Grade 9 Unit 5

Classification (Taxonomy)

- **Principles of classification**
- **The five kingdoms system**

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5.1 Principles of classification

-**Taxonomy** –is branch of biology dealing with identification, nomenclature, description and classification.

- The word **'taxonomy'** is derived from the Greek words ***taxis*** (= arrangement) and **nomos** (= law) and the term 'taxonomy' was coined by A. P. de Candolle in 1813.

- Classification- is the scientific process of arranging organisms into groups based on similarities.

Biologists classify living things for the following **reasons**:

1. To simplify their study.
2. To bring order out of chaos or confusion.
3. To try to understand how life originated.
4. To understand the diversity of life on Earth.

- Aristotle (384–322 BC) was the earliest (first) to attempt classification system.
- He tried to classify all living things into plant and animals categories.

- But the **modern classification** of plants and animals based on a system devised by **Carolus Linnaeus** (1707–1778).
- Carolus Linnaeus published two books such as **'*Species Plantarum*'**, published in 1753 and **'Systema *Naturae*'** in **1758**.
- In his book called **'Systema *Naturae,*'** Linnaeus introduced **systems of Binomial nomemclature** for a species.
- The scientific name of any organism consists of genus and species. The two names of an organism are in **Latin**.

Simple rules for writing scientific names

1. The first name is the name of the **genus** to which the organism belongs. It is begin with a capital letter. Sometimes the name of the genus is reduced to just the capital letter, e.g. *H. sapiens, C. simensis*.
2. The second name is the name of a **species**. It is written with a small letter.
3. The two names are underlined when hand written or in italics when printed.

Living things are classified and named for the following main reasons:

1. To create an internationally accepted way of referring to a particular living thing.
2. To avoid confusion created by common (local/vernacular) names of different languages.
3. To help in simplifying classification and study of living things.

A biological key or **identification key** is a device or special method, which constructed properly and used to the identification of unknown species.

- It is a series of contrasting statements required to make comparison and identification.
- The simplest type of identification key is the **dichotomous key** (*di* means two and *chotomous* means branching).
- A **dichotomous key** is a type of key that is based on making successive choices between two **statements** or alternatives and used to identify unknown specimens.
- The statements are descriptions of the external features of specimens.

- Linnaeus recognized a need for placing organisms into groups based on similarities and differences.
- Organisms those put into groups are called **taxa** /singular **taxon**/.
- Linnaeus also established **taxonomic Hierarchy**. They are also known as Linnaean hierarchy.
- It is defined as sequence of categories in a decreasing from most inclusive **kingdom** to least inclusive **species**.
- Kingdom is the highest rank followed by phylum, class, order, family, genus and species.
- Species is the lowest rank in the Hierarchy and used as the smallest basic unit of classification.
- A **species** is: *a group of organisms that can breed successfully with one another to produce fertile offspring*.

- Phylum is a term used for animals while its synonym **'Division'** is used for plants.

In Linnaeus' time the **two Kingdom system of classification** with Plantae and Animalia kingdoms was developed that included all plants and animals respectively.

- Later with the discovery of microscope, biologist identified unicellular and microscopic organisms from both plant and animal kingdoms. They set a new kingdom called protista using criteria of unicellularity and multicellularity.
- The **three-kingdom classification system** used by scientists in 1800's contains Kingdom plantae, K.Animalia and K. protista.
- With the invention of **electron microscope** and detail studies of internal structures of cell, scientists identified cells with no separate nucleus from protists.
- Using criteria of prokaryocity and eukaryocity, biologists proposed 4th new kingdom called **kingdom monera**. Then **four-kingdom system of classification** remained for many years until 1969.
- Later considering characteristics of cell wall composition that made of chitin and saprophytic mode of nutrition, the fungi were placed in a separate kingdom – **Kingdom Mycota(Fungi).** Kingdom fungi was last(5th) and most recently discovered kingdom.

R.H. **Whittaker** (**1969**) proposed a **Five Kingdom Classification**. The kingdoms defined by him were named Monera, Protista, Fungi, Plantae and Animalia. The main criteria for classification used by Whittaker include cell structure, body organization, mode of nutrition, reproduction and phylogenetic relationships.

Carl Woese (in **1978)** developed **a new classification system** that arranged organisms according to their molecular characteristics and then cellular characteristics.
Woese devised **three classification** groups called *domains*. A domain is larger than a kingdom.
Domains;

- **Bacteria:** Bacteria that have peptidoglycan cell walls.
- **Archaea:** Prokaryotes that do not have peptidoglycan cell walls.
- **Eucarya:** contains organisms from the following kingdoms:

Kingdoms

- Protista (*Note*: This is in the process of changing.)—algae, protozoa.
- Fungi—one-celled yeasts, multicellular molds, and mushrooms.
- Plantae—moss, conifers, ferns, flowering plants.
- Animalia—insects, worms, sponges, and vertebrates.

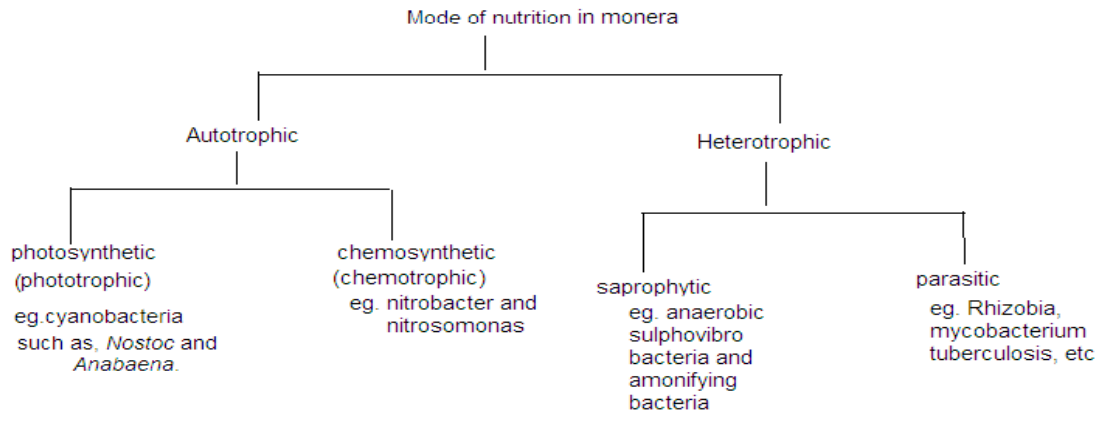
The **three-domain system** has also been proposed that divides the Kingdom Monera into two domains, leaving the remaining eukaryotic kingdoms in the third domain and thereby **a six kingdom classification**.

