CLASSIFICATION OF ORGANISMS

Classification is defined as the grouping of organisms together basing on the features they have in common.

Taxonomy is defined as the science of classification.

Braches of taxonomy

Nomenclature is the giving of names to organisms.

Systematics is the placing of organisms into groups basing on their similarities and differences.

Binomial nomenclature is the assigning of two Latin names to each organism. The first name/word is the *generic* name and the second name/word is the *specific* name.

In binomial nomenclature, the following rules are observed;

i. The generic name starts with the upper case (capital letter) while the species name starts with a lower case (small letter).
ii. Unless written in italics, the two words must be underlined separately e.g. Homo sapiens/ *Homo sapiens.*

THE TAXONOMIC HIERARCHY

This is the descending order in size of the taxonomic group is Kingdom, Phylum (division in plants), Class, Order, Family, Genus and Species.

Each taxonomic group is called a taxon or taxa (plural). Each taxon posses a diagnostic feature i.e. features which are unique (peculiar) to that group e.g. presence of vertebral column is a diagnostic feature for phylum Chordata. Fur is a diagnostic feature for class mammalia and feathers are peculiar to birds.

What is a species? This is a group of organisms having many common physical and other features and if sexually reproducing, they can breed to produce fertile offsprings.

WAYS OF CLASSIFYING ORGANISMS

Artificial classification: this is based on one or a few easily observable characteristics for simplicity and convenience.

Natural classification: this considers natural relationships between organisms e.g. internal and external features. The features considered include;

- Embryology
- Physiology
- Biochemistry
- Cell structure
- Behavior

Phylogenetic classification: this is based on evolutionary history (phylogeny) of organisms. Organisms belonging to the same group are believed to share a common ancestor. It bases so much on fossil evidence.

Phonetic classification: this is based only on observable characteristics and all characters are considered to be of importance. A lot of data is collected and the degree of similarity between different organisms is usually calculated by computers.

NOTE: classification today is mostly natural and phylogenetic.

SPECIMEN IDENTIFICATION AND KEYS

A specimen key involves listing observable characteristics of organisms and matching with those features which are diagnostic in a particular group.

The characteristics used in keys should be readily observable morphological characters. They may be qualitative e.g. shape or quantitave e.g. number of segments. The characteristics must be constant for that species and not subject to variations as a result of environmental influence, colour and size are highly discouraged.

Dichotomous key

This is a simple diagnostic key in which pairs of statements called **leads**, each dealing with a

particular characteristic is numbered e.g. 1, 2, 3, e.t.c. The paired statements of each lead should be contrasting and mutually exclusive. Such that by considering them in order, a large group of organisms are broken down into progressively smaller groups until the unknown organism is identified. An example of a dichotomous key for indentifying arthropods is shown below,

1 a) Has 8 legs… .....W
b) Has 6 legs… 2

2 a) Has long antennae X
b) Has short antennae.....3

3 a) Has proboscis… .....Y
b) Has mandibles… .....Z

THE FIVE KINGDOMS

A. Prokaryotae
B. Protoctista
C. Fungi
D. Plantae
E. Animalia

VIRUSES

Viruses do not fit in any of the above kingdoms because they are on the border of living and non-living things. Viruses have a simple structure consisting of a small piece of nucleic acid either DNA or RNA which in most viruses is surrounded by a protein or a lipoprotein.

Characteristics of viruses

i. They lack a cellular structure i.e. they are acellular
ii. They are the smallest living things 20-300nm in diameter
iii. They are obligate endoparasites i.e. they can only live parasitically inside other cells.
iv. They depend on host cells for reproduction
v. Viruses are highly specific i.e. each virus recognises and infects a particular host.
vi. Most viruses enter their hosts by phagocytosis and pinocytosis

Reasons why viruses are considered to be living things

a. They posses genetic material
b. They can mutate and hence evolve
c. They carry out protein synthesis in host cells
d. They are capable self replication when inside host cells
e. They can transmit characteristics to the next generation
f.

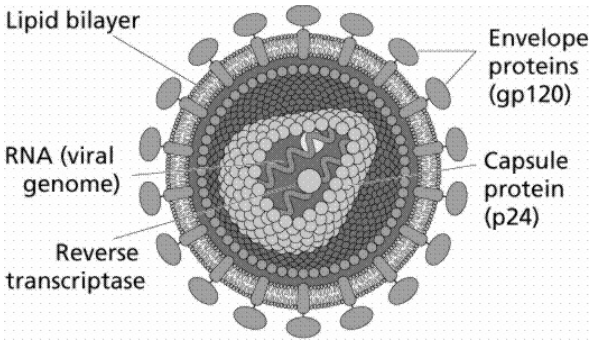
Reasons why viruses are considered to be non-living things

a. They can be crystallised
b. They lack enzyme systems
c. They cannot metabolise unless they are inside host cells
d.

Generalised structure of a virus

Core	This is the inner region in which the genetic material (DNA or RNA) is found. The DNA or RNA may be single stranded or double stranded
Capsid	This is the protective coat of protein surrounding the core. The Capsid is made up of subunits called **capsomeres.**
Envelop	This is found only in some large viruses

Structure of the HIV virus



The HIV virus is spherical and about 1000nm in diameter. The core region contains 2 molecules of single stranded RNA and reverse transcriptase enzyme surrounded by a cone shaped protein capsid. The capsid is enclosed by an envelope composed of a lipid and glycoprotein.

The reverse transcriptase enzyme converts single stranded RNA into double stranded DNA copies.HIV is referred to as a **retrovirus** because the enzyme reverse transcriptase, found in retroviruses, catalyses the conversion of viral RNA into DNA i.e. reverse transcription. The viral DNA made is then inserted into the host's DNA where it directs the production of more viral properties.

The envelope contains glycoproteins which bind specifically to helper T-cell receptors, enabling the virus to enter the helper T-lymphocytes.

Examples of viral diseases;

a. In plants
   i. Cassava mosaic disease
   ii. Tobacco mosaic disease
   iii. Tomato bush stunt disease
   iv. Southern bean mosaic disease
   v.
b. In animals
   i. Small pox
   ii. The Acquired Immuno Deficiency Syndrome (AIDS)
   iii. Rabies
   iv. Measles
   v. New castle disease
   vi.

KINGDOM PROKARYOTAE

Prokaryotes are organisms whose genetic material is not bound by a nuclear membrane.

All members are unicellular and they belong to two main groups;

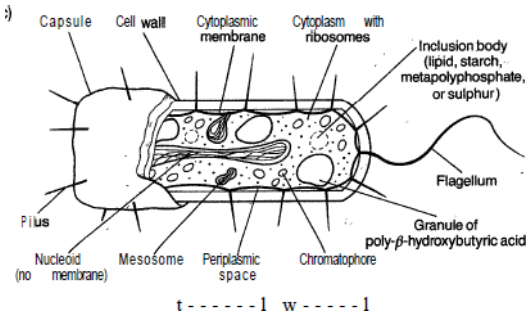
a. Archaea
This group contains organisms that grow under extreme conditions e.g. halophiles which grow under extremely high salt concentration

b. Hyperthermophiles
This group contains organisms that grow under very high temperatures.

BACTERIA

They are the smallest unicellular organisms and they are the most abundant.

Generalised structure of a bacteria



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CLASSIFICATION OF BACTERIA

This is based on structural and metabolic features.

Classification by shape

There are four main shapes of bacteria and they are as follows;

a. **Spherical shape** (cocci, singular = coccus) They may be clusters e.g. *Staphylococcus aureus* which causes boils and food poisoning.

They may occur in pairs enclosed by a capsule, diplococci e.g. *Diplococcus*

pneumoniae which causes pneumonia.

They may occur in chains, streptococci e.g. *Streptococcus thermopiles* which gives yoghurt the creamy flavor

b. **Rod shaped** (bacilli, singular = bacillus)
They may occur as single rods e.g. *Escherichia coli* which lives in the guts of humans and *Bacillus anthrax* which causes anthrax.

They may occur in chains e.g. Azotobacter which fixes nitrogen in the soil.

c. Curved or spiral shaped

Spiral shaped bacteria include *Spirillum* species

Curved shaped bacteria include the coma shaped (vibrios) bacteria such as *Vibrio cholera* which causes cholera.

d. Filamentous bacteria
This group includes *Actinomyces* which occur in the mouth and may cause dental caries.

Classification by method of respiration

a. Aerobic bacteria
These bacteria require oxygen for respiration. Obligate aerobes cannot survive without oxygen but facultative aerobic bacteria can survive in the absence of oxygen.

b. Anaerobic bacteria
They respire without oxygen and obligate anaerobes are killed in the presence of oxygen. Facultative anaerobic bacteria can use oxygen but can respire without it.

