CELL DIVISION

In order growth, repair of worn out tissues, reproduction to occur, cells must multiply through a process called, **cell division**.

Qn. What is cell division?

Cell division is the formation of new cells from a parent cell.

The new cells formed as a result of cell division are called **daughter cells** which are also capable of further division giving rise to other new cells.

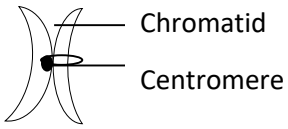
Qn. Which of the following best describes a cell that gives rise to new cells?

A. Daughter cell B. mother cell C. sister cell. D. parent cell

Some important terms used in cell division

Likely asked question. What is meant by the following?

a) **Chromosome**; this is a thread-like structure in the nucleus on which genes that determines an organism's characters are carried



b) **Chromatid**; this is one half of a chromosome.

c) **Centromere**; this is a structure of chromatid attachment and separation on a chromosome.

d) **Sister chromatids**; these are chromatids of the same chromosome.

e) **Homologous chromatids**; these are chromatids of different chromosomes in a bivalent.

f) **Bivalent**; this is a pair of homologous chromosomes.

g) **Chiasmata**; this is a crossing over point between two homologous chromatids.

h) **Haploid**; this is where a cell has half the number of chromosomes compared to the parent cell.

i) **Diploid**; this is where a cell has a whole set of chromosomes.

j) Replication; this is where a structure produces an exact copy of itself.

Types of cell division

Qn. State the types/ forms of cell division

i) Mitotic cell division (mitosis)

ii) Meiotic cell division (meiosis)

Cell division involves nuclear division followed by cytoplasm division immediately (cytokinesis) both of which comprise a cell cycle

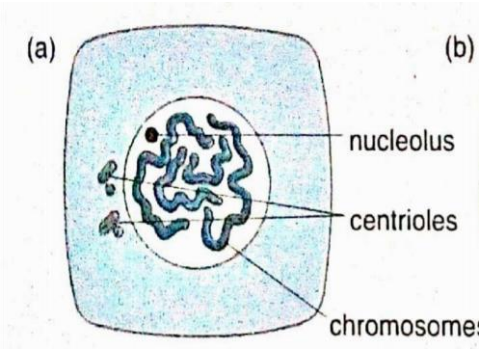
Each form of cell division involves four phases. These are in their order;

1. Prophase
2. Metaphase
3. Anaphase
4. Telophase

Before the cell divides, it undergoes a resting stage called **Interphase**

During interphase, the following events occur;

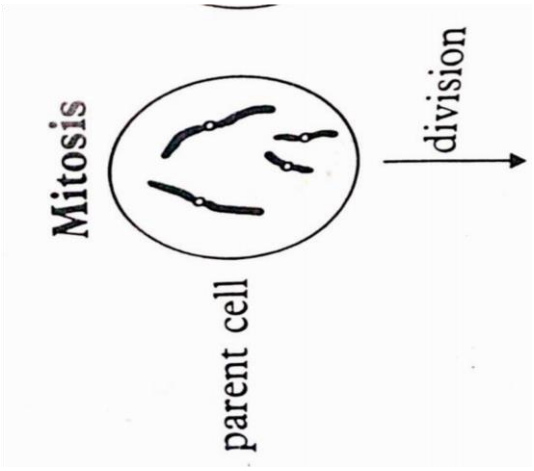
- Chromosomes not visible (are thread like)
- Centrioles replicate
- Replication of DNA (double)
- Production of ATP (energy)
- Formation of new organelles (mitochondria, ribosome, chloroplast), duplication

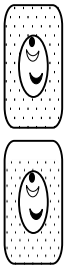


MITOSIS

Qn. What is meant by mitosis and state where it occurs in animals and plants?

This is the type of cell division in which the parent cell divides giving rise two daughter cells each having the same number of chromosomes as the parent cell.





Two daughter cells form

Where mitosis occurs

In animals, It occurs in somatic cells e.g. in man, it mainly occurs in;

- The bone marrow
- The epidermal cells of the gut
- The malpighian cells of the epidermis of the skin

In plants, it occurs in meristems e.g.

- The apical meristems
- The cambium

Qn. Describe the process of mitosis

Mitosis involves four phases which are Prophase, Metaphase, Anaphase and Telophase.

Mitosis is preceded by interphase and during this phase;

Chromosomes not visible, Centrioles replicate, DNA doubles, Production of ATP (energy), Formation of new organelles (mitochondria, ribosome, and chloroplast).

During Prophase

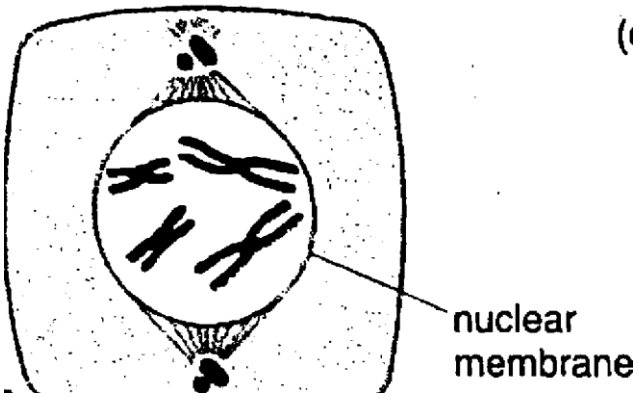
-Chromatin threads condense to form distinct chromosomes,

-Centrioles at opposite sides of the nucleus

-Spindle fibres start to form

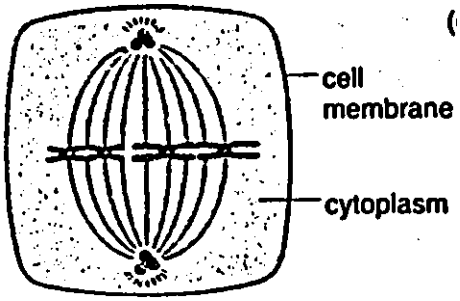
-Nucleolus disappears

-Nuclear membrane breaks down



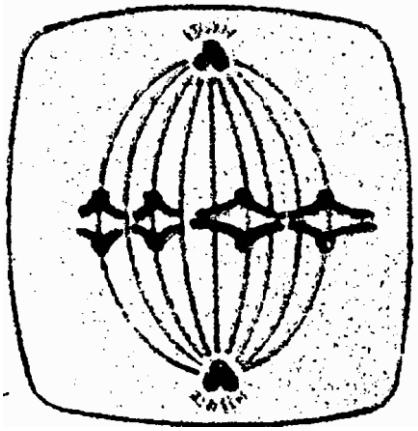
During Metaphase,

- Chromosomes arrange themselves on equator of spindle
- Homologous chromosomes do not associate
- Chromatids draw apart at the centromere towards opposite poles
- Chromosomes migrate at the equator



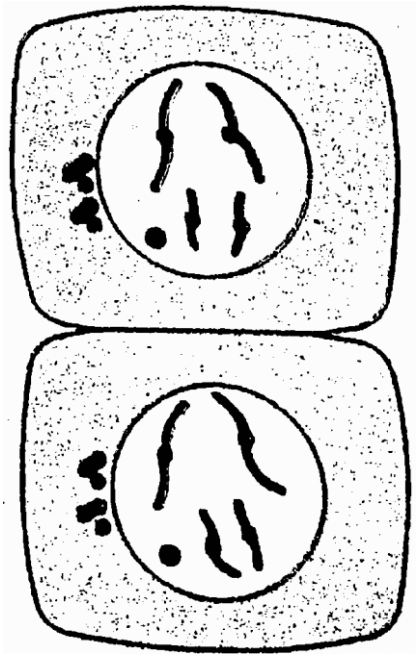
During Anaphase

- Spindle fibres contract and shorten
- Sister Chromatids part company and migrate to opposite poles of the cell with the centromeres leading
- Chromosomes reach their destination
- Spindle fibres begin to break down.



