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P530/2
BIOLOGY
(Theory)
Paper 2
DECEMBER, 2020
2½ hours

JINJA JOINT EXAMINATIONS BOARD

Uganda Advanced Certificate of Education

MOCK EXAMINATIONS – DECEMBER, 2020

BIOLOGY

(THEORY)

Paper 2

2 hours 30 minutes

INSTRUCTIONS TO CANDIDATES

Answer question ONE in section A plus three others from section B.

Candidates are advised to read questions carefully, organize their answers and present them precisely and logically.

Illustrate, whenever necessary, with well labelled diagrams.

SECTION A (40MARKS)

1. When DDT was first manufactured, it was applied as a method of controlling housefly populations over time. Populations of two species of houseflies and that of a spider were monitored over a period of thirteen months. Shortly after the second month of data collection was when the DDT was applied and it was established that the DDT was not toxic to the spider. The results of the study were recorded in the table below. Study the table carefully and answer the following questions:

Table 1

Time(months)	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Housefly C (x1000)	35	35	35	20	2	7	17	32	50	65	79	88	82	81
Housefly F (X1000)	79	82	79	80	62	40	17	0						
Spider W (X1000)	72	76	81	78	66	56	49	46	46	48	55	70	85	86

a. Plot suitable graphs to represent the results of this study. (6 marks)

b. i. How does the population of the spider relate with the population of houseflies in this investigation? (10 marks)

ii. Explain the relationship in the populations in (b) (i) above. (12 marks)

c. i. How do you explain the effect of the use of DDT on the observed trends of the three populations of the animals? (8 marks)

ii. Basing on the information given, what would happen if DDT was toxic to the spider? (4 marks)

SECTION B: (60 MARKS)

2. a. Describe the mechanism of forward locomotion of a cartilaginous fish like Scyliorhinus fish(dogfish) . (10 marks)

b. Describe how the structural features in birds are related to their flight. (10 marks)

3. a. What is meant by transpiration? (3 marks)

b. Explain how the following factors affect transpiration:

i. Temperature. (4 marks)

ii. Sunken stomata in leaves. (5 marks)

c How does transpiration benefit plants? (8 marks)

4 a. Describe the term ecosystem. (2 marks)

b. Precisely outline the information required to describe the make-up of an ecosystem. (8 marks)

C. Describe the flow of energy through ecosystems and describe the various ways in which man's activities can influence the flow at all levels in terrestrial ecosystems. (10 marks)

5 a i. Distinguish photoautotrophic from chemoheterotrophic nutrition. (2 marks)

ii. Describe the ways in which the structure of the leaf contributes to its successful functioning. (13 marks)

b i How does the absorption spectrum of chlorophyll a differ from that of chlorophyll b? (3 marks)

ii. Explain the effect of lowering oxygen concentration on C3 and C4 photosynthesis. (2 marks)

6. a. Compare the structures of the photoreceptor cells of the mammalian eye. (6 marks)

b. Describe how the mammalian eye accommodates objects. (7 marks)

