GROWTH AND DEVELOPMENT

Growth *is a permanent irreversible increase in size or dry weight of an organism.*
Development *is the increase in complexity of an organism for example seedling becoming a mature plant.*

GROWTH IN CELLS AND ORGANISMS

In **unicellular** organisms, growth occurs as a result of increased cellular components such as proteins, organelles and cytoplasm.
In **multicellular** organisms however, growth occurs by **cell division** and **cell enlargement** or **elongation**.

i. **Cell division:** this refers to the increase in the number of cells of an organism. This occurs mainly by **mitosis.**
   - During this process, there is an increase in the number of cell organelles, such as mitochondria, replication/duplication of DNA and increase in volume of cytoplasm.
   - This is then followed by division of the cytoplasm with its contents into two such that two identical daughter cells are formed.

ii. **Cell elongation/enlargement:** this involves an increase in the size of the cell. This occurs normally due to uptake of water or synthesis of new cell constituents.

Importance of mitosis or cell division in organisms

- Mitosis results into growth due to increase in number of cells
- Important in repair of tissues by replacing damaged and dead cells; thus wound healing
- It is the basis of asexual reproduction by binary fission in amoeba
- Formation of gametes in mosses

PARAMETERS USED TO MEASURE GROWTH

Growth is estimated by measuring some parameters depending on the organism whose growth is to be determined. The parameters used include:

- ✓ Length (height)
- ✓ number of body structures for example number of leaves on a plant
- ✓ girth or circumference of a tree
- ✓ Fresh weight/mass i.e. mass of an organism including body tissues and moisture content.
- ✓ Dry weight or mass, this includes only the mass of accumulated tissue without moisture. However it is difficult to carry out and permanently destroys the organism involved but gives an accurate measure of growth.
- ✓ Area e.g. leaf area
- ✓ volume

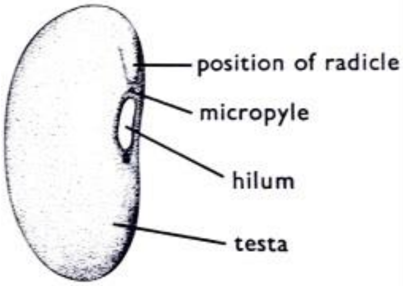
GROWTH IN PLANTS

Factors affecting growth in plants

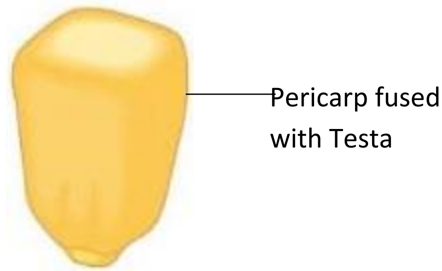
- Nutrient availability
- Carbon dioxide concentration
- Light intensity
- Temperature
- pH
- Presence of growth promoters
- Hereditary factors

SEED STRUCTURE

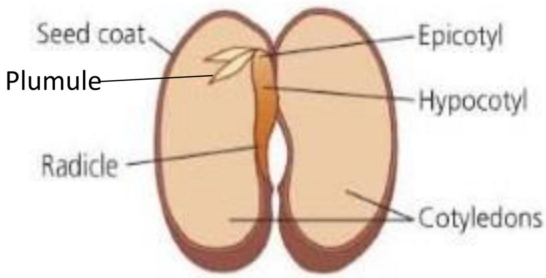
External structure of a bean seed



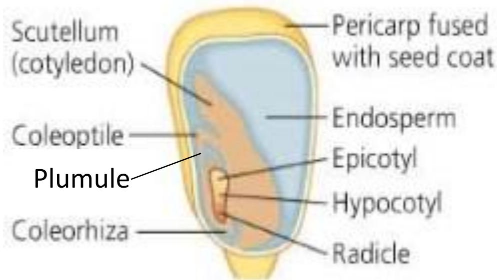
External structure of a maize seed



Internal structures of a bean seed



Internal structures of a maize seed



Functions of parts of seeds

a) **Testa**; these are formed from integuments round the ovule.
   Function: protects the inner parts of seed i.e. embryo, cotyledon, endosperm from fungal, bacterial and insect attack.
b) **Hilum;** scar left by the stalk (funicle) which attached ovule to ovary wall
c) **Micropyle;** opening in integuments through which pollen tube released male nuclei for fertilization, remains a tiny pore opposite tip of radicle.
   Function: allows entry of water for germination.
d) **Plumule;** contains meristem tissue for growth of shoot
e) **Radicle;** contains meristem tissue for growth of root
f) **Cotyledon;** storage of food
g) **Endosperm;** storage of food
h) **Coleoptile;** sheath protecting plumule in monocot seeds
i) **Coleorhiza;** sheath protecting plumule in monocot seeds.

GERMINATION

This is the process by which a seed grows into a seedling capable of self-sustenance.

Conditions necessary for seed germination

There are three conditions necessary for germination to occur

i. Water (moisture)
ii. Oxygen
iii. Warmth (suitable temperature)

(i) Water

Water is needed for the following:

- ✓ It activates the enzymes within the seed to hydrolyze the stored food.
- ✓ It softens the testa to enable it easily rapture during growth of radicle and plumule
- ✓ Enlargement of seed to rupture testa
- ✓ It dissolves the stored food materials making it easily absorbed by the embryo.
- ✓ It is a medium of transport of the dissolved food substances in the embryo shoot and root.

(ii) Oxygen

Oxygen is necessary for the process of respiration, which involves the oxidation of food to provide energy required for growth processes such as cell division.

(iii) Warmth

Suitable temperature is important for the enzyme controlled reactions to proceed, in the cotyledon, endosperm and embryo of the germinating seed.

- At very low temperatures, the enzymes are inactive and at high temperatures, they are denatured hence no germination.
- Germination requires optimum temperature which varies from 10℃-50℃ for most tropical seeds.

TYPES OF GERMINATION

There are two types of germination;

i. **Epigeal germination:** this is the type of germination in which the cotyledons of seedling appear above the ground.

This is due to faster growth of the hypocotyl as compared to epicotyl e.g. in bean seedling, pea seedling, mango seedling. Generally in most dicotyledonous plants

ii. **Hypogeal germination:** this is the type of germination in which the cotyledons of seedling remain below the ground.

This is due to faster growth of the epicotyl as compared to hypocotyl e.g. in maize seedling, wheat seedling, rice seedling. Generally in most monocotyledonous plants

EXPERIMENTS ON GERMINATION

Title: **Experiment to show that oxygen is necessary for germination**

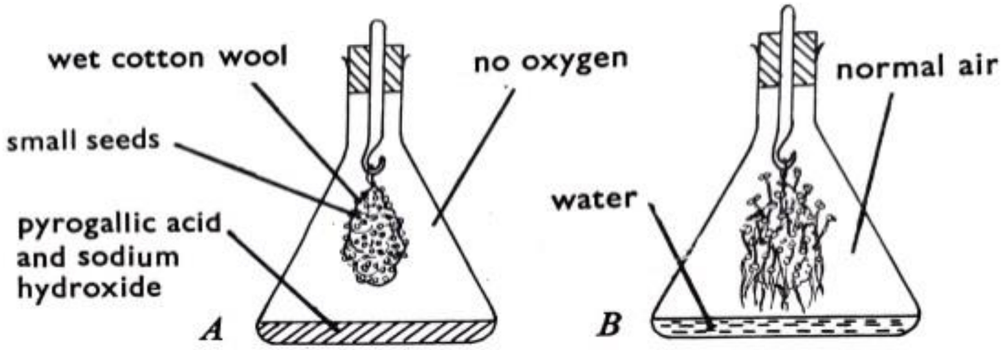
Materials

- *2 conical flasks,*
- *2 corks,*
- *Water,*
- *Cotton wool,*
- *Viable bean seeds*
- *Pyrogallic acid*
- *2 threads*
- *Sodium hydroxide solution*

Procedure:

- ❖ Two sets of viable bean seeds are rolled separately with wet cotton wool such that the seeds stick on the cotton wool.
- ❖ Each set of seeds is tied with a thread
- ❖ The first set of seeds is suspended inside a tightly corked conical flask containing a solution of Pyrogallic acid and sodium hydroxide solution, such that cotton doesn't touch the solution. This is set up A
- ❖ The solution in A deprives the seeds of oxygen by absorbing it from air
- ❖ The second set of seeds is suspended inside a tightly corked conical flask containing water, such that cotton doesn't touch the water. This is set up B, the control experiment
- ❖ Both set ups are placed in the same conditions of light and temperature for 3 days.

