PAPER 2: UNEB 2010

17.1 Section A

A study was conducted on the germination and early growth of sorghum. The grains were soaked in cotton wool in a greenhouse 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 question that follow

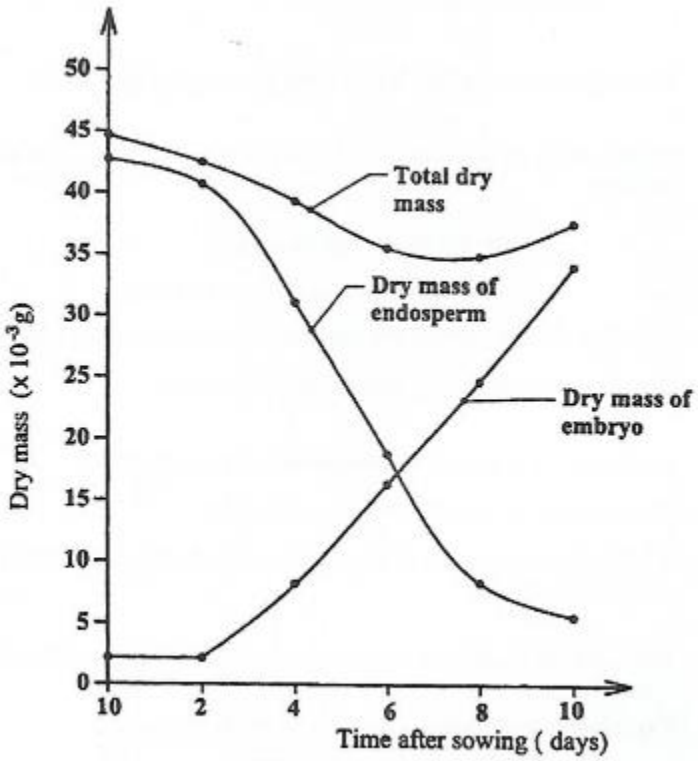

Fig. 1

(a) Explain the variation with time of

(i) Dry mass of endosperm.

Variation

From 0-2 days dry mass of endosperm decreases gradually. It then decreases rapidly from 2-8 days and finally gradually between 8-10 days.

Explanation

As a result of inhibition and osmosis, the endosperm becomes hydrated. This activates enzymes such as the enzymes of respiration.

Between 0-2 days, the respiration enzymes oxidize the available simple molecules such as glucose for energy, hence the gradual decrease in dry mass.

The energy generated is used to synthesize digestive enzyme which breakdown starch, the main food storage form, in the endosperm to glucose. The glucose then transported to the growing regions of the embryo. This occurs rapidly between 2-8days and accounts for the rapid decrease in dry mass of the endosperm during this period.

After 8 days, other sources of energy take effect as the effective mass of the endosperm becomes exhausted. The little food left in the endosperm is digested slowly. Then the dry mass of the endosperm reduces more gradually.

(ii) Dry mass of embryo

Variation

From 0-2 days, the dry mass of embryo is constant; it then increases rapidly almost linearly, from 2-10 days.

Explanation

0-2 days is a period of mobilization of the seed for germination. No growth has yet taken place in the embryo and its mass therefore remains constant.

From 2-8 days, the food molecules mobilized by digestion of food stored in the endosperm are transported to the growing regions in the embryo. The embryo starts to grow and so increases in dry weight.

From 8-10 days, the first leaf emerges and starts to photosynthesis. This increases the rate of growth of the embryo.

(iii) Total dry mass of sorghum seedling.

Variation

Total dry mass decreases gradually in the first 7 days and then increases gradually thereafter.

Explanation

In the first 7 days, the overall loss in dry mass is due to aerobic respiration which consumes glucose in both the endosperm and embryo. During this period, the rate of growth of the embryo less than compensates for the loss, leading to an overall decrease in total dry mass.

At about day 7, the first leaf emerges ad starts to photosynthesize. The resulting increase in dry mass then more than compensate for losses due to respiration so that a net increase in dry mass is observed.

(b) Explain why the following were done

(i) Oven-drying the seeds.

The seeds were oven-dried to make sure that all the water is dried out without decomposing the organic matter in the seed.

(ii) Separating in components.

The seed components were separated in order to stop growth and exchange of materials between them and to compare dry mass

(iii) Sowing seeds in a greenhouse.

The seeds were sown in a green house in order to expose them to the same conditions during germination and growth. It is easier to control conditions in the greenhouse than those of the natural environment.

(c) From the information given, name the method used to measure growth and give its limitations.