Telophase (cell constrict)

- Cell membrane starts to constrict across the middle
- Nuclear membrane reforms
- Nucleolus reform
- Spindle apparatus degenerates
- Cytoplasm divides into two new daughter cells with exact number of chromosomes as the parent cell
- Chromosomes uncoil, become thread like



There are two features in mitosis that ensure that the chromosome constitution is preserved

- Replication of chromosomes before cell division
- Arrangement of the chromosome on the spindle

Roles of mitosis

- Growth of an organisms e.g. development of fertilized egg into adult
- Asexual reproduction e.g. protest with binary fission
- Genetic stability (no variation)
- Cell replacement e.g. skin cells
- Regeneration e.g. legs in crustacean and arms in star fish

Differences between mitosis in plants and animal cells

Plant	Animal
No	Centrioles present
No	Aster form
Cell division involves formation of a cell plate	Cell division involves cleavage of cytoplasm
Occurs mainly at meristems	Occurs in tissue throughout the body

Note: Species in which there are two sets of chromosomes are referred to as diploid (2n) animals. Those with one set of chromosomes are referred to as haploid (n). Some plants are polyploid

MEIOSIS

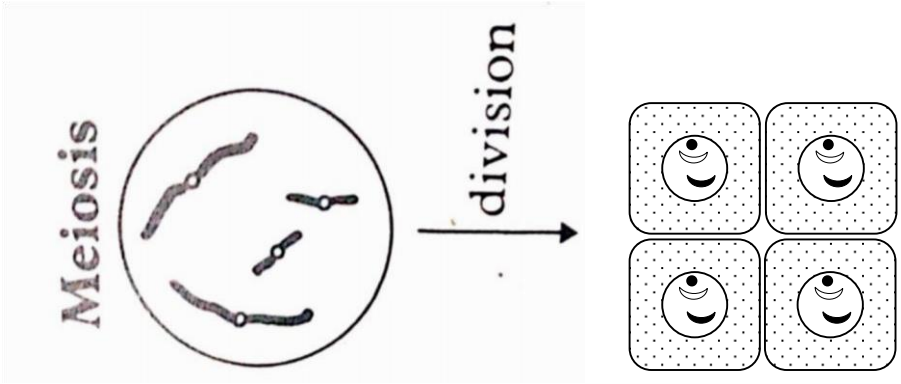
This is the type of cell division in which diploid parent cell divides into four daughter cells each having half the number of chromosomes as the parent cell.

The daughter cells formed are haploid. It occurs in reproductive cells

A reproductive cell is a cell that produces gametes e.g

In animals, it occurs in the testis (males) which produces sperms and ovaries (females) which produce ova

In plants, it occurs in the anther which produces pollen grains and embryo sac which produces egg nuclei.



Parent cell **Four haploid daughter cells**

Meiosis occurs in two major phases.

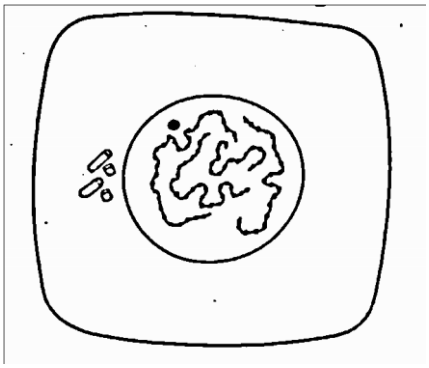
1. Meiosis I (first meiotic division)
2. Meiosis II (second meiotic division)

The first meiotic division results into separation of homologous chromosomes while the second meiotic division results into separation of sister chromatids**.**

Like in mitosis, during interphase, the cell carries out several activities to prepare for division. These include;

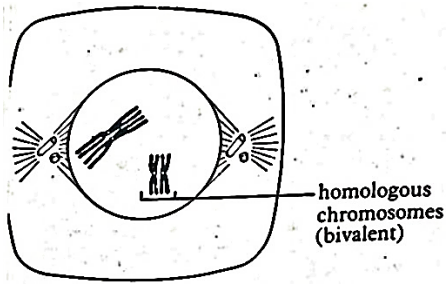
Interphase

- Chromosomes not visible are thread like
- Replication of DNA
- Production of ATP
- Formation of new organelles



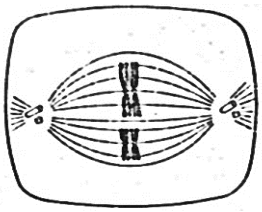
Prophase I

- Nucleolus disappears
- Centrioles arranged on opposite sides of nucleus
- Spindles form
- Chromosomes condense
- Homologous chromosomes come together (synapsis) forming a bivalent



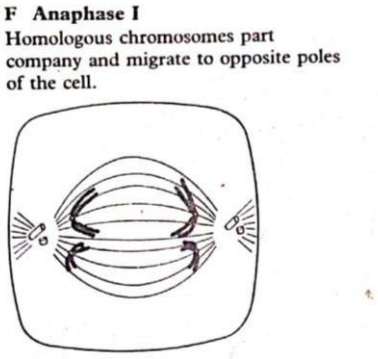
Metaphase I

- Homologous chromosomes move to the equator of the spindle together(behaves as a unit)



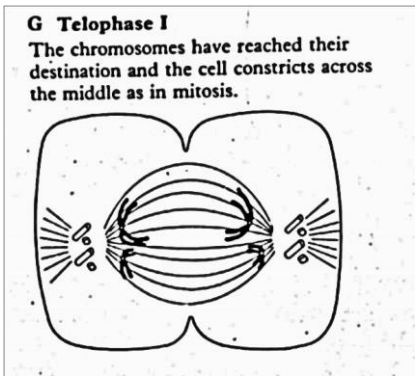
Anaphase I

- Homologous chromosomes part company move towards opposite poles of the spindle



Telophase I

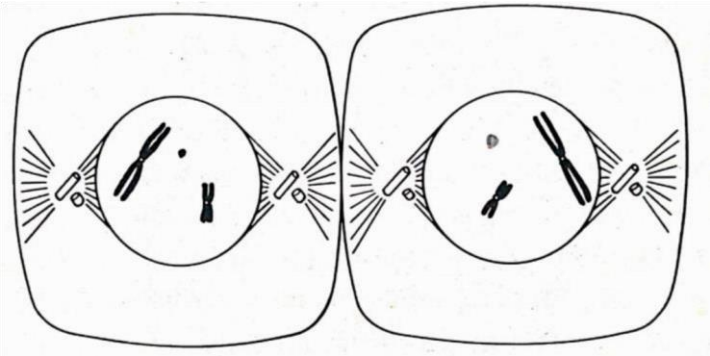
- The chromosomes have reached their destination and the cell constricts across the middle as in mitosis



2nd meiotic division aims at separating Chromatids

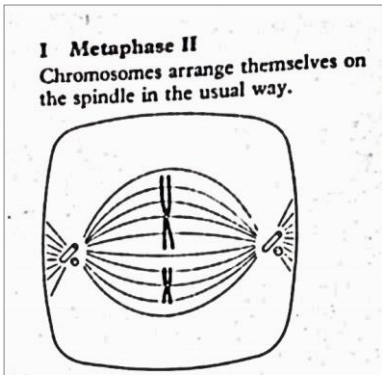
Prophase II

- Two daughter cells prepare for the 2nd division
- Centrioles replicated
- New spindles are formed



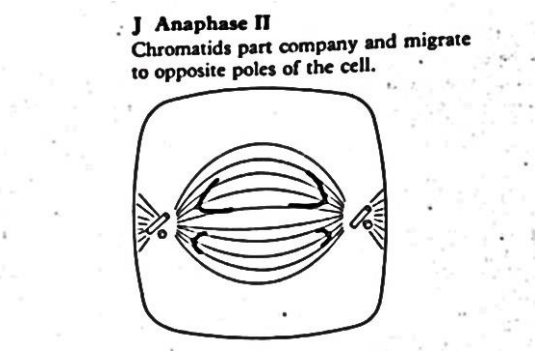
Metaphase II

- Chromosomes arrange themselves on the spindle in the usual way



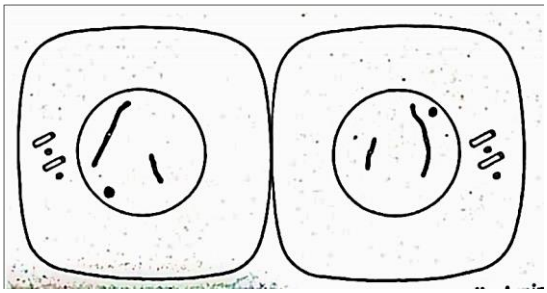
Anaphase II

- Chromatids part company and arrange to opposite poles of the cell



Telophase II

- Cells constrict across the middle
- The nuclear membrane and nuclei reform



Significance of meiosis

- Sexual reproduction which involves production of gametes
- Genetic variation : provides opportunity for new combinations of genes to occur in the gametes the is through crossing over and independent assortment

1. Independent assortment

   Orientation of bivalents at the equator of the spindle in metaphase I is random. The bivalents line up independently and therefore the chromosomes in each bivalent separate (assort) independently of these in other bivalents during anaphase I

2. Crossing over

   As a result of chiasmata, crossover of segments of Chromatids occurs between homologous chromosomes during prophase I leading to the formation of new combinations of genes on the chromosomes of the gametes.