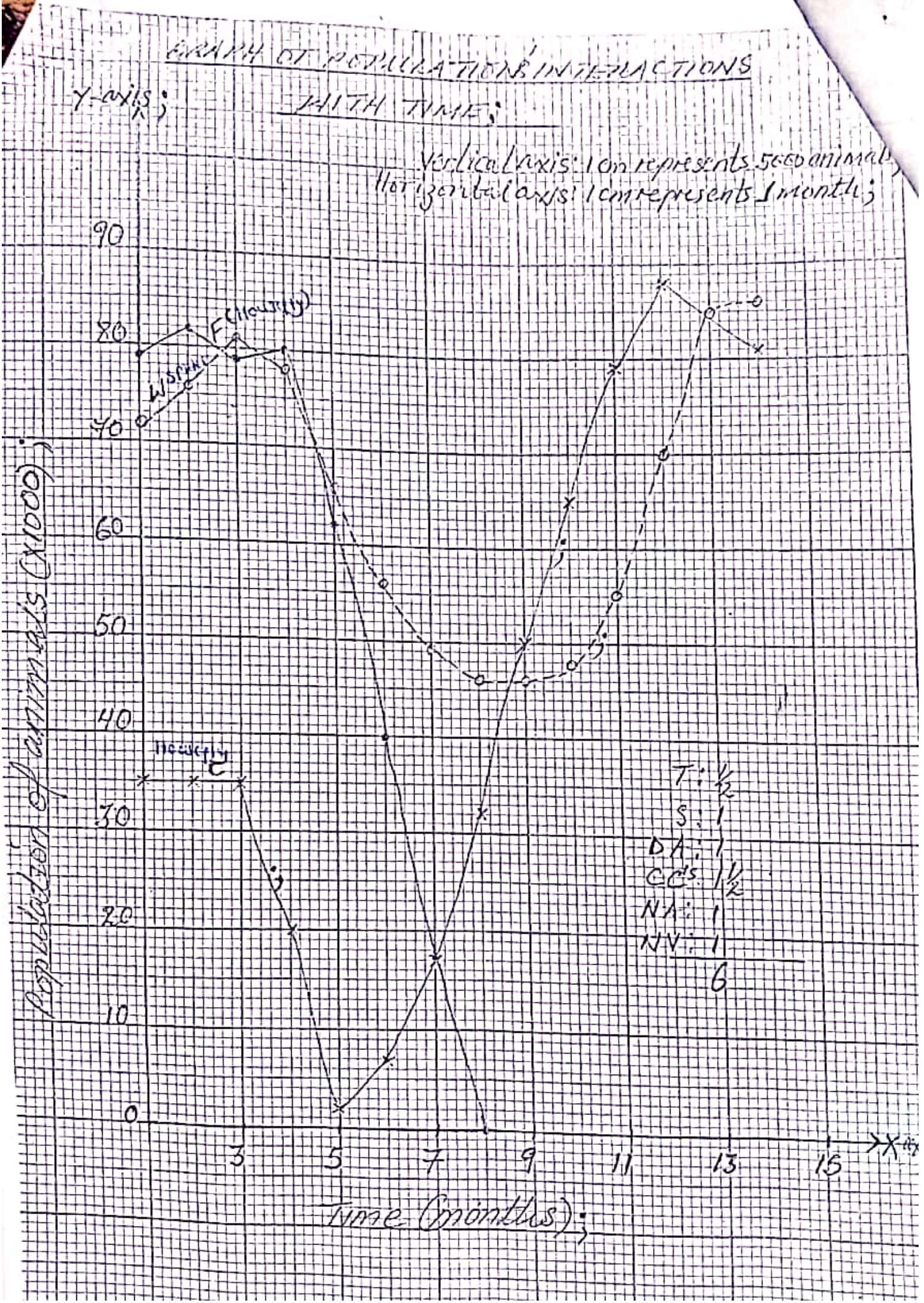
c, Describe the trichromatic theory of colour vision. (7 marks)

 End.

GRAPH OF POPULATION INTERACTIONS WITH TIME;

Y-axis;

Vertical axis: 1 cm represents 5000 animals;
Horizontal axis: 1 cm represents 1 month;



b) i) In the first three months;

max: 10

The population of the spider was fluctuating about the norm;

Similar to that of population of housefly F;

As the population of housefly F decreased; after the third month; that of the spider also decreased;

Similarly, the population of housefly C also decreased;

As the population housefly F continued to decrease, in the next four months, that of C increased; although that of the spider also decreased; but remained constant; within the 7th and 9th month.

This was followed by increase in population of the spider; until in the 12th month when it was maximum; while that of housefly C was maximum in the 11th month;

Both the populations of housefly C and the spider stabilized above their original constant populations; (10 mks)

ii) Initially the population of the spider and housefly F were at equilibrium;

This was a prey – predator relationship; where the spider was feeding more on – house fly F at the carrying capacity;

High population of F over C implies that the former had competitive advantage over housefly C; whose population remained much lower;

Decrease in population of housefly F from the 3rd year; reduced the available food for the spider; such that some of them starved to death due to competition between themselves;

Significant decrease in population of housefly F, enabled population of housefly C to increase; due to reduced competition between the two species of the houseflies;

The low constant population of the spider was due to the individuals transiting from feeding on housefly F to housefly C;

With increase in population of housefly C the spiders subsequently fed on them; and started increasing until they stabilized at higher populations; (12 mks)

C i) The toxic DDT had an immediate effect of killing housefly C; but this effect came about a month later on housefly F;

Whereas it was able to kill species F to extinction; species C was able to develop resistance to DDT;

