SHAABAN ROBERT SECONDARY SCHOOL.

BIOLOGY FORM IV NOTES

GROWTH

Meaning of Growth:

Growth is a permanent increase in size and dry mass/weight of an organism.

The growth process is not a steady one; sometimes growth occurs rapidly, at other times slowly. Individual patterns of growth vary widely because of differences in heredity and environment.

Growth can be either ***negative*** or ***positive***

Positive growth occurs when the rate of cell increase is higher than the rate of cell loss.

Negative growth occurs when the rate of cell increase is lower than the rate of cell loss.

Note:

Growth in multicellular organisms occur as a result of:

- ✓ ***Assimilation***. The absorption of nutrients followed by utilization to form new protoplasm.
- ✓ ***Cell division***. That is, formation of new cells from the pre-existing cells. This results in an increase in number of cells.
- ✓ ***Cell expansion***. The cell increases in size when it absorbs water by osmosis especially in plants where cells take in water into their vacuoles and expand.
- ✓ ***Cell differentiation***. This is when various cells are specialized for performing different functions
- ✓ ***Cell elongation***. That is, permanent increase in size of a cell due to increase in protoplasm.

What is the difference between growth and development in living organisms?

Development is a change in structure and complexity of an organism.

It involves cell differentiation and formation of various tissues and organs that perform specific functions.

Growth is ***quantitative***, that is, it can be measured by weight, volume and mass *while development* is ***qualitative***, that is, it cannot be measured.

The two processes (growth and development) occur together. That is, growth is accompanied by development.

Importance of Growth

I. Helps to repair the old or damaged cells of the body.
II. It helps to adapt the organism to its environment due to cell differentiation.
III. It leads to maturation of reproductive organs which affects perpetuation of the species.
IV. Enable increase in size and weight of the body of an organism.
V. It gives rise to a more complex and elaborate multicellular organism.

VI. It gives rise to various cells specialized for various functions. E.g., red blood cells, white blood cells, palisade cells, guard cells, xylem, phloem, etc.

Types of Growth

There are several types of growth which includes:

i. Diffuse growth
ii. Localized growth
iii. Allometric growth
iv. Isometric growth
v. Intermittent growth
vi. Determinate growth
vii. Indeterminate growth

- ✓ ***Diffuse growth*** is a type of growth whereby growth occurs in *all parts of the body* of an organism. E.g., in animals
- ✓ ***Localized growth*** is a type of growth in which growth takes place in specific regions of an organism. E.g., primary growth takes place at the root tips and shoot tips only.
- ✓ ***Allometric growth*** is a type of growth whereby *different parts of the body of an organism grow at different rates and stop growing at different time*. E.g., in human, brain grow faster initially than other organs then stops while the rest of the body continue to grow. In plants, flowers grow faster than the vegetative parts.
- ✓ ***Isometric growth*** is the type of growth whereby all body organs grow at the same rate. E.g., in fish, locust, etc.
- ✓ ***Intermittent growth*** is the type of growth in arthropods in which growth takes place in a series of stages called instars. E.g., in grasshoppers, housefly, cockroach, etc.
- ✓ ***Determinate growth*** is the type of growth in which an organism stops growing when a certain body size or age is attained. E.g., in mammals, birds and annual plants.
- ✓ ***Indeterminate growth*** is the type of growth in which an organism does not stop growing. E.g., perennial plants, shrubs, fish and reptiles

Measurement of Growth

Growth can be measured by:

i. Total fresh weight
ii. Volume
iii. Length
iv. Number
v. Dry weight/mass

- ✓ ***Total Fresh Weight:*** this method involves weighing the whole organism at regular intervals. The method does not involve injury to the organisms. But this method is influenced by the changes in water content of the body.

- ✓ ***Volume:*** this involves placing the organism in a water-filled container and determine the water displacement using an overflow can. The water displaced is measured using measuring cylinder.
- ✓ ***Length:*** this involves measuring the length of the organism. E.g., in plants. Its advantage is that it does not injure the plant. However, it ignores growth in other directions such as width and internal growth.
- ✓ ***Number:*** this method is used to measure growth in unicellular organisms such as bacteria, algae and protozoans. It involves collecting and counting the number of organisms in samples at fixed volume periodically. The total population can be estimated by the formula:

$$N = \frac{AxB}{C}$$

Whereby:

A = *Average number of organisms per sample*

B = *Total volume of sample*

C = *Volume of sample*

N = *Total population number*

- ✓ ***Dry weight:*** this method involves killing the organism and heating it at 110^0C to remove water. This is more accurate method as it measures weight irrespective of water content.

Limitations of Estimating Growth

i. There is lack of accuracy while measuring the volume of an organism with irregular shape
ii. Growth shows irregularities as a result of fluctuation in environmental factors. E.g., nutrients.
iii. Growth is measured using dry mass. This involves killing the organism.
iv. If a single linear dimension such as height or length is used, it fails to measure other directions. E.g., internal growth and increase in width.

Factors Affecting Growth

Factors affecting growth in living organisms can be classified into two major groups.

- ✓ ***External factors***. These are factors that originate from the environment to which the organism is subjected. They are sometimes referred to as environmental factors. These include nutrients, temperature, pH, diseases, sunlight, water, oxygen and carbon dioxide availability, population density, etc.
- ✓ ***Internal factors***. These are factors that originate from within the organism itself. They include hormones, heredity, enzymes, etc.

External Factors Affecting Growth in Living Organisms

i. ***Nutrients***. Lack of enough nutrients lead to poor growth as nutrients are important in growth. That is,

- ✓ *proteins* help in manufacturing of new cells and replacing the dead ones;
- ✓ *carbohydrates* provide energy required for growth and provide heat for activities of the enzymes;
- ✓ *vitamins* help the body to fight against diseases hence promoting growth;
- ✓ *Mineral salts* are important for general metabolic activities of the body.

ii. ***Temperature***. This is very important for enzyme-controlled activities. For example, during seed germination process, optimum temperature is required. Many enzymes are effective within the range of $36^0 - 37^0 C$. If the temperature is very low, the enzymes become in active and if the temperature is too high, the enzymes are denatured, hence the rate of growth decreases.

iii. ***pH***. This is the degree of alkalinity or acidity of the environment. For example, some bacteria grows and multiply (reproduce) in acidic medium while others would only do this in alkaline medium; the acid-base reaction of soil is important for soil fertility. Some plants grow well under soil which is acidic and others in alkaline soil.

iv. ***Diseases***. Diseases destroy physiological processes taking place in the body of a living organism hence, hindering growth.

v. ***Sunlight energy***. Green plants and all photosynthetic organisms their own food by the process of photosynthesis in the presence of sunlight. In the absence of light these organisms cannot manufacture their own food and hence there will be no growth. The effect of light on growth can be studied under three headings: **light intensity**, **light quality** and **duration of light**. Growth is generally favored by darkness, but light is necessary because of its role in the manufacture of food. Young plants growing in the absence of light develop elongated thin stems with narrow leaves and poorly developed shoot system. Such plants are said to be **etiolated**. In weak intensity of light, the internodes are short and the leaves are expanded. In strong intensity of light, the plant assumes a normal height. Very low light intensity reduces the rate of overall growth of the plant, by lowering the rate of photosynthesis. Growth in full spectrum of visible light is found to be better than the growth in any one of the different colors of light

vi. ***Water***. Water is necessary for enzymes and for the body metabolism. In plants, for example, it helps in photosynthesis hence growth.

vii. ***Oxygen and carbon dioxide concentration***. Oxygen is required by living things for aerobic respiration to provide energy necessary for growth. Hence lack of oxygen gas will affect proper growth. Carbon dioxide is needed by plants for photosynthesis for them to grow. If carbon dioxide availability is very low, the rate of photosynthesis will be low and hence the rate of growth in plants will also be very low.

viii. ***Population size***. When there is high population size, there is competition for mating sites, shelter and few available nutrients as compared to the situation where there is low population density. Hence high population will lead to low rate of growth while low population will lead to high rate of growth.

Note:

1. The above factors apply for both plants and animals. In addition to the above factors, growth human beings can further be affected by:
   - ✓ ***Cultural factors:*** The physical growth of human beings is definitely affected by cultural factors. Culture differs from ethnic group to ethnic group. The body growth differences

correlate with varied cultural groups. The physical growth of the body follows some adaptations in different geographical areas of distribution of the groups.

- ✓ ***Socioeconomic factors:*** Socioeconomic influence on human growth is also a well-known factor. Children from different socioeconomic levels differ in average body size at all ages. It is clear that growth of the children and adults in those families with good financial status is always good compared to the case in poor families. However, growth differences are more closely related to the home conditions than to the strictly economic status of the families. Size of family exerts an indirect influence on the rate of growth. In a large family with limited income the children do not get proper nutrition.

2. In addition to the factors above, plants can also be affected by:
   - ✓ ***Pollutants:*** Pollutants can hamper plant growth. Many pollutants composed of poisonous gasses (such as carbon monoxide, Sulphur dioxide, hydrogen fluoride, hydrogen sulphide) are capable of restraining growth, even bringing plants to death. Pollutants from household or industrial wastes are also able to restrain plant growth
   - ✓ ***Biotic factors:*** Diseases, plant pests, weeds and harmful substances released by roots (allelopathy) affect plant growth drastically. Weeds compete with plants for moisture, nutrients, and light. Root knot nematodes reduce absorption, so more fertilizer is necessary. All of these have negative impacts on plant growth and development.
   - ✓ ***Soil condition***: The characteristics of soil play a big part in the plant's ability to extract water and nutrients. If plants are to grow to their potential, the soil must provide a satisfactory environment for plant growth. Plant growth is influenced by the soil properties such as texture or structure, salinity, acidity, waterlogging, or compaction
   - ✓ ***Relative humidity:*** Relative humidity (RH) is the amount of water vapor in the air, expressed as the proportion (in percent) of the maximum amount of water vapor it can hold at certain temperature. The relative humidity affects the opening and closing of the stomata which regulates loss of water from the plant through transpiration as well as photosynthesis. Transpiration is slower in humid conditions. This is because diffusion of water vapor out of the leaf slows down if the leaf is already surrounded by moist air.

Internal Factors Affecting Growth in Living Organisms

i. ***Hormones***. There are hormones which are directly related to growth in living organisms. In plants, for example, auxins secreted at the apex of shoots and roots promote growth by elongation of plants. Auxins also affect tropisms in plants. *(For more details of effects of hormones in plants refer to table 1 below)*. In animals, growth hormone affects growth. Change in concentration of growth hormone affects growth. If there is over secretion of growth hormone, ***gigantism*** results. If there is under secretion of growth hormone ***dwarfism*** will result. *(For more details of the effect of hormones in animals refer to table 2 below)*.

ii. ***Heredity***. The genetic make-up of an organism also affects growth. E.g. Some plants have genes for tallness while others have genes for shortness.

iii. ***Enzymes***. These are important in metabolic processes necessary for growth. E.g., respiration which is the source of energy required for growth. Destruction of enzymatic activities will therefore affect the rate of growth.

Note: Effects of Different Hormones in plant and animal growth

Table 1: effects of different hormones in plant growth

Plant hormone	Effect
Indole acetic acid (IAA)—the main auxin. Other three auxins seem to have rather marginal importance for plants in natural environments.	• Promotes cell division • Promotes cell enlargement • Promotes response of shots and roots to stimuli such as light, water and gravity • Promote growth of adventitious roots • Induces parthenocarpy (formation of fruits without fertilization) • Causes formation of the abscission layer at the base of the leaf stalk, leading to falling of leaves (abscission). • Inhibits development of lateral buds, thus promoting apical dominance • Causes formation of callus tissue. Callus tissue forms at the site of an injury to bring about healing in the plant. • Controls division in the vascular cambium and xylem differentiation. • Used as the rooting hormones in stem cuttings. • 2-4 D is used as an herbicide to kill broadleaf, dicotyledonous weeds. • Promotes flowering in pineapples.
Gibberellins	• Promote cell division and elongation of internodes in dwarf plants. • Induce parthenocarpy by initiating formation of Indoleacetic acid (IAA) • Promote lateral bud development • Inhibit development of adventitious roots • Inhibit formation of the abscission layer on the leaf petiole • Promote germination of seeds • It helps in inducing seed germination by breaking seed dormancy and initiating the synthesis of hydrolases enzymes for digesting reserve food.
Cytokinin	• Stimulate cell division • Stimulate formation of callus tissue

	• Promote flowering • Break seed dormancy • Promote formation of adventitious roots • Promote development of lateral buds by inhibiting apical dominance. • Low concentration of Cytokinin induces cell elongation and causes ageing of leaves • Help in the production of new leaves, chloroplasts, and adventitious shoots. • Help in delaying senescence by promoting nutrient mobilization.
Ethylene (ethane)	• Promotes ripening of fruits • Causes formation of callus tissue, leading to falling of fruit and leaves • Stimulates thickening of the stem while inhibiting stem elongation • Helps in breaking seed and bud dormancy. • Promotes root-growth and formation of root hairs.
Abscisic acid (ABA)	• induces seed dormancy by inhibiting seed germination, growth of stems, and sprouting of buds • Causes fruits and leaves to fall (abscission) • Promotes flowering • Stimulate apical dominance by suppressing development of lateral buds • Stimulates stomatal closure during water stress
Indole butyric acid	Synthetic plant hormone that promotes elongation of stems and roots

Table 2: effects of different hormones in animal growth

Hormone	Effect
Somatotrophin	The most important hormone controlling growth from birth up to adolescence is growth hormone or somatotrophin. This is a polypeptide secreted by the pituitary. It helps in growth of bones and thereby increases the height of persons. It also causes an overall growth rate of most of tissues including brain.
Thyroid hormone	This hormone plays a vital role throughout the whole period of growth. The activity of the thyroid decreases gradually from birth to

	adolescence. In low secretion of the hormone, skeletal maturity, dental maturity and growth of the brain are all affected. During adolescence a new phase of growth occurs under the control of steroid hormones secreted by the adrenals and gonads. The gonads of both sexes secrete estrogens in small quantities from the time of birth onwards. At puberty the estrogen level rise sharply in girls and to a much more limited extent in boys; the sex differences is possibly due to an inhibitory hormone secreted by the seminiferous tubules of the testicle.
Testosterone	Testosterone, produced by the testicle, is important in stimulating growth and it is responsible for the greater growth of muscles.
Gonadotropins	Gonadotropins are responsible for the growth of the ovaries and testis, and later on, the secretion of estrogens and testosterone responsible for the growth and development of secondary sex characters.

Mitosis and Growth

Mitosis is a type of cell division in which a cell divides into two daughter cells each with the same number of chromosomes as the parent cell.

During growth, there is increase in the number of cells which is brought about by the process of mitosis that occurs in the somatic (body) cells and not in gamete (sex) cells.

Stages of Mitosis

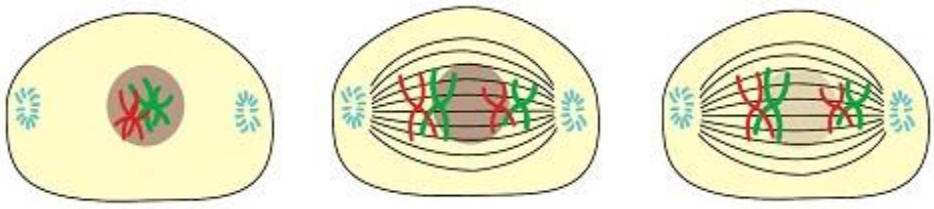
There are four stages of mitosis which are:

i. Prophase
ii. Metaphase
iii. Anaphase
iv. Telophase

Prophase

Events which occur in prophase are:

- ✓ Centriole replicate and each pair move to the opposite poles
- ✓ Spindle fibers are formed
- ✓ Nuclear membrane and nucleolus start to disappear (disintegrate)
- ✓ Chromosomes shorten and thicken
- ✓ Chromosomes split longitudinally except at the centromere to form chromatids

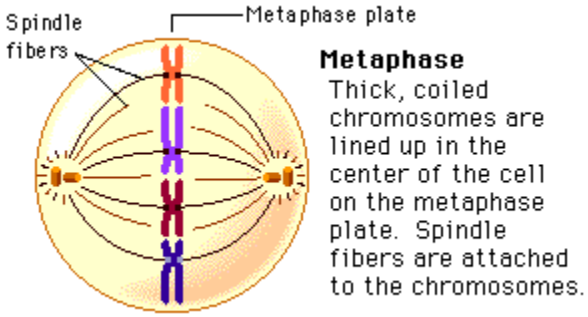


Early Prophase Mid Prophase Late Prophase

Metaphase

Events during metaphase occur as follows:

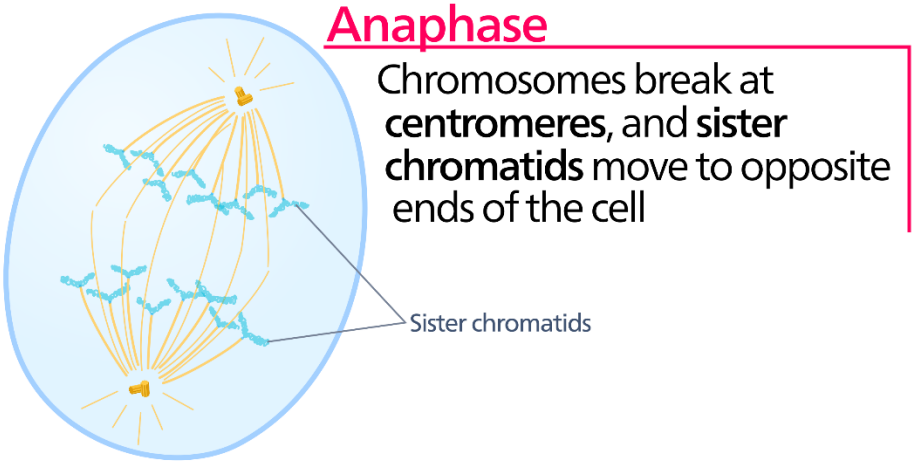
- ✓ Formation of spindle fibers is complete
- ✓ Chromatids move to the equator of the spindle
- ✓ The centromere of each chromatid become attached to a spindle fiber



Anaphase

Events of anaphase stage are as follows:

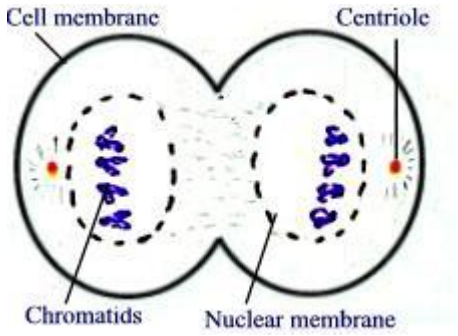
- ✓ The centromere splits and the sister chromatids separate from each other. Each one of them now being referred to as ***chromosome.***
- ✓ Chromosomes begin to move towards the opposite poles of the cell by contraction of spindle fibers which join centromere to the centrioles



Telophase

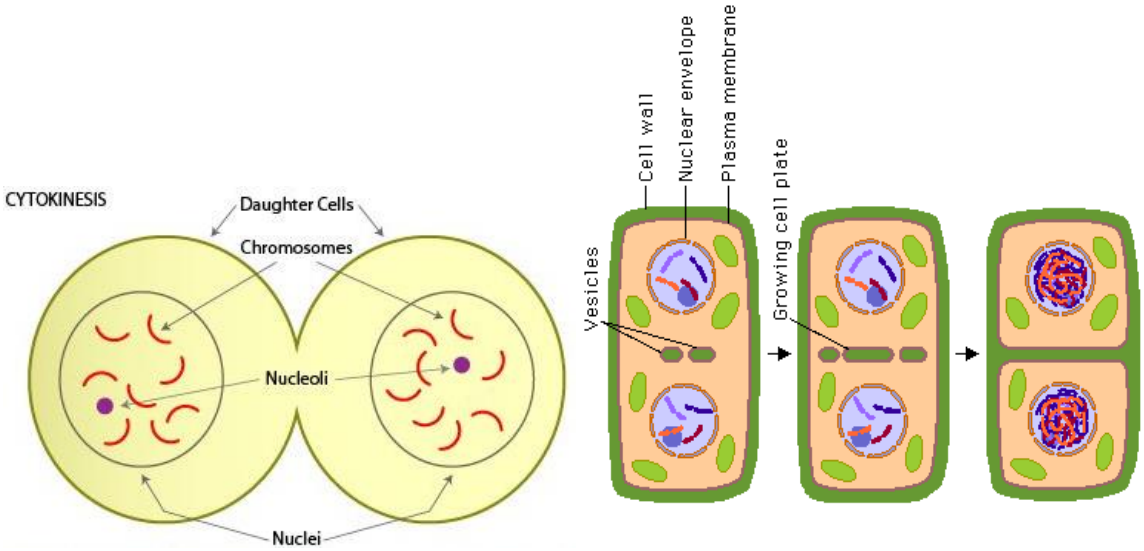
Events during Telophase are:

- ✓ Chromosomes lengthen and become distinct
- ✓ The spindle fiber disappears
- ✓ Nuclear membrane forms around each set of chromosomes
- ✓ The cell constricts across the middle and divides into two.
- ✓ The two daughter cells formed each has diploid number of chromosomes



Telophase is immediately followed by ***cytokinesis.*** This is the division of cytoplasm whereby the cytoplasm pinches at the middle of the cell until two distinct daughter cells are formed.

In plant cells, a delicate membrane called ***cell plate*** start to form at the middle of the cell. Finally, a new cell wall forms on the either side of the plant.



Significance of Mitosis

- ✓ It ensures genetic continuity as it maintains the same number and type of chromosomes in daughter cells as in the parent cell.
- ✓ It leads to increase in population growth in unicellular organisms
- ✓ It helps to replace worn out and damaged cells.
- ✓ It enables growth in multicellular organisms when followed by cell enlargement.
- ✓ It is the basis of asexual reproduction.

Similarities between Mitosis and Meiosis

- ✓ Both involves the process of nucleus/cell division
- ✓ Both involves chromosomes
- ✓ Similar changes occur in prophase, metaphase, anaphase and Telophase
- ✓ In both cases, DNA replication takes place
- ✓ Both occurs in living cells

Differences between Mitosis and Meiosis

Mitosis	Meiosis
✓ Occurs in somatic cells	✓ Occurs in sex cells
✓ The number of chromosomes is retained constant in daughter cells as in parent cells	✓ The number of chromosomes in daughter cells is half the number of chromosomes in mother cells
✓ No crossing over	✓ There is crossing over
✓ No variations because daughter cells are the same genetically as parent cells	✓ There are variations because daughter cells are not the same genetically as parent cells
✓ Take place in one phase to complete division	✓ Take place in two phases to complete division. That is, meiosis I and II
✓ Two daughter cells are formed	✓ Four daughter cells are formed
✓ New cells do not fuse to form zygote	✓ New cells produced fuse to form zygote

Growth and Development in Flowering Plants

In most flowering plants, growth starts when the seed begins to germinate.

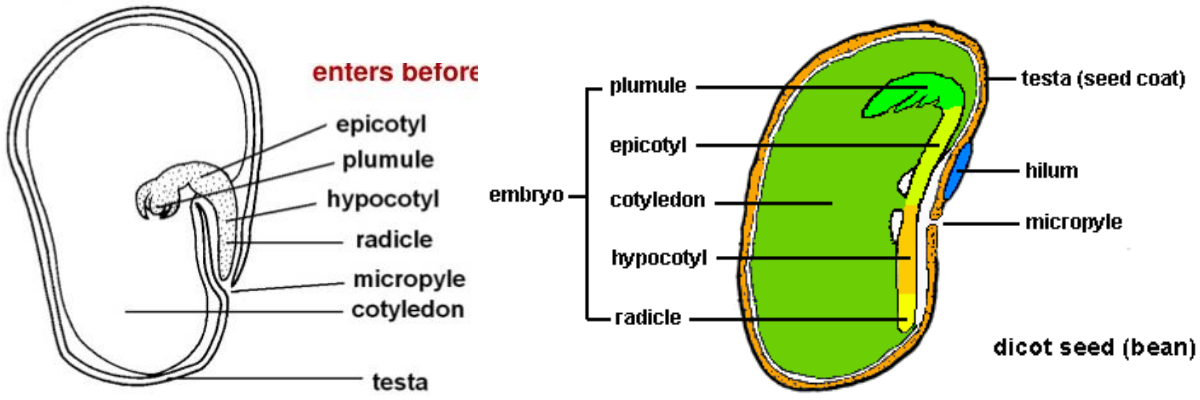
Germination is the process by which a seed develops into a seedling. *Seedling* is a young plant.

Structure of a Seed

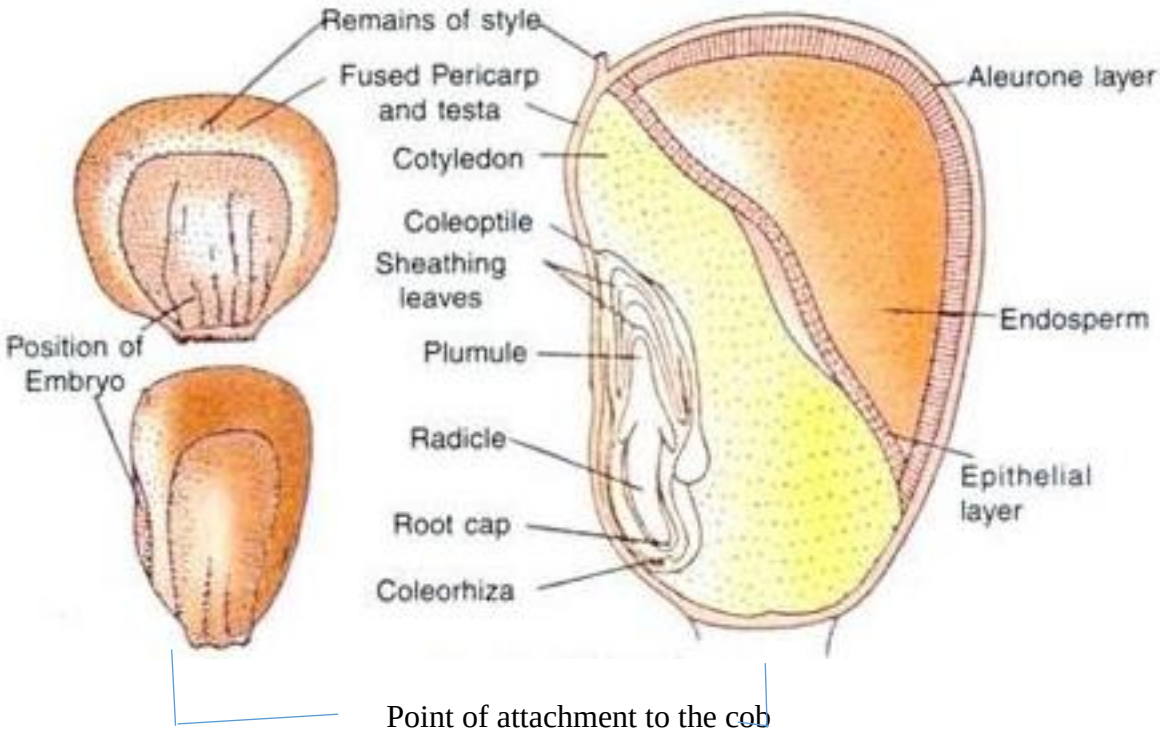
Seed develops from the ovules. The ovules are surrounded by the ovary which later develop into a fruit after fertilization.

After pollination, a *zygote* is formed. The embryo differentiates into an embryonic shoot called ***plumule*** and embryonic root called ***radicle***. The embryo also differentiates into seed-leaves known as ***cotyledons***.

The plumule is connected to the cotyledon, a tissue that stores food needed during germination.



Longitudinal Section of a Dicot Seed



External and Internal Structure of a Monocot Seed (maize grain)

- ✓ ***Testa*** is thick protective outer covering of a seed which protects the seed from drying up and attack by microbes. It is also known as the seed coat.
- ✓ ***Micropyle*** is a tiny hole in the Testa opposite to the tip of the radicle. It allows water to get into the embryo before germination.
- ✓ ***Radicle*** is the embryonic part which grows and develop into the root system of the plant.
- ✓ ***Plumule*** is the leaf part of embryo which develop into shoot.
- ✓ ***Hilum*** is a scar left by the stalk which attaches ovule to the ovary wall.
- ✓ ***Cotyledon*** is a seed-leaf which contain food reserves used during the early stages of seed germination. Food stored is mostly starch and protein.
- ✓ ***Epicotyl*** is the region of an embryo or seedling stem just above the cotyledon or just below the plumule
- ✓ ***Hypocotyl*** is the part of the stem of an embryo plant beneath the stalks of the cotyledons and just above the root or radicle.
- ✓ ***Coleoptile*** is the pointed protective sheath covering the emerging shoot (plumule) in monocots such as grasses.
- ✓ ***Coleorhiza*** is a closed hollow cylinder or sheath of leaf like tissue surrounding and protecting the radicle (young root) in monocot seedlings.
- ✓ ***Root cap*** is a section of tissue at the tip of a plant root (radicle) which protects the growing delicate root against physical damage.
- ✓ **Endosperm** is the tissue produced inside the seeds of most of the flowering plants following fertilization. It surrounds the embryo and provides nutrient in the form of starch, though it can also contain oils and protein. This can make endosperm a source of nutrients in the human diet.

