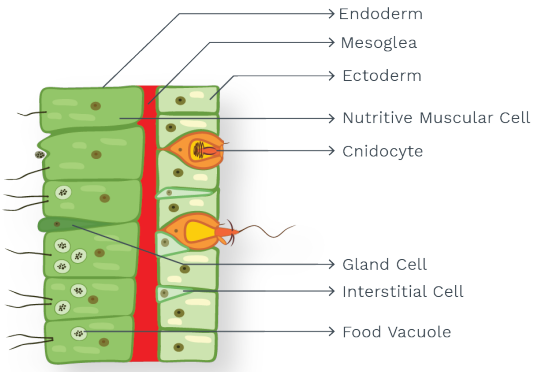


FIG. SECTION OF BODY WALL OF HYDRA

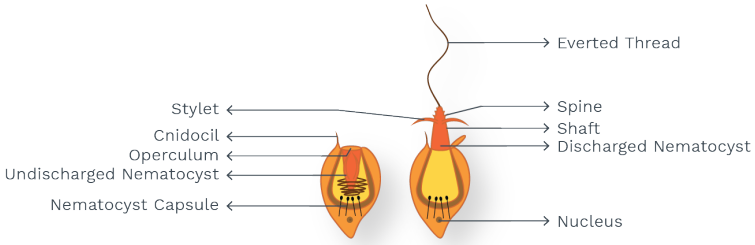


FIG. CNIDOBLAST OR NEMATOBLAST

- **Nutrition:** They are carnivorous and feed on nematodes, insects and crustaceans.
  The prey is captured by the nematocysts and partially extracellular digestion takes place (outside the cell in a cavity).
  Then it is moved into the **gastrovascular cavity** and intracellular digestion takes place.
  Digested food is sent to all parts of body.
- **Respiration:** It is carried out by the body surface via diffusion.
- **Excretion:** Ammonia is the chief excretory product.

- **Nervous System:** A primitive form of nervous system is present, which consists of a network of nerve cells and their processes.
- **Reproduction:** Life cycle of a coelenterate consists of two forms-

  One is the attached polyp and the other is the free-swimming medusa.

  Polyps are fixed and cylindrical in shape. Polyps are without gonads. Polyps feed and protect the colony and reproduce asexually by budding.

  Medusa is free living. It is umbrella-shaped and formed by blastostyle. Medusa has four gonads. Reproduces sexually.

  Metagenesis is seen in *Obelia*. In it, the polyp reproduces asexually to form medusa and medusa reproduces sexually to form polyp. Such an alternation of generation is known as metagenesis.

  Direct or indirect development takes place by planula, scyphistoma and ephyra.

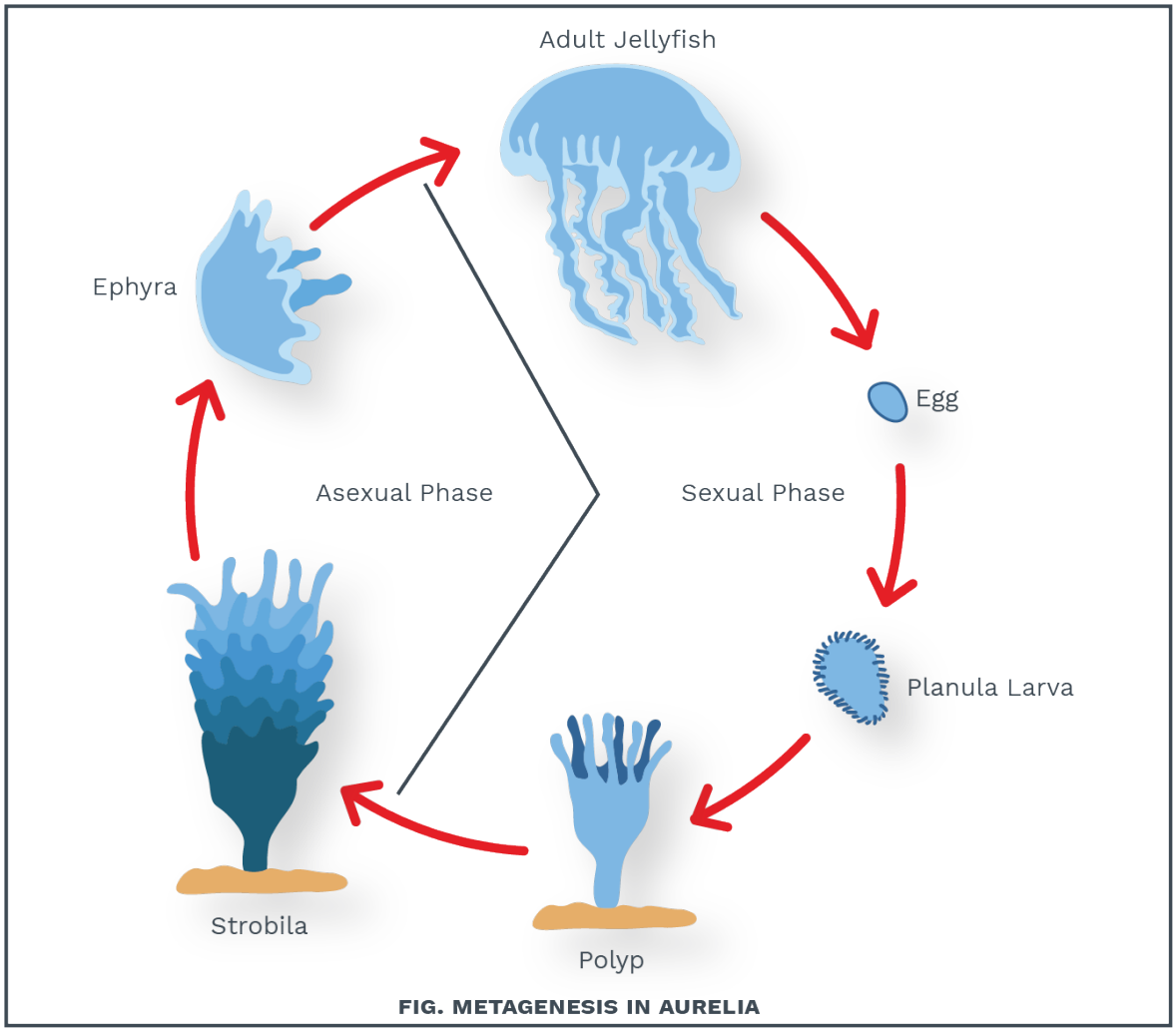
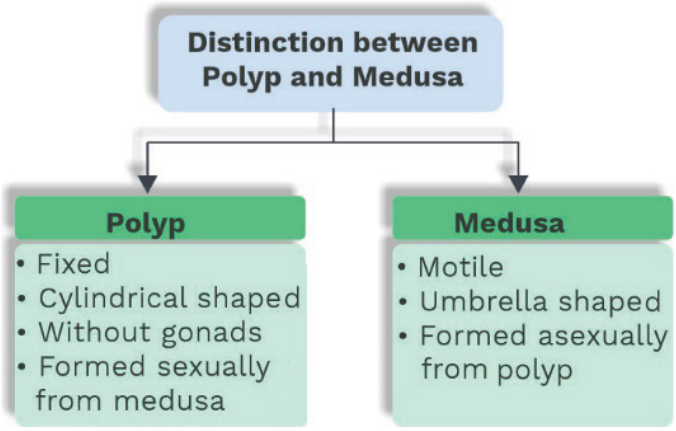


FIG. METAGENESIS IN AURELIA



- **Examples:**
  Hydra: Fresh water polyp
  Obelia: Sea fur
  Physalia: Portuguese man-of-war
  Adamsia: Sea anemone
  Pennatula: Sea-pen
  Meandrina: Brain coral

Classification of Phylum Cnidaria

- Phylum Cnidaria is classified into the following three classes on the basis of the dominance of medusa or polyp phase in the life cycle-
- **Class Hydrozoa:** Water animals. They have either polyps or both polyps and medusa are present. Examples – *Obelia, Physalia*
- **Class Scyphozoa:** Cup-shaped animals. They have medusa only. Examples – *Aurelia, Rhizostoma*
- **Class Anthozoa:** Flower-shaped animals. They have polyps only. Examples – *Adamsia, Meandrina*

Distinctive features over Porifera

- Tissue level of organisation
- Digestive cavity is present
- Tentacles with cnidoblast
- Few nerve cells are present
- Motile forms are also present

PHYLUM CTENOPHORA

- The phylum is commonly known as comb jellies or sea walnuts. *Ktene* means comb-a group of cilia and *phoros* means bearing. Initially,they were placed as a subphylum in Cnidaria but Eschscholtz recognised it as a separate phylum Cnetophora. Nematocysts are absent so known as Acnidaria.
- **Habitat:** Mostly marine, solitary, free swimming
- **Level of organisation:** Tissue level of organisation.
- **Symmetry:** Symmetry is radial. The arrangement of combs gives it a radial symmetry whereas the tentacles and the gastrovascular cavity are bilaterally symmetrical.
- **Germ layer:** They are diploblastic, having outer epidermis and inner gastrodermis.
- **Coelom:** Acoelomate
- **Body structure:** Most adult, tentacle-bearing ctenophores have a high capacity to regenerate the missing body regions.

  The body wall consists of two layers – the epidermis and gastrodermis and middle jelly-like mesoglea with some cells and muscle fibres.

  Nematocysts are absent. Special adhesive cells known as **Colloblasts** are present in the epidermis of the tentacles which help in capture of food.
- **Locomotion:** It is with the help of **eight external vertical ciliated comb plates** called as swimming plates. The combs usually propel away from the mouth and thus they usually swim in the direction in which the animal is eating.
- **Nutrition:** The digestive tract consists of the mouth, pharynx, stomodeum or stomach, which is highly coiled, has canals and two anal pores.

  Thus, digestive tract is complete. Digestion is both extracellular and intracellular.

  They are carnivorous animals. Most of the unwanted matter is thrown out of the mouth

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Bioluminescence: Ctenophores or comb jellies use bioluminescence for instant signalling. Calcium changes the shape of the enzyme photoprotein and it produces light.

and small unwanted particles are ejected through the anus.

- **Nervous System:** The brain and central nervous system are absent in them. Nervous system is **diffused type**.
- Respiratory, circulatory and excretory systems are absent.
- **Reproduction:** They are hermaphrodite, except the members of genus *Ocyropsis*, which are dioecious.

  Asexual reproduction is absent. They reproduce sexually.

  The gamete formed, moves out of the body from the mouth. Fertilisation is thus external. In *Coeloplana* and *Tjalfiella*, gametes are taken in through the mouth and fertilisation is internal.

  Development includes Cydippid larvae. When there is shortage of food, they become small in size and do not produce gametes. Once the food supply becomes normal, they grow in size and reproduce.
- Most ctenophores are capable of reproduction before they reach adulthood and this is known as **paedogenesis**.
- **Examples:**

  Pleurobrachia: Sea Gooseberry

  Beroe

  Cestum: Venus's Girdle

Classification of Ctenophora

- Phylum Ctenophora is classified into the following two classes, on the basis of the presence or absence of tentacles:
- **Class Tentaculata:** Two, long, aboral tentacles are present. Examples – *Cestum, Coeloplana*
- **Class Nuda:** Tentacle is absent. Example – *Beroe*

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Corals: They are hard materials secreted by marine, mostly colonial, polypoid coelenterates. Corals form the stable marine ecosystem.
Corallium rubrum is a type of red coral which is used in jewellery as red moonga stone.

Distinctive Features Over Cnidaria
Comb like ciliary plates
Bioluminescence

PHYLUM PLATYHELMINTHES (FLAT WORMS)

- The term Platyhelminthes was given by Gegenbaur. *Platy*-flat;*helminth*-worms.
- **Habitat:** They are mostly parasitic and a few are free-living like *Dugesia*.
- **Level of Organisation:** They have an **organ-system level** of organisation. The body is dorsoventrally flat and hence known as flatworms. The body is usually unsegmented like in Liver fluke (*Fasciola hepatica*) except in Tapeworm (*Taenia solium*).

Keywords

- Metagenesis
- Cnidoblasts
- Bioluminescence
- Colloblasts

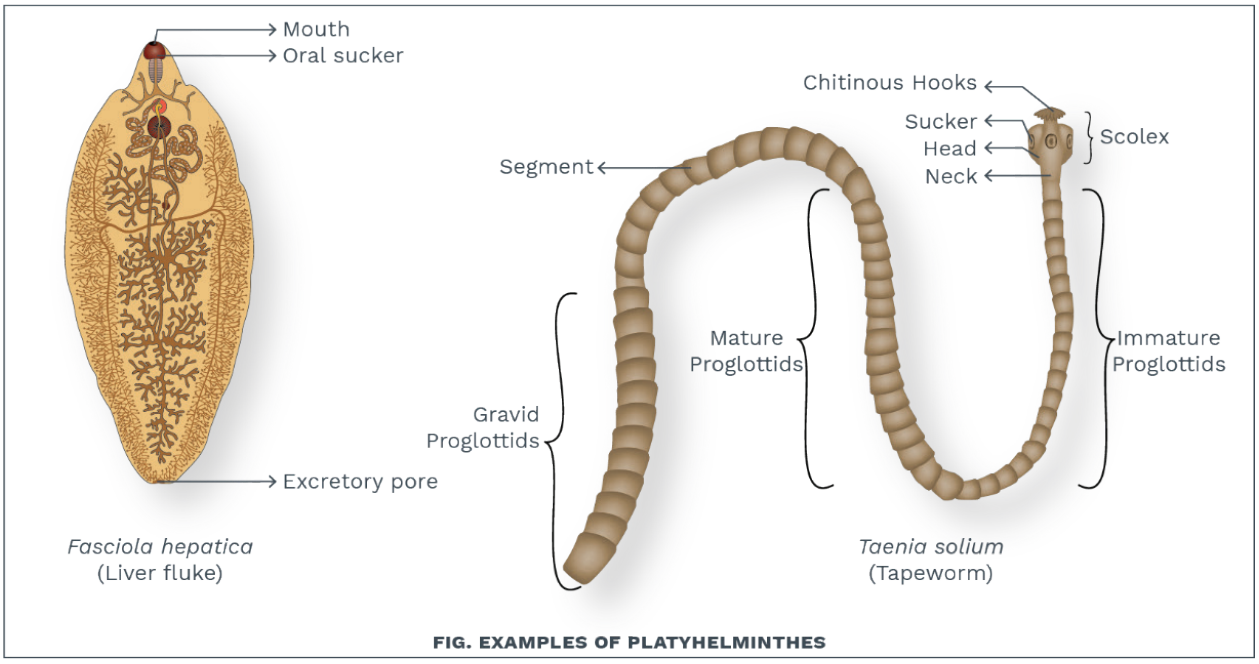

FIG. EXAMPLES OF PLATYHELMINTHES

- **Symmetry:** They have bilateral symmetry (first bilateral animal).
- **Germ Layer:** They are **first triploblastic** organisms.
- **Body structure:** The space between the body wall is filled with parenchyma. The fluid present in

Rack your Brain

Which proglottides of tapeworm show apolysis and why?

the parenchymal walls maintains the body shape and acts as a hydroskeleton.

Muscles in the body wall are mesodermal.

Below the epidermis longitudinal, circular, oblique muscles are present.

The body consists of sucker with which they attach to the host. The suckers are present at the anterior end i.e. oral suckers.