SET UP



Observation: *Most seeds in set up B germinate while those in set up A don't.*
Conclusion: *oxygen is required for the process of germination.*
ACTIVITY 1:
Describe an experiment to show that;

i. Warmth is required for germination
ii. Moisture is required for germination

SEED DORMANCY

This is a condition in which viable seeds fail to germinate.

Causes of seed dormancy

a) Hard seed coat such that radicle cannot rupture.
b) Low moisture content.
c) Impermeable seed coat which prevents water flow into the seed.
d) Presence of germination inhibitors which prevent germination.

Ways of breaking dormancy

- Availing enough water to activate hydrolysis enzymes
- Allowing an after ripening period for seeds.
- Exposing seeds to intense heat to break hard seed coat
- Exposing seed to extreme cold conditions
- Light treatment for a specific critical period to activate germination
- Filing of the seed coat to reduce its thickness so that it's permeable to water.
- Chemical action on the seed coat to make it soft for radicle to rupture
- Soaking to soften seed coat

Importance of dormancy period to a seed

i. Increases chances for germination to occur when conditions are most favourable
ii. Enables seedling that results to prevent adverse environmental conditions
iii. Prevents competition between offspring and parent plant
iv. Prevents competition between new plants and other neighbouring plant species.
v. Enables plants to prevent areas infested with pests which would otherwise hinder their success
vi. Allows time for seed dispersal

NB;

- ***Dormancy can also be induced in seeds for purposes of storage***
- ***Dormancy can also occur in buds of a plant, called bud dormancy which prevents vegetative growth***
- ***Seeds of different plant species have different dormancy periods***

MERISTEMS: these are regions where continuous cell division takes place in a plant. Examples of meristems include;

i. Apical meristems found at shoot and root tips and are responsible for primary growth.
ii. Lateral meristems which includes the vascular cambium and the cork cambium
iii. Intercalary meristems found at the nodes of monocots

PRIMARY GROWTH

This is the first form of growth that occurs in all plants that involves elongation of the shoot and root.

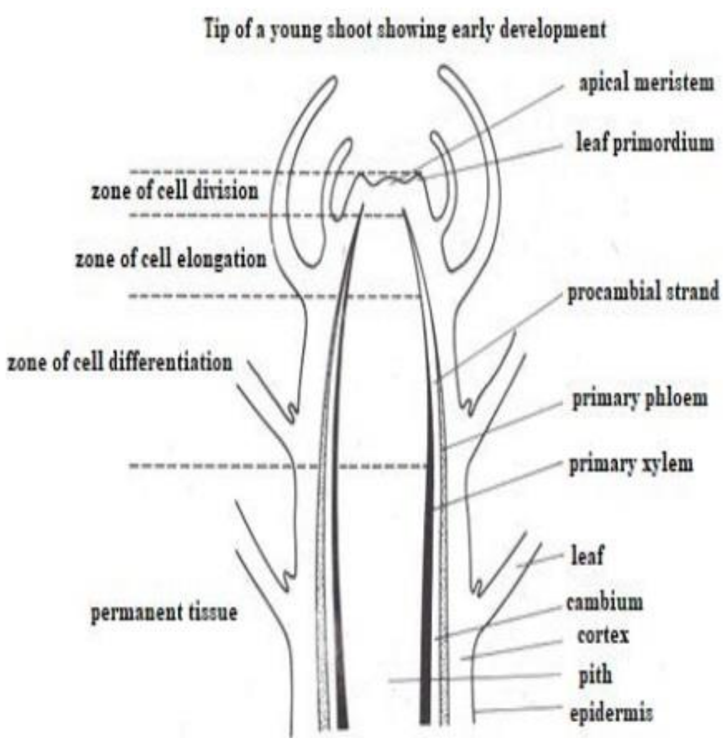
Upon germination, the seedling undergoes **primary growth** such that the radicle elongates to rupture through the testa, followed by the plumule.

Primary growth occurs at the **apical meristems** found at the **tip of the shoot** and the **tip of the root.**

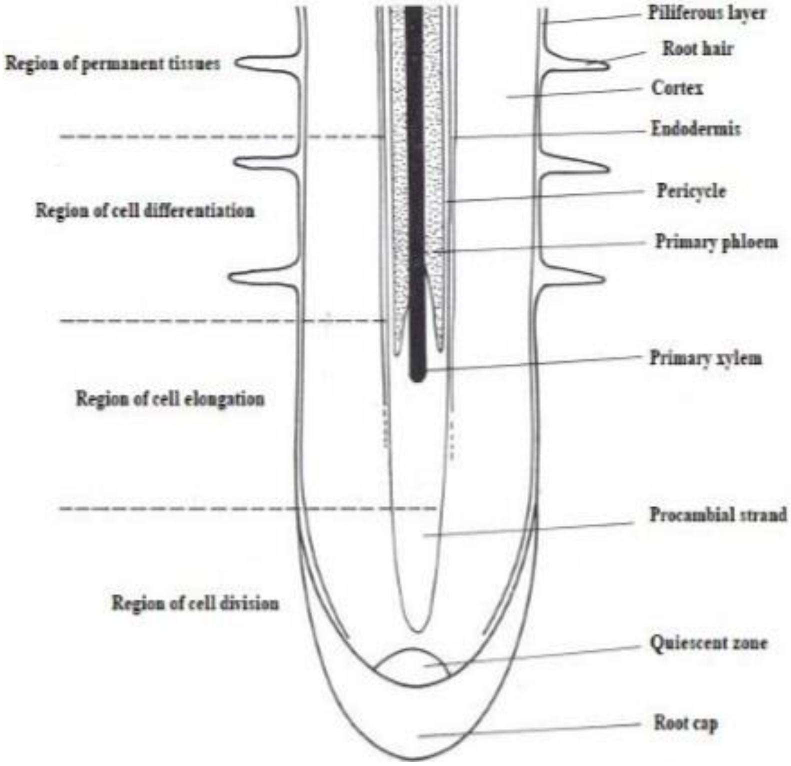
Primary growth results into formation of the primary plant body, it's thus responsible for initial plant growth.

NOTE: the only form of growth that occurs in *monocots and herbaceous plants is primary growth.*

Longitudinal section through shoot and root of a seedling to show growth regions



Tip of young root showing early growth



For both shoot and root sections shown above, there are three important regions of distinct activity;

i. Region of cell division
ii. Region of cell elongation
iii. Region of cell differentiation

i. Region of cell division

This is a region in which meristematic cells continuously divide to form cells that move either upward or downward. Cells that move downward form the root cap which protects the root tip. Cells that move upward move into a region of cell elongation

ii. Region of cell elongation

In this region, cells increase in size due to uptake of water by osmosis, forming vacuoles. These cells have thin cell walls which enable expansion/elongation when the cell takes in water. The region of cell division is also responsible for the increased length of the shoot upward and the root downward.
As cells proceed upward, they start to differentiate into specialized cells

iii. Region of cell differentiation

In this region, modifications start to occur to groups of cells resulting into the formation of specialized cells such as primary phloem, primary xylem etc.