Similarities between mitosis and meiosis

- Both begin with diploid nucleus
- Both have single duplication
- Have similar stages
- In both there is spindle formation
- In both chromosome arrange at the equator

Differences between mitosis and meiosis

STAGE	MITOSIS	MEIOSIS
Prophase	- Homologous chromosomes remain separate - No formation of chiasmata - No crossing over	- Homologous chromosomes pair up - Chiasmata form - Crossing over may occur
Metaphase	- Pairs of Chromatids lineup on the equator of spindle	- Pairs of chromosomes lineup on the equator of spindle
Anaphase	- Centromeres divide - Chromatids separate - Separating Chromatids identical	- Centromeres do not divide - Whole chromosomes separates Separating chromosomes and their Chromatids may not be identical due to

		crossing over
Telophase	- Same number of chromosomes in daughter cells as parent cells - Bothe homologous chromosomes present in daughter cells if diploid. -	- Half - Only one of each pair
Occurrence	- May occur in haploid, diploid or polyploidy cells - Occurs during formation of somatic cells and some spores - Formation of gametes in plants	- Only occurs in diploid or polyploidy cells - Occurs during formation of gametes or spores

GROWTH AND DEVELOPMENT

Growth is defined as the permanent, quantitative increase in size or dry weight of an organism. It is accompanied by an increase in the amount of protoplasm.

Growth is brought about by cell division, cell elongation or enlargement. Cell division results in the increase of body (somatic cells). Cell differentiation helps cells to perform specific functions well. Development is the process by which body cells of organisms grow to advanced stages and become complex. Development of an organism involves growth, cell differentiation and organization of cells into various structures.

FACTORS THAT AFFECT GROWTH OF ORGANISMS

***Amount of nutrients available for organisms**

An organism gets sufficient nutrients grow faster than one with a deficiency of nutrients.

***Temperature**

Bodily functions are controlled by enzymes which work well within certain temperature ranges

***Light**

This affects growth of plants mainly light affects the formation of chlorophyll, photosynthesis, opening and closing of stomata, flowering, and phototropic responses.

***pH** This greatly affects microbes and other lower animals which live in environments with water.

***Hereditary factors.**

The ability of an organism to grow is inherited from parents through genes.

***Hormones.**

Thyroxin controls the rate of growth.

***Diseases.**

Some diseases retard growth.

Other factors include Oxygen, water, excretory products.

GROWTH IN PLANTS

Germination

This is the growth and development of an embryo of a seed into a young plant or seedling under favorable conditions. Seeds can either be endospermic or non-endospermic.

Germination starts with absorption of water (imbibition)

CONDITIONS NECESSARY FOR GERMINATON

Environmental conditions

Water, air/oxygen, suitable temperature, light

Internal factors

Viability of seeds, food stored in seeds, enzymes, absence of germination inhibitors.

-Water is necessary in germination of seeds for activation of enzymes in seeds

Providing necessary medium for enzyme activity

Dissolving and hydrolyzing stored food materials and transporting them to the growing parts of the shoot and roots.

The process by which seeds take up water is referred to as imbibitions. The seed swells and bursts.

This allows oxygen and to enter the seed and carbon dioxide produced to escape

-Oxygen is needed for respiration to yield energy.

-Suitable temperature is needed for proper functioning of enzymes

Photoblastic seeds require a certain amount of **light** exposed to them before they can germinate.

-Viable seeds have mature embryos and all seed parts are present in the seed.

If there are no food reserves, the embryo does not germinate.

-Enzymes regulate the uses of stored food in the seeds.

Changes during germination

The following changes occur during germination:

-the seed absorbs water through the micropyle by imbibition and later by osmosis

-the seed swells and the testa (seed coat) rupture

-enzymes become activated and begin to hydrolyse complex stored food into simpler soluble molecules e.g. starch is hydrolysed by amylase into glucose, proteins by protease in amino acids.

-the soluble molecules are then transported to the embryo.

-the rate of respiration increases rapidly so as to generate sufficient energy required for growth

-the radical emerges first and grows downwards to form the root system

-the radicle develops root hairs and begins to absorb water and mineral salts

-the shoot develops foliage leaves and starts to photosynthesize

-the cotyledons, their food reserves exhausted wither away.

TYPES OF GERMINATION

Hypogeal germination e.g. maize

Cotyledons of the seeds remain below the ground. This is brought about by the rapid elongation of the epicotyl which causes the plumule to row straight out of the ground. The sheath, coleoptile protects the plumule.

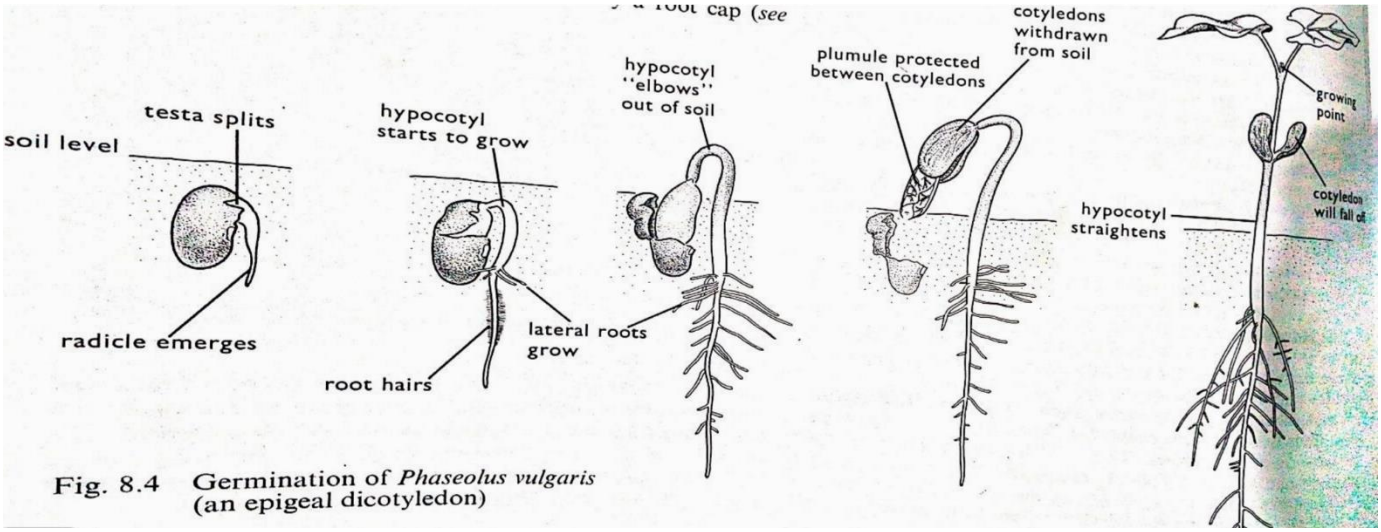


Fig. 8.4 Germination of *Phaseolus vulgaris* (an epigeal dicotyledon)

