P530/2

BIOLOGY

(Theory)

Paper 2

Nov/ Dec, 2022

21/2 hours

UGANDA NATIONAL EXAMINATIONS BOARD

Uganda Advanced Certificate Of Education

BIOLOGY

(THEORY)

Paper 2

2 hours 30 minutes

INSTRUCTIONS TO CANDIDATES:

*This paper consists of sections; **A** and **B**.*

*Answer question **one** in section **A** plus **three** others from section **B**.*

Candidates are advised to read the question carefully, organize their answers and present them precisely and logically illustrating with well labelled diagrams where necessary.

SECTION A (40 MARKS)

Question 1 is compulsory.

1. Studies were carried out to show how some of the complex organic compounds such as lignin, cellulose and pectin present in leaves are broken down by the action of organisms feeding on decaying organic matter over time. The results were plotted on the graph as shown in figure 1. Study the figure and answer the questions that follow.

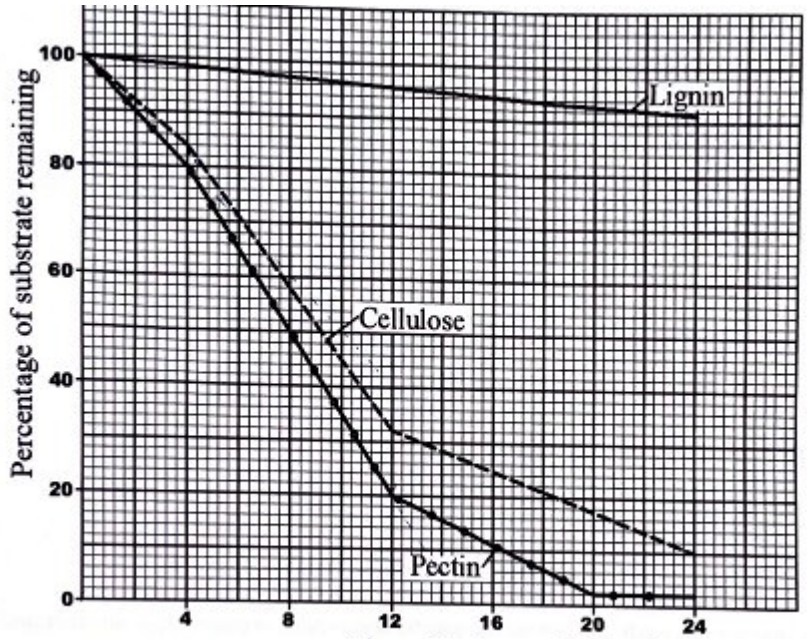

Fig. 1

(a) (i) Describe the rate at which each of the complex organic compounds is broken down. (08 marks)

(ii) Explain your descriptions in (a) (i). (14 marks)

(b) Explain the ecological significance of the process of breakdown of plant materials shown in figure 1. (05 marks)

(c) Explain how fungi are broken down plant materials. (05 marks)

(d) How is lignin

(i) important in plants? (05 marks)

(ii) useful to man? (03 marks)

SECTION B (60 MARKS)

*Answer any **three** questions from this section.*

*Any additional question(s) answered will **not** be marked.*

2. (a) Describe the different mechanisms by which the human body prevents loss of blood. (08 marks)

   (b) Explain how the sodium-potassium pump mechanism brings about osmotic balance in a human body cell. (12 marks)

3. (a) How is m RNA formed from DNA in a cell? (10 marks)

   (b) Describe how the information on m RNA is used in the synthesis of an enzyme. (10 marks)

4. (a) How are flowering plants adapted for reproduction on land? (10 marks)

   (b) Describe the process of the development of an embryo sac in flowering plants. (10 marks)

5. (a) Compare the structure of the cardiac and skeletal muscles. (06 marks)

   (b) Explain how each of the following is suited to its function:

   (i) Cardiac muscle. (07 marks)

   (ii) Skeletal muscle. (07 marks)

6. (a) What are isolating mechanisms? (02 marks)

   (b) Explain how each of the isolating mechanisms led to emergence of new species in a population. (18 marks)