The few flies that survived reproduced and inherited the resistant variety; and out competed the less resistant variety F; consistent use of DDT in the subsequent months became less effective in killing the flies;

DDT therefore, provided an environmental factor that resulted in natural selection; (8 mks)

ii) The population of the spider would have decreased rapidly;

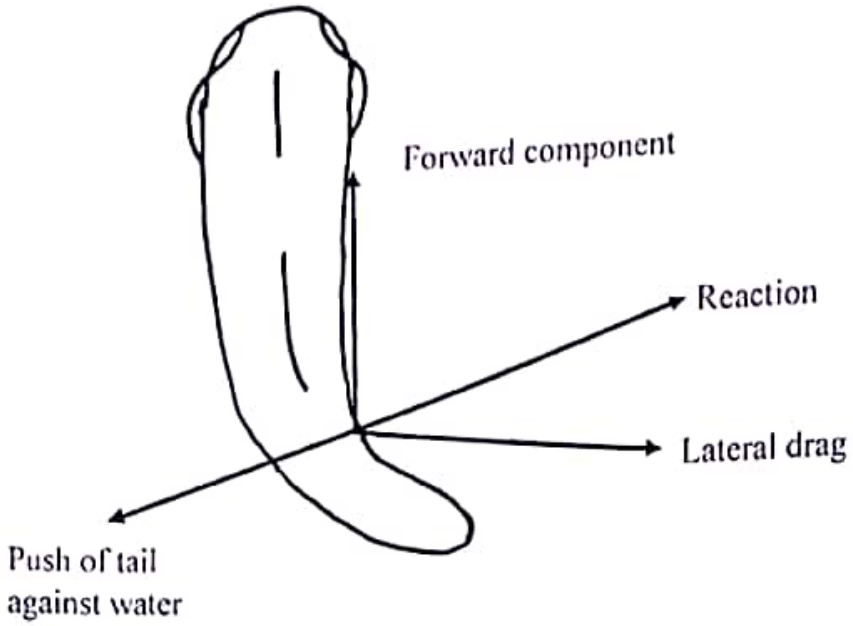
There would have been population explosion for housefly C if the spider failed to develop resistance to the DDT;

If the spider had developed resistance to DDT; then their population and that of species C would have stabilized much later than it was observed; (4mks)

Total (40mks)

SECTION B (60MKS)

2. a) - Dog fish has a vertebral column of a long, flexible rod; with blocks of myotome muscles attached along both sides to transverse processes of the vertebrae;
   - the myotomes contract and relax alternately on each side of the vertebral column; starting from anterior end of the fish and moving towards its tail;
   - the contractions and relaxations bend the posterior half of the body into a series of waves; with tail showing most side to side movement;
   - the force exerted on water by the tail produces effective forward component that propels the fish forward through the water;



- stability/ controlled forward locomotion is maintained by the fins; with rolling prevented by all fins; yawing prevented by anterior, posterior dorsal fins and ventral anal fins; and pitching of the head prevented by the pectoral and pelvic fins; (10mks)

b)

- Their bodies are highly streamlined in shape; to offer little resistance to air during flight;
- Tails are short; to cut down the drag but increase ability to manoeuvre during flight;
- The pectoral girdles are strongly developed; to provide firms bases for the wings;
- Have sizeable keeled sternum; to give a large surface area for the attachment of the powerful pectoral flight muscles;
- The wing bone or forelimb bones are elongated and fused; to provide strong supportive structure for the attachment of the primary flight feathers;
- The body skeletons are rigid in many places (eg some vertebrae are fused vertebral column fused to the pelvic girdle); to transmit more efficiently the force of the wings and give better lift during flight;
- Have a number of body bones hollow and spongy; to reduce body weight;
- Have small sex organs outside the breeding season; to reduce body weight;

- Have cavities in the hollow bones filled by air sacs; to improve ventilation in the bird by supplying the lungs with fresh air during inspiration and expiration;
- The cavities of the long bones have struts; to give them strength to resist breakage;
- Have contour feathers which provide the main body cover; to insulate the body from cooling effect of the air as the birds move through it;
- Have large brain; for excellent muscular co-ordination during flight;
- Have the nictitating membrane in the eyes; that remove particles from the eyes during flight; Ru. nictating x
- Have powerful flight muscles or pectoralis major and pectoralis minor; To operate wing movements in flight; ½ @ = 14

TOTAL (20mks)