First animal to have **cephalisation**.

- **Coelom: Acoelomate**.
- **Nutrition:** Digestive system consists of an alimentary canal which is incomplete (without anus).

  Mouth leads into the pharynx, then oesophagus which opens into the intestine and the intestine is divided into many branches known as diverticula or caeca. This is the case in Liver fluke. In tapeworm the gut is absent.
- **Respiration:** Well-developed respiratory system.

  Respiration is through the body surface.

  Parasites like *Taenia* show anaerobic respiration.
- **Excretion:** Excretory system consists of flame cells or protonephridia that consist of cilia.

  The cilia move and this appears like **flickering flame** and is thus known as **flame cell**. Flame cells are also known as Solenocytes.

  Flame cells help in osmoregulation.

  Excretory pore present on the ventral surface of the body.

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Parasitic adaptations in Platyhelminthes:

- Flattened body for easy attachment to the host.
- Suckers and hooks to attach to the organs of the host.
- Produce a large number of eggs or sperms.
- Outer layer resistant to the digestive enzymes of the host.

Definitions

Independent host: A host in which the parasite undergoes its asexual phase.
Example: Snail is an intermediate host of liver fluke.
Primary host: A host in which a parasite attains sexual maturity.
Example: Sheep is a primary host of liver fluke.

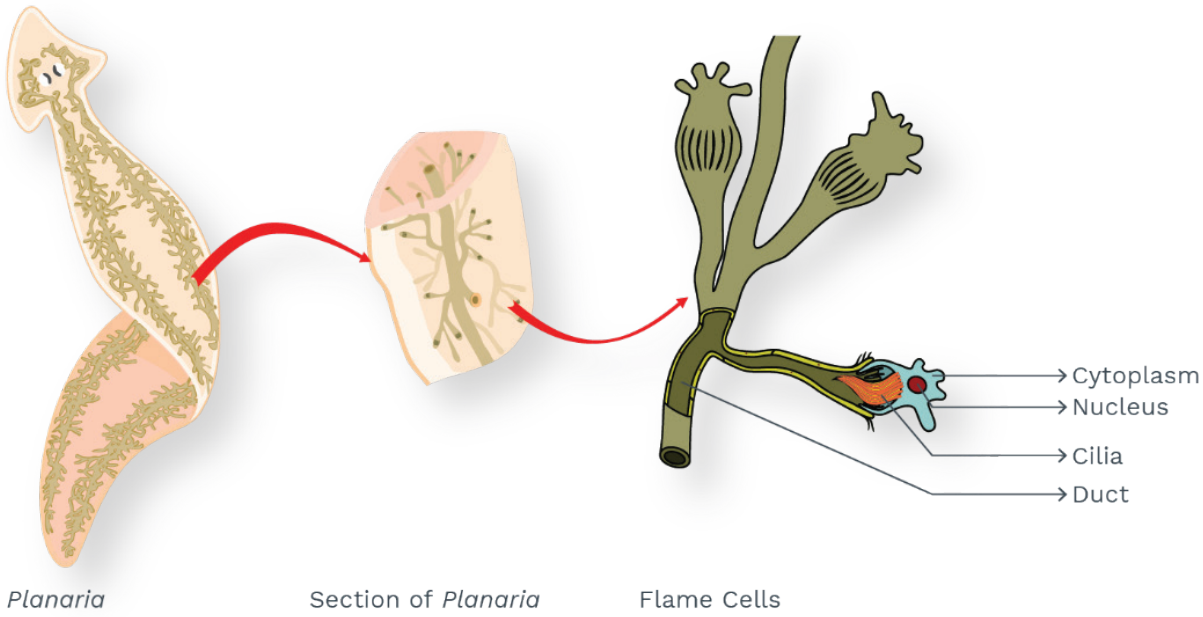


FIG. EXCRETORY STRUCTURE OF PLANARIA (PLATYHELMINTHES)

- **Nervous system:** Nervous system consists of a brain around the pharynx.

  Nervous system is primitive and ladder-like having a brain ring and 1-3 paired longitudinal nerves connected at intervals by transverse commissures.

  Nerves arise from the brain towards the anterior and posterior part of the body.
- **Reproduction:** They are hermaphrodite.

  Life cycle is digenetic i.e., completed in two hosts.

  Primary host is sheep and secondary host is snail as in Liver fluke. Primary host is man and secondary host is pig in case of Tapeworm.

  Self-fertilisation is seen in *Taenia* and cross-fertilisation is seen in *Fasciola*.

  Development is through the formation of many larval forms. In flukes miracidium, sporocyst, redia, cercaria and metacercaria larvae are present. In tapeworm, oncosphere, hexacanth and cysticercus larvae are seen.

Skeletal system and circulatory system are absent.

Regeneration: It takes place in some of the flat worms like in *Planaria*.

- **Examples:**

  Dugesia: Planaria
  Schistosoma: Blood fluke
  Fasciola: Liver fluke
  Taenia: Tapeworm

Table. Common Flatworm Infections in Human

Disease	Causative Agent	Organ Affected
Fascioliasis	*Fasciola hepatica*	Liver
Taeniasis, Cysticercosis	*Taenia solium*	Intestine
Schistosomiasis	*Schistostoma japonicum*	Blood
Echinococcosis	*Echinococcus multilocularis*	Liver, lungs
Fasciolopsiasis	*Fasciolopsis buski*	Intestine

Classification of Phylum Platyhelminthes

Is classified into the following three classes on the basis of body shape, mouth position and habitat:

- **Class Turbellaria:** Body is leaf-like, free-living and mouth is present on the ventral side. Highest power of regeneration. **Examples** – *Planaria*
- **Class Trematoda:** Body is leaf-like, either ecto or endoparasites. Mouth is present on the anterior end. **Example** – *Fasciola*

- **Class Cestoda:** Ribbon-like, endoparasites. Mouth and alimentary canal are absent. **Example:** *Taenia solium*

Distinctive Features Over Ctenophora

- Organ/organ-system level of organisation
- Bilateral symmetry
- Triploblastic
- Nervous system with brain, nerve cords
- Organised excretory organs, gonads

PHYLUM ASCHELMINTHES OR NEMATHELMINTHES OR NEMATODA (ROUNDWORM)

- Gegenberg proposed the term – Nemathelminthes.
- The word "nematode" comes from a Greek word '*nema*' means thread '*eidos*' means form. They are commonly known as roundworms, as they appear round in cross-section. They are found in aquatic and terrestrial habitat. Some are parasitic and are some free living.
- **Level of organisation:** The body is unsegmented, elongated, cylindrical, tapering towards the two ends. They have **organ level** of organisation.
- **Germ layer: Triploblastic**
- **Body Structure:** Body wall consists of an outer cuticle, middle syncytial epidermis and innermost longitudinal muscles.

  Cuticle is thick, tough, transparent layer secreted by the epidermis. It consists of five distinct layers.

  First layer is made up of lipids, second layer is made up of keratin, third layer is sulphur-rich protein matricin, and fourth layer is of fibres, and the fifth layer is the inner basement membrane.

  Cuticle secretes anti enzymes which neutralizes the effect of the digestive juices

Previous Year's Question

Which one of the following is a matching set of a phylum and its three examples?

(1) Porifera-*Spongilla, Euplectella, Pennatula*
(2) Cnidaria - *Bonellia, Physalia, Aurelia*
(3) Platyhelminthes -*Planaria, Schistosoma, Enterobius*
(4) Mollusca -*Loligo, Teredo, Octopus*

of the host.

Epidermis is present below the cuticle, bearing fat and glycogen reserves. The innermost layer consists of longitudinal muscles.

The pressure of the fluid and action of the surrounding muscles are used to change an organism's shape that produces movement.

- **Coelom:** True coelom is absent. **Pseudocoelom** as mesoderm is found in the form of small pouches in between the ectoderm and endoderm.

  The pseudocoelomic cavity is filled with the pseudocoelomic fluid. It maintains the shape of the body and forms the hydro skeleton of the body.

- **Digestion:** The digestive tract is complete and straight.

  It consists of the mouth, muscular pharynx, straight intestine and anus.

  They feed on the blood and the partially or fully digested food from the host. Food is sucked by the rhythmic muscular activity of the pharynx.

  Digested food is absorbed by the intestine and the undigested food moves out of the anus.

Respiration: Respiration occurs through the surface of the skin.

- **Excretion:** Excretory system is simple.

  Flame cells or protonephridia are absent. They consist of giant cells known as **renette cells or H-shaped** excretory system.

  It consists of two longitudinal excretory canals which are connected by a transverse network (below the pharynx). This transverse duct opens into a common canal that runs to the excretory pore.

- **Nervous system:** Consists of nerve ring or **circumpharyngeal ring** that forms nerves forward and backward in the body.

  Sensory organs are present and they are

Rack your Brain

There is an absence of circulatory system in *Ascaris*. How does it transport food, oxygen and waste in its body?

Previous Year's Question

Ascaris is characterized by

(1) presence of true coelom but absence of metamerism

(2) presence of true coelom and metamerism (metamerisation)

(3) absence of true coelom but presence of metamerism

(4) presence of neither true coelom nor metamerism.

of three types namely Papillae, Amphids, Phasmids.

Papillae are present on the lips, surrounding the mouth.

Cervical papillae are present behind the lips and they are tactile in function. Anal papillae are present ventrally, below the posterior end in males and help in copulation.

Near a single papilla, a single amphid is present. These are gustatory or chemoreceptors. Phasmids are chemoreceptors opening on either side of the tail.

- **Reproduction:** Sexes are separate and hence show sexual dimorphism.

  The female body is longer than the male body. Fertilisation is internal. Development may be direct or indirect. Indirect development takes place by the formation of larva.

  Filariform larva is found in *Ancylostoma* (Hookworm), Microfilaria larva is found in *Wuchereria* (filarial worm), *Rhabditiform* larva is present in *Ascaris*.

  Well-developed respiratory, circulatory and skeletal system is absent.

- **Examples:**

  Ascaris: Intestinal Roundworm
  Wuchereria: Filarial worm
  Ancylostoma: Hook worm

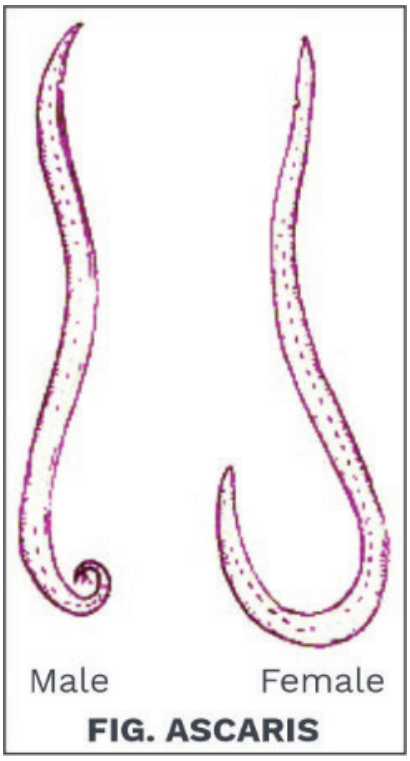


FIG. ASCARIS

Table. Common Worm Infections in Human

Disease	Causative Agent	Organ Affected
Ancylostomiasis	*Ancylostoma duodenale*	Intestine
Ascariasis	*Ascaris lumbricoides*	Intestine
Enterobiasis	*Enterobius vermicularis*	Intestine
Trichinosis	*Trichinella spiralis*	Small intestine, periorbital region
Lymphatic Filariasis	*Wuchereria bancrofti*	Lymphatic system

Classification of Aschelminthes

It is classified into the following two classes, on the basis of the presence or absence of phasmids:

- **Class Aphasmidia:** Phasmids are absent, while Amphids are present. Example – *Plectus*,
- **Class Phasmidia:** Phasmids are present. Example – *Enterobius*

Distinctive Features Over Platyhelminthes

- Syncytial Epidermis
- Muscular layer of body wall
- Digestive tract is complete

PHYLUM ANNELIDA (SEGMENTED WORM)

- The phylum Annelida was named by Lamarck.
- **Habitat:** They occur in fresh water, seawater or moist soil. Some are free-living and some are burrowing or parasitic. The body of the Annelids is divided into metameric segments (externally by

ring like growth known as annuli and internally by transverse septa).

- **Level of Organisation:** They show **organ-system** level of body organisation.
- **Symmetry: Bilateral** symmetry.

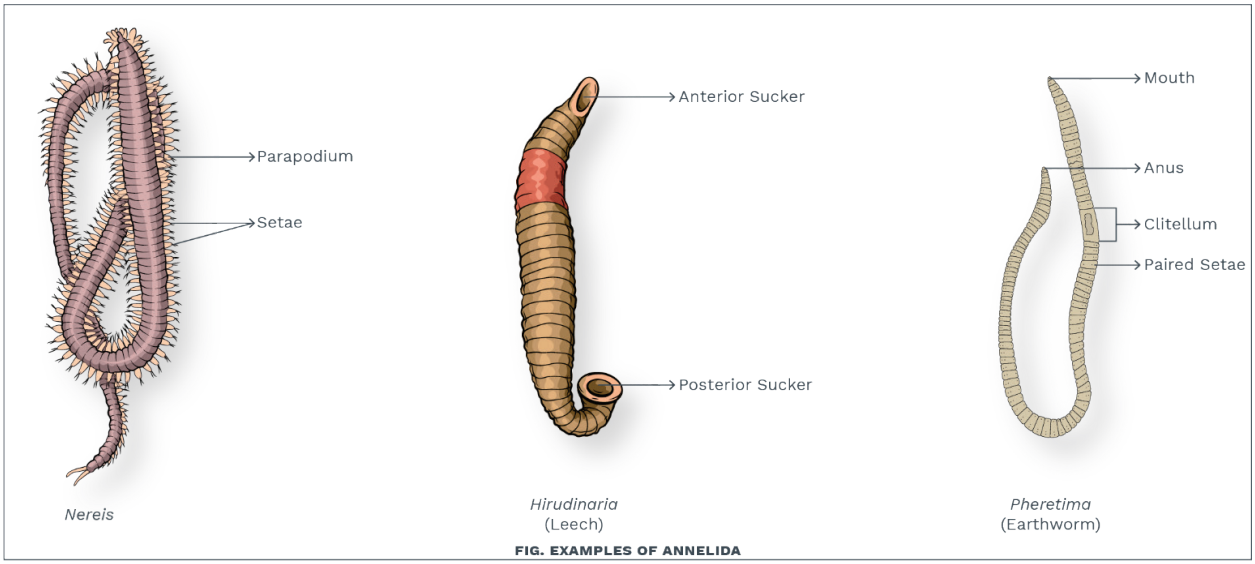


FIG. EXAMPLES OF ANNELIDA

Body Segmentation: Peristomium is the first segment of the body that differs from the other segments. It surrounds the ventrally elongated, slit-like mouth (peri-around; stoma-mouth) hence named as peristomium.

Prostomium is not a true segment, it is a triangular fleshy lobe lying in front of the mouth.

It consists of two pairs of eyes and a pair of short cylindrical sensory tentacles and two-jointed palps.

Body layers: The body wall consists of cuticle, epidermis and muscles.

The epidermis consists of columnar cells which consist of glandular and sensory cells. The epidermis secretes cuticle.