The primary growth that occurs in shoots and roots can be experimentally demonstrated in which the region of most active growth, showing a larger extension can be determined.

AN EXPERIMENT TO DETERMINE THE REGION OF MOST RAPID GROWTH IN RADICLES

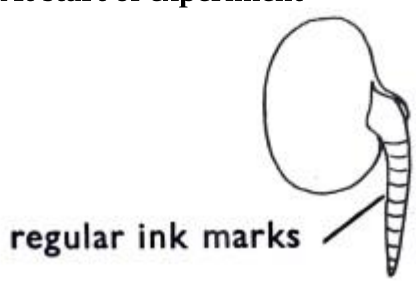
Materials

- 5 bean seedlings grown for 3 days
- Indian ink
- moistened cotton wool
- petri dish

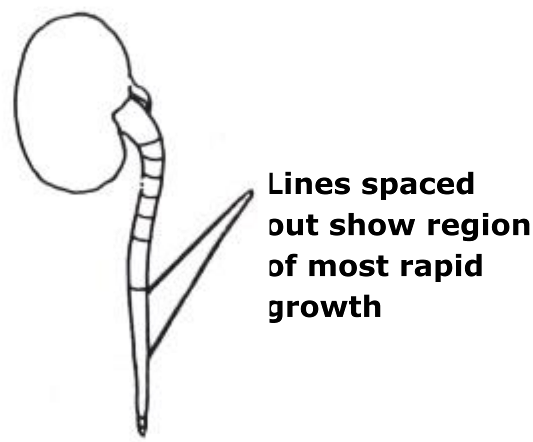
Procedure

- Straight radicles of bean seedlings that have been grown for 3 days on moist cotton wool in a petri dish are marked with lines at regular intervals of 2mm with Indian ink.
- The seedlings are arranged such that the radicles point downward and left to continue germinating for four days.
- After 4 days, the length between line marks is measured to determine the region of most rapid growth

At start of experiment



At end of experiment



Comment

- *Lines between which the greatest length is noted show the region of most rapid growth*

ACTIVITY 2

1. Define the term seed dormancy
   a) list reasons why some seeds become dormant
   b) explain ways in which dormancy can be broken
   c) give the significance of dormancy period to plants
2. a) By using an illustration, describe the regions of growth in a young root.
   b) Name the type of growth which herbaceous plants and monocots are limited to during growth
3. The table below shows results obtained from an experiment to determine growth in a bean seedling.
   Study it and answer the questions that follow.

TIME (Days)	Length of shoot (mm)
Day shoot appears. Day 0	2
Day 2	5
Day 4	8
Day 6	12
Day 8	16
Day 10	21

a) Plot a graph to represent the data in the table above
b) Describe the events that take place before day 0

DEVELOPMENT IN PLANTS AND SECONDARY GROWTH

The course of germination of monocots shows some clear distinctions as compared to the course of germination of dicots. However, for both, germination involves both growth and development processes which are enabled by a series of physiological processes in the seed/seedling.

Course of germination of a bean seed (dicot)

i. **Physiology of germination**

- ✓ The seed takes in water through the micropyle such that the seed swells.
- ✓ Water activates hydrolytic enzymes which catalyze the breakdown of stored food materials such as starch to glucose and proteins to amino acids in the cotyledons at favourable temperature.
- ✓ The water also dissolves the formed soluble food nutrients which are then transported to the actively growing regions of the embryo where new cells and new protoplasm are formed
- ✓ The glucose may be oxidized during respiration to release energy required for processes of growth.
- ✓ The glucose may also be converted to cellulose which is used to form new cell walls.
- ✓ Amino acids are used to form cell membrane and new protoplasmic components.
- ✓ The glucose formed also lowers the osmotic potential, more water is taken in, cells formed expand such that the radicle grows and bursts through the testa.

ii. **Development of seedling**

- ✓ The radicle grows out of the seed, down between the soil particles with its tip protected by the root cap.
- ✓ Root hairs develop where elongation has ceased to take place.
- ✓ Water and salts are absorbed by the root hairs and moves to other regions of the seedling.
- ✓ Lateral roots develop from the radicle which anchor the seedling firmly into the ground.
- ✓ Hypocotyl starts to grow at a high rate such that the cotyledons are pulled out of the testa and through the soil to appear above the soil surface. This is **Epigeal germination**
- ✓ The testa now falls off
- ✓ The plumule protected by the cotyledons is now growing such that as the hypocotyl straightens and the cotyledons are separated, the plumule becomes exposed.
- ✓ Cotyledons become green and capable of photosynthesizing.
- ✓ Epicotyl grows further, plumule leaves expand and photosynthesize making the seedling independent of the cotyledons which fall off

The illustration below shows the stages of growth and development of a germinating bean seedling, ***Phaseolus vulgaris.***

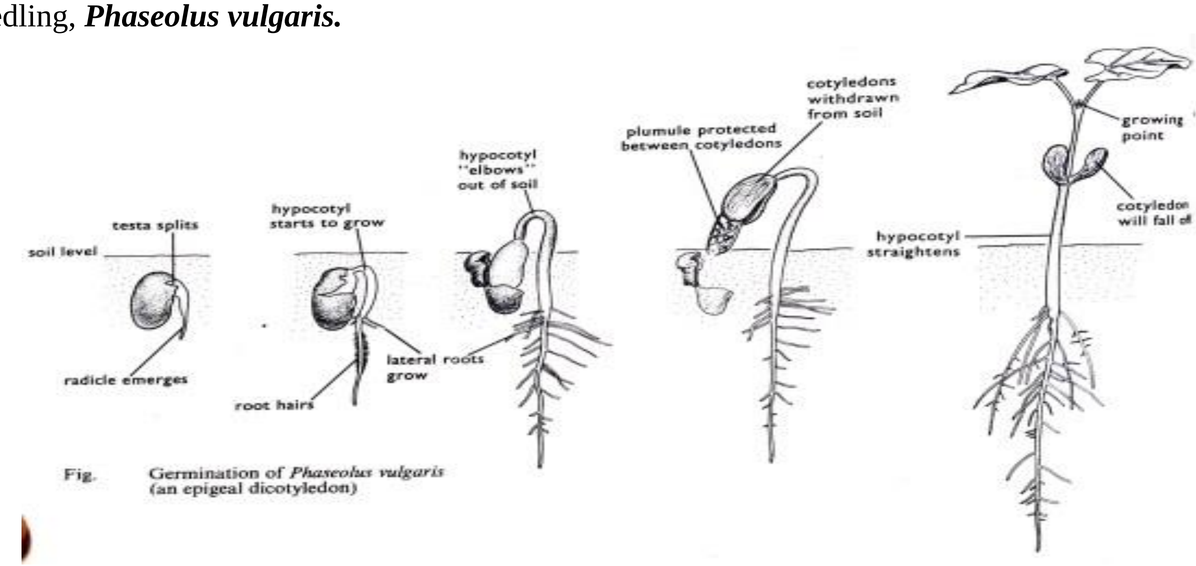


Fig. Germination of *Phaseolus vulgaris* (an epigeal dicotyledon)