3. a) Transpiration is loss of water from a plant; by evaporation and diffusion out; through stomata, cuticle and lenticels; (3mks)

b) i) Higher temperatures increase the kinetic energy and movement of water molecules; the rate of transpiration increases as temperature increases;

High temperature also reduces the humidity of air around the leaf surfaces; increased diffusion gradient increases the rate of transpiration; (4mks)

ii) Sunken stomata form small pockets in which water vapour collect;

Wind cannot blow away the water vapour molecules; accumulation of the water vapour molecules reduces the diffusion gradient; between the inside and the outside of the stomata; diffusion or loss of water through stomata slows down/transpiration slows down; (5mks)

c) Loss of water from the leaves creates a transpiration stream; that brings in a continuous supply of fresh water;

Water provides turgor to leaves; to make them better exposed to light for photosynthesis; Transpiration stream provides a continuous supply of mineral ions;

Evaporation of water from the leaves cools the plant; and prevent overheating of leaves in hot climates;

Water vapour from the leaves form part of the water cycle which provides water for plants; (8mks)

Total (20mks)

4. a) Ecosystem refers to a self-contained unit; through which energy flows and nutrients cycle. / All the biotic and abiotic components in a natural environment (2mks)

b)-Numbers of each species; / population (density);
- Index of diversity;
- Trophic level of each species;
- [Which are: producers; herbivores; secondary consumers; tertiary consumers; top carnivores; decomposers; food chains/webs;]
- Biomass;
- Energy input into system or amount of light available;
- Amount of light absorbed or gross primary productivity;
- Net primary productivity;
- Climate details, [like temperature, humidity, availability of water, pH of water, salinity of water and type of soil] **(8mks)**

- Ecological pyramids eg Pyramid of number, energy

C) Some solar energy is captured by photoautotrophs/producers; in photosynthesis;

Not all solar energy is absorbed, some is reflected;

About 1% of incoming useful light is converted into gross primary productivity (GPP); Cultivated crops may achieve higher levels of GPP and net primary productivity during growing season;

The amount of light falling on producers can be decreased by selective planting, for example, coniferous woodlands will not only block light from forest floor; but tall trees will cast shadows on adjacent land.

Deforestation drastically reduces numbers of producers/ the amount of light absorbed;

This contributes to soil erosion and therefore even fewer producers;

Air pollution/ acid rain can decrease numbers of producers; which affect other trophic levels;

Ground level ozone pollution can affect crops detrimentally;

Desertification can result in formerly productive land becoming useless;

Use of green houses and lighting of certain wave lengths like red and blue can increase photosynthesis;

Covering the ground with black plastic to reduce weed growth will decrease light energy absorbed by plants but will increase thermal energy of soil;

Removal of crops reduces food energy available for herbivores;

The herbivores will only be able to make use of some of the energy trapped in producers;

If the herbivores are eaten by humans or other animals, so their biomass is not available to other members of the food web;

Intensive farming (cows/pigs) will produce considerable biomass from excretory products; encouraging decomposer food chains;

Carnivores obtain only small percentage of energy taken in by primary consumers;

Losses of energy from respiration; indigestible bones; predators like foxes may be hunted for sport; other large secondary consumers may be killed as they interfere with human activities e.g. deers and snakes; This reduces energy for tertiary consumers;

Burning dead organisms; forest fires started by humans make less energy available for decomposers and detrivores;

Spraying fields with a variety of chemicals may have effects on soil decomposers; making the recycling of minerals slower; ½ @ (max 10 mks) (10mks)

Total (20mks)

5. a) i) Photoautrophic organisms use light energy from the sun as an energy source for synthesizing organic compounds from inorganic materials, with carbon dioxide as a source of carbon; whereas chemoheterotrophic organisms use organic compounds which are synthesized from pre-existing organic sources of carbon, using energy from chemical reactions; (2mks)

ii) **Overall form and position;**

- Large surface area to volume ratio for maximum interception of light and efficient gaseous exchange;
- Blade often held at right angles to incident light, particularly in cotyledons;

Stomata

- Pores in the leaf allow gaseous exchange. Carbon dioxide needed for photosynthesis, with oxygen a waste product;
- In cotyledons, stomata are located mainly in the shady lower epidermis, thus minimizing loss of water vapour in transpiration;

Guard cells:

- Regulate opening of stomata (ensure stomata open only in light when photosynthesis occurs);