- It involves killing of the plant. Therefore, serial measurement on the same plant are not possible.
- It is very time consuming/It is a tiresome procedure.
- Obtaining similar seeds

(d) (i) Name two internal factors in the seed that would affect the results above.

- Presence of germination inhibitors
- Premature embryo
- Hard seed coat
- genetic factors
- amount of food stored
- viability of seeds stored

(ii) Suggest precautions that could have been taken to ensure reliable results.

- Use seeds of comparable size and weight.
- Seeds should be obtained from the same plant and should have been stored in the same conditions for the same duration.
- Seeds should be subjected to the same conditions during the period of the experiment.
- A large number of seeds should be used and a mean dry mass of the components determined.
- Large number of seeds are used obtain mean values

(e) What conclusion can be drawn from the graph after 8days?

The total dry mass increased due to onset of photosynthesis and growth no longer depends on the stored food in endosperm

(f) Explain what would happen if the experiment continued for another 10days.

The dry mass of the endosperm would decrease gradually to a minimum due to exhaustion of food reserves while the dry mass of the embryo and the total dry mass of the seedling would continue increasing rapidly due to photosynthesis.

SECTION B

2. (a) Describe the structure of the vascular system in higher plants.

The vascular in high plants consists of two types of vascular tissue, the xylem and phloem.

- The xylem contains two types of conducting cells: tracheid and vessel elements. Both types of conducting are hollow, non-living and lack end walls, they are connected end to end to form a continuous pipeline for water and mineral transport. The xylem elements have lignified side walls which are perforated by numerous bordered pits.
- The conducting cells of phloem are the sieve-tubes, each associated with a companion cell. Sieve-tube cells contain cytoplasm no nuclei. Strands of cytoplasm, called plasmodesmata, extend from one cell to another through the sieve plates (perforated cell end walls)
- The vascular system extends from the roots to the leaves and vice versa. In the roots, the vascular tissue is located in the vascular cylinder; in the stem, it forms vascular bundles; and in the leaves. It is found in leaf veins.

(b) How is the system in (a) adapted to its function?

Adaptions of xylem to its function.

- Its cells have no end walls and so allow unimpeded flow of water.
- Lignin in the cellulose side walls makes it impermeable to water and solutes. This prevents wastage during transport.
- Having spiral and annular thickening gives it a tensile strength and prevents the vessel from collapsing.
- Presence of pits allows passages of water in and out of the lumen.
- Lignin also strengthens the vessels in order to structural support to the plant.

- Have elongated cylindrical cells for continuous flow of water.
- The torus in bordered pits as a plug for controlling passage of water in some plants.

Adaptations of phloem to its function.

- The sieve tubes are elongated, cylindrical cells connected end to end. Their end walls have sieve plates perforated with pores to allow continuous flow of materials.
- The sieve tubes have no nucleus to create more room for movement of materials.
- Within the lumen of the sieve elements are cytoplasmic filaments/ strands which are continuous from cell to enable continuous flow of materials.
- The companion cells have nuclei and other organelles. They control the flow of materials through the phloem sieve tubes.

3. (a) Explain what is meant by alternation of generations.

Alternation of generations is the alteration between a diploid sporophyte generation and the haploid gametophyte generation in a **single life cycle** of a plant.

(b) Compare the life cycle of a moss and a fern.

Similarities between the life cycle of a moss and a fern

- In both the diploid sporophyte produces spores and the haploid gametophyte produces gametes.
- In both the female gamete is non-motile while the male gamete is motile.
- In both the sporophyte grows out of the gametophyte.
- In both gametes are produced by mitosis.
- In both gametophyte is photosynthestic

Differences

Life cycle of moss	Life cycles of a fern
- Gametophyte is dominant	- Gametophyte is dependent
- Sporophyte is dependent	- Sporophyte is dominant
- Sporophyte is very temporary and photosynthesizes to a limited extent	- Sporophyte is long-lasting and photosynthetically active
- Gametophyte is long-lasting	- Gametophyte is a temporary organ

(c) What is the importance of alternation of generations to the life of a moss and a fern?

- There is rapid multiplication as spores are normally produced in large numbers
- Spores can survive harsh conditions and germinate when conditions are favorable
- Spores leads to formation of different varieties since meiosis takes place during their formation.
- Fertilization restores diploid chromosome number. Production of gametes by mitosis ensures that the haploid gametophyte state is maintained. This maintains the plant genome.
- Alternative between gametophyte and sporophyte generations ensures that the plant colonizes different habitats in the ecosystem.
- Interdependence between gametophyte and sporophyte generation ensures existence of both generations and avoids extinction of the plant species.