Germination Process

- ✓ The seed absorbs water through the Micropyle and swells up.
- ✓ The swelling up of the inner tissue cause rapture of the softened Testa.
- ✓ Water dissolves the food stored in the cotyledon/endosperm to release energy

- ✓ Radicle (embryonic root) is the first to emerge and grow downwards between soil particles.
- ✓ The tip of the radicle is protected by root cap. The root hair develops which create a surface area for absorption of water and mineral salts. Later the lateral roots develop anchoring the radicle firmly in the soil.
- ✓ Radicle elongates to push the cotyledons with its enclosed plumule above the ground
- ✓ The plumule (embryonic shoot) emerges upwards, forming first foliage leaves which will have chlorophyll that absorbs solar energy for photosynthesis.

Conditions Necessary for Seed Germination

These conditions are classified into two main categories which are:

i. External conditions/factors
ii. Internal conditions/factors

External Factors or Conditions Necessary for Seed Germination

i. Water
   - ✓ Water is absorbed by the seed through the Micropyle
   - ✓ It softens Testa so that it can rapture/burst easily do that the radicle and plumule can emerge easily.
   - ✓ Water causes the seed to swell and dissolve the stored food substances so as to simplify its digestion into simple soluble form for the growing of the embryo.
   - ✓ It is required by the enzymes in the seed which start to digest the stored food into soluble form and speed up the rate of respiration.
   - ✓ Water acts as a transport medium in the seed.

ii. Oxygen
   - ✓ It diffuses into the seed through the Micropyle but when the Testa raptures it diffuses directly to the tissues.
   - ✓ It is used during respiration which produces energy for processes like cell division and transport of food to the growing parts.

iii. Suitable/Optimum Temperature
   - ✓ Optimum/suitable temperature is needed to activate the enzymes which catalyzes the hydrolysis of the stored food substances in the seed to provide energy for germination.
   - ✓ Enzymes are most active at optimum temperature. At low temperature enzymes are inactive while at very high temperature enzymes are denatured/destroyed.

Internal Factors/Conditions Necessary for Seed Germination

i. Enzymes
   - ✓ Enzymes are important for hydrolysis of stored food substances. E.g., diastase enzymes convert insoluble starch to soluble form.
   - ✓ Respiration requires a series of enzymes

ii. Hormones
   - ✓ These act as growth stimulators. E.g., Auxins.

iii. Seed Viability
   - ✓ Seed viability refers to the ability of the seed to germinate provided all other conditions are kept constant. Only alive and healthy seeds with mature embryo germinates.
   - ✓ Seeds that have stayed for very long time lose their viability (some)

Changes Occurring During Seed Germination

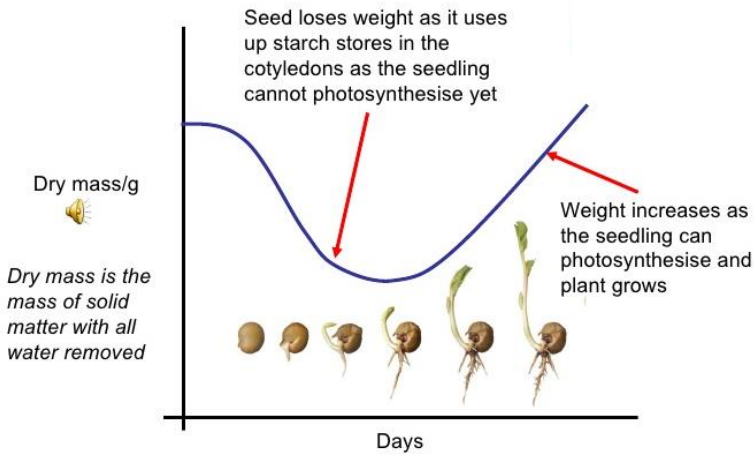
i. Physical changes
   - ✓ The seed absorbs water through Micropyle and swells up
   - ✓ The Testa/seed coat burst.
   - ✓ The radicle emerges.
   - ✓ The radicle continues to elongate and give rise to many seed roots
   - ✓ The radicle elongates and pushes the seed out of the ground
   - ✓ The seed coat is discarded and the two cotyledons open out and begin to photosynthesize.
   - ✓ The plumule emerges and produces the first true leaves.
   - ✓ At this stage the young plant is called is called ***seedling***.

ii. Chemical changes

As the seed absorbs water the food stored undergo changes. They are hydrolyzed into soluble food.

Enzymes in a stored food include:
- ✓ Diastase –catalyzes the hydrolysis of starch into simple sugar
- ✓ Lipase –catalyzes the digestion of lipids into fatty acid and glycerol
- ✓ Proteases –catalyzes the digestion of protein to amino acid.

- During germination a lot of energy is required. The stored food materials are oxidized to release energy needed for germination
- As the seed germinate, its weight decreases until the seedling is capable of photosynthesizing. The germinated seed decreases in weight because the stored food is being used for growth of the seedling.



Variation of Dry Mass of a Germinating Seed

Types of Germination

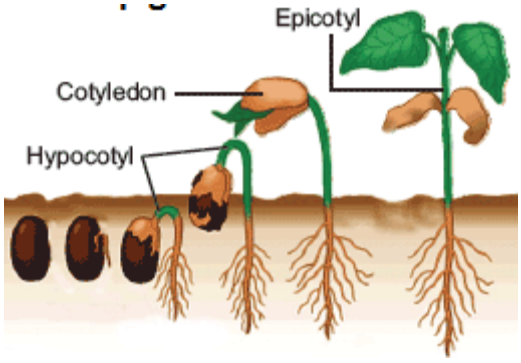
There are two types of germination. These are

i. Epigeal seed germination
ii. Hypogeal seed germination

Epigeal Seed Germination

This is the type of seed germination whereby the cotyledon of the seed is brought above the ground. This occurs in dicot plants like beans, cotton and ground nuts.

In Epigeal seed germination the hypocotyl carries cotyledon and plumule above the ground. Hypocotyl is part of the seedling below the cotyledon.

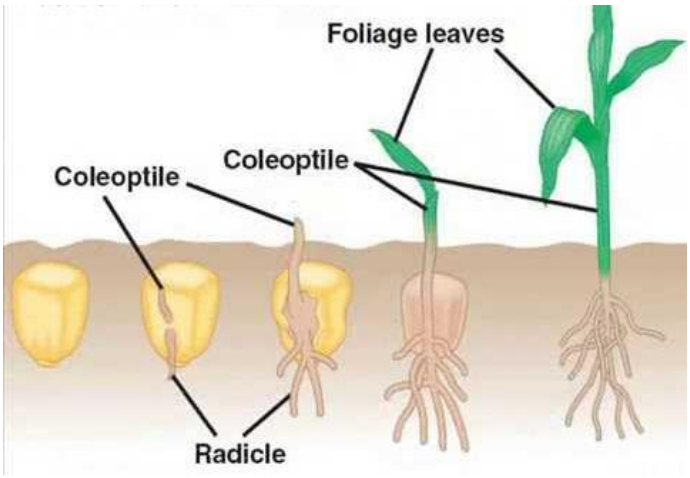


Epigeal Seed Germination in a Dicot Seed

Hypogeal Seed Germination

This is the type of seed germination whereby the cotyledon of the seed remains below the ground. It occurs in monocot plants like maize, millet and wheat.

In hypogeal seed germination, epicotyl carries the plumule to the ground. Epicotyl is a part of the seedling above the cotyledon.



Hypogeal Seed Germination in a Monocot Seed

Differences between Epigeal and Hypogeal Seed Germination

Epigeal Seed Germination	Hypogeal Seed Germination
✓ The cotyledon is brought above the ground	✓ The cotyledons remain below the ground
✓ Occurs mostly in dicot seeds	✓ Occurs mostly in monocot seeds
✓ Plumule and cotyledons are carried by hypocotyl	✓ Only plumule is carried out by epicotyl
✓ Cotyledons can photosynthesize	✓ Cotyledons can only store food
✓ Hypocotyl elongates first before epicotyl	✓ Epicotyl elongates first before hypocotyl

Seed Viability

Seed viability is the ability of seeds to germinate and grow into adult plants

Factors Affecting Seed Viability

i. ***Seed maturity***. A seed is more viable if it is fully mature. A seed which is not mature cannot germinate.
ii. ***Nature of the Testa***. A seed having too thin Testa becomes dehydrated before it germinates. This kills the seed. Also, a Testa which is too thick prevents entry of water into the seed. If no water enters the seed, germination cannot take place.
iii. ***Storage conditions***. Storing seeds in a place that is too cold or too hot kills the embryo. Most seeds are well stored at room temperature of about 25^0C.
iv. ***Temperature and moisture***. Seeds germinate at specific (optimum) temperature and moisture conditions. Under too dry conditions the seeds will not germinate. On the other hand, the seed do not germinate if temperature is too low.
v. ***Food store***. Adequate food stores are marked by big cotyledon or food storing tissue called endosperm. If a seed does not have adequate food stores, there will be no germination, and if germination starts, the seedling dies before it has fully germinated.
vi. ***Light intensity***. Light is very important for the growth of a young seedling since it enables photosynthesis by foliage leaves and the green cotyledons.

Seed Dormancy

- ✓ Seed dormancy is a state in which **seeds** fail to germinate even under environmental conditions normally favorable for germination.
- ✓ During seed dormancy, the metabolism activities are usually very low but sufficient to help the seed cells survive.
- ✓ Some seeds will not germinate immediately after harvest even if they are supplied with suitable conditions.
- ✓ The seed must pass a dormant period lasting for weeks, months and even years depending on the type of a seed before they can germinate.
- ✓ Other seeds can germinate immediately after being shade from the parent plant.

Importance of Seed Dormancy

- ✓ It adds survival value of the plant seeds. That is, it ensures that not all seeds germinate at the same time. This is very important especially during prolonged drought conditions. If all seeds germinate at the same time in such condition, all seedlings would perish.
- ✓ Seed dormancy help an organism to withstand unfavorable conditions such as extreme cold, drought, shortage of water, etc.
- ✓ It allows time for dispersal of seeds by agents such as water and wind
- ✓ Temporary dormancy which is helpful for their harvesting, dry storage and as a source of food. In the absence of dormancy these grains were likely to germinate in the field and experience unfavorable conditions.

Causes of Seed Dormancy

- ✓ Immature embryo
- ✓ Hard (impermeable) seed coat/Testa
- ✓ Presence of growth inhibitors
- ✓ After-ripening

- ✓ Food and water availability
- ✓ Climatic conditions
- ✓ Lack of enough oxygen

Ways of Breaking Seed Dormancy

- ✓ Removal of hard/impermeable Testa by methods such as use of fire, rubbing the seed with sand, etc.
- ✓ Treating the seed with chemicals such as acids
- ✓ Provide the seed with enough air/oxygen
- ✓ Provide the seed with suitable/optimum temperature
- ✓ Ensure seed embryo is mature enough to germinate

Primary and Secondary Growth

Primary growth is the increase in length of the shoots and roots. It is brought about by cell division, cell elongation and cell differentiation in the shoot and root apices.

Secondary growth is the increase in thickness (girth) of wood, stem and root. It is brought about by cell division, cell expansion and cell differentiation in the intercalary cambium between the xylem and phloem of the vascular cambium.

Note:

Apical Dominance is the inhibition of the development of the lateral bud by the terminal bud. This is because apical bud (terminal bud) contains high concentration of the growth hormone called Auxins. E.g. (IAA).

Differences between in Animals and Plants

Growth in Animals	Growth in Plants
✓ It is diffused. That is, it takes place throughout the body	✓ It is localized. That is, it takes place in specific regions of the body called ***meristems***
✓ Broken parts such as limbs cannot be whole regenerated	Broken parts such as branches can be regenerated
✓ Growth takes place for definite periods before maturity	✓ Growth continues throughout the life of the plant
✓ Growth does not involve increase in the number of parts	✓ growth involves increases in the number of parts
✓ Each species has a distinct season for growth	✓ Growth take place during definite seasons
✓ The young one is identical to adults except in the body size and sexual maturity	✓ A seedling does not resemble an adult plant

Plant Development and Activity of Meristem

In plants, growth and development occurs in certain regions called ***Meristems.*** The main meristems are located at the tip of roots and shoots and they are called ***Apical Meristems.***

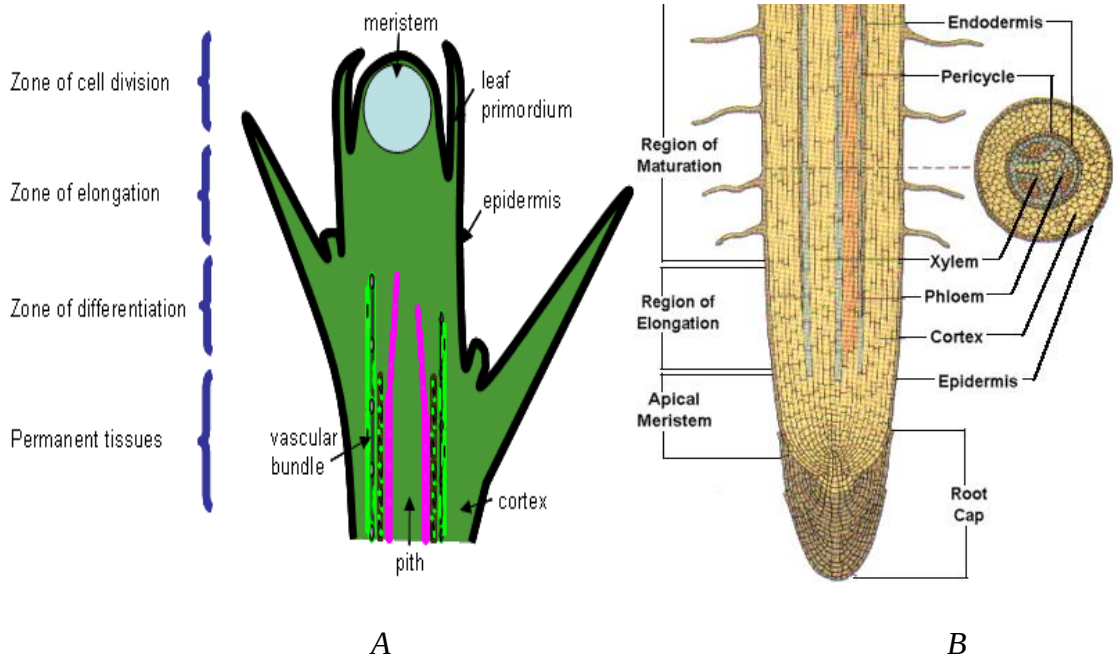
Meristem is a group of plant tissue usually made up of small cells capable of dividing indefinitely and giving rise to similar cells. ***OR*** is a group of cells/tissues that have the ability to divide rapidly by mitosis to form new cells.

Types of Meristems

i. ***Apical meristem***. This is a type of meristem which occurs at the tip of shoots and roots of plants. This causes growth in length of roots and stems called primary growth.

ii. ***Lateral meristem***. This is the type of meristem which occur in the vascular cambium. This causes growth in girth of shoots and roots called secondary growth.

iii. ***Intercalary meristem***. This is the type of meristem which occurs in the region of permanent tissue. E.g., the base of the leaves in many monocotyledonous plants.



A *B*

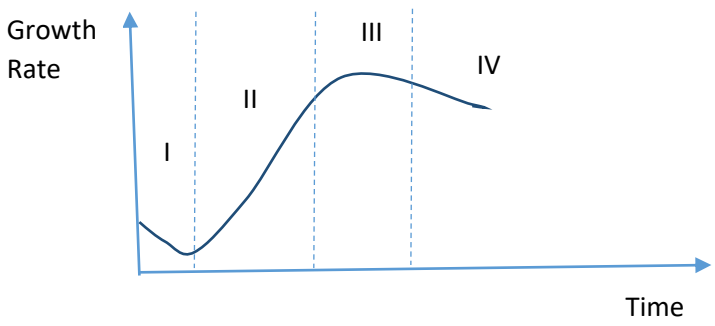
Longitudinal Section of Dicot shoot apical meristem (A) and Longitudinal (with cross-section) of Dicot root apical meristem (B)

Growth Curve

Some of the criteria used to measure growth includes height, weight and cell number measured at a given time.

A growth curve is drawn in heights, weight and cell number against time. During growth period, growth rate is not the same.

S-Shaped Growth Curve



This graph is known as *sigmoid curve*. The curve is called sigmoid curve because it resembles the Greek letter sigma (δ). It has four phases. These are:

I. The lag phases
II. The log/rapid/exponential phase
III. Stationary phase
IV. Decline phase

Lag Phase*:* this is the phase where there is little growth or slight decrease in growth. E.g., in flowering plants, there is loss of dry weight during seed germination. Growth rate is slow at this phase because:

- ✓ The number of dividing cells is small.
- ✓ The cells of organisms are not yet adjusted to the environment.
- ✓ This is the time of rapid cell division but very little expansion

Log/rapid/exponential Phase*:* this is the stage where there is maximum rate of growth. Growth is rapid because:

- ✓ There is large number of dividing cells and expanding cells
- ✓ The rate of cell increase is greater than the rate of cell increase
- ✓ The cells or organisms have adjusted to the environment hence food, space, air, water, light, etc. are not limiting.

Stationary Phase*:* this is the stage where growth ceases (stops) and the parameters under consideration remains constant. The rate of cells increase is equal to the rate of cells death. In micro-organisms, the number of individuals dying is approximately equal to the number of individuals formed.

Decline phase: this is the stage at which the maximum peak is reached and growth starts to decline. This can be because:

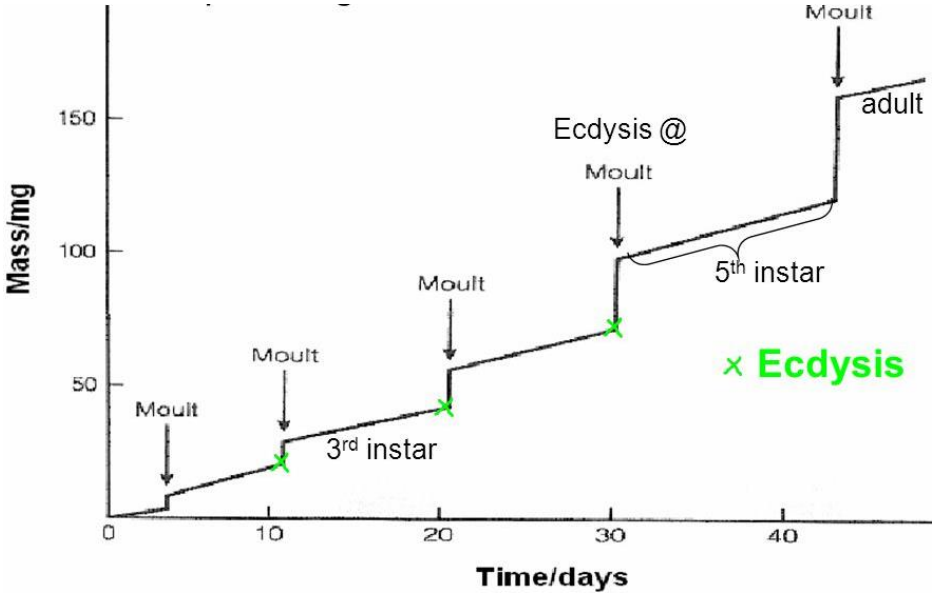
- ✓ The rate of cell death is more than the rate of cell increase
- ✓ Most cells have fully differentiated and hence can't undergo most differentiation.

Intermittent Growth Curve

Intermittent growth is the type of growth that occurs in stages. E.g. in arthropods. These series of stages show sudden changes in weight or lenth. Each stage is called ***Instar***. All arthropods have an exoskeleton made up of hard chitinous cuticle which prevent growth of the body as it hardens. Growth occurs rapidly again after ecdysis/moulting.

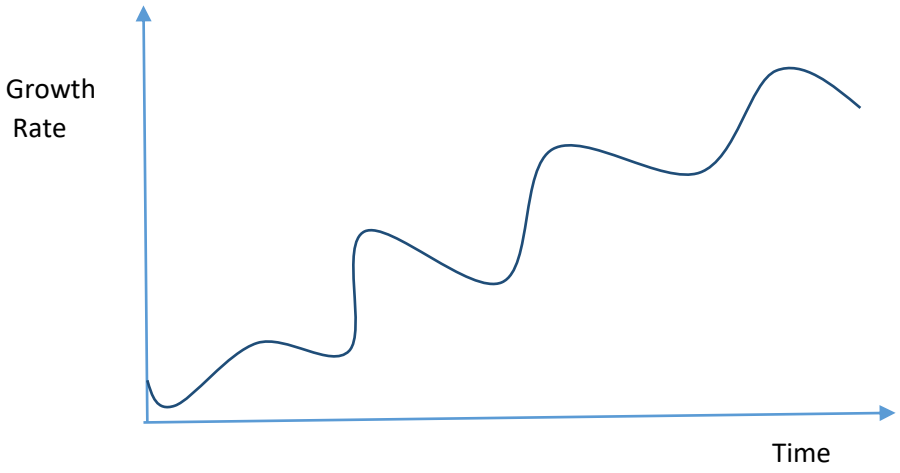
Ecdysis is the periodical shade off of the exoskeleton to allow growth in arthropods.

The graph for intermittent growth is as shown below:



Indeterminate Growth Curve

Terrestrial perennial plants exhibit wave curve. This is because such plants are exposed to dry and wet seasons during their life. Under wet seasons growth is rapid, while under dry season growth is low. Since the wet and dry season alternate. Rapid growth will also be alternating with low rate of growth.



Metamorphosis

This refers to the series of changes in the body shape and structure by which an egg of an animal change into an adult organism. E.g., insect, amphibians, etc.

Types of Metamorphosis

There are two main types of metamorphosis. These are:

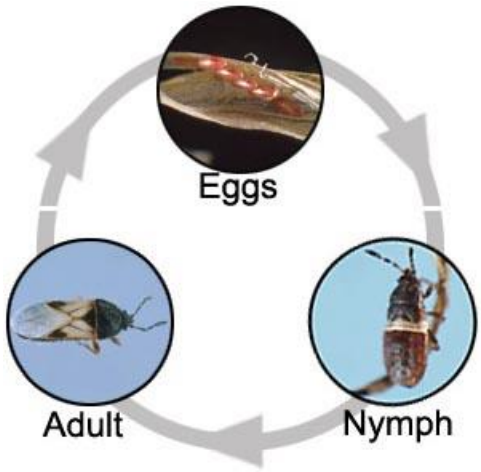
i. Complete metamorphosis. E.g., Butterflies, houseflies, mosquitoes, beetles, etc.
ii. Incomplete metamorphosis. E.g., cockroaches, grasshoppers, frog, etc.

Complete Metamorphosis: the egg hatches into larva and pupa then adult. Pupa and larva are completely different in form and behavior from adult.

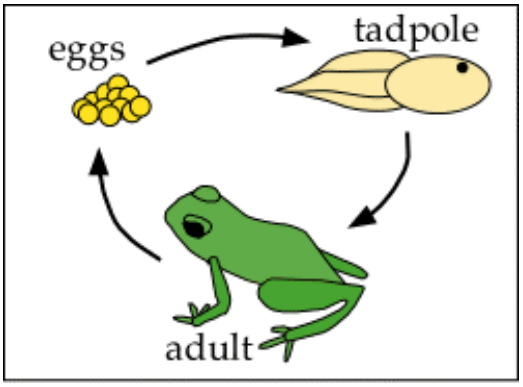
Larva stage is the feeding and growing stage after which is transformed into a pupa. The larva of butterfly is called ***caterpillar.*** The larva of housefly is called ***maggot***.

Pupa is outwardly dormant. It is inactive neither moving nor feeding. Changes take place within its body giving rise eventually to the adult or imago.

Incomplete Metamorphosis: in this case, the egg hatches into nymph. The nymph resembles the adult in many ways. It therefore undergoes very few changes to attain the adult body form.
Nymph differs from the adult in that it has no wings and it is smaller in size.



Metamorphosis in Frog: the egg hatches to tadpole. The tadpole then develops into adult and then the cycle starts again.



Differences between Tadpole and Adult Frog

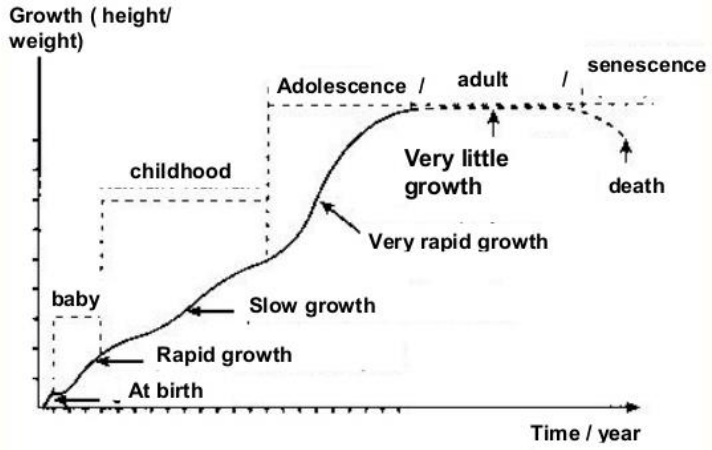
Adult Frog	Tadpole
Has four legs	Has no legs
Has no gills	Has gills
Has no tail	Has tail
Has no operculum	Has an operculum

Stages of Postnatal Growth in Human

Postnatal growth is the growth that takes place after birth. It is categorized into four stages. These are:

i. Childhood
ii. Adolescent
iii. Adulthood
iv. Senescence/old age

Note: Development in humans involve increase in ability to perform various skills both physical and intellectual.



Growth Curve in Humans

Childhood Stage (1-10 years)

This is the stage between birth and sexual maturity **OR** is the period of rapid growth because cells divide rapidly. It is divided into:

- ✓ Infancy (baby) stage (0-3 year). It is the period of rapid growth.
- ✓ Juvenile stage (4-10 years). Here there is slow rate of growth.

Adolescence Stage (11-18 years)

This is a period of rapid growth that takes place between childhood and adulthood.

- ✓ There is sex maturity
- ✓ It is accompanied by physical and emotional changes that occurs in both boys and girls to prepare their bodies for parenthood
- ✓ It occurs at the ages of 11-13 years for girls and 12-14 years for boys.

Adulthood Stage (19-45 years)
This is the stage where there is very little growth. Adults are physically and psychologically maturing to make families.

Senescence/Old Age Stage (46-55 years)

This is the stage of senescence and begins at age of between 45 and 55 years OR simply after menopause in woman. Men tend to diminish their sexual activity but they are not actually sterile.

Psychological and Behavioral Changes Associated with Growth and Development

The changes that occur may differ slightly among individuals and societies depending on factors such as

- ✓ Diet
- ✓ Social environment
- ✓ Eating habit
- ✓ Heredity
- ✓ Sex

Behavior Changes during Adolescence

- ❖ Refusing to listen to their parents and supervisors
- ❖ They rebel against parental orders
- ❖ Peer groups are formed and they may play great role in expressing the characters of the youth.
- ❖ Boys and girls become conscious of themselves as boys and girls. Boys would like to talk to girls and girls would like to talk to boys (interested in opposite sex)

Psychological Changes during Adolescence

Psychological changes are noticeable symptoms of internal changes that may cause emotional and intellectual changes among youths.

Very often the emotional changes are not easily noticed except when there are external signs like crying or laughing. The changes are as follows:

- ❖ Youth develop positive social attitudes such as to have love sympathy for others.
- ❖ Making decision about major things in their lives.
- ❖ Making some unnecessary argument with parents and elders
- ❖ They identify themselves as much more important on the social stage
- ❖ They are seeking for independence

Psychological Changes during Old Age

- ❖ Loss of memory due to death of brain cells
- ❖ Power of concentration becomes low.