Classification by methods of nutrition

a. Autotrophic bacteria
These bacteria manufacture their own organic food from carbon dioxide.
Photoautotrophic (photosynthetic) bacteria use energy of sun light to convert carbon dioxide into carbohydrates. Examples include; the blue-green bacteria, sulphur bacteria and cyano bacteria.
Chemoautotrophic (chemosynthetic) bacteria use energy from chemical reactions to convert carbon dioxide into carbohydrates. Inorganic substances such as ammonia, methane and hydrogen sulphide are oxidized to release energy.
Examples include;

Nitrosomonas $NH_4^+ \longrightarrow NO_2^- + \text{Energy}$

Nitrobacter $O_2 + NO_2^- \xrightarrow[O_2]{} NO_3 + \text{Energy}$

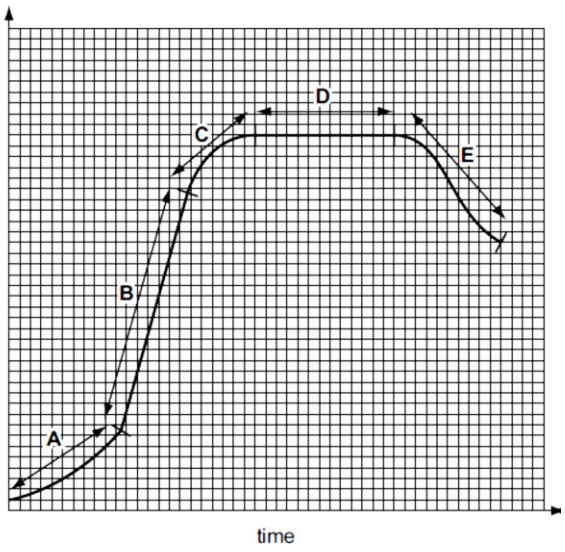
b. Heterotrophic bacteria
This feeds on already made organic food but in different ways.
Chemo-heterotrophic bacteria obtain energy from chemicals in food.
Saptrotrophic bacteria obtain their food from dead and decayed organic matter. Such bacteria secrete enzymes into the food, and absorb the soluble products of extra cellular digestion with the saptrotrophic body for assimilation.
Parasitic bacteria live on other organisms (hosts) from which they obtain food as the host suffers harms.
Mutualistic bacteria live in close associations with legumes in the root nodules
Note: *Escherichia coli* contribute vitamins B and K groups. Rhizobium fixes nitrogen into the plants as it is provided with a shelter.

Classification by staining reaction

Gram positive bacteria; they stain purple with a gram stain. The cell wall lacks an extra outer membrane.

Gram negative bacteria; they stain pink with a gram stain. Their cell wall lacks an extra outer membrane which is made out of lipids and polysaccharides. The outer membrane gives them protection against penicillin and lysozymes.

POPULATION GROWTH CURVE OF BACTERIA



Lag phase (A). The population increases gradually as the bacteria are still adapting to their new environment and growth has not yet achieved the maximum rate. The bacteria also synthesises new substances.

Log phase (B). The population increases rapidly with time. The bacteria have adapted to the environment and enzymes have been synthesised to digest food which is in abundance so as to support the rapidly increasing population.

Decelerating phase (D) There is slow population growth because food has reduced.

Stationary phase (E) The population remains constant with time because the death rate equals to the rate of formation of new cells due to;

i. Stiff competition for decreasing food
ii. Depletion of oxygen (reduction of oxygen)
iii. Accumulation of toxic wastes from metabolism

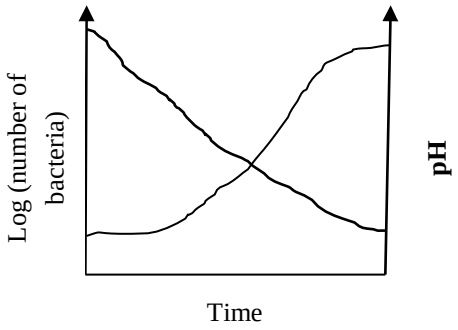
Phase of decline (F). The population declines slowly because the cells stop multiplying due to exhaustion of oxygen, accumulation of wastes and exhaustion of nutrients.

FACTORS WHICH AFFECT BACTERIAL GROWTH

1. Nutrient availability
2. Oxygen availability
3. Temperature
   i. High temperature speeds up bacterial population growth up to 40^0C after which it declines
   ii. Very low temperatures slow down bacterial growth because the enzymes become inactivated.
4. Availability of moisture
5. Accumulation of toxic waste products (carbon dioxide). Low pH results from the reaction between carbon dioxide, from respiration with water to form the weak carbonic acid.

   i.e. $CO_2 + H_2O \longrightarrow H_2CO_3$

Low pH inhibits bacterial population growth while high pH favours bacterial population growth.



ECONOMIC IMPORTANCE OF BACTERIA

1. They are cultured for research purposes
2. They facilitate the making of foods like yoghurt, cheese and vinegar
3. They are used for making antibiotics, amino acids and enzymes.

4. In humans, vitamin K and B complex are produced by the symbiotic bacteria (*E. Coli*) while in animals it is used to break down cellulose.
5. They cause decomposition of dead organic matter, hence enabling their disposal.
6. They take part in nutrient recycling e.g. the nitrogen cycle, carbon cycle and the phosphorous cycle.
7. On the other hand, bacteria cause food to get spoilt
8. Bacteria like *Thiobacillus* and *Disulphovibrio* produces sulphuric acid which destroys underground metal pipes.

KINGDOM PROTOCTISTA

Protists are eukaryotes and they may be unicellular or multicellular. They are placed under several phyla but those of much importance at this level include the following.

PHYLUM RHIZOPODA

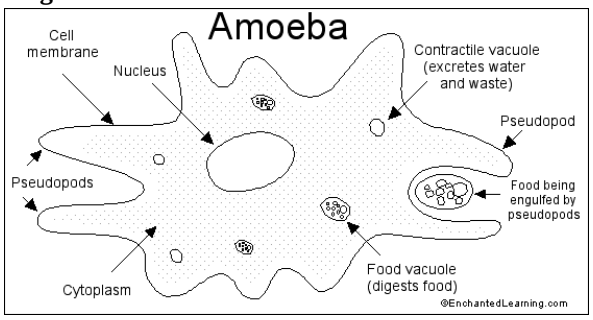
Examples include;

i. *Amoeba proteus* which lives in fresh water
ii. *Entamoeba histolytica* which causes amoebic dysentery

Characteristics

- They are unicellular and bear pseudopodia (false feet) which enables movement and phagocytosis
- They reproduce asexually
- They feed heterotrophically

Diagram of Amoeba



Functions of the parts

The **mitochondria** is used in the production of energy for the contractile vacuole

The **cytoplasm** is the place where all the important chemical reactions take place.

The **contractile vacuole** is used for osmoregulation

The **nucleus** is essential for directing activities

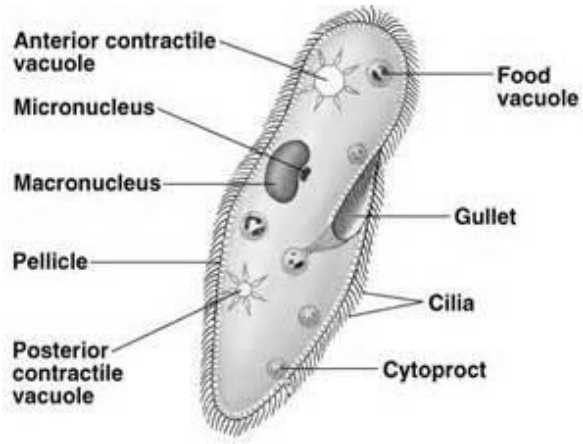
PHYLUM CILIOPHORA (CILIATES)

Examples include Paramecium, Stentor, Vorticella, Didinia e.t.c.

Characteristics

- They are unicellular
- They feed heterotrophically
- Their cilia has a 9+2 tubule arrangement
- The cilia collects food and enable locomotion in water
- Their habitat is fresh water and marine water
- They have two types of nuclei, the larger macro nucleus which controls all cell metabolic activities and the micro nucleus which controls sexual reproduction called conjugation.
- The macro nucleus is polyploid i.e. it has more than two sets of chromosomes and the micro nucleus is diploid i.e. it has two sets of chromosomes.

Diagram of a paramecium



PHYLUM ZOOMASTIGINA (Flagellates)

Examples include trypanasoma which causes trypanasomiasis (sleeping sickness), trychomonas

Characteristics

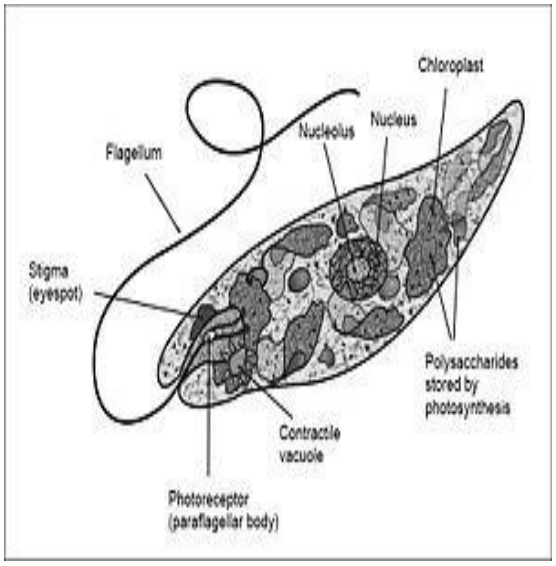
- They bear flagella for locomotion
- They are heterotrophic
- They are unicellular
- The reproduce both asexually and sexually
- They bear a 9+2 tubule arrangement

PHYLUM EUGLENOPHYTA

The only member is euglena which lives in an aquatic environment.