Cuticle prevents desiccation of the body and provides protection. The glandular cells

secrete mucus which lines the burrow in which they live and prevents them from collapsing.

Muscles lie below the epidermis. Circular, longitudinal and oblique muscles are present. The pressure of the fluid and action of the surrounding muscles are used to change an organism's shape and produce movement.

- **Germ layer:** Triploblastic
- **Ceolom:** They are coelomate. The coelom is schizocoelic in nature i.e. developed by the splitting of the embryonic mesoderm.

  Many septa divide the cavity into compartments.
- **Locomotion:** is brought about by the **setae, parapodia** and suckers.

  Setae are stiff bristles present on the body. Parapodia are flattened, fleshy flap-like outgrowth of the trunk which is present on the lateral side of the body.

  Parapodia near the middle part of the trunk are the largest which goes on decreasing in size towards the two ends.

  Suckers are present in Leeches and help in locomotion.
- **Nutrition:** They are carnivorous (*Nereis*), omnivores (Earthworm), and sanguivorous (feeding on blood) like Leech.

  Digestive tract is complete with the presence of mouth, buccal cavity, pharynx, oesophagus, stomach, intestine, rectum and anus.

  Mouth lies ventrally, a post-oral ciliated band lies behind the mouth.

  Gut has the presence of oesophagus, stomach, and intestine.

  Respiration: It takes place with the help of the moist skin (known as cutaneous respiration) and by parapodia. In some organisms, respiration also takes place through the gills.
- **Circulation:** It is of closed type.

Previous Year's Question

Which one of the following is not a characteristic of Phylum Annelida?

(1) Pseudocoelom
(2) Ventral nerve cord
(3) Closed circulatory system
(4) Segmentation

Rack your Brain

True coelom and closed circulatory system were first evolved in which group of organisms during the course of evolution?

It means that the blood flows through closed tubes or blood vessels. Blood consists of plasma containing many nucleated, colourless, amoeboid cells or corpuscles and dissolved pigment haemoglobin or erythrocruorin.

It gives red colour to the blood and helps in transport of respiratory gases and food in the body.

- **Excretion system:** It consists of numerous coiled structures placed in the metameric segments known as **nephridia**.

  They are present in all segments except a few anterior and posterior ones. Each nephridium consists of nephrostome, body and terminal ducts.

  Nephrostome consists of a ciliated funnel communicating with the coelom. Nephrostome leads into the short tube-like neck. The body consists of two parts, a short straight lobe and a twisted lobe.

  Twisted lobe consists of proximal and distal limb. The distal limb ends in a short, narrow duct known as terminal duct. They excrete ammonia out of the body.
- **Nervous system:** It is represented by ganglia that are arranged segmentally.
- Nervous system comprises of the nerve ring and ventral nerve cord. The nerve ring consists of a paired cerebral ganglia.

  A pair of pear-shaped ganglia connect together to form the brain, which lies between the buccal cavity and pharynx in the third segment.

  The ventral nerve cord sends nerves to the posterior end of the body. Nerves are supplied from the ganglion to the other segments of the body.

  Nervous system forms a nerve net beneath the epidermis, within the muscles of the body wall and alimentary canal.

Gray Matter Alert!!!

An anticoagulant hirudin is present in salivary glands of blood sucking leeches (Sanguivorous).

Sensory receptors like tactile receptors, gustatory receptors and photoreceptors are found in the Annelids.

- **Reproduction:** Annelids are both unisexual (as in *Nereis*), bisexual (as in Earthworm).

  Fertilisation is external.

  Development is mostly direct. If indirect, the fertilized eggs develop into trochophore larvae.

  Later, they sink to the sea-floor and metamorphose into adults. Trochophore larva is minute, ciliated, unsegmented and pear-shaped.

  In a well-grown larva, a tuft of cilia in the apical sensory organ is present.

  A very unique feature of the larva is the presence of **preoral ciliated girdle** of cilia (prototroch) cells above the equator.

  Larval nephridia are present in the lower part of the body.

- **Examples:**

  Lumbricus

  Pheretima -Earthworm

  Hirudinaria -Bloodsucking leech

Classification of Phylum Annelida

- Phylum Annelida is classified into the following four classes, on the basis of the presence or absence of parapodia, setae, metamers:

  Class 1 – Polychaeta – Segmentation is internal or external. Many setae on the lateral parapodia. Examples – *Nereis, Aphrodita*

  Class 2 – Oligochaeta – Segmentation is internal and external. Few Setae. Examples – *Lumbricus, Nais*

  Class 3 – Hirudinea-Segmentation is external without internal septa. Setae absent. Example – Leech

  Class 4 – Archiannelida-Segmentation is internal. No setae. Examples – *Dinophilus, Protodrilus*.

Distinctive Features Over Aschelminthes

- Metameric segmentation
- Presence of parapodia
- Closed circulatory system

PHYLUM ARTHROPODA (ANIMALS WITH JOINTED APPENDAGES)

- **Habitat:** They are found in air, water, land, burrowed in soil and in the bodies of plants and animals. The body consists of jointed legs or appendages.
- **Level of Organisation:** They have an organ-system level of organisation
- **Symmetry:** Show bilateral symmetry and body is segmented.
- **Coelom:** They are **coelomate**.
- **Germ Layer: Triploblastic**
- **Body structure:** Body is divided into head thorax and abdomen.

  The head and thorax fuse together to form the cephalothorax. The body wall or exoskeleton consists of a single layer of epidermis, an internal basement membrane and cuticle.

  The epidermis is one cell thick and gives rise to the basement membrane. Cuticle is secreted by the epidermis. It is present all over the body except the midgut region.

  Cuticle is divided into two layers-Epicuticle, Procuticle. Epicuticle is made up of proteins, lipids and a waxy layer. This waxy layer makes the cuticle impermeable to water.

  The procuticle is made up of chitin protein. In some Arthropoda, there is a deposition of calcium carbonate and calcium phosphate on it. Cuticle provides protection and rigidity to the insects.

  Cuticle becomes thick, hard and non-flexible which makes the predation of arthropods difficult.
- **Nutrition:** They have different types of mouthparts for **feeding, biting and chewing** like that are found

Gray Matter Alert!!!

Living fossil: *Limulus* has shown no changes since it has evolved on the earth and therefore is known as living fossil.

Limulus

Rack your Brain

Muscles developed for the first time in _____.

in the grasshoppers, cockroaches; **piercing and sucking** type as present in mosquito and bed bug, **chewing and lapping** type found in honey bees, **sponging** type as in housefly and **siphoning** as in butterfly. Digestive system is complete with mouth and anus.

The alimentary canal consists of stomodaeum (foregut), mesenteron (midgut) and proctodaeum (hindgut). From the mouth, the food reaches the stomach where food is acted upon by the enzymes.

The digested food is absorbed by the small intestine and undigested food moves out of the anus.

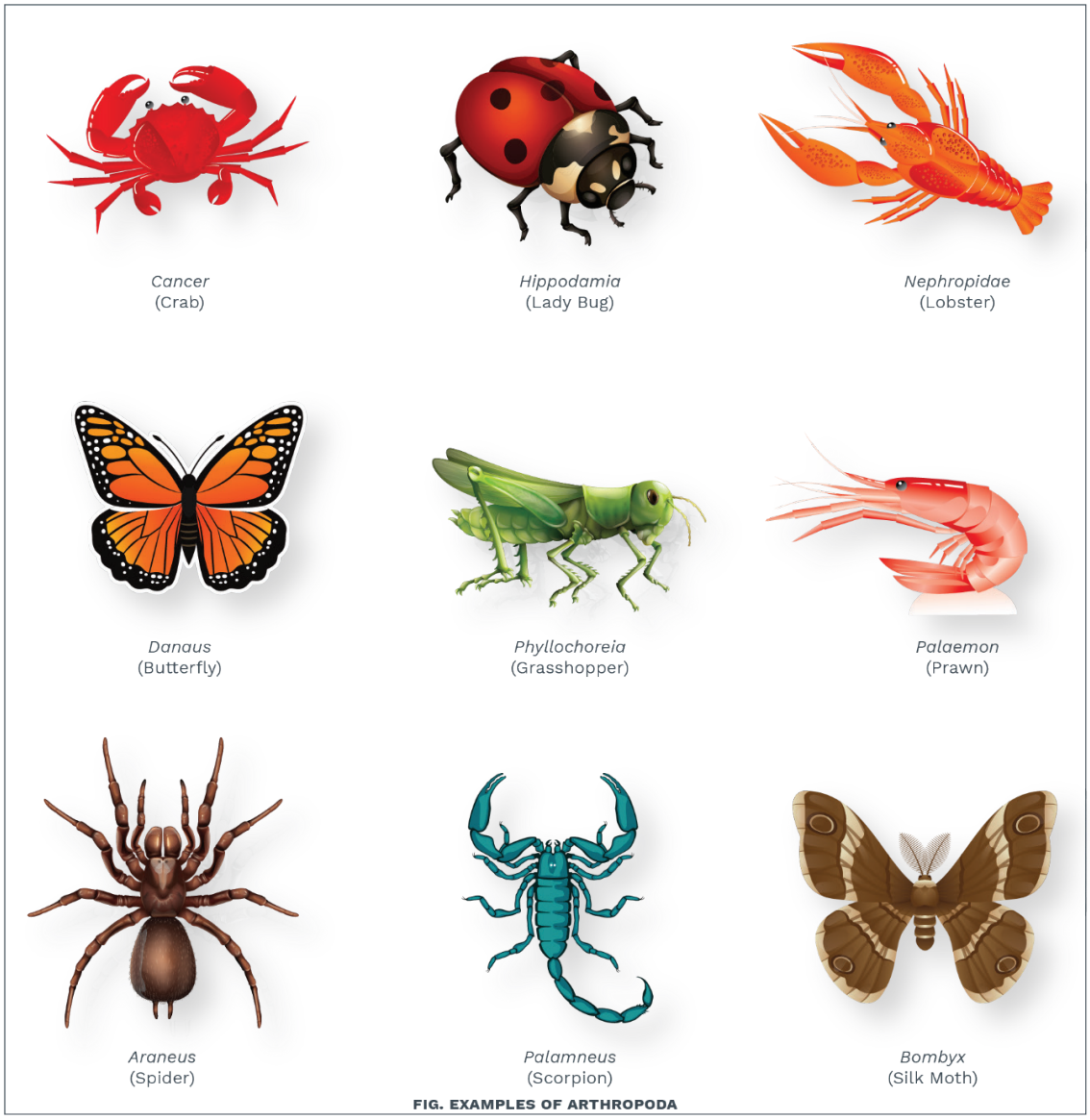


FIG. EXAMPLES OF ARTHROPODA

- **Respiration:** In arthropods occur through the **body surface, gills,book lungs or tracheae**. Spiracles are tiny breathing pores present on the sides of the thorax and abdomen.

  Air moves into the body through the spiracles. Spiracles open into an opening known as atrium which leads into fine air tubes known as tracheae.

  Tracheae are further branched to form tracheoles which are filled with fluid tissue that helps in exchange of gases by diffusion.

  Book lungs consist of a series of leaflike plates within a chamber. They are usually found in the 3rd to 6th segment of the body.

  Air is drawn in and expelled out of this chamber by muscular contraction. Horseshoe crabs have book gills which are analogous to book lungs but function in arthropods found in water.
- **Circulation:** The circulatory system in arthropods is **open**; their blood flows through cavities between the internal organs and not through closed vessels.

  Arthropods consist of a heart which is divided into a linear row of chambers, one in each segment of the body, which helps in pumping blood to different parts of the body.

  Blood or haemolymph consists of clear liquid plasma and white blood cells. Blood has no pigment.
- **Excretion:** It is through the malpighian tubules or green glands. Malpighian tubules are slender projections that emerge from the digestive tract that are attached at the junction of the midgut and hindgut.
- **Nervous system:** It is similar to that found in the Annelids. Sensory organs like tentacles and eyes are present.

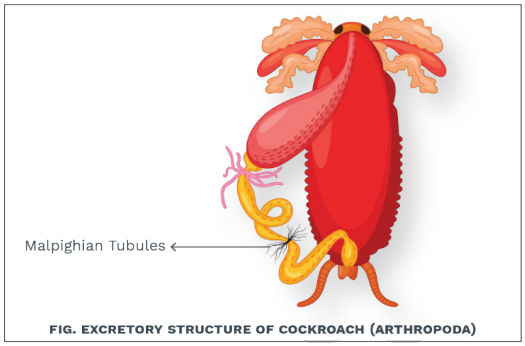


FIG. EXCRETORY STRUCTURE OF COCKROACH (ARTHROPODA)

Eyes found in arthropods are compound eyes. They are composed of many independent visual units, often thousands of them, called **ommatidia.**

Each ommatidium is covered with a lens and linked to a complex of eight retinular cells and a light-sensitive central core.

- **Reproduction:** They are dioecious. Fertilisation is internal. Development is direct or indirect with some larval forms.

  Parthenogenesis takes place in some arthropods. Development of an egg into a complete individual without fertilisation is called **parthenogenesis**. This type of development is seen in the male honeybees.

- **Examples:**

  Bombyx mori – Silk moth
  Apis indica – Honey bee
  Mantis – Praying mantis
  Palamneus – Scorpion
  Aranea – Spider

Classification of Phylum Arthropoda

- Phylum Arthropoda is divided into many subphyla and classes on the basis of the body divisions and presence or absence of appendages. Few of the subphyla have been divided into classes. Some of the classes are:

  Class – Crustacea: The body is divided into cephalothorax. and abdomen. Two pairs of antennae and a pair of compound eye are present. Example – *Palaemon, Cancer*

  Class – Chilopoda: Body is divided into head and trunk. Each trunk bears a pair of legs. Example – *Scolopendra* (Centipede)

  Class – Arachnida: The body is divided into cephalothorax and abdomen. It bears six pairs of appendages. Examples – Scorpion, Spider

  Class – Diplopoda: Body is divided into head, thorax and abdomen. A single pair of

Rack your Brain

Eusocial phenomenon is seen in which organisms?

antennae is present. Each thoracic segment bears a pair of legs. Example – *Julus*

Class – Insecta: Body is divided into head, thorax and abdomen. Consists of a pair of antennae and a pair of compound eye. Examples – Silverfish, termites, butterfly

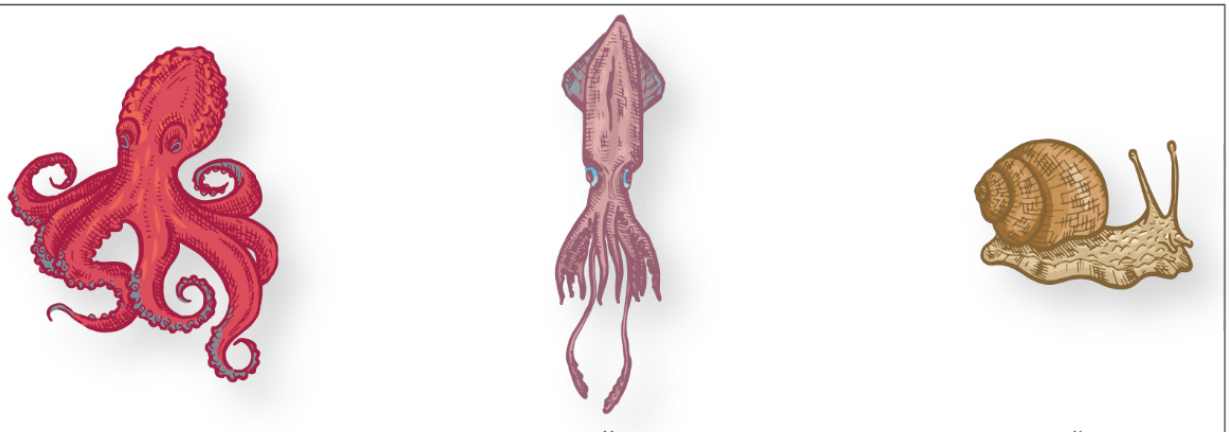
Class – Merostomata: Aquatic, antennae absent, body segmented. Example – *Limulus*

Distinctive Features Over Annelida

External segmentation only
Jointed appendages
Exoskeleton of Chitin

PHYLUM MOLLUSCA (SOFT BODIED ANIMAL)

- It is the second-largest phylum after Arthropoda. Mollusca is derived from the word *mollis* or molluscs which means soft-bodied.
- **Habitat:** It consists of all marine animals ranging from a giant squid to a small snail.
- **Level of Organisation:** Organ-system level of organisation.
- **Symmetry:** It is bilateral but in *Pila* (apple snail) due to the presence of twisting of the body during the growth (torsion) is asymmetrical.



