A-level

UACE Biology 2001 paper 2 guide

1. In an experiment to determine the factors affecting photosynthesis, seedlings of a plant were divided into two groups and grown at a constant high light intensity (25 arbitrary units), another group grown at a constant low light intensity (3 arbitrary units). When the plants were mature, their apparent rates of photosynthesis in milligrams of oxygen released per unit leaf are per hour, were measured over a range of different light intensities

Figure 1 shows the results of the experiment. In addition, some characteristics of the two groups of plants were recorded on table 1

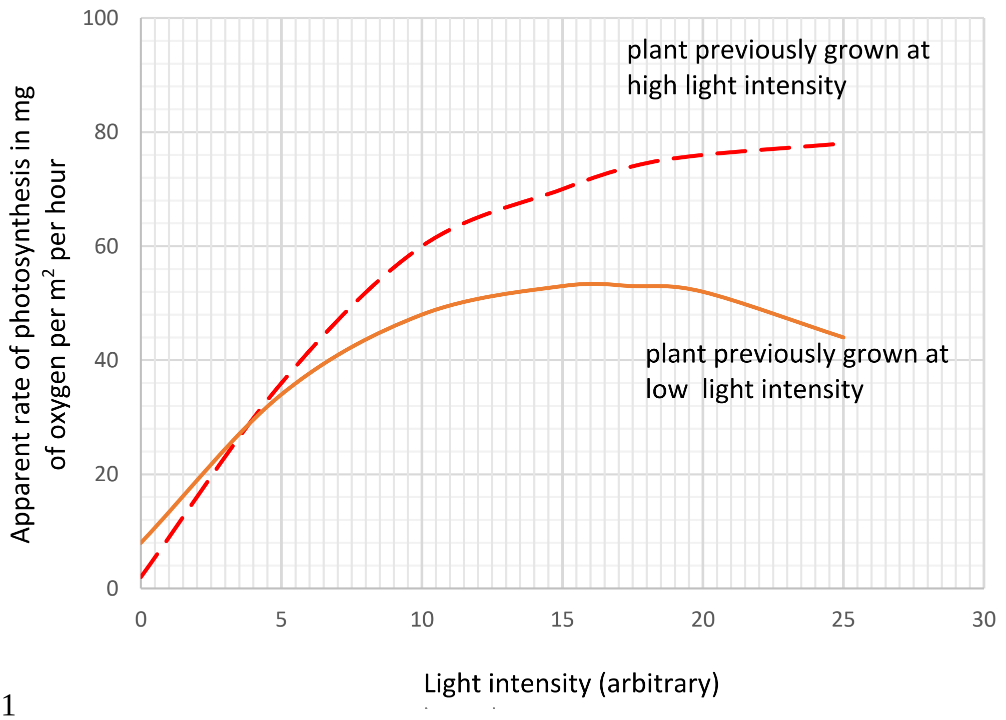

Table 1

Groups of plants	Characteristics
Plants grown at high light intensity	Big, dark green leaves with short internodes
Plants grown at low light intensity	Small, pale yellow leaves with long internodes

(a) From the graph, state
  (i) differences in the effect of light intensity on the groups of plants (8marks)
  (ii) similarities in the effect of light intensity on the two groups of plants. (3marks)
(b) Suggest explanation for the differences you have stated in (a) (i). (8marks)
(c) Explain the pattern of the curve for plants grown in low light intensity. (6marks)
(d) Explain the observed characteristics of the two groups of plants as indicated in table 1.
(9marls)
(e) Suggest why:

(i) Seedlings of the same plant were used in the experiment. (2marks)
(ii) The rate of release of oxygen was used to measure the rate of photosynthesis. (2marks)

(f) Name two factors that may limit the rate of photosynthesis of plants previously grown in high light intensity, if subjected to light intensity above 25 arbitrary units. (2mark)

Solution

(a)(i) Differences

Plants previously grown at low light intensity	Plants grown at high light intensity
Photosynthetic rate is generally lower	Photosynthetic rate is generally high
Photosynthetic rate reduces at high light intensities	Photosynthetic rate increases and peaks at higher light intensities
Optimum light intensity for photosynthesis is lower	Optimum light intensity for photosynthesis is higher
Photosynthetic rate reaches a peak at lower light intensity	Photosynthetic rate reaches a peak at higher light intensity
Peak photosynthetic rate lower	Peak photosynthetic rate higher
Photosynthetic rate is higher at lower light intensities.	Photosynthetic rates are lower at low light intensities
Increase in photosynthetic rates with light intensities is gradual	Increase in photosynthetic rate with light intensities is rapid

(i) Similarities

a. Increase in light intensities cause increase in photosynthetic rate at lower light intensities in both cases
b. In both there is optimum light intensity at which photosynthetic rates remain constant called the peak photosynthetic rate.
c. In both groups, photosynthetic rate is low at lowlight intensity

(b) Explanation for the differences

Plants grown previously at high light intensity generally have higher rate of photosynthesis at higher light intensities because are well adapted to trapping and utilization of light energy for photosynthesis than those previously grown at low light intensity, i.e.