Course of germination of a maize grain (monocot)

i. Physiology of germination

- ✓ A maize grain is a fruit containing one seed but with a thin pericarp which allows entry of water such that the seed swells.
- ✓ The water absorbed activates enzymes which catalyse the breakdown of starch and proteins stored in the endosperm
- ✓ The soluble nutrients formed are transported through the cotyledon to growing regions in the embryo.

ii. Development of seedling

- ✓ Due to the fall in osmotic potential resulting from glucose formed, more water enters the seedling such that the radicle bursts through the coleorhiza and fruit wall into the soil.
- ✓ Root hairs grow on the upper regions of the radicle.
- ✓ Plumule protected by the coleoptile, a sheath with hard pointed tip, grows through the fruit wall as a result of faster growth of the epicotyl.
- ✓ Adventitious roots grow from the base of the plumule
- ✓ Plumule protested by coleoptile appears above the soil surface, leaving the cotyledon below soil surface absorbing food from the endosperm and transmitting it to the growing shoot and root. This is called **Hypogeal germination**
- ✓ The first foliage leaves now burst out of the coleoptile accumulate chlorophyll and become photosynthetic. The coleoptile remains as a sheath round the leaf bases.
- ✓ Both Cotyledon and exhausted endosperm rot away as the photosynthesizing seedling is fully independent.

The illustration below shows the stages of growth and development of a germinating maize seedling, ***Zea mays.***

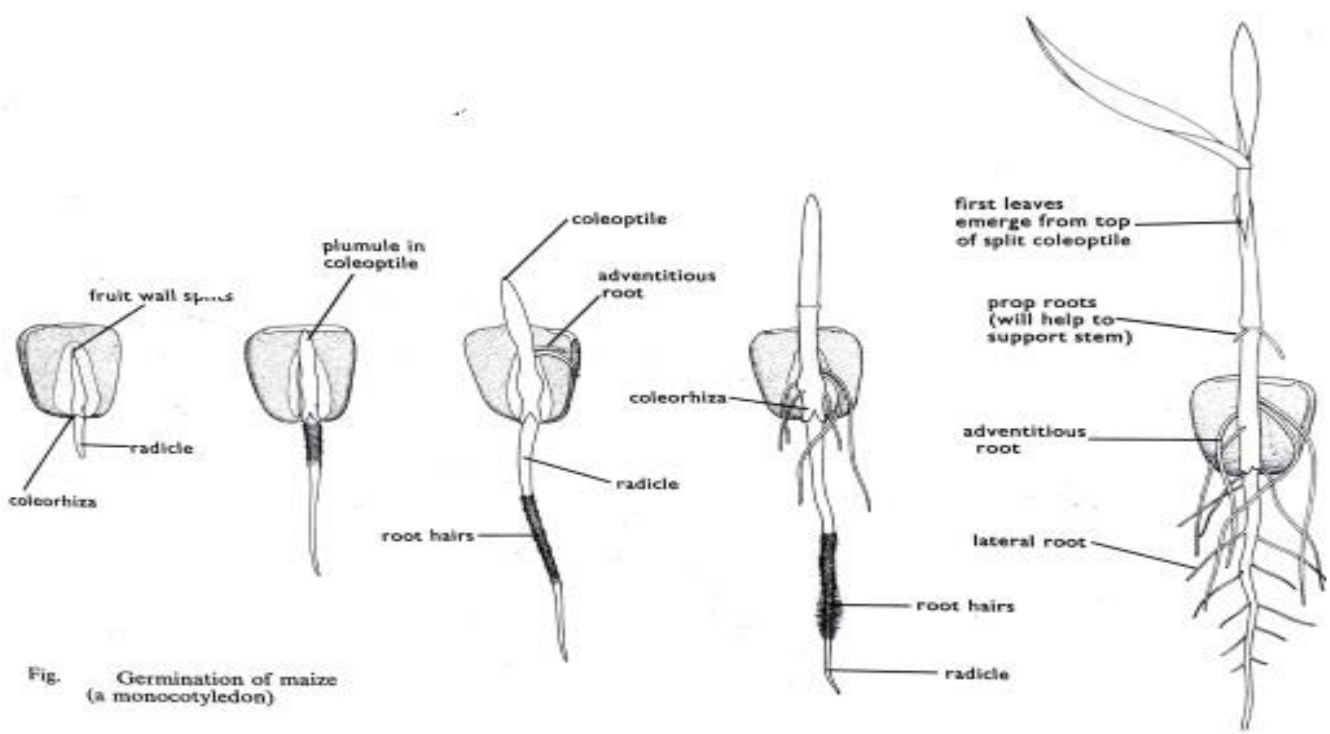
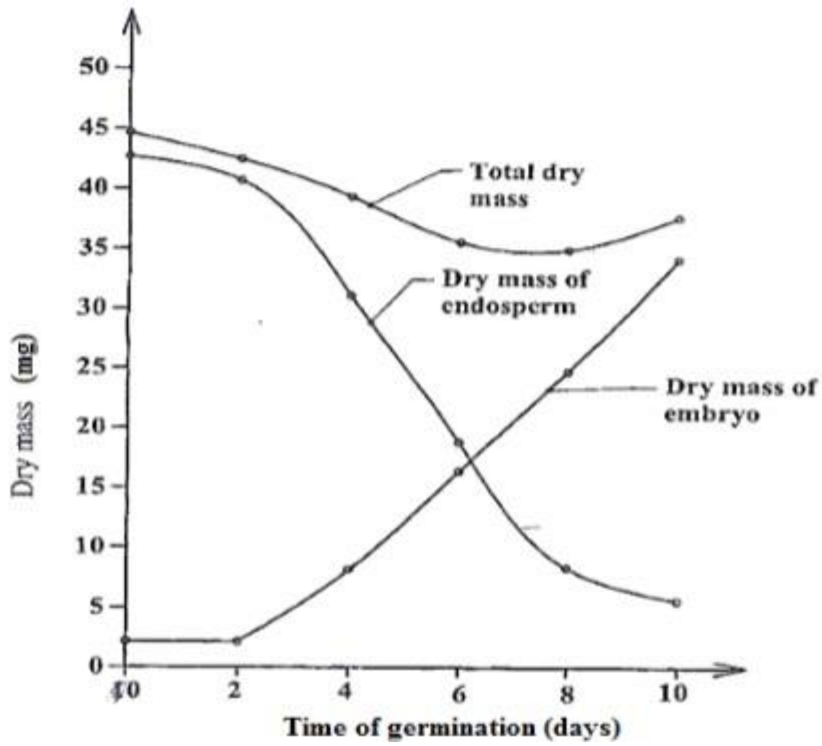


Fig. Germination of maize (a monocotyledon)

The graph below shows changes in dry mass of endosperm, embryo and total dry mass of seedling during germination.



ACTIVITY 3

a) Describe the change in dry mass of

i. **Endosperm**
ii. **Embryo**

b) Explain the changes in dry mass of

i. **Endosperm**
ii. **Embryo**
iii. **Total dry mass**

POST GERMINATIONAL DEVELOPMENT IN PLANTS

During germination, in the region of differentiation in both the shoot and the root, cells become more specialized to form modified cells and tissues of the plant.
After germination, growth continues at meristems i.e. at the **apical meristem** primary growth continues while at the **lateral meristems** (vascular cambium and cork cambium), secondary growth takes place.