- ❖ Loss of hair of the head
- ❖ Wrinkling of the skin
- ❖ Lowered resistance to diseases
- ❖ Weakening of bones
- ❖ Heart muscles and arteries loose elasticity which later decreases rate of blood flow
- ❖ Difficulty in breathing
- ❖ Degeneration of nervous system and as a result hearing and vision becomes less cute, failing of eye sight and poor sense of taste and smell.
- ❖ Loss of muscular strength and joint stiffness

Factors Affecting the Rate of Physical Deterioration of Human Body

i. Poor nutrition
   - ❖ Excess take of food leads to obesity which shortens individual's life span.
   - ❖ Excessive fats burden the heart and may cause coronary thrombosis
   - ❖ Lack of enough food lead to poor growth of the body

ii. Diseases and infection
   - ❖ Pathogens (parasites) deprive our bodies of nutrients and oxygen, damages the tissue and produce toxic substances that accelerate deterioration

iii. Poverty
   - ❖ Poor families are not able to acquire better medical services and education. This leads to poor health which quickens ageing

iv. Emotional disturbances
   - ❖ Such as stress, frustration, tension and anxiety shorten the life span of an individual

v. Some behavior such as alcoholism and drug abuse

vi. Lack of exercise

The Limiting Factors that Regulate Growth in Individual and Population

i. *Food and water availability*. In the area where food and water are adequate, competition is reduced and population increases. If there is no food and water for individuals, population decreases

ii. *Light intensity.* Light is important for green plants to make their own food. Plant competes for light with each other in the area of dense vegetation.

iii. *Space.* Organisms compete for breeding sites and shelter. Harsh environment and lack of space cause accumulation of waste products which may lead to eruption of diseases or death of the organisms.

iv. *Accumulation of toxic wastes.* High accumulation of poisonous substances such as carbon dioxide, carbon monoxide, Sulphur dioxide and nitrogen wastes (ammonia) affects the life of individual and hence the general population

v. *Diseases.* Overcrowding result in the rapid spread of diseases within a population and outbreak of epidemic diseases can wipe the whole population out. E.g., Ebola.

vi. *Predators and Parasites.* Predators kills another organism for food. A parasite is an organism that obtain its nutrients from another living organism. An increase in number of number of predators and parasites leads to death of prey and host organisms.

vii. *Oxygen and carbon dioxide concentration.* These are respiratory gases. Oxygen is required by all living organisms for respiration process to produce energy. Carbon dioxide is required by plants as raw material or photosynthesis. Pollution off the environment will lead to deficiency of these gases.

viii. *Climate.* Weather and climatic condition affects the size of population. Due to excessive heat in deserts, there is low population compared to tropical rainforests.

Practical Work on Growth and Development

Experiment 1

Aim

To find whether oxygen gas is necessary for germination

Requirements/Resources

Soaked seeds, cotton wool, flat bottomed flask, cork, water, pyrogallic acid and sodium hydroxide

Procedures

- ✓ Put some pyrogallic acid and sodium hydroxide solution in flask A
- ✓ Wrap few seeds in moist cotton wool
- ✓ Suspend the moist cotton wool from the cork inside the flask A by use of hooked wire
- ✓ Repeat the experiment for flask A in a flask B but without pyrogallic acid and sodium hydroxide. This is your control experiment
- ✓ Leave the set up for 5 days

Revision Questions

1. a. Differentiate growth from development.
   b. Of what importance is growth?
2. a. Plants exhibit <u>localized growth</u> while human being exhibit <u>diffused growth</u>. Distinguish the underlined terms.
   b. Distinguish between:
      i. Primary growth and secondary growth
      ii. Allometric growth and isometric growth
3. a. What is seed germination?
   b. Briefly explain the internal factors and external factors necessary or seed germination to occur.
   c. Differentiate epigeal germination from hypogeal germination.
4. Briefly explain six (06) factors affecting the rate of deterioration of the human body.
5. a. Define mitosis
   b. What is the significance of mitosis?

c. List down the stages of mitosis.

6. a. Distinguish between:
   i. radicle and plumule
   ii. hypocotyl and epicotyl

   b. Give the differences between *plant growth* and *animal growth*.

7. Draw a sketch graph to show:
   a. A typical growth curve of a bean plant as it develops from seed to maturity
   b. A typical growth curve of an insect.
8. a. What do you understand by the term meristem?
   b. Name two types of meristems and their significance
   c. Secondary growth is most common in dicots but very rare in monocots. Why?
9. a. Name five diseases against which children are immunized.
   b. Give four advantages of breast feeding over bottle feeding.
   c. Bottle milk can substitute breast milk. Give four (04) reasons for substitution.
10. Write an essay on seed dormancy using the following guideline:
    - ❖ Meaning of seed dormancy
    - ❖ Six causes of seed dormancy
    - ❖ Six methods of breaking seed dormancy
    - ❖ Two advantages and one disadvantage of seed dormancy
11. Study figures 1 and 2 below and answer the questions which follow:

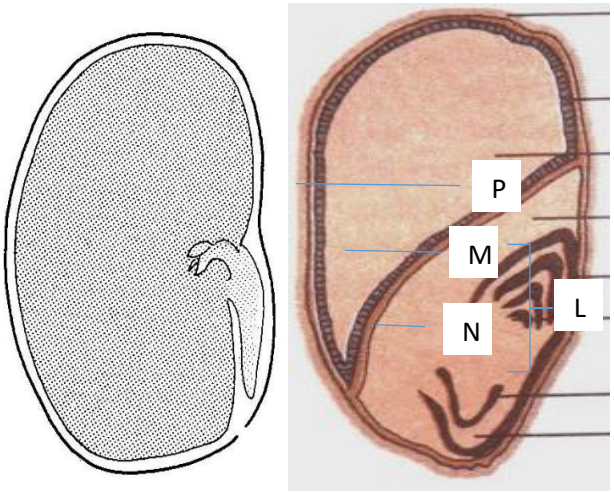


Figure 1

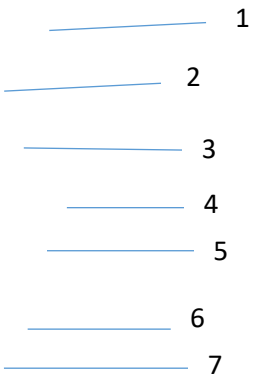


Figure 2

   a. What does figure 1 represent?
   b. Name parts indicated by letters L to P
   c. What does figure 2 represent?
   d. Name parts indicated by numbers 1 to 7
   e. Give the letter of the part in figure 1 which is:
      i. The embryonic shoot
      ii. The embryonic root
   f. Of what function is part P?
12. Study figure 3 below and answe the questions which follow:

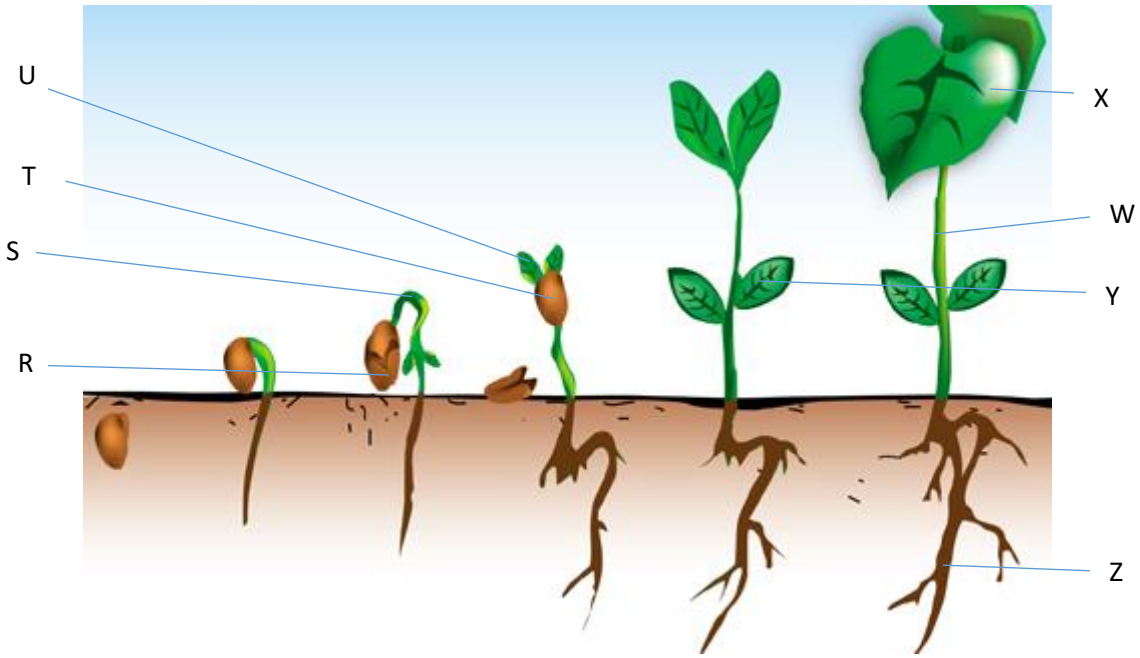


Figure 3

a. Give reason to suggest whether the figure exhibits epigeal or hypogeal seed germination
b. Name parts R to Z in figure 3
c. Name four (04) other plants which exhibit the type of germination you have named in (a) above.
d. State function of part Z
e. Give adaptation(s) of part Z to the function tou have stated in (d) above.

13. Study figure 4 and 5 below then answer the questions which follow:

Figure 4

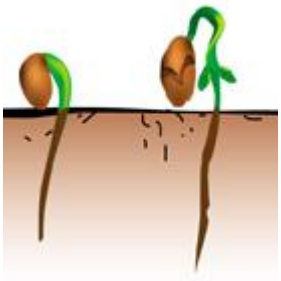


Figure 5

a. Give common names of the organism/part of the organism represented by figures 4 and 5
b. Name the process through which figure 4 develops into figure 5
c. Briefly explain three (03) external factors required by figure 4 to develpo into figure 5
d. List down physical changes which occur in figure 4 to develop into figure 5

14. Figure 6 is an ordinary cell. Observe the figure carefully and answer the questions which follow.

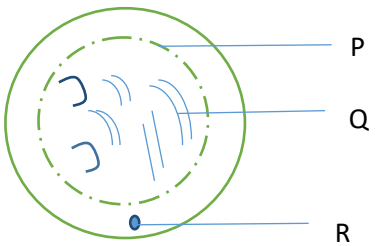


Figure 6

a. Name parts P, Q and R
b. How many chromosomes are there altogether?
c. How many pairs of homologous chromosomes are there?
d. If this cell divides by mitosis, how many chromosomes will be in each daughter cell?
e. If the cell divides by meiosis, how many chromosomes will be in each daughter cell?
f. How many daughter cells will be formed if the cell divides by:
    i. Meiosis
    ii. Mitosis

15. Study figures 7A and 7B below and answer the questions which follow:

Figure 7A

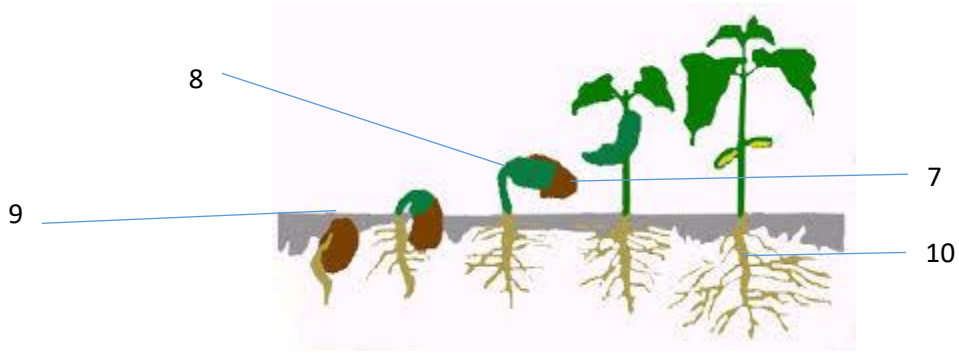


Figure 7B

a. Name the parts indicated by numbers 1 to 10
b. What external conditions do you think possibly help the grain/seed to the developmental stage you are seeing
c. Explain the role of each condition you have named in (b) above.

16. Study the process A and B in figure 8 and answer the accompanying questions below:

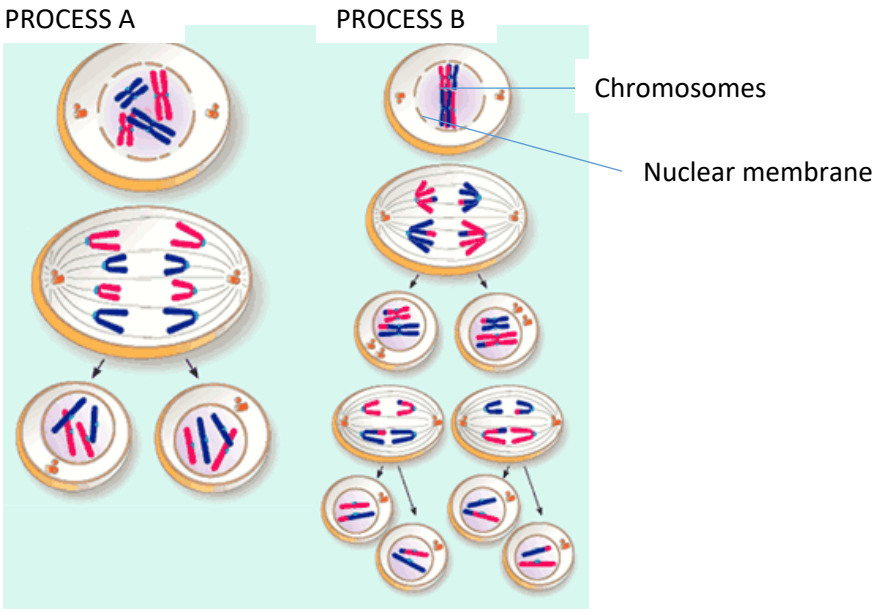
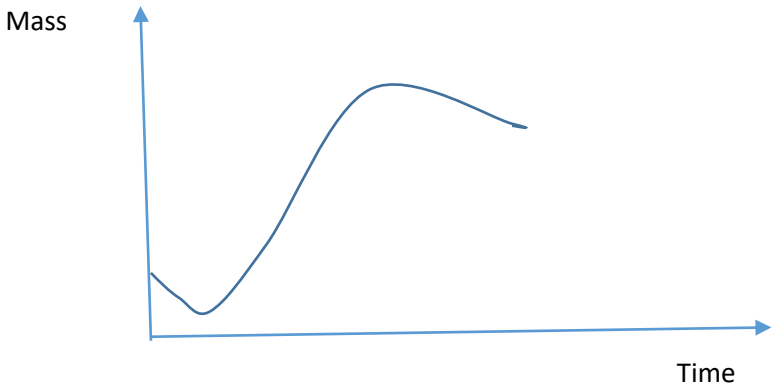


Figure 8

a. Name process A and B
b. Give the significance of process A
c. Give four (04) differences between process A and B

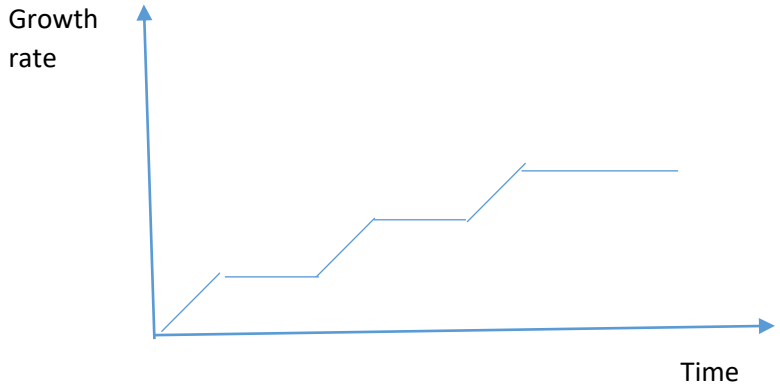
17. Hemed set up an experiment on a bean radicle as shown in figure 9 below:
18. a. What is the role of cotyledons and endosperms in seed during germination?
    b. Give two functions of micropyle of a seed
    c. Explain two internal factors and four external factors affecting growth in plants.

19. The graph below represents a growth curve of a certain plant as it develops from seed to maturity.



a. Suggest common nsmes of two plants which exhibit such a growth curve
b. What type of growth curve is shown by the graph?
c. Giving reasons, explain why the plants named in 9(a) above must exhibit such a growth curve.

20. The diagram below represents a growth rate pattern of a certain group of animals. Study it carefully and answer the questions which follow:



    a. Name two groups of animals which exhibit such growth pattern
    b. Why such animals exhibit such growth pattern?
    c. What type of graph is represented by the above diagram?

21. With the help of diagrams, briefly state the events occurring at each stages of mitosis.

GENETICS

Organisms arise from other organisms through reproduction. Organisms arise from organisms of the same species.
E.g., A human arise from human, tomato seed produce tomato plant.

Organisms resemble or differ from their parents in certain features. This means that some features from the parents are passed on into the Offspring.

The process of passing of features from the parents to the offspring is called **HEREDITY.**

- The fact that organisms differ from their parents in certain features, this means that organisms show some **VARIATION.**

GENETICS: Is a branch of science that deals with the study of heredity and variation.
HEREDITY: Is possession of characteristics similar to those of the parents.
OR
HEREDITY is the transmission of characteristics from the parent to the offspring.
VARIATION: Is the possession of characteristics different from those of the parents and other offspring.
OR
VARIATION is the physical difference which exist among member of a population.

COMMON TERMS USED IN GENETICS:

1. **GENOTYPE:** Is the genetic makeup (constitution) of an organism

2. **PHENOTYPE: Is** the outward or physical appearance of an organism. It is determined by the interaction of genes and the environment.

Example of phenotypes in man:

- Height
- Skin pigmentation (color)
- Eye color
- Shape of various body parts e.g., face

Example of phenotypes in plants

- Height
- Flower color
- Seed color and shape.

NB: Organisms may have the same phenotype but different genotype.

3. **DOMINANT GENE:** Is the gene/Allele that expresses its effects in both homozygous and heterozygous state.

OR
DOMINANT GENE is the gene that masks the expression of the other gene when they occur together.
E.g., In garden pea, tallness (T) is dominant over shortness (t)

4. **RECESSIVE GENE:** Is the gene/Allele which fail to express its effect in heterozygous state.

OR
Recessive gene is the gene which expresses its effect only in homozygous state.

- Is the masked gene in heterozygous state.

E.g., In garden peas "shortness" is recessive because it does not express its effect in heterozygous state.

5. **HOMOZYGOUS:** Is the state where the alleles/gene forming a pair in an individual are similar.

HOMOZYGOTE/PURELINE

This is an organism that has two identical alleles of one gene which control a particular trait.

Example of identical pair of genes:

- TT for tallness in pea plants
- tt for shortness in pea plants.

6. **HETEROZYGOUS**: Is the state where the alleles are dissimilar

HETEROZYGOTE: Is an organism that has different allele/gene which control particular trait/character.

E.g., Tt (T- for tallness and t - for shortness in pea plants)

7. **TRAIT:** Is the characteristic which is inherited by the offspring.

Example of traits in man:

E.g., Color of the skin, hair texture, blood group, height.

8. **GENE**: Is a part of chromosome that carries the genetic material called DNA. Genes are responsible for transferring trait from parent to the offspring. They are referred to as **HEREDITARY FACTORS.**

9. **ALLELE:** Is an alternative form of a gene controlling the same characteristic/trait but producing different effect. T is an allele of "t" where T- control tallness, and t - shortness but both control height.
10. **LOCUS/LOCI:** Is the exact position/location occupied by gene in a chromosome.
11. **LETHAL GENE:** A gene which is defective that can cause death to the organism which contain it in a homozygous condition.

E.g., Sickle cell gene.

12. **DIPLOID:** Is a nucleus of a cell that has its chromosomes in homologous pair.

These includes all the somatic (body) cells denoted by "2n"

13. **HAPLOID:** Is a nucleus of a cell that has half number of chromosomes in a body cell. The haploid cells are produced in gonads i.e., ovaries and testes. The haploid includes the sperm and ova. It is denoted by "n".
14. **PARENTS:** Are individuals that form the starting point of a breed. Cross between parents produce offspring.
15. **FIRST FILIAL GENERATION**: Is the offspring produced after crossing the parental generation. It is abbreviated as **"F_1"** generation.
16. **SECOND FILIAL GENERATION**: Is the offspring produced after crossing the **F_1**generation. It is abbreviated as **"F_2"** generation.
17. **HYBRID:** Is offspring produced by crossing two individuals with contrasting characters.
18. **MONOHYBRD INHERITANCE**: Is the inheritance of one pair of contrasting characteristics.
    E.g., Inheritance of height where an individual is either tall or short.
19. **DIHYBRID INHERITANCE:** Is the inheritance of two pairs of contrasting of characteristics.

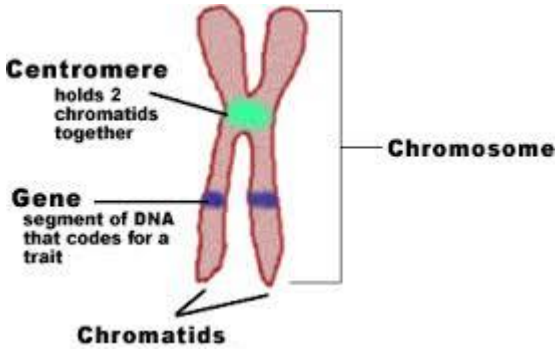
E.g., crossing of round and yellow peas seeds with wrinkled and green pea seeds.

20. **MUTATION:** is a sudden random change in the genetic makeup of a cell, causing it and all cells derived from it to differ from normal cells.

21. **MUTAGEN:** is an agent capable of increasing the rate of mutation in an organism like formaldehyde and nitrous acid.

22. **SELFING:** is the crossing offspring of the same pair of parents

23. **CHROMOSOMES:** these are thread-like structures found in the nucleus of the cell visible only when the nucleus is undergoing division.



PRINCIPLES OF INHERITANCE

The basic principle of inheritance was first worked by Gregory Johann Mendel who was an Australian monk and a member of Augustinian monastery of Brunn Australia

- Mendel was looking for the law that govern the passage of characteristics from one generation to another.
- He did experiments on the way in which traits are inherited using garden pea (*Pisum sativum*) which he grew in his monastery garden. He conducted his experiment from 1856 – 1863
- Mendel studied monohybrid inheritance first, then he studied dihybrid inheritance.

Monohybrid inheritance is the type of inheritance which involve the passage of one pair of contrasting characters (e.g., TT x tt, BB x bb

Dihybrid inheritance is the type of inheritance which involve the passage of two pairs of contrasting characters (e.g., TTRR x ttrr) were,

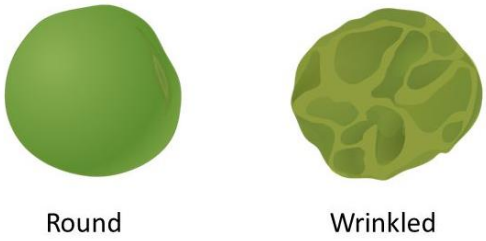
TT – Tall pea plant. RR – Round pea seed Testa
tt – Short pea plant, rr - wrinkled pea seed Testa

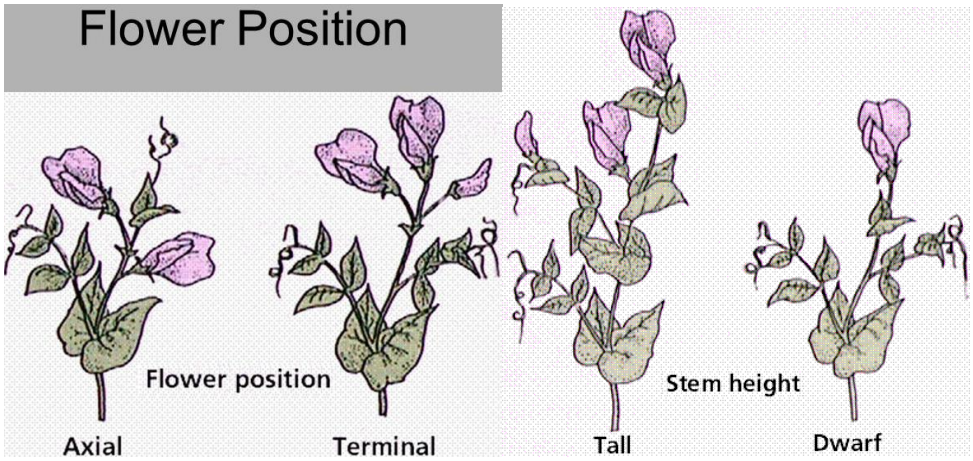
Qn. Why Mendel chose the garden peas for his experiments?

Reasons:

i) The garden pea has many contrasting and easily recognizable characteristics/traits.
   - The traits occur in two contrasting forms. i.e.
     - The seeds are either round or wrinkled.
     - The flowers are either at the terminal or axial position
     - The plants are either tall or short
     - The fully ripened pods are either green or yellow.
     - The pod shape is either inflated or constricted

- Note that in each case there are no intermediate forms of traits





ii) The flowers of a garden pea plant are bisexual and naturally self-pollinated.
iii) It is possible to cross-pollinate the flowers of a plant
iv) The garden pea plants mature relatively fast and produces many offspring (seeds)
v) The hybrid obtained from cross fertilization was fertile.

MENDEL'S PROCEDURE:

- He crossed pure line tall (TT) garden pea plant with pure line short (tt) garden pea plant making one plant (TT) only by removing the stamen (male part) before the ovary was mature, he then wrapped with papers the pistil to prevent the pollen grains from reaching it.
- When the ovary matured, he dusted pollen grains from a pure line short plant.

DIAGRAM PRESENTATION OF MANDELIAN MONOHYBRID CROSS

Let T be gene for tallness

t be gene for shortness

Such that:

TT = homozygous tall plant

tt = homozygous short plant

Tt = heterozygous tall plant

The cross:

TT – Homozygous (pure line) tall pea plant

tt – Homozygous (Pure line) short pea plant

Parent phenotype (P) Tall pea plant x short pea

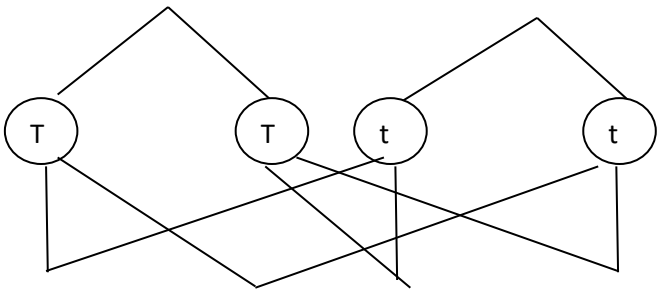
Parent genotype: Homozygous tall plant x homozygous short plant

Parent genes *TT* *x* *tt*

Meiosis

Gametes formed

Random fertilization



First filial generation (F1) genotypes Tt Tt Tt Tt

First filial generation F1 phenotypes All are tall

From the above crossing diagram:

First filial generation (F1) genotypes: *All heterozygous tall plants*

First filial generation F1 phenotypes: *All are tall plants*

- As all the F1 were tall, Mendel concluded that tallness is dominant over shortness.
- Then he planted the seeds from the plants obtained (F_1 generation) to see what kind of a plant will grow.
- In this case he allowed self-pollination from the first filial generation where he found that 75% were tall and 25% were short in the F2. Mendel concluded that shortness must be a recessive character.

Diagram presentation (Self crossing F1 members)

- **Let** T be gene for tallness
  t be gene for shortness

Such that:

TT = homozygous tall plant

tt = homozygous short plant

Tt = heterozygous tall plant

The cross:

Tt – Heterozygous tall pea plant (Hybrid)

Tt – Heterozygous tall pea plant (Hybrid)

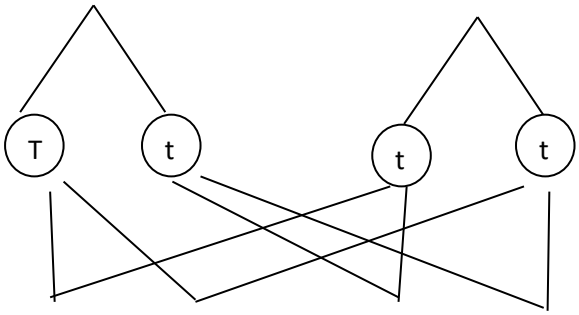
Parented phenotype (P_2): Tall pea plant x tall pea plant

Parent genotype: Heterozygous tall x heterozygous tall

Parental genes *Tt* *x* *Tt*

Meiosis

Gamete formed



Random Fertilization

Second filial generation (F_2) genotypes: *TT* *TtTttt*
Second filial generation (F2) phenotypes: *3 tall, 1 short*

From the above crossing diagram:

Second filial generation (F2) genotypes: *1TT, 2Tt, 1tt*

Second filial generation (F2) phenotypes: *3 tall plants, 1 short plant*

That is:
F_2 genotype: 1 is homozygous tall (TT)
2 are heterozygous tall (Tt)
1 is homozygous short (tt)
F_2 phenotypic ratio 3:1 ($^3/_4$ tall, ¼ short)
F_2 genotypic ratio 1:2:1 ($^1/_4$ homozygous tall) ½ heterozygous tall, ¼ homozygous short)
Calculated in percentage:
F2 Genotype:
25% homozygous tall plants,
50% heterozygous tall plants,
25% homozygous short
F2 Phenotype:
75% tall plants
25% short plants

- Mendel conducted other experiments to observe heredity by considering other traits apart from height and obtained the following results on monohybrid inheritance.