Octopus (Devil Fish) | *Loligo* (Squid) | *Pila* (Apple Snail)

FIG. EXAMPLES OF MOLLUSCA

- **Germ Layer:** Triploblastic
- **Coelom:** coelomate, (Shizocoelom – greatly reduced) unsegmented. Coelom is reduced. It is present around the heart, kidney and gonads.
- **Body Structure:** *Neopilina* is a segmented mollusc. The body is divided into head, mantle, muscular foot and visceral hump.

  The **foot or podium** is **muscular** and is distinct from the rest of the body. In *Pila,* the foot consists of many pedal glands which secrete a slime trail during locomotion.

  Head foot complex is attached to the visceral mass by a short neck.

  Foot gets its nerve supply from the pedal nerve cords or pedal ganglia. Mantle is a layer which encloses the cavity known as the mantle or pallial cavity.

  The animal retracts its head and foot into the cavity in order to protect itself from any danger and to rest.

  The head is retracted first and then the body. **Mantle also secretes the shell** in most of the molluscs.

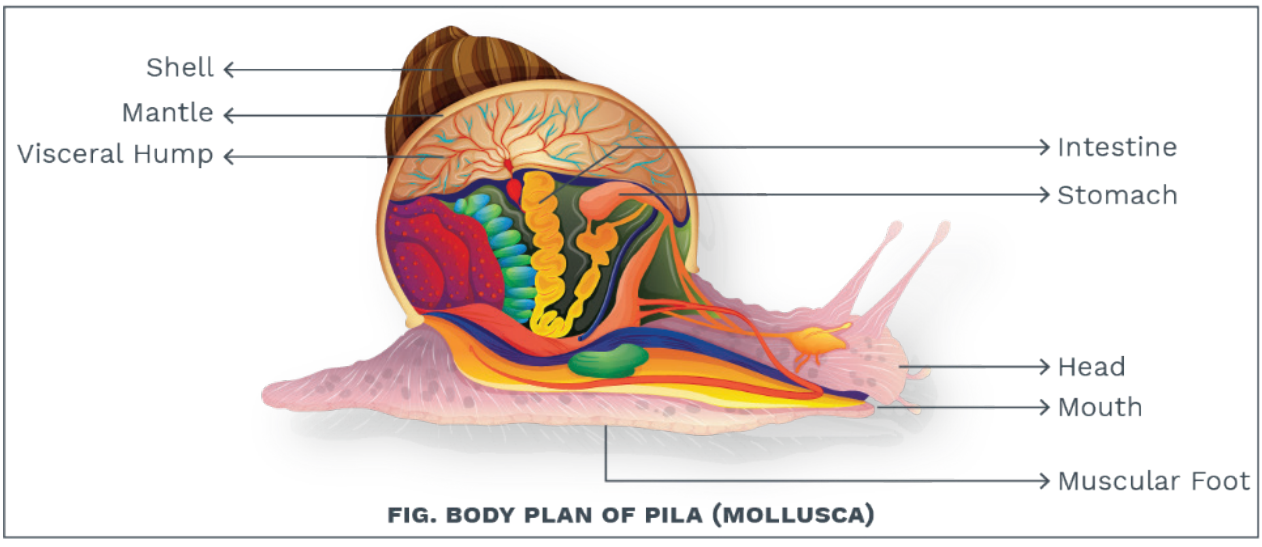


FIG. BODY PLAN OF PILA (MOLLUSCA)

- **Nutrition:** Some molluscs are herbivores while others are carnivores. The digestion is extracellular.

  The Digestive tract is complete, starting with the mouth and ends with the anus. The mouth consists of radula which can be compared to a tongue and consists of minute teeth present on them.

  The radula helps the molluscs to take in food. It is used in feeding by snails, to bore through shells by predator snail, to cut the prey by squids. The digestive tract is ciliated.
- **Respiration:** In molluscs, it can be cutaneous or Pallial, Branchial or Ctenidial or Pulmonary respiration. Respiration by the integument or by the mantle is the simplest method.

  Respiration occurs through the soft surface of the body. Most of the aquatic molluscs respire by the gills or by ctenidia. Water flows through it and by the process of diffusion gases are exchanged.

  In some molluscs, actual gills are absent and other morphologically different structures are present.

  In *Doris*, anal gills are present; while in *Aeolidia* adaptive gills are present on the dorsal surface of the body. In terrestrial molluscs like *Limax* gills or ctenidium are absent and the mantle cavity is transformed into pulmonary sac or lungs for aerial respiration.
- **Excretion:** Excretory organs are a pair of metanephridia. Ammonia is the main excretory substance.
- **Circulation:** The blood circulates between gills and heart, through the blood-filled space haemocoel.
- Except cephalopods, all molluscs have an **open circulatory system**.
- **Nervous system:** It comprises of cerebral, pleural, pedal and visceral ganglia connected by connectives and commissures.

Rack your Brain

Radula is one of the characteristics of Mollusca, but which Mollusc lacks a radula?

Gray Matter Alert!!!

Haemocyanin: It is present in the blood of the Molluscs which gives it a blue colour when exposed to oxygen.

Gray Matter Alert!!!

Pearl: It is formed by nacre layer. Nacre layer' is called 'Mother of pearl'. This layer is made up of $CaCO_3$ and conchiolin protein.

Pinctada

Connectives connect dissimilar ganglion and commissures connect similar ganglion. In many molluscs, a short fleshy stalk known as Ommatophore is present on either side behind the second pair of tentacles.

At the tip of the ommatophores are present a black, circular eye. Statocysts i.e., organ of equilibrium is present in the molluscs.

Each statocyst is a hollow structure filled with fluid and calcium particles known as statoconia.

- **Reproduction:** They have separate sexes, but several snails are hermaphrodites.

  Sperm and eggs are spawned into the water. Fertilisation is external, but internal fertilisation can also be seen in several species.

  Development is indirect through the free larval forms Veliger, Trochophore or Glochidium.

- **Examples:**

  Neopilina
  Chaetopleura: Chiton
  Unio: Fresh water mussel
  Pila: Apple snail
  Loligo: Squid
  Octopus: Devil fish

Classification of Phylum Mollusca

- Phylum mollusc is divided into seven classes on the basis of the shell:

  Aplacophora: Shell absent. Example – *Neomenia*

  Monoplacophora: They are one plate bearing. The shell is spoon-shaped. Example – *Neopilina*

  Polyplacophora/Amphineura: Shell consists of 8 plates. Non-ganglionated nerve ring is present around the mouth with two interconnected nerve cords. Example – *Chiton*

  Scaphopoda: Shell is tubular and open at both ends. Example – *Dentalium*

Gray Matter Alert!!!

Connecting link: *Neopilina* is a connecting link between Annelida and Mollusca.

Gastropoda: It includes the largest number of molluscs. Shell is made up of one piece. Example – *Helix*

Pelecypoda or Bivalvia: Shell is made up of two halves. *Pinctada, Unio*

Cephalopoda: Shell is external, Head and foot region are modified to form a structure which has eyes and tentacles. Thus, their name is cephalopoda or 'head –foot'. Examples – *Sepia, Loligo, Octopus*

- **Distinctive features over Arthropoda**

  Distinct head
  Better sense organs
  Gills/lungs for respiration

PHYLUM ECHINODERMATA (SPINY SKINNED ANIMALS)

- Initially, Echinodermata was placed along with colelenterata in Radiata. Later, Leukart in 1847, identified it as a separate group. Echinodermata (*echinos*-spiny; *derma*-skin) are known as spiny-skinned animals. The term echinodermata was coined by Jacob Klein.
- **Habitat:** They are marine animals and found at the bottom of the water body. Except-*Synapta similis*, some are free living or sessile.

  The shape of the body may be star-shaped, cylindrical or spherical.

  The star-shaped body consists of five radiating arms ambulacral and five interradii arms called as inter-ambulacral.
- **Level of organisation:** They have an **organ-system** level of organisation of the body,
- **Coelom: Coelomate**.Coelom is lined by amoeboid cells.
- **Germ layer:** Triploblastic and the body wall consists of epidermis which extends all over the body. It consists of scattered gland cells and neurosensory cells.

  The gland cells secrete a protective mucus sheet around the body. The neurosensory

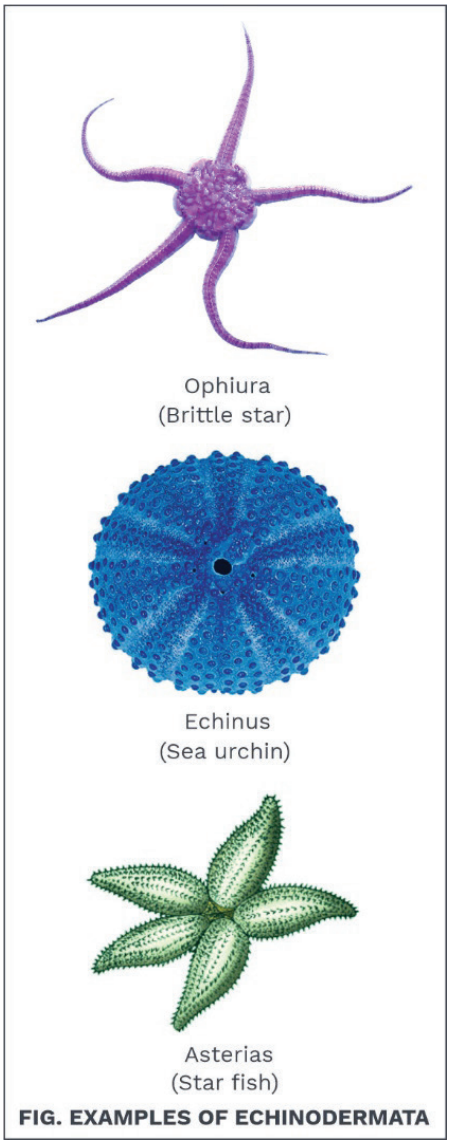


FIG. EXAMPLES OF ECHINODERMATA

cells are connected to form a nerve net below the epidermis.

Below the epidermis, lies the dermis which consists of the self-secreted calcareous plates or ossicles.

Pedicellariae are a small wrench- or claw-shaped appendage with movable jaws, called valves which are present on the body of some echinoderm like sea star and sea urchin.

They keep the body surface clear of algae, encrusting organism, and other debris.

- **Symmetry:** The larval forms show bilateral symmetry. The five-armed adults show radial symmetry. The echinoderms have the ability of regeneration and autotomy.
- **Canal System:** The echinoderms consist of canal system which is a modification of the coelom.

  It consists of a calcareous perforated plate on the aboral surface of the central disc known as madreporite.

  This madreporite leads to the stone canal which is known as **madreporic canal**.

  Stone canal opens into the ring canal, which is in the form of a pentagonal ring around the oesophagus.

  There are small, rounded yellowish structures that open into the ring canal on the inner side. Such bodies are known as **Tiedmann's gland**.

  The ring canal gives out radial canals which further give out two series of lateral canals.

  The lateral canal opens into the tube feet. Each tube foot consists of rounded sac-like structure called as **ampulla**, a middle tubular part podium and a cup-like sucker at the lower end.

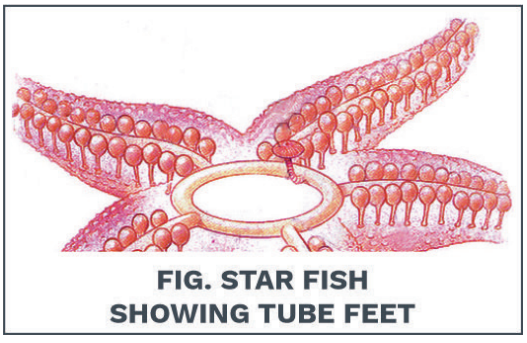


FIG. STAR FISH SHOWING TUBE FEET

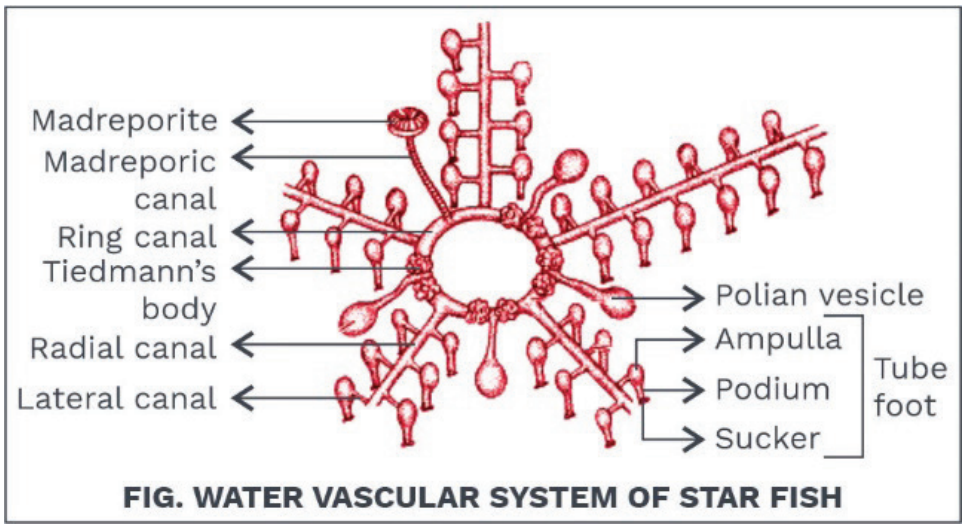


FIG. WATER VASCULAR SYSTEM OF STAR FISH

- **Circulation:** A true blood vascular system is absent in the echinoderms. It consists of a haemal system which is enclosed within a perihaemal system.
- **Respiration:** It occurs through the structures known as **dermal branchiae or papullae** which are outgrowths on the surface of star fish. They are continuous with the coelom and help in exchange of gases by diffusion. Respiration also occurs through peristomial gills in sea urchins, genital bursae in brittle star.
- **Nervous system:** It is primitive. It consists of nerve net consisting of nerve fibres and some ganglion cells. They are present in the whole body. Neurosensory cells are present on the epidermis. They are of two types – tactile and olfactory. Tactile cells are found in the tube feet and olfactory cells are present around the mouth. Sea star possess red eyespots at the end of each arm at the base of the terminal tentacle.
- **Excretion:** Well developed excretory system is absent. Ammonia is the excretory product which is thrown out of the body through the papullae.
- **Reproduction:** Sexes are separate except in few individuals. Fertilisation is external. Development

is indirect through the free swimming larval forms. The larval forms are the early Bipinnaria, later Bipinnaria, Brachiolaria, Holothuroidea, Echinoidea larva.