Characteristics

- They are mostly unicellular
- They reproduce asexually
- They move by flagella
- Some are photosynthetic while others are heterotrophic or autotrophic



PHYLUM APICOMPLEXA (sporozoans)

Members include plasmodium which causes malaria in humans

Characteristics

- they are unicellular
- they are heterotrophic
- they lack locomotory structures
- they are spore producing parasites of animals
- they reproduce sexually and asexually
- their lifecycles are complex involving several animal hosts

Life cycle of plasmodium

An infected anopheles mosquito bites a person, injecting plasmodium sporozoites in its saliva. The sporozoites enter the person's liver cells. After several days, the sporozoites undergo multiple divisions and become merozoites, which use the apical complex to penetrate red blood cells. The merozoites divide asexually inside the red blood cells. At intervals of 48 or 72 hours (depending on the species), large numbers of merozoites break out of the blood cells, causing periodic chills and fever. Some of the merozoites infect other red blood cells. Some merozoites form gametophytes. Another anopheles mosquito bites the infected person and picks up plasmodium gametophytes along with blood.

Gametes form from the gametophytes; each male gametophyte produces several slender male gametes. Fertilisation occurs in the mosquito's digestive tract, and a zygote forms. An oocyst develops from the zygote in the wall of the mosquito's gut. The oocyst releases thousands of sporozoites, which migrate to the mosquito's salivary glands.

PHYLUM OOMYCOTA

Includes peronospora which grows on grapes and pythium which causes late potato blight and tomato rot

They are characterized by production of spores that bear flagella. Such spores are produced both sexually and asexually.

PHYLUM CHLOROPHYTA (green algae)

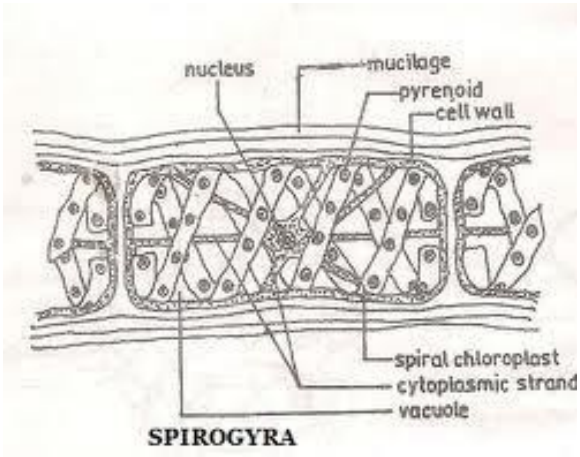
The members include volvox, chlorella and spirogyra

Chlorella which is a unicellular non filamentous alga that lives in fresh water ponds

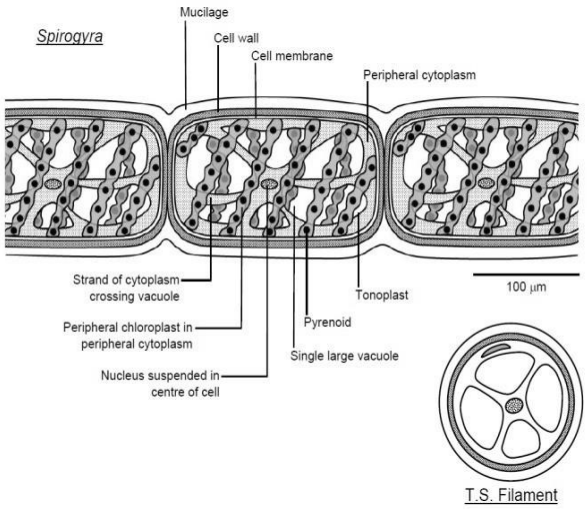
Chlamydominas which is a motile unicellular algae

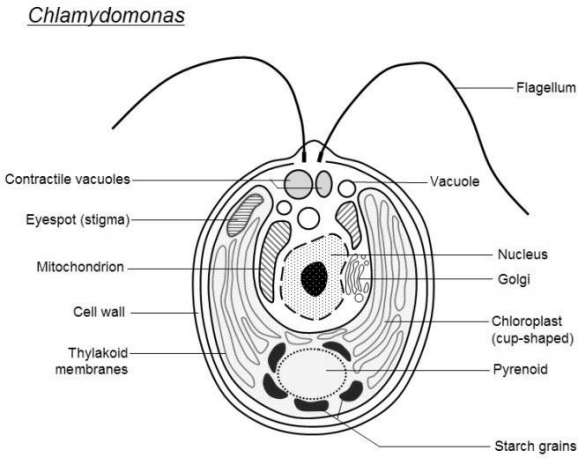
Characteristics

- They contain chlorophyll and therefore they are photosynthetic
- Their cell walls contain cellulose
- They store starch
- They reproduce sexually and asexually
- Spirogyra is a filamentous algae that lives in fresh water ponds



SPIROGYRA





Spirogyra is a filamentous algae that lives in fresh water ponds

PHYLUM PHAEOPHYTA

These are the brown algae. The members include Fucus, Laminaria and Ascophyllum.

Characteristics

- They posses chlorophyll and therefore carryout photosynthesis
- They are multicellular
- They are marine and are therefore called the sea weed
- They contain a brown pigment called fucoxanithin which gives them a brown colour

PHYLUM RHODOPHYTA

These are red algae and members include chodris.

Characteristics

- It is marine
- It contains chlorophyll hence it carries out photosynthesis
- It contains a red pigment called phycoerythin
- It also contains a blue pigment called phycocyanin
- It produces agar which is extracted from them for laboratory purposes

ECONOMIC IMPORTANCE OF ALGAE

1. They can be used as fertilisers in farms
2. The carry out photosynthesis in oceans which:
    - Provide food for other organisms
    - Release oxygen
    - Reduce carbon dioxide which would cause acidity in water
3. Some of their products are useful in various industrial processes
4. Algae blooms result in severe pollution of water bodies.
5. Chlorella can be cultivated to provide Single Cell Protein (SCP) for humans and animal consumption

KINGDOM FUNGI

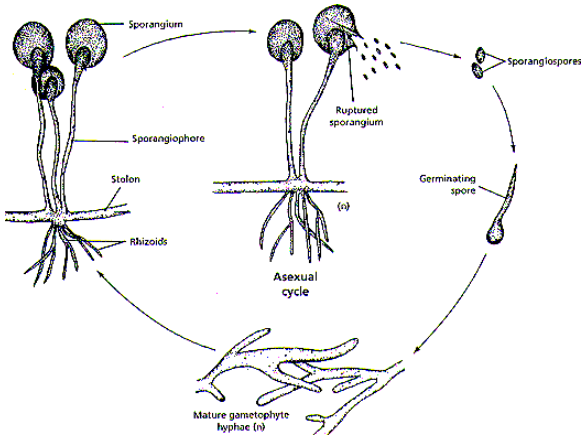
Characteristics that distinguish them from plants

- Carbohydrates are stored as glycogen but not as starch
- Their cell walls contain chitin but not cellulose
- They have no chlorophyll hence they don't carry out photosynthesis
- They reproduce by spores that lack flagella
- They carry out heterotrophic nutrition as parasites and saprophytes on microorganisms.
- Their bodies are usually made up of a mycelium of thread like multi nucleate hyphae without distinct cell bodies (aseptate) or they may have cross walls (septate)
- They undergo nuclear mitosis i.e. their cytoplasm, nuclear membrane and cell membrane never divided
- Fungal mitochondria have flattened cristae (whereas plants have tubular ones)

CLASSIFICATION OF FUNGI

PHYLUM ZYGOMYCOTA

Members include mucor and rhizopus (bread mould). They live in damp organic matter e.g. bread



Note;

a. The sporangium is black when ripe and colour less when immature. It produces spores for asexual reproduction
b. The sporagiophore is a vertically growing hypha that bears the sporangium.
c. Rhizoids which are root like structures

PHYLUM ASCOMYCOTA

Members include Penicillium, Aspergillus and Yeast sacchromycetes.

Characteristics

- Penicillium species form blue; some are green or sometimes yellow moulds on bread, decaying fruit e.t.c.
- Their hyphae have cross walls called septa, therefore Penicillium is septate
- It reproduces asexually by means of spores called conidia formed at the tip of special hyphae called conidiophores.
- Penicillium produces penicillin which is an antibiotic, during aerobic respiration.

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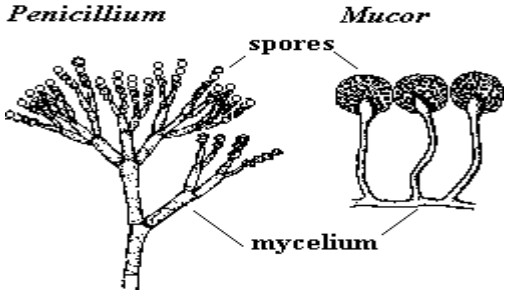
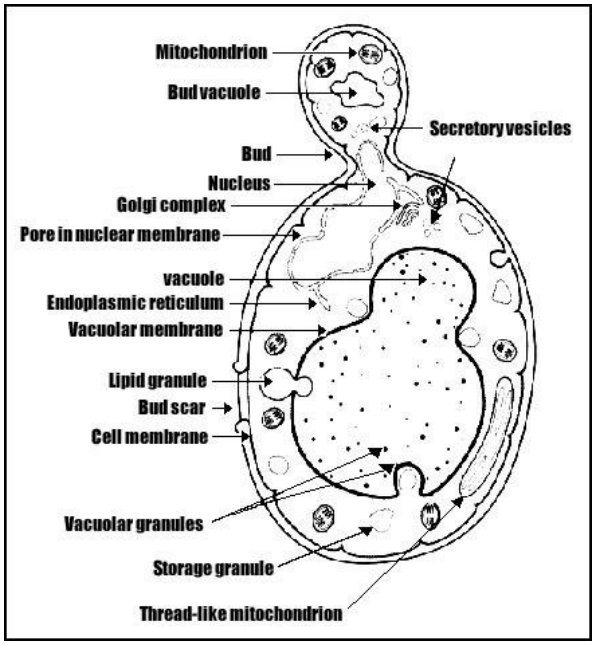