Epigeal germination e.g. beans

The cotyledons are carried above the ground due to the rapid elongation of the hypocotyls upwards. Once exposed to the surface, the cotyledons separate exposing the plumule. The cotyledons develop chlorophyll and start carrying out photosynthesis

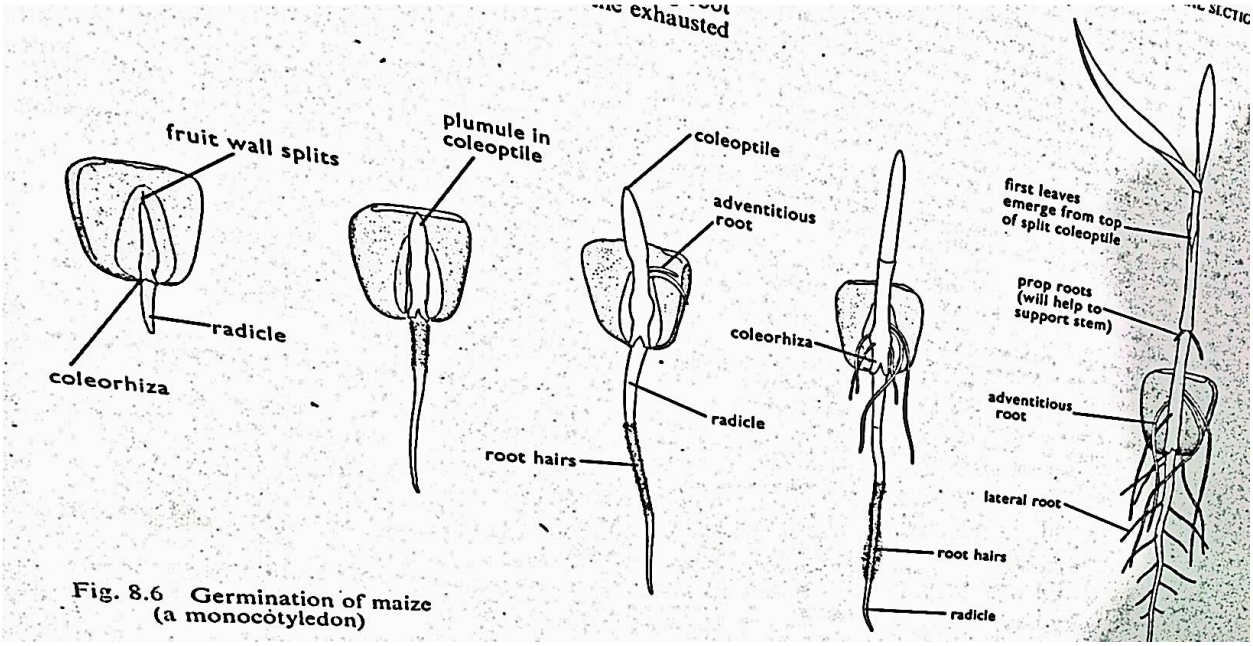
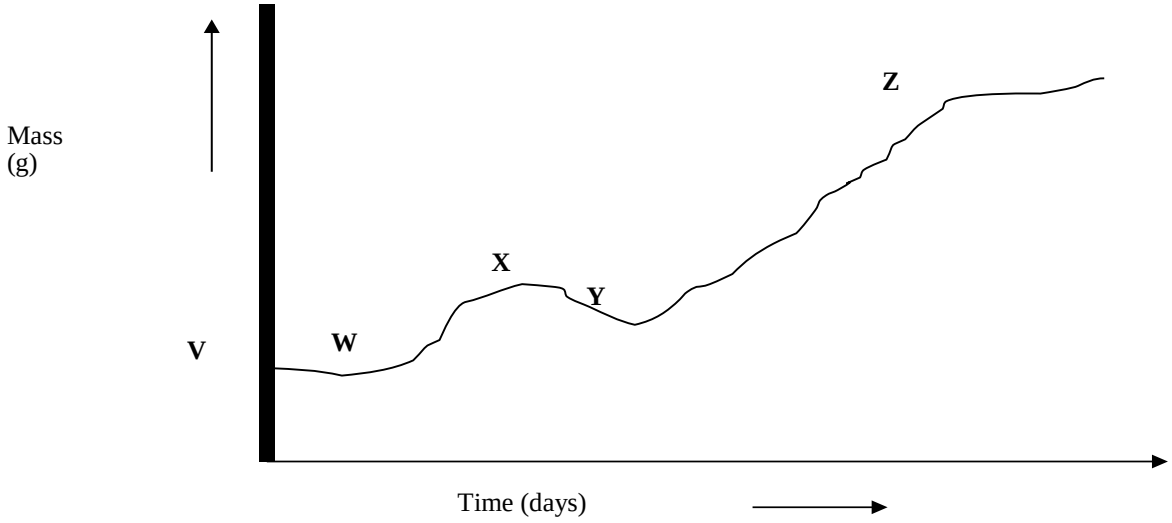


Fig. 8.6 Germination of maize (a monocotyledon)

VARIATION OF SEED MASS DURING SEED GERMINATION.

The mass of seed remains the same in the first day or second day. It then sharply increases for the next few days of germination and then slightly falls down. After this period, the mass of seeds rapidly increase before slowing down.

A graph showing change in mass with time during seed germination



V-W The seed is still dormant and has not yet started germinating.
W-X The weight of the seed increases sharply because it has absorbed water and germination has started.

X-Y The weight of the seed decreases because the stored food is used up to provide energy for growth.

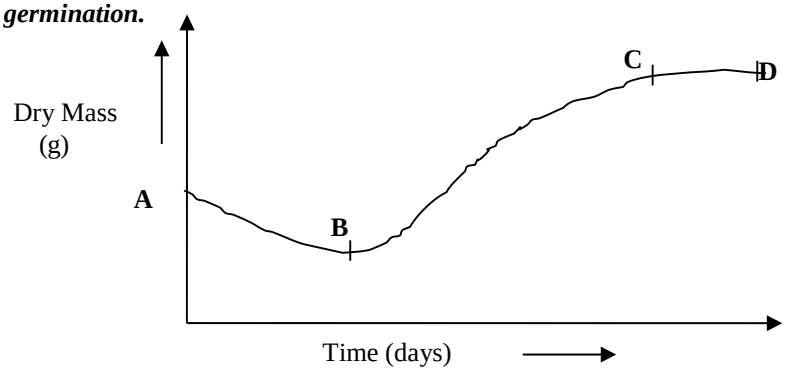
Y-Z The weight increases rapidly because the embryo has grown into seedling. Seedling builds up new cells and at the same photosynthesis is occurring hence producing more food than one being used up.

Beyond point **Z** the plant weight may remain constant and then start to decrease due to production of seeds, fruit which are later dispersed.

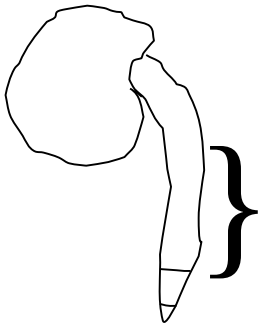
CHANGES IN DRY WEIGHT OF SEEDLING DURING GERMINATION

The dry mass or weight of a seedling is the weight of seedling after the water content has been removed. This is normally done by placing the seedlings in an oven at moderate temperature until all the water in it evaporates. The changes in dry weight of seedling during germination are illustrated in the graph in the figure below.

A graph showing changes in dry mass of seedlings with time during seed germination.



A-B The dry weight decreases because the stored food is used up in respiration for cell growth.
There is little or no growth. This phase of growth is called lag phase.
B-C between B and C, the dry weight begins to increase steadily or sharply because the seedling has reached a stage of producing more food by photosynthesis than it can use up during respiration. The number of cells also increases which increases the dry weight.



Various structures may arise from a shoot (leaves, flowers, stem branches and roots) so that the apical meristem rises to various kinds of meristem or **primordial**. **Leaf primordial** arise from the stem

Apical meristem in a pattern and sequence that determines the arrangement of leaves (singly or in pairs and in one or more planes). In the axil of each leaf primordium is another meristematic area, the bud **primordium.** The node remains a site of meristematic potential.

