UACE Biology 2020 paper 2

1. In an experiment, cells obtained from the root of wheat of seedlings were studied in a culture media of varying oxygen concentrations. The effect of oxygen concentration on uptake of potassium ions in the root cell sap, and the consumption of sugar by the root cell sap were investigated and the results presented as shown in figure 1.

   Study the figure and answer the questions that follow

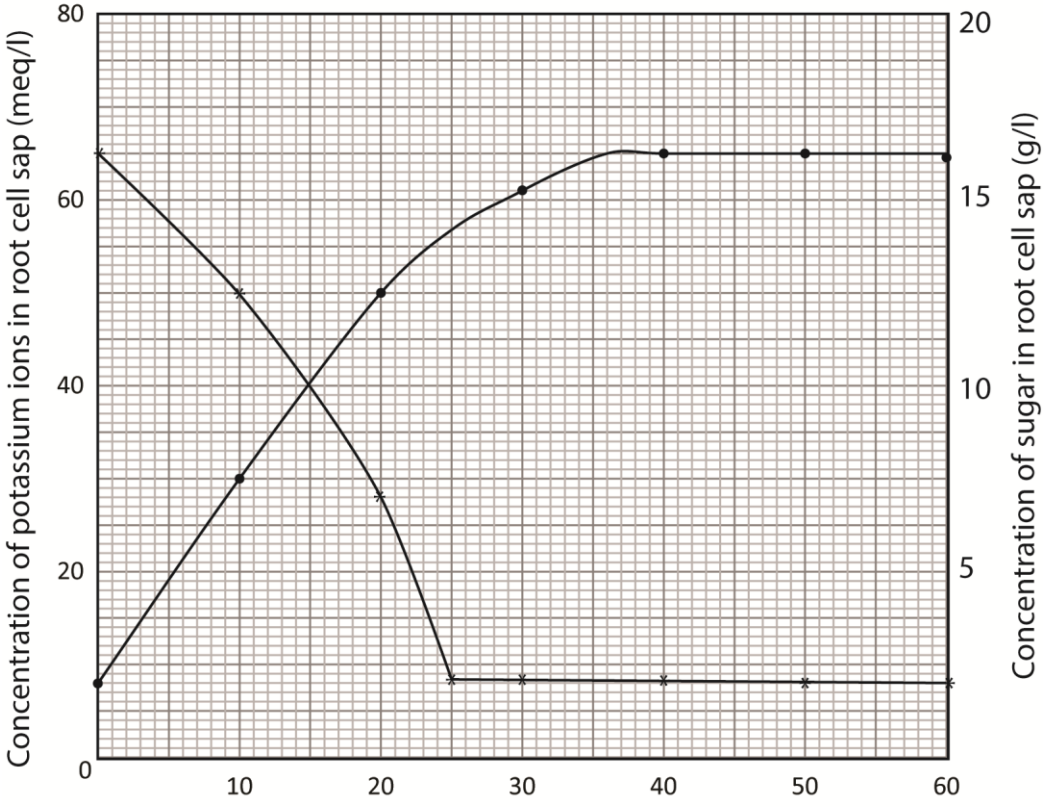


Fig.1 Percentage of oxygen in the culture solution

   (a) Describe the variations in the concentrations of ;
      (i) Potassium ion in the root cell sap over different percentages of oxygen in the culture solution. (03marks)
      (ii) Sugar in the root cell sap over different percentage of oxygen in the culture solution
   (b) Explain the effect of increasing the percentage of oxygen in the culture solution on the concentration of
      (i) Sugar in the root cell sap (11 marks)

(ii) Potassium ions in the root cell sap (08marks)

(c) Suggest reasons for the presence of potassium ions in the cell sap of the root at 0% oxygen in the culture solution. (06marks)

(d) Explain what would happen to the concentration of potassium ions in the root cell sap if in another experiment potassium cyanide was added in small quantities into the culture solution at 20% of oxygen. (06marks)

(e) Explain two other factors that may favour absorption of the potassium ions. (04marks)

SECTION B (60MARKS)