Characteristics of the yeast cell

- It has oval shaped cells
- It is unicellular
- Reproduces by budding
- Yeast produces ethanol during anaerobic respiration

PHYLUM BASIDIOMYCOTA

Members include mushrooms, toad stools, puff balls and rusts. Rusts attack cereal crops

Characteristics

- They reproduce asexually by sporulation
- They have septate hyphae

ECONOMIC IMPORTANCE OF FUNGI

1. They cause decomposition of sewage and organic material in soil
2. Penicillium and Aspergillus form antibiotics during aerobic respiration
3. Yeast forms alcohol during anaerobic respiration
4. Yeast is used in bread production
5. Fermentation of Aspergillus forms citric acid used in lemonade formation
6. Used for experimental purposes especially in genetic investigations
7. Fungi causes decomposition of stored food and deterioration of natural materials like leather
8. Some fungi cause plant diseases e.g. powdery mildew caused by *Erysphie graminae*
9. Some are poisonous to man
10. They cause skin irritations e.g. ringworms
11. They are eaten as food e.g. mushrooms

KINGDOM PLANTAE (plants)

Characteristics

- Their cell walls contain cellulose
- They reproduce both sexually and asexually
- They are multi cellular
- They are photosynthetic except for some parasites that lack chlorophyll
- They have alternation of generations i.e. the haploid and diploid generations alternate in the lifecycle.

PHYLUM BRYOPHYTA (bryophytes)

The members include mosses and liverworts. The members live in damp shady soils or tree logs.

Bryophytes are the smallest land plants and they are thought to have evolved from green algae.

Characteristics

- They lack vascular tissues
- They lack true roots, stems or leaves
- Their body is a **thallus** which is differentiated into simple “leaves and stems”
- Alternation of generation occurs and the gametophyte generation is dominant

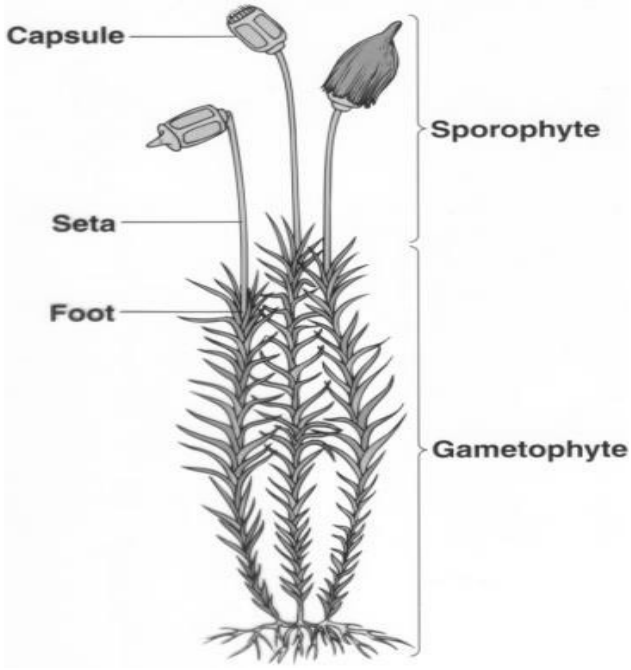
- The gametophyte is anchored by thallus rhizoids which grow from the stem.

NOTE: Water and mineral salts are absorbed by the whole plant surface because the plant surface lacks a cuticle; therefore water uptake occurs by **osmosis.**

Phylum bryophyta contains two main classes;

1. Class hepaticae (liverworts)
2. Class Musci (mosses)

EXTERNAL FEAUTRES OF A MOSS



ALTERNATION OF GENERATION

This is the occurancy of two or more generations within the lifecycle of an organism, a haploid gametophyte and a diploid saprophyte.

Generalised life cycle p.g. 39 in BIOLOGICAL SCIENCE

Description of alternation of generation in a bryophyte like a moss

A moss consists of two distinct forms in its lifecycle i.e. the haploid gametophyte which is dominant and the diploid sporophyte

The antheridia (sperm producing organ) and archegonia (egg producing organ) may be located on the same plant or different plants.

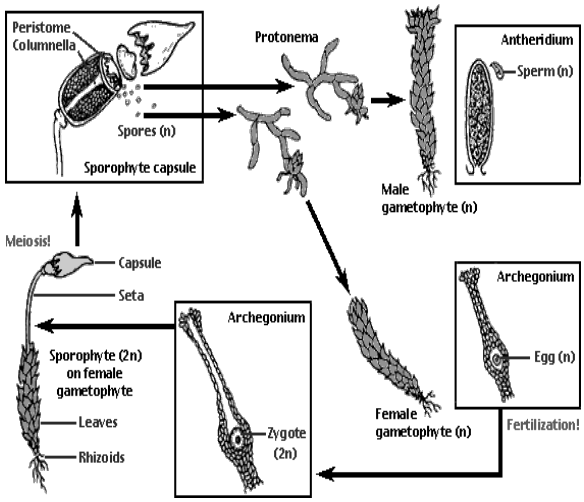
When mature, the antheridia shade their sperms (antherozoids) into the archegonia aided by the rain-splash.

The haploid biflagellate sperms fuse with haploid eggs (ospheres) to form a diploid zygote (oospheres)

The zygote develops into sporophytes which attach and survive on the gametophyte

When mature, the sporophyte produces haploid spores by meiosis. The spores are released by splitting of the spore capsule when dry.

When the spores land on moisten soils, they germinate into a protonema which later develops into a new diploid gametophyte



PHYLUM PTERIDOPHYTA (Filicinophyta or the ferns)

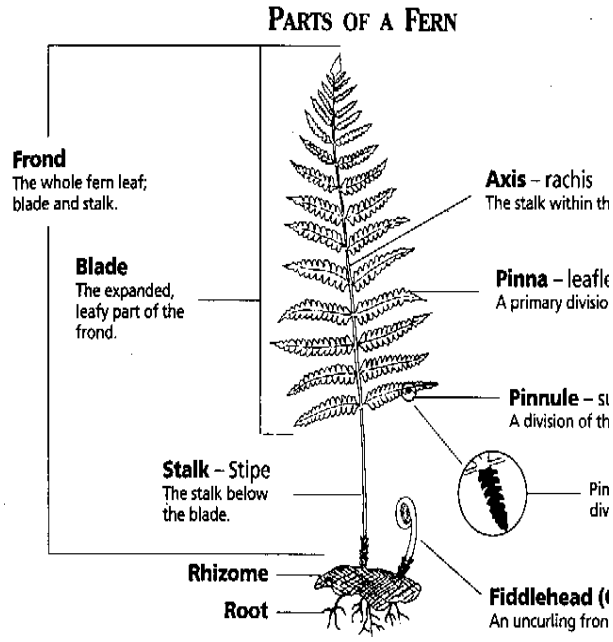
Members include; Pteridium and Dryopteris

Characteristics

- The vascular tissue (xylem and phloem) are present.

- The leaves are relatively large and are called fronds. The large surface area of the leaves increases the photosynthetic surface of the plant
- Spores are produced in sporangia (singular; sporangium), usually in clusters called sori (sorus, singular)
- Alternation of generation occurs and the sporophyte is dominant
- The gametophyte is reduced to a small simple prothallus
- The sporophyte generation posses true roots, stems and leaves.

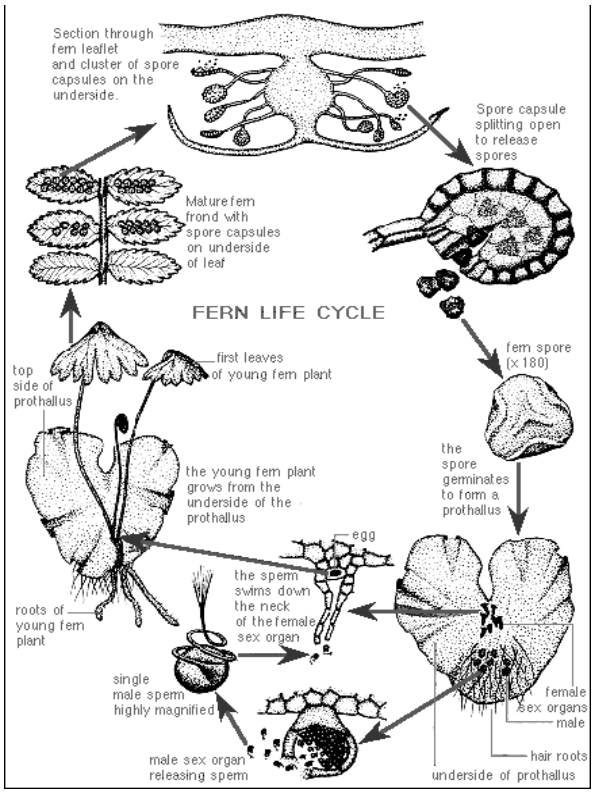
    The roots penetrate the soil to absorb water and dissolved mineral salts



ALTERNATION OF GENERATIONS IN A FERN (Pteridophyte/filicinophyte)

A fern consists of two distinct forms in its life. The diploid sporophyte, which is the dominant stage and the haploid gametophyte