REGION OF GROWTH

Growth in plants occurs at the tip of shoot and root by cell division and cell elongation i.e. when the new cells expand. Measurement of region of growth in a seedling e.g. bean seedling is best done by measuring length of radicle at regular intervals of time.

EXPERIMENT

AIM: To find out the region of growth in radicle.

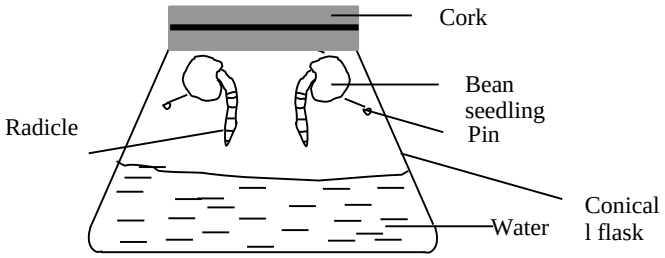
MATERIALS

- Cork - Conical flask
- Water - Indian water proof ink
- Pin - Bean seedling
- Ruler

PROCEDURE/METHOD

- Bean seedlings with straight radicles after few days' germination are marked with Indian water proof ink at 2mm intervals.

- The seedlings are then pinned to the bottom of the cork, which is then fixed in the mouth of conical flask with little water as shown in the figure below.



- The flask is placed in a dark place to allow the radicle continue to grow for about 2 days.
- The gaps on radicle are then measured again using a ruler.

OBSERVATION

There is a short distance between the markings at the tips of radicles and at its tops i.e. there is no change in length of gaps at furthest back and tips.

In between these two areas, there is an increase in length of gaps as shown in the figure below.

CONCLUSION

Region of growth in a root is a short distance located behind the tip of the root.

An experiment to investigate whether water is necessary for germination

Apparatus / materials

4petri dishes
Cotton wool
Been seeds
Water

Procedure

- Label the four Petri dishes A, B, C and D.
- In petro dish A, place soaked beans on wet cotton wool and cover
- In Petri dish B, place soaked beans on dry cotton wool and cover
- In Petri dish C place dry beans on dry cotton wool and cover

- In Petri dish D fill with water and place socked beans in water then cover
- Leave the dishes for one week and then observe **Setup**

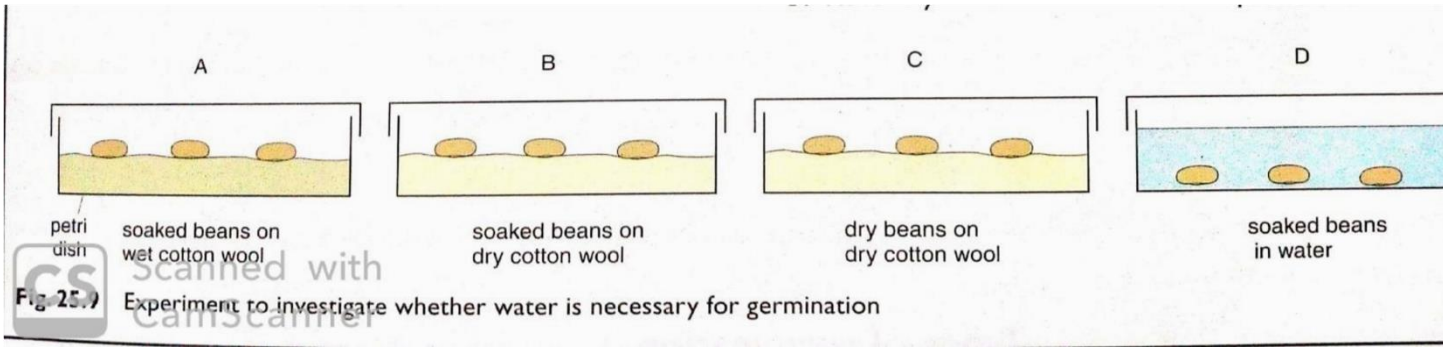


Fig. 25.7 Experiment to investigate whether water is necessary for germination

Observation

Explanation

An experiment to investigate whether oxygen is needed for germination

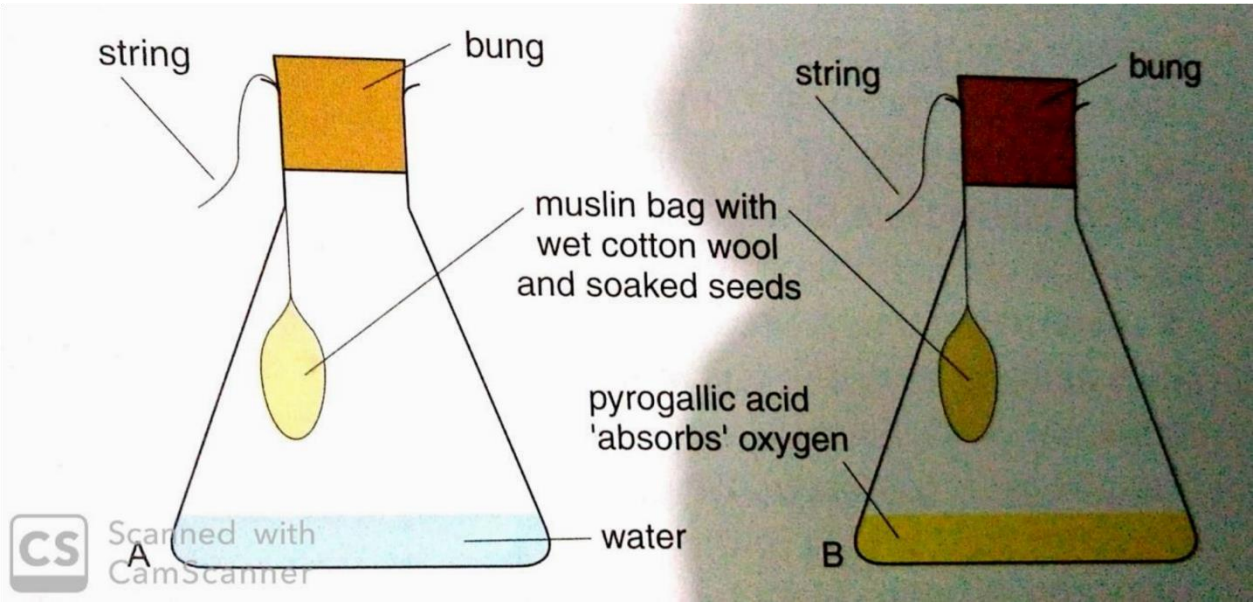
Apparatus

2 conical flasks, 2pieces of muslin, string, soaked been seeds
Cotton wool, 2 corks, Pyrogallic acid, water

Procedure

- Label one conical flask A and the other B
- Place water in the flask marked A and pyrogallic acid in the flask marked B to depth of about 1cm
- Soak the cotton wool in water and divide it into two. Place soaked bean seeds on each piece of cotton wool
- Wrap each piece of cotton wool and the seeds in muslin and tie to form a bag
- Using a piece of string, suspend each bag in one of the conical flask
- Seal the flasks with the corks
- Leave the experiment s for one week

Setup



Observation

Explanation

3. An experiment to investigate whether water is necessary for germination

Apparatus/ materials

3 Petri dishes, soaked beans, cotton wool, water, incubator, fridge

Procedure

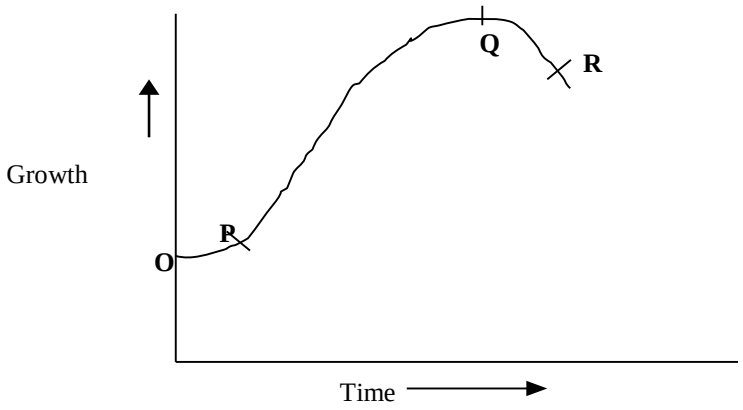
- Label Petri dishes A,B and C
- Place dump cotton wool in each Petri dish
- Place ten soaked bean seeds in each dish
- Leave dish A at normal room temperature
- Place dish B in a fridge at low temperature
- Place dish C in an incubator at a temperature of 40oc
- Leave the setup for a week

Observation

Explanation

GROWTH IN PLANTS

Young plants grow faster than older ones. The growth of a plant is slow at first stages because of less photosynthesis hence more assimilation. The growth then gradually increases until it reaches a maximum after which growth slows down as shown in the figure below.