Answer any three questions from this section

Any additional question(s) answered will not be marked

2. (a) What is the importance of osmoregulation in animals? (02marks)
   (b) Explain how mammals living in arid areas overcome the problem of water shortage. (18marks)
3. (a) How is light involved in production of ATP during photosynthesis? (08marks)
   (b) Explain how energy contained in ATP molecules produced during photosynthesis is assimilated in the body of a herbivores.
4. (a) What is meant by the term **variation**? (02marks)
   (b) A part from mutation, explain how genetic variation arises in sexually reproductive species. (10marks)
   (c) How does polyploidy lead to variation in species? (08marks)
5. (a) What is meant by the term **population** in ecology? (02 marks)
   (b)What assumptions are made when using capture-recapture method of estimating population size? (08marks)
   (c) Explain the ways in-breeding affects natural population? (06marks)
   (d) Suggest factors which may contribute to a climax community being unstable? (04marks)
6. (a) Describe the process of primary growth in plants. (06 marks)
   (b) Describe the role of gibberellins in plant growth. (07marks)
   (c) Explain the meaning and role of seed dormancy in the life cycle of a flowering plant. (07 marks)

SUGGESTED ANSWERS

1. In an experiment, cells obtained from the root of wheat of seedlings were studied in a culture media of varying oxygen concentrations. The effect of oxygen concentration on uptake of potassium ions in the root cell sap, and the consumption of sugar by the root cell sap were investigated and the results presented as shown in figure 1.

   Study the figure and answer the questions that follow

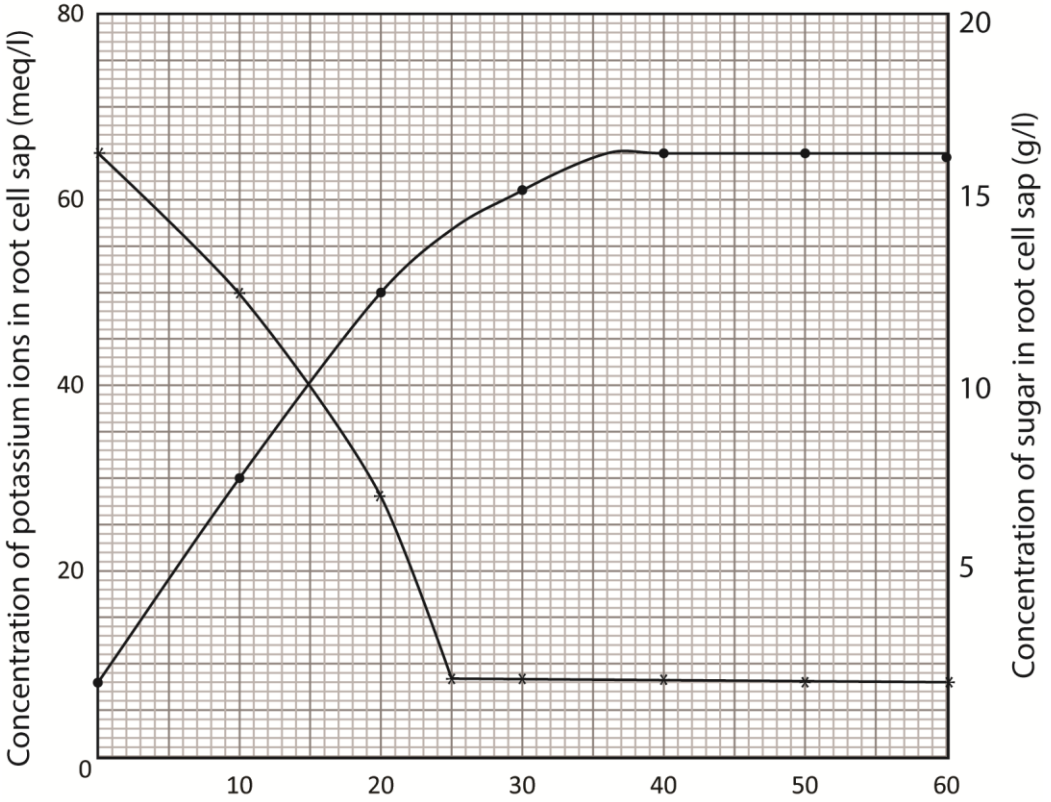


Fig.1

(a) Describe the variations in the concentrations of ;

(i) Potassium ion in the root cell sap over different percentages of oxygen in the culture solution. (03marks)

The concentrations of potassium ions in cell sap increase steeply from 8meq/l at zero percentage of oxygen in the culture solution to 65meq/l at 36 percentage of oxygen in the culture solution. From 36 to 60 per cent of oxygen in the culture solution the concentration of potassium ions in the cell sap remained constant at 65meq/l.