- The diploid spore (mother cell) inside the sporangia divide
- When mature, the protecting covering (indusium), shrinks and catapults the spores of the sporangia
- The spores germinate into a heart-shaped prothallus which is the gametophyte
- Prothallus bears antheridia which produces haploid sperms and archegonia which produces eggs by mitosis
- On rupturing, the ciliated sperms from the antheridia swim towards the fertile eggs in the archegonia
- The zygotes develops into sporophytes



COMPARISON BETWEEN A MOSS AND A FERN

Similarities

- Both form spores
- Both grow in damp soils/ organic matter
- Alternation of generation occurs in both
- In both the gametophyte is anchored by the rhizoids

Differences

Moss	Fern
No vascular tissue	Vascular tissue present

No sorus	Sorus present at leaf underside
Spore capsule present	No spore capsule
Saprophyte is attached to gametophyte	Gametophyte is attached to sporophyte
It lacks true roots, leaves and stems	True roots, stems and leaves are present
No rhizoids	Rhizoid present
Gametophyte not heart shaped	Gametophyte is heart shaped
Leaves are simple and small	Leaves are relatively large

COMPARISON OF ALTERNATION OF GENERATION BETWEEN MOSSES AND FERNS

Similarities

- Spore formation occurs in spore bearing sporangia
- Sporophytes are diploid while gametophytes are haploid
- Spores form by meiosis whereas gametes are formed by mitosis
- Sexual and asexual reproduction occurs
- Male gametes are motile while eggs are non motile
- In both there's only one dominant stage
- The gametophyte bears the archegonia
- Sperms formed in the antheridia are brought into contact with the eggs by some mechanism

Differences

Moss	Ferns
The sperms are biflagellate	The sperms are ciliated
Sporophytes grow on the gametophyte	Sporophyte is self supporting
Spores germinate into a protonema first and then into a gametophyte	Spores germinate directly into a gametophyte
Gametophyte is a dominant generation	Saprophyte is a dominant generation
There is much dependency on water for growth, spore dispersal and gamete transfer	There is less dependency on water, only being used for gamete transfer and spore germination
Gametophytes may or may not bear both sexual reproductive organs	Gametophytes always bears both sexual reproductive organs

SIGNIFICANCE OF ALTERNATION OF GENERATION

1. Spores cause rapid multiplication of species
2. Different habitats of the ecosystem are exploited by the different generations
3. It enables plants to cope with adverse environmental conditions
4. Reduces chances of extinction
5. Gametes are formed by meiosis which brings about genetic variations

PHYLUM CONIFEROPHYTA

Members include Cedars, Horches and Christmas tress i.e. Firs and Spruce

Characteristics

- They bear cones in which spore producing sporangia and seeds develop
- They lack fruits and flowers
- The seed is naked i.e. it is not enclosed by the ovary wall.
- Leaves are usually needle-like with a thick waxy cuticle

Economic importance

1. A source of soft wood for timber
2. Pine nuts are used in cooking
3. Spruce and firs are used as Christmas trees

PHYLUM ANGIOSPERMOPHYTA

This phylum includes all flowering plants

Characteristics

- They flowers in which sporangia, spores and seeds develop
- The seeds are enclosed in an ovary

- After fertilisation, the ovary develops into a fruit
- There are two classes of Angiospermatophyta
    - Monocotyledon
    - Dicotyledon

Monocots	Dicots
Embryo sac has one seed leaf (cotyledon)	Embryo sac has two seed leaves (cotyledons)
Have scattered vascular bundles in the stem	Have a ring of vascular bundles in the stem
Flower parts are usually in 3's or multiples of 3	Flower parts are usually in 4's or 5's or multiples of 4 or 5
Calyx and corolla are not usually easily distinguishable	Calyx and corolla are easily distinguishable
They are usually wind pollinated	They are often insect pollinated
Have narrow leaves with parallel venation	Have broad leaves with network venation

Challenges or problems faced by plants

1. Desiccation/ dry out
2. Support in air/ on land
3. Obtaining nutrients
4. Obtaining gases for respiration
5. Movement of the reproductive gametes
6. Environmental variables such as light intensity, temperature, pH e.t.c.

Summary of adaptations of seed bearing plants to life on land

1. Leaves possess stomata for gaseous exchange
2. Leaves and stems are covered by a waxy cuticle which minimises water loss
3. They possess true roots which enable water and dissolved mineral salts to be absorbed
4. They undergo secondary growth which enable seed bearing plants to compete effectively for light and other resources
5. The fertilised ovule (seed) is retained for sometime on the parent plant (sporophyte) from which it obtains protection and food before dispersal.
6. Fertilisation is not dependent on water therefore reduces necessity for water inside the sporophyte which is well adapted for terrestrial life.

The adaptations above may also be considered as the advantages of seed bearing plants over mosses and ferns

KINGDOM ANIMALIA

General characteristics

- Their cell walls lack cell walls
- Most can move from one place to another i.e. they are motile
- They are multicellular eukaryotes
- They have a nervous common system except the sponges

Definition of terms

1. Tissue

This is a group of cells, often similar in structure and origin, operating together to perform a specific function

2. Tissue differentiation

This is the specialisation of tissue for different functions

3. An organ

This is the structural distinct part of the body which usually performs a particular function.

An organ is made up of similar types of tissue which are highly organised and have structural relationship with each other.

4. Organism

This is the interrelationship of different organ systems which together perform a specific function

5. Symmetrical body

This is the body which when cut, may produce halves which are mirror (identical) images of each other.

Bilateral symmetrical body

This is the body which can be divided into two identical halves along one plane only.

Radial symmetrical body

This is the body which can be cut along more than one plane to produce halves that are identical to each other.

6. Asymmetrical body

This is a body which cannot produce halves that are mirror images of each other if cut along any plane.

LEVELS OF ORGANISATION

Four levels of organisation are recognised;

1. Unicellular level (single cell organisation)

Protists have all the functions which are carried out by an organ system being performed by a single organelle in the cell. Such organisms include paramecium, amoeba plasmodium e.t.c.

2. Tissue level of organisation

These are primitive multicellular animals in which physiological processes are carried out mainly by isolated cells and tissues. Apart from reproductive organs, there are no structures that can be regarded as organs but most of the cells are integrated to form tissues.

Such animals represent a stage in evolution preceding the development of organs and organisms which are the characteristics of higher forms.

Tissue level is considered to be between the colonial and unicellular levels of organisation.

Tissue level of organisation includes animals such as hydra.

3. Colonial level of organisation

These organisms have different types of cells each carrying out a different function. They are therefore regarded as colonies of single cells rather than multicellular individuals e.g. sponges

4. Organ level of organisation

Plants, mammals and the majority of animals have their functions carried out mostly by organ and organs systems

Advantages and disadvantages of unicellular level of organisation

Advantages

1. Their small size enables living in a variety of habitats
2. There is less food intake
3. There is no need for the development of complex excretory organs since they take in less food.
4. No necessity for development of complex circulatory and gaseous exchange structures since simple diffusion combines with their large surface area to volume ratio
5. There's no need for development of complex support systems like cartilage, bones, xylem e.t.c.

Disadvantages

1. Predators

Advantages and disadvantages of multicellular level of organisation

Advantages

1. Worn out cells are easily replaced by cell division
2. Multicellularity allows tissue specialisation which increases efficiency in performing body functions
3. They have complex physiological mechanisms which enable the maintenance of a relative constant internal environment
4. They have a larger complex support system which increase the chances of catching prey but also reduces chances of predation
5. They have an efficient sensory system due to tissue specialisation which enables animals to escape from predators quickly.

Disadvantages

1. They require large quantities of food
2. They require specialised locomotory structures to enable motion
3. They produce a large quantity of waste products hence a necessity for development of complex excretory systems
4. They have a small surface area to volume ratio that requires development of transport systems since simple diffusion cannot supply enough nutrients to the animal

PHYLUM CNIDARIA (Cnidarians)

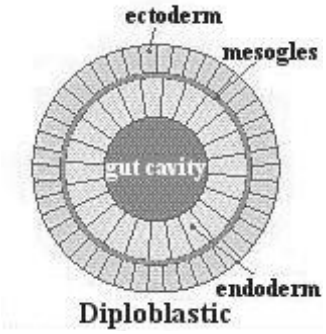
Members include Hydra, Obelia, sea anemone, Portuguese man of war and Jelly fish.

Characteristics

- They are **diploblastic animals** i.e. they have two cell layers separated by the mesogloea (a Jelly-like non-cellular layer)

The mesogloea may contain cells that have migrated from other layers.

Transverse section through the body of Cnidarians



- They have nematoblasts (stinging cells) which when touched (stimulated) release a chemical which can be used to capture prey or used to defend against predators

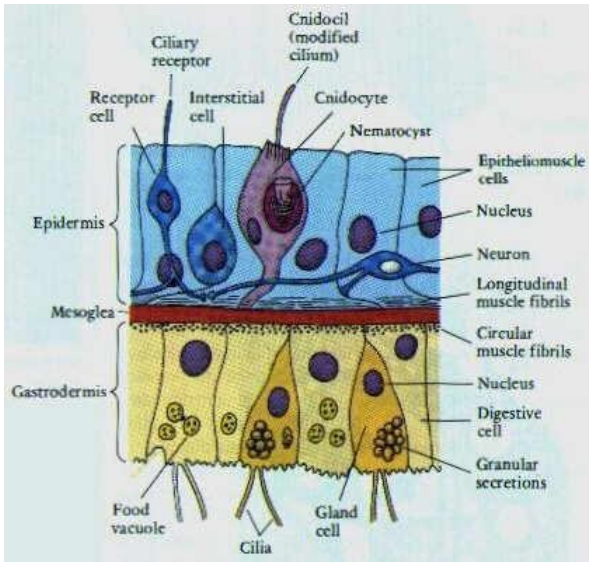
Nematoblasts occur in the ectoderm and when touched, can inject toxins into the prey/ predator which results into paralysis of the small animals.