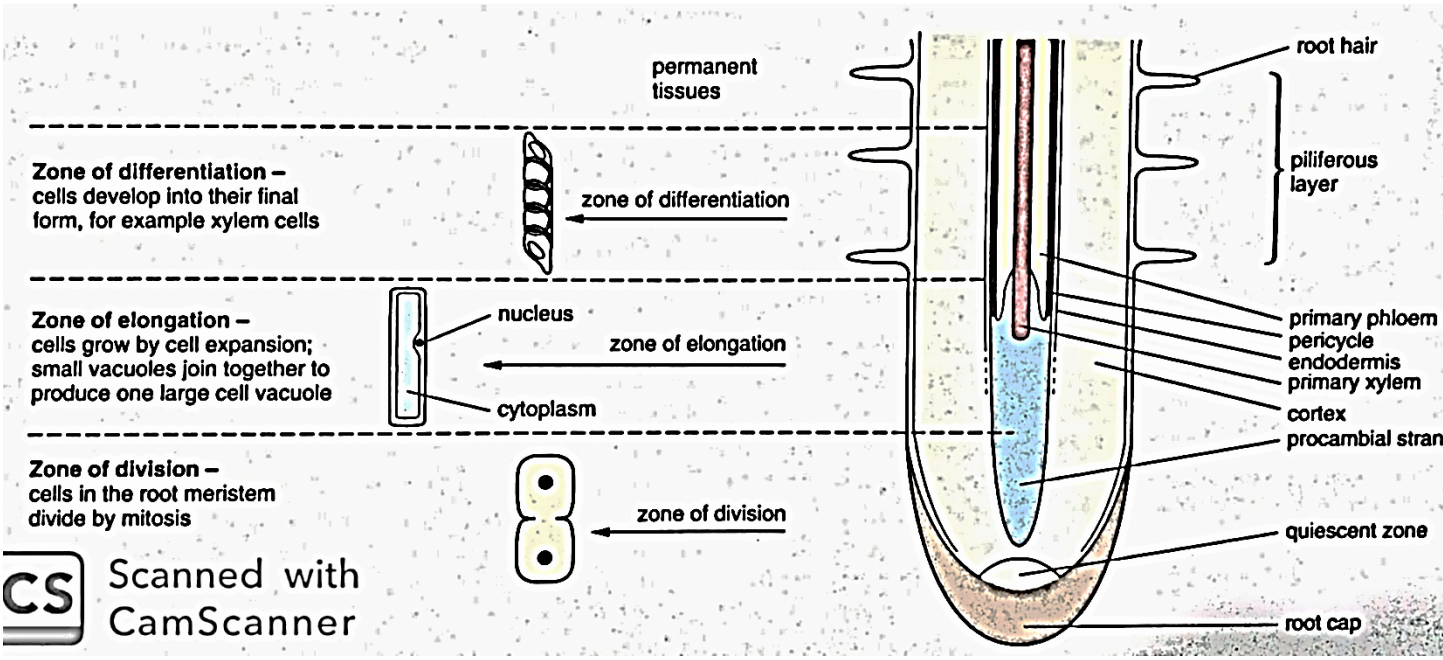


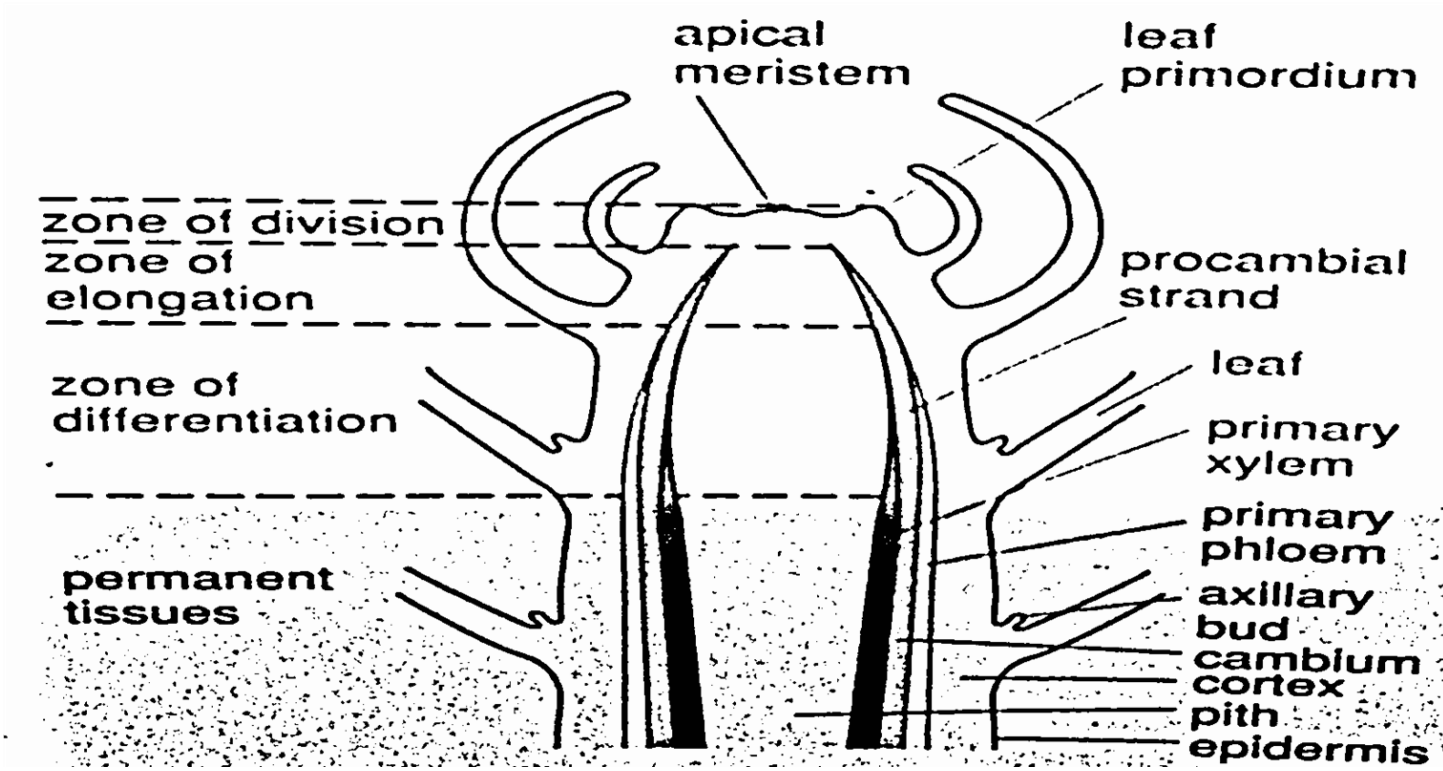
O-P Growth rate is slow i.e. is not rapid.
P-Q Period of rapid growth.
Q-R Period of slow growth.
The graph above shows that growth starts slowly then accelerates and is followed by deceleration.

SECONDARY GROWTH IN PLANTS

In plants there are regions where growth takes place called meristems. Meristems are a group of plant cells that divide rapidly by mitosis. The root meristems consist of a group of unspecialised cells. The cells divide and, only then, become specialized for particular functions a process called differentiation

Other meristems near the tip of the shoot control the growth of the stem. These two groups of cells are called primary meristems. They are concerned mainly with increasing the height of plants.