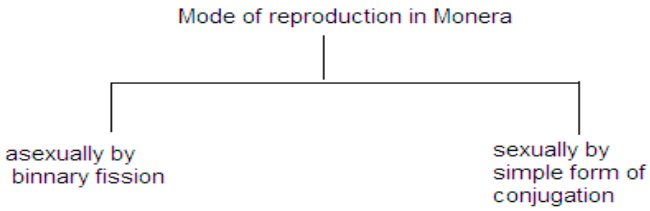
5.2 The five kingdoms system

- the Whittaker system of classification
- The main criteria for classification used by Whittaker include cell structure, levels of cellular organization, mode of nutrition, reproduction and phylogenetic relationships.
- we will study characteristics of Kingdoms Monera, Protista. Fungi, Plantae and Animalia.

kingdom Monera

- all are unicellular and microscopic.
-all are **prokaryotic** that do not have a separate nucleus.
- all have cell wall in their cellular feature.
- They occur almost everywhere, also live in extreme habitats such as hot springs, deserts, snow and deep oceans where Very few other life forms can survive.





There are two s**ubkingdoms** of Kingdom Monera:

• **Archaebacteria**- they live in some of the mostly harsh habitats such as extreme salty areas (halophiles), hot springs (thermoacidophiles) and marshy areas (methanogens).

- Archaebacteria differ from other bacteria in having a different cell wall structure and this feature is responsible for their survival in extreme conditions.
- Methanogens are present in the gut of several ruminant animals.

• **Eubacteria**- is also called the true bacteria.

- They are characterised by the presence of a rigid cell wall, and if motile, a flagellum.
- The cyanobacteria (also referred to as blue-green algae) have chlorophyll *a* similar to green plants and are photosynthetic autotrophs

kingdom Protista

- It includes eukaryotic unicellular and simple multicellular organisms.
- protistan cell body contains a well defined nucleus and other membrane-bound organelles.
- Protists exhibit a wide range of forms, locomotion, nutrition and reproduction.
- Protists reproduce asexually and sexually by a process involving cell fusion and zygote formation.

They are divided into two sub-kingdoms

- Sub-kingdom Protozoa
- Sub-kingdom Algae

Protozoans

- all are unicellular, heterotrophs and live as holozoic or Parasitic.
- all have no cell wall and no chloroplast.

Divided into three phyla

1. Phylum Sarcomastigophora
2. Phylum Ciliophora
3. Phylum Apicomplexa

The phylum Sarcomastigophora

- contains a diverse group of protists combined into one phylum because they all possess a single kind of nucleus and use flagella or pseudopodia for locomotion.

*- **Rhizopoda** - **amoeboid cells** use **pseudopodia** help them move from place to place and **engulf** food particles by phagocytosis.

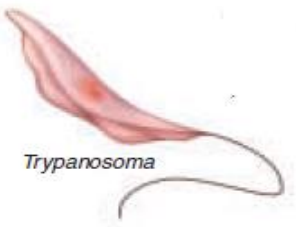
Eg. ***Amoeba proteus***

- In parasitic species such as ***Entamoeba histolytica***, which causes amoebic dysentery, cysts enable the amoebas to resist digestion by their animal hosts.

***- Zoomastigophora** is composed of unicellular, heterotrophic organisms that are highly variable in form.

- Each has at least one **flagellum**, with some species having thousands.
- They include both **free-living** and **parasitic** organisms.

Eg. ***Trypanosoma spp***; causes many serious human diseases, the most familiar of which is trypanosomiasis also known as African sleeping sickness which is transmitted by tsetse flies.



***Leishmania spp*;** causes Leishmaniasis disease, which is transmitted by sand flies.

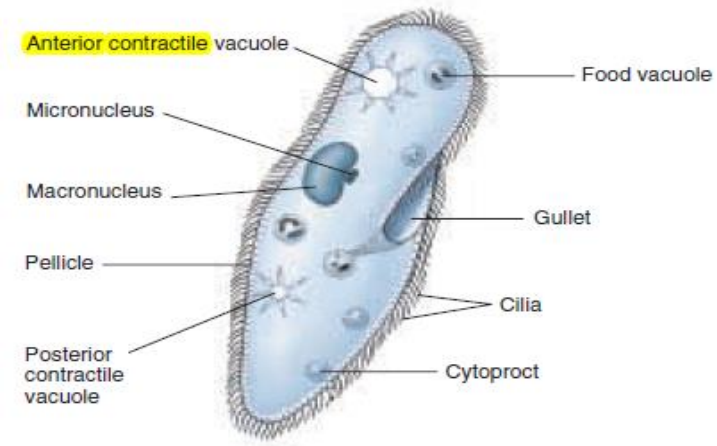
***Giardia lamblia**; causes* Giardiasis infection in human.

The phylum Ciliophora; the Ciliates

-The cilia are specialized locomotory structures and also have feeding functions.

- Cilia are anchored to microtubules beneath the cell membrane, and they beat in a coordinated fashion.
- Ciliates form vacuoles for ingesting food(holozoic nutrition) and regulating their water balance.

Eg. Paramecium; has a sexual process called **conjugation,** in which two individual cells remain attached to each other for up to several hours.



The phylum Apicomplexa: The Sporozoans

- All sporozoans are non-motile, spore forming parasites.

Eg. *Plasmodium spp.*

- **Malaria**, caused by infections by the sporozoan *Plasmodium,* is one of the most serious diseases in the world.
- The life cycles of sporozoans changes b/n sporozoites in mosquitoes and merozoites in human liver.

Algae

- Consists organisms from unicellular to multicellular.
- all are aquatic.
- contain cell wall and chloroplast so that they are photosynthetic.
- Most unicellular algae are free-living aquatic organisms and together are known as **phytoplankton.**

Algae have **four basic body forms**

1. unicellular eg. Euglena, chlamydomonas
2. colonial eg. *Volvox,*
3. filamentous eg. spirogyra
4. Thallus eg. Kelps(seaweeds)

Divided into 6-phyla

1. **Dinoflagellata;** unicellular with two flagella and can produce **bioluminescence.**
2. **Euglenophyta**; unicellular, with no cell wall and flagellated. Eg. *Euglena*
3. **Bacillariophyta**(**diatoms)** or **Chrysophyta**; unicellular, colonial. eg centric diatoms and golden algae
4. **Chlorophyta**(**green algae**); unicellular, colonial, filamentous, and multicellular eg. Chlamydomonas, volvex, spirogyra
5. **Rhodophyta**(**Red algae**); multicellular eg. *Corallina* alga
6. **Phaeophyta**(**Brown alge**); multicellular eg. kelps

KINGDOM MYCOTA (FUNGI)

- are eukaryotic, non-photosynthetic organisms, and most are multicellular heterotrophs.
- Most fungi are microscopic molds.
- The study of fungi is called **mycology**

Structure of Fungi

- Filaments of fungi are called **hyphae.** (singular, *hypha*)
- The cell walls of hyphae contain **chitin**, a polysaccharide that also makes up the exoskeleton of insects, crustaceans, and other arthropods.
- A mass of hyphae that forms the body of a fungus is a **mycelium.**
- In some species, the cells that make up hyphae are divided by cross sections called **septa.**

- Hyphae whose cells are divided by septa are called *septate hyphae.*
- The hyphae of other fungi do not have septa and are called coenocytic hyphae or non-septate or aseptate hyphae.
- Several species of fungi can change form in response to changes in their environment.
- This ability to exist in two different forms is called **dimorphism.**

Mode of nutrition in mycota

All fungi are heterotrophic
- saprophytic: absorb soluble organic matter from dead substrates after extracellular digestion.
- parasitic: that depend on living plants and animals

- Some fungi can also live as symbionts
  - in association with green algae as **lichens** and
  - in association with roots of higher plants as **mycorrhiza**.