- **Examples:**
  Asterias–Star fish
  Ophiura–Brittle star
  Echinus–Sea urchin
  Cucumaria–Sea cucumber
  Antedon–Sea lily

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Antedon: It shows high power of autonomy and regeneration.

Classification of Phylum Echinodermata

- Phylum Echinodermata is divided into five classes on the basis of the shape of the body:
  Class Asteroidea: Body is star-shaped.
  Example – *Asterias*
  Class Ophiuroidea: Body is star-like, sharply marked off from the central disc.
  Example – *Ophiothrix*
  Class Echinoidea: Body is globular or disc-like. Example – *Echinus* (sea urchin)
  Class Holothuroidea: Body elongated and cylindrical.
  Example – *Holothuria* (sea cucumber)
  Class Crinoidea: Body has a central disc.
  Example – *Antedon*
- **Distinctive Features Over Mollusca**
  Water vascular system for locomotion
  Radial symmetry

PHYLUM HEMICHORDATA

- *hemi*-half; *chorde*-chord. Initially was treated as a sub-phylum of Chordata but later given the status of an independent phylum.
- **Habitat:** They are living in burrows and are mostly marine.
- **Shape:** Body is elongated **worm like** consisting of proboscis, collar and trunk.
- **Body layer:** Skin layer consists of single epidermis.
- **Symmetry:** Bilateral

- **Coelom:** Body cavity is enterocoelus, that is divided into protocoel, mesocoel and metacoel.
- **Germ Layers: Triploblastic**
- **Nutrition:** Mostly ciliary feeders. Complete alimentary canal is present in digestive system.
  This is straight or U-shaped. Digestive tract is complete.
  Narrow openings called gill slits are present on the dorsal side. They are usually present in several pairs.
- **Respiration:** Occurs through the **gill slits**. **Ciliary filter feeders** present that test the quality of water and food entering the organism.
  Circulation: Circulatory system is open with a contractile heart vessel with two longitudinal vessels connected to each other by lateral vessel.
  Excretion: A single proboscis gland helps in excretion.
  Nervous System: Nervous system is not so advanced, consisting of inter epidermal nerve plexus. *Balanoglossus* has both mid-dorsal and mid-ventral nerve cord that is present along the entire length of the body. Neurosensory cells are present on the epidermis are sensitive to touch and light.
  Reproduction: Sexes are separate.
  Gonads are one to many.
  Fertilisation is external.
  Direct or indirect development with a free-swimming **tornaria larva**.
  Special Feature: True notochord is absent.
  A notochord like structure is found in their buccal cavity, that is called 'buccal diverticulum' or **'stomochord'** (a hollow outgrowth arises from the roof of buccal cavity).
- **Examples:**
  Balanoglossus
  Saccoglossus

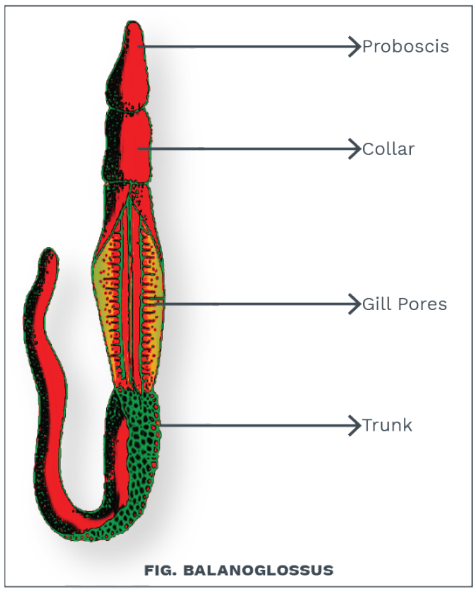

FIG. BALANOGLOSSUS

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Connecting link: Hemichordata is a connecting link between Non-Chordata and Chordata.

Classification of Hemichordata

- It has been divided into the following two classes on the basis of body forms:

  Class Enteropneusta:

  Examples: *Balanoglossus, Saccoglossus*

  Class Pterobranchia:

  Example: *Rhabdopleura*

Distinctive features of Hemichordata

- Presence of stomochord
- Presence of notochord-like structure known as buccal diverticulum.

Summary: Non-Chordata

Features	Protozoa	Porifera	Coelenterata	Ctenophora	Platyhelminthes
Level of organisation	Protoplasmic	Cellular	Tissue	Tissue	Organ and organ-system
Symmetry	Asymmetrical	Asymmetrical	Radial	Radial	Bilateral
Germ layer	No layer	Diploblastic	Diploblastic	Diploblastic	Triploblastic
Coelom	Acoelomate	Acoelomate	Acoelomate	Acoelomate	Acoelomate
Segmentation	Absent	Absent	Absent	Absent	Absent
Digestive system	Absent	Absent	Incomplete	Incomplete	Incomplete
Circulatory system	Absent	Absent	Absent	Absent	Absent
Respiratory system	Absent	Absent	Absent	Absent	Absent
Excretory system	Contractile vacuole	Osculum/ canal system	Mouth	By cells	Flame cells
Fertilisation	Absent	Internal	External	External	Internal
Development	Direct	Indirect	Indirect	Indirect	Indirect/Direct

Salient Features of Different Phyla in the Animal Kingdom

Summary: Non-Chordata

Features	Aschelminthes	Annelida	Arthropoda	Mollusca	Echinodermata	Hemichordata
Level of organisation	Organ-system	Organ-system	Organ-system	Organ-system	Organ-system	Organ-system
Symmetry	Bilateral	Bilateral	Bilateral	Bilateral	Radial (adult) Bilateral (Larva)	Bilateral
Germ layer	Triploblastic	Triploblastic	Triploblastic	Triploblastic	Triploblastic	Triploblastic
Coelom	Pseudocoelomate	Coelomate	Coelomate	Coelomate	Coelomate	Coelomate
Segmentation	Absent	Present	Present	Absent	Absent	Absent
Digestive system	Complete	Complete	Complete	Complete	Complete	Complete
Circulatory system	Absent	Present	Present	Present	Present	Present
Respiratory system	Absent	Absent	Present	Present	Present	Present
Excretory system	Excretory pore	Nephridia	Malpighian tubule	Gills	Absent	Proboscis gland
Fertilisation	Internal	Internal	Internal (usually)	External	External (usually)	External
Development	Direct/Indirect	Direct	Indirect/ Direct	Indirect	Indirect	Indirect

Salient Features of Different Phyla in the Animal Kingdom

Chordata

Identifying characteristics of the chordates

- **Presence of a notochord:** A rod-like structure is present in the organisms, which in the later stages undergoes some changes to form the vertebral column.
- **Presence of dorsal hollow nerve cord:** The nerve cord lies to the dorsal of the notochord and is always hollow.
- **Presence of pharyngeal gill slits:** At some stage of the life cycle the chordates have a pair of gill slits on the lateral side. In Pisces,they are present throughout the life.

Classification of Chordata

Phylum Chordata is divided into three subphyla:

Subphylum Urochordata
Subphylum Cephalochordata
Subphylum Vertebrata

- **Sub-phylum Urochordata**

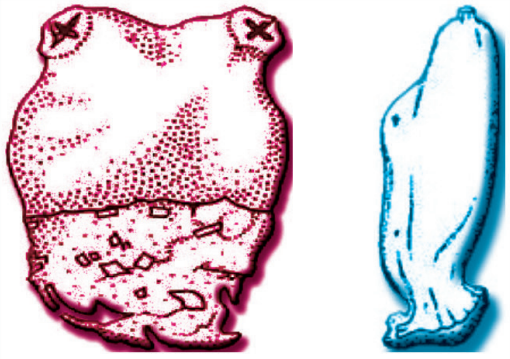
Uros-tail; *chordate*-notochord bearing

The organisms of this phylum are sedentary.
They are called **tunicates** as they are covered by a leathery test made up of a chemical tunicin. The notochord is only present in the tail of the larva and disappears in the adult.
Dorsal nerve cord in the larva is replaced by nerve ganglion in the adult.
They have gill slits for respiration.
Open circulatory system. The heart is tubular and ventral.
Mostly hermaphrodite. Development is indirect with a swimming larval form.

- **Subphylum Cephalochordata**

cephalos-head; *chordata*-notochord bearing

The organisms in this phylum are motile.
The notochord is present from head to tail and is persistent throughout the life of an organism.
Gills slits are better developed and adapted for respiration.



Herdmania *Ascidia*

FIG. EXAMPLES OF UROCHORDATES

Tail present throughout the life cycle.
Excretion by **protonephridia**.
Nerve cord dorsal and tubular.
Hermaphrodite.
Fertilisation is external. Indirect development through a free-swimming larva.

- **Examples:** *Amphioxus*
- **Subphylum Vertebrata**

The members of this subphylum are much advanced than the members of the above-mentioned two phyla.
Notochord is replaced by a bony structure called the vertebral column in the adult.
Brain is enclosed in a hard bony structure called cranium.
Exoskeleton and endoskeleton both are present.
Digestive system is well developed.
Respiration is either by gills, skin or by the lungs.
Circulatory system and heart are well developed; heart having two, three or four chambers.
Sense organs are well developed like the eyes, ear, nose, and tongue.
Pair of kidneys are present for excretion. Substances that are excreted can be Ammonia, uric acid, and urea.
Nervous system consists of brain and the spinal cord.
Sexes are separate.
Fertilisation can be either external or internal.
There is no asexual reproduction.
It is divided into two divisions:

- **Division 1:** Agnatha - Jawless Vertebrates.
- **Division 2:** Gnathostomata-Jawed Vertebrates.

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Retrogressive metamorphosis: Larval form changes from a well-developed form to a less developed one. The free swimming larva (with notochord) changes into a sessile, non-chordate adult. Example: *Herdmania*

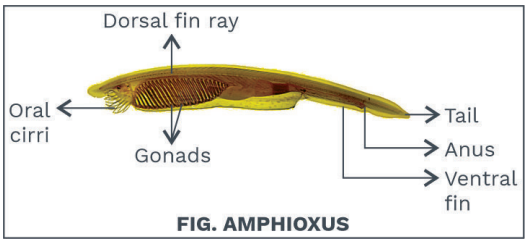

FIG. AMPHIOXUS

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Progressive Metamorphosis: Larva modifies from a less developed to a better developed form, as in Amphibians (Anurans).

Agnatha

- Notochord is present throughout the life.
- Vertebral column is not well developed and is just present in the form of small arches over the notochord.
- It has two classes Ostracodermi and Cyclostomata.

  Ostracodermi: It is an **extinct class** – *ostracon* – shell;*derma*-skin. The body was covered with small plates known as dermal scales and thus got the name Ostracodermi. Jawless fish-like primitive animals. **Examples:** *Cephalaspis*

  Cyclostomata: *cyklos*:circular; *stome*: mouth. Ectoparasite. Body is elongated eel-like with circular mouth. It has **sucking type** of mouth. Median fins are present but no paired appendages. 5-16 pairs of gill slits are present. **Cranium and vertebral column are cartilaginous**. Heart is two chambered. No renal portal system. Dorsal nerve cord and 8-10 cranial nerves are present. Sexes are separate or united; with external fertilisation. Development is indirect with a larval stage. Adult move from marine water to fresh water for spawning and then they die. The larva after metamorphosis return to the ocean. **Examples:** *Petromyzon* (Lamprey), *Myxine* (Hagfish)

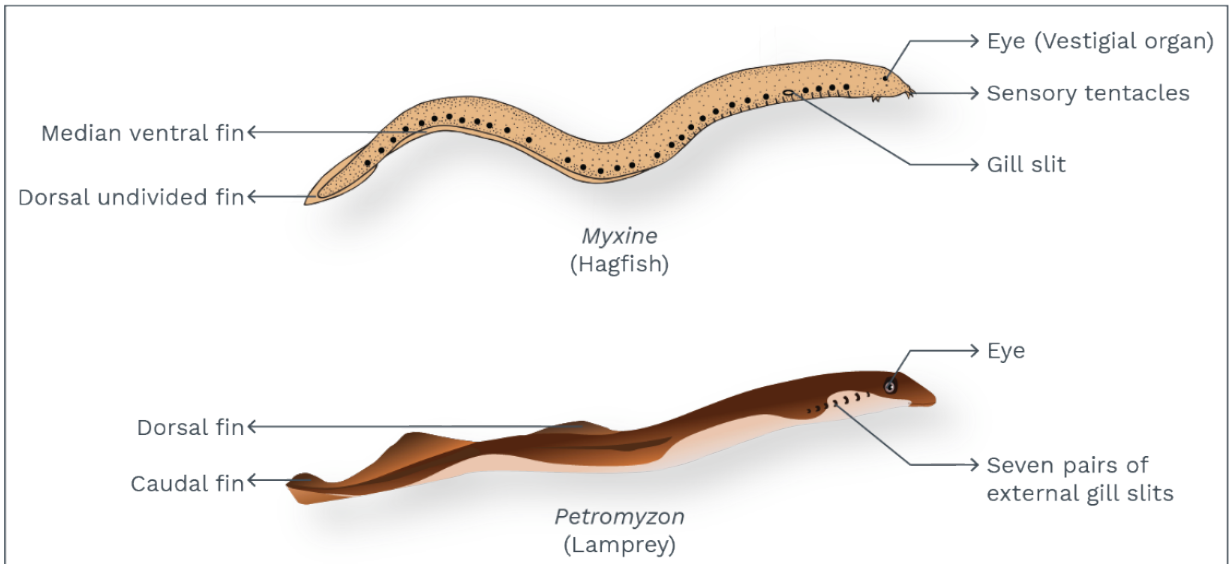

FIG. EXAMPLES OF CYCLOSTOMATA

Gnathostomata

- Notochord is present in the larval forms and is replaced by a well-developed vertebral column.
- Paired fins or limbs are present.
- It is divided into two super classes:

  Super Class Pisces – Consists of all the fishes

  Super Class Tetrapoda – Possessing two pairs of limbs. Tetrapoda is divided into four classes namely Amphibia, Reptilia, Aves and Mammalia.

SUPER CLASS PISCES

- It is divided into two classes having living members on the basis of the endoskeleton.

  Chondrichthyes: *chondros* -cartilage; *ichthys*-fish

  Osteichthyes: *osteon*-bone; *ichthys*-fish

Chondrichthyes

- Habitat-They are present in marine water.
- Body Structure- Dorsoventrally flattened.

  Exoskeleton is formed of **placoid** dermal scales. Endoskeleton is made up of cartilage.

  Fins are present which help in swimming. Paired fins are pelvic and pectoral, while unpaired fins are dorsal, ventral and caudal. Tail fin is unequal (**heterocercal**). Dorsal fins are two in number.

  Notochord is present throughout the life of the organism.

  Sense Organ-Eyes have nictitating membrane. Internal ear present.

  Ampullae of Lorenzini – Electroreceptors on dorsal surface of head to detect the vibrations and electric field.