Secondary growth refers to increase in thickness (girth) of plant shoots and roots. It occurs in all dicotyledonous plants except herbaceous dicotyledonous plants. It also occurs in gymnosperms.

However, monocotyledons don't undergo secondary growth. Secondary growth results in the formation of permanent tissues and is also termed as **secondary thickening**

Secondary growth is brought about by the division of cambium (secondary meristems) ring and cork cambium. When the cambium ring (vascular cambium) divides, it forms secondary xylem on the inside and secondary phloem on the outside. The cork cambium is responsible for the formation of wood (bark) in dicotyledonous plants

Note

Primary growth in plants results from cell division and elongation of apical meristems in root and hoot

Secondary growth results from division of lateral meristems such as cambium to increase diameter

IMPORTANCE OF SECONDARY GROWTH

- It increases the girth of stems and roots to provide extra support for other plant parts above.
- It helps in regeneration of plants parts.
- used in healing of wounds by forming callus tissue on shoots and roots.

Methods used to measure growth

*use of linear dimension such as length of height or circumference e**.g child growth**

***measurement of the mass E.g in

babies

*measurement of dry mass.

Dry mass is the amount of organic material in an organism minus the water in its cytoplasm. This is done by drying an organism in an oven at about 80oc. The water evaporates but the carbohydrates, lipids and proteins don't burn.

Organisms are constantly weighed until a constant dry mass is measured.

Disadvantages of the method
-It kills the organism so growth is not followed individuals.
-large number of organisms are used and needed

SEED DORMANCY

This is a condition whereby viable seeds fail to germinate under certain conditions. It is caused by several factors

CAUSES OF SEED DORMANCY

- **Immature embryo of seed:** This may cause dormancy in seed germination since the embryo may undergo development before germination occurs
- **Presence of germination inhibitors:** Substances like abscissic acid do not promote germination of seeds when present
- **Extremes** of temperatures: These greatly affect the functioning of enzymes in seeds. High temperatures denature enzymes and low temperatures inactivate them.
- **Presence of hard, impermeable seed coat:** Such a seed coat does not allow water and gases to enter seeds.
- **Lack of sufficient oxygen available for seeds:** If oxygen is absent, seeds respire anaerobically and obtain less energy.
- **Dryness** of soil which does not allow germination of see**ds**

WAYS OF BREAKING SEED DORMANCY

(i) **Harvesting mature seeds:** This involves allowing embryos in seeds to develop up to maturity for a certain period called **after ripening.**

(ii) By providing **growth promoters** which inactivates the germination inhibitors.

(iii) By exposing seeds to a cold period (chilling) to initiate germination. This is a common method of breaking seed dormancy in cereals

(iv) By providing suitable conditions of oxygen, temperature, moisture etc which favour germination.

(v) Removing the hard seed coat by: - Soaking seeds in water to soften it.

- Physical removal **(scarification)** by action of bacteria in soil.
- Action of fire to burn away seed coat.
- Passing seeds through animal guts.
- Filing the seed coat to make it soft or thin.
- Churning seed coat in concentrated sulphuric acid

IMPORTANCE OF SEED DORMANCY

1. It improves the chances of a seedling to grow to maturity.
2. It reduces the risk of seeds being frozen to death during unfavourable conditions.
3. It promotes germination of seeds during favourable conditions.
4. An extended period of dormancy gives seeds a greater opportunity to be removed away from the parent plant hence useful in seed dispersal.

PLANT GROWTH AND HORMONES

Plant growth is controlled by auxins. Other plant hormones important in plants include

1. Gibberellins:

-these promote extensive growth of intact plants by stimulating stem elongation.
-they promote seed germination in some cereal grasses ad bolting of perennials such as lettuce.

-They are also sprayed onto fruits to produce seedless fruit such as grapes

2. Cytokinins:

-stimulate cellular division, enlargement of cotyledons and development of lateral buds

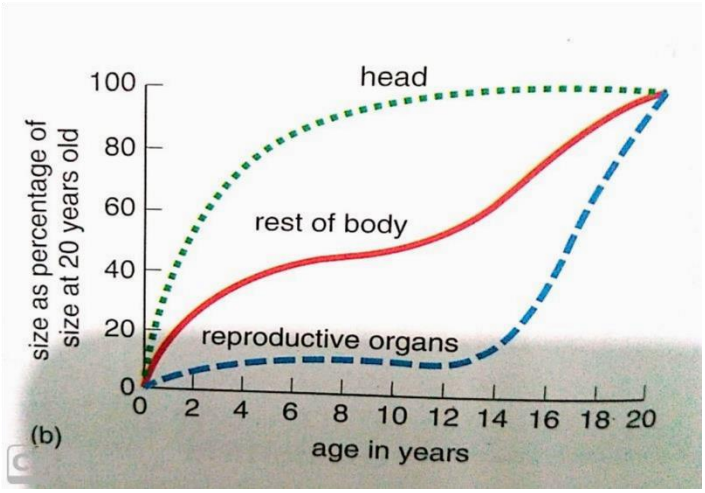
3. Abscissic acid:

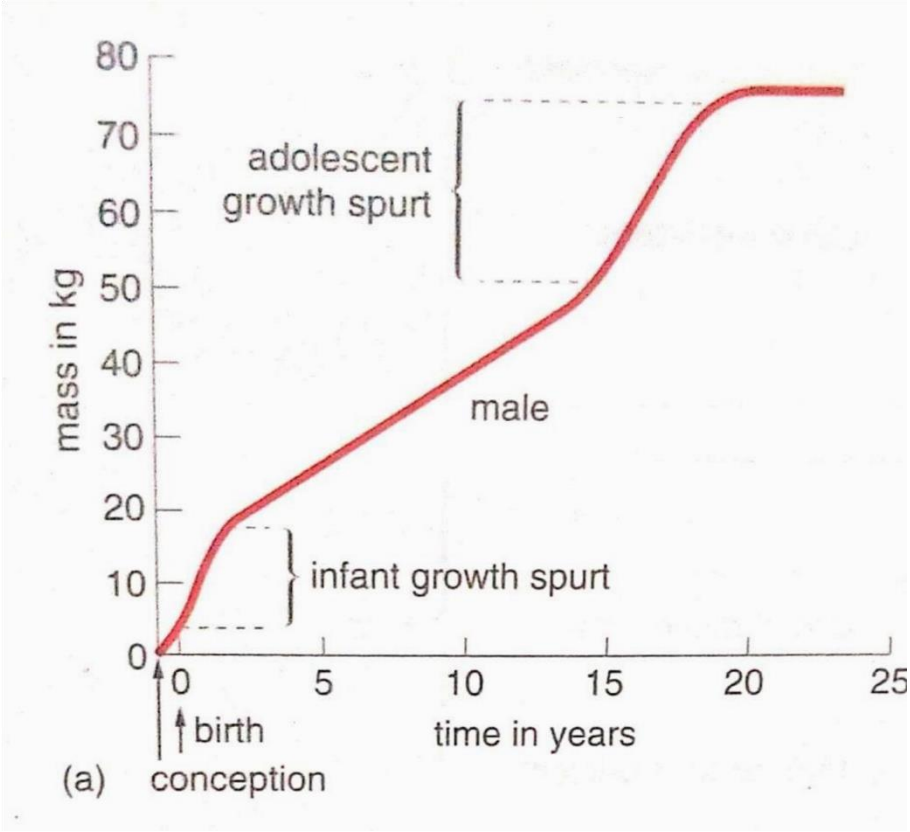
-acts mainly as a growth inhibitor.
-It is presents in large quantities in dormant buds.
-It also influences dormancy in some seeds

GROWTH IN ANIMALS

Unlike plants, growth in animals is not localized to certain parts. It occurs throughout the body parts and is controlled by hormones. However, there is variation in growth of animals. Mammals and many other animals exhibit **continuous growth** i.e. do not stop growing from birth to maturity even though their growth rate changes. The growth of humans and other mammals ceases at maturity.