Mode of reproduction in fungi

Asexual reproduction
- buding
- fragmentation
- sporulation; producing asexual spores such as
  - -zoospores/sporangiospore
  - conidia

sexual reproduction
reproduce by
- zygospores/ oospores
- ascospores
- basidiospores

Kingdom fungi is classified further into **four** phyla
- Based on means of sexual reproduction
  1. Phylum Zygomycota/ phycomyceta
  2. Phylum Ascomyceta/ sac-fungi
  3. Phylum Basidiomyceta/ bracket fungi or puffballs
  4. Phylum Deuteromyceta/ imperfect fungi

Phylum Zygomycota/ phycomyceta

Eg. **Rhizopus** (bread molds) or **mucor**
- The mycelium is **coenocytic** or **non-septate**.
- They are **saprotrophic** (decomposers)and **parasitic**
- reproduce asexually by producing **zoospores**/sporangiospores inside sporangium sac.
- reproduce sexually by conjugation with fusion of two haploid nuclei forming **zygospore.**

Phylum Ascomyceta/ sac-fungi

Eg. **Penicillium** and **yeast(**saccaromyces)
- The mycelium is septate.
- They are saprophytic and parasitic
- The asexual spores are **conidia** produced exogenously on the special mycelium called conidiophores.
- Conidia on germination produce mycelium.
- Sexual spores are called **ascospores** which are produced endogenously in sac like asci (singular ascus).

Phylum Basidiomyceta/ bracket fungi or puffballs

Eg. **Mushrooms**/Agaricus ; saprophytic
Rusts and **smuts**; parasitic
- The mycelium is septate.
- reproduce asexually by fragmentation.
- Sexually reproduce by producing basidiospores in basidium.
- The basidiospores are exogenously produced on the basidium (plu.: basidia).
- The basidia are arranged in fruiting bodies called basidiocarps.

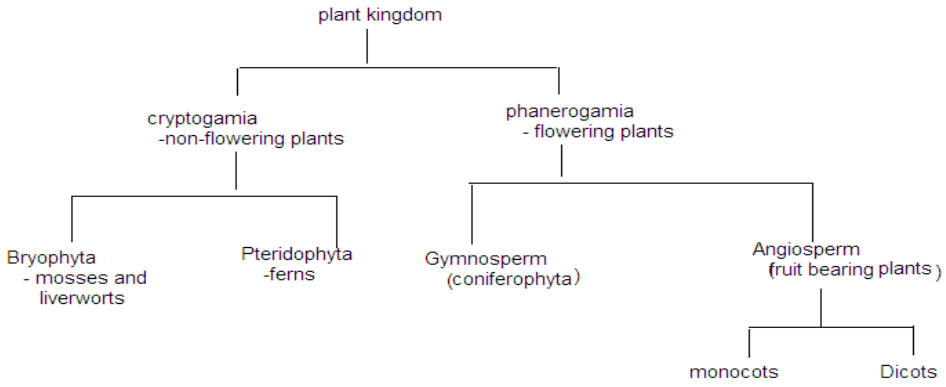
Phylum Deuteromyceta/ imperfect fungi

Eg. *Trichoderma*
- The mycelium is septate and branched.
- Sexual reproductive stage is **unknown**.
- Asexual reproductive method is by producing **conidia**.

Kingdon Plantae

- All are eukaryotic multicellular
- They have cell-wall made of cellulose.
- contain chloroplast so they are photosynthetic.
- But some are partially heterotrophic eg. Venus flytrap insectivorous plant.
- The life cycle of plants show distinct phases; the diploid sporophytic(vegetative) and the haploid gametophytic stages that alternate with each other called **alternation of generation.**

Kingdom plantae - is divided into four divisions



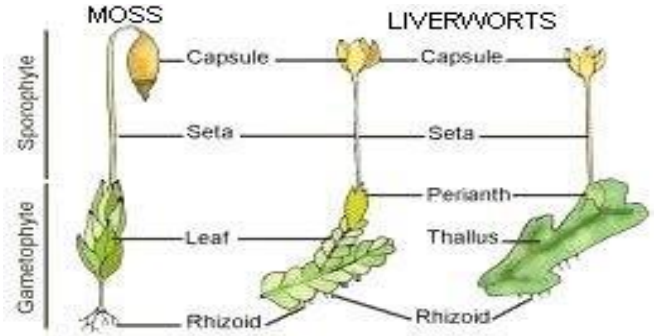
- Pteridophytes, Gymnosperms and Angiosperms are called **Tracheophytes** due to the presence of **vascular tissue.**
- Bryophyta, Pteridophyta, Gymnosperms and Angiosperms are called **Embryophyta** as they have **embryo.**

Division Bryophyta

- Bryophytes are known as the **amphibians** of the plant kingdom b/c they need water for sexual reproduction.
- They grow in dense patches on the **moist shady** places like walls, damp soil, tree trunks etc.
- Root like structures called **rhizoids** fix them to the soil.
- Plant body is differentiated into stem like and leaf like structures.
- They are non-vascular (do not have xylem and phloem)

Eg. mosses and liverworts

The best examples of bryophytes are mosses like *Etodon concinnus*, found in the Bale Mountains, and *Funaria* spp.



- The dominant photosynthetic free living stage is **gametophyte.**
- The **sporophyte** is short lived and depends on the gametophyte. Water is essential for fertilization.

Mode of reproduction in Bryophytes

Asexual reproduction

- Vegetative reproduction by **fragmentation**, **budding**, **tubers** etc
- Asexual by **Gemmae**- asexual buds in **liverworts**.

Sexual reproduction

-The **vegetative plant** body is the **gametophyte** and all members are **homosporous**.