END

MARKING GUIDE FOR UACE BIOLOGY P2 2022

SECTION A: (40 MARKS)

1. (a) (i) Description

Lignin is broken down gradually/slowly from 0 to 24 weeks/throughout;

Cellulose rate of breakdown (increases) gradually from 0 to 4 weeks; then (increases) rapidly from 4 to 12 weeks; and then (increases) gradually from 12 to 24 weeks;

Pectin rate of breakdown (increases) gradually from 0 to 4 marks; then (increases) rapidly/faster from 4 to 12 weeks; (increases) gradually from 12 to 24 weeks; and then remains constant from 20 to 24 weeks: 8 X @ 1 mark, Max 08 marks

Acc percentage of substrate remaining **decreases**

Rej Rate of breakdown **decreases**

(ii) Explanation

- **Lignin**, is a polymer of various sugars and amino acids/complex polymer; once deposited in spaces between cellulose molecules makes the cell wall much rigid/hard; and impermeable to water; thus not easily broken down to simple molecules; since decomposition/breakdown requires water;
- **Cellulose,** is a polysaccharide consisting of long straight chains of beta glucose molecules; linked by glycosidic bonds; and hydrogen bonds between neighbouring chains; resulting in the formation of cross linked parallel chains/microfibrils; which are embedded in gel-like matrix; which is fully permeable to water; making it easy for decomposition process;
- **Pectin**, are short polysaccharides; which form a gel-like organic matrix; they cement cellulose fibres using ionic bonds which are highly soluble/highly hydrophilic; so it easily breaks down; max 14x @1 mark

(b) **Ecological significance of breakdown**

The breakdown of plant materials such as cellulose/lignin/pectin is carried out by microorganisms referred to as saprophytes/decomposers (**Acc** bacteria/fungi); they free inorganic materials; ensuring continued supply of raw inorganic materials for primary producers/plants; which synthesize them into organic compounds/carryout photosynthesis; to recycle matter in nature; max 05x @ 1 mark

(c) **Fungi breakdown of plant material**

The mycelia of fungi penetrates the food material; secreting a variety of enzymes; including cellulase/pectinase/Carbohydrases; that digest the complex organic matter into simple soluble nutrients; which are absorbed; max 05x @ 1 mark

(d) (i) **Role of Lignin in plants**

- It serves as cement/binder between cellulose microfibrils; making cell walls very rigid to provide mechanical support; in xylem/sclerenchyma;
- Lignified tissues are impermeable to water and die losing protoplasm forming a hollow water proof tube/xylem vessel; for water transport;
- The impregnation of cellulose walls with lignin increases the adhesion of water molecules; and helps the water to rise up the stem by capillary;

Any 5x @1 mark

(ii) **Importance to man**

- For production of wood/timber due to complex strong nature;
- Used in making biodegradable plastic/lignin based plastics;
- For combustion/coal/fossil fuel/energy;
- In manufacture of pulp which is used to make news prints/ paper industry;
- As roughage it avoids constipation e.g. bamboo; Any 3x@ 1 mark

SECTION B: (60 MARKS)

2. (a) **Prevention of blood loss**

- The body prevents blood loss through vessel constriction; to reduce blood flow to a particular region;
- Sticking of endothelia; due to altering of endothelial cells of the capillary that forces the cells to constrict keeping a small vessel sealed;
- Formation of a platelet plug; the damaged endothelium exposes the collagen fibres of the underlying connective tissue; so that the platelet stick tightly together forming a semi-solid mass which plugs the vessel;
- Blood clotting; due to conversion of fibrinogen to fibrin; that forms a thread-like mesh that stops bleeding;

10X @1 mark, max 08 marks

(b) **Role of sodium potassium pump in osmoregulation of a cell**

Osmotic balance of human body cells is controlled by the sodium-potassium pump which consists of protein carriers; the pump transports potassium from outside; into the cell by active transport/using ATP; while the sodium ions are pumped from the inside to the outside; for every three sodium ions pumped out of the cell, two potassium ions are pumped into the cell cytoplasm; this leads to a net increase of the concentration of sodium outside the cell; hence water moves out of the cell; by osmosis;
Sodium ions diffuse back into the cell; together with other molecules like glucose; which increased the sodium ion concentration
Repeated active pumping of sodium ions out of the cell ensures that excess water does not accumulate; 13 X 1mark, max 12 marks