No.	Contrasting character of parents	Phenotype of F_1 generation	Phenotypic ratio of F2 generation
I.	Tall stem x short stem	All tall	3 tall: 1 short
ii.	Round x wrinkled seeds	All round	3 rounds: 1 wrinkled
iii.	Inflated x constricted pod	All inflated	3 inflated: 1 constricted
iv.	Green x yellow pods	All green	3 green: 1 yellow
v.	Axial x terminal flowers	All axial	3 axials: 1 terminal

EXERCISE:

1. A pure breeding pea plant with smooth seeds was crossed with pure breeding pea plant with wrinkled seeds. All F1 were smooth.
   i) Show the results of the F_1 and F_2

ii) State the genotypes and phenotypes of F1 and F_2

iii) Work out the phenotypic and genotypic ratios of the F_2.

2. In an experiment a variety of garden pea plant having smooth seed coat was crossed with a variety having a wrinkled seed coat. All the seeds obtained in F1 generation has smooth seed coat.

- The F_1 generation was sealed. The total number in F_2 generation was 7324. Let the gene for smooth seed coat be "R"

a) Work out for the phenotype of F_2

b) Work out for the following for F_2

i) Phenotype

ii) Genotype

iii) Phenotypic ratio

iv) Genotypic ratio

c) Calculate the total number of; -

i) Wrinkled seeds in F_2

ii) Smooth seeds in F_2

Questions:

3. Fur in mice is determined by the alleles. The allele for black fur is dominant over the allele for brown fur. A homozygous black mouse is crossed with a homozygous brown mouse. What will be the result of the F_1? If the F_1 offspring are allowed to mate, what are the genotypes, phenotypes, genotypic and phenotypic ratio of the F_2?
4. The laboratory technician at Mtakuja Secondary school performed an experiment with the aim of proving Mendelian experiment on single factor inheritance for a color coat in mice. In the experiment, pure-breed (homozygous) black fur mouse (male) was mated with a pure-breed brown fur mouse (female). The gene for black fur color was dominant over the gene for brown fur color. Use crosses to show the possibilities of the results in the first filial generation.
5. Explain the meaning of the following:

(I) Gene

(ii) Recessive

(iii) Phenotype

6. In an experiment conducted on single factor inheritance, an individual which was male homozygous tall married a female who was homozygous dwarf. The gene for tall was dominant over dwarf. Use the crosses to find out possibility of the phenotypic results and the ratio in the first filial generation.

MENDEL'S CONCLUSION:

Mendel concluded that;

i) Inheritance is not a process whereby features of the two parents are blended together to produce an intermediate result. Instead, the hereditary characteristics are transmitted as discrete units called **hereditary factors** from the parents to the offspring. These factors are nowadays are called **genes.**

ii) Each characteristic is determined by a pair of contrasting hereditary factors. **For example.** The height of a garden pea is determined by a factor for tallness or dwarfness. An adult organism contains a pair of these factors which may be identical or non-identical.

iii) Hereditary factors are transmitted from the parent to the offspring through gametes. During gamete formation the two contrasting factors separate (segregate) in such a way that each gamete contains one factor. During fusion (fertilization) of sperm and egg. (Nuclei), the factors recombine at random.

MENDEL'S LAWS:

Mendel's first law of inheritance (law of segregation) states that: "During gamete formation the two factors responsible for the expression of a particular trait segregate, so that only one factor from each pair is represented in each gamete"

Mendel's second law (Law of independent assortment) states that: "Each of the two alleles of one gene may combine randomly with either of the alleles of another gene independently"

APPLICATION OF MENDEL'S LAW:

i) Gives a new idea about the new combination of hybrid
ii) Important for plant and animal breeding to produce new genes.
iii) Plants with new combination can be produced

PEDIGREE ANALYSIS:

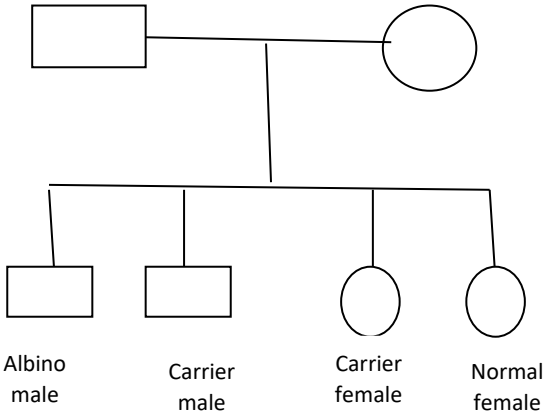
Is a diagram or family tree showing genetic relationship among a set of individuals normally with respect to special traits.

In pedigree:

- Circle represents female
- Square represents male

Example:

A marriage between two heterozygous for albinism trait can be represented as:



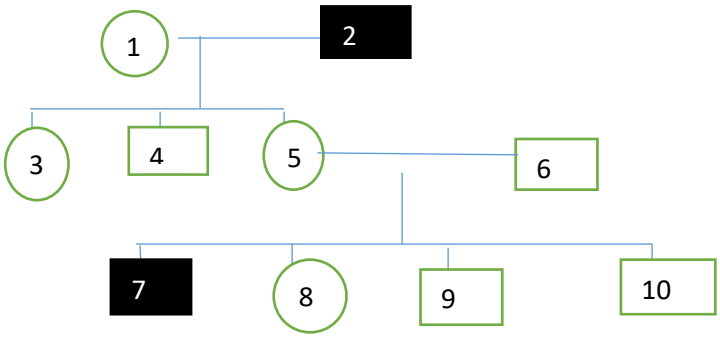
Question:

Study the pedigree below and then answer the questions that follows; -

Key:

= Females

= males



Open figures indicate normal phenotype, black figures indicate color blind individuals.

(i) What is the probable genotype of 1?
(ii) Is the answer to (I) above 100% certain? Explain.
(iii) What is the genotype of 5 and 9?
(iv) Justify your answer in (iii) above.
(v) If 3 marries a normal man, what are the chances that she will have a color blind son? Illustrate your answer.

TEST CROSS:

This is a cross between individual of unknown genotype with homozygous recessive individual.
OR
It is a cross between an organism showing a dominant trait with another organism with homozygous recessive genes for the trait.

IMPORTANCE OF TEST CROSS:

- It is used to determine the gene of on individual

- A homozygous individual e.g., TT and heterozygous individual Tt will all appears tall phenotypically.
- In this case it is easy to identify the phenotype but not the genotype i.e., either TT or Tt.

Therefore, we use test cross to identify the genotype of unknown individual.

- If an organism is homozygous dominant all the offspring will show dominant trait.
- If an organism is heterozygous, half of the offspring will show dominant trait and the remaining half will show the recessive trait in 1:1 ratio.

Example:

A cross between tall plant and short pea plant, given that a gene for tallness is dominant.

a) If one of the parents is homozygous tall then all F_1 will be phenotypically tall.

Let T be gene for tallness
t be gene for shortness
Parental phenotype tall x short
Parental genotype TT x tt
Therefore, all F1 individuals will be continue phenotypically tall

b) If one of the parents is heterozygous tall then offspring will be 50% tall and 50% short

Parental phenotype tall x short

Parental genotype Tt x tt

Two offspring are phenotypically tall and two (2) phenotypically short. The ratio is 2:2 which is 1:1, percentage is 50% tall and 50% short.

BACK CROSS:

This is the cross between an offspring and its homozygous parent.

- The difference between test cross and back cross is that, in test cross an individual is crossed with any homozygous recessive individual and not necessarily the parent of that organism as in the case of back cross.

PUNNET SQUARE

Punnet square is the chart showing possible combination of factors among the offspring.

Punnet square is a check box diagram used to illustrate the formation of zygotes. It is used to show the crosses.

- The female gametes are placed on the right-hand side (horizontally) while the male gametes are placed on the left side (vertically).
- Symbols for male and female gametes are; -

♀ - Represents female gametes

♂ - Represents male gametes

Example: A cross between homozygous tall male and heterozygous tall female can be shown as follows.

- **Let**: T be gene for tallness

t be gene for shortness

Such that:

TT = homozygous tall plant

tt = homozygous short plant

Tt = heterozygous tall plant

The cross:

- Female genotype: Tt

Male genotypes: TT

♂ \ ♀	T	t
T	TT	Tt
T	TT	Tt

Phenotypes: All offsprings are tall

Genotypes: 2 offspring are homozygous tall and 2 offspring are heterozygous tall.

SIMPLE MENDELIAN TRAIT IN HUMAN:

- Mendel 's work is centered on a pattern of inheritance of traits in garden pea plants. Other studies have revealed that, there are some traits in other organisms that follow closely the pattern of Mendelian inheritance. Such traits are called ***simple Mendelian traits***.

The following are examples of Mendelian traits in human; -

1. Albinism
2. Hemophilia
3. Tongue rolling
4. Color blindness
5. Sickle cell anemia
6. Rhesus factor

1. ALBINISM:

This is a hereditary condition characterized by lack of melanin in the skin, hair and eyes.

- Melanin is responsible for the pigment color. Albino has light skin; white hair and the eyes are pink or red while the iris varies from a dull grey in color.
- Albinism is controlled by a **recessive gene** represented as "a".
- Homozygous recessive individual for the gene is albino, 'aa'.
- A gene for melanin production is dominant therefore, the genotypes for a person with normal pigmentation are; -
  - AA – homozygous normal and
  - Aa - heterozygous normal (carrier)
- The genotypes for albinism are
  - "aa" – homozygous recessive (albino)

Example:

What will be the result for normal skin man who marries an albino?

Let "A" – be gene for normal skin pigment

"a" – be gene for albinism

Then: The genotypes for normal man are either:

"AA" – Homozygous normal OR

"Aa" – heterozygous normal

i) If the man is "AA":

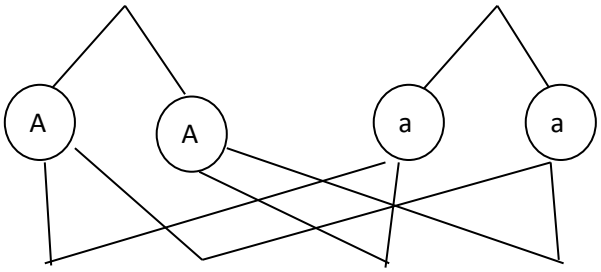
Parental phenotypes: *Normal man x Albino woman.*

Parental genotypes: *Homozygous normal man x Albino woman*

Parent genes AA x aa

Meiosis

Gametes formed



Random fertilization

Offspring genotypes: Aa Aa Aa Aa

Offspring phenotype: All are normal

From the above crossing diagram:

Phenotypes: *All offspring were normal*

Genotypes: *All offspring were heterozygous normal (carriers)*

ii) If the man "Aa"

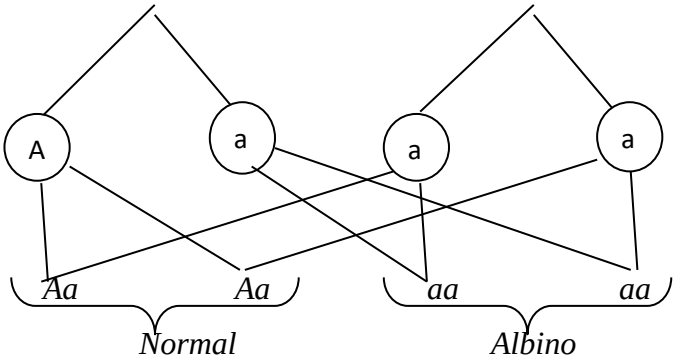
Parental phenotypes: *Normal skin color man x albino woman.*

Parental genotypes: *Heterozygous normal skin man x albino woman*

Genes *Aa* *x* *aa*

Meiosis

Gametes formed



Random fertilization

Offspring genotype: *Aa* *Aa* *aa* *aa*

Offspring phenotype: *Normal* *Albino*

From the above crossing diagram:

Phenotypes: *2 will have normal skin color,2 will be albino*

Genotypes: 2 will be heterozygous normal skin color (carriers) 'Aa' and 2 will be albino (aa)

Questions:

1. What is the result of a cross between two heterozygous parents for Albinism?
2. Albinism is controlled by a recessive gene. A person who is homozygous recessive suffers from albinism while a person who is homozygous dominant or heterozygous does not suffer.

(a) What will be the result of a normal man who married an albino woman?
(b) What would be the result of a cross between heterozygous parents?
(c) What would be the result of a cross between a heterozygous parent with an albino parent?

(d) What would be the result of a cross between a heterozygous parent and a homozygous normal parent?

NB:

- Lack of melanin in the skin can lead to sunburn due to exposure to ultraviolet radiation.
- Albino cannot control the amount of light entering their eyes so their vision is interfered in bright light.
- Albinos are advised to cover most of their body parts with clothing to protect their bodies from sunburn and to put on sunglasses in bright light to protect their eyes.

HAEMOPHILIA:

This is a hereditary trait characterized by delayed blood clotting resulting in prolonged bleeding. It is determined by a gene carried in X chromosome. It is also characterized by a tendency to bleed in the skin, muscles and joints.

- A small skin injury can lead to death due to prolonged bleeding
- Hemophiliac girls rarely live beyond puberty because of excessive menstrual bleeding.
- Hemophilia is controlled by a **Recessive gene** located in X chromosome.
- It is more common in males than in females.
- Homozygous recessive female (and recessive males for the gene) individuals are hemophiliac while dominant males for the gene and homozygous dominant females are normal whilst heterozygous females are normal but carriers.
- The incidence of hemophilia can be reduced by avoiding marriages between heterozygous individuals.

Examples:

1. If hemophiliac man marries heterozygous woman how many children will be hemophiliac and how many will be normal?

Let: X^H - *be gene for normal individual*

X^h - *Be gene for hemophiliac individual*

Such that:

X^HX^H = *homozygous normal woman*

X^HX^h = *heterozygous normal (carrier) woman*

X^hX^h = *hemophilia woman*

X^HY = *normal man*

X^hY = *hemophiliac man*

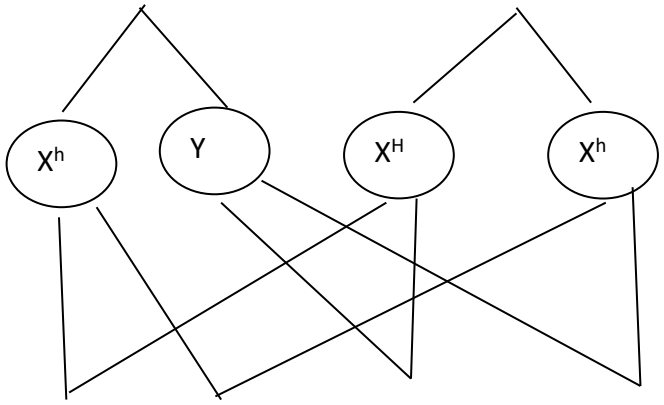
Parental phenotype: *Hemophiliac man x normal woman*

Parental genotypes: *Hemophiliac man x heterozygous normal woman*

Parent Genes: X^hY *x* X^HX^h

Meiosis

Gametes formed



Random fertilization

Offspring genotypes X^HX^h X^hX^h X^HY X^hY

Offspring phenotypes: *Normal* *Hemophiliac* *Normal* *Hemophiliac*

From the above crossing diagram:

- **Offspring phenotype:***2 is normal, 2 are hemophiliac*
- **Offspring genotype:***1 is heterozygous normal female (X^HX^h), 1 is hemophiliac female (X^hX^h), 1 is normal male (X^HY) and 1 is hemophiliac male (X^hY)*

Questions:

1. Hemophilia is a hereditary trait controlled by recessive gene located on X chromosome. Heterozygous and homozygous dominant females are normal while a homozygous recessive female is hemophiliac. If a normal man marries a hemophiliac woman, what would be the genotypes and phenotypes of the offspring?
2. If a gene for hemophilia is carried by a sex-chromosome and controlled by a recessive gene, what will be the genotypes of the filial one generation if normal man marries a carrier woman?

3. SICKLE CELL ANAEMIA:

This is a genetic disorder that makes the red blood cells assume a sickle shape. It is controlled by a **recessive gene.**

- When the red blood cells are sickle-shaped, their ability to carry oxygen is too much reduced causing anemia.
- The inheritance of sickle cell anemia can be reduced by avoiding marriage between closely related people.
- The gene responsible for sickle-cell anemia has two possible alleles: Hb^swhich is a sickle cell gene and Hb^A which is a normal gene. The Hb^A is a normal gene which is dominant while Hb^s is a recessive gene.

Example:

A normal man but carrier for sickle cell anaemia marries a sickle celled woman. Give; -

i. The phenotypes of the parents
ii. The genotypes of the parents
iii. The phenotypes and genotypes of the offspring
iv. The percentage of children living with sickle cell anaemia.
v. The percentage of normal children

Solution:

Let Hb^A – be gene for normal red blood cell

Hb^S – be gene for sickle cell anaemia

Such that:

Hb^AHb^A = homozygous normal red blood celled person

Hb^AHb^s = Heterozygous normal red blood celled person

Hb^sHb^s = Sickle-celled person

Parent phenotype: *Normal red blood cell man x Sickle cell woman*

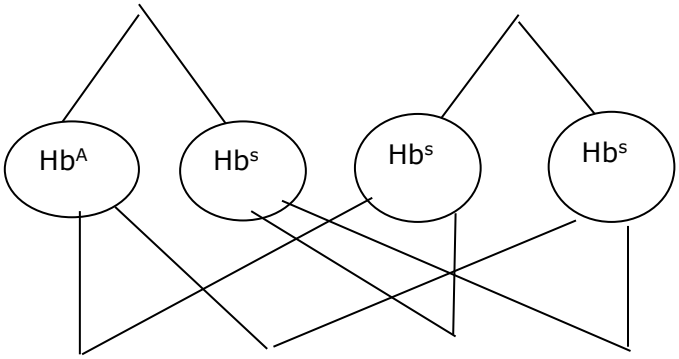
Parent genotype: *Heterozygous red blood cell man x Sickle cell anaemia woman*

Parent genes Hb^AHb^S *x* Hb^SHb^S

Meiosis

Gametes formed

Random fertilization



Offspring genotypes: Hb^AHb^S Hb^AHb^S Hb^SHb^S Hb^SHb^S

Offspring phenotypes: *Normal but carrier* *Sickle called anaemia*

iii) Phenotypes of offspring

- 2 are normal, 2 are sickle cell anaemia

Genotypes of the offspring

2 are heterozygous normal (carriers) – Hb^AHb^S

2 are sickle cell anaemia (Hb^SHb^s)

iv) The percentage of children with sickle cell

$^2/_4$ x 100 = 50%

∴ 50% of the children will be normal

Heterozygotic advantage:

Normally the plasmodia reside in the red blood cells in the body since they have no nucleus so that they can be well adapted to their function. When they reside there, they grow and replicate themselves to the maximum capacity of the cell. After this event the cell bursts and release the plasmodia and they attack other red blood cells.

The sickle cell gene is a lethal gene – meaning that it is a gene that is fatal to cause death. So, the red blood cells with the gene for sickle cell, does not support the growth nor replication of the plasmodia.

The plasmodia remain dormant, hence fail to grow nor to replicate till their demise. Therefore, people who are heterozygotic sickle cell anemia, will never suffer from malaria.

4.COLOR BLINDNESS:

This is the hereditary trait characterized by the inability to distinguish between certain colors of the light spectrum. The most common color blindness is Red-green color blindness in which an individual fails to distinguish red from green color. Color blindness is controlled by a **recessive gene carried on X chromosome**

- Homozygous recessive female individuals and recessive males are color blind while homozygous dominant female and dominant male individuals are normal whilst heterozygous females are normal but carriers.

Let: $\mathbf{X^C}$ – be gene for normal individual

X^c – be gene for color blindness

Then:

X^CX^C – Normal female individual
X^CX^c – Normal female individual but carrier
X^cX^c - Color blind female individual
X^CY – Normal male individual
X^cY – color blind male individual

Example:

Color blindness in human is caused by a recessive gene carried by X chromosome. If a carrier woman marries a color blind man.

a) What is the probability that the first child will be color blind?
b) What is the percentage of getting a normal child?
c) What is the percentage of getting a carrier child?

Let: X^C – be gene for a normal individual

X^c – be gene for color blind individual.

Such that:

X^CX^C – Normal female individual
X^CX^c – Normal female individual but carrier
X^cX^c - Color blind female individual
X^CY – Normal male individual
X^cY – color blind male individual

Then:

Genotype of carrier woman - X^CX^c

Genotype of color blind man - X^cY

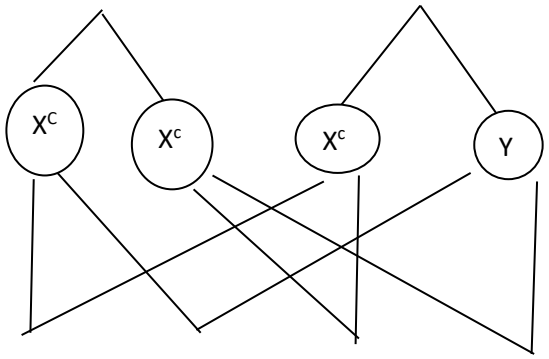
Parent phenotypes: *Normal woman x color blind man*

Parental genotypes: *heterozygous normal woman x color blind man*

Parental genes X^CX^c *x* X^cY

Meiosis

Gametes formed



Random fertilization

Offspring genotypes X^CX^c X^CY X^cX^c X^cY

Offspring phenotypes: **Normal (carrier) Normal colorblind colorblind**

From the above crossing diagram:

- **Offspring phenotypes:***2 is normal, 2 are color blind*
- **Offspring phenotype**: *1 is normal but carrier (heterozygous normal) female, 1 is normal male, 1 is color blind male and 1 is color blind female.*

a) Probability of the first child to be color blind:

Probability: number of chances for an event
Number of possible events

$^2/_4 = 0.5$

The probability is 0.5

b) The percentage of getting a normal child is:

$^2/_4$ x 100% = 50%

- **The percentage is 50%**

- The percentage of getting a carrier child

$^1/_4$ x 100% = 25%

- **The percentage is 25%**

Question:

1.Normal man marries a woman who is a carrier for color blindness gene.

Calculate the percentage of getting.

i) Color blind child
ii) Homozygous normal children

2.Color blindness is a hereditary trait controlled by a recessive gene located on the X chromosome. Homozygous dominant and heterozygous females are normal and have the ability to distinguish colors while homozygous recessive females are color blind. What would be the genotypes and phenotypes of the offspring if a color blind man marries a homozygous normal woman?

3.Color blindness is a sex-linked character controlled by a recessive gene located on the X-chromosome. Only homozygous females suffer from this condition. It is more common to males. What percentage will the males suffering from color blindness be if a normal male marries a color blind female?

5. TONGUE ROLLING:

This is the ability of some people to roll their tongue into U-Shape.

- Tongue rolling is a hereditary trait controlled by **dominant gene.**
- Heterozygous and homozygous dominant individuals are tongue rollers while homozygous recessive individuals are non-tongue rollers.
- That is:

Let R = dominant gene for tongue rolling
r = recessive gene for tongue rolling

Then :

RR - Homozygous dominant (Tongue roller)

Rr- Heterozygous dominant (Tongue roller)

rr – Homozygous recessive (non – Tongue roller)

Example:

John is a tongue roller. He marries a woman who is a non – tongue roller. Show all the offspring obtained.

Solution:

Let: R-be gene for tongue roller
r-be gene for non-tongue roller

Such that:
RR = homozygous tongue roller
Rr = Heterozygous Tongue roller
rr = homozygous non-Tongue roller

Then:

- The genotype of John who is a tongue roller can be either "RR or Rr"
- The genotype of a woman – non tongue roller is "rr"

1st case: If John is RR

Parental phénotype : *Tongue roller x non Tongue roller*

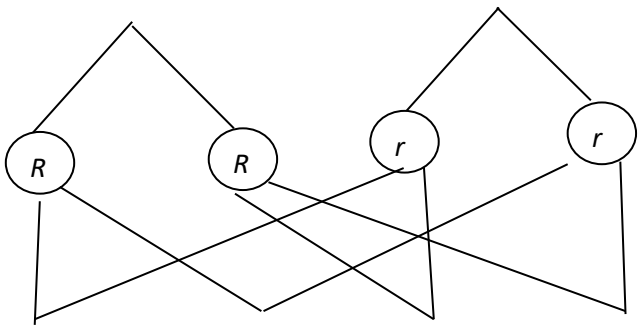
Parental genotype: *Homozygous tongue roller x homozygous non-tongue roller*

Parental genes: *RR x rr*

Meiosis

Gamete formed

Random fertilization



Offspring genotypes: *Rr* *Rr* *Rr* *Rr*

Parental Phenotypes: *All are tongue rollers*

From the above crossing diagram:

- **Offspring phenotypes:** *All are tongue rollers*
- **Offspring genotypes:** *All heterozygous tongue rollers (carriers)*

Second case: when John is Rr

Parental phenotypes : *Tongue roller x non Tongue roller*

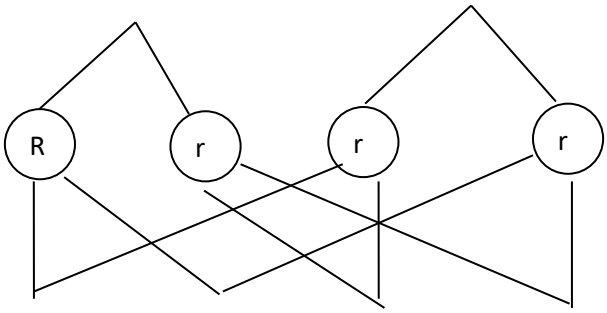
Parental génotypes : *Heterozygous Tongue roller x homozygous Non-Tongue roller*

Parental genes Rr x rr

Meiosis

Gametes formed

Random fertilization



Offspring genotypes Rr Rr rr rr

Offspring phenotypes: Tongue roller Non -tongue rollers

From the above crossing diagram:

- **Offspring phenotype:***2 are tongue rollers, 2 are non-tongue rollers*
- **Offspring genotype:***2 are heterozygous tongue rollers, 2 are homozygous non-tongue rollers*

Question:

Alex who is heterozygous tongue roller married a woman who is also heterozygous tongue roller. Give.

i) The percentage of getting children who are homozygous tongue rollers.
ii) The percentage of non – tongue roller children
iii) The probability of getting any tongue roller child

Non-Mendelian Inheritance

This describes the traits whose inheritance do not follow Mendelian pattern of inheritance. These include:

1. Multiple alleles inheritance

2. Co-dominance inheritance
3. Incomplete dominance

1. MULTIPLE ALLELE

Cases studied in Mendelian inheritance shows that each character is controlled by a gene which may have appeared in one or two forms of alleles. Multiple alleles refer to condition when a single character is controlled by three or more alleles e.g., blood groups, eye color in mice, etc.

BLOOD GROUPS:

In human, the ABO blood group system is a heritable characteristic passed from parent the offspring.

There are four blood groups: -

a) Blood group A
b) Blood group B
c) Blood group AB
d) Blood group O

Blood group is determined by three alleles/ genes A, B and O these three alleles are responsible for production of antigen in red blood cell.

Hence:

Allele/Gene	Antigen
I^A	A
I^B	B
I^O	None

- The genes for blood groups are represented by letter I.
- Allele /gene I^O is recessive to both I^A and I^B
- Allele /gene I^A is dominant over gene I^O
- Allele I^B is dominant over gene I^O
- Allele/gene I^A and I^B are co-dominant to each other; they both express themselves in the phenotype.

Blood group (Phenotype)	Possible genotype
A	1^A1^A or I^AI^O
B	I^BI^B or I^BI^O
AB	I^AI^B
O	I^OI^O

Example:

Determine the genotype of parents if: -

a) One parent is blood group A and the other is blood group B but all the groups are represented among the children.
b) One parent is blood group B and the other is blood group O but half of the children are blood O and half are blood group B.

c) One parent is blood group AB and the other is blood group A but half of the children are blood group A and the other half one blood group A.