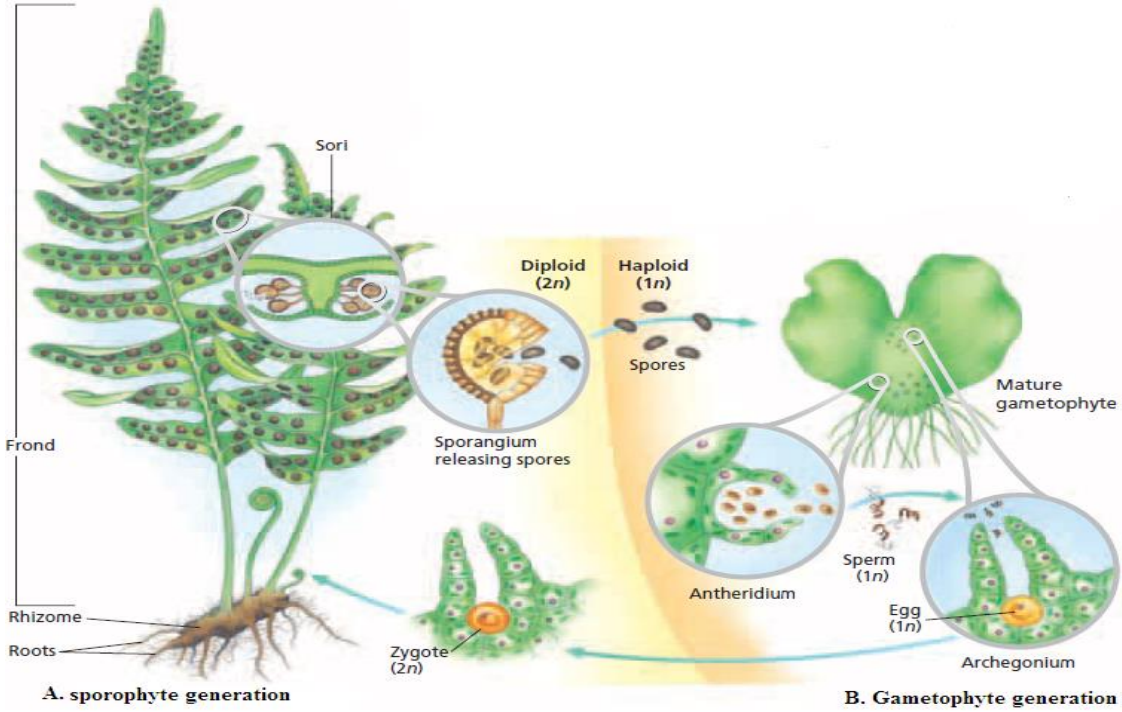
- Multicellular sex organs present and are found in clusters.
- **Male reproductive organs** is the club shaped **antheridium** and the **female** part is the flask shaped **archegonium**.
- Anthredium produce biflagellated **antherozoids(sperm cells)** which are **motile** and archegonium produce the **egg**.
- Antherozoid fuses with the egg to form the **zygote**.
- The sporophyte is not free living and it derives nourishment from the **photosynthetic gametophyte**.

- The sporophyte form **Haploid spores** by meiosis and the **spore** germinates to form the **gametophyte**.
- Alternation of generation present- haploid phase alters with the diploid phase

Division Pteridophyta (also known as the **Filicinophyta**)

Eg. **Ferns-** Another example of a pteridophyte is the fern ***Dryopteris* spp**.

- First terrestrial plant possesses vascular tissue like **xylem** and **phloem**. So they are known as vascular cryptogams.
- Plant body is differentiated into true root, stem and leaves.
- **Plant body is the sporophytic generation.**
- Fern stems have **rhizomes**, which grow horizontally just below the surface of the soil.
- Leaves may be small (**microphyll**) as in *Selaginella* or large (**macrophyll**) as in ferns.
- The tightly coiled new leaves of ferns are called **fiddleheads.**
- Fiddleheads uncoil and develop into mature leaves called **fronds.**
- Leaves are of two types vegetative and fertile.
- Fertile leaves are the spore bearing in the underside of the fronds called **sporophylls**.
- **haploid spores** are formed inside the **sporangia** by meiosis.
-A cluster of sporangia is called a **sorus**, plural, **sori**.



Pteridophytes further classified into four **classes**:

- Psilopsida (*Psilotum* - Whisk ferns)
- Lycopsida (*Selaginella*- Club mosses)
- Sphenopsida (*Equisetum*- Horsetails)
- Pteropsida (*Pteris*-ferns).

Division Gymnospermae

- The conifers, which are gymnosperms of the phylum Coniferophyta, include pine, cedar, redwood, fir, spruce, juniper, cypress, and bald cypress trees.
- They are important sources of wood, paper, turpentine, ornamental plants, and Christmas trees.
- Flowerless **seed bearing plants**.

The main characteristics of the gymnospermae are:

- Their seeds are not enclosed in fruits (naked seeds).
- They have small **needle-shaped leaves** with a **thick waxy cuticle** that **reduces water loss** and minimizes damage by excess heat or cold.
- They are **evergreen** so they can photosynthesize all year long.
- The reproductive structures are found in cones.

The genus *Pinus* (for example, ***Pinus sylvestris***, ***Pinus resinosa***, ***Pinus radiata***) is a good example of a conifer.

Classified into **four classes**:

• 1.Cycadopsida Eg: *Cycas*

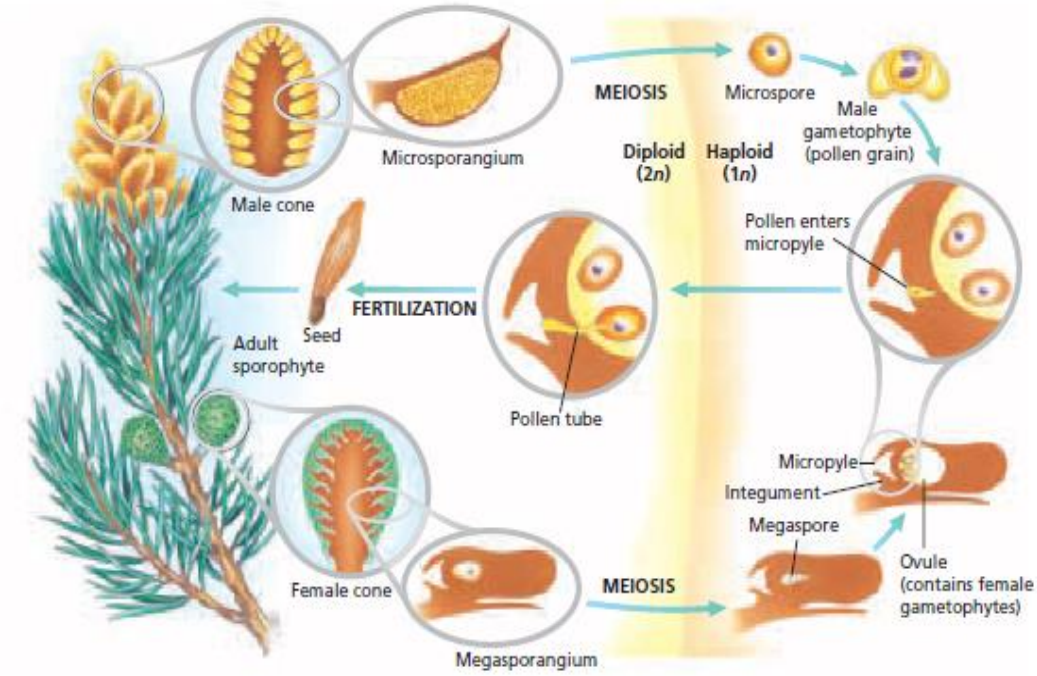
• 2. Coniferopsida eg: *Pinus*

• 3. Gnetopsida: Eg: *Gnetum*.

• 4. Gingopsida- *Ginko*

The life cycle of a gymnosperm

- alternates between a large sporophyte (the dominant generation), which produces two types of spores in cones, and microscopic gametophytes, which produce gametes. Female gametophytes produce eggs, and male gametophytes produce sperm.