- They are radially symmetrical i.e. the body can be divided into equal halves by more than one straight line/plane which passes through the central body
- They exhibit polymorphism i.e. individual cells have specialised shapes with different functions

Polymorphism is the existence of the cell organisms in a number of morphologically distinct forms.

- They have tentacles which bear stinging cells called nematoblasts

The structure of a body wall of hydra



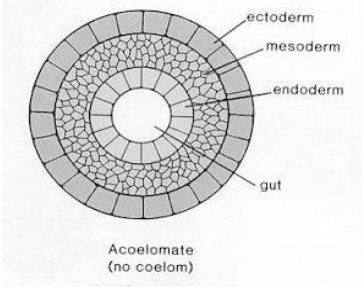
Hydra belongs to the tissue level of organisation which enables cells to act together in a relatively coordinated manner so as to carry out various functions effectively.

PHYLUM PLATYHELMINTHES

Members include tapeworm (taenia), blood fluke (Schistosoma), liver fluke (Fasciola hepatica) and planaria

Characteristics

- They are Triploblastic i.e. the body is composed of three layers, the outer ectoderm and the inner endoderm and between these two is the mesoderm



- They have bilateral symmetry i.e. The body can only give two equal and opposite halves if cut along one plane.
- They have an un-segmented body

- Their bodies are dorsal ventrally flattened
- They are hermaphrodites, often with elaborate precautions to minimise self fertilisation
- They have flame cells for excretion and osmoregulation

Significance or importance of possessing a mesoderm in the body

1. It allows triploblastic organisms to increase in size and thus results into the considerable separation of the alimentary canal from the body wall
2. Used in forming a variety of organs which may combine together and contribute towards an organ system of organisation
3. It enables the improvement of muscular activity by triploblastic organisms. It's necessary because of their increased size which renders the use of flagella or cilia inappropriate.

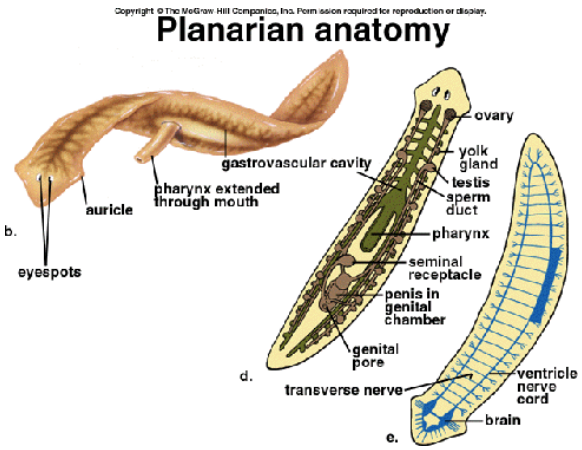
There are three classes in phylum platyhelminthes

Class Turbellaria

Members in this class include planaria which lives under stones in fresh water streams.

Characteristics

- The cuticle is absent
- The enteron is present
- They have delicate soft bodies
- They have sense organs in the adult stage
- Cephalization occurs

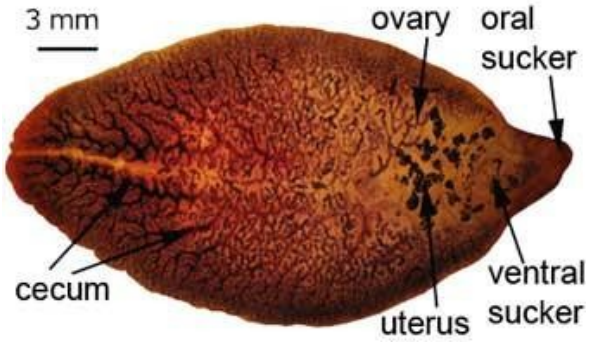


Class Trematoda (flukes)

Members include Fasciola (lever fluke) and Schistosoma (blood fluke) which causes Schistosomiasis (Bilharzia) in tropical countries.

Characteristics

- They have a leaf-like shape
- They bear suckers for attachment to the host
- They have a thick outer cuticle
- The enteron is present
- They are endoparasites (live inside the body) or ecto parasites (live on the outer surface of the host)



Class Cestoda (tapeworms)

Examples include *Taenia solium* and *Taenia*

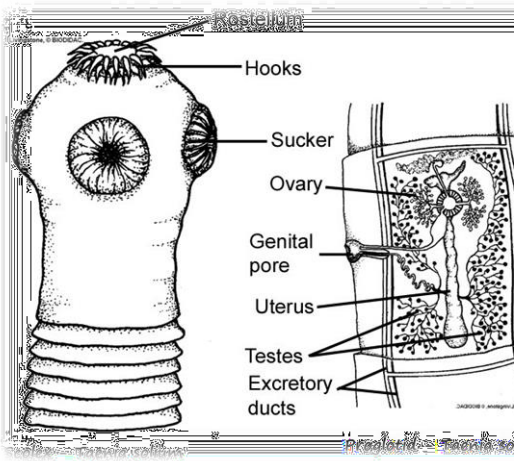
Saginata

Characteristics

- They are endoparasites.
- They have flattened elongated bodies with a distinct head called scolex which bears hooks and suckers for attachment to the host.
- The body is divided into proglotidds which are able to break off.
- They have no mouth/gut (enteron).
- They use the host digested food by absorbing it directly through the integument.
- There is a thick cuticle for protection against the host's enzyme digestion.
- They lack cilia.

ADAPTATIONS OF PLATYHELMITHES TO A PARASITIC MODE OF LIFE

1. They have a special way of gaining entry into the body of the host but locomotory structures are generally reduced or absent.
2. They have structures which anchor them onto their host. Liver flukes have suckers; tapeworms have both hooks and suckers.
3. They protect themselves against the internal environment. Flatworms produce inhibitory substances to prevent their being digested by host enzymes.
4. They have complex lifecycles. Fasciola and Taenia have a secondary host which transfers one parasite from the primary host to another.
5. They have a very high reproductive output. Adults devote much of their energy and body space to sexual reproduction.



PHYLUM NEMATODA (round worms)

Members include;

a. *Ascaris Lumbricoides*, which is an intestinal parasite
b. *Wucheriria bancroft*, which infects the human lymphatic system and causes elephantiasis
c. *Thread worms* which are endoparasites of dogs and cats plus humans, mainly children.

Characteristic features

- They are triploblastic
- They have bilateral symmetry
- They have an un-segmented cylindrical body
- Their alimentary canal is straight from the mouth to the anus.
- Their sexes are separate
- They lack cilia
- A cuticle of protein is present
- Some are free living plant and animal parasites
- They are elongated and round in cross-section with pointed ends

PHYLUM ANNELIDA (segmented worms)

General characteristics

- They are coelomate and triploblastic
- They have no Chitineous cuticle
- They possess Chitineous bristles called *chaetae*
- They exhibit *metameric segmentation* i.e. their segments are repeated and are of the same age and size
- They have bilateral symmetry

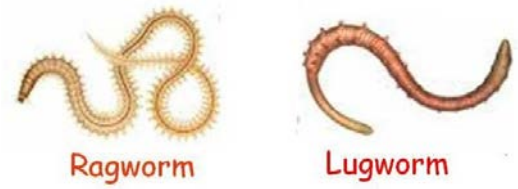
The main classes of phylum annelida include;

Class Polychaeta (marine worms)

Members include the rag worm (Nereis) and lug worm

Characteristics

- The sexes are separate
- Most are marine
- Most of them have a distinct head
- The chaetae are numerous and occur on later projections of the body called *parapodia*
- They lack the *clitellum*

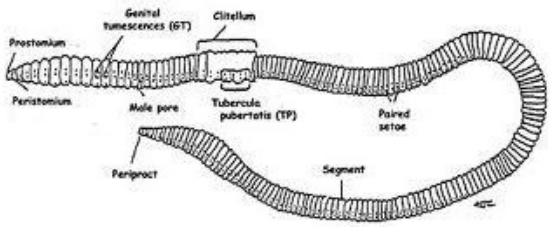


Class Oligochaetae (earthworms)

- They possess relatively few chaetae

- No larval form
- They have a less distinct head
- They lack parapodia
- They are hermaphrodites
- They live in fresh water or soil
- *Clitellum* is present. The clitellum is a saddle-like region of oligochaetae which is prominent in sexually mature animals. Contains mucus glands which secrete a sheath around copulating worms binding them together, the resultant cocoons houses the fertilised eggs during their development

Examples include Lumbricus



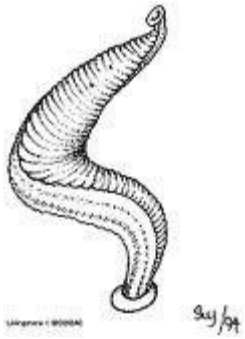
Biological importance of earthworms

1. They mix soil layers
2. They burrow tunnels which improves aeration and drainage of the soil
3. They add organic matter to soil by excretion and death
4. Secretions of the gut neutralise acidic soils
5. Dead vegetation is pulled into the soil where decay takes place

Class Hirudinea

Members include Hirudo the medicinal leech

- Free living carnivores
- No chaetae or parapodia
- No distinct head
- No clitellum
- Some are ecto-parasites with anterior and posterior suckers



THE COELOM

This is the main (secondary) body cavity of many triploblastic animals, in which the gut is suspended. The principal mode of origin is by separation of the mesoderm from the endoderm. It contains a fluid (coelomic fluid) which receives excretory wastes and/ gametes, which reach the exterior via ciliated funnels and ducts.

