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BIOLOGY THEORY PAPER 2

P530/2

MARKING GUIDE

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1 a) ii) From 0 to 30 minutes, the rate of uptake of mineral salts was rapid in absence of cyanide, because there is ATP production by respiration for active uptake of mineral salts, and diffusion occurring, while in presence of cyanide the rate of mineral uptake increased gradually, because it's mainly by diffusion, down concentration gradient, which is slow, as cyanide inhibits/stops ATP production by respiration, so active transport can't occur. From 30 to 110-120 minutes, the rate of mineral uptake in presence of cyanide continued to increase gradually because of high concentration gradient, between surrounding soil solution and cell sap of root hairs, allowing diffusion of minerals, while in absence of cyanide the uptake of minerals was more gradual, due to reduced ATP production for active uptake of minerals and no more diffusion, (because of no more concentration gradient between soil solution and cell sap of root hairs). Above 120/110 minutes / From 110/120-240 minutes, the rate of uptake of mineral salts in presence of cyanide remains constant, because the concentration of mineral ions in the cell sap of root hairs was equal to that in the <sup>net</sup> surrounding soil solution, and therefore no diffusion occurs, while in the absence of cyanide rate of mineral uptake increased gradually, due to continued ATP production from respiration used for gradual active uptake against concentration gradient.

$e_{1/2}mk$ , max 12mk

Peny: 2f difference not brought out!



ii) - Low temperatures;

- Low oxygen concentration;

- Low glucose/substrate concentration;

Any 2.  
max 02.

(b)(i). Both nitrates and plant phosphates are essential for better growth and development of crop shoots and roots; more growth occurs when all nutrients are present ✓

- Phosphates/ phosphorus is more vital for growth and development of shoots and roots or lack of nitrates have less effect on growth and development of roots and shoots than lack of phosphates/phosphorus; ✓

- Growth and development of roots is more affected by lack of phosphorus; nitrates (nutrients) ✓

- Mineral salts essential for growth and development are obtained by crop plants from the soil; ✓

1 mark @ ; 04 marks.

(ii). Nitrates are used in the synthesis of amino acids; which form vital protein molecules such as enzymes; controlling biochemical reactions; growth substances such as auxins and gibberellins; essential growth and development; and protein molecules for formation of plant structures; ✓

Nitrates also provide nitrogen for synthesis of chlorophyll pigment; used for absorption of light energy during photosynthesis; ✓

Phosphates are used to form ATP; essential for uptake of minerals; and cell division in actively growing parts of plants; ✓

Phosphate is also used in formation of structures such as cell membranes; ✓

Both nitrates and phosphates are used in the formation of nucleic acid (DNA and RNA); DNA formed controls all cell activities including cell division; ✓

Both nitrates and phosphates are important in the synthesis of co-enzymes such as NAD and NADP; which are essential in respiration and photosynthesis and both processes influence plants growth and development; ✓

½ mark @ ; 07 marks.

(c)(i). - Leaching resulting from over flooding of crop gardens with water; ✓

- Monoculture/ monocropping; ✓

- Soil erosion; ✓

- Burning; ✓

- Excessive use of inorganic fertilizers and herbicides; ✓

- Denitrification in water logged gardens; ✓

1 Mark @ ; (04 marks)



- Lightning;
- mutualism (Rhizobium);
- mycorrhizae;
- Insectivorous;

(ii). Through mutualistic or symbiotic associations, Nitrogen fixing bacteria in roots nodules of legumes, convert the gaseous nitrogen into nitrates taken up by crops. Also hyphae of certain fungi are associated with roots of citrus plants or mycorrhizal association, and mycorrhizal roots obtain mineral more efficiently than ordinary roots. Some plants e.g. Pitcher plants are insectivorous/ carnivorous, trapping small insects and obtaining nitrates from their bodies.

Mark @; 06marks.

(d). Absorbed nitrates are converted to ammonia, which combines with carboxylic acids to form amino acid molecules. Amino acids are polymerized through condensation reactions, to protein molecules or protein food substances stored in crops structures, such as seeds. When humans consume or ingest such structures or food substances and are digested, amino acid molecules are released; these are absorbed at the ileum and it is the form nitrogen is supplied to body cells.

Mark @; 05marks.

Total = 40marks max.