Previous Year's Question

A common characteristic of all vertebrates ,without exception is

(1) the division of body into head, neck, trunk and tail
(2) their body is covered with an exoskeleton
(3) they possess two pairs of functional appendages
(4) the presence of a well developed skull

FIG. PLACOID SCALES

Lateral line system is present in the body with rheoreceptors.

- **Digestive System:** Mouth is ventral and gut opens by the cloacal aperture.
  Teeth are modified placoid scales.
  Intestine has scroll valves.
  Digestion is extracellular.
- **Respiration:** External nares are present.
  Usually 5 pairs of naked gills are present which are not covered with the operculum.
  Air bladder is absent, thus they have to swim continuously to prevent sinking.
- **Circulatory System:** Heart is two-chambered and venous.
  Biconvex red blood corpuscles consist of nucleus.
  They are cold-blooded.
  Renal portal system is well developed.
- **Nervous System:** Brain has large olfactory lobe and small cerebellum.
  There are ten pairs of cranial nerves.
- **Excretory System:** Excretory organs are a pair of kidneys which are mesonephric.
  Excretion is ureotelic.
- **Reproduction:** In males, pelvic fins bear claspers which help in copulation.
  The oviduct is known as Mullerian ducts.
  Gonads are in pairs. Gonoducts open into the cloaca.
  Fertilisation is internal.
  Females are **oviparous or ovoviviparous**.
  Development is direct without metamorphosis.
- **Examples:**
  Scoliodon: Dog fish
  Carcharodon: Great white shark
  Pristis: Saw fish
  Trygon: Sting ray
  Torpedo: Electric ray
  Rhincodon: Whale shark
  Chimaera: 'Rat fish' or 'King of herrings'

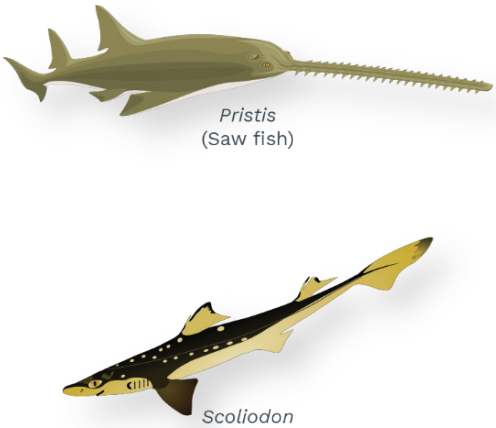

FIG. EXAMPLES OF CHONDRICHTHYES

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Electric Organs: Some Chondrichthyes have electric organs for creating an electric field. The electric organ is derived from modified nerve or muscle tissue. The electric discharge from them is used for navigation, communication, defense and also for paralyzing the prey.

Rack your Brain

What is the ecological importance of *Gambusia*?

Distinguishing Features of Chondrichthyes

- Paired fins.
- Placoid scales are present.
- Tail fin is heterocercal.
- Paired gonads with gonoducts.

Osteichthyes

- **Habitat:** They are present in marine water, fresh water, cold or warm waters.
- **Body Structure:** Bilaterally flattened, spindle-shaped and streamlined.
  Paired fins are pelvic and pectoral while unpaired fins are dorsal, ventral and caudal.
  There is one dorsal fin present.
  Tail fin is **homocercal.**
  Fins are present which help in swimming.
  Endoskeleton is made up of **bones**. In the larval stage, it may be cartilaginous.
  Exoskeleton is formed of **cycloid and ctenoid** dermal scales.

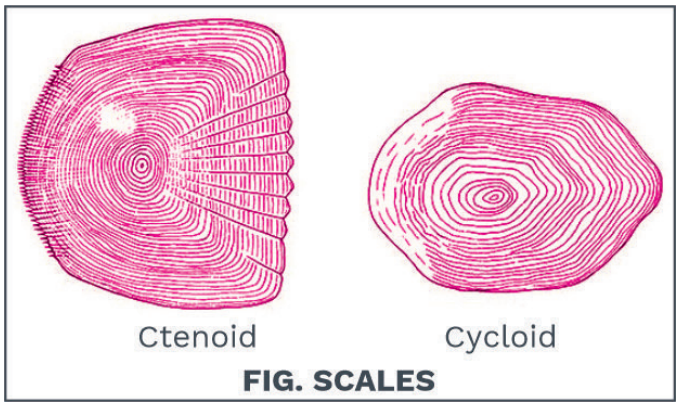

FIG. SCALES

- **Sense Organ:** Eyes have nictitating membrane.
  Lateral line system is present in the body of fishes, which includes many receptors organs which can detect vibrations (rheoreceptor) and electric field.
- **Digestive system:** Mouth is terminal. Jaws lack teeth. Anus is present.

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Interesting facts: *Chimaera*-Connecting link between cartilaginous and bony fishes .

Sting Ray-Its tail consists of barbed spines. Each spine contains poison and can make a severe wound on the victim.

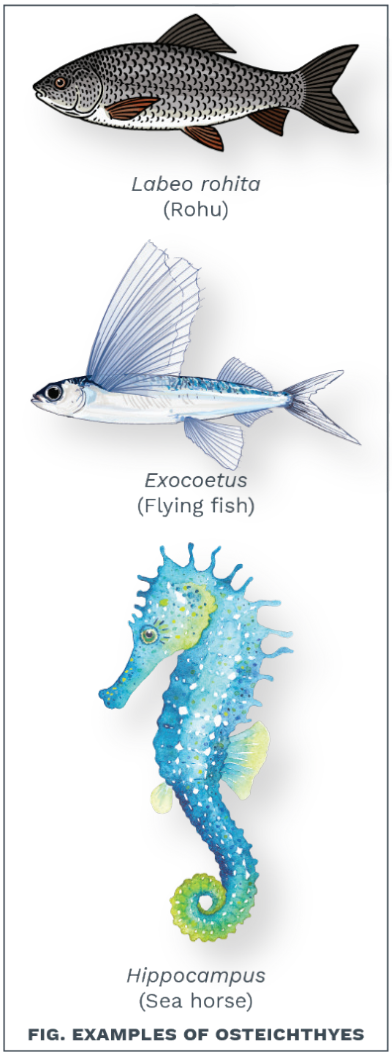

FIG. EXAMPLES OF OSTEICHTHYES

- **Respiration:** Four pairs of gills covered with operculum is present.
- **Circulatory System:** Heart is two-chambered: sinus venosus and conus arteriosus. Red blood corpuscles consist of nucleus.
  Renal portal system is well developed.
  Aortic arches are present as four pairs.
  Poikilothermic animals.
- **Nervous System:** Brain has small olfactory lobe and large cerebellum.
  There are ten pairs of cranial nerves.
- **Excretory System:** Excretory organs are kidneys which are mesonephric.
  Excretory product is ammonia. Marine, bony fishes excrete trimethylamine oxide and fresh water fishes excrete ammonia.
  Urinary bladder is absent.
- Reproduction- Fishes are unisexual.
  In males, **claspers are not present**.
  Fertilisation is internal or external.
  Females are oviparous.
  They do not have any amnionic membrane, hence they are Anamniota
- **Examples:**
  Fresh water – *Labeo rohita* (Rohu), *Clarias* (catfish), *Catla*
  Marine – *Hippocampus* (Seahorse), *Exocoetus* (Flying fish)
  Aquarium – *Betta* (Fighting fish), *Pterophyllum* (Angel fish)

Distinguishing Features of Osteichthyes

- Bony endoskeleton
- Air bladder present
- Homocercal tail fin
- Gills covered by operculum

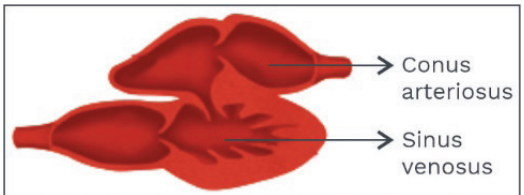

FIG. TWO CHAMBERED HEART IN PISCES

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Migration in fishes:
Catadromous: Migration of fish from river to sea for breeding.
Example: *Anguilla*

Anadromous: Migration of fish from sea to rivers for spawning (breeding).
Example: *Hilsa*

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Accessory respiratory organs: Supra-branchial chamber, labyrinthine organ and the respiratory membrane act as accessory organs in *Anabas* which help in respiration when the fish comes out of water for sometime.

Rack your Brain

Which fish is considered as a connecting link between the fishes and the amphibians?

Table. Difference between Chondrichthyes and Osteichthyes

Features	Chondrichthyes	Osteichthyes
Scales	Placoid scales	Cycloid and ctenoid
Tail	Heterocercal	Homocercal
Air bladder	Absent	Present
Excretion	Ureotelic organisms	Ammonotelic organisms
Scroll valve in intestine	Present	Absent
Cloaca	Present	Absent
Ampullae of Lorenzini	Present	Absent
Fertilisation	Internal	External

CLASS AMPHIBIA

- **Habitat:** They are found on land as well as in water.
- **Body Structure:** Body is divided into head, trunk and tail (tail may or may not be present).
  The skin is either rough or smooth and moist due to the presence of glands on the body.
  Pigment cells called chromatophores are present.
  Two pair of limbs, therefore they are tetrapods and pentadactyl (five digit in each limb).
  Limbs are absent in some.
  Example: *Ichthyophis*

Paired fins absent, unpaired fins may be present.

Exoskeleton is absent. Endoskeleton is mostly bony.

Nictitating membranes are developed in the eyes.

- **Digestive System:** Mouth is large and upper or lower or both jaws have teeth.

  Tongue is protrusible.

  Teeth are homodont and polyphyodont.

  Alimentary canal ends in the cloaca.
- **Respiration:** Respiration is by skin and lungs.

  Larval forms have gills and in some organisms like *Proteus* external gills are present.
- **Circulatory System:** Heart is three-chambered, consisting of two auricles and one ventricle.

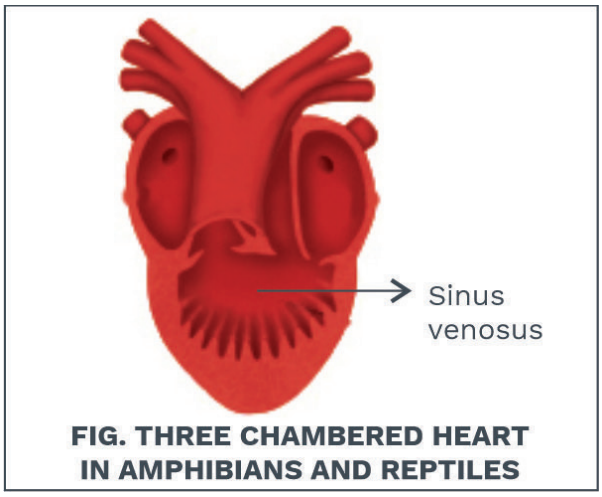


FIG. THREE CHAMBERED HEART IN AMPHIBIANS AND REPTILES

Aortic arches are one to three in number.

Hepatic portal and renal portal system are well-developed.

They are cold-blooded i.e. **poikilothermic**. They show aestivation in summers and hibernation in winters.

- **Nervous System:** Brain is poorly developed.

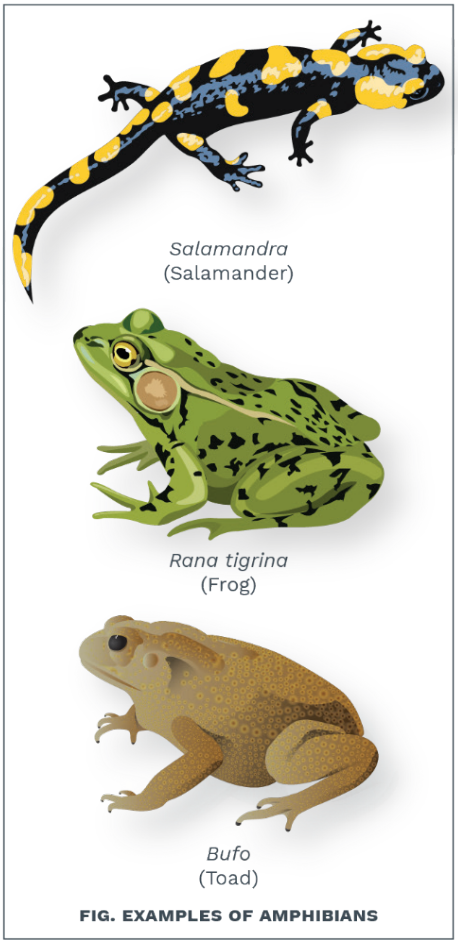


FIG. EXAMPLES OF AMPHIBIANS

Skull is dicondylic i.e., have two occipital condyles.

Ten pairs of cranial nerves are present.

- **Sense organs:** Eyes with nictitating membrane are present.

  Tympanic membrane present.

- **Excretory System:**

  Kidneys are mesonephric, large urinary bladder is present, which open by urinary ducts into the cloaca.

  Excretory product is **urea and ammonia.**

  Alimentary canal, urinary bladder and reproductive tract open outside through the cloacal aperture.

- **Reproduction:** Sexes are separate.

  Males do not have copulatory organs.

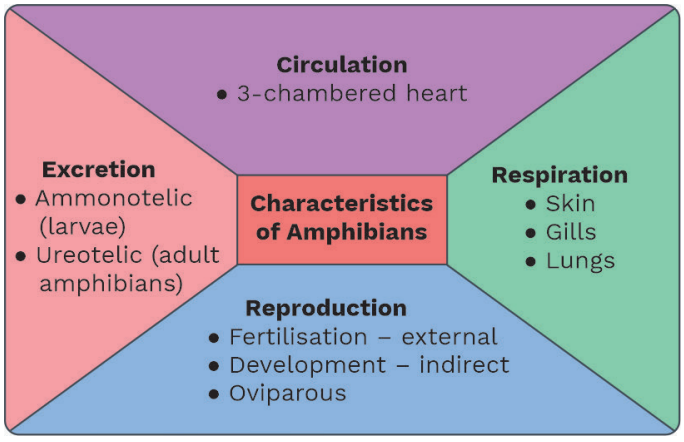
  Gonoducts open into the cloaca.

  Fertilisation is external. But **Salamander** shows **internal** fertilisation.

  Females are oviparous.

  Development is external. No embryonic membranes are present.

  Larva metamorphose into the adult.



- **Examples:**

  Ichthyophis-Blindworm

  Amphiuma-Congo eel

  Ambystoma-Tiger Salamander

FIG. AXOLOTL LARVA

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Neoteny: When there is deficiency of iodine in water, the Axolotl larva of *Ambystoma* does not metamorphose into an adult and becomes sexually mature.

Bufo-Toad
Rana-Frog
Salamandra-Salamander

Classification of Amphibia

Living Amphibians are classified into three orders:

- **Apoda:** Limbless,blind and elongated.
  Examples: *Ichthyophis*
- **Urodela:** Tail present, two limbs are present that are weak.
  Examples: *Necturus* (Mudpuppy), *Amphiuma* (Congo eel)
  Ambystoma-Tiger Salamander, *Proteus*
- **Anura:** Tail absent, two limbs are present.
  Examples: *Rana* (Frog), *Bufo* (Toad)

Distinctive Features of Class Amphibia

- Live both on land and water
- Skin with mucous glands is seen
- Three-chambered heart
- Poikilothermic animals
- Ureotelic

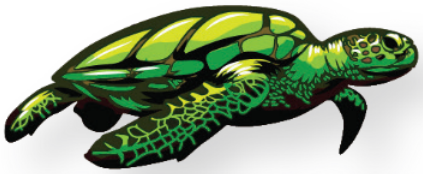
CLASS REPTILIA (CREEPING OR CRAWLING VERTEBRATES)

- **Habitat:** They are found both on land and in water but mostly on land. They are creeping, burrowing and mostly carnivores.
- **Body Structure:** Body is bilaterally symmetrical and consists of head, neck, trunk and tail.
  Two pair of limbs that are pentadactyl. Limbs are absent in snakes.
  Digits are provided with claws.
  Endoskeleton consists of bones.
  Exoskeleton consists of epidermal **scales or scutes and plates**.
  Skin is dry, rough without any glands. Snakes shed their skin.