Division Angiospermae

- Angiosperms are known as flowering plants and **have covered seeds**.
- The main characteristics of the angiosperms are:
  - They have flowers as reproductive organs.
  - They have their seeds enclosed in a fruit.
  - They have well-developed **xylem** and **phloem** tissue.

Angiosperms are again divided into **two classes** according to the **number of cotyledons** they have in their seeds.

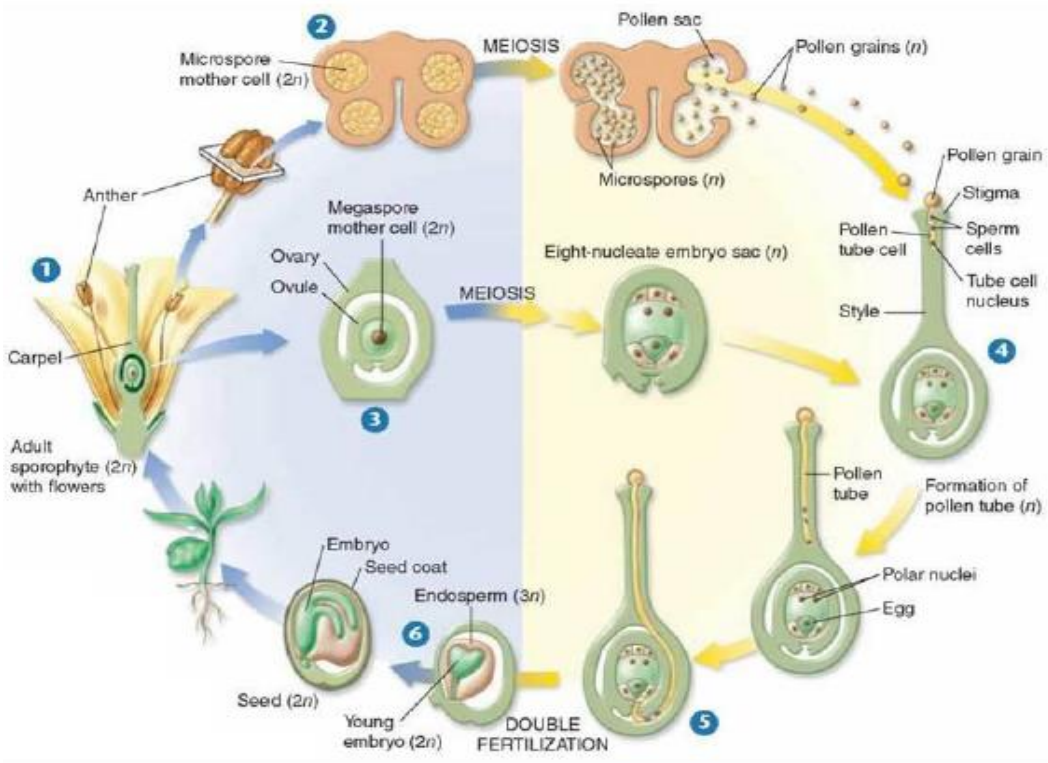
- 1. **Class Monocotyledons (monocots)**
- 2. **Class Dicotyledons (dicots)**

Comparision between Monocotyledones (monocots) and Dicotyledones (dicots)

Plant type	Embryos	Leaves	Stems	Flower parts	Examples
Monocots	One cotyledon	Parallel venation	Scattered vascular bundles	Usually occur in threes	lilies, irises, orchids, palms, tulips, bananas, pineapples, onions, bamboo, coconut, grasses (including wheat, corn, rice, and oats)
Dicots	Two cotyledons	Net venation	Radially arranged vascular bundles	Usually occur in fours or fives	beans, lettuce, oaks, maples, elms, roses, carnations, cactuses, most broad-leaved forest trees

Life cycle of Angiosperms

- In a process called **double fertilization**, one sperm fuses with an egg, forming a zygote.
- The zygote eventually develops into an **embryo**.
- Another sperm fuses with **two polar nuclei**, forming an **endosperm**.
- The endosperm provides nourishment for the embryo.



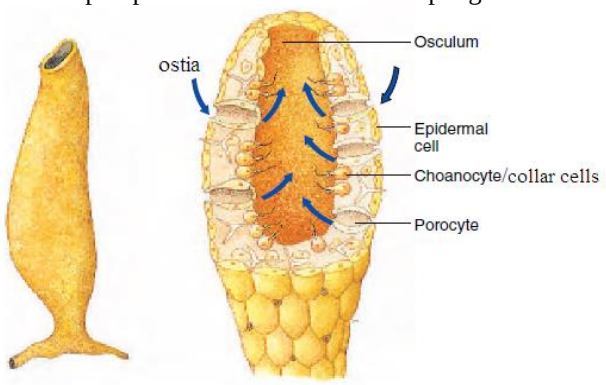
KINGDOM ANIMALIA

- is characterised by heterotrophic eukaryotic organisms that are multicellular and their cells lack cell walls.
- Their mode of nutrition is holozoic – by ingestion of food.
- They have nervous systems so they are sensitive to their surroundings.
- There are **33 animal phyla**, but here we shall only consider the **main** ones.
  1• **Porifera** (sponges)
  2• **Coelenterata** (Cnidaria)
  3• **Platyhelminthes** (flatworms)
  4• **Nematoda** (roundworms or nemathelminthes)
  5• **Annelida** (segmented worms)
  6• **Mollusca** (soft-bodied animals)
  7• **Echinodermata** (spiny-skinned animals)
  8• **Arthropoda** (joint-footed animals)
  9• **Chordata**
- The first eight phyla are also called **invertebrates**.
- The phylum **Chordata** includes the **vertebrates** – all the animals which have a **spinal cord** enclosed in a **backbon**e of **vertebrae**.

Phylum Porifera – the sponges

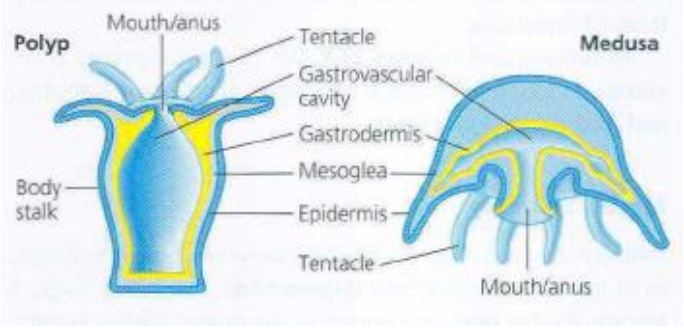
- are heterotrophic, multicellular organisms that do not have cell walls, they are classified as animals.
- have no gastrula stage, exhibit less cell specialization than most other animals, and have no true tissues or organs.
- are aquatic animals.
- Adult sponges are **sessile**, which means that they attach themselves firmly to a surface and do not move.
- They are hollow filter feeders.
- The basic body plan of a sponge consists of two layers of cells.
- The body wall forms a hollow cylinder that is closed at the bottom and open at the top.
- The interior of the cylinder is lined with flagellated cells called **choanocytes** or collar cells.

- By beating their flagella, choanocytes draw water into the sponge through numerous pores, called **ostia.**
- The water that is pumped into the interior of the sponge leaves through the **osculum**, the opening at the top of the sponge.