- They have more chloroplasts for trapping sunlight energy.
- Have enzymes with higher optimum temperature.
- Have high stomata density to increase the rate of gaseous exchange and prevent overheating at higher light intensity
- Has much carotenoid to prevent damage to chlorophyll from very bright light.

Plants previously grown at low light intensity have high photosynthetic rate at lower light intensities because

- Its enzyme have low optimum temperature
- Has thin leaves to maximize light penetration
- Long internodes exposes each leave to light
- Low stomata density reduces heat low to avoid over cooling.

(c) Initially the of photosynthesis increase with temperature (0.5 -4 unit light intensity), because increase in light intensity increases the rate excitation of electrons from PSI and PSII leading to production of ATP and NADPH for the dark reaction.

The rate of photosynthesis then slows up because other factors other than light (such as amount of chlorophyll, carbon dioxide) limit the rate.

The rate of photosynthesis then drops because at very high light intensity, high temperature denatures the photosynthetic enzymes.

(d) Plants previously grown at low light intensity have

- Have pale leaves because they have density of chlorophyll
- Have small leaves are due to low rate of photosynthesis producing less nutrient to build structures
- Long internodes to allow increase in length to search for light.

Plants previously grown at high light intensity

- Have dark leaves due to high density of chloroplast
- Have broad leaves due to available nutrients from photosynthesis
- Broad leaves to provide large surface area to trap light

(e) (i) to minimize errors due to genetic composition
(ii) oxygen is easier to quantify.

(f) – temperature
- Chlorophyll
- Carbon dioxide concentration

2. (a) Monoecius plants have separate male and female flowers on the same plant e.g. maize. Out breading occurs as a result of cross pollination when pollen grains are transferred from the anther of one flower to the stigma of another flower but of the same species. Mechanisms that promote outbreeding include
   - The unisexual flower promote cross pollination and hence outbreeding
   - Large flowers with brightly colored petals attract pollinating insects to transfer pollen grain from one flower to another
   - Stamens could mature and release pollen grain before stigma of the same flower is receptive
   - Pollen grain fail to germinate on the stigma of the same plant
   - Stigma matures before anthers of the same plant release pollen grains
   - Scent attract pollinators promoting cross pollination

   (b) How sexual reproduction causes variation

   - Random fusion of gametes
   - Crossover of genes on homologous chromosomes at prophase I of meiosis
   - Random segregation of homologous at metaphase I of meiosis

3. (a) Structural adaptation of red blood cells
   - Thin membrane to reduce diffusion distance of gases
   - Biconcave shape increase surface area for gaseous exchange
   - Lack of nucleus increase space for hemoglobin
   - Lack on mitochondria not to use up oxygen transported
   - Highly flexible to squeeze through blood capillaries

   Biochemical adaptations of red blood cells
   - Contains hemoglobin to increase oxygen carrying capacity of the red blood cells
   - Contains carbonic anhydrase enzyme to enhance transport of carbon dioxide
   - Produced and occur in large number to increase oxygen carriage

   (b) (i) Effect of variation in pH of mammalian blood on ability of hemoglobin to associate with oxygen

   - Decrease in pH due to increase in carbon dioxide of hydrogen ions reduces the ability of hemoglobin to combine with oxygen; the free hemoglobin molecules combine with hydrogen ions to form hemoglobinic acid leading to release of oxygen
   - Increase in pH due to low carbon dioxide concentration increases the ability of hemoglobin to combine with oxygen

   (ii) Physiological significance
   - Low pH leads to release of oxygen to tissues while high pH in the lungs leads to uptake of oxygen by hemoglobin in the lungs
   - Uptake of hydrogen ions by hemoglobin buffers pH

4. (a) Role of apical meristems in root growth

   - Apical meristem of the root is a mass of irregularly arranged cells, which divide and cut off cells in all direction giving rise to primary meristematic tissue, root cap procambium, ground meristem and protoderm.
   - At the very tip of apical meristem is a quiescent zone, a group of initials from which all other cells of the root originate

- Cells a head of meristems form the root cap, the root cap parenchyma cells protect the delicate growing root tip, the cells at the root cap slough off as the root grows and push its way through the soil.
- Bulk of the cell cut off the root cap meristem give rise to central procambial strand (procambium)
- The procambial strand forms the primary phloem from which sieve tubes and companion cells develop.
- Primary xylem from which tracheid, xylems develop, vascular cambium from which secondary xylem and phloem develop
- Pericyle from which lateral roots develop and contributes to secondary growth.
- Ground meristem give rise to epidermis, with specialized cells called root hairs
- Cell division and expansion of the cells cut off the apical meristem contributes to overall elongation/primary growth of the root.