SECONDARY THICKENING

This is growth that occurs after primary growth due to activity of the lateral meristems resulting into the increase in girth of the plant.
Secondary growth results into formation of **wood** and **cork.**

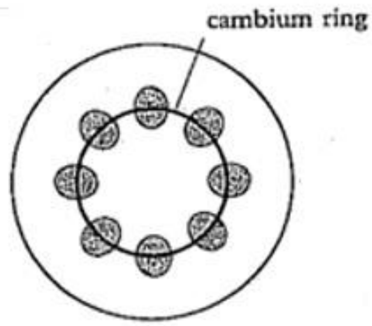
Process of secondary growth

During the process of secondary growth, the vascular cambium which contains meristematic cells starts to divide with in non-herbaceous dicots. The division of cells of the cambium results into formation of secondary xylem on the inside and secondary phloem on the outside.

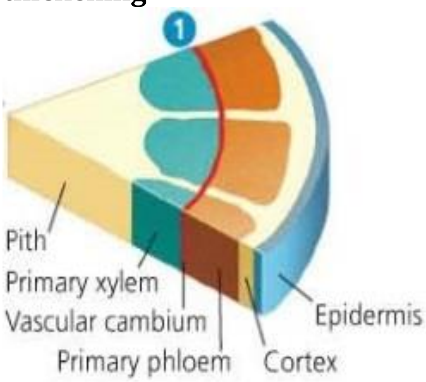
Since secondary growth occurs at almost definite intervals of time, new secondary xylem is deposited as old formed secondary xylem is pushed further away in concentric rings. Therefore, rings further away are older than rings close to the pith. The secondary xylem forms the wood.
As the secondary phloem is pushed further away it ruptures. The spaces formed are filed by cork formed from cork cambium.

The illustrations below show stages of development in which secondary growth occurs

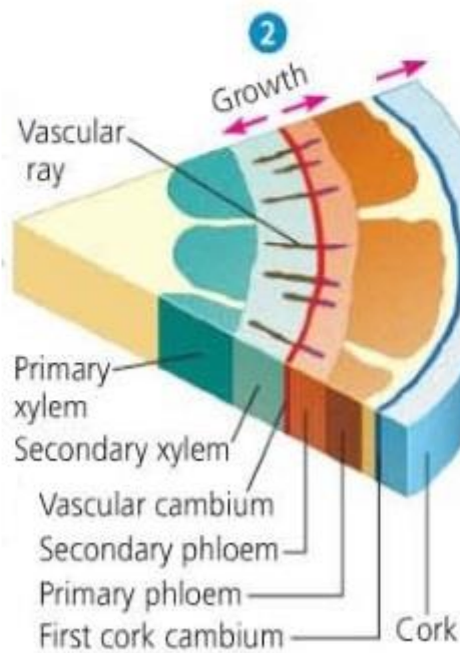
Cross section through young dicot stem



Section of dicot stem before secondary thickening



Secondary growth occurs



GROWTH AND DEVELOPMENT IN ANIMALS

Factors affecting growth in animals

i. Nutrient availability
ii. Hereditary factors
iii. Hormones e.g. thyroxine hormone

GROWTH PATTERNS IN ANIMALS

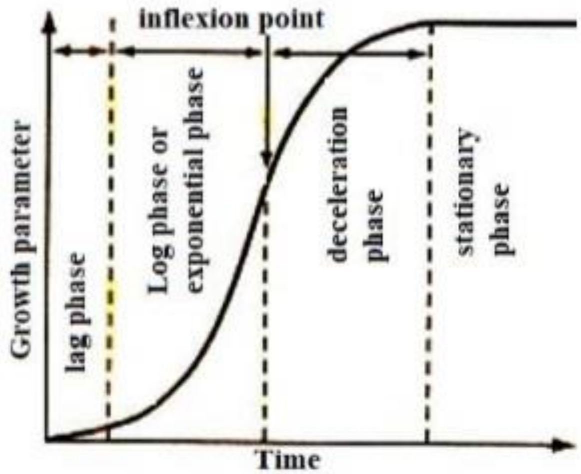
In animals growth occurs throughout the body of the organism unlike in plants where growth is localized in specific areas called meristems. Most animals grow continuously until they reach maturity, this is called **continuous growth** for example invertebrates such as echinoderms. In Arthropods like insects growth is **discontinuous**, i.e. there are periods of growth and no growth.

As earlier discussed, different parameters such as height, weight, dry mass, area etc may be used as measures of growth.

When a parameter of growth is measured relative to set intervals of time, a growth curve is produced. A typical growth curve shows the cumulative increase in a parameter e.g. weight or dry mass over a period of time. This curve is normally S shaped and called a sigmoid growth curve as shown below.

*Organisms that exhibit the sigmoid growth curve are said to have **limited growth** i.e. they grow up to maturity and growth ceases*

Sigmoid growth curve



The sigmoid growth curve above has the following phases;

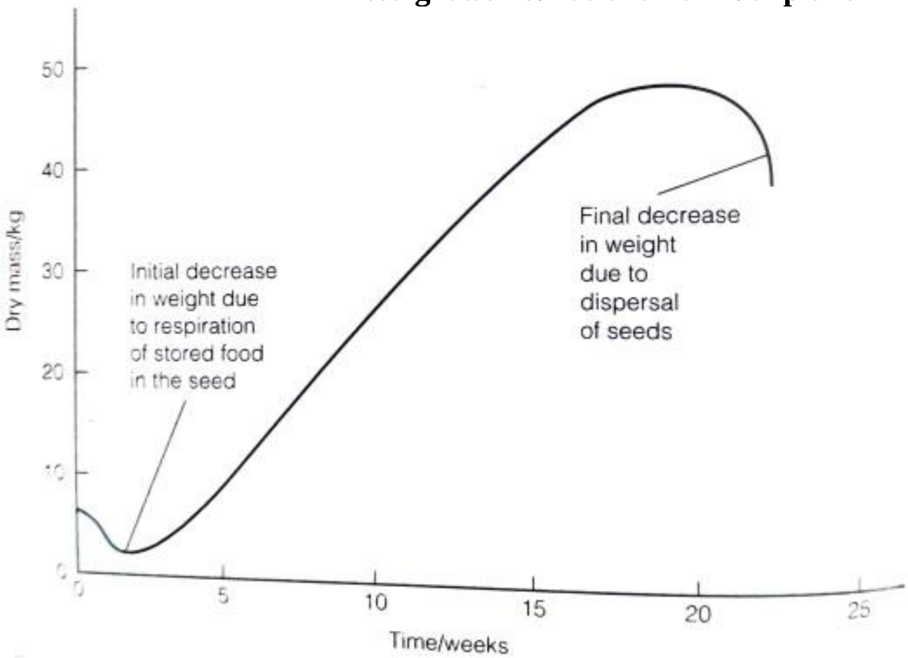
1. **Lag phase**
   This is the initial phase during which little growth occurs. At this stage, the rate of cell division is low.
2. **Log phase / acceleration phase**
   This is also referred to as rapid growth phase or phase of exponential growth. The rate of cell division here is very high such that the number of new cells formed is proportional to the number of cells already present and the nutrients available.
3. **Deceleration phase**
   During this phase, growth is still taking place but at a lower rate. Here, growth is limited to a set of internal factors or external factors to the organism.
4. **Stationary phase**
   During this phase, the parameter of growth being considered is constant showing that no more growth is taking place.

NB; Beyond the stationary phase, the trend of the graph depends on the species of animal; some species may maintain the constant size for example arthropods while others undergo negative growth such that the parameter of growth being considered reduces. This occurs during old age for example among *Homo sapiens, typical of **limited/definite growth***

LIMITED GROWTH (DEFINITE GROWTH)

It is found in annual plants and majority of vertebrate animals e.g. humans. In limited growth an organism grows to an average maximum size which is characteristic of the species and then growth stops. This is followed by senescence (decline in old age and death). It is also observed in insects and birds. The growth curve obtained is typically sigmoid except there may be an initial decrease in mass during early stages of germination in plants. And once leaves start photosynthesizing, growth proceeds in a sigmoid, and when the seeds and fruits are released at the end of the growing period, the mass of the plant may decrease prior to death.