2(a). Natural selection is when organisms with characteristics best suited or coinciding with environment factors survive better/ selected for, and reproduce offspring with similar features to succeeding generations, while artificial selection occurs when humans select organisms that show desirable characteristics and allow them to reproduce, so that their desirable characteristics are retained in future generations.

1 mark @ 04 marks

(b). Through selective breeding man carries out outbreeding or cross breeding hybridization to produce hybrids. Hybrids have superior characteristics than either of their parents, they are high yielded varieties of crops and livestock. Grow very rapidly and are large in size. Have high resistance to diseases, and long droughts. To maintain these desirable characteristic of hybrids, man in breeds/ carries out selective reproduction between offspring of same parents, to produce offspring with similar desirable characteristics.

1 mark @ 08marks

(c). Persistent use of antibiotics and pesticides may result into resistant forms of pathogens and pests, arising by random mutation, the nonresistant forms are soon eliminated by the antibiotics or pesticides leaving reduced number of resistant forms. The resistant bacterial cells multiply rapidly binary fission under favorable conditions, and since have only one DNA, all bacteria cells reproduced are resistant. Persistent use of pesticides or insecticides eliminates the non-resistant forms and resistant pests survive. These now multiply rapidly and their population increases exponentially, posing a worse effect than even before the use of pesticides.

1 mark @ ; 08 marks

Total = 20marks max.



3(a)(i). In unicellular eukaryotes the distance for transport of materials is small; so diffusion alone is enough to convey substances to various parts. Unicellular eukaryotes have a large surface area to volume ratio; so have their entire body surface exposed for uptake/absorption and elimination of substances; for transport to and from any closest part of their cells. Low m.p.; so low demand for metabolites; and low waste (it can be eliminated across the body by diffusion). Short diffusion distance

1/2 marks @ ; 03marks

(ii). The gases exchanged and transported in flowering plants are CO<sub>2</sub> and O<sub>2</sub>. Plants take in CO<sub>2</sub> and must be supplied to all photosynthetic or mesophyll cells, which are mainly restricted to leaves. leaves have stomata, through which diffusion of CO<sub>2</sub> occurs, when they are opened mainly during day or in the presence of light. The stomata are connected to airspaces in leaves, and these ease circulation of CO<sub>2</sub> to all photosynthetic cells.

Being less metabolically active the little oxygen required diffuse from soil air via root hairs to other cells in plants.

Some oxygen from photosynthesis diffuses directly to growing plants like apical meristem in shoot. CO<sub>2</sub> produced during respiration and not used in photosynthesis may diffuse out through (lenticels or cracks in stem of plants cuticle/stomata). to the respiring tissue

1/2 marks; for any 8, 04marks)

(iii). Haemoglobin is a conjugated globular protein molecule; and would partially dissolve in plasma increasing viscosity of blood; and this will be difficult to pump to various parts of the body by the heart. By ultrafiltration haemoglobin molecules would filter into glomerular filtrate; and cannot be reabsorbed back into blood in capillaries; so will be lost in urine. Its presence in glomerular filtrate would also affect reabsorption since proteins are osmotically active.

In cells haemoglobin molecules are separated small molecules and this arrangement enables efficient combination with large amount of oxygen; than plasma-based haemoglobin that are aggregates of many small molecules.

1/2 marks @ 04marks 04 marks

1

(b). The mammalian heart wall is made up of cardiac muscle, which is myogenic.

The walls of atria are thin, because their contraction is for pushing blood to ventricles; and the walls of ventricles especially left ventricle are thicker, because their powerful contraction pumps blood all other parts of the body.

Muscle fibres or cells of cardiac muscle are separated by <sup>intercalated</sup> intercalary disc; these strengthen the muscle tissue; and aid in the <sup>rapid spread</sup> impulse transmission.

Muscle fibres have cross-bridges, which promote rapid conduction of impulse through the heart wall; There are numerous mitochondria in the muscle fibre; to provide ATP for continuous contractions of heart wall.

The muscle fibres are surrounded by a small amount of connective tissue which carries blood vessels; and net-work of capillaries surround each muscle fibre; to ensure continuous supply of materials to cardiac muscle cells contracting continuously.