Solution:

a) Parent blood group A = 1^A1^A or I^AI^O

Parent blood group B = I^BI^B or I^BI^O

Offspring are blood groups A, B, AB or O

Then:

Parental phenotype: *Blood group A x Blood group B*

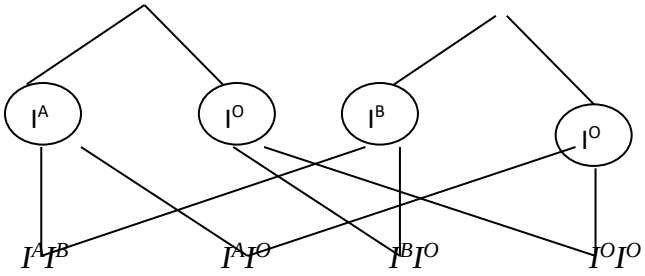
Parental genotype: *Heterozygous blood group A x Heterozygous blood group B*

Parental **genes:** I^AI^O *x* I^BI^O

Meiosis

Gametes formed

Random fertilization



Offspring genotype I^AI^B I^AI^O I^BI^O I^OI^O

Offspring phenotype: *AB* *A* *B* *O*

Conclusion: The genotype of the parents must be I^AI^O and I^BI^O which will give children of blood group A, AB, B, O

b) The genotype of parent with blood group B is either I^BI^B or I^BI^O

The genotype with blood group O is I^OI^O

Then:

Parental phenotypes: Blood group B x blood group O

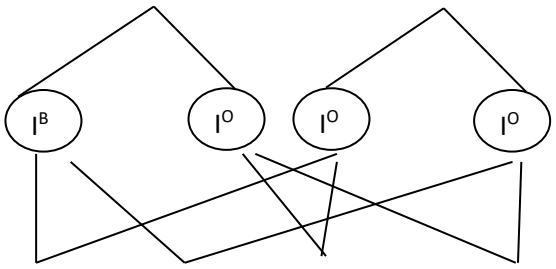
Parental genotypes: Homozygous blood group B x heterozygous blood group B

Parental genes I^BI^B *x* I^BI^O

Meiosis

Gametes formed

Random fertilization



Offspring genotype I^BI^O I^BI^O I^OI^O I^OI^O

Offspring phenotype: *2 are blood group B, 2 are blood group O*

The percentage is 50% of the offspring will have blood group B while 50% will have blood group O.

Conclusion:

The genotype of the parent must be I^BI^O and I^OI^O which will give children with blood group B and O by half.

Solution c:

- The genotype of parent with blood group AB is I^AI^B
- The genotype of parent with blood group O is I^OI^O

Then:

Parental phenotype: *Blood group AB x Blood group O*

Parental genotypes: *Blood group AB* *x* *Blood group O*

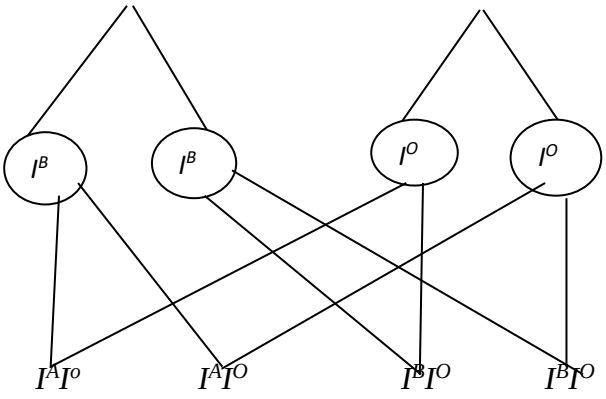
Parental genes: I^AI^B *x* I^OI^O

During meiosis

Gametes formed

Random fertilization

Offspring genotype:



Offspring phenotype: 2 are blood group A, 2 are blood group B

Hence: 50% is blood group A and 50% is blood group B

Conclusion:

The genotype of the parents must be I^AI^B and I^OI^O which will give a half child with blood group A and half with blood group B.

2. **CO-DOMINANCE**

   Co-dominance occurs when both alleles are expressed equally in the phenotype of the heterozygote. The red and white flower in the figure below has co-dominant alleles for red petals and white petals

3. **INCOMPLETE DOMINANCE**

Incomplete dominance occurs when the phenotype of the offspring is somewhere in between the phenotypes of both parents; a completely dominant allele does not occur.

For example, when red snapdragons (CRCR) are crossed with white snapdragons (CWCW), the F1 hybrids are all pink heterozygotes for flower color (CRCW). The pink color is an intermediate between the two parent colors. When two F1 (CRCW) hybrids are crossed they will produce red, pink, and white flowers. The genotype of an organism with incomplete dominance can be determined from its phenotype (Figure below).

		White Flower	
		C^W	C^W
Red Flower	C^R	C^RC^W	C^RC^W
	C^R	C^RC^W	C^RC^W

Pink petals of a flower due to incomplete dominance

The flower has pink petals because of incomplete dominance of a red-petal allele and a recessive white-petal allele.

SEX DETERMINATION:

Sex is a condition of being a male or female.

In human cells there are 23 pairs of homologous chromosomes

- 22 pairs (42 chromosomes) are Autosome chromosomes and 01 pair (02 chromosomes) are sex – chromosomes.
- The sex chromosomes determine sex of an individual in human beings.
- These two chromosomes are X – Chromosome and Y chromosome.
- A female individual carries two X – chromosomes (XX) while a male individual carries X – chromosome and Y – Chromosome (XY).

Hence: The female genotype is XX

The male genotype is XY

- The two sex chromosomes in females are similar in shape and size and are said to be *homogametic (XX)* while the two sex chromosomes in males are different in shape and size and are said to be *heterogametic (XY)*.
- The male produce two types of sperms, half of them containing 22 autosomes plus Y chromosome, and the other half containing 22 autosomes plus the X- chromosome. ***(22 + Y = 23 or 22 + X = 23)***
- A female produces one type of eggs all containing 22 autosomes plus an X-Chromosome. ***(22 + x = 23)***
- During fertilization one sperm fuses with an egg to form a zygote.

Hence:

- If a sperm carrying a Y – chromosome fuses with an egg (ovum), the zygote formed will have 44 autosomes plus the XY chromosomes. This will produce a male zygote.
- If the sperm carrying x – chromosome fuses with an egg (ovum) the zygote formed will have 44 autosomes plus XX chromosomes. This will develop into a female zygote.

That is:

Consider the genetics diagram below:

Parent phenotype *Male* *x* *Female*

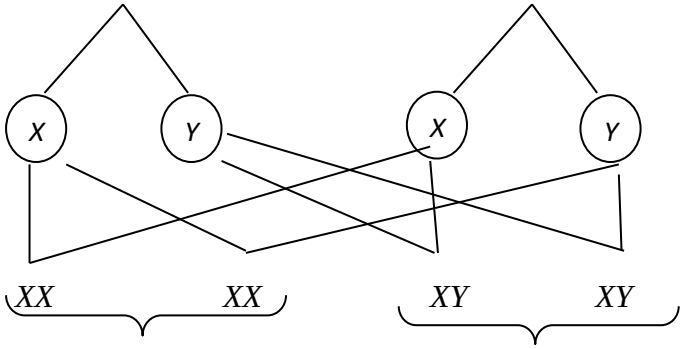
Parental genotype *XY* *XX*

Meiosis

Gamete formed

Random Fertilization

Offspring Genotypes



Offspring phenotypes *Female* *male*

From the above crossing diagram:

Two offspring are girls while two are boys

Phenotypic ratio 1:1

Percentage: 50% boys – 50% girls

Hence:

The one who determine the sex of an individual is a male (father) since the Y – chromosome which determine the male sex are formed in male only.

- This means that, mothers cannot be blamed for not having a male child.

SEX LINKAGE:

These are characteristics which are inherited together with sex chromosomes. The gene responsible for them are located on the sex – chromosomes

SEX LINKED GENE:

These are genes located on sex – chromosomes. Most sex-linked genes are on the X – chromosome because it is large in size while Y – Chromosome carries very few of such genes if any because of its small size.

SEX – LINKED TRAIT/CHARACTERISTICS:

- Are traits whose expression is governed by sex – linked gene/allele

OR

- Sex linked traits/characters are those traits whose genes are carried on the sex chromosomes.

Examples:

- Hemophilia
- Hairy ears
- Red- green color blindness

Example:

Genotypes for hemophilia

Let: X^H – be gene for normal

X^h - gene for hemophilia

Phenotype	**Genotype**
Normal female	X^HX^H
Normal but carrier	X^HX^h
Hemophiliac female	X^hX^h
Hemophiliac male	$X^h Y$

Example 1:

A gene for hemophilia is carried by sex chromosomes and controlled by recessive gene. If a normal man marries a carrier woman show the offspring genotypes and phenotypes.

Soln:

Let X^H – be a gene for normal individual

X^h – be a gene for hemophiliac individual

Genotype for the normal man – X^HY

Genotypes for carrier woman – X^Hx^h

Then:

Parental phenotype: *normal male x normal female*

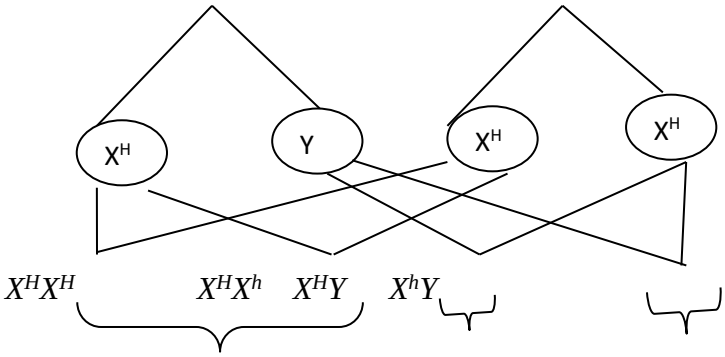
Parental Genotypes: *normal male x heterozygous normal female*

Parent genes: X^HY x X^HX^h

Meiosis

Gametes formed

Random fertilization



Offspring genotype X^HX^H X^HX^h X^HY X^hY

Offspring phenotype *Normal woman Normal man hemophiliac man*

From the above crossing diagram:

Offspring phenotype: *2 are normal women, 1 is normal man and 1 is Hemophiliac man*

Offspring genotype: *I homozygous normal woman (X^Hx^H), 1 is heterozygous normal woman (X^Hx^h) – carrier, 1 is normal man (X^HY), 1 is Hemophiliac man (X^hY)*

Exercise:

Explain why hemophilia affects males more than females.

Answer:

Because a single recessive allele in male cause hemophilia while a female would be a carrier.

SEX – LIMITED CHARACTER/TRAITS:

These are traits/characteristics restricted to one sex only.

- Sex limited trait gene is carried by both male and female. However, these genes are activated by hormones.
- E.g. (1) Beards in humans which develop as a result of production of male Hormones.

(2) Baldness in males

(3) Hairy pinna and nose in males

Genes for such traits may be carried on autosome chromosomes

SEX INFLUENCED CHARACTERS /TRAITS:

These are characters/traits that tend to be more easily seen/conspicuous in one sex than the other. They could be caused by the expression of a gene.

e.g. (i) Breast are more conspicuous in female than in male

(ii) Long hair of the male lion

(iii) Big comb of the cockerels

SEX PREFERENCE

Sex preference is tendency of favoring one sex (gender) to the other. This promotes sex discrimination in the society.

Sex selection: Choosing the preferred sex (gender) of the baby to be born.

Causes of Sex Preference:

i) Land ownership
ii) Wealth inheritance
iii) Clan and sex name
iv) Dowry/bride price

Disadvantages of sex preference:

i) Conflicts – families find themselves in conflicts which may lead to divorce, hence street children.
ii) Lead to inequality and discrimination between males and females in the society
iii) Boys being educated and given ample time to play and learn while girls stay at home and do home activities.

Questions 01:

Color blindness is a sex – linked trait.

i) If a color blind man marries a normal woman show how the offspring will be.
ii) Why color blindness is more common in males than females?
iii) If a carrier woman marries a normal man, some of their sons will suffer from color blindness while others will have normal vision, some daughters will be carriers while the rest will have normal vision. Show the above using genetic diagram.

Question 02:

Hemophilia is a sex – linked trait caused by a recessive gene carried on the X – Chromosome. A carrier woman marries a normal man. Using letter H to represent the dominant gene; -

a) Work out the genotype and phenotype of F1 generation
b) What is the probability of the couple getting hemophilia son?

Question 03:

Color blindness in human beings is caused by a recessive sex-linked gene. If a carrier woman marries a color blind man, using letter C to represent dominant gene:

a) What is the probability that their first child will be color blind?
b) If man's mother was color blind what was her genotype?
c) What proportional of all children are expected to be normal?

GENETIC MATERIAL

The *cell* contains *nucleus*. The nucleus contains thread-like structures called *chromosomes*. Chromosomes are made up of *genes*. Genes are composed of *nucleic acids* called *Deoxyribonucleic Acid (DNA)*.

Apart from DNA there are other nucleic acids called *Ribonucleic Acids (RNA)* which are found in both the cytoplasm and in the nucleus of the cell.

All RNAs are made in the nucleus by DNA by the process known as transcription. *DNA and RNA are the genetic materials of the cell*.

Types of chromosomes:

There are two types of chromosomes in the nucleus of the cell of human.

(a) *Autosome* chromosome

(b) Sex-chromosome (*Heterosome*)

a) Autosome chromosome:

They carry all genetic information except that of sex. In humans, the autosome chromosomes are 44 in number *(22 pairs of homologous chromosomes)*

b) Sex chromosome (Heterosome)

A chromosome that determines sex of the organism in human. There are two sex chromosomes which form one pair. These are: -

- X – Chromosomes and
- Y-chromosomes

Therefore, male individuals carry XY while female individuals carry XX chromosomes. *(That is, xx-females, xy-males)*.

These chromosomes carry the genes in a linear sequence.

GENE:

Genes are nucleotide chemical unit of inheritance arranged along chromosomes and are capable of being replicated and mutated.

OR

Gene is a part of chromosome that carries the genetic material responsible for transferring hereditary trait from the parents to the offspring.

- Each gene occupies a specific location on a chromosome known as locus (Loci-plural)
- Genes contain genetic materials made up of chemical substances called nucleic acid.

Types of Nucleic Acids

- There are two types of nucleic acids found in the cell. These are:
    a) DNA – deoxyribonucleic acid
    b) RNA – Ribonucleic acid

DEOXYRIBONUCLEIC ACID (DNA)

DNA is a genetic material contained in the genes which has a double-stranded shape or coil-twisted like a ladder to form a double helix.

Characteristics of DNA:

- It has a double-stranded shape or coil-twisted like a ladder to form a double helix.
- DNA carries genetic information that determines characteristics of an organism.
- DNA is the genetic material of most organisms which is a major constituent of the chromosome within the nucleus.

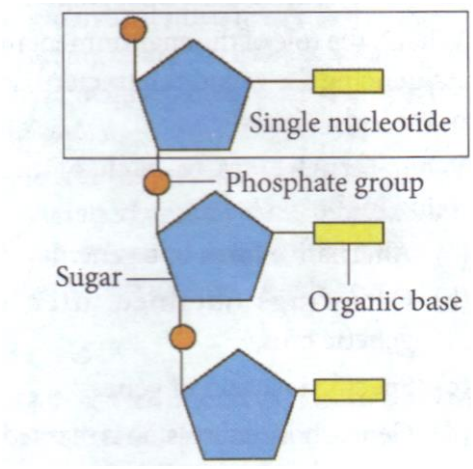
STRUCTURE AND COMPOSITION OF GENETIC MATERIAL:

STRUCTURE OF DNA:

- DNA has a double-stranded shape or coil-twisted like a ladder to form a double helix.
- DNA is made up of units called nucleotides which are arranged to form very long molecules called polynucleotide.
- Each nucleotide consists of deoxyribose sugar, pentose sugar *(five carbon sugar),* phosphate group and organic bases.

Hence the composition of DNA is: -

i) Deoxyribose sugar (five carbon sugar)
ii) Phosphate group
iii) Organic bases



i) Deoxyribose sugar:

- Is a sugar in DNA
- It is a five-carbon sugar (pentose sugar)

ii) Phosphate group:

- It is found in DNA as well as in RNA
- It gives acidic characteristic to the DNA
- This makes frame work of the strand DNA.

iii) Organic bases: (Nitrogenous bases).

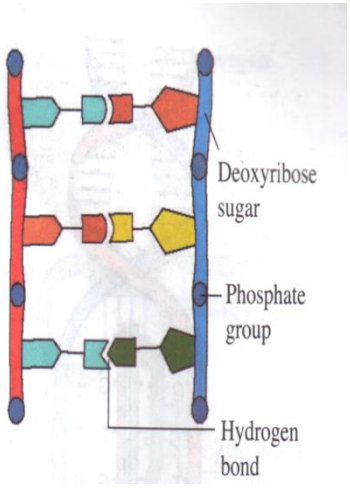
DNA contains four (04) different bases that are: -

- Adenine (A)
- Thymine (T)
- Guanine (G)

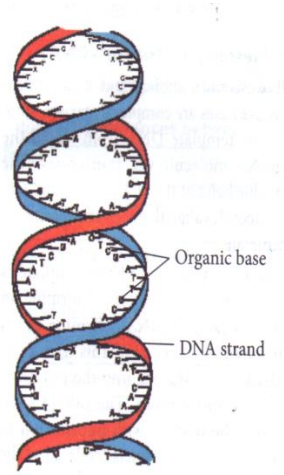
- Cytosine (C)

Guanine and adenine are collectively called purines while cytosine and thymine are collectively called pyrimidines.

The bases combine in such a way that Adenine pairs up with thymine whereas cytosine pairs with guanine. The bases are held together by a weak hydrogen bond.



Untwisted DNA strand



Double Helix Structure of DNA

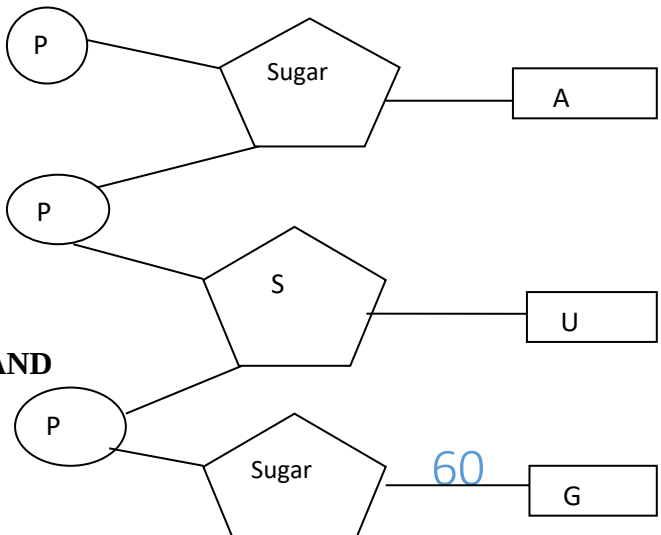
THE STRUCTURE OF RNA:

- RNA is made up of a single strand of polynucleotide
- Polynucleotide is made up of many nucleotides
- Each nucleotide consists of ribose sugar, Phosphate group and organic base.
- RNA has uracil instead of thymine as in DNA, therefore the organic bases in RNA are Adenine(A) Guanine (G) Cytosine(C) and uracil (U)

Hence the composition of RNA is: -

- Ribose sugar, phosphate group, organic bases which are adenine (A), Guanine (G), cytosine (C) and uracil (U)
- RNA is concerned with protein synthesis in the ribosome found in the cytoplasm.
- Most RNA is synthesized in the nucleus and distributed to other parts of cytoplasm.

In some viruses RNA is hereditary materials.



RNA STRAND

There are three (3) forms of RNA:

i) Messenger RNA (M – RNA)
ii) Transfer RNA (t – RNA)
iii) Ribosome RNA (r – RNA)

These are involved with protein in our bodies.

DIFFERENCES BETWEEN DNA AND RNA

No.	DNA	RNA
i.	Has a deoxyribose sugar	Has ribose sugar
ii.	Has organic bases cytosine, guanine, adenine and thymine.	Has Organic bases cytosine, guanine, adenine and uracil
iii.	It has a double strand (double helix)	Has a single strand
iv.	Found in the nucleus, mitochondria and chloroplast	Found in the nucleus and cytoplasm
v.	There is only one form of DNA.	There are three forms of DNA.

VARIATION

Variation is the possession of characteristics that are different among members of a species.

TYPES OF VARIATION:

There are two types of variation. These are;

a) Continuous variation.
b) Discontinuous variation.

Continuous variation:

This is the one which has intermediate forms of traits among organisms in which there is no clear cut (distinction) of traits between individuals, e.g., Height, mass, volume, length and IQ.

- It is controlled by both genes and environmental factors.
- Continuous variation is also known as quantitative trait.

a) Discontinuous variation:

- This is the type of variation whereby there is no intermediate forms of traits among organisms in which there is a clear cut/distinction of the traits between individuals.

e.g., Ability to roll the tongue, whereby the individual may roll the tongue or not.

- Sex, either an individual is a female or a male
- Albinism; An individual is ether an albino or not
- Blood groups; an individual can be blood group A, B, AB or O
- Rhesus factor: an individual is either RH^+ or RH^-
- Ear lobes; an individual has either free ear lobes or attached ear lobes
- Red or white eyes of drosophila

NB: Discontinuous variation is controlled by genes only. It is also known as qualitative variation

CAUSES OF VARIATION:

Variation is caused by environmental factors and genetic factors.

Environmental factors:

a) Food: Lack of certain types of food leads to deficiency disease such as kwashiorkor, marasmus, rickets
b) Light intensity: Affect growth of plants which use it during photosynthesis
c) Pathogens cause diseases to an organism making an individual different from normal ones.

Variation due to environmental factors cannot be inherited because such variations are produced in the body cells (somatic) and not in sex cell.

Genetic Factors:

a) **Meiosis:** During meiosis there is segregation of pairs of chromosomes producing a wide variety of different gametes. The number of combinations depends on pairs of chromosomes. In human being the number of combinations is *2n*, where *n* is haploid number of chromosomes. Therefore, this means n^{23} which are the same as 8388608 combinations. This reduces the chance for the individuals being the same.
b) **Fertilization:** During fertilization the nucleus of the male and female gametes fuse. This permits parental genes to be brought together in different combination in this way desirable and undesirable qualities of the parents can be combined in the offspring.
c) **Mutation;** is the sudden change in genetic material which can be inherited. Mutation is caused by mutagens such as radiations and chemicals. Mutations are more harmful or lethal and a few are beneficial. The individual who has undergone mutation is known as mutant, appear different from the rest of population.
d) **Migration:** Species is not normally uniformly distributed but occurs in small isolated populations known as zones.

An example is fish in different ponds. If the member of another dam migrates and mate with members of other dam, the offspring resulted will have different characters from the parent.

e) Incomplete dominance; The formation of intermediate characters due to failure of two dominant genes to dominate one another:

Different between:

Continuous variation	**Discontinuous variation**
i) There is no clear-cut distinction between the phenotype. E.g., Involves a range of phenotype	i) It shows clear cut distinction between the phenotypes e.g., Male or female
ii) It is controlled by many genes	ii) It is controlled by one or few genes
iii) It is modified by environmental condition	iii) It is not modified by environmental condition

TYPES OF CHARACTERISTICS:

A. Acquired Characteristics:

These are characters or traits of individuals developed as a result of adaptation to the environment. E.g., Body weight, walking style.

B. Inherited characters:

These are characters that are passed on from the parents to the offspring through sexual reproduction. Those characteristics are said to be heritable characteristics

Comparison between

Heritable (Genotypic) Character	**Non-Heritable (Phenotypic) Character**
i) Are due to genes	- Are due to environment e.g., food
ii) Re-appear in the offspring	- Cannot re-appear in offspring
iii) Mainly unchangeable in life time	- Sometimes changeable in life time

APPLICATION OF GENETICS:

i) Genetic engineering
ii) Genetic counseling
iii) Plant and animal breeding
iv) Crime investigation
v) Blood transfusion

1. GENETIC ENGINEERING:

This is the altering of the structure of DNA by man

Genetic Engineering enables to:

i) Carry out research
ii) Manufacturing of animal protein. e.g., Hormones
iii) Improve animal and plant breeds
iv) Correct genetic disorder

Application of genetic engineering in:

(a) **Medicine:** It is applied in medicine whereby different diseases are able to be treated, especially genetic diseases.

Example:

i) Production of insulin hormone for treating diabetes mellitus. In this case the gene in man that codes for insulin is transferred to bacteria to produce pure insulin in large quantities.
ii) Production of human growth hormone.
iii) Vaccines' production.
iv) Blood clotting factors such as fibrinogens needed by hemophiliacs are produced.

(b) Agriculture: -

i) **Production** of herbicides which are resistant to crops are sprayed which selectively kills only weeds leaving crop's healthily growing. This solve the problems that most weed killers are not selective.
ii) **Nitrogen fixation:** Genes are introduced into crop plants for nitrogen fixation without relying on nitrogen fixing bacteria. The nitrogen fixing bacteria are found in the root nodule of leguminous plants. They convert free nitrogen to nitrates which are used as fertilizer to make protein and other organic compounds.

(c) Biological weapons:

Micro-organisms that cause diseases have been used in wars. The micro-organisms are closed and thrown into the territory of the enemy.

Example: i/ *Vibrio cholerae*
ii/ *Salmonella typhi*
iii/ *Bacterium bacillus* (Anthrax)

2. GENETIC COUNSELLING:

Genetic information is used to advice couples who have hereditary disorder about the chances of children inheriting the disorder like sickle cell anaemia, albinism, hemophilia, etc.

Genetic information could also be used in choosing marriage partner.

This simply helps in giving information and advice about the risk of genetic diseases and their outcomes.

3. PLANT AND ANIMAL BREEDING:

Crossing two genetically dissimilar individual of the same species produces individuals that possess beneficial characteristics not shown by either of the parents. The individual (organism) obtained, through crossing the individual with contrasting characters are called hybrids and this process is called hybridization.

4. CRIME INVESTIGATION:

DNA can be extracted from small samples of cell found at the scene of crime. E.g., In traces of blood, hair, saliva, etc. In case of rape, semen can be used. Also finger prints can be used.

5. BLOOD TRANSFUSION AND SETTLE OF PARENTING DISPUTES:

The study of blood groups and Rhesus antigen used in blood transfusion, blood group and DNA can be used for settle parental disputes.

QN: 1. Write an essay on application of genetics with examples where possible.
2. Explain the importance of genetics in biological science and related fields.

MUTATION:

Mutation is the sudden unexpected change in genetic makeup of an organism which can be inherited from one generation to another.

CAUSES OF MUTATION:

There are various factors that cause mutations.

- Factors that cause mutations are called **mutagens** while individuals affected by mutation are called **mutants.**

These factors which cause mutation (mutagens or mutagenic agents) are: -

i) Exposure to radiations like x-rays, gamma rays and ultraviolet rays.
ii) Exposure to certain chemicals like mustard gas, pesticides like DDT, etc.
iii) Exposure to heavy metals e.g., mercury
iv) Exposure to food additives/preservatives e.g., bromated food products.
v) Mutation in the gonads can be accelerated by temperature shock/high increase in temperature.

TYPES OF MUTATION:

There are two types of mutation: -

i) Chromosomal mutation

ii) Gene mutation

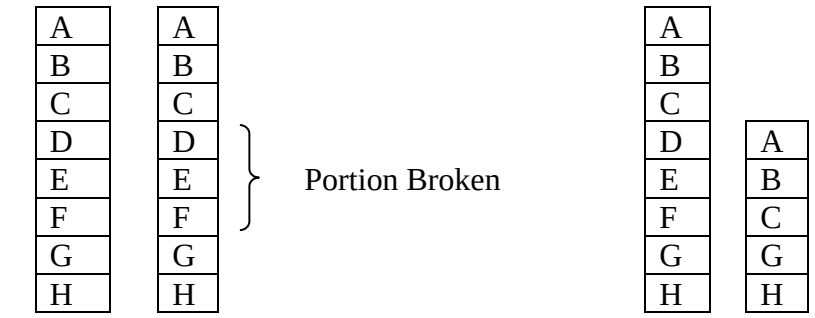
CHROMOSOMAL MUTATION:

Chromosomal mutations are mutations which involve changes in structure and number of chromosomes.

TYPES OF CHROMOSOMAL MUTATION:

i) Deletion:

This occurs when a portion of the chromosome breaks off and fails to reconnect to any of the chromatids. This results to new characteristics in the offspring different from the parents as the genes within the part of chromosome break off are not represented.

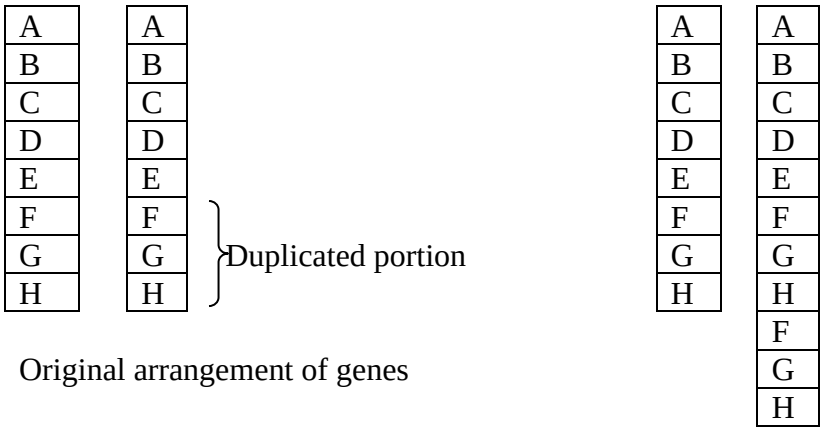


Original arrangement of Genes in a chromosome

Result

ii) Duplication:

This occurs when a portion of chromosome is represented twice.