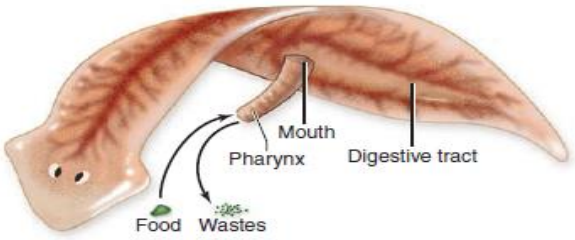
Phylum Coelenterata (Cnidaria)

- Sea anemones, **hydra**, **jelly fish** and coral are among the members of this phylum.
- In the center of the body is a hollow gut called the **gastrovascular cavity,** which has a single opening or mouth.
- Surrounding the mouth, a ring of **tentacles** for capturing prey.
- They have stinging cells on their tentacles for poisoning or immobilising prey and predators.
- They have only one opening, the mouth, and their bodies have **radial symmetry**.



Phylum Platyhelminthes – flatworms

- Their bodies develop from three germ layers such as: ectoderm, mesoderm, and endoderm. and are more complex than those of sponges, and cnidarians.
- Flatworms have **bilaterally symmetrical bodies**, with dorsal and ventral surfaces, right and left sides, and anterior and posterior ends.
- They are **hermaphrodites** – they contain both male and female sex organs.
- They live in other animals as parasites or are free-living in fresh water.
- Examples of platyhelminthes include ***Planaria* spp**, which live in fresh water, **tapeworms** and **liver flukes** like *Fasciola hepatica*.



Figure; **planaria**

Phylum Nematoda (nemathelminthes) – roundworms

- Roundworms are thought to be the most numerous animals in the world.
- It has been estimated that there are around 5 billion roundworms in the top 7 cm of an acre of soil.
- Nematodes have narrow, thread-like bodies, which are pointed at both ends and **bilaterally symmetrical.**
- Roundworms are among several phyla of animals known **as *pseudocoelomates***.
- **Pseudocoelomates** are so named because they have a **pseudocoelom**, which is a **hollow**, **fluid-filled cavity** that is lined by mesoderm on the outside and endoderm on the inside.
- Their bodies are not segmented and are round in cross-section,
- They don't have a circulatory system.

- but they do have a **complete digestive system** with both mouth and anus.

Eg. important parasites, such as ***Ascaris,*** which infects the guts of both humans and pigs, and the family **Filariidae**, which cause **elephantiasis a**nd **Hookworms.**

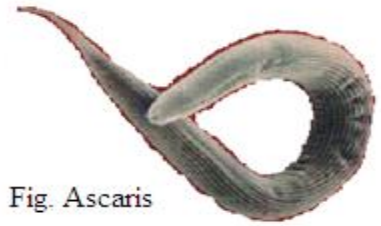
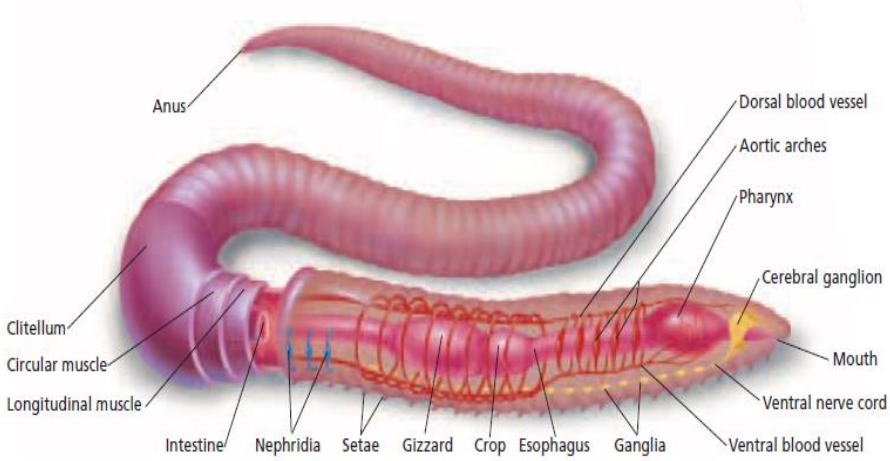


Fig. Ascaris

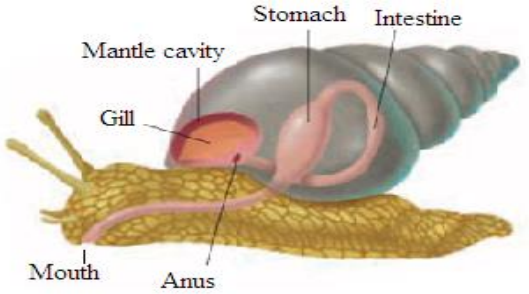
Phylum Annelida- segmented worms

- Their bodies are segmented **bilaterally symmetrical** worms.
- Segmentation is the most distinctive feature of annelids.
- Annelids have a true coelom, but the coelom in annelids is divided into separate compartments by partitions.
- They have a **closed blood circulatory system**.
- They are **hermaphrodites**, with male and female reproductive organs and they have bristle-like structures called **chaetae** to help them move.
- The common **earthworm**, ***Lumbricus terrestris***, is a good example.
  Earthworms are very important because they increase the **fertility of the soil**.
- ***Hirudo* spp**, the medicinal **leech**, is another example of an annelid worm.



Phylum Mollusca(soft-bodied animals**)**

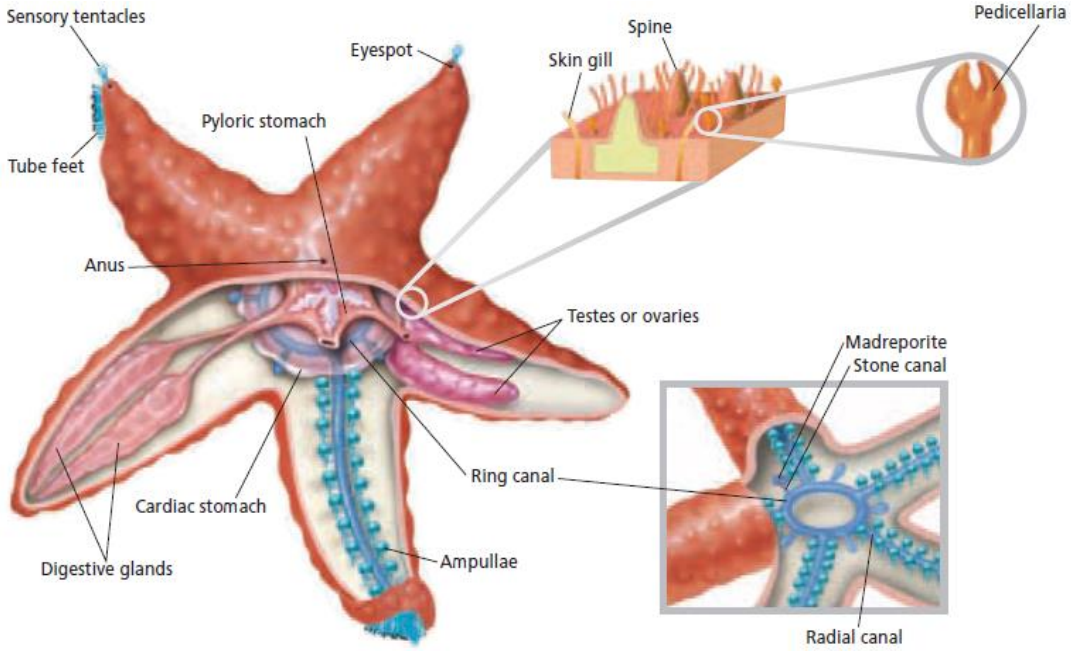
- The molluscs have a wide range of lifestyles and include the most **intelligent** of the invertebrate species.
- Octopi and squid have well **developed brains**.
- They may have **shells** or be **shell-less**, live in the sea, or in fresh water or on land.
- The main features of the mollusks include a soft muscular foot with a soft body, which is often protected by the shell.
- Their bodies are divided into **head**, **foot** and **visceral mass** and they are **not segmented**.
- They breathe through **gills**.
- **Examples of molluscs** include **slugs** and snails like the **giant East African land snail** (***Achatina fulica***), **bivalves** like ***Mytilis* spp**, the marine mussel and **octopuses** and **squids**.