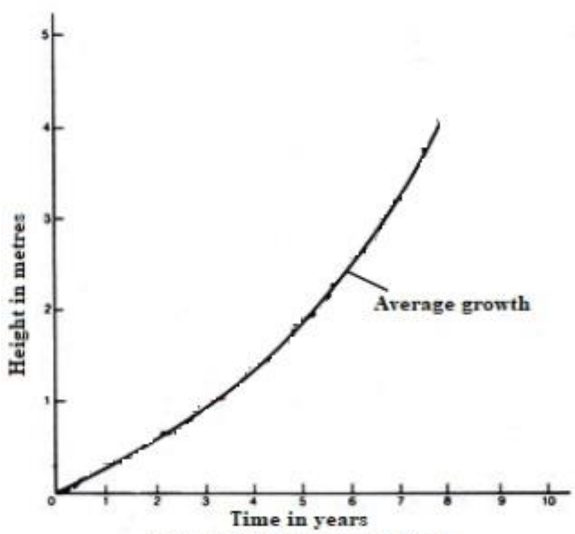
Limited growth curve of an annual plant



UNLIMITED/INDEFINITE GROWTH

Perennial plants, grow continuously throughout their lives i.e. their curve never flattens out. They have an unlimited or **indefinite growth**. It is also found in fungi, algae, animals particularly invertebrates like cnidarians, echinoderms and vertebrates like fish and reptiles.

Curve showing unlimited growth

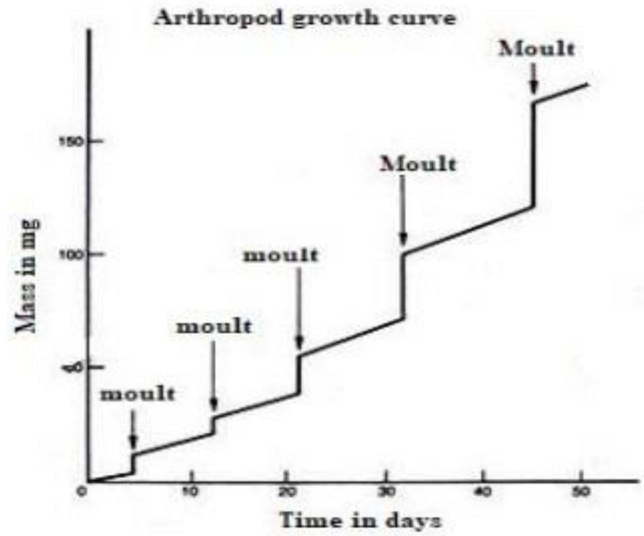


Perennial plant growth curve

INTERMITTENT GROWTH (Discontinuous growth)

Arthropods such as insects have a characteristic growth pattern. Their exoskeleton is incapable of expansion, they have to moult periodically for growth to occur. Before a new exoskeleton has fully hardened, it is capable of some expansion. During this, time insect may take up water in order to

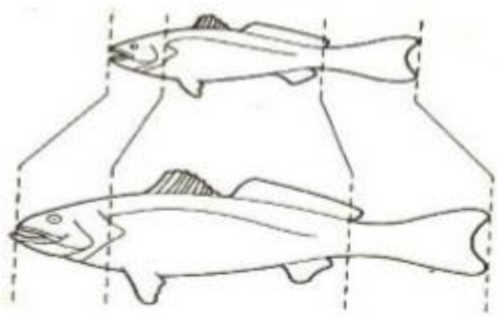
expand the exoskeleton as much as possible. This gives room for further growth and the organism changes abruptly to a new size after every moult.
A plot of length of such an organism against time gives a characteristic star-like curve. The steep portions correspond to the time of moulting. The flat portions correspond to the stages between moults also known as ***instars.***



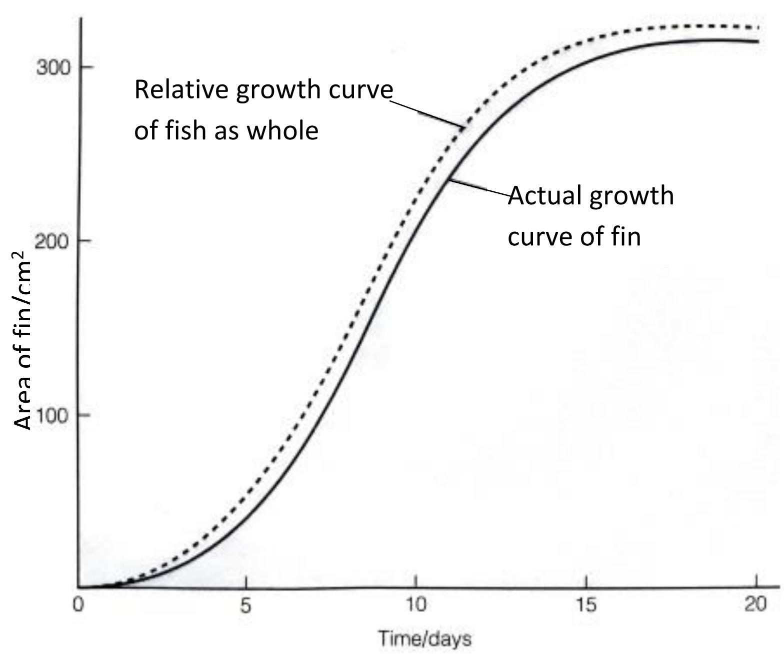
ISOMETRIC AND ALLOMETRIC GROWTHS

Isometric growth occurs when an organ grows at the same mean rate as the rest of the body. In this situation, change in size of the organism is not accompanied by a change in shape or external form of an organism, i.e. the proportion of the 2 structures remains the same. This type of growth is typical of fish, insects e.g. locusts (except for the wings and genitalia), leaves of plants
In fish for example, the size of a fin in relation to the size of the entire fish size remains the same throughout the life of the fish.

ILLUSTRATION



Graph showing isometric growth of a fin of a fish



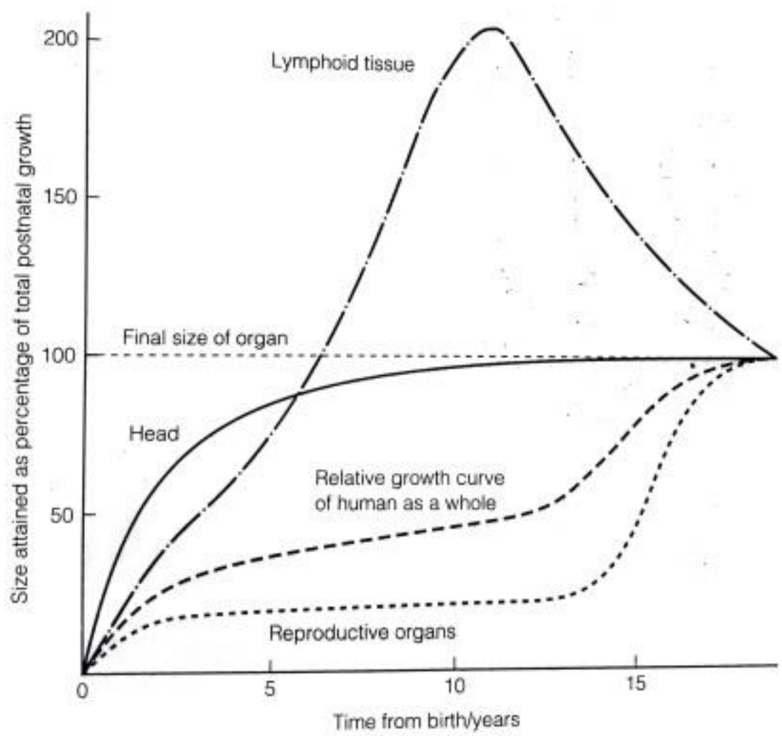
Observation from the graph

- ***From 0 days to 5 days, there is a gradual increase in area of fin and whole fish***
- ***From 5 days to 10 days, the area of fin increases rapidly, so does area of whole fish***
- ***From 10 days to 15 days, area of both fin and whole fish increases gradually***
- ***From 15 days to 20 days, area of both fin and whole fish is constant***