The SAN or pacemaker in the right atrium is the source of the rhythmic heart beat; and the rate of heart beat is controlled by nervous; and hormonal stimulation e.g. the adrenaline hormone; Connected to SAN are sympathetic nerves that increase heart beat rate; and vagus nerve that lowers the rate of heart beat.

1/2 marks for any 18,09marks)

Total = 20marks max

4 (a). In both the products of light stage ATP and NADPH<sub>2</sub> are used in the fixation of CO<sub>2</sub> during the enzyme controlled stages;

In C<sub>3</sub> plants only RuBP is the CO<sub>2</sub> acceptor and the only the enzyme is RuBP carboxylase; while in C<sub>4</sub> plants CO<sub>2</sub> acceptor are PEP and the enzyme PEP carboxylase in the mesophyll cells and RuBP in the presence of RuBP carboxylase in bundle sheath cells; Single fixation of CO<sub>2</sub> in C<sub>3</sub> plants during Calvin cycle produces PGA a 3 carbon compound as the first stable molecule; while the double fixation of CO<sub>2</sub> first in palisade cells produces oxaloacetic acid (OAA), a 4 carbon compound as the first stable organic substance;

In C<sub>3</sub> plants RuBP carboxylase catalyses also the combination of RuBP with oxygen in the presence of low CO<sub>2</sub> concentration or high oxygen concentration/ C<sub>3</sub> plants photorespire as

- Similarities
- Both use ATP in CO<sub>2</sub> fixation;
  - Both use NADPH<sub>2</sub> in fixation;
  - Both are controlled by enzymes;



## Differences

- C<sub>3</sub> plants**
- fixation occurs in bundleshoot cells
  - RUBP is main CO<sub>2</sub> acceptor
  - RuBP carboxylase enzyme
  - optimum temperature is low
  - 1<sup>st</sup> stable product is PGA / 3C cpd
  - ~~Accepts~~ accepts O<sub>2</sub> / No photorespiration
  - single fixation of CO<sub>2</sub>
  - higher compensation point

- C<sub>4</sub> plants**
- occurs in mesophyll bundle sheath cells
  - PEP is the main acceptor
  - uses PEP & RUBP for fixation
  - use both RUBP & PEPs
  - optimum temperature is higher
  - 1<sup>st</sup> stable product is OAA / 4C cpd
  - Does not accept O<sub>2</sub> / No photorespiration
  - Double CO<sub>2</sub> fixation
  - Lower compensation point

oxygen is a competitive inhibitor of CO<sub>2</sub> fixation by RuBP carboxylase; While in C<sub>4</sub> plants no photorespiration at all as PEP and the enzyme PEP carboxylase combine or fix CO<sub>2</sub> even at every low partial pressure of CO<sub>2</sub>;

In C<sub>3</sub> plants a rise in temperature increases the rate of photorespiration than CO<sub>2</sub> fixation and the fixation of CO<sub>2</sub> is highest at moderate temperature; while C<sub>4</sub> plants CO<sub>2</sub> fixation is also favoured by high temperatures and are much productive than C<sub>3</sub> plants in tropical climates characterized by higher temperatures;

1 mark @ ; for any 8 08marks

(b)(i). The fact that light is a limiting factor of photosynthesis indicates a light controlled stage of the process;

The effects of variation of temperature and CO<sub>2</sub> concentration on the rate of photosynthesis indicate an enzyme- controlled stage of the process;

1 mark @; 02 marks

(ii). Increase in productivity in crops depends on increased rates of photosynthesis or amount of stored products manufactured in leaves; and so all factors that favour maximum rate of photosynthesis increase crop productivity;

The limiting factors of photosynthesis on light intensity or suitable temperatures for the given crop types; and CO<sub>2</sub> concentration; High light intensity favours high rate of photosynthesis; and crop must be grown in open gardens; In presence of high light intensity C<sub>3</sub> plants are efficient at a temperature around 20 – 25°C; while C<sub>4</sub> plants require high temperatures provided naturally in our tropical climates; High CO<sub>2</sub> concentration increases crop productivity and addition of organic matter to crop gardens is essential for increasing CO<sub>2</sub> concentration;

1mark @ for any 10;10 marks

Total = 20marks max

5(a). These are pesticides or chemicals used to eliminate mainly vectors and arthropod parasites, crop pests and weeds; Most of these chemicals are non-specific killing even many non-targeted organisms including microorganisms in soil; This also causes outbreaks of other pests because of destruction of their natural predators;