Phylum Echinodermata(spiny-skinned animals**)**

- The sea **urchins**, **starfish** and **brittle stars** make up this phylum of invertebrates.
- The skin contains many **spines**.

- They have a **mouth** (on the **lower side**), a **gut** and an **anus** (on the **upper side**).
- They are all marine animals, and move around using **tube feet**.
- The adults have five arms, but the larval stages do not.
- **Examples** include ***Asteris***, the **common starfish**,
  Echinus, the common **sea urchin** and
  Paracucumana tricolor, a brightly coloured **sea cucumber** known as a **sea apple**.

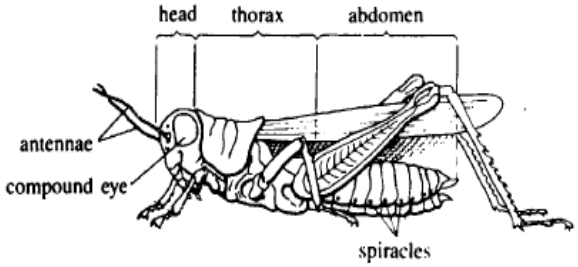


Phylum Arthropoda(joint-footed animals**)**

- it gets its name from two Greek words, *arthron* – joint, and *podos* – foot.
- They have an external exoskeleton made of chitin that prevents excessive water loss.
- Arthropods are animals with segmented bodies and jointed limbs.
- They have a well-developed nervous system and a complete gut from the mouth to anus.
- The phylum Arthropoda is divided into a number of classes according to the **number of limbs**, presence and **number of antennae** and **number of body parts**.
- These include **insecta**, **crustacea**, **arachnida**, **diplopoda** and **chilopoda**.

Class insect

- They have a body divided into three body parts; **head**, **thorax** and **abdomen**.
- They have **three pairs** of **jointed legs** on the thorax along with one or **two pairs of wings**.
- On their head they have a **pair of antennae** and **one pair of compound eyes**.
- Insects include **flies**, **butterflies** and **moths**, **beetles**, **wasps** and **bees**.



Class crustacean

- The crustacea are mainly aquatic.
- The body is made up of two parts – a **cephalothorax** (head fused with thorax) and abdomen.
- They have more than **four pairs of jointed legs**, **two pairs of antennae** and **simple eyes**.
- The body is often protected by a tough covering called a **carapace**.
- Crustaceans include *Daphnia*, **crab**, prawn, **shrimp**, **barnacle**, **water flea**, **lobsters**, **woodlice** and **crayfish**.

Class arachnida

- The arachnida (the spiders) are mainly terrestrial although some are aquatic.

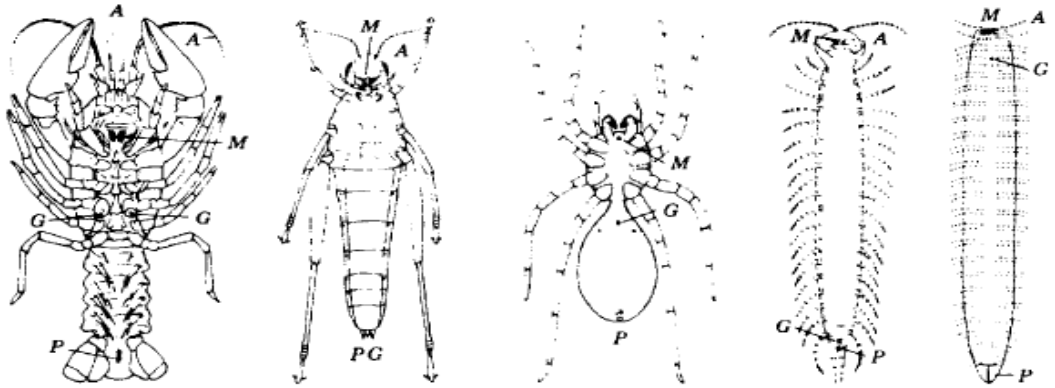
- They have two body parts – a **cephalothorax** (fused head and thorax) and the abdomen – with **no antennae**.
- They have eight **legs** in **four pairs**.
- Arachnids have **simple eyes** but often up to **eight** of them.
- Spiders spin silken webs.
- Examples of arachnids include **spiders**, **ticks**, **scorpions** and **mites.**

Class chilopoda and Class diplopoda

- The chilopoda – the **centipedes** – and the diplopoda – the **millipedes** – are often confused.
- They both have long bodies with many segments and lots of legs!

Differences between centipedes and millipedes

Centipedes	Millipedes
Have flattened bodies	Cylindrical bodies
Have brightly coloured bodies	Dull-coloured bodies
Have few or less segments	Have more segments
Have one pair of limbs per segment	Have two pairs of limbs per segment
Carnivorous (feed on other animals)	Herbivorous
Have poisonous claws for paralysing their prey	Have claws for biting and chewing plant material



Representatives of the five major classes of arthropods.

Phylum Chordata

- The term chordata is derived from the term notochord.
- A **notochord** is a flexible rod-like structure, made of cartilage, which runs along the dorsal side of the body.

Members of the subphylum Vertebrata, within the phylum Chordata have, at some stage of life,

- a notochord (a rod-shaped supporting axis below the nerve cord)
- a dorsal hollow nerve cord
- gill slits (pharyngeal pouches) -paired structures in the throat region later replaced by lungs and gills.
- and post-anal tail (a tail that extends beyond the anus).

Vertebrates

- Today, there are about 45,000 species of vertebrates, which make up less than 0.1% of the animals alive on earth today.
- Vertebrates have three characteristics that distinguish them from other chordates.
  - First, vertebrates have **vertebrae** (singular, *vertebra*), bones or cartilage that surround the dorsal nerve cord and form the spine.
  - Second, vertebrates have a **cranium,** or skull, that protects the brain.
  - Third, all vertebrates have an endoskeleton (an internal skeleton) composed of bone or cartilage.