COMMENT: *area of fin and area of whole fish increase by a similar factor, they remain proportional throughout growth and development.*

Allometric growth occurs when an organ grows at different rate from the rest of the body. In this case, increase in size of the organism is accompanied by a change in shape of the organism. This pattern of growth is characteristic of mammals for example human beings. The relative proportions of growth and development are shown in the figure below:

Allometric growth as shown by Human organs and tissues



Observations from the graph

- ✓ The head grows at a faster rate than the whole body and all body parts earlier on in life.

Reason; *to enable growth of the brain which is responsible for coordination of activities of all other body parts.*

- ✓ Lymph tissue which produces white blood cells to fight infection grows rapidly early in life, at a rate higher than that of human body as a whole.

Reason*; to increase immunity to be able to combat any infection*

- ✓ By adult life, the mass of lymph tissue is less than half of what it was in early adolescence because of the immunity acquired.
- ✓ Reproductive organs grow very slowly in early life or remain small in size but develop rapidly with an onset of sexual maturity (puberty) at about 14 years until final size is attained.

Reason; *early in life, humans are incapable of reproduction as brain is controlling growth of vital organs. With increased release of sex hormones at puberty, reproductive organs start growing rapidly to full size*

Question: the table below shows the changes observed in dry weight in mg of a barley seedling, its embryo and endosperm during the first ten days after onset of germination.

Time/days	**Embryo**	**Endosperm**	**Whole seedling**
0	2	41	45
2	2	39	43
4	7	32	41
6	15	21	38
8	22	11	35
10	35	6	43

a) Suggest how the experiment was carried out
b) Using a suitable scale and on the same set of axes plot graphs of dry weight of embryo, endosperm and whole seedling against time.
c) Describe and account for the changes in weight shown by:
   i) The embryo
   ii) The endosperm
   iii) Whole seedling during the period of the experiment.
d) Explain how you would expect the weight of the whole seedling to change if the experiment was carried out in the dark.

Question:

A study was conducted on the germination and early growth of sorghum. The grains were soaked in cotton wool in a green-house and at two – day intervals, samples were taken and separated into two components, of endosperm and embryo (seedling), which were then oven dried and weighed. Figure 1 shows the variation of total dry mass, dry mass of endosperm and embryo.

Use the information to answer the questions that follow.

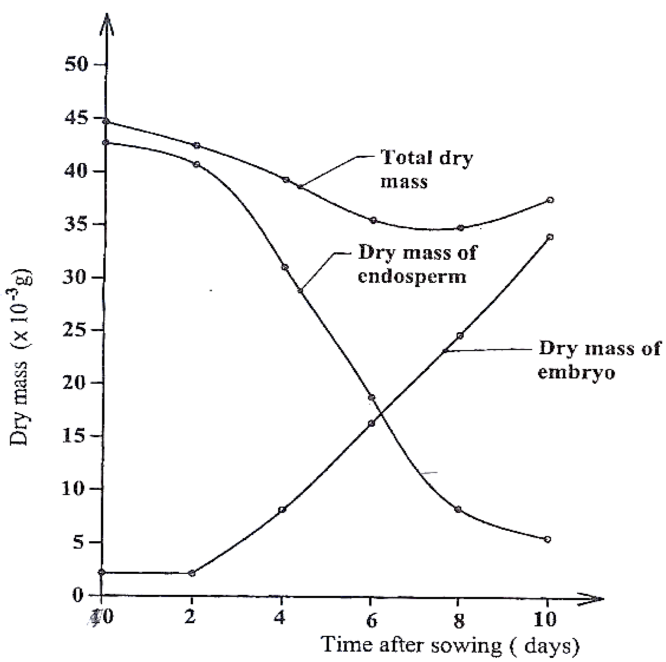


Fig. 1

a) Explain the variation with time of
   (i) Dry mass of endosperm
   (ii) Dry mass of embryo
   (iii) Total dry mass of seedling
b) Explain why the following were done.
   i) Oven drying the seeds
   ii) Separating the seed components
   iii) Sowing seeds in a green house
c) From the information given, name the method used for measuring weight, give any possible disadvantage of the method
d) What conclusion can be drawn from the graph after 8 days
e) Suggest what would happen if the experiment continued for another 10 days.

GROWTH AND DEVELOPMENT IN INSECTS

Insect metamorphosis; *these are series of developmental stages of an insect from egg to adult.*
There are two types of insect metabolism;

i. Complete metamorphosis: this is a form of metamorphosis involving four stages including egg, larva, pupa and adult.

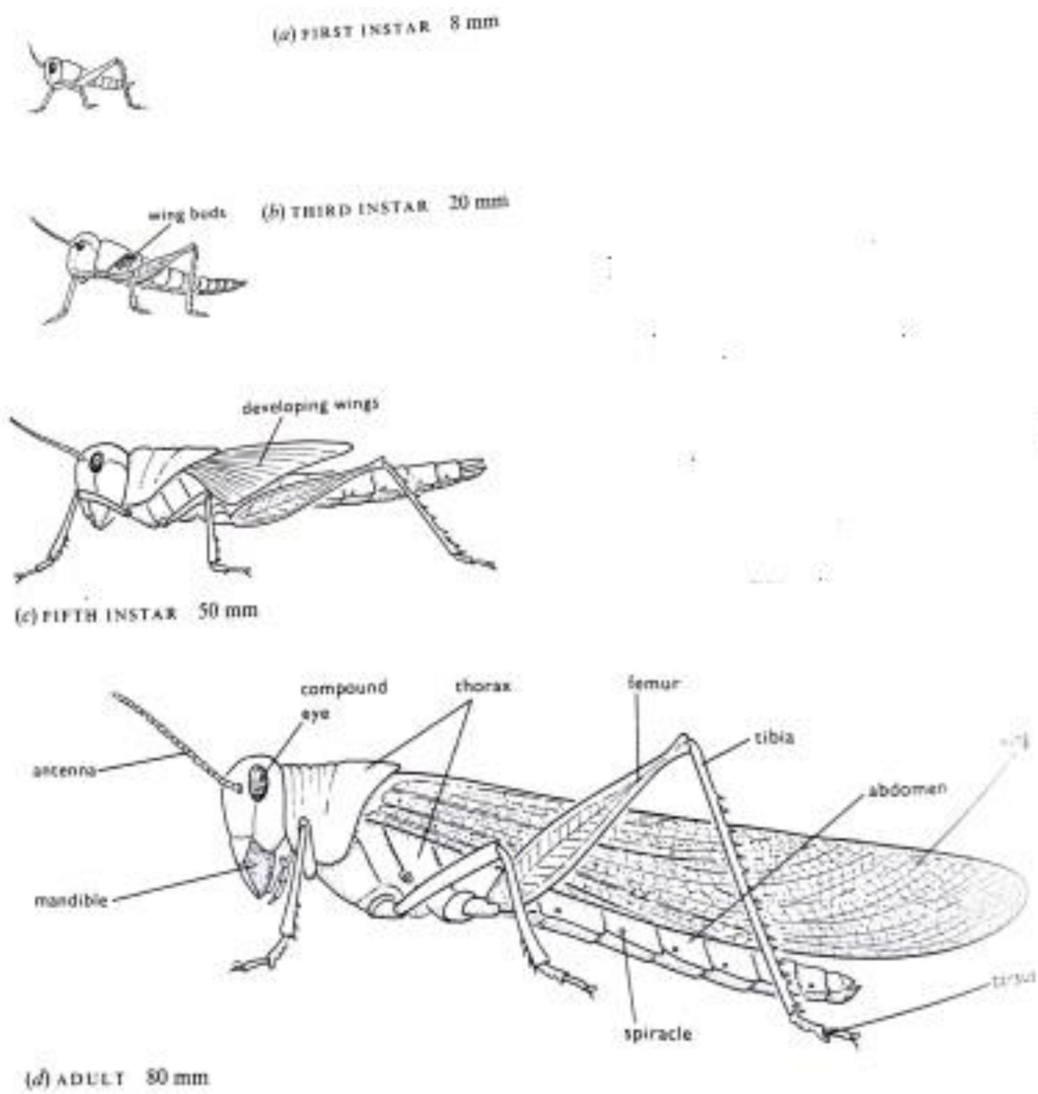
Examples of insects that undergo complete metamorphosis include butterfly, housefly, and mosquito.
During complete metamorphosis, **eggs** hatch to form **larvae** which differ considerably from the adults.
Each larva undergoes a series of moults until it changes its appearance into a dormant stage called **pupa** often encased in a *puparium* (pupal case)
During the pupa stage, the organism undergoes structural changes in which the ptilinum, a sac like structure in the head can be blown out such that the top of the puparium is burst open the ptilinum is withdrawn into the head as the pupa metamorphoses to form a perfect insect, the **adult** (imago)
The adult crawls out of the puparium, its wings expand and harden and it's now capable of flight.