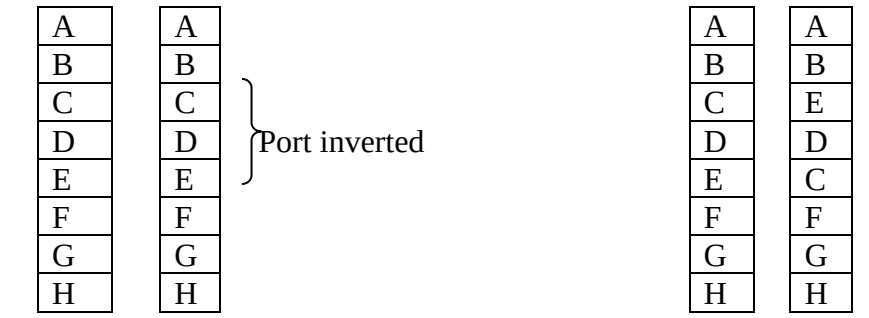


Original arrangement of genes

Result

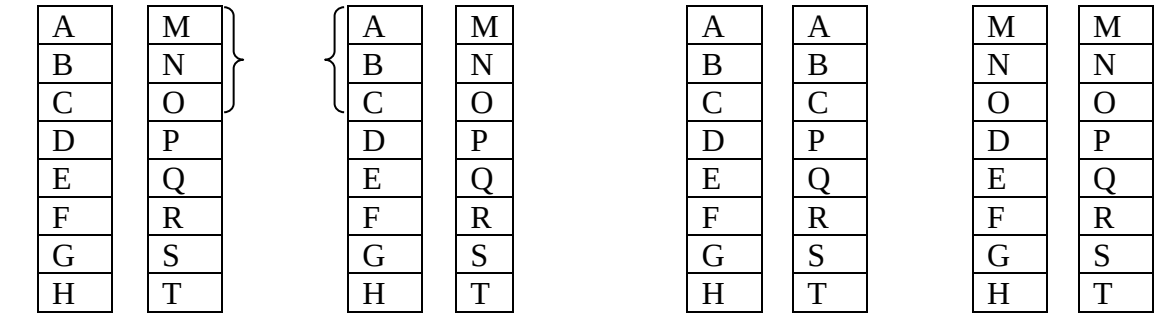
iii) Inversion:

This occurs when a portion of a chromosome breaks and becomes reattached with the genes in a reverse order.



Original arrangement of genes Result

iv) **Translocation:** This occurs when a segment/portion of a chromosome breaks off and becomes attached to another chromosome of a different homologous pair.



Original arrangement of genes Results

GENE MUTATION:

Gene mutations occur as a result of change in the chemical structure of genes when there is a change in the sequence of nucleotides in the segment of DNA which alters the sequence of bases in a gene.

- The gene in which the change occurs is known as a mutant gene
- The mutant gene can be replicated along

TYPES OF GENE MUTATION

i) **Deletion**: This is the removal of a base from a DNA structure. The result is alteration of base sequence reducing the number of amino acids.

E.g., Original nucleotide base: GAT GAT GAT

Mutant nucleotide base: GAT GTG ATG

(A is deleted)

ii) **Duplication:** This occurs when the base in a nucleotide is represented twice also known as insertion.

E.g., Original nucleotide base: GAT GAT GAT

Mutant nucleotide base: GAT GGA TGA

(G is added)

iii) **Inversion:** A portion of DNA strand is cut and inverted. The inversion results in alteration of the base sequence in DNA.

E.g., Original nucleotide base: GAT

Mutant nucleotide base: TAG

iv)**Substitution:** This is the replacement of a base with another

E.g., If thymine (T) of a base triplet ATA on the DNA molecule is replace (substituted) by cytosine the result is a new triplet ACA on the DNA

IMPORTANCE OF MUTATION:

Mutation can increase the ability of some organisms to survive e.g., the resistance to DDT by insects such as mosquito and resistance to penicillin by bacteria.

Effects of Mutation:

Mutation result in genetic disorders. Gene mutations that occur in the sex cells are passed on to the next generation. This is the cause of genetic diseases e.g., sickle cell anemia, hemophilia, color blindness, albinism, etc.

Also, tumors are caused by gene mutation that make a patch of cells divide uncontrollably in which some tumors can be cancerous. **Chromosome mutations** can lead to disorders such as Down's syndrome, Turner's syndrome and Klinefelter's syndromes.

i) Down's syndrome (Mongolism)

This is caused by the presence of an extra chromosome number 21 hence; these individuals have 47 number of chromosomes.

- They have reduced resistance to infections.
- Are mentally retarded
- Show cardiac malfunctions
- Short body with stubby fingers

ii) Turner's Syndrome:

This is an individual with 45 chromosomes (44 + XO) in a cell of 46 chromosomes (44 + xx)

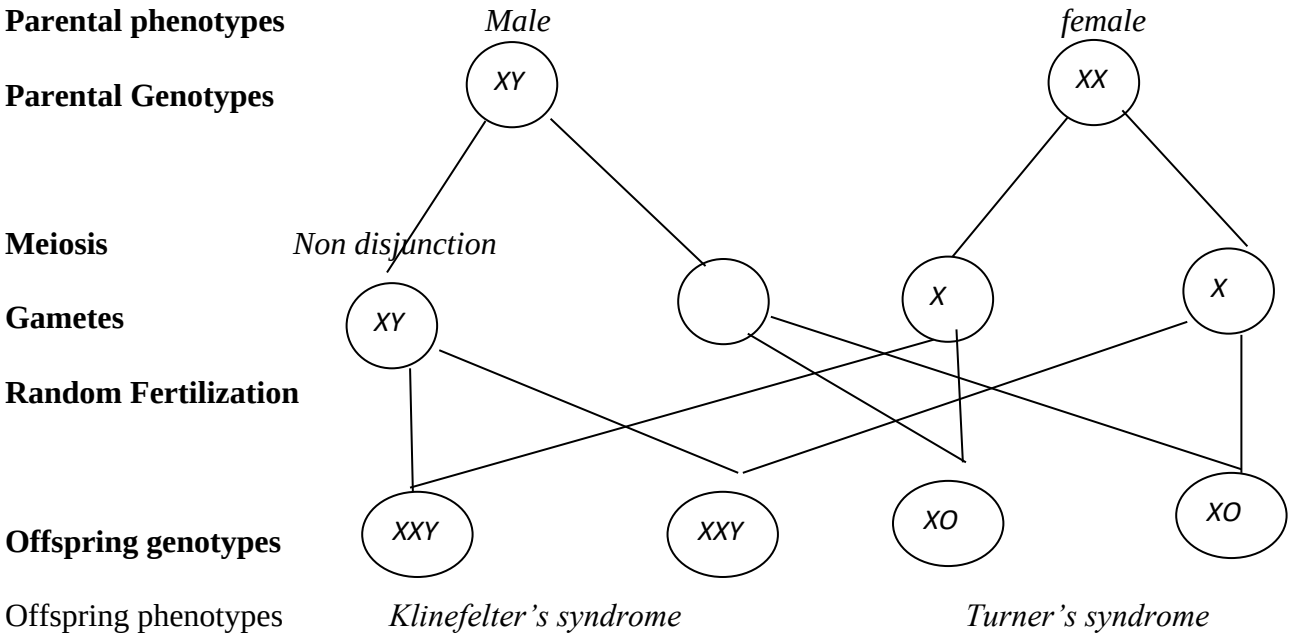
- These individuals have one x – chromosome and no other sex chromosome (XO)
- The individual is a sterile female
- Abnormally short female
- Have neck folds.

iii) Klinefelter's syndrome:

This is caused by failure of the X-chromosome to separate during the process of egg formation.

- An individual with this condition has two x chromosome and one Y – Chromosome (XXY)
- This is sterile male with female like features

NB: These syndromes are a result of meiosis not taking place properly in which the homologous chromosomes fail to separate resulting to addition or loss of one chromosome in a daughter cell.



NB: XXX – normal female while XO–not viable

CLASSIFICATION OF LIVING ORGANISMS

KINGDOM ANIMALIA

General characteristics of the kingdom

- They are multicellular organisms
- They use heterotrophic mode of nutrition
- They are capable of locomotion
- Most animals have nervous system to coordinate body action and response
- They have no cell wall
- They are eukaryotic cell organisms
- They store excess carbohydrates in form of glycogen.

Distinctive features

i) They have nervous system coordination
ii) They are capable of locomotion
iii) They are heterotrophic feeders through ingestion

Members:

Human being, Rat, Jelly Fish, Tape worm, Housefly, Millipede, Beetle, Tilapia, Toad

Habitat of kingdom Animalia

Note:

- Habitat is a place where an organism lives.
- The following are types of habitats:
  (a) AQUATIC (living in water) e.g., tilapia. Aquatic habitat is further grouped into
    (i) Marine (Living in oceans or Seas)
    (ii) Fresh water.
  (b) TERRESTRIAL: (Living on land particularly those which live on the surface of the land)
  (c) AERIAL: The animals which spend most of their time in air, for example some birds and bat.
  (d) Both aquatic and terrestrial

E.g., amphibians (frogs and toads)

  (e) PARASITES: - are those animals which live either wholly or partly on or in the body of other animals and obtain their nourishment from them
    (i) Endoparasite e.g., ascaris
    (ii) Ectoparasite e.g., ticks.

MODE OF NUTRITION

They have heterotrophic mode of nutrition. That is the mode where by organism cannot prepare its own food.

MODE OF REPRODUCTION

They undergo sexual mode of production.

Economic importance of Kingdom Animalia

i) Some animals are source of food. E.g., Meat, Milk and eggs.
ii) Some are source of labor force. E.g., Donkey, Camel and oxen
iii) Some animals produce manures to make the soil fertile e.g., Cattles.
iv)Some animals act as source of tourist attraction e.g., Elephant, lions, Rhino, Zebra, Hippo
v) Other animals are destructive to the environment e.g., termites(wood) elephants (crops)
vi)Animals provide leather (skin used to make shoes, bags, belts)

vii) Animals are used for security purpose e.g., dogs.
viii) Biological control - certain animals can be used to control a population of another species of animals e.g., cats control population of rat.
ix) Animals are used for research work purposes. E.g., rats and guinea pigs for medical research.
x) Certain animals are pollinators. E.g., birds and insects like honey bees.

NOTE:

Animals can be placed into major groups on the basis of the presence or absence of notochord at least at one stage on their development.

NOTOCHORD: is the supporting rod like structure running longitudinally along a dorsal side of the animal persisting throughout the life or may be replaced by backbone.

These animals with notochord are called CHORDATES while those which lack notochord are called NON-CHORDATES.

PHYLA OF KINGDOM ANIMALIA

i) Phylum Platyhelminthes
ii) Phylum Nematoda (Aschelminthes)
iii) Phylum Annelida
iv) Phylum Arthropoda
v) Phylum Chordata

1. PHYLUM PLATYHELMINTHES

The organisms found in this phylum are flat worms and tape worms.

Characteristics of phylum Platyhelminthes

- They have flat body (they are dorsal-vertically flattened)
- They have one opening only(mouth) no anus
- They have hooks and suckers for attachment to the host
- They have segmented body.
- They have no body cavity called Coelom
- They have no digestive, respiratory and circulatory system.

Members:

Liver fluke, Tape worm, Planaria

CLASSES OF PHYLUM Platyhelminthes

a) Class TREMATODA
b) Class CESTODA
c) Class TURBELLARIA

a) CLASS TREMATODA

General characteristics:

- They have flat body
- They have suckers for attachment to host
- They are all parasites

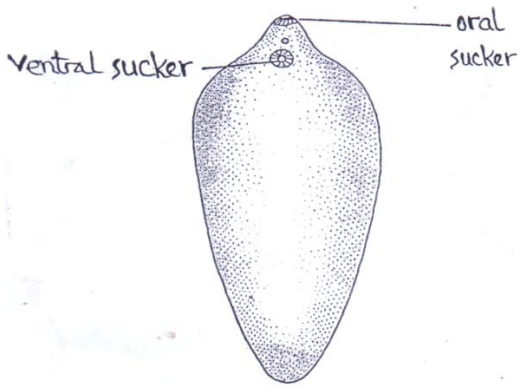
Distinctive characteristics:

- Leaf-like flat body with a thick protective coat
- Have suckers for attachment to host

Members:

Liver Fluke,

Diagram



Liver Fluke

Habitat:

They are parasitic (Endoparasites)

- live in the liver of sheep and cattle
- Some live in blood stream

Economic importance

Advantages

i)Used in biological studies

Disadvantages

ii) Feed on tissue and blood of liver causing a great damage and even death

Adaptations to habitat

- Have thick protective coat to host's digestive enzymes.
- Have suckers for attachment to host

b) CLASS CESTODA

General characteristics: -

- They have flat body
- They are tape-like and narrowing towards anterior end.
- They have segmented body
- They have suckers and hooks for attachment to the host
- They have thick cuticle to resist digestive enzymes
- They have proglottids with reproductive structure (contain both male and female reproductive Organs)
- They are endoparasites.

Distinctive characteristics:

- They have hooks in scolex (Head) for attachment to host
- Lack alimentary canal
- They have proglottids which break off

Members:

Tapeworm, i.e., *Taenia solium*

Habitat:

- They are parasitic (endoparasites)

- They live in small intestine of vertebrates i.e., human being and cattle.

Adaptations to habitat:

- They have thick cuticle to resist digestive enzymes in the host.
- They have suckers and hooks for attachment in the host.

Economic importance

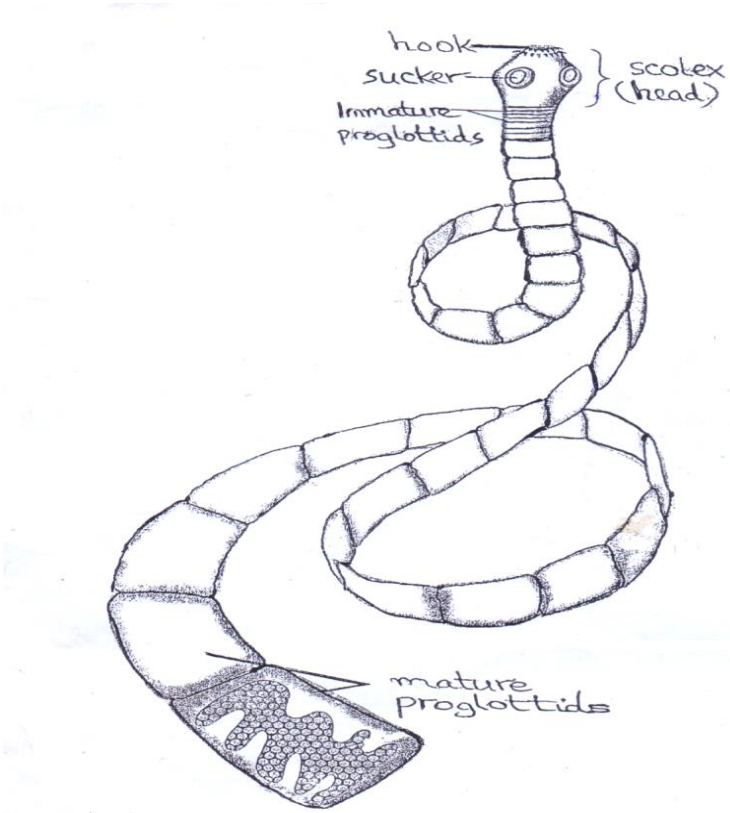
Advantages

i) They are very important resources used in biological studies i.e., Scientific research

Disadvantages

i)Cause diseases in humans such as Taeniasis

ii) They rob food from host causing malnutrition



Tape worm

c) CLASS TURBELLARIA

General characteristics

- They have flat body
- They have cilia on the ventral side of the body.
- Some are free living
- They have only mouth (no anus)

Distinctive features

- They have cilia on the underside (ventral side)
-

Members:

Planaria

Habitat

- They are aquatic living in fresh water.

Economic importance

Advantages

- Used in research
- Planarians have been used to combat mosquitoes with some success

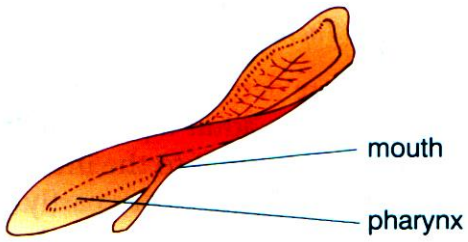
Disadvantages

-
-

Adaptations to habitat

- Their flat body makes them survive without the need for circulatory system. Diffusion and osmosis are enough to deliver oxygen and nutrients from the environment and remove waste materials from the body.
- Ability to regenerate lost parts of the body in case of injuries
- Reproductively, they can easily multiply since they are hermaphrodites
- The free-living planarians have nervous system which enable them to detect and respond to stimuli

Diagram



Planaria

2. PHYLUM NEMATODA /ASCHELMINTHES

This phylum comprises of round worms that may be either parasites or free living (round worms)

General characteristics

- They have unsegmented body
- They have cylindrical body pointed on both ends
- They have a complete alimentary canal with mouth and anus present (They have two opening mouth and anus).
- They are endoparasite/especially on small intestine
- They have no body cavity
- They are bilaterally symmetrical i.e.; their body can be divided into two equal parts.
- They are triploblastic. That is, their body are made up of three layers which are ectoderm, mesoderm and endoderm.

Distinctive features

- They have unsegmented body
- They have round body pointed at both ends (cylindrical body)
- They have no cilia or flagella
- They have cuticle made up of protein

Members

- Ascaris (*Ascarislumbricoides*)
- Hook worm

Habitat

- They are free living in soil, aquatic in both fresh and sea water
- They are endoparasite living in the alimentary canal of animals such as human being and cattle.

Adaptations to habitat

- Their body are covered with a protective thin cuticle (protein)
- The endoparasites have hooks and suckers for attachment to the host.
- The endoparasites have very thin skin to facilitate diffusion of materials
-

Economic Importance of phylum Aschelminthes (Nematoda)

Advantages:

i) Round worm help in decomposition hence improve soil aeration and soil drainage.

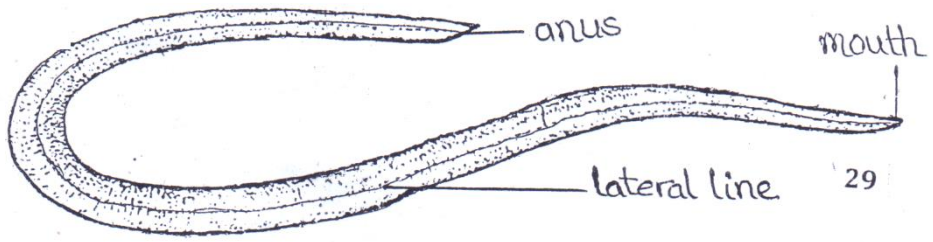
ii) They are used in scientific research as specimen (Are used in studies)

Disadvantages:

i) They cause internal injuries (damage) in human gut.

ii) They cause diseases in man such as elephantiasis

iii) They deprive the host nutrients causing malnutrition.



NOTE:

3. PHYLUM ANNELIDA

General characteristics

- Their body are made up of rings called segment (they have segment body)
- They have a thin moist, non-chitin cuticle
- They have chaeta (Bristles)

Distinctive features

- They have chaetae for movement

MEMBERS: Earthworm, Lungworm

CLASSES OF PHYLUM ANNELIDA

I) CLASS OLIGOCHAETA E.g. Earth worm

II) CLASS POLYCHAETA E.g., Lug worm

III) CLASS HIRUDINEA E.g., Leeches

CLASS OLIGOCHAETA

General characteristics

- They have long cylindrical body pointed at one end

- They don't have distinct head
- They have segmented body.
- Their body have small bristles called chaeta
- They have moist cuticle surrounding the body wall
- They have hydrostatic exoskeleton for movement and support.

Distinctive features

- Have fewer chaetae than polychaetae
- Both sexes are present in a single organism (hermaphrodite)

Members:

Earth worm

Habitat

Earthworm is a terrestrial organism it lives in moist soil.

Adaptations to habitat

- Possess chaetae which aids locomotion
- Thin moist skin for gaseous exchange

Economic importance of earth worm

Advantages

i)They are used by fisherman as bait for catching fish.

ii)They are used as food in some communities

iii)They are used in school for learning /studies

iv)Having established their efficiency in converting organic substrates to composts, they are now widely used in vermicomposting for waste management, production of soil amendments, and other uses

v)These worms have been found to be an excellent source of animal feed protein, essential amino acids, fats, vitamins, and minerals for livestock and fish

vi)They can be processed into human food. They have been used as such by natives of Africa, South America, Japan, China, Papua New Guinea and New Zealand

In farmers

i)Burrowing allows plant roots to grow more easily

ii)Burrowing aerates the soil, providing essential oxygen for respiration of plant roots

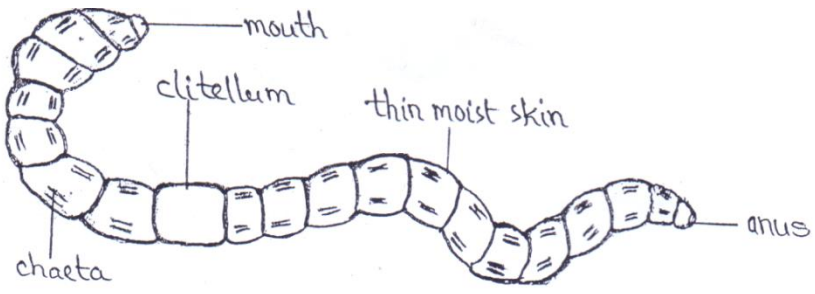
iii)They increase soil fertility through decomposition process.

iv) Burrowing improvers soil drainage and prevent it from becoming water logged

Disadvantages

-
-

Diagram



4. PHYLUM ARTHROPODA

Arthropods are organisms with jointed appendages,

General characteristics

- They have jointed legs/ appendages six or more (3 or more pairs) are present and each has several joints.
- They have segmented bodies
- They have body covered by hard exoskeleton made up of chitin
- They undergo moulting/Ecdysis
- The gaseous exchange occurs through general body surface, Gills and trachea
- The body cavity is much reduced and filled with blood.

Distinctive features

- They have jointed appendages
- They have exoskeleton made up of chitin

Members:

Grasshopper, Crab, Spider, Millipede, Housefly, Beetle, Bee.

Economic importance of phylum Arthropoda

Advantages

i)Some are source of food e.g., locusts are edible
ii) Some produce commercial products, e.g., honey, wax,
iii) They help in pollination of the plants E.g., Butter fly, bees
iv) Some insects (E.g., wasps) are used in biological control of pests.
v) Some improve soil drainage and aeration E.g., Termites. earthworm

Disadvantages

i)Some (E.g., bees) are poisonous. They can sting man to cause serious pain or even death
ii)Disease vectors. E.g., Female anopheles mosquito to malaria, housefly to cholera
iii)Some (E.g., Locusts) are serious pests of food crops.
iv) Ectoparasite such as bugs and lice, these bite man and cause nuisance.

CLASSES OF PHYLUM ARTHROPODA

There are five (05) classes of phylum Arthropoda

These are

(i) Class insecta E.g. Grass hopper
(ii) Class Crustacea E.g., Crab
(iii) Class Arachnida E.g., Spider
(iv) Class Chilopoda E.g., Centipede
(v) Class Diplopoda. E.g., millipede

1. CLASS INSECTA

Distinctive features

- Their body divided into three parts Head, Thorax and Abdomen
- They have three pairs of jointed legs
- They have one pair of antennae for sensitivity
- They have one pair of compound eyes.
- They have exoskeleton made up of chitin
- Most adults form wings, some have one or two pairs of wings.

Members:

Grasshopper, Beetle, Housefly, Black ant, Bee, cockroach, butterfly

Habitat

Most insects are terrestrial free-living organism (live on land)

Adaptation to habitat

i) They have powerful hind legs for hopping e.g., grasshopper.
ii) They have large wings that facilitate flying.
iii) They have sensitive antennae helps to seek food and navigate.
iv)They have spiracles for entry and exit of air, tracheal system for gaseous exchange.
v) They have exoskeleton for protection against physical damage

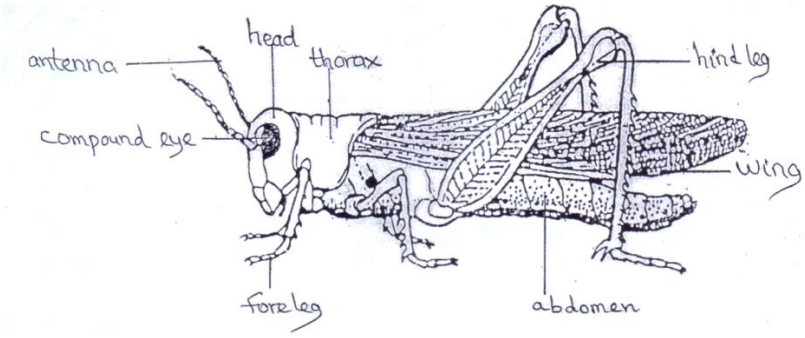
Economic importance of class insecta

Advantages

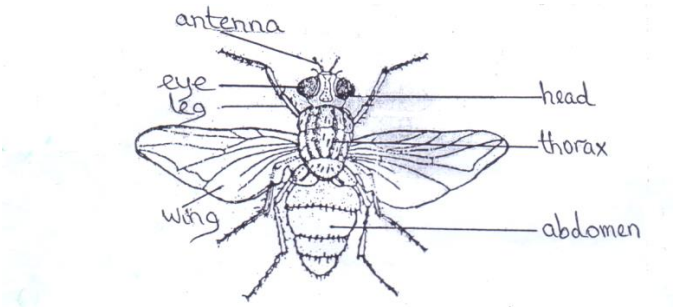
i) Some are edible (can be used as food) e.g., Locusts
ii) Some produce commercial products E.g., Bee produces honey and wax
iii) They pollinate plants through feeding on pollen and nectar. e.g., Housefly, Bee
iv)Some insects are used in the biological control of pests E.g., Wasps
v) Soil dwelling insects feed on dead plants hence speed up decay process. E.g., Termites.
vi)Burrowing insects ((e.g., termites) improve soil aeration

Disadvantages

i) Some are poisonous E.g. Bee can sting man and cause serious pain or even death.
ii) Some transmit diseases E.g., Female anopheles' mosquito to malaria and house fly to cholera
iii) Some are serious pests of food crops. E.g., Locusts
iv)Some are ectoparasites E.g., Tick, Bugs and lice can bite man and cause nuisance.
v) Some are destructive to man's properties e.g., termites (wood)



Grasshopper



Housefly

2. CLASS CRUSTACEA

Distinctive features

- They have two (02) pairs of antennae
- They have bi-forked jointed appendages

General characteristics

- They have two pairs of antennae
- They have bi-forked appendages
- They have (05) pairs of jointed legs.
- Their body divided into two parts Abdomen and Cephalothorax (head fused with thorax)
- They have chelicerae for capturing prey and for defense.

Members:

Crab, Lobster, Shrimps.

Habitat

They live in marine and fresh water (they are all aquatic)

Adaptation to habitat

- Possess Compound eye has thousands of light-gathering units. Each makes its own picture of part of an object. Good for all-around viewing and for spotting movement
- Eyes at ends of long, flexible, retractable stalks
- Two large claws fight off enemies and capture prey
- Antennae are sense receptors that respond to touch and chemical stimuli
- Possess exoskeleton for protection against physical damage

ECONOMIC IMPORTANCE OF CLASS CRUSTACEA

Advantages

(i) Source of food, especially lobsters, shrimps, prawns, crabs and crayfish

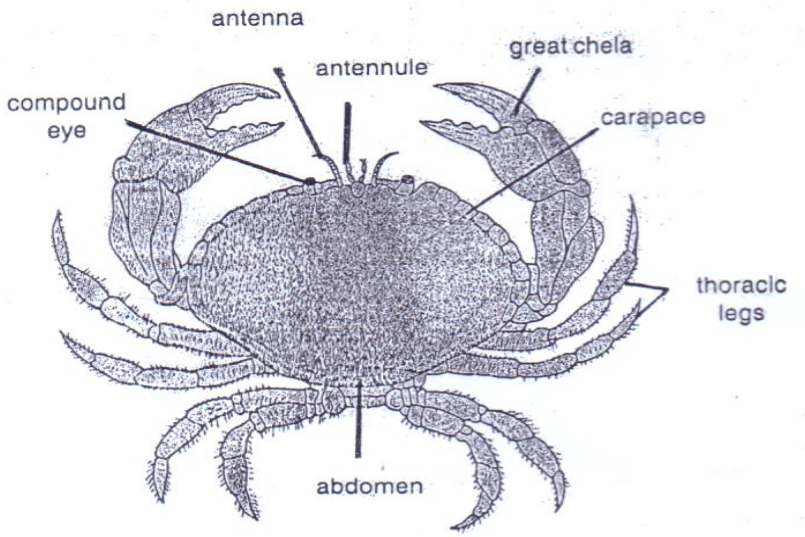
(ii) Used as fish bait. In most parts of America, crayfish - especially the soft-shelled varieties - are very popular among fisherman as fishing bait

(iii) They act as scavengers. Crustaceans are beneficial to the ecosystem as they play an important part in the destruction of decaying vegetables and animal bodies in the water.