(b) Formation of secondary tissue in dicotyledonous plants
Secondary tissue is formed by activity of lateral meristem and causes increase in girth or secondary growth
There are two types of lateral meristem vascular cambium and cock cambium

- The vascular cambium has two types of cells
  Fusiform initials are narrow, elongated cells, they divide by mitosis forming secondary phloem to the outside and secondary xylem to the inside; the middle layer remain meistematic. After division of the cambium cells, they expand and vacuolated; finally they differentiate into phloem sieve tubes, companion cells, xylem vessels and tracheid. As more xylem is formed than phloem; the phloem is pushed outside the cambium ring.

  Ray initials are almost spherical cells, divide by mitosis to form secondary parenchyma cells which accumulate to form rays between neighboring xylem and phloem. The rays maintain a living link between the cortex and the pith and store food. Radial division of the cambial cells occur to keep pace with increase in girth, annual growth rings occur due to seasonal difference in growth.

- Cork cells are tightly packed and gradually die, lenticels develop in the cork as a mass of loosely packed, thin walled dead cells lacking suberin; they have large intercellular spaces allowing gaseous exchange and transpiration.

5.

(a) Describe the trend of succession that would take place on a bare rock. (10marks)

- Succession on bare rock is called primary succession and occurs in three stages.
  Pioneer stage
- Bare rock breaks down physically and chemically during the process of weathering
- Rain water assist in weathering because it is acidic. It dissolves some minerals leading to rock disintegration
- These conditions are not favorable for most plants but lichen are the fast to inhabit the rock, they are called pioneer organism.
- Invasion of lichens on bare rock cause further weathering, and their death humus to the soil formed. This makes it possible for invasion of mosses. Moss form a dense mat which trap tiny particles of rock, some organic debris and water.
  Spruce stage
- Death of the moss add to the nutrient content of the mat so that eventually the mat support germination of seed of colonizing angiosperm whose bodies also contribute to the growing layer of soil.

Climax stage

- Soon large woody shrubs begin to grow in the newly formed soil
- Lichen and moss may be covered by decaying leaves causing their death.
- Eventually thicker layer of soil develops, leading to growth of big trees
- Animal species immigrate into the forming fauna and the size of animals that invade increase as the size of the vegetation increase.
- After a long time, the mature forest community grows. This is called climax community.

(b) Outline the flow of energy in the climax community described in (a) (10marks)

- Energy in form of light from the sun is used for photosynthesis to produce organic molecules.
- The initial amount of energy fixed by ecosystem is called gross primary production (GPP) . part of this energy is used by the producers (plant) for respiration the remainder in form of organic matter is called the Net Primary production (NPP)
- The energy flow in the climax community from one trophic level to another in unidirectional.
- The energy is transferred in form of organic mater following feeding relationship among organisms that constitute food chain and food webs in a community
- At each feeding level, there is considerable loss of energy in various ways such as respiration, death and decay and through excreta.

Thus the energy flow in decreasing quantities from producer (plant) to primary consumer (herbivores and finally to decomposer.

6.

63. (a) Qualities of gaseous exchange surface

- Has large surface area
- Moist
- Thin to reduce distance for diffusion
- Freely permeable to respiratory gases
- Has good blood supply
- Has good ventilation

(a) (i) adaptation of an insect for efficient gaseous exchange

- Has highly branched tracheal system that ramify the whole body up to individual cells
- Tubules open to atmosphere to receive oxygen through spiracles
- Tracheoles have thin walls to facilitate diffusion of gases
- Tracheal system is ventilated by contraction of abdominal and thoracic muscles.

(i) Adaptations of flowering plants to gaseous exchange

- Has many stomata on leaves and lenticel to allow gaseous exchange
- Broad leaves gives provide large surface area for gaseous exchange
- Cells in mesophyll layer are loosely packed to allow spaces for gaseous exchange
- Leaves have thin cuticle

(ii) Adaptation of amoeba for gaseous exchange

- Has large surface area to volume ratio
- Has thin membrane