Illustration (**do not draw)**

ii. Incomplete metamorphosis: this is a form of metamorphosis which involves three stages; egg, nymph and adult suth that the nymph resembles the adult.

Examples of insects that undergo incomplete metamorphosis include; cockroach, locust, grass hopper etc.
During incomplete metamorphosis, **eggs** hatch to form a **nymph**. The first nymph has no wings
The nymphs then undergo about five moults with the stage between moults called an instar.
With each moult, the size of the nymph increases, with considerable increase in size of wings.
After the fifth moult, changes are more pronounced with wings being considerably larger.
An **adult** forms

Illustrations to show relative differences in size of instars formed after successive moults. (do not draw)



Similarities betewenn complete and incomplete metamorphosis

- The first stage in both is an egg
- Both involve structural changes of the organism
- In both, the adult has the largest size of all stages
- Both involve moulting which stops once an adult emerges

Differences between complete metamorphosis and incomplete metamorphosis

Complete metamorphosis	Incomplete metamorphosis
• Consists of 4 developmental stages	• Consists of 3 developmental stages
• Each stage is considerably different from the next structurally	• Considerable similarity between nymph and adult structurally
• After hatching,each stage feeds on different nutrient sources characterised with diffrence in mouth parts	• After hatching, proceeding stages have the same nutrient sources characterised with same mouth parts
• Has a dormant pupa stage	• There is no domant stage

STAGES OF DEVELOPMENT IN AN AMPHIBIAN e.g. a toad

- After fertilization, the zygote formed contains a nucleus and yolky granules from which nutrients required for development are obtained and is enclosed in a jelly.
- The nucleus divides to form two nuclei, followed by the division of the cytoplasm so that two cells, each with a nucleus appear.
- A second division takes place in each cell but at right angles to the fisrt division forming 4 smaller cells
- A third division takes place in the four cells, this time at right angles to the other two, forming eight cells of which the lower four are slightly larger than the upper four.
- Divisions continue such that the zygote is hollow ball of tiny cells. cells continue increasing in number, a process called **cleavage**
- As cleavage continues in the first few hours, the number of cells increases but with almost no increase in size of the hollow ball, now called an embryo.
- Later, the embryo begins to elongate and develops a distinct head and tail.
- In the embryo, cells differentiate and organize to form structures and organs of the tadpole. Energy and raw materials for this process of development come from the yolk.
- After about thirty hours, the tadpole escapes from the jelly, with an undeveloped mouth and still obtaining nutrients from yolk in its intestines.
- Tadpole now has a mucuous gland by which it attaches to weed.
- Two pairs of external gills develop, mouth opens in three days with horrny toothed jaws which it now uses to scrap food off weeds.
- After about four days, mucous gland begins to disappear, distinct head and tail form.
- Internal gills form which open by the gill slits through the buccal cavity to the outside.
- A chamber called atrium forms around each gill slit such that on the outside the gill is protected by the operculum, a fold of skin
- In about 7 days, external gills are reabsorbed into the body and gaseous exchange is through gill filaments of internal gills
- At about 60 days, hind limb buds grow at junction between tail and body. They develop into perfect legs in three days.
- At this point legs front legs have grown but covered by operculum and tadpole mones by wiggling its tail
- Tadpole diet changes fron vegetation to flesh
- At about 10 weeks under the action of thyroxine hormone,complete metamorphosis takes place to form a frog in which,front legs break through the operculum with left leg appearing first, followed by the right leg.
- The tail shortens and is digested into the body of the tadpole, proving nutrient to tadpole which at this time has stopped feeding.
- The skin, lerval lips and horny jaws are shed leaving a much wider mouth and lighter coloured skin

STAGES OF DEVELOPMENT IN A MAMMAL e.g. human.

- After fertilization, the egg now called zygote undergoes rapid cell division, a process called **cleavage** as it passes down the oviduct to the uterus in 3 days.
- The outer layer of cells of embryo form the chorion and amnion. The chorion forms villi for implantation into the uterine linning from which it obtains nutrients.
- The villi develop to form the placenta by which exchange of materials such as glucose, amino acids, oxygen, salts and waste products between the embryo and uterus takes place.
- The amnion a membrane around the foetus contains a fluid, amniotic fluid which protects the foetus from damage or unequal pressure.
- The internal organs of the embryo including heart, kidneys, liver are now developed.

- At about 10 weeks, the foetus is clearly developed with distinct hind and fore limbs, ears, eyes, head.
- At about 5 months of growth and development, the embryo vigorously moves its limbs in the amnion.
- Through out this course of development to a few weeks before birth the foetus has its back facing the cervix.
- A few weeks before birth, the foetus lies with its head downwards facing the cervix

Measurement of weight of human baby for a given period of time

- ✓ Measurement of weight is done for babies between 0 to 2 years to monitor their growth
- ✓ Measurement of weight of the baby is done using a hospital grade platform weighing scale such as a bean balance.

Procedure

- Remove shoes, clothing and diaper from infant
- Place scale in zero mark position
- Place the infant in the centre of the platform
- Record the measurement to the nearest decimal fraction
- Remove child from the weighing scale

Precautions

i. ***The measuring scale must be checked regularly to ensure accurate results are obtained***
ii. ***Weights should be caliberated using knownweights on the scale to check accuracy***
iii. ***Scale must be placed on a flat, uncarpeted floor***

Significance of results

- The child may be measured every week such that when the measurements for the 2 months are obtained, a graph showing variation of weight of child with number of weeks is plotted.
- The curve obtained is then used to deduce the pattern growth of the baby such that any abnormal pattern can enable clinicians recommend dietery intervention.
- The results may also be compared with those expected for normal growth.