Disadvantages

(i)They are harmful to the other animals.

(ii) Various crustaceans are intermediate hosts of certain parasitic worms whose final host is man. E.g., lung fluke has as its first host a freshwater snail, and as its second host a freshwater crab or crayfish. Man becomes the final host by eating a raw or undercooked second host. Infection leads to a chronic bronchitis



3. CLASS ARACHNIDA

Distinctive features

- They have (4) four pairs of limbs (legs) which are attached to cephalothorax
- They use book lungs for breath

General characteristics

- They have (04) pairs of walking limbs/legs attached to cephalothorax
- Most of them are parasites
- Have exoskeleton made up of chitin
- They use book lungs for gaseous exchange
- Their body divided into two parts (Head and cephalothorax)

Members:

Spider, ticks, Mites, Scorpion

Habitat

They are terrestrial organism (land animals)

Adaptations to habitat

(i) Presence of exoskeleton for protection against physical damage and desiccation
(ii) Possess four pairs of walking legs for locomotion
(iii) Some have poisonous claw for poisoning of the prey. E.g., scorpions.

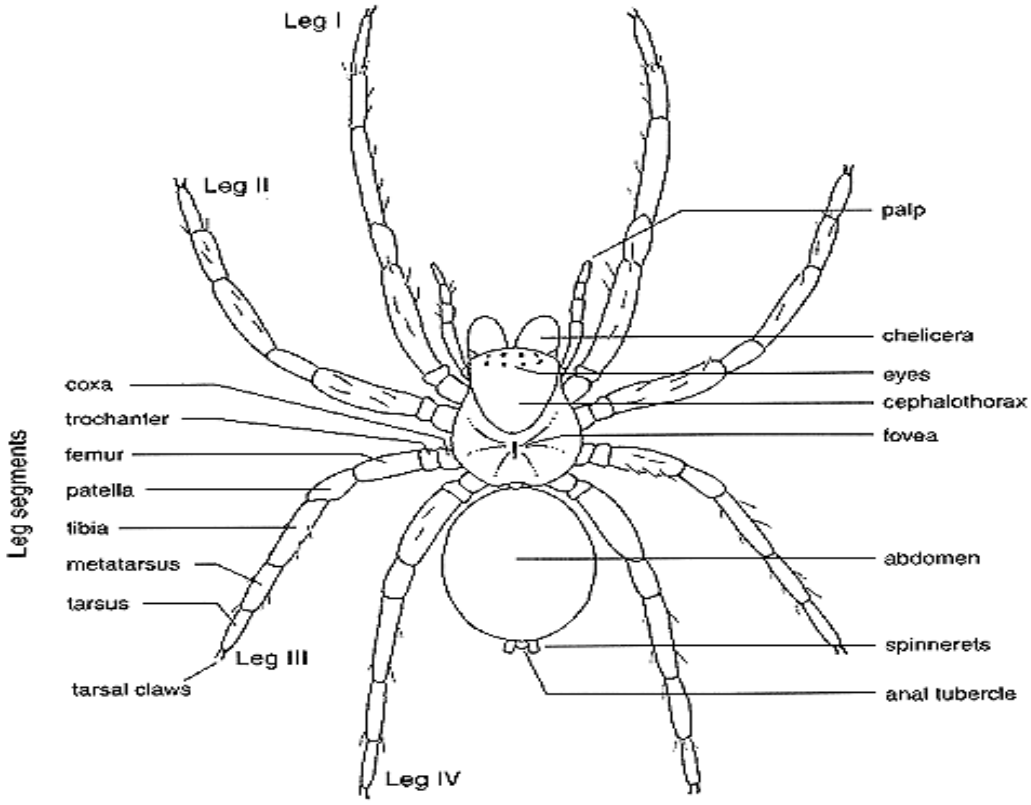
Economic importance of Arachnida

Advantages

(i) Produce silk materials for making clothes
(ii)Some are source of food E.g., Spider to animals
(iii) Used in biological research

Disadvantages

(i) Cause diseases to man and cattle. The disease called typhus that affects cattle is caused by tick
(ii)Some spiders and scorpions are poisonous E.g., Scorpions are poisonous to man.



External Structure of Spider

4. CLASS CHILOPODA

General characteristics

- They have segmented body. Each segment bears one pair of walking legs
- They have one pair of antennae
- They have dorsal ventrally flattened body
- They have simple eyes
- They have exoskeleton made up of chitin
- The first pair of legs modified into poisonous claws for capturing prey.
- They are carnivorous organism

Distinctive features

- Have dorsal ventrally flattened body (have flat body)
- Have segmented body.
- Each segment has one pair of legs.

Members:

Centipedes

Habitat

They are terrestrial organisms found in dark hiding areas such as under bricks and logs.

Adaptations to habitat

i) Possession of poisoning claw for poisoning and capturing the prey.
ii) Possession of many legs for fast movement in search of food, mate and escape from enemies.
iii) Possession of a pair of antennae for detection of external stimuli
iv) Ability to survive in diverse environments ranging from desert to wet conditions
v) Ability to undergo Ecdysis several times throughout their lives that make them survive longer than expected of a small arthropod. It can live for 2-5 years.

vi) Ability to regenerate lost parts of the body like legs and antennae.

vii) Possession of hard exoskeleton for protection against desiccation and physical damage

ECONOMIC IMPORTANCE OF CLASS CHILOPODA

Advantages

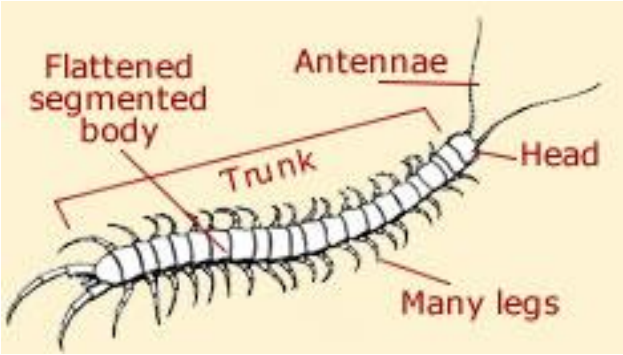
i) They are soil dwelling animal hence increase soil aeration and drainage hence soil fertility

ii) Centipedes are carnivorous to insects spiders and worms

Disadvantages

i) Centipedes have a poisonous bite to humans

Diagram.



5. CLASS DIPLODA

General characteristics

- They have segmented body
- Each segment bears/have two pairs to walking legs
- They have round body in cross section (they have cylindrical body)
- They have one pair of antennae
- They have simple eyes
- They have exoskeleton made up of chitin
- They are herbivorous feeders

Distinctive features

- They have round body (cylindrical)
- They have segmented body
- Each segment has two pairs of legs

Members:

Millipede

Habitat

It is a terrestrial organism that live in dark, damp moist places, also under decaying organic matters

Adaptation to habitat

(i) Numerous legs for locomotion

(ii) Exoskeleton which is protective to inner body parts

(iii) Ability to curl their bodies when threatened

(iv) Ability to produce foul-smelling or poisonous compounds against their enemies when threatened

ECONOMIC IMPORTANCE OF CLASS DIPLOPODA

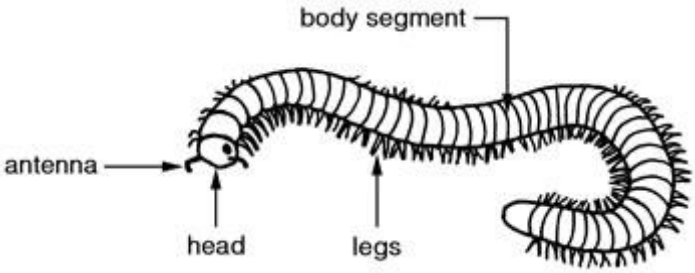
They have antennae for sensitivity

Advantages

i) Improve soil aeration and drainage by burrowing
ii) Improve soil fertility
iii) Source of food to same community
iv)Used in studies

Disadvantages

They are detrimental in that they feed on the roots and other parts of the growing plants.



PHYLUM CHORDATA

General characteristics

- They have notochord (at least at one stage of their developments).
- They have endoskeleton
- They have tail behind the anus. (Post - and tail)
- They have gills slits at least during the embryonic stage.
- They have dorsal tubular/hollow nerve cord (spinal cord)
- They have closed circulatory system
- They have sense organ E.g., Eyes, Skin

Distinctive features

- They have notochord in the embryonic stage.
- They have dorsal tubular nerve cord (spinal cord)
- They have endoskeleton
- They have tail behind the anus
- They have gills slits at least during embryonic stage.

CLASSES OF PHYLUM CHORDATA

i) Class CHONDRICHTHYES - sharks
ii) Class OSTEICHTHYES - Tilapia fish
iii) Class AMPHIBIA - Frogs
iv)Class REPTILIA - crocodile

v) Class AVES - Birds
vi)Class MAMMALIA - Mammals

Members of phylum:

Shark, tilapia, Frog, Lizard, Hen, Rat

Economic importance of phylum Chordata

Advantages

- Give advantages of classes- Chondrichthyes, Osteichthyes, amphibian, reptilian, Aves and Mammalia

Disadvantages

- Give disadvantages of classes of phylum Chordata.

1. **CLASS CHONDRICHTHYES**

General features

- Their skeleton is cartilaginous.
- Their body is covered with placoid scales
- Their mouth and nostril are ventrally placed
- The caudal fin (tail) has two lobes that differ in size.
- Their gills are open directly to the outside (No operculum/ Gills cover)
- Each pair of gills is in separate compartment

Distinctive features of a class Chondrichthyes

- They have skeleton composed of soft bones called cartilage
- They have ventral mouth and nostril
- Gills are open directly to the outside
- Both covered with placoid scales

Members:

Shark, Rays

Habitat:

Aquatic - marine.

Adaptation of class Chondrichthyes to its habitat:

- Streamlined body to reduce resistance during forward movement
- Have fins which aid in controlling locomotion in water.
- Have gills which are respiratory surfaces
- Have nostrils which are chemoreceptor
- Have powerful skeletal muscles which aid in movement.

Economic importance of class Chondrichthyes

Advantages

- They are the source of food mainly is protein
- They are the source of income.
- Used in studies
- Balance in ecosystem
- Shark liver oil is used in tanning of leather and preservation of wood, as a lubricant; as a folk medicine against rheumatism, burns, and coughs; as a general tonic; as a laxative; and as an ingredient of cosmetics

Disadvantages

- They are predatory to man and other organisms.

-
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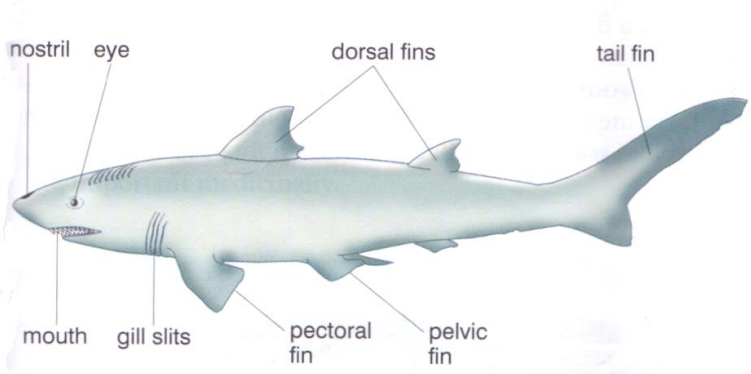
Diagram



2. CLASS OSTEICHTHYES (BONY FISH)

General Characteristics.

- The skeleton is made up of bones (hard)
- Their body is covered with overlapping bony scales (ganoid scales)
- The mouth is terminally placed and nostrils are found on dorsal surface
- The gills are found in a common chamber and are covered by operculum
- The tail fin has lobes of the same size.
- Most have air sac (swim bladder) which aids buoyancy

Distinctive features

- Have skeleton made up of bones.
- Have terminal mouth
- Have body covered with overlapping scales
- Have gills covered by operculum(opercula)

Members:

Tilapia, Lungfish, Cat fish, etc.

Habitat

They are found in both sea and fresh water

Adaptation to habitat (for bony fish)

- It has eyes which are designed to focus under water
- It has gills to absorb oxygen from water
- Presence of fins to propel through water
- It has stream lined body for swimming
- It has swim bladder to maintain an appropriate level of buoyancy
- It has lateral line for sensitivity in water.
- Nostrils for chemoreception

ECONOMIC IMPORTANCE

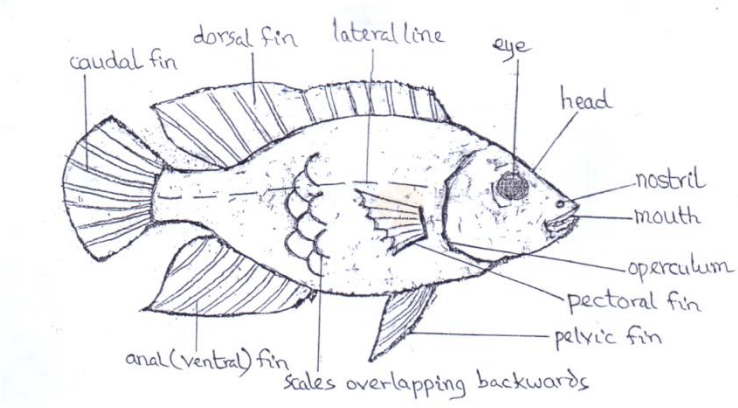
Advantages

- Used as a source of food to man
- Used as a source of income
- Fish oil is important medically

- Fish meal is used as fertilizer
- Used in biological studies

Disadvantages

- They are predatory to smaller aquatic animals (e.g., small fish)



3. CLASS AMPHIBIA

General features

- They have skin which is always moist and without scales
- They have heart with three (03) chambers, two auricles and one ventricle.
- The gaseous exchange is done by gills in the tadpole and in adults take place in lungs, skin and mouth.
- Their life cycle involves a larva form called tadpole.
- The eggs of amphibians are generally covered with a jelly like substance and are laid in water.
- Their body temperature varies with that of the environment. i.e., They are ectothermic

Distinctive characteristics

- Have thin moist, permeable skin which is used for gaseous exchange.
- Eggs covered with jelly like substance and are laid in water.
- Show double life. That is, spend at least part of their life in water and on land.
- Their bodies are not covered by scales

Members:

Frog, Toad, Salamanders.

Habitat

- They live both in water and land.

Adaptations to the habitat

- Thin most buccal lining and lung skin, for gaseous exchange
- Powerful hind limbs for leaping
- Nostril for chemoreception

Economic importance of class amphibia

Advantages:

- Source of food

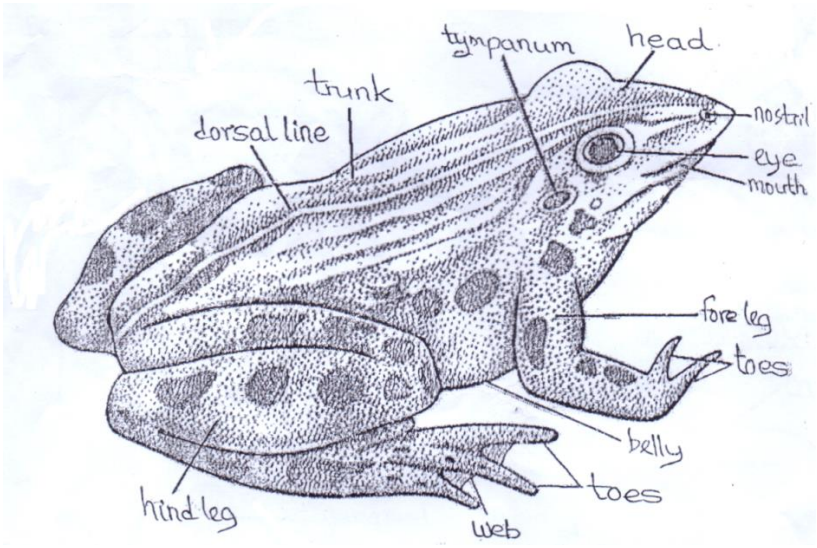
- For tourists' attraction
- Reduce insect pest as they feed on insects.

Disadvantages

-

-

Diagram



4. CLASS REPTILIA

General characteristics

- They have dry skin covered with horny scales.
- They lay eggs on land covered with soft shells
- They have no external ear.
- Their body temperature varies with that of the environment, ectothermic.
- With exceptional of crocodiles who have four chambers, the rest have heart with two atria and two separated partially ventricles.
- They have no pairs of pentadactyl limbs.
- They use lungs for gaseous exchange.
- Their body divided into head, neck and trunk.
- Tail is well developed in some while it is reduced in others.

Distinctive features

- Have dry skin covered with horny scales
- Eggs covered with soft shells and are laid on land.

Members:

Tortoise, Lizard, Snake, Crocodile, Chameleon

Habitat

- Live all over the planet such as desert, forest, rock areas most live on trees or in the ground
- Majority are terrestrial organisms. (E.g., Lizard) while others are aquatic organisms.

Adaptation of habitat

- Some involve camouflage that helps them to blend in with their environment.
- Some develop gaudy colors and display

ECONOMIC IMPORTANCE OF CLASS REPTILIA

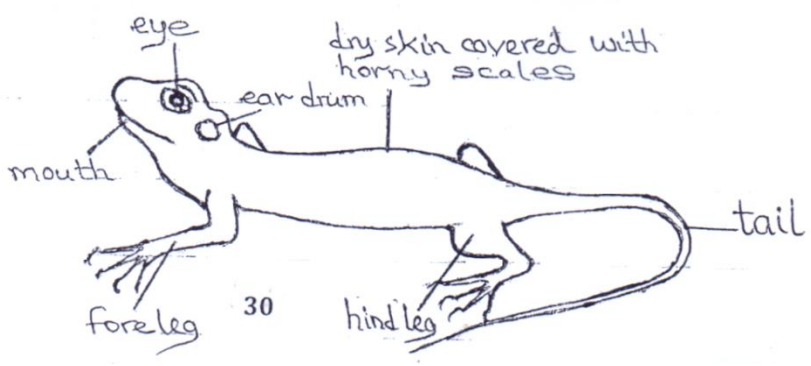
Advantages:

- Used as food in some community
- The skin is used to make articles like handbags belts and shoes.
- Some are scavengers,

Disadvantages

- Some reptiles are poisonous E.g., Poisonous Snake
- Some reptiles attack and kill human. e.g., crocodile

Diagram.



5. CLASS AVES (BIRDS)

General characteristics

- Their body is covered by feathers
- They have legs with scales
- The anterior pair of limbs are modified into wings.
- The mouth is modified into beak which vary according to the feeding habits
- They lay hard shelled eggs
- They have hallowed bones to reduce weight and aid flight
- The body is stream lined to overcome air resistance during flight.
- Maintain the body temperature at a constant level
- They have no external ears
- They have two pairs of pentadactyl limbs.
- They have four chambered hearts.
- They show internal fertilization

Distinctive features

- Skin covered with feathers
- Lower parts of legs have covered with scales
- Mouth is modifying into beak or bill
- Eggs covered with hard shells are laid on land.

Members:

Chicken, Flamingo, Eagle, Owl.

Habitat: Terrestrial e.g., hen, Aerial e.g., Owl

Adaptation to the habitat

- Streamlined body to facilitate forward movement
- Hollow bones to reduce density for effective flight
- The forelimbs are modified to wings for flight
- Feathers (e.g., quill feathers) increase surface area of wings for efficiency flight
- Feathers overlap backwards to reduce resistance to wind during flight
- Feathers provide insulation against heat loss/gain
- Effective eyes for excellent vision

Economic importance of class Aves

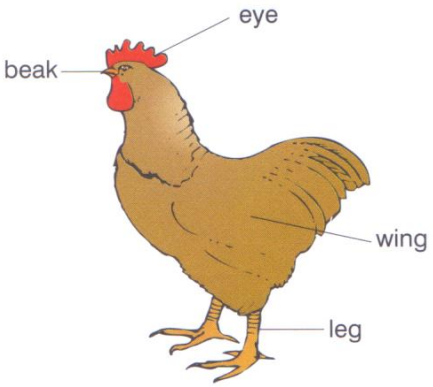
Advantages.

- Agents of pollination
- Source of food E.g., Meat, Eggs
- Ornament like those made of feathers
- Clean environment as some birds feed on dead bodies.
- Produce manure e.g. Chicken.

Disadvantages

- Can transmit disease from one place to another E.g. (Birds Flue)
- Some can destroy human properties such as crops. e.g., quelea quelea

Diagram



6. CLASS MAMMALIA

General characteristics

- They have hair or fur on all or part of their body.
- They have mammary glands, in female these produce milk which is used to feed the young.
- They have teeth of different types and shapes (heterodont dentition)
- They maintain their body temperature at constants level i.e., Homoeothermic.

- They are viviparous (i.e., The zygote develops internally and gets all its requirements from the maternal body)

Distinctive features

- Skins covered with fur (hair)
- Have mammary glands
- Have teeth of different types and shapes. (Heterodont dentition)
- Have a diaphragm
- Have external ear called Pinna

Members:

Rat, Bat, Cow

Habitat

- Terrestrial e.g., rat, man
- Aquatic e.g., whale
- Aerial e.g., bat

Adaptations to habitat

- Has a long tail for balance
- has external ear for sound collection
- Has limbs which are modified for digging
- Have teeth for cutting, tearing and chewing food
- Fur especially to animals living in Polar Regions, insulated the body.

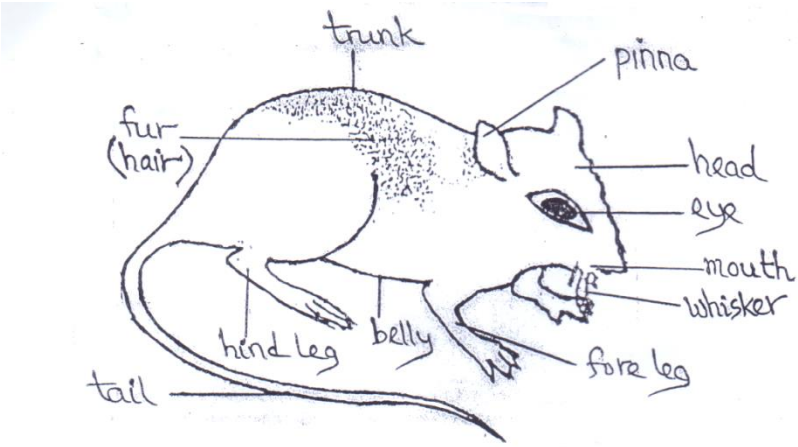
ECONOMIC IMPORTANCE OF CLASS MAMMALIA

Advantages

- They are the source of food E.g., Cattle, sheep, Rat
- They are the source of materials E.g., Skin for leather and feces for manure.
- For tourist attraction E.g., Wild life species
- Used in studies and scientific researches
- Source of labor force e.g., donkey, camels
- For security purpose e.g., dogs

Disadvantages

- Predation of humans and livestock - The predators include lions and leopards
- Crop damage e.g., by rats, elephant, monkeys
- Spread of diseases e.g., Plague



Why rat is considered as pest

- It consumes and damage human food in the field and in stores
- Through graining and burrowing habit, they destroy many articles such as clothes, furniture, Building.
- They are responsible for transmitting dangerous diseases to man, e. g: Plague.

ORGANIC EVOLUTION

Organic evolution is the gradual change/development of organisms from simple life forms to more complex life forms over a course of time.

IMPORTANCE OF ORGANIC EVOLUTION:

i. It explains how different life forms have developed and why organism show both differences and similarities.
ii. It tells us why living things undergo changes over a long period of time from generation to generation.
iii. Explains how new species emerged from pre-existing ones

THEORIES OF ORIGIN OF LIFE:

There are different theories put forward to explain the origin of life. The main theories of origin of life are: -

i) Special creation
ii) Spontaneous generation theory.
iii) Steady state theory
iv) Biochemical evolution
v) Cosmozoan theory

1. SPECIAL CREATION THEORY:

This theory explains that, the whole universe and all the living things were created by a Supreme Being (Supernatural Being) called God at the time of the formation of the world.

- The forms of life created did not change with time and will continue to remain unchanged.
- The differences and similarities between organisms are as a result of how the organisms were created/designed. The support of this theory is met in religious books like Bible & Quran

2. SPONTANEOUS GENERATION THEORY:

This theory proposed that all living things arose spontaneously from non-living things like moisture, soil and mud.

- The concept of living organisms emerging from non-living matter is called Biogenesis.
- The Egypt people believe that mud of Nile could give rise to living creatures like frogs, toad, snakes, worm even crocodiles.
- Greek believe that rats came from garbage.
- They also believe that bacteria were spontaneously generated from rotten meat.

3. STEADY STATE THEORY:

The theory suggested that life has no origin. The planet earth and all organisms have always been here and that the earth had always been able to support life.

4. BIOCHEMICAL EVOLUTION THEORY:

This theory is also known as scientific theory of organic evolution: -

- The theory postulates that, life probably started by a catalytic effect that made free elements to combine to form molecules.
- In the early stages of its existence the earth was too hot for life to exist.
- Elements started to combine chemically due to the catalytic effect of lighting ultraviolet radiation and possibly gamma radiations.
- The first four gases to form were: -

  Ammonia (NH_3)
  Hydrogen (H_2)

Water vapor (H_2O)
Methane (CH_4)

The earth continued to cool allowing a further combination of simple compounds to form complex, self-replicating molecules resembling the genetic material, DNA.

- Further development led to the formation of simple forms of first living cells, resembling the present-day viruses and bacteria. Most complex organisms developed later.

  Therefore; this theory explains that, life arose from the evolution of simple molecules into more complex ones and their ultimate evolution into cells.

5. COSMOZOAN THEORY:

This theory suggests that life on earth originated from elsewhere in the universe and arrived on this planet by some means yet to be known.

THEORIES OF ORGANIC EVOLUTION:

The main idea of organic evolution is that, population of living things undergo changes generation after generation.

These theories are: -

i) Lamarckism
ii) Darwinism

LAMARCK'S THEORY OF EVOLUTION:

Jean Baptist de Lamarck was a French biologist who made the first attempt to explain the origin of species and their adaptation to environment.

He developed the theory of organic evolution based on; -

a) Theory of use and disuse of organs
b) Theory of inheritance of acquired characters.

Lamarck's theory of organic evolution states that "*If an organ is very much used it becomes strong and enlarged or more useful, if unused or rarely used it becomes smaller, less functioning even disappear*".

He further proposed that *"the acquired characters through use or disuse of organs by an individual are transmitted to the next generation"*.

Deductions:

i) Condition in the environment is more dynamic and constantly under changes.
ii) Changes in the environmental conditions creates new needs which may head to changes in behavior of an organism.
iii) Changes in behavior of an organism involve fresh use or disuse of the body organs.
iv) The fresh use or disuse organs lead to change in structure and functions of old organs.
v) The use of body parts lead to increase in size and cause it to undergo changes and become more efficient and disuse of organs will eventually lead to disappearance of the organs.
vi) The new organ is an acquired which was believed to be heritable. After many generations the changes will be so great that the organisms possessing them will be different from the ancestors.

Evidence of the use and disuse theory according to Lamarck.

i) The evolution of long neck and legs of modern giraffe

- The earliest giraffe had short neck suitable for reaching short grass and shrubs when the grass became scarce, the giraffe had to stretch their neck and forelimbs to feed on leaves of the taller plants. As a result, their necks and forelimbs became longer.

- The giraffe that acquired the longer necks and forelimbs then passed the changes into their offspring from generation to generation.

ii) **The development of webbed-feet on aquatic birds e.g., Duck feet**. The aquatic birds which acquired webbed-feet had terrestrial ancestors which did not have webbed-feet.

- Lamarck suggest that webbed feet in aquatic birds came as a result of constant spreading of the bones when swimming and looking for food.