(ii) Sugar in the root cell sap over different percentage of oxygen in the culture solution

The concentrations of sugar in cell sap decrease steeply from 15.25g/at zero percentage of oxygen in the culture solution to 2g/l at 25 percentage of oxygen in the culture solution. From 25 to 60 per cent of oxygen in the culture solution the concentration of sugar in the cell sap remained constant at 2g/l.

(b) Explain the effect of increasing the percentage of oxygen in the culture solution on the concentration of

(i) Sugar in the root cell sap (11 marks)

At zero concentration of percentage oxygen in the culture solution the concentration of sugar in root cell sap is high because sugars are not respired in absence of oxygen.

As the percentage of oxygen in the culture solution increases, oxygen diffuses into the root cell and used for respiration of sugar.

The rate of respiration of sugar depends on the amount oxygen available. Therefore, the concentration of sugar left in the cell sap is inversely proportional to the percentage of oxygen available in the culture solution.

The rate of respiration is maximum at 25 per cent of oxygen in the culture solution.

Beyond 25 per cent of oxygen in the culture solution no further increase in respiration or removal of sugar from the cell sap because

- the basic concentration sugar in the cell sap was reached or the respiration enzymes are saturated.
- Respiration enzymes are saturate
- Optimum temperature is exceeded
- The concentration of sugar is cell sap is too low for sugar to diffuse into the mitochondria

(ii) Potassium ions in the root cell sap (08marks)

The concentration of potassium ions in the root cell sap increases with increase in percentage of oxygen in the culture solution because there is increased energy output from the respiration of sugars in the root cell sap.

Further increase in uptake of potassium ions ceases beyond 25% of oxygen concentration probably because

- the enzyme involved in the transport are saturated
- there is no further increase in energy from respiration of sugar
- the temperature is not enough to activate further intake of ions
- the potassium ions in the culture solution are depleted.
- Increased rate of diffusion of potassium ions from the cell sap

(c) Suggest reasons for the presence of potassium ions in the cell sap of the root at 0% oxygen in the culture solution. (06marks)

- potassium ion are necessary for plant life
- some potassium ion passively/diffuse in the root cells

(d) Explain what would happen to the concentration of potassium ions in the root cell sap if in another experiment potassium cyanide was added in small quantities into the culture solution at 20% of oxygen. (06marks)

The concentration of potassium ions will fall from 50meq/l to 8meq/l because potassium cyanide poisons the active transport mechanism

(e) Explain two other factors that may favour absorption of the potassium ions. (04marks)

- Increase in temperature favours absorption of enzymes up to optimum temperature because it activates enzymes involved in active transport.

- Increase in concentration potassium ions in culture solution increases the availability of ions to be taken it

SECTION B (60MARKS)

Answer any three questions from this section

Any additional question(s) answered will not be marked

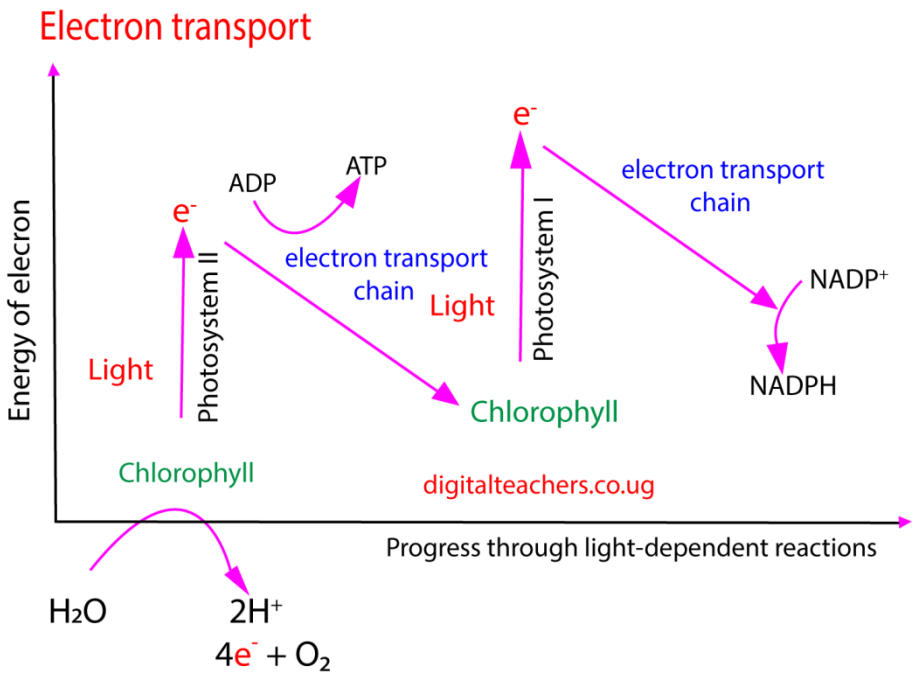
2. (a) What is the importance of osmoregulation in animals? (02marks)
   Osmoregulation is the maintenance of the correct concentration of the body fluids at a stead state.
   (b) Explain how **mammals** living in arid areas **overcome the problem of water shortage**. (18marks)