Biological significance of the coelom

1. It provides space in which internal organs can grow, develop and function independently of each other
2. It contains coelomic fluid which bathes the organs and can act as a hydrostatic skeleton
3. It allows the animal's internal organs to move independent of each other and move independent of the whole body e.g. the gut can perform peristalsis without causing the body wall to move into waves of contraction
4. Coelomic fluid may be used to circulate food, waste materials and respiratory gases although these functions are mainly carried out by the body vascular system.

Problems caused by the coelom

i. It separates the body wall from the gut, causing difficulty in transporting digested food and respiratory gases resulting into the development of transport system
ii. Increased size and complexity requires a more complex coordination system, therefore a more elaborate nervous system

PHYLUM MOLLUSCA

Characteristics

- These are triploblastic coelomate animals
- They have soft bodies which are covered by a calcareous shell i.e. shell containing calcium. These shells are produced by special epidermal tissue called *mantle*
- They have an un-segmented body with a head, foot with a visceral hump is a central mass of internal organs
- They have bilateral symmetry

The classes of phylum mollusca include;

Class Gatropoda

Members include slugs and Helix (the garden snail)

Characteristics

- They have a distinct head with eyes and sense tentacles
- The shell when present is single and often coiled
- They have a radula (a tongue-like organ) armed with rows of teeth, with which they feed

Class Pelycopoda

Examples include mussels, oysters and clams.

Characteristics

- No tentacles
- Head reduced
- The shells have two halves
- They are filter feeders

Class Cephalopoda

Examples include squids, octopus and cat fish.

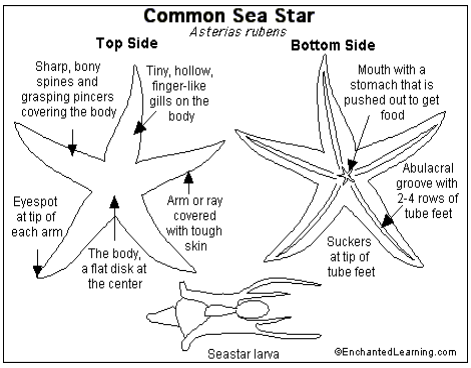
They possess a head like structure i.e. false head

PHYLUM ECHINODERMATA

Examples include starfish, sea cucumbers, sea lilies, brittle stars and sea urchins.

Characteristics

- Their skin bears spines hence the name of the phylum
- Adults show penta-radiate symmetry (5-way symmetry) but their larval forms show bilateral symmetry
- The mouth generally occurs on the lower side (oral side) while the anus occurs on the upper side (literal side)
- They lack a proper circulatory system
- They are exclusively marine inhabitants
- They have a calcareous skeleton
- They move slowly by the concerted action of numerous suctorial tube feet



PHYLUM ARTHROPODA

Arthropods contain more species than any other phyla. Insects in particular, account for more than half of all known arthropods. Insects have been successful in exploiting every type of habitat because they have undergone adaptive radiation i.e. they suited for flying, burrowing, living in aquatic areas, parasitism e.t.c.

Diagnostic features of arthropods

Possession of jointed appendages for feeding, locomotion and sensory purposes

Possession of an exoskeleton comprising of a chitineous cuticle and sometimes calcareous matter which makes it rigid and stiff at the mouth parts but flexible at the joints

Other characteristic features

- Triploblastic coelomate
- Bilateral symmetry
- Metameric segmentation

- The coelom is much reduced and the main body cavity is a haemocoel i.e. the coelom is almost completely displaced during devolvement by another cavity called the haemocoel which is filled with blood

NOTE

- Arthropods are at a high danger of blood loss from injury because they have the open blood system
- The high blood volume in arthropods enables them to maintain a high metabolic rate allowing them to be very active animals

Disadvantages associated with the presence of an exoskeleton

1. It's weight to strength ratio decreases with the size of the animal making it less efficient as the animals becomes larger
2. It resists growth and therefore periodical moulting (ecdysis) is required if the animal is to grow
3. During moulting, the body of the arthropod is soft and very vulnerable to attack by predators and pathogens

The groups of arthropods include;

Class Crustacea/ crustaceans

Members in this phylum include; Lobsters, Barnacles, Water fleas, Daphnia, and Astacus

Barnacles are sessile and remain attached to rocks by the head. Wood lice are the only terrestrial crustacean.

Characteristics

- Two pairs of antennae
- A pair of compound eyes
- Gaseous exchange occurs by gills
- Three pairs of mouth parts (jaws)
- They are mainly aquatic
- Head and thorax are not distinctively separate i.e. they possess a cephalothorax

Class Chilopoda

This class has Lithobius, (the centipede)

- Terrestrial and mainly carnivorous
- Have a clearly defined head, but all other body parts are similar
- They possess one pair of antennae
- They possess one pair of mouth parts (jaws)
- Eyes, either simple or compound, are absent
- Numerous identical legs i.e. one pair per segment
- No larval form
- Gaseous exchange occurs by the trachea

Class Diplopoda

The only member of this class is the millipede.

Characteristics

- Mainly terrestrial
- Mainly herbivorous
- The head is distinct but all other body segments are similar
- One pair of mouth parts
- One pair of antennae
- Eyes, either simple or compound, are absent
- Numerous identical legs with two pairs per segment
- They lack a larval form
- Gaseous exchange is by the trachea

Class Arachnida

Members include mites, ticks, scorpions, spiders (Epeira, the web spinning spiders) e.t.c.

Characteristics

- Mainly terrestrial
- Mainly carnivorous
- Two major body divisions present i.e. a cephalothorax and abdomen
- No antennae
- No true mouth parts but a pair of appendages are used for capturing prey and the second pair is used as sensory palps.
- Simple eyes present but no compound eyes
- Four pairs of walking legs
- No larval form

- Gaseous exchange is by lungs or gill books or trachea

Class Insecta

Diagnostic features

a. Three main body divisions i.e. head, thorax and abdomen
b. Three pairs of legs on the thorax, one pair per segment
c. Three thoracic segments i.e. prothorax, mesothorax and metathorax.

Other characteristic features

- Mainly terrestrial
- No gills in adults
- They have simple eyes
- Usually three pairs of mouth parts
- Gaseous exchange occurs by trachea
- Lifecycles commonly involves metamorphosis

Subclass Apterygota, these are wingless insects and they include Lepisma (silverfish) a common inhabitant of bathrooms and kitchens

Subclass Pterygota, these are winged insects which are further divided into two;

a. Exopterygota

This is whereby the wings develop externally.
They undergo incomplete metarmorphosis i.e. Hemimetabolus
Examples include;

- Locusta (the long horned grass hopper)
- Periplaneta (cockroach)
- Dragon flies

b. Endopterygota

The wings develop internally.
They undergo complete metamorphosis i.e. holometabolus

Egg → larva → pupa → adult

The larval stage is specialised for eating and growing. They are known by such names as caterpillars and grab
The adult is specialised for dispersal and reproduction

Examples include;

- Pieris (butterfly)
- Apis (honey bee)
- Musca (housefly)

Some orders of class insecta

Order Orthoptera

Examples include crickets, grasshoppers and walking sticks.

Characteristics

- Chewing mouth parts
- Straight wings
- Complete metamorphosis
- Two pairs of wings with the front wings being narrow and leathery. The hind wings are broad, membranous and folded when at rest

Order Dictyoptera

Examples include cockroaches and mantids and their characteristics include;

- They are dorso ventrally flattened
- They undergo incomplete metamorphosis
- Two pairs of wings with the front wings being narrow and leathery. The hind wings are broad, membranous and folded when at rest.

Order Isoptera

Members include termites and their characteristics include;

- Chewing mouth parts
- Workers and soldiers are wingless
- They undergo incomplete metamorphosis
- Reproductive termites possess two pairs of similar membranous wings which are held out flat when at rest and the wings are shed off after the mating

Order Hemiptera

It includes all the bugs, and their characteristics include;

- Piercing and sucking mouthparts
- Two pairs of membranous wings

Order Homoptera

It includes aphids and cicadas. Their characteristics include the following;

- They have piercing and sucking mouth parts
- Incomplete or complete metarmorphosis
- Some species can reproduce without mating
- Some are wingless, others possess one or two pairs of membranous wings

Order Hymenoptera

Members include ants, wasps, bees and sawflies. Their characteristics include;

- Chewing and lapping mouth parts
- Worker ants and few others are wingless
- Two pairs of small stiff and membranous wings that interlock during flight
- The front wings are larger than the hind wings
- They undergo complete metamorphosis

Order Lepidoptera

Members include butterflies and moth.