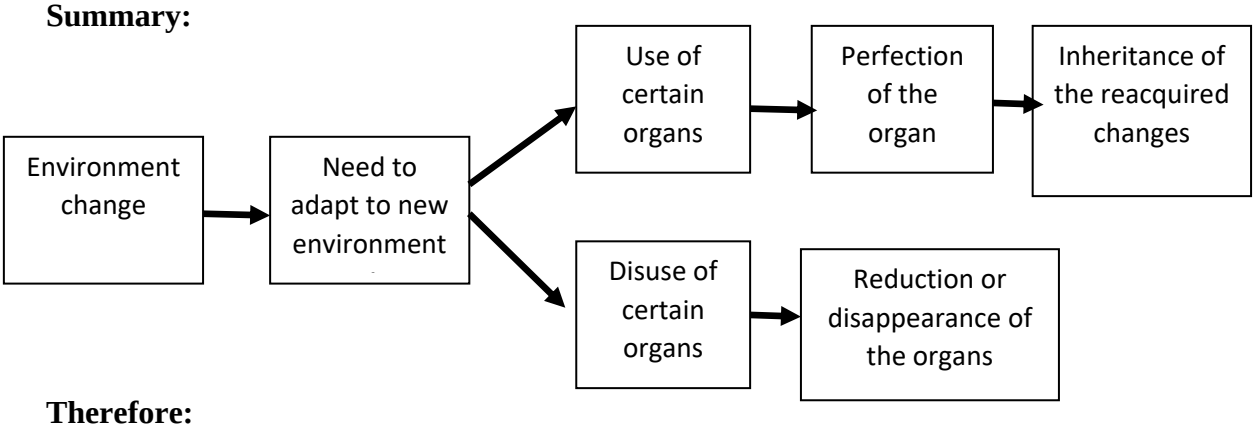
iii) **Loss of legs in snakes:** The ancestors of the snakes made their ways through narrow passage and thick vegetation.
This led to disuse of limbs and elongation of their bodies.

iv) Cave dwelling organisms lost their eye sight due to disuse of eyes since they live in constantly dark environment**.**

v) **Black smiths' muscles can develop due to hand work**; the developed muscles were inherited by the black smith's children.

vi) **Birds like ostrich and kiwi lived in an environment not requiring flight**, hence their wings were reduced and became functionless.
Lamarck proposed that, these changes of structures acquired during the life of an individual were then passed on to their offspring and subsequent generation resulting to emergence of new species.

Summary:



Therefore:
Lamarck believed that acquired characters modified by use and disuse will pass into their offspring (will be inherited) generation to generation.

Merits of Lamarck's theory:

i) The theory helped to explain the role of the environment in producing phenotypic changes in an organism. Body building exercises increase the size of muscles but they are not inherited.

ii) It spread the idea of organic evolution of species and many people became attracted to the work of organic evolution.

iii) His theory was simple and provided a way in which change in organism could come about

iv) It was the first completely widespread theory that was offered.

Demerits of Lamarck's theory:

i) The acquired characters are not inherited since they are non-genetic and do not influence the genotype.

ii) Lamarck did not know the source of individual variation on how is passed on from parents to offspring

iii) The second Lamarckian principle that new organs result from new needs is quite false. In other words, desire of the animal leads to the formation of new structures not true because it means that

the man who mused "Birds can fly, so why cannot I? Should have grown wings and taken to the air.

DARWIN'S THEORY OF ORGANIC EVOLUTION

Charles Darwin was a British biologist who put forward the theory of natural selection or survival for the fittest in 1832.

- The theory of natural selection states that *"Organisms with unfavorable traits are eliminated while those with favorable traits survive and are able to reproduce successfully"*
- Darwin bases his theory on the following observations he made.

Observations:

1. **Reproductivity:**
   All living things have the ability to reproduce, however their number remains relatively (more or less) constant from one generation to the next. This indicate that only few offspring born can reach the time of adulthood and reproduce.
   Therefore, *there is a struggle for existence* that cause many offspring to die before becoming adults.
2. **Struggle for existence:**
   The presence of large number of offspring leads to competitions for limited resources such as food, light, water, mate and favorable temperature.
   Moreover, they have to cope with unfavorable low temperature, diseases, etc.
3. **Variation within species:**
   Members of species differ from one another in various characteristics. Many of these characteristics are genetic and can be passed from parents to their offspring. Advantageous variation enables survival in the environment.
4. **Survival of the fittest:**
   Some organisms do pass characters which are good. Such organisms will survive to the maturity and will be able to reproduce.
   - The good characters are passed on to the offspring, the members lacking favorable characteristics (with unfavorable characteristics) die, leaving no offspring.
   - The result is the propagation of favorable characteristics in the population and elimination of unfavorable ones.
   - This leads to organisms which are in the process by which new species are formed from pre-existing ones. That is, ***speciation***.

   For new species to emerge the groups of living organisms must be isolated where isolation brings new species due to being acted upon by natural selection /environmental factors making them different from others.
   - Also, these organisms may be acted upon by mutation. (Genetic changes).

   Kind of isolation mechanisms that can lead to emergence of new species are; -

   i) *Ecological isolation***:**
   - Environmental barriers that keep populations (demes) above which make them occupy different types of habitats from original types for feeding/breeding reasons/escape from predators, climate, hence ecologically separated from one another, better adopted to the prevailing environmental condition hence origin of new species.

Note: ***Deme*** *is a subdivision of a population consisting of closely related plants, animals, or people, typically breeding mainly within the group*.

ii) *Reproductive isolation*:
This is caused by such changes that bring about barriers to successful mating between individuals of the same species.

iii) *Geographical isolation*:
These are physical barriers such as oceans, seas, mountains, ice, valleys that prevent the organisms from exchanging their genes.

iv) *Behavioral isolation*:
This is the change in the behavior before mating period. That is courtship or nesting.

5. Continuous Selection:

The most favorable variation (organisms with favorable traits) goes on increasing generation after generation. These variations become very large such that, they result to very different organisms from ancestors and this is the formation of new species.

Deductions:

i) Many individuals fail to survive and reproduce.
There is a struggle for existence within a population. That is, organisms compete for resources such as food, shelter and mate.

ii) In the struggle for existence, those individuals showing variation adapted to their environment have a reproductive advantage and produce more offspring than those not well adopted.

NOTE:

- *Survival of the fittest* means the ability of an organism to live up to reproductive age and give rise to the offspring.
- *Struggle for existence* means competition for limited natural resources among individuals in a given population of species.

Merits of Darwin's theory of natural selection:

i) Darwin's ideas explain evolution by natural selection or survival of the fittest. His explanation is regarded to be possible explanation of organic evolution.

ii) He was correct to say, individuals in a population show some variation. E.g., they differ in size, resistance to disease and strength.

iii) Darwin's contribution has been considered great because he did much to publicize the idea of organic evolution through his writing more than any other single biologist.

iv) It is true that individuals of a population struggle for existence where they compete for resources such as food, mate, light and water.

v) Darwin was the first to suggest that organisms are well adapted to their environment.

Demerits of Darwin's theory of evolution:

i) Darwin does not explain the cause of variation between individuals and how variations are passed on from parents to their offspring because he did not understand the role of genes.

ii) Natural selection does not explain how organisms could change from one form to another, but only how organisms are favored or disfavored by environmental changes. Natural selection acting over time can lead to complex adaptation.

iii) Darwin failed to explain the presence of vestigial organs which remain generation after generation without elimination.

iv) Over-specialization of organs is not explained by Darwin.

v) He does not distinguish between heritable and non-heritable characters.

NATURAL SELECTION AND THE MECHANISM OF EVOLUTION:

Natural selection is the survival for the fittest organisms which are best suited to the environment and dying out of organisms that do not have necessary adaptations. The fittest survive and pass their characteristics to the next generation.

- Darwin was the first person to put forward the assumption that this process had evolutionary power i.e., natural selection.
- Natural selection holds that, these living things that are more suited to the natural condition of their habitats will prevail by having offspring that will survive where as those that are unfit will disappear.

Examples:

i) Deer herds under the threat of predators. Naturally, those that can run faster will survive while slower runners will be selected out.

ii) Industrial mechanism:

Before onset of industrial revolution in England, the color of tree barks around was white. Therefore, dark moths resting on these barks of trees could be easily seen by predators and had very little chance to survive.

- After industrial revolution the bark of trees were darken by soot and this led to increase in number of dark moths as they were not easily seen. The light-colored moths were easily seen and hunted.
- As a result, the number of light-colored moths decreased.

EVIDENCE OF ORGANIC EVOLUTION:

These are evidences which show that organic evolution has taken place.

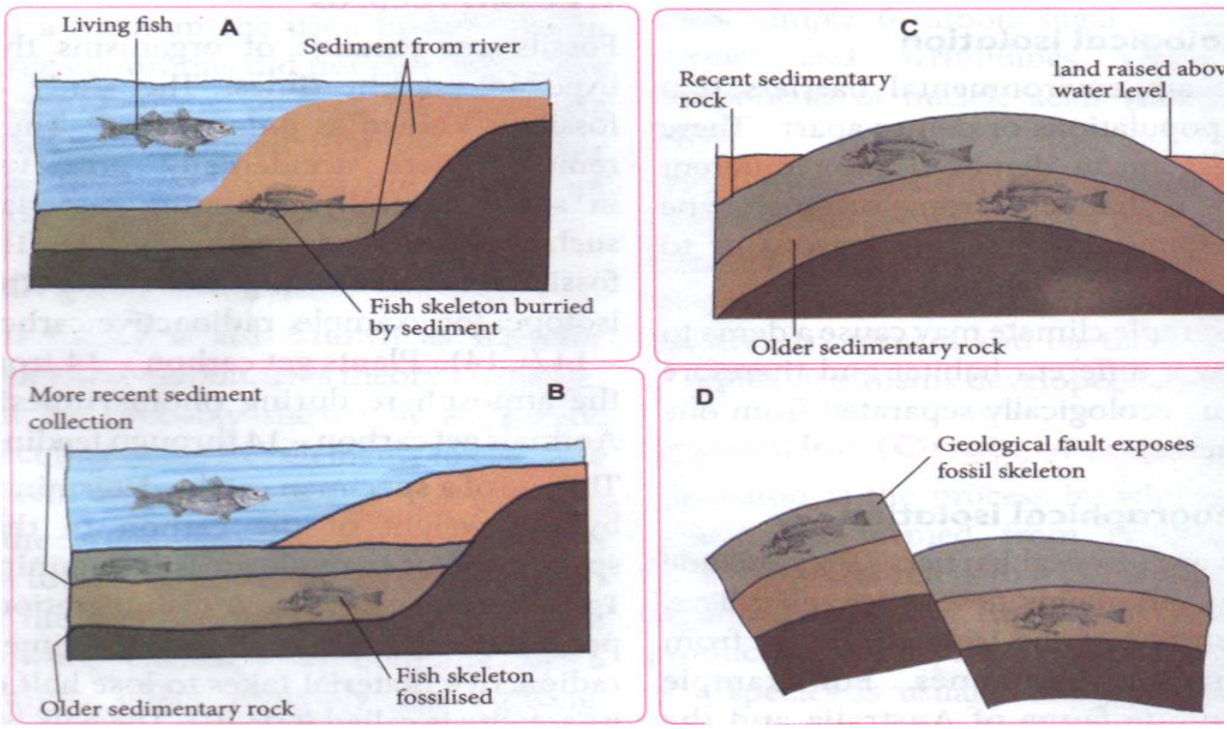
1. Evidence from fossil record.
2. Evidence from comparative morphology and anatomy.
3. Evidence from comparative embryology
4. Evidence from comparative cytology and biochemistry
5. Evidence from Biogeography
6. Evidence from classification
7. Evidence from serology
8. Evidence from comparative selection
9. Evidence from comparative physiology
10. Evidence from Real-life situation

1. Evidence from fossil records:

Fossils are remains of organisms that lived in ancient times preserved naturally in rocks e.g., skeletal parts.

- The study of fossils is known as paleontology
- Fossils are dated using carbon 14
- Fossil evidence shows that different organisms appeared at different times on earth.
- Fossils give evidence of changes in organisms and they recover the organisms which became extinct like Dinosaurs.

  E.g., recent fossils appear to be complex and tend to resemble each other while older fossils show some variations with the present-day organisms.



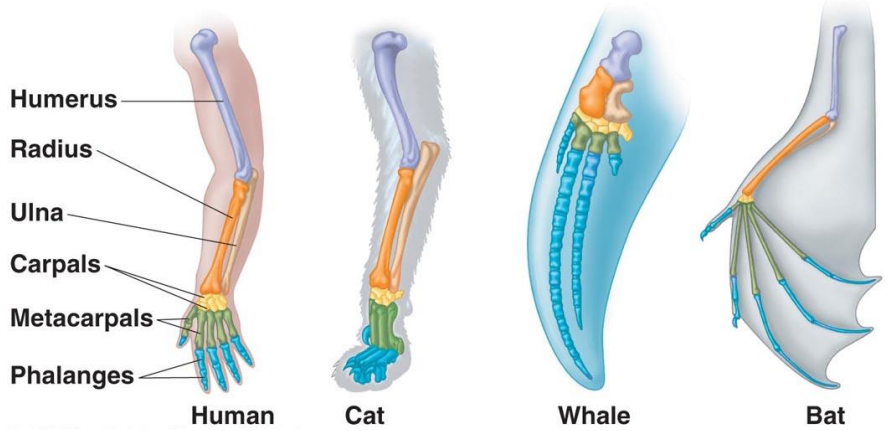
2.Evidence from comparative anatomy and morphology:

This is the study of biological structures in different organisms.

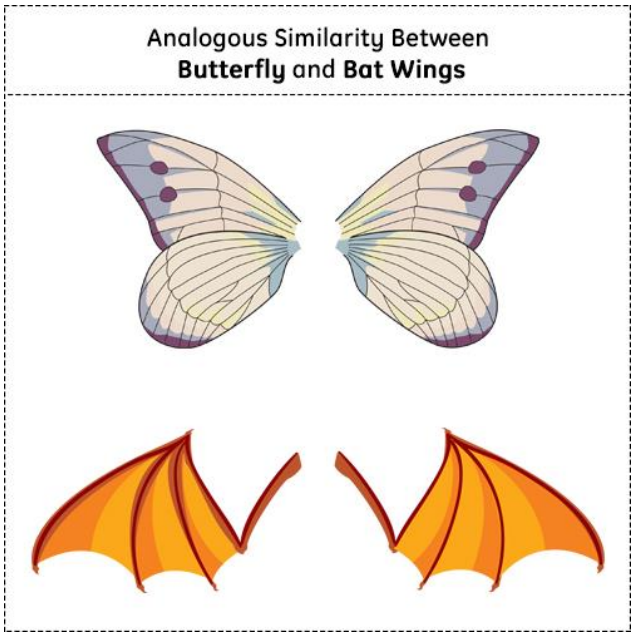
- Comparative anatomy of groups of animals or plants are said to reveal that certain structural features are basically similar among organisms. the pentadactyl limbs in nearly all vertebrates resemble in the arrangement of bones. This resemblance is said to be a result of common ancestry.
- The variations observed in shape, size and number of bones is due to the adaptation to different functions of these fore limbs. These are said to be homologous structures.

NOTE:

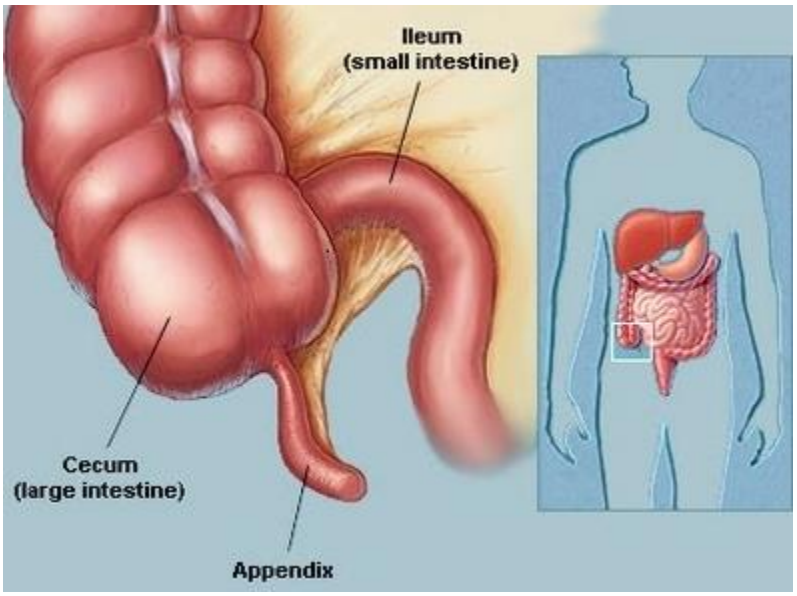
- ***Homologous structures*** are structures which have the same structure (origins) but perform different functions in different organisms e.g., limbs of vertebrates like human being, goat, wings of bird and bat, flipper of dolphins. In man forelimbs are used for holding, in goat for walking, in bats for flying and in whale for swimming.



- ***Analogous structures*** are structures which perform the same function in different organisms but have different origin (structure) e.g., wings of birds and insects are used for flight but have different structure (origin).



- ***Vestigial structure*** are functionless organs which have ceased to function in some organisms during evolution because they became less important or unnecessary due to environmental changes e.g., appendix, tail in human being, whales, wings in flightless birds like ostrich, penguin etc.



- Presence of these structures, that is, homologous, analogous and vestigial suggests that all these animals have evolved from common ancestors but as a result of organic evolution such structures have been modified.

3.*Evidence from comparative embryology*:

Embryology is the study of embryos.

- At certain stages of embryonic development some groups of animals look very similar although the adults show differences e.g., the resemblance between embryos of all

vertebrates' amphibians, reptiles, fish, birds and mammals in which these embryos in their embryonic stages develop tails and gill slits.

- This suggests that all vertebrates arose from a common ancestor.

4.Evidence from comparative cytology and biochemistry (Cell Biology):

- The cells of most living things possess the same organelles such as mitochondria, ribosome, cell membrane, etc. which perform similar functions.
- Many biological chemicals such as ATP, DNA and RNA are found in most cells.
- Organisms sharing the same chemical characteristics are considered to be more closely related and this suggests that, they have a common ancestral origin.

5.Evidence from biogeography (geographical) isolation:

This is the geographical distribution of animals and plants in the various parts of the world due to barriers like mountains, rivers, deserts, and valleys etc. which separate (isolate) population of species from exchanging their genes. As a result, in-breeding may change. E.g., the unique fauna of Australia and the Galapagos Island are different due to geographical isolation.

6.Evidence from classification:

Organisms are classified into Kingdom, phylum, classes, order, family, genus and species on the basis of similarities and differences.

- Classification results into an arrangement of organisms starting with the simple to complex forms.
- The similarities show that they are interrelated and have common ancestry.

7.Evidence from comparative selection:

It is based on human who select animals or plants with desirable traits and separate them from those who do not possess such traits.

- This allows breeding between organisms with desirable traits.

After repeating this process for a few generations, a new breed of animals is formed which might result into formation of new species.

8. Evidence from Comparative Physiology:

Physiology is the study of the functions of human body.

Examples:

- A person may develop a defective thyroid gland. If thyroxin from cattle is injected into that person, his metabolism is restored to normal.
- The body fluids of both aquatic and terrestrial animals are fundamentally similar. That is, in both cases, their ionic compositions are similar to sea water.

Therefore, these examples show that living organisms are inter-related and might have originated from the same ancestor.

9. ***Evidence from Comparative Serology:***

A comparison of the serum proteins of the related species using antibody-antigen reaction reveals some similarities. The degree of similarities is higher in species that are closely related.

Example:

Human serum proteins are very similar to those of gorillas and chimpanzees

Therefore, this suggests a common ancestral origin.

10. ***Evidence from Real-life Situation:***

Resistant strains of bacteria to antibiotics and pesticides. Many diseases are caused by bacteria. The use of penicillin and other antibiotics has introduced new selection pressure with the bacterial population. Some bacteria are resistant to antibiotics and some are non-resistant.

Examples:

- Bacteria which cause TB, Staphylococcus species, have developed resistance to the type of penicillin which used to treat TB.
- Plasmodium species resistant to chloroquine drugs which used to cure malaria
- There are mosquitoes and houseflies which are resistant to DDT pesticide

An organism that is resistant to drugs or pesticides has acquired resistance or has mutated and passes this resistance on to the successive generations. This leads to a population of resistant organisms

HIV, AIDS AND STI'S

HIV = Human Immunodeficiency Virus,
AIDS = Acquired Immunity Deficiency Syndrome,
STI's = Sexually Transmitted Infections

What is HIV?

This is Human Immunodeficiency Virus. The HIV causes AIDS.

What is AIDS?

This is Acquired Immunity Deficiency Syndrome. This is a condition in which a person is infected with HIV develops sign of repeated prolonged illness resulting from the body lowered ability to defend itself against diseases. If a person is HIV positive, he /she has been infected with the virus that causes AIDS.

What is STI's?

This is Sexually Transmitted Infections which basically are transmitted through sexual contact.
HIV/AIDS is distinguished from other STI's in different ways.

i) AIDS – Virus can infect man through means such as infected blood transfusion, from mother to her newly born baby either during delivery or lactation, sharing of skin piercing tools like sharp blades, syringe and pins while other STI's such a gonorrhea and syphilis can't.
ii) HIV – Affect the white blood cells (WBC) of human. The WBC concern with natural body defense against infection. While other STI's mainly affect the reproductive organ.
HIV/AIDS is currently incurable but its spread can be prevented or controlled while STI's are curable with antibiotics.
iii) HIV/AIDS –finally lead to death of the person while other STI's can lead to sterility on person but not necessarily death.

RELATION BETWEEN HIV/AIDS AND STI's:

The body opening lining is delicate. The lining of mouth, anus, cervix and penis tube (urethra) can easily be damaged to cause sores opening so STI's can destroy the lining to cause sores and opening wounds. The HIV is very minute (small) hence one can be infected easily by HIV/AIDS.

SYMPTOMS OF STI's:

i) Pain during urination
ii) Smelly or thick or colored discharge from vagina or penis.
iii) Bleeding after sexual intercourse
iv) Painful in abdomen
v) Men's testis may have sores or swollen
vi) Women may bleed between their normal periods
vii) Lumps or bumps may grow around the genitals
viii) Sores may appear which may or may not be painful
ix) Rashes may appear
x) Yellowing of the skin or eyes

MOST COMMON TRANSMISSION METHODS OF HIV/AIDS:

i) Contact with blood
ii) Sexual intercourse without condom
iii) Mother to baby through contacts with vaginal fluid during delivery
iv) Through breast feeding

v) Sharing of contaminated sharp instruments such as needle, syringes, piercing instruments.

HIV CAN'T BE TRANSMITTED THROUGH:

i) Hugging and holding hands
ii) Kissing or touching
iii) Sneezing or coughing
iv) Sharing a public swimming pool
v) Sharing toilet or drinking containers.

IMPACTS OF HIV/AIDS AND STI's IN COMMUNITY:

a) Hinder human economic development

- By decreasing labor supply due to increase mortality rate and illness.
- Through killing people of various professional and skills that would bring economic development.
- Through decline government income because enterprises can't produce much tax and revenue falls.
- It also forces government to spend huge sum of money in dealing with HIV epidemic (e.g., TACAIDS) projects instead of dealing with project like infrastructure project and social services.

b) INCREASE POVERTY:

HIV decrease the number of working adults in a family. It also forces family to spend the little saving available or getting into debt in struggling to pay for medical treatment or funerals.

c) REDUCE LIFE EXPECTANCY:

Due to HIV/AIDS average life expectancy has fallen by 20 years. Most deaths occur between 20 years and 49 years of age. This age group is most economically productive and child rearing groups.

d) BURDEN TO CHILDREN:

And not only cause burden to children by losing parents or guardians but also cause trauma and hardship. It causes some children to take more responsibilities so as to earn income, produce food and care for young ones and family members. This denies their right to education, protection and chance to fulfill their future dreams.

e) BURDEN TO GRANDPARENTS:

AIDS affect both parents leading to orphan children. Therefore, the grandparents have to take the burden of responsibility.

f) STIGMA:

People tend to discriminate those who live with HIV. The victims are not considered by people. They are not employed so they lack some opportunity in the community.

VOLUNTARY COUNSELLING AND TESTING (VCT):

VCT: Means voluntary counseling and testing. It is the process of voluntary test and confidential advice and testing for an individual.

This process takes place into two forms:

i) Pre- testing counseling
ii) Post – testing counseling

i) Pre-testing counseling: - Is done prior to testing. This is done to prepare an individual to understand and cope with testing results.
ii) Post – testing counseling: - Is done after testing

Counseling at testing always takes place in a VCT center or hospital or health centers.

WHO SHOULD VISIT VCT SERVICES?

i) Anyone who has been exposed to risky sexual behavior
ii) Couples who are planning to get married or start family
iii) Those who have had more than one sexual partner now or in the past.
iv) Women or men whose spouse may have HIV
v) Anyone who is seriously considering changing his /her sexual behavior
vi) Commercial sex workers.
vii) Intravenous drug users or anyone who has shared sharp instruments such as needles or blades.
viii) Anyone who wishes to find out his/her status.

SIGNIFICANCE OF VCT:

i) Knowing about HIV/AIDS status enables the person to plan for future.
ii) It prevents HIV/AIDS transmission because it promotes sexual behavior change and wise decision.
iii) It is a means to HIV/AIDS treatment and care.
iv) It helps a person to get useful and right information about HIV/AIDS. Information can be obtained from the counselors, brochures and TV programs.
v) It provides psychological support for people living with HIV/AIDS. This helps them to live normal life.
vi) It helps government in planning for care and treatment by knowing the number or infected people.
vii) It gives confidence to people who are planning marriage or pregnancy.
viii) Testing negative is strong motivation for one to reduce risky sexual behavior.
ix) It helps to prevent mother to child transmission.
x) Testing positive gives an opportunity to find out how to live a longer and have a more productive life.

PROCEDURES AND TECHNIQUES OF VCT:

i) Counseling and testing must be truly voluntary. The clients must agree on their own will to be counseled and tested.
ii) The result should be given to the correct person. This maintains confidentiality.
iii) Counselor should ensure that the client has adequate understand of the results.
iv) When the client is negative the counselor should provide information how to remain negative.
v) It is better to provide pre-testing and post-testing counseling by the same counselor instead of separate counselor.
vi) Unless it is very necessary results should not be provided in written form.

LIFE SKILLS NEEDED FOR PEOPLE LIVING WITH HIV/AIDS AND STI's:

People living with HIV/AIDS (PLWHA) needs care and support and sympathetic understanding from relative and friends.

IMPROTANCE OF PROVIDING CARE AND SUPPORT TO PLWHA:

i) It makes a person to feel happier, secure and less isolated.
ii) It helps the patient to live longer
iii) It reduces the risk of infection with other diseases
iv) It reduces the fear of death because family members and friends are nearby.

CARE AND SUPPORT OF PLWHA:

i) Provide the patient with balanced diet containing all types of food substance in the right proportions.
ii) Keep the patient's beddings and clothing clean. This will keep the patient comfortable.
iii) Keep the patient clean by keeping feces, urine, vomiting, blood, and sweat from spreading.
iv) You may be required to attend the patient after he/she visited the toilets /latrine. Be sure that you wear protective gloves and wash your hands.
v) If the patient has diarrhea, vomiting and sweat give him extra fluid such as water or tea for drinking.
vi) Keep wound covered especially on those parts likely to come into contact with patient's bedding or clothing.
vii) Do not share sharp instruments such as razor blades and needles. This will help to avoid infection with sores and cuts.
viii) Offer financial support where possible if patient cannot work. He or she needs money for medicine and food.
ix) Offer spiritual support, share feelings, be honest and open
x) Provide physical support if needed.

PRECAUTIONS TO BE TAKEN WHEN HANDLING PLWHA & STI's:

i) Do not touch body fluids such as blood, stool and urine with your bare hands. Hence wear plastic bags or gloves on your hands.
ii) Wash the gloves or plastic bags in hot water every time after using them.
iii) Wash the beddings and clothes with soap. Make sure they are dried well in the sunshine
iv) Do not share sharp "instruments such as razor blades, syringes and tooth brush.
v) Keep your own and sick person sores clean and covered
vi) Dispose of properly vomits or bandages used when dressing wounds.
vii) Learn about the way HIV can and cannot be transmitted.

MYTHS AND MISCONCEPTION ABOUT HIV AND AIDS:

i) AIDS is witch craft and a curse
ii) HIV is transmitted by mosquito
iii) School girls and boys do not have AIDS
iv) Health people do not have HIV
v) Smart people do not have HIV
vi) HIV is same as AIDS
vii) HIV does not cause AIDS
viii) Sexual intercourse with a girl or an infant / animal cure AIDS

ix) Health people do not have the virus
x) Showering with cold water after sex will prevent HIV.