Graph of curves in humans


head
rest of body
reproductive organs
size as percentage of size at 20 years old
100
80
60
40
20
0
0 2 4 6 8 10 12 14 16 18 20
age in years
(b)



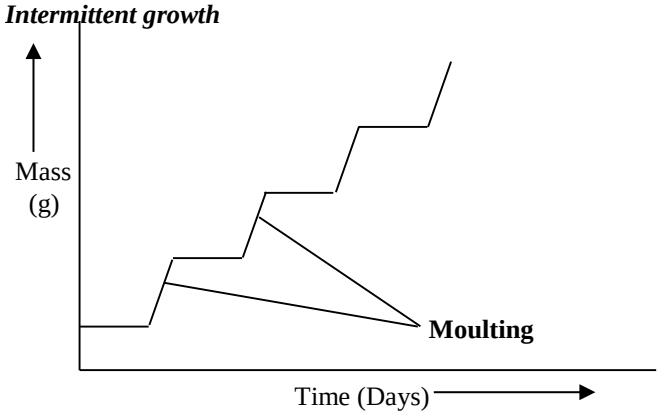
Arthropods on the other hand, usually have a number of periods of extremely rapid growth followed by a long period in which there is little or no growth.

This growth pattern is termed as **discontinuous growth**.

GROWTH IN INSECTS

Insects just like other arthropods have an exoskeleton which is not capable of expansion. In order to grow, insects shed off the exoskeleton, a process called **moulting.** This is followed by rapid growth before a new exoskeleton becomes fully developed and hardened. This is done by insects taking in much water.

Growth curve of an insect showing discontinuous Intermittent growth



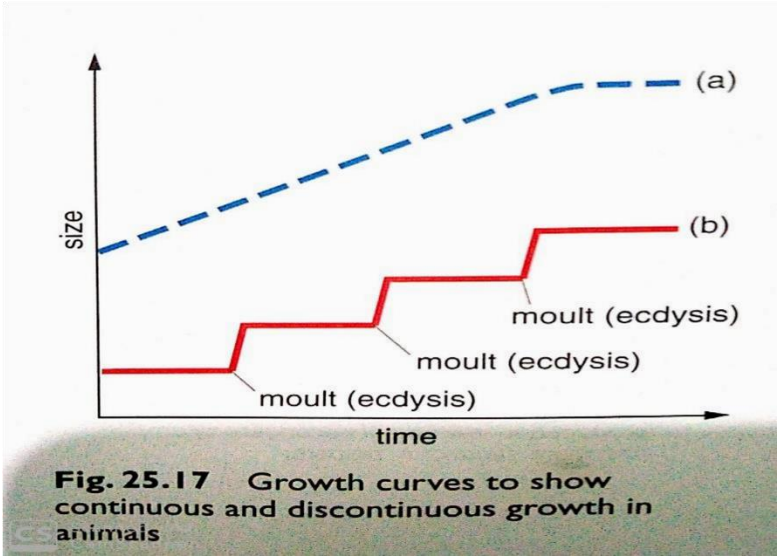


Fig. 25.17 Growth curves to show continuous and discontinuous growth in animals

In most animals, moulting is triggered by secretions of the thyroid gland or pituitary gland. Many mammals shed their hair in spring, and some even moult and regenerate parts of their bodies; deer, for example, grow new antlers, and the lemming acquires new claws. Birds usually moult in the late summer without effect on their ability to fly, and snakes and amphibians cast off their skins several times a year. The moulting of hard exoskeleton or cuticle occurs in crustaceans and insects. During moulting **(ecdysis)** the exoskeleton splits longitudinally and the next stage or form, nymph, pupa, imago emerges out of it. This kind of transformation is termed as **metamorphosis**

METAMORPHOSIS IN INSECTS

Metamorphosis is the transformation from the larval to adult form that occurs in life cycle of some organisms e.g. insects and amphibians. It is controlled by some hormones.

TYPES OF METAMORPHOSIS

There are two types of metamorphosis namely:

(i) Incomplete(or hemimetabolous) metamorphosis

(ii) Complete (or holometabolous) metamorphosis

INCOMPLETE METAMORPHOSIS

It occurs in some insects like cockroaches, crickets, aphids, etc. in this type of metamorphosis the eggs hatch into **nymphs** which resemble adults except that they are smaller, lack wings and sexually immature. Repeated moulting occurs before the nymph becomes an adult. In incomplete metamorphosis, the young resembles the adult. The animal's form gradually changes through moulting, or shedding.

COMPLETE METAMORPHOSIS

This occurs in some insects like moths, butterflies, houseflies, bees, mosquitoes etc. Here, eggs hatch into larvae which differ from adults. Each larva

Undergoes a series of moults and considerable feeding to become a pupa. A pupa is dormant since it doesn't feed. It undergoes considerable tissue breakdown and reorganisation internally to become an **adult (imago)**. In complete metamorphosis, a clear distinction exists between the various stages of the animal's development. In the first phase, an embryo forms inside an egg. When the egg hatches, the animal is called a larva. During the next period, the larva changes into a pupa. At the end of the pupal stage, the adult emerges.

IMPORTANCE OF METAMORPHOSIS

Metamorphosis helps insects and other animals to prepare adult life in new environment. This increases on chances of exploiting, space, food resources in different environments.

It also minimizes competition between young ones and adults. Since the two may be in different environment.

GROWTH AND DEVELOPMENT OF AMPHIBIANS

Just like insects, amphibians undergo metamorphosis. The fertilized egg undergoes **cleavage** (series of cell division) and **gastrulation** (re-arrangement of cells into distinct layers) during the first two days. By the third day, the embryo develops into a young **tadpole**

Just after hatching, the tadpole is a tiny short-bodied creature with a disc-like mouth. It clings to plant vegetation and nourishes on yolk in its body until it starts to feed. Soon after hatching, the body lengthens, and two pairs of external gills appear at the sides of the head. The tail lengthens and develops a caudal fin. The mouth opens and the tadpole begins to feed on microscopic water plants such as algae by scrapping the leaves with horny lips.

At this stage, the operculum grows and the tadpole begins to develop internal gills in about 20-35 days, from hatching, internal gills fully mature. In this state, the tadpole becomes free swimmer and horny lips disappear.

A long coiled digestive tract develops and the tadpole starts living on aquatic vegetation scums. At this stage, the tadpole is a fish-like animal with two chambered heart; and transforms into an adult.

Soon after the appearance of the front legs, the tadpole then starts re-absorbing its tail. Late in metamorphosis, the tadpole's mouth broadens and teeth develop.

As those external changes occur, equally important, the internal changes also occur. A sac-like chamber forms in back of the throat. This divides into two sacs becoming the lungs. The heart becomes three-chambered and gill arteries turn into carotid, aortic aches and pulmonary cutaneous arteries. The gills stop functioning and the tadpole comes to the surface frequently to gulp air.

Even before the tail is totally reabsorbed the tadpole leaves water and comes to land as young frog or toad. The young frog or toad undergoes continuous development to become mature.

Revision questions

Q 1. Describe the events that occur in a germinating seed.

Q2. What type of cell division is responsible for growth? Reason?

Q3. How is growth in plants different to growth in animals?

Q4. Describe the external and internal changes that occur in a germinating maize grain.

Q5. State the differences between complete and incomplete metamorphosis.

Q6. What is the importance of the caterpillar being markedly different from the butterfly?

Q7. Intercalary meristems are found in the nodes of monocotyledonous plants. What is the use of lateral meristems?

Q8. How do you measure (i) fresh mass (ii) Dry mass of sample seedlings.

9 (a) Describe what happens in animal cell during each of the following stages of mitosis

(i) Prophase (05marks)

(ii) Anaphase (05marks)

(b) State the importance of mitosis. (02marks)

(c) Give three differences between mitosis and meiosis. (03marks)

10. (a) (i) What is meant by mitosis? (02marks)

(ii) What is the importance of mitosis in living things? (08marks)

(b) Give differences between mitosis and meiosis?