Previous Year's Question

Necturus is
(1) hellbender
(2) congo eel
(3) mudpuppy
(4) blind-worm

Crocodilus
(Crocodile)



Testudo
(Tortoise)

Chameleon
(Tree Lizard)

Crotalus cerastes
(Rattle snake)

FIG. EXAMPLES OF REPTILES

- **Digestive System:** Most of the reptiles are carnivores, hence mouth is wide.
  Teeth are homodont and polyphyodont. In turtles, teeth are replaced by a horny beak.
  Jacobson's organ is present in the roof of the mouth.
  Alimentary canal terminates into the cloacal aperture.
- **Respiration:** Respiration is by the lungs.
- **Circulatory System:** Heart is three-chambered, consisting of two well-developed auricles and an incomplete ventricle. In crocodile, the heart is four-chambered.
  Red blood corpuscles are nucleated.
  Renal portal system is less developed.
- **Nervous System:** Skull is **monocondylic** i.e. consists of one occipital condyle.

Cerebrum is more developed than the amphibians.

12 pairs of cranial nerves are present.

- **Excretory System:** Kidneys are metanephric and excretory product is urea, except in crocodile it is ammonia.
- **Reproduction:** Sexes are separate. Males consist of a muscular copulatory organ.

  Fertilisation is internal and they are mostly oviparous.

  Egg has a large amount of yolk (polylecithal) and cleavage is meroblastic.

  Egg is covered with a leathery shell and always laid on land.

  No metamorphosis.

- **Poison apparatus:** Poisonous snakes have a poison apparatus in their heads bearing two poison glands, their ducts and the fangs.

  Two sac-like poison glands are present on either side of the jaw. These glands are modified parotid glands.

  Fangs are specialised teeth that act as a syringe to inject the poison into the body of the victim.

  Snake poison has neurotoxic and haemotoxic effects.

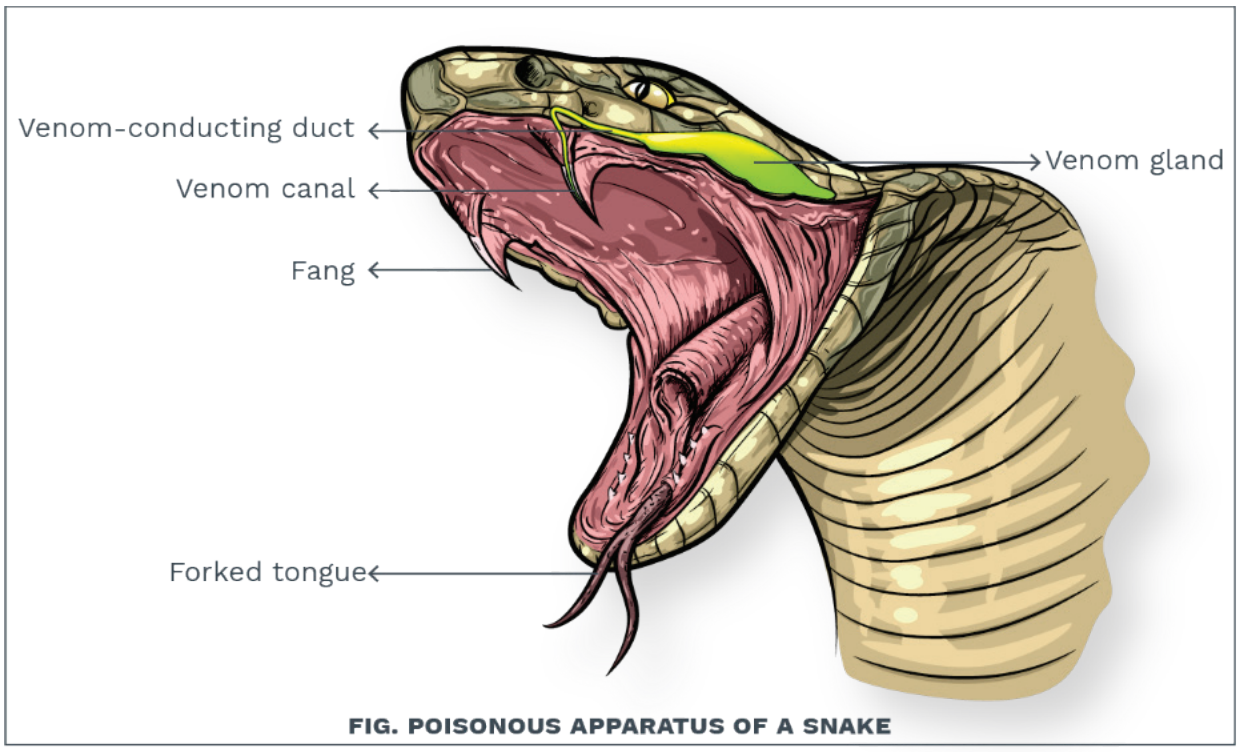
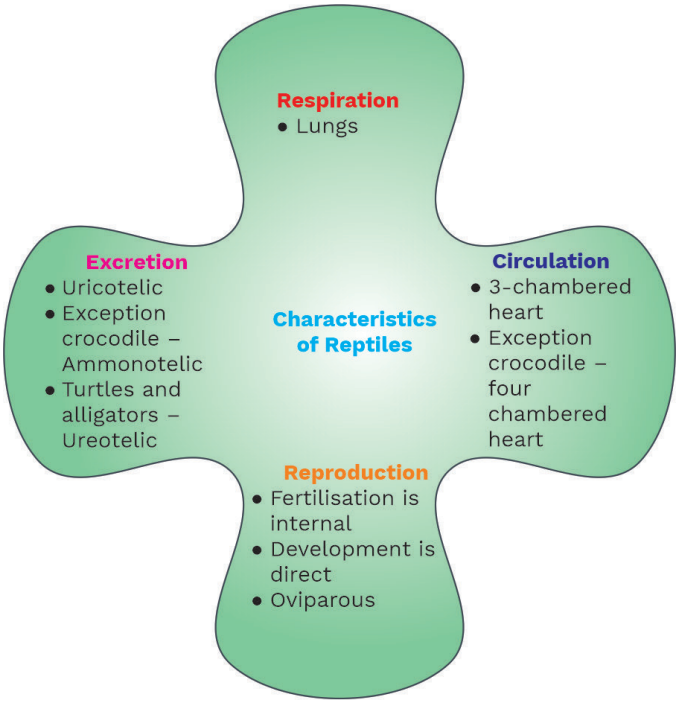


FIG. POISONOUS APPARATUS OF A SNAKE

- **Examples:** *Hemidactylus flaviviridis* -House lizard
  Varanus komodoensis-Komodo dragon
  Chamaeleo chamaeleon-Chameleon
  Python molurus-Python
  Crocodylus palustris-Mugger Crocodile



Classification of Reptilia

- Class reptilia is divided into two subclasses consisting of living members:
  Subclass Anapsida: Solid skull roof and no temporal opening. Examples – Turtle,Tortoise
  Subclass Diapsida: Skull with two temporal openings separated by bones. Examples – Lizard, Alligator, Cobra

Distinctive Features of Class Reptilia

- Dry skin with scales
- Three-chambered heart, except in crocodile
- Poikilothermic
- Mostly uricotelic

Gray Matter Alert!!!

Connecting link: *Seymouria* is considered as a connecting link between amphibians and reptiles.

Gray Matter Alert!!!

Peculiar features of King Cobra:
Builds nest
Exhibits cannibalism

Previous Year's Question

Which is not a true amphibian?
(1) Salamander
(2) Toad
(3) Tortoise
(4) Frog

Rack your Brain

Which fossil proved that birds have evolved from reptiles?

CLASS AVES

- They are flying vertebrates. They can also be referred to as 'glorified reptiles'.
- **Body Structure:** Body is spindle-shaped and divided into four regions namely head, neck, trunk and tail.
  - Skin is dry, except for the presence of oil gland or green gland at the root of the tail.
  - Neck is long and flexible and tail is short and stumpy.
  - Two pair of limbs.
  - The forelimbs are modified into wings, covered with feathers and consisting of hollow (**pneumatic**) bones.
  - Forelimbs are used for flying.
  - The hindlimbs are modified for walking, running, food capturing and swimming.
  - The foot consists of four clawed toes, out of which the first one is directed backward.
  - Endoskeleton consists of long, pneumatic bones.
  - Bone marrow is absent.
- **Digestive System:** Jaws are modified into a beak, which lacks teeth.
  - Beak is modified for crushing, tearing, nectar sipping, wood cutting.
  - Mouth leads into the alimentary canal that has crop and gizzard.
  - Crop stores and softens the food while gizzard helps in crushing and churning the food.
  - A three-chambered cloaca is present.
- **Respiration:** Respiration is by lungs.
  - Air sacs are connected to the lungs.
  - Larynx is without vocal cords. A voice box or syrinx is present at the junction of the trachea and bronchi.
- **Circulation:** Heart is four-chambered and they are warm-blooded.
- **Excretory System:** Kidneys are metanephric and

Rack your Brain

Name the bird that can be considered as a torch bearer of all migratory birds?

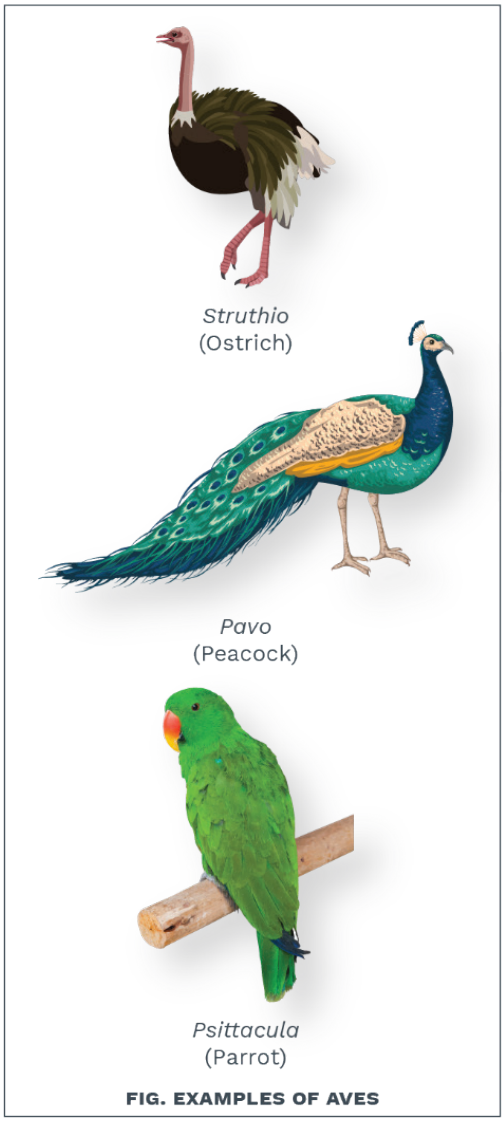


FIG. EXAMPLES OF AVES

consist of three lobes. Urinary bladder is absent and excretion is **uricotelic.**

- **Nervous System:** Skull is monocondylic, consisting of a single occipital condyle.
  Cerebrum, cerebellum and optic lobes are well developed.
  12 pair of cranial nerves are present.
  Eyes are large and consist of nictitating membrane
- **Reproduction:** Sexual dimorphism is seen in them.
  Males consist of a pair of abdominal testis and females consist of only one functional ovary. Fertilisation is internal. Development is direct.
  Females are oviparous.
  Eggs have a large amount of yolk and a hard calcareous shell.
  Four embryonic membranes namely amnion, chorion, allantois and yolk sac are present.
  Eggs are developed by external incubation. Young ones that hatch, resemble the adult.
- **Examples:**
  Corvus splendens-Crow
  Passer domesticus-Sparrow
  Pavo Cristatus-Peacock
  Bubo bubo-Great-horned owl
  Psittacula eupatria-Alexandrine Parrot

Flight Adaptations in Bird

- **Shape of the body:** The body is spindle-shaped, streamlined in birds. This shape helps the bird to offer minimum resistant to the wind.
- **Compact body:** The body is light dorsally but heavy ventrally, which helps it to glide through the air. The attachment of the wings higher up in the body; presence of lighter body organs on the above and heavy muscles below it helps it in flight.
- **Feathers:** They are light and cover the body.

Feathers are directed backward which help the bird to shear the friction and fly ahead. The feathers also help in maintaining the temperature of the body at high altitudes.

- **Modification of limbs:** Forelimbs are modified into wings and help in flying. The shape of the wings helps to reduce air pressure above and increases air pressure below the body. Thus, helping in flight.
- **Short tail:** The short tail acts as a rudder in changing direction during flight and to check flight.
- **Endoskeleton:** The presence of hollow bones which help the body to be light in weight. The bones are light as they are filled by air spaces and not bone marrow.
- **Air sac:** They are attached to the lungs and provide extra support to the bird for respiration during flying and help in internal perspiration of the bird, thus maintaining body temperature.
- **Warm-blooded:** This provides them greater energy for the flight.

Classification of Aves

- Aves are classified into two subclasses.

  Subclass Archaeornithes: Extinct, toothed beak, long tail, low power of flight. Examples – *Archaeopteryx*

  Subclass Neornithes: Modern as well as extinct birds. Wings well developed for flight, tail short, teeth absent. Examples – Penguin, *Columba*

Distinguishing Feature of Aves

- Fore limbs modified into wings with feathers
- Four-chambered heart
- Homeothermic
- Uricotelic

CLASS MAMMALIA

- **Habitat:** They are found in a large number on terrestrial habitats.
- **Body Structure:** Body is divided into a head, neck, trunk and tail.

  Limbs are two with five or less than five digits. These help in walking, running, flying, swimming.

  Exoskeleton is made up of nails, hairs, scales, claws, hooves and horns.

  Endoskeleton is made up of hard bony structure.

  Oil glands (sebaceous glands) and **sweat glands** are present on the body.

  The coelom consists of three cavities: One is the pericardial cavity which lodges the heart, second is the two pleural cavities which lodge the lungs and the abdominal cavity with the other parts of the body.
- **Digestive System:** Mouth consists of two movable lips.

  The mouth consists of a set of teeth.

  They are of different types (heterodont), borne in the socket (thecodont) and represented by two set in lifetime (diphyodont).

  Mouth leads into the alimentary canal which ends on the anus.

  A muscular partition separates the thoracic cavity from the abdominal cavity.
- **Respiration:** It is by the lungs. A cartilaginous flap is present over the glottis, known as epiglottis. It helps to direct the food toward the food pipe away from the windpipe. Larynx consists of a pair of vocal cords.
- **Circulatory System:** Heart is four-chambered having double circulation i.e. blood flows through the heart twice in one cycle.