   Note the **key words are bolded**

   - Camel excretes high uric acid content to reduce water loss in urine
   - Mammals such cows and elephants have fur to reduce water loss through evaporation
   - Mammals e.g. camels living in arid areas have low glomerular filtration rate.
   - Some mammals such as rats are nocturnal to reduce water loss during day
   - Small mammals go into a state of dormancy during summer or dry season, a phenomenon called aestivation.
   - By using metabolic water. E.g. a desert animal such as kangaroo rat tends to metabolize fats rather than carbohydrate to obtain a high yield of water.
   - They have tissues that tolerant to water loss e.g. the camel tissues are exceptionally tolerant to dehydration.
   - Most mammals such kangaroos, camels have fewer or no sweat glands to limit the amount of water they lose through perspiration.
   - Some mammals such as camel have big humps to store fat which are metabolized to form water
   - Gain water from food and drinking water.
   - Development of embryo inside the body prevents dehydration of the fetus.
   - Lungs/gaseous exchange surface inside the body to reduce drying up.
   - Gain water from food and drinking water.
   - Development of embryo inside the body prevents dehydration of the foetus.
   - Lungs/gaseous exchange surface inside the body to reduce drying up.
   - Some animals like elephants smell water at a long distance

3. (a) How is light involved in production of ATP during photosynthesis? (08marks)
   During photosynthesis ATP is produced when strike chlorophyll and cause excitation of electrons and electron transmission.

The events of electron transport are described in the figure below



ATP is formed as follows

(i) Non cyclic photophosphorylation
The flow of electrons from PSII to PSI in thylakoid membrane causes accumulation of H^+ inside the thylakoid space creating a gradient. The passage of H^+ out of the thylakoid provides energy to synthesise ATP.

(ii) Cyclic photophosphorylation
Here when PSI is struck by light, electron is excited, passes through electron carrier system and then returned to PSI; that is PSI is the electron donor and acceptor. H^+ builds up in the thylakoid space creating a gradient. Then the passage of H^+ out of the thylakoid provides energy for synthesising ATP. It is useful to synthesise ATP when synthesis of $NADPH_2$ is not necessary.

(b) Explain how energy contained in ATP molecules produced during photosynthesis is assimilated in the body of a herbivore. (12 marks)
Carbohydrates formed by photosynthesis are turned into starch, cellulose and proteins:

In ruminant herbivores such as cows and goats: starch and cellulose are fermented in the rumen of ruminant by mutual microorganism to volatile fatty acids that are absorbed in small intestines. The little starch that enters the small intestine is poorly digested due to a relative deficiency in amylase.

Similarly proteins are fermented in the rumen into amino acids and short chain peptide chains and these are absorbed in the small intestines.

In non- ruminant herbivores such as horse and rabbit: digestions of starch and proteins are done in stomach and small intestines by enzymes while cellulose is digested by symbiotic bacteria in the cecum/hind gut. The products of digestion are absorbed in the small intestines.

4. (a) What is meant by the term **variation**? (02marks)

Variations are the differences in characteristics shown by organism belonging to the same natural population or species.

(b) A part from mutation, explain how genetic variation arises in sexually reproductive species. (10marks)

Other than mutation variations are caused by

(1) **Gene reshuffling**

(i) Independent assortment of genes at meiosis I allow gene reshuffling in in two ways

- ***Orientation on the equator in metaphase I***

During metaphase I of the first meiotic division homologous chromosomes came together in pairs and subsequently segregate into daughter cells independently of each other. The result of this independent assortment is the production of the wide variety of different gametes depending on which particular chromosome end up with one another in each cell.