Due to random mutation resistant strains or varieties of pests evolve; and as a result of selection these few pests that have a natural resistance to the pesticides or poison survive; and reproduce to increase in numbers causing resurgence chemically Many pesticides are persistent



less poisonous or lethal but persistent in the environment. They get incorporated in food chains and accumulate toxic levels in organisms at the top of food chains such as the carnivorous birds; <sup>higher trophic levels</sup>

1 mark @ ; 08 marks

(b) Food materials obtained from animal bodies contain mainly proteins, and fats/lipids, and animals produce enzymes that readily digest proteins to amino acids, the form in which nitrogen is supplied to animal cells. Lipids are hydrolyzed to glycerol and fatty acids. Animal proteins are high value proteins supplying all the essential amino acids. Fats yield a lot of energy when they are respired. Most proteins obtained from plant material are of low value as they do not supply one or more of the essential amino acid molecules when hydrolyzed. Plant food materials contain mainly cellulose, which is indigestible or not digested by any enzyme produced in animals.

1 mark @ for any 8, 08marks.

c) The diet of herbivorous mammals are plant materials or vegetation, which are largely cellulose, and very difficult to digest. Also large volumes must be consumed as vegetation is poor in nutrients. While the diet of carnivorous mammals is meat, and it is digestible, and very rich in nutrient values; therefore guts of herbivorous mammals long or large and complex to cater for large amount consumed and digestion of the vegetation, compared with the shorter and simple <sup>carnivorous omnivorous guts</sup> <sup>vegetable/cellulose</sup> <sup>plant materials are</sup> <sup>protein</sup> <sup>vegetable/plant material</sup>

½ mark @ 04 marks

Total = 20marks max

6(a)(i). The feedback inhibition ensures that suitable body conditions are maintained within normal or functional levels or limits; as any deviation provokes a response that tends to reduce the magnitude of the change, <sup>homeostatically</sup> <sup>to ensure efficient functioning of the body</sup> <sup>to ensure efficient fu</sup>

The internal body temperature is maintained around  $37^{\circ}\text{C}$ ; an increase or decrease to lethal levels result to death; optimum temperature for enzyme activity.

The blood and tissue fluids must be isotonic to cells of the body; as haemolysis of cells results from hypotonic body fluids; and their crenation results from hypertonic fluids;

The blood sugar level must be maintained at  $90\text{--}100\text{mg}/100\text{cm}^3$  of blood; which is adequate for all respiring tissues in a normal functioning body; and abnormally high levels of sugar in blood cause diabetic condition or general body dehydration;

pH of tissue fluids and blood must neutral; because acidic or alkaline pH would affect enzymes involved in metabolic processes.

½ marks @ 06marks

5 c). The diet of herbivorous mammals is mainly plant material/cellulose/vegetation while that of carnivorous animals is protein/meat. Cellulose is very difficult to digest & very poor in nutrients therefore large volumes have to be consumed; for proteins are easy to digest & very rich in nutrient values; therefore herbivorous mammals have long/large/complex gut to cater for large amount consumed & digestion of cellulose compared with the shorter and simple carnivorous gut.



10 Under suitable conditions with little environmental resistance, such as shortage of food, predators, and parasites, and competition for space, animal populations tend to grow exponentially. As the numbers increase the environmental resistance sets in or will increase, and when birth rate equals death rate the population size is regulated at an equilibrium at an optimum level for conditions, <sup>carrying capacity</sup>

1 mark @ ; 5 marks

(b). Human population size or growth is not regulated by negative feedback mechanisms because man has improved the farming methods or agriculture, and carries out selective breeding of crops and animals, food storage, and transport facilities are available, which all increase the quantity, quality, availability and range of food, therefore starvation or lack of food cannot be the cause of death or regulate the population.

Through improved hygiene, development of medicines and antibiotics, and increased capacity to detect diseases, death due to infectious diseases has been greatly reduced.

Modern methods of contraceptives promote family size that can have high standard of living;

- Ability to modify environment enable man to create more land for agriculture;
- Ability to predict or detect local calamities saves many populations from catastrophic death;

1 mark @ for any 09 marks

Total = 20 marks max

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