3. (a) **Messenger RNA synthesis in a cell**

Messenger RNA is formed from DNA by transcription; within the nucleus of cell; DNA double helix unzips/unwinds to expose DNA single strands; by breaking of hydrogen bonds between paired bases catalysed by **helicase enzyme**;

RNA polymerase attaches itself on to the transcribing/conducting strand at a particular base sequence/promoter site to initiate transcription; the nitrogen bases on the transcribing strand attract complementary nucleotides; and as the enzymes moves from the region of transcription; the double helix of DNA reforms just behind; until it reaches the stop/nonsense/terminating codon; and the enzyme detaches from the DNA and mRNA peels from DNA; and leaves the nucleus through nuclear pore to the cytoplasm;

14 X 1mark, max 10 marks

(b) **Synthesis of enzymes from messenger RNA**

The information on the messenger RNA is converted into a sequence of amino acids; which assembles to form a polypeptide; by a process of translation; that occurs on the ribosome within the cytoplasm of the cell;

Messenger RNA attaches to small subunits of ribosomes to expose its codons to the large subunits; transfer RNA combines with a specific amino acid and becomes activated; and the combination of t RNA with a complementary anticodon is attracted to codons on the m RNA; The t RNA previously attached to the big unit of ribosome leaves and goes back to the cytoplasm to carry the next amino acid;

The ribosome continues to move along the m RNA and translation continues until the peptide chain encounters a top/nonsense codons or slip over the m RNA strand;

The long polypeptide formed has a primary structure; which is folded to form a tertiary structure of the enzyme;

16 X 1mark, max 10 marks

4. (a) **Adaptations of flowering plants for reproduction on land (BS pg 50, 52)**

- Fertilisation is not dependent on water thus gametes are produced within specialised organs called flowers; that produce nectar to attract pollinators that transfer male gametes/brightly coloured petals/conspicuous flowers;
- Ability to produce large quantities of/sticky pollen grains which can successfully be transferred to the stigma of female gamete by pollinating agents;
- Female gametes are protected within the ovary and with the development of style through which the pollen tube grows;
- Double fertilisation which is only limited to angiosperms results in the formation of endosperm/food store for the embryo;
- The fertilised ovules which develop into seed remain attached to the parent plant from which it obtains protection and food;
- The mature seeds are enclosed in a fruit for protection/dormancy; and dispersal;
- Some flowering plants rely on vegetative reproduction which necessitates storage of food in stems/leaves/tubers; that allow the plant to survive or reproduce asexually during adverse conditions;

10 marks @1 mark

(b) **Embryo sac development (BS pg 718, Kent 292**

The embryo sac develops from a single embryo sac mother cell; which undergoes meiosis; to form four haploid cells/tetrad, three of these degenerate and the one remaining cell develops into the embryo sac;

Within the embryosac, the nucleus undergoes three successive mitotic divisions to produce 8 daughter nuclei; four nuclei migrate to each end of developing sac; one nucleus from each group moves to the centre of the embryosac to form the polar nuclei; the remaining 3 cells at the chalaza/top become antipodal cells; while one of the cells at the micropyle end becomes egg cell; while the remaining two become the synergids; to support the egg cell; 10 @1 mark

ACC. Appropriate diagrams

5. (a) **Comparison of structure of cardiac and skeletal muscle**

Similarities

- Both are covered by a sarcolemma;
- Both have cross striations/stripped;
- Both are made up of fine fibres/myofibrils;
- In both each myofibril is made up filaments; of actin and myosin filaments;
- Both have **numerous** mitochondria;
- Both are supplied with **numerous** blood vessels/highly vascularised;
- Both are cylindrical; Any 3