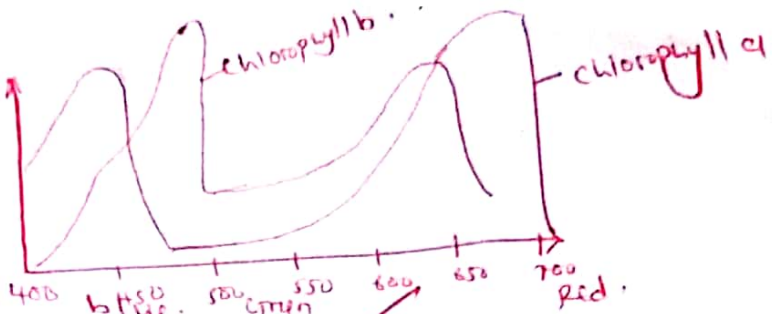
Mesophyll:

- Contain special organelles for photosynthesis, the chloroplasts, containing chlorophyll;
- In cotyledons, palisade mesophyll cells, with more chloroplasts, are located near the upper surface of the leaf for maximum interception of light;
- Length of the cells increases the chance for light absorption;
- Chloroplasts are located near the periphery of the cell for maximum absorption of light and easier gas exchange with intercellular spaces;
- Chloroplast may be phototaxic (that is move within the cell towards light);
- In cotyledons, spongy mesophyll has large intercellular spaces for efficient gaseous exchange;

Vascular system:

- Supplies water, a reagent in photosynthesis, as well as mineral salts;
- Remove the products of photosynthesis;
- Supporting skeleton provided together with collenchyma and sclerenchyma;

14 (13mks max)



b) i) Chlorophyll a absorption in red light is about twice that of chlorophyll b; and the absorbption peak is at a slightly longer wavelength (lower energy);
Absorption in the blue is lower and shifted to a slightly shorter wave length (higher energy); for chlorophyll b. (3mks)

ii) Lowering oxygen concentration stimulates C_3 photosynthesis because it reduces competition between oxygen and carbon dioxide for the active site of RuBP carboxylase;
Lowering oxygen concentration does not affect C_4 photosynthesis because PEP carboxylase does not accept oxygen; (2 mks)

Total **(20mks)**

6. a) Similarities in structure:
   - both cells consist of inner and outer segments;
   - both synapse/link with bipolar neurons, then optic nerve fibre;
   - both have photosensitive pigments in the vesicles of the outer segment;
   - both contain numerous mitochondria in the inner segment;
   - outer and inner segments are connected by pair of cilia;

   Rej: Similarities which are not structural ½ @ = 2 ½ max (2mks)

   Rej. None structural / sim & dif.

   Differences in structure:

RODS	CONES
- Outer segment is rod-shaped	Outer segment is cone-shaped;
- A group of rods link with one bipolar neurone (show retinal convergence)	Each cone singly links with one bipolar neurone; (No retinal convergence)
- The photoreceptive pigment is rhodopsin	The photoreceptive pigment is iodopsin;
- The pigment occurs only in one form	Three different types /forms of iodopsin;

(4 mks)

b) To accommodate a near object, the circular ciliary muscles contract;

Then the suspensory ligaments holding the lens become laxed/tension on the suspensory ligaments is reduced;

The elastic lens assumes a more convex shape;

Light refracted by cornea is further strongly refracted and focused by the lens onto the retina;

For a distant (Far) object however, the ciliary muscle relax;

Causing the suspensory ligaments to be taut/stretched;

Making the lens to become thin/less convex to refract and focus light onto the retina; (7mks)

c) Trichomethic theory

Cones exist in 3 types; each containing a different type of iodopsin pigment; which is more sensitive to the primary colours of bright light; ie blue, green and red;

Different colours are perceived by mixing the information from different types of cones produced different degrees of stimulation; resulting into colour mixing; Equal stimulation of all cones produces colour sensation of white; eg when both red and green cones are (equally) stimulated, yellow or orange is perceived;

max 07

OR

Iodopsin exists in 3 different forms; each occuring in a different type of cone cell; each form of iodopsin is sensitive to either blue, green or red light; The brain interprets various impulses triggered by bleaching of iodopsin and relative stimulation of the three type of cone; thus perceiving the colour. If two cone types are stimulated at the same time, each cone cell type causes transmission of impulse to brain; which interprets a secondary colour;