- ***Crossing over***

In prophase of the first meiotic division, homologous chromosomes came together and make intimate contact with each other. Chromatid of homologous chromosome may break and rejoin at any place called chiasmata.

b. **Fertilization**

Union of gametes at fertilization results in alleles present in one gamete being united with alleles in another. If a population consist of large number of out breeding individual, the amount of variation that may result from this is again virtually infinite.

(2) Environmental factors cause variations as result of differences in the surroundings or what an individual does. For instance, the amount of food available to an organism determines its size.

(c) How does polyploidy lead to variation in species? (08marks)

Polyploidy occurs when there is an increase in the entire haploid sets of chromosomes; i.e., 3n triploid], 4n [tetraploid]

Polyploidy is more common in plants than animals and is responsible for the following effects in plants:

- **Increased Genetic Diversity**: Polyploids have more genetic material due to multiple copies of their genomes. This diversity can lead to novel traits and adaptations.

- **Gigas Effect**: Polyploids often exhibit larger organs, known as the "gigas" effect. For example, larger leaves, flowers, and fruits can result from polyploidy.
- **Buffering of Deleterious Mutations**: Having duplicate copies of genes allows polyploids to tolerate mutations better. If one copy is damaged, the other can compensate.
- **Heterosis (Hybrid Vigor)**: Polyploids can show increased vigor and performance compared to their diploid counterparts. This phenomenon, known as heterosis, is valuable in plant breeding.
- **Reproductive Isolation**: Polyploidy can lead to reproductive barriers between different polyploidy levels, contributing to speciation.
- **Tolerance to Stress**: Anatomical and physiological changes resulting from polyploidy can enhance tolerance to abiotic (e.g., temperature, drought) and biotic stresses (e.g., diseases).

5. (a) What is meant by the term **population** in ecology? (02 marks)

A population is group of individuals of the same species in a defined area

(b)What assumptions are made when using capture-recapture method of estimating population size? (08marks)

- Organisms mix uniformly within the population.
- Sufficient time elapsed between capture and recapture to allow uniform mixing.
- The population is closed, i.e. there is no emigration and immigration to the specified area.
- Making does not hinder movement of organism or make the conspicuous to predators.
- Marking are permanent.
- The mark does not harm the animal
- There must be no mortality between the mark and recapture times.
- The mark doses not make an animal more/less easily captured

(c) Explain the ways in-breeding affects natural population? (06marks)

This can lead to negative genetic effects, such as **decreased growth rate, behavioral abnormalities, and reduced fertility and fecundity**, especially in small isolated populations.

(d) Suggest factors which may contribute to a climax community being unstable? (04marks)

- Floods
- Fire
- Diseases
- Draught
- Earthquake
- Predators and parasites

6. (a) Describe the process of primary growth in plants. (06 marks)

Primary growth causes an increase length through cell division and cell elongation (increase in size of cells) at the tip of the roots and the stem.

(b) Describe the role of gibberellins in plant growth. (07marks)

- Promotes stem and root elongation thus, genetically dwarf varieties of peas and maize are restored to normal growth and dwarf beans can be converted into runners by application of gibberellins.

- Mobilize enzymes that release nutrient reserves in grass seeds.
- they stimulate the growth of side branches from axillary buds
- they break dormancy and promotes germination of seeds
- promotes bolting and flowering in long day plants
- promotes development of seedless fruits (parthenocarpy)
- delays senescence

(c) Explain the meaning and role of seed dormancy in the life cycle of a flowering plant. (07 marks)

Is the state in which a seed that is viable will not germinate even if the conditions that are necessary for germination are provided?

Importance of seed dormancy

- ensures that germination occurs when conditions are optimum
- Seed are able to withstand adverse external conditions such as very cold or very dry whether.
- It allows seed and fruits to disperse
- Increases self-life of seeds
- Prevents all seeds from germinating at same time, which can be beneficial in avoiding total loss from short-term adverse weather or herbivores.
- Maintaining genetic diversity: by staggering germination over time, dormancy helps maintain genetic diversity within a plant population, which is crucial for adaptation and resilience.

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