  They are warm-blooded i.e. **homeothermal**. Renal portal system is absent.

Macropus
(Kangaroo)

Balaenoptera
(Whale - Aquatic mammal)

FIG. EXAMPLES OF MAMMALS

Rack your Brain

Which ape is considered to be the most intelligent of all?

Blood consists of red blood corpuscles which are enucleated and biconvex in shape which help in transporting gases, white blood cells are nucleated and irregular in shape which help to fight against the infection and the platelets that help in the clotting of blood.

- **Nervous System:** Skull is dicondylic i.e. consists of two occipital condyles.

  There is the presence of **12 cranial nerves** in the skull.

  The brain consists of cerebrum and cerebellum. Optic lobes are four in number and called corpora quadrigemina.

  Corpus callosum connects the two cerebral hemisphere.
- **Excretion:** Kidneys are bean-shaped. Excretory product is **urea** and excretory fluid is called urine.

  Kidneys lead into the ureters which lead into the urinary bladder and further into the urethra.
- **Reproduction:** Sexes are unisexual.

  Sexual dimorphism is well developed.

  Males have a copulatory organ known as penis and a pair of testes which lies in the scrotal sac.

  Females consist of a pair of ovaries.

  Egg consists of very little yolk and no shell. Fertilisation is internal and development is internal i.e. most of them are viviparous except Duck- billed platypus and Echidna
- Development of the foetus takes place inside the uterus and the placenta provides nutrition to the developing foetus from the mother. After the birth, the young one is fed by the mother.
- Parental care is highly developed.
- **Examples:**

  Panthera leo – Lion

  Panthera tigris – Tiger

  Phoca – Seal

  Camelus – Camel

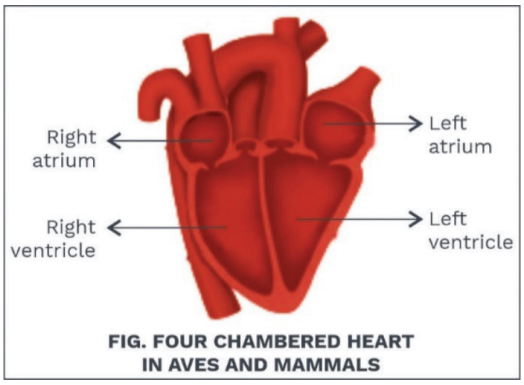


FIG. FOUR CHAMBERED HEART IN AVES AND MAMMALS

Ornithorhynchus
(Duck - billed Platypus)

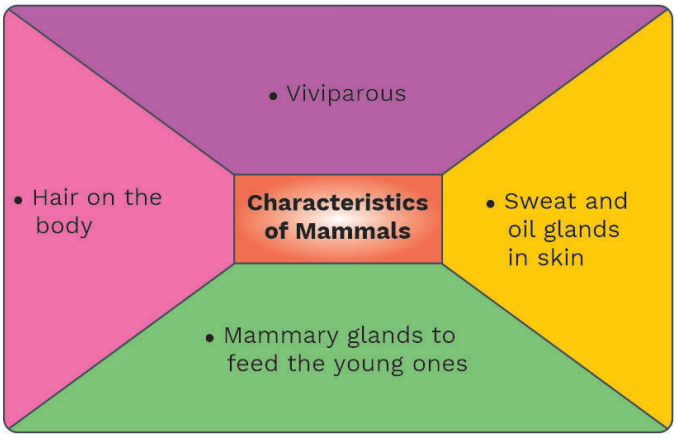
- Connecting link between reptiles and mammals
- Mammary glands without teats


Tachyglossus
(Spiny anteater)

- Mammary glands without teats
- Males show gynaecomastism

FIG. EGG LAYING MAMMALS

Bos indicus – Cow
Homo sapiens sapiens – Human



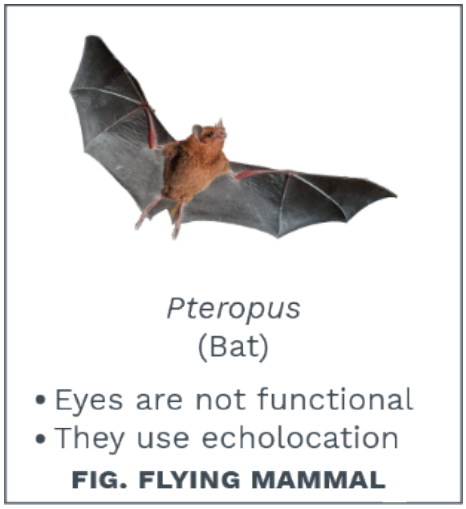


FIG. FLYING MAMMAL

Classification of Mammalia

Mammalia is divided into two subclasses:

- **Subclass Prototheria:** They are oviparous i.e. egg-laying mammals. Examples – Duck-billed Platypus, *Tachyglossus* (Echidna)
- **Subclass Theria:** They are viviparous i.e. give birth to young ones. Examples – Humans, Kangaroo. It has been further divided into Metatheria and Eutheria. Metatheria consists of infra-class marsupialia i.e., pouched animals. **Examples:** *Macropus* (Kangaroo), *Phascolarctos* (Koala), *Didelphis* (opossum)

Gray Matter Alert!!!

Age of Fishes-Devonian Period
Age of Amphibians-Carboniferous Period
Age of Reptiles-Mesozoic Era

Summary: Difference Between Non-Chordata and Chordata

Features	Invertebrates (Non-Chordates)	Vertebrates (Chordates)
Symmetry	Radial, biradial or lacking	Bilateral
Metamerism	True, pseudometamerism or lacking	Internal segmentation
Post-anal tail	Lacking	Usually present projecting beyond anus
Level/Grade of organisation	Protoplasmic to organ-system	Organ-system
Germ layers	2(diploblastic), 3(triploblastic) or lacking	3(triploblastic)
Coelom	Acoelomate, pseudocoelomate or truly coelomate	Truly coelomate
Gill slits	Pharynx perforated by gill slits	Gill slits are absent

Summary: Difference Between Non-Chordata and Chordata

Notochord	Absent	Present at some stage or replaced by a backbone made of ring-like vertebrae
Heart	Dorsal, lateral or absent	Ventrally placed
Hepatic portal system	Absent	Present
Haemoglobin	In plasma or absent	In red blood corpuscles
Respiration	Through body surface, gills or tracheae	Through gills or lungs
Nerve cord	Solid	Hollow
Nervous system	Bearing Ganglia	Without ganglia
Reproduction	Asexual reproduction predominant	Sexual reproduction predominant

Summary: Subphylum Vertebrata

Features	Pisces	Amphibia	Reptilia	Aves	Mammalia
Habitat	Aquatic	Aquatic and terrestrial	Mainly terrestrial and sometimes aquatic	Aerial	Terrestrial, aquatic
Locomotion	Swimming	Hopping on land and swimming in water	Creeping and running on land	Flying in air and walking on land	Running, walking on land
Skeleton	Endoskeleton and exoskeleton	Endoskeleton	Endoskeleton and exoskeleton	Endoskeleton and exoskeleton	Endoskeleton and exoskeleton
Digestion	Extracellular	Extracellular	Extracellular	Extracellular	Extracellular
Respiration	Gills	Gills, skin,lungs	Lungs	Lungs	Lungs

Some Characteristics of Different Classes of Subphylum Vertebrata

Summary: Subphylum Vertebrata

Circulation	Two-chambered heart, Poikilothermic	Three-chambered heart, Poikilothermic animals	Three-chambered heart, exception crocodile (Four-chambered heart), Poikilothermic animals	Four-chambered heart, homeothermic animals	Four-chambered heart, homeothermic animals
Excretion	Ammonotelic	Ammonotelic, Ureotelic	Uricotelic	Uricotelic	Ureotelic
Reproduction: Sexes	Unisexual	Unisexual	Unisexual	Unisexual	Unisexual
Fertilisation	External	External	Internal	Internal	Internal
Development	Indirect	Indirect	Direct	Direct	Direct
Examples:	Rohu, *Catla, Anabas*	Toad, Salamander	Alligator, Tortoise	Pigeon, Ostrich	Giraffe, Whale

Some Characteristics of Different Classes of Subphylum Vertebrata

SOLVED EXERCISE

Q1 **Which one the following Phylum does not show organ-system of organisation?**
(1) Porifera (2) Annelida (3) Arthropoda (4) Mollusca

A1 **(1)**
Porifera has a cellular level of organisation.

Q2 **A complete digestive system has**
(1) one opening (2) no opening
(3) two openings (4) three openings

A2 **(3)**
Mouth and Anus are present.

Q3 **Bilateral symmetry is shown by**
(1) Coelenterates (2) Ctenophores (3) Sponges (4) Annelida

A3 **(4)**
Annelids can be divided into two identical halves in one plane only. Coelenterates and Ctenophores are radially symmetrical while Sponges are asymmetrical.

Q4 **Coelenterates are**
(1) triploblastic (2) coelomate
(3) diploblastic (4) asymmetrical

A4 **(3)**
They have two germ layers.

Q5 **Aschelminthes are**

(1) Acoelomates **(2) Diploblastic**

(3) Pseudocoelomate **(4) Coelomate**

A5 **(3)**

Mesoderm is present in scattered pouches.

Q6 **Notochord is absent from**

(1) Porifera to Pisces **(2) Coelenterata to Echinodermata**

(3) Pisces to Mammals **(4) Porifera to Echinodermata**

A6 **(4)**

They are non-chordates and lack notochord. Pisces to mammals have a notochord and are later replaced by vertebral column.

Q7 **Pisces secrete nitrogenous waste in the form of**

(1) Sulphates **(2) Ammonia** **(3) Urea** **(4) Uric acid**

A7 **(2)**

Ammonia is dissolved in water and is excreted out.

Q8 **Blood will flow at low and high pressure in**

(1) Cockroach **(2) Tiger** **(3) Snail** **(4) Prawn**

A8 **(2)**

Closed system has blood flowing at low and high pressure through blood vessels.

Q9 **Book lung is present in**
(1) Spider **(2) *Octopus*** **(3) Leech** **(4) *Nereis***

A9 **(1)**
Respiratory organ of some Arthropods.

Q10 **Intracellular digestion occurs in**
(1) Fish **(2) Earthworm** **(3) Leech** **(4) Sponge**

A10 **(4)**
Digestion takes place outside the cell in an organ cavity.

Q11 **Malpighian tubules are**
(1) excretory organs of insects **(2) excretory organs of annelids**
(3) respiratory organs of insects **(4) respiratory organs of annelids**

A11 **(1)**
Present in insects for removal of waste products.

Q12 **What is common among silverfish, scorpion, crab and honey bee?**
(1) Jointed legs **(2) Metamorphosis**
(3) Compound eyes **(4) Poison glands**

A12 **(1)**
Jointed appendages are present in Arthropoda.

Q13 ***Sycon*** **belongs to a group of animals, which are best described as**
(1) unicellular or acellular
(2) multicellular without any tissue organization
(3) multicellular with a gastrovascular system
(4) multicellular having tissue organization, but no body cavity

A13 **(2)**
They show cellular level of organization.

Q14 **Ommatidia serve the purpose of photoreception in**
(1) cockroach **(2) frog** **(3) humans** **(4) sunflower**

A14 **(1)**
Serve as a sensory organ in Arthropoda.

Q15 **Which one of the following is a matching pair of an animal and a certain phenomenon it exhibits?**
(1) ***Pheretima*** **– Sexual dimorphism**
(2) ***Musca*** **– Complete metamorphosis**
(3) ***Chameleon*** **– Mimicry**
(4) ***Taenia*** **– Polymorphism**

A15 **(2)**
Show complete metamorphosis i.e., egg, larva, pupa and adult.

Q16 **Given below are four matchings of an animal and its kind of respiratory organ:**
(A) Silverfish – Trachea **(B) Scorpion – Book lung**
(C) Sea squirt – Pharyngeal slits **(D) Dolphin – Skin**
The correct matchings are
(1) (A) and (B) **(2) (A), (B) and (C)** **(3) (B) and (D)** **(4) (C) and (D)**

A16 **(2)**
Respiratory organ of Dolphin is lungs.

Q17 **In which of the following animals the nerve cell is present but brain is absent?**
(1) Sponge **(2) Earthworm** **(3) Cockroach** **(4) *Hydra***

A17 **(4)**
It has nerves but no nerve cells.

Q18 **In which of the following animals dimorphic nucleus is found?**
(1) *Amoeba proteus* **(2) *Trypanosoma gambiense***
(3) *Plasmodium vivax* **(4) *Paramecium caudatum***

A18 **(4)**
It has macronucleus and micronucleus.

Q19 **In *Hydra*, waste material of food digestion is removed from**
(1) body wall **(2) flame cells**
(3) mouth **(4) tentacles**

A19 **(3)**
Undigested food removed from mouth.

Q20 **The nephridia in earthworm are analogous to**
(1) nematoblasts of *Hydra* **(2) flame cells of *Planaria***
(3) gills of prawn **(4) trachea of insects**

A20 **(2)**
Excretory organs of earthworm and *Planaria*

Q21 **Uricotelism is found in**

(1) mammals and birds
(2) fish and fresh water protozoans
(3) birds, land reptiles and insects
(4) frogs and toads

A21 **(3)**
Uricotelism means excretion of uric acid.

Q22 **One of the following is a very unique feature of the mammalian body**

(1) homeothermy
(2) presence of diaphragm
(3) four-chambered
(4) Blood circulation

A22 **(2)**
Unique feature of mammals is the presence of diaphragm.

Q23 **Both male and female pigeons secrete milk through**

(1) salivary glands
(2) modified sweat glands
(3) crop
(4) gizzard

A23 **(3)**
Pigeons are noted for their unique ability to produce pigeon's milk.

Q24 **Eutherians are characterised by**

(1) hairy skin
(2) true placentation
(3) ovoviviparity
(4) glandular skin

A24 **(2)**
Eutheria contains the placental mammals, such as humans.

Q25 **What is common in a whale, bat and rat?**
(1) Absence of neck
(2) Muscular diaphragm between thorax and abdomen
(3) Extra-abdominal testes to avoid high temperature of body
(4) Presence of external ears

A25 **(2)**
Whale, bat and rat are mammals. Diaphragm is present in mammals.

Q26 **Bullfrog of India is**
(1) *Rana tigrina* **(2) *R. sylvatica***
(3) *R. ecatesbeiana* **(4) *R. esculenta***

A26 **(1)**
The common Indian bull frog is *Rana tigrina.*

Q27 **Feet of kingfisher are modified for**
(1) wading **(2) perching** **(3) running** **(4) catching**

A27 **(1)**
Hindlimbs are variously modified for various functions like perching, grasping and wading.

Q28 **Pneumatic bone is found in**
(1) shark **(2) *Rana*** **(3) pigeon** **(4) whale**

A28 **(3)**
Pneumatic bones are present in birds to make them light weight.

Q29 **A common characteristic of all vertebrates without exception is**
(1) the division of body into head, neck, trunk and tail
2) their body covered with an exoskeleton
(3) the possession of two pairs of functional appendages
(4) the presence of well developed skull

A29 **(4)**
The subphylum vertebrata have a well-developed central nervous system.

Q30 **Annual migration does not occur in the case of**
(1) Arctic tern **(2) *Salmon***
(3) Siberian crane **(4) Salamander**

A30 **(4)**
Others show migration for breeding or for surviving unfavourable conditions.