4. (a) Explain how organisms have overcome the challenges of being multicellular.

- There is division of labor, different cells being adapted to perform specific functions. This has improved efficiently in co-ordination of life-sustaining processes.
- Specialized respiratory surfaces have been developed to enhance gaseous exchange. These are usually highly folded to increase surface area for gaseous exchange. For example, lungs and gills.
- A specialized transport system has been developed to move gases and other materials to and from the body cells. For example, in higher animals and plants.

- In some, the body is flattened, thus reducing the distances between the two body surfaces and enhancing the process of diffusion. For example, in flat worms and leaves of plants.
- A specialized supporting system such as a skeleton in most animals has been developed to support, protect and assist locomotion of the organism.
- In some, the body is constructed such that the tissues are thin. This reduces the diffusion distance. For example, in hydra.
- In some, there exists a system by which the external medium is brought is brought into the body so that it comes into intimate contact with all the tissues in order to enhance exchange of materials by diffusion. For example, the tracheal system of insects.

(b) Explain the movement of animals from place to place

- To find food, unlike plants, animals are not able to manufacture their own food. As a result, they have to move from one place to another to find food to eat.
- To avoid being captured by predations. Animals which are fed upon by predators (prey) have developed efficient locomotors mechanisms and move from place to place to avoid being captured by predators.
- To find new and favorable habits. Many times, conditions in the habitant of an animal become unfavorable. Animals in such conditions will have to move from one place to another in order to find a new favorable habitant.
- To find suitable mates. In order to reproduce, animals move from place to place in order to find a suitable mate, with which to reproduce.
- To avoid overcrowding and therefore competition for the available resources.

5. (a) Describe the characteristics of receptor cells.
    - Transduction; receptor cells are capable of changing physical stimuli into an electrical impulse.
    - Sensitivity; receptor cells are able to detect the slightest change in their environment (stimulus)
    - Adaptation; if a stimulus is maintained, receptor cells are able to adapt to it so that the stimulus no longer causes an impulse, however strong it is.
    - Inhibition; receptor cells can be stopped from firing impulses by special synaptic connections. As a result, certain impulses are transmitted only when required.

Precision; receptors are able to transmit the information precisely without alteration.

(b). Describe the role played by each of the following in the maintenance of balance in a human body.

(i) Semi-circular canals.

The ampulla in the semi-circular canals consists of groups of sensory cells whose hairs are embedded in dome-shaped gelatinous, capulla. The canals are filled with fluid called endolymph. There are three in number, arranged in three planes; vertical canals detect movement in upward direction; horizontal canals detect backward and forward motion while lateral canals detect sideways movements of the head.

When the head moves in any one of these planes, the fluid in the relevant canal also moves, displacing the capulla. Due to inertia, the capulla is deflected in the opposite direction to that of movement of the head.

This puts strain on the sensory cells, causing them to fire impulses in the different nerve fibres to the brain.

The pattern of impulses is interpreted by the brain which detects the direction and speed of movement and sends instructions to relevant organs than maintain dynamic balance.

(ii) The utriculus and sacculus contain maculae which are regions containing receptor cells. These have their hair-like processes attached to otoliths.

By varying the position of the head, the pull of gravity over the hairs on the otoliths tilts them accordingly.

The different influences of the pull of gravity result in a pattern of impulses to the brain. The brain interprets the position of the head in space and accordingly sends instruction to relevant muscles to restore balance.

6. (a) Explain what is meant by variation

Variation refers to the existence of different functional, physical or behavioral characteristics among organisms of a population. It may arise by gene mutation, chromosomal mutation or recombination

(b) How does meiosis contribute to variation?

- Crossing over between chromatids of homologous chromosomes occurs during prophase I of meiosis. This shuffles linked genes and provides a source of genetic recombination.
- During metaphase I of meiosis, chromosomes are distributed randomly at the equator and subsequently segregate independently during anaphase I. this leads to further mixing of genes which are then expressed in the gametes.

(c) Describe the role of variation in evolution.

In the presence of variation, organisms respond to change in different ways.

- In presence of a selection pressure, organisms which are more suitably adapted i.e. with favorable variations, survive and reproduce while organism with unfavourable variations die and may be weeded out. As a result, a new strain of organisms with favorable variations arises.

- Also certain variation may limit successful sexual reproduction among organisms of a population. As a result, the population may be split into two differently intern-breeding populations which may later evolve into a new species of organisms.

- Some variations may be so lethal; that organisms containing them do not survive to the next generations, even without a selection pressure. As a result, such organisms become extinct in the subsequent generations, leaving a strain of organisms with non-lethal variations.