In addition, they also have the following features:

- A closed blood **circulatory system** consisting of blood vessels.
- A well-developed **nervous system**.
- Two pairs of **limbs**.
- **Kidneys** as excretory organs.

Vertebrate animals form the largest group of the phylum Chordata and they are divided into five classes:

1• Class Pisces – the fish
2• Class Amphibia – the amphibians

3• Class Reptilia – the reptiles
4• Class Aves – the birds
5• Class Mammalia – the mammals

Class Pisces

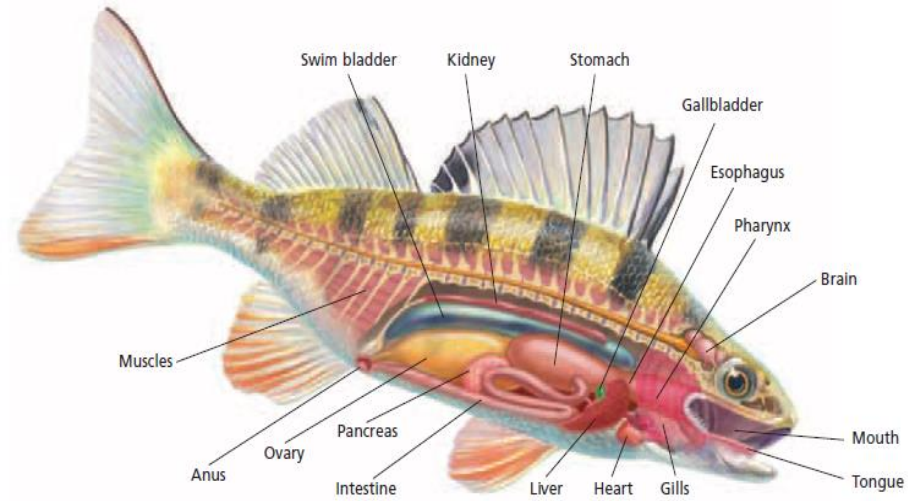
- These are the fishes.
- They are aquatic, i.e. they live in water, except the **mudskipper** and **lung fish**, which can spend short periods breathing in air.
- They use gills for gaseous exchange and have fins for swimming.
- They have streamlined bodies with scales on their skin.
- Fish are **ectothermic** – they rely on heat from their environment to regulate their body temperature.
- Fish are important to people the world over **as a source of food**.

The class Pisces is divided into **two subclasses**:

• **Bony fish** (**teleosts**) – examples include ***Tilapia***, **Nile perch**, **cod**, **mackerel** and **catfish**.
• **Cartilaginous fish** (**elasmobranchs**) – examples include **sharks**, **skates** and **rays**.

Differences between bony fish and cartilaginous fish

Bony fish	Cartilaginous fish
Have bony skeleton	Have cartilaginous skeleton
Have round-shaped scales	Have scales that are not round shaped
Have opercula (gill covers) covering their gills	Have no opercula (gill covers) but have gill slits
Have homocercal tails (even size fins)	Have heterocercal tails (one part is larger than the other)
Are usually smaller in size	Are usually larger in size



Class Amphibia

-The word **amphibian** comes from two Greek words *amphi*, which means **both**(double), and *bios*, which means life.
- This means that amphibians spend part of their lives (as *larvae or tadpoles*) **in water** and part of it (as *adults*) **on land**.
- This class includes the amphibians (**frogs**, **toads**, **newts** and **salamanders**).
- The amphibians were the first vertebrates to colonise the land.
- They have simple sac-like **lungs** and smooth **moist skin**, which is also **used as a respiratory surface**.
- Their lifecycle includes **metamorphosis**, and
- They **need water for successful reproduction** as **fertilisation** is external and the larval form (tadpole) is aquatic.
- Gills are only present in the larval forms.
- Amphibians are **ectothermi**c.

- Anurans (**frogs** and **toads)** are found worldwide except in polar climates and a few isolated oceanic islands.

Differences between a frog and a toad

Frog	Toad
Has a smooth skin	Has a rough skin
Has a moist skin	Has a dry skin
Has more webbed feet	Has less webbed feet
Has a brightly coloured body	Has a dull-coloured body
Has a more streamlined body	Has a less streamlined body
Has extra-long hind legs	Has hind legs that are not extra long

Class Reptilia

- The **reptiles** are mainly **terrestria**l animals.
- They have **dry skin** with **scales** and their gas exchange takes place exclusively in the **lungs**.
- They have developed **internal fertilization** and they **lay eggs** on land in a **leathery shell**.
- Some reptiles even keep the eggs within their body and give birth to fully developed young.
- The gill slits that are a chordate feature are seen only in embryonic development in the reptiles, and reptiles have **no external ears**.
- Reptiles are **ectothermic**.
- Examples include **snakes**, **crocodiles**, such as the Ethiopian crocodile, a subspecies of the **Nile crocodile** known as ***Crocodyus niloticus niloticus***, and **lizards**, for example, the East African spiny tailed lizard, *Cordylus tropidosternum*.

Class Aves-birds

-Birds have feathers over most of their body, and scales on their legs.
- The forelimbs are adapted as **wings**, which most birds use to fly.
- The **sternum** or **breastbone** has been **enlarged** into a big keel shape for the attachment of the wing muscles, particularly in those birds that fly.
- The **jaws** are toothless and are covered by a **horny beak**.
- Birds reproduce using **well-developed eggs** with a **hard shell** and in many cases the parent birds spend a lot of time and effort raising their young(**Oviparity**).
- Birds have **light skeletons**, which makes it easier for them to fly.
- They are **endothermi**c, which means they use heat produced by their own metabolism to regulate their body temperature.
- Of the main chordate features, only the **hollow nerve cord** remains in an **adult** bird.
-Examples include **domestic fowl**, the **wattled ibis** (*Bostrychia carunculata*), white collared **pigeon** (*Columba albitorques*) and the Ethiopian **eagle owl** (*Bubo capensis*).

Class Mammalia

- **Mammals** are the best known of all animals.
- A true mammal **produces milk** for its young in mammary glands.
- They are also **endothermi**c- has a high internal body temperature and regulates its own body temperature.
- A mammal has hair on the skin and external ears.
- Most mammals also **produce live young** which have developed for a time within the body of the mother in a structure called the **uterus**.
- As with the birds, chordate features are only plainly visible in the embryos.
- The mammals range in size from tiny **shrews** to **elephants** and **whales**.

Subdivisions of mammals

- Mammals are classified according to the **way their young are produced**.
- There are **three sub-classes** of mammals:
  1. **Egg-laying mammals(Monotremes)** – lay eggs,
     e.g. duck-billed **platypus**, Short-beaked **echidna**
  2. **Marsupials** – produce immature young, which are nourished by milk in the pouch,
     e.g. kangaroo, koala bear, opossum.
  3. **Higher mammals(Placental Mammals)** – produce fully developed young, which are nourished by milk from the mammary glands,
     e.g. rats, cows, elephants, cats, monkeys and humans.