- Long antennae
- Complete metamorphosis
- Sucking mouth parts shaped like a coiled tube when at rest
- The front wings are usually larger than the hind wings
- Possess to pairs of usually broad wings which possess scales

Order Diptera

Members include houseflies, mosquitoes and midges. Their adult characteristics include;

- Two large compound eyes
- Piercing mouth parts
- Complete metarmorphosis
- The two front wings are transparent and the two hind wings are reduced to halteres which serve as balancing organs during flight

Order Siphnoptera

This order includes the fleas and their characteristics include;

- They are wingless
- They lack eyes
- They exhibit incomplete metarmorphosis
- They possess piercing mouthparts

Order Odonata

Members include dragon flies and damsel flies. Their adult characteristics include;

- Chewing mouthparts
- Two pairs of equal sized transparent membranous wings that cannot be folded.
- They have huge eyes
- They possess very small antennae
- Legs cannot walk but are used to capture prey in air
- They mate in flight
- They exhibit incomplete metarmorphosis

PHYLUM CHORDATA

During their lifetime, all chordates possess the following structures;

1. **Notochord**

This is a rigid but flexible dorsal rod which consists of vacuolated cells surrounded by a tough outer coat. In primitive chordates, a notochord prevents shortening of the body so that most of the force of muscle contractions is transmitted into bending movements, which are useful for swimming.

2. **Hollow dorsal nerve cord (central nervous system)**

This is formed by invaginations from the outer wall layer (ectoderm) of the embryo and develops as a group of cells which is later closed off at the top.

3. **Pharyngeal gill slits (visceral clefts)**

These are perforations on either side of the pharynx which occurs in all chordate embryos.

In vertebrates, the number of slits is greatly reduced and may be modified for different purposes. For example, in fish and larval amphibians, their walls are lined with feathery gills which are used for gaseous exchange. In fish and larval amphibians, their walls are lined with feathery gills which are used for gaseous exchange. In reptiles, birds and mammals, the only opening which remains is the Eustachian tube in the ear. In primitive chordates, visceral clefts are retained for straining food particles from water.

Other features possessed by my most but not all chordates include;

4. **Post anal tail** i.e. a post anal extension of the body or a true tail
5. **Segmented muscle blocks** (myotomes) which are considered as a secondary adaptation for swimming.
6. **Closed circulatory system** in which blood flows forward ventrally and backwards dorsally

Phylum Chordata is divided into two main groups

a. Acraniata

These are chordates without a skull and the notochord remains i.e. it is not replaced by a vertebral column.
Acraniates are sub-divided into two;

Tunicata (urochordata)

Members of this subphylum include the sea squid and its characteristics include;

- The notochord is present
- The adult tunicates are sessile filter feeders which are enclosed in a tunic.

Cephalochordata

Members of this phylum include amphioxus and its characteristics include;

- The larvae are free swimming
- The adults possess a pharynx which is modified for filter feeding
- The notochord persists

b. Craniata (vertebrata)

These are chordates with a cranium (skull) enclosing the brain. The notochord is replaced by a vertebral column made of cartilage/bone.
They have two pairs of limbs/fins.
They have a well-developed central nervous system
Vertebrates are subdivided into the following taxa.

Subphylum Agnatha i.e. craniates without jaws or jawless fishes

Class cyclostomata

Members include Hampreys and Hag fish. Their characteristics include;

- No paired fins
- Semi ectoparasites i.e. they attach onto the body of fish, sucking on the fish's blood.
- They have numerous gills
- They have round suctorial mouthparts and a rasping tongue
- They have a well-developed notochord in adults.

Subphylum Gnathosotomata i.e. craniates with jaws. It includes all the following classes.

Class chondrichtyes

Examples of members of this phylum include dog fish, skates, rays and sharks. Their characteristics include;

- The skin bears placid scales (tooth-like scales)
- The skin contains dermal dentricles i.e. tooth-like structures with a central pulp cavity surrounded by an outer covering of enamel
- Pectoral and pelvic fins are paired
- Visceral clefts are present as separate gill openings (5 pairs)
- The anus is ventrally positioned
- They are poikilothermic
- They are marine dwellers.
- The tail is heterocercal i.e. the dorsal lobe of the tail fin is usually larger than the ventral lobe and this enables balancing since a swim bladder is lacking
- They have a cartilaginous skeleton

Class osteichthyes

Members include tilapia, perch and the herring.
Their characteristics include;

- Bony endo skeleton
- Mouth is terminal
- Visceral clefts present i.e. separate gill openings (4 pairs) but covered by a bony flap called operculum
- The skin bears a cycloid and others ctenoid scales
- Fertilisation is external
- The tail is hormocercal
- They are poikilothermic
- The swim bladder is present
- Some are marine while others are fresh water dwellers

Class crossopterygota

It includes the lung fish.

- They have paired fins
- They are mostly predators
- They live mostly in fresh water

Class amphibia

Members include Bufo (toad), Rana (frog), newts and salamanders. Their characteristics include;

- Partly aquatic and partly terrestrial
- Have simple sac-like lungs
- Have a soft moist skin used as a supplementary gaseous exchange surface
- They have two pairs of pentadactyl limbs
- Breeding occurs in water i.e. fertilisation is external
- They are poikilothermic
- Visceral clefts (gills) are present in aquatic larvae and gills are present in adults
- Newts and salamanders possess tails in adults and in the larva stage but frogs and toads possess the tail in the larva form only.

Class reptilia

Members of this class include alligators, crocodiles, snakes and reptiles.

- They exhibit internal fertilisation
- They have a bony endo skeleton
- They have a dry scaly skin with horny scales
- They are poikilothermic
- They have soft shelled eggs
- They are mostly terrestrial
- Gaseous exchange occurs by lungs
- They lay a cleidoic (shelled egg)

Class aves

This class includes all birds and their characteristics include;

- The skin bears feathers
- Their legs bear scales
- Fore limbs modified into wings
- They exhibit internal fertilisation
- They lay well developed cleidoic eggs
- They are homeothermic
- They possess lungs for gaseous exchange

Class mammalia

The characteristics for the members of this class include;

- Having mammary glands
- Possession of a pinna (external ear)
- They are endothermic or homeothermic
- Fertilisation is internal
- The skin bears fur with two types of glands i.e. the sebaceous glands and the mammary glands
- They are mostly viviparous i.e. they give birth to active young ones rather than laying eggs

Subclass prototheria

It includes all egg laying mammals e.g. the spiny anteater and the duck billed platypus. They lay large yoked eggs but like other mammals, their young ones suckle.

Subclass theria

These are non-egg laying mammals which are divided into groups;

a. **Meta-theria/marsupial mammals**
   These are mammals which have porches in which the young ones are located and suckle for most of their development, having been born in a very immature state e.g. kangaroo

b. Eutheria/placental mammals
These are mammals whose young ones develop to mature ones while in the womb or placenta before they are born. Examples include humans

Some orders of class mammalia include;

1. Order insectivora which includes moles and shrews
2. Order carnivora which includes cats and dogs.
3. Order cetacea which includes dolphins and whales
4. Order chiroptera which includes bats
5. Order rodentia which includes rats
6. Order primate which includes chimpanzee, humans, monkeys, apes and lemurs.
7. Order proboscidea which includes the elephant
8. Order ungulate which includes cattle, sheep, horses and goats.

Problems faced by animals living on land

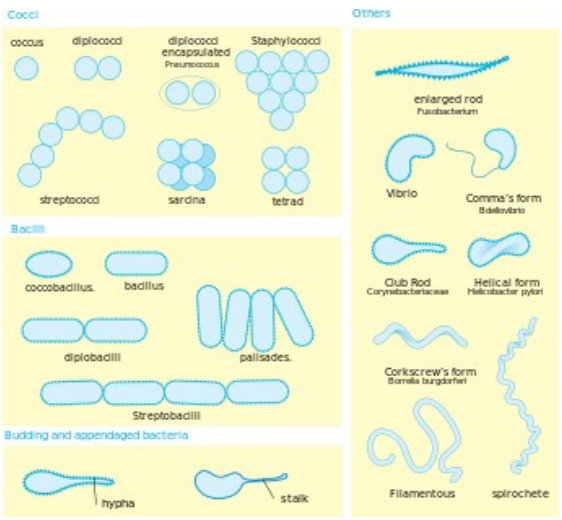
i. Obtaining support
ii. Water loss
iii. Gaseous exchange
iv. Homeostasis
v. How to reproduce without water

Adaptations of animals to live on land

1. Oxygen being less soluble and more plentiful in air than in water has led to the animals developing moist gaseous exchange surface coupled with breathing mechanisms e.g. lungs in invertebrates
2. To avoid desiccation, various animals have developed different mechanisms e.g. amphibians are restricted to damp habitats. Reptiles, birds, mammals and insects have a water tight surface layer which enables them to inhabit dry areas. Reptiles and birds produce a semi-solid nitrogenous waste containing uric acid which requires less water.
3. Internal fertilisation and production of shelled eggs in reptiles and internal development in mammals enables them to conserve water and become fully terrestrial. Amphibians have failed to overcome the problem of reproducing on land as they keep reverting to water for egg laying to prevent them from drying.
4. Air provides very little supply to terrestrial animals because of its low density as compared with water which has a high density. These animals have developed skeletons for support in air and muscular mechanisms for locomotion.

Amphibians, reptiles, birds and mammals have strong muscles and they are tetrapods (four limbed animals) with limbs built on the pentadactyl. This enables the body to be lifted off the ground and propel the animal forward.

5. A variation in environmental conditions, most especially temperature has been overcome completely only by birds and mammals by evolving homeothermy i.e. they generate heat within their tissues physiologically and maintain a constant body temperature independent or external conditions. This provides optimum conditions for enzyme reaction and proper brain development. All other remaining terrestrial animals are poikilothermic and regulate their body temperature by bathing in the sun e.g. reptiles



The Five Kingdoms