Differences

Cardiac muscle	**Skeletal muscle**
• Has one/two nuclei	• Many nuclei;
• Nucleus central in each muscle fibre	• Nucleus at periphery of muscle fibre
• Has intercalated discs	• No intercalated discs;
• Fibres branch and cross connect with each other forming a complex net-like arrangement	• Fibres are not branched;
• Innervated from within the heart muscle/SAN present	• Innervated by voluntary part of nervous system;
• Muscle cells are shorter	• Muscle cells are longer;

Any 3, max 6 marks

(b) **Adaptations of muscles**

(i) **Cardiac muscles**

- Has many mitochondria that release energy for continuous contration;
- Cardiac muscle has SAN in the heart muscle which enables the heart contract rhythmically;
- It is richly supplied with blood capillaries to supply enough oxygen and nutrients for muscles continuous contraction;

- It has interconnections by intercalated discs which makes the muscle fibres a network for quick impulse transmission throughout the heart muscle to cause rhythmic contractions;
- It has slow contractibility than other muscles to prevent muscle fatigue/long refractory periods avoid muscle fatigue;
- Muscle fibres are arranged in such away to allow rapid diffusion of action potentials/excitations from one fibre to another;
- There is the SAN in heart walls so that the cardiac impulses are myogenic/self-generated within the heart itself; 7 X @1mark, max 07 marks

(ii) **Skeletal muscle**

- The sarcoplasm contains numerous mitochondria for supply of ATP; and numerous sarcoplasmic reticula for transportation of substrates needed for supply of energy/for storage of calcium ions that initiates muscle contraction;
- Has a rich network of blood vessels/capillaries for supply of nutrients/oxygen/removal of waste products;
- A muscle fibre is made up of myosin and actin filaments which slide over other to bring about contractions/relaxation of the whole muscle affecting movement;
- Supplied by voluntary nervous system via motor nerves from the brain and spinal cord to convey impulses from central nervous system to muscles; when stimulated it quickly contracts to effect movement in time;
- Numerous myofibrils arranged parallel to another; to increase strength;
- Many neuromuscular junctions throughout muscles; to make contractions more rapid and powerful as fibrils contract simultaneously;
- Have several myoglobin molecules for oxygen storage and release when oxygen levels drop;
- Phosphocreatine to regenerate phosphates required for ATP production;
- Elongated muscle fibres for considerable contraction;
- Parallel fibres for maximum contractile effect;
- Reciprocal muscles to allow antagonistic contraction;

13 X @1mark, Any 7 marks

6. (a) **Isolating mechanisms**; are factors which act as barriers to prevent interbreeding between populations of organisms/demes; this provides the opportunity for each population to evolve along its own lines/gene pool; 02 marks

(b) **Role of isolating mechanisms in speciation (Kent pg 451)**

- Geographical isolation; occurs when organisms are separated from each other by physical barriers; such as a mountain/river/ocean; leading to evolutionary differences that make them fail to interbreed when reunited;

- Seasonal/temporal isolation; occurs when organisms breed/mate or flower at different times of the year;
- Ecological isolation; occurs when organisms live/inhabit different habitats within same are/similar regions but have different habitat preferences;
- Behavioural isolation; occurs when animals exhibit behavioural patterns and mating only results if the courtship display by one sex results in acceptance by the other sex;
- Mechanical isolation; occurs in animals where differences in genetalia prevent successful copulation/in plants related species of flowers are pollinated by different animals;
- Hybrid inviability; hybrids are produced by fail to develop to maturity;
- Hybrid sterility/polyploidy; hybrids fail to produce functional gametes;
- Hybrid breakdown; F1 hybrids are fertile but F2 generation and backcrosses between F1 hybrids and parental stocks fail to develop or are infertile;
- Gametic isolation; gametes maybe prevented from meeting due to genetic or physiological incompatibility between different organisms prevents hybrids forming e.g. in animals the sperm may not survive in the female's reproductive tract/or in plants, the pollen tube fails to grow; the fusion of the gametes may not take place/gametes are incompatible despite sperms reaching the ovum/or the pollen tube entering the micropyle;

20 X@ 1mark, max 18 marks

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