KAMSSA 2022 MOCK BIOLOGY PAPER 2

Question 1

1 (a) Describe the variations of rate photosynthesis in barley and sugar can at 10 $^0$C

**In barley**;

- At 0 arbitrary units of carbon dioxide concentration, the rate of photosynthesis was zero
- As carbon dioxide concentration increased from 0 arbitrary units to 500 arbitrary units, the rate of photosynthesis increased gradually and attained a maximum
- As carbo dioxide concentration increased from 500 to 600 arbitrary units, the rate of photosynthesis remained relatively constant.

**In sugar cane**;

- At 0 arbitrary units of carbon dioxide concentration, the rate of photosynthesis was zero
- As carbon dioxide concentration increased from 0 to 40 arbitrary units, the rate of photosynthesis increased rapidly
- As carbon dioxide concentration increased from 40 to 70 arbitrary units, the rate of photosynthesis increased gradually and attained a maximum
- From 70 to 600 arbitrary units of carbon dioxide concentration, the rate of photosynthesis remained relatively constant

1 (b) Compare the variations of photosynthetic rate of barley and sugarcane at 10 $^0$C

similarities

- Both have the same photosynthetic rate at 250 arbitrary units of carbon dioxide concentration
- Both have the same photosynthetic rate at zero arbitrary units of carbon dioxide concentration
- For both sugar cane and barley, the rate of photosynthesis increased from 0 to 70 arbitrary units of carbon dioxide concentration
- In both, the rate of photosynthesis attains a maximum
- For both, the rate of photosynthesis becomes constant after the maximum

Difference

| Photosynthetic rate in barley | Photosynthetic rate in sugarcane |
|---|---|
| • Increased rapidly from 0 to 70 arbitrary units of carbon dioxide concentration | • Increased gradually from 0to 70 arbitrary units of carbon dioxide concentration |
| • Maximum rate was attained at a lower carbon dioxide concentration | • Maximum rate was attained at a higher carbon dioxide concentration |
| • Has a higher photosynthetic rate from 0 to 250 arbitrary units of carbon dioxide concentration | • Has a lower photosynthetic rate from 0 to 250 arbitrary units of carbon dioxide concentration |
| • Has a lower photosynthetic rate from 250 to 600 arbitrary units of carbon dioxide concentration. | • Has a higher photosynthetic rate from 250 to 600 arbitrary units of carbon dioxide concentration |
| • Attains a lower maximum rate of photosynthesis | • Attains a higher maximum rate of photosynthesis |

1(c) Give a generalized explanation for the trend of the photosynthetic rate shown by the results in the figure above.

- In sugarcane, the photosynthetic rate increased more rapidly than in barley initially because sugar cane is a C4 plant that efficiently fixes carbon dioxide at the low carbon dioxide concentration using phosphoenol pyruvate carboxylase that has a high affinity for carbodiimide and has no oxygenase activity. This prevents photorespiration
- On the other hand, barley, had a lower photosynthetic rate attributed to a lower affinity for carbon dioxide by its enzyme Ribulose 1,5 bisphosphate carboxylase oxidase. Under lower carbon dioxide concentration, this enzyme fixes oxygen, resulting in photo respiration that results into loss of assimilated carbon dioxide
- In both plants, at different temperatures, the rate of photosynthesis towards the maximum because other factors other than carbon dioxide had become limiting.
- After the maximum, the rate of photosynthesis becomes constant in both plants at different temperatures because this is the level at which carbon dioxide ceases to be a limiting factor for photosynthesis
- In sugarcane, the rate of photosynthesis increased more rapidly than in barley at 25$^{o}$C because the carbon dioxide fixing enzyme Phosphoenol pyruvate carboxylase has a higher optimum temperature and fixes more carbon dioxide at lower carbon dioxide concentrations as opposite to Rubulose 1,5 bisphosphate carboxylase that has a lower optimum temperature

1(d) Explain why sugar cane had a higher rate of photosynthesis than barley at 25 $^{0}$C (07 marks)

- Sugar cane a c4 plant can reduce photorespiration due to Ribulose 1,5 bisphosphate and Ribulose 1,5 bisphosphate carboxylase being kept away from air
- Tightly parked bundle sheath cells to minimize exposure to air that could result in photorespiration that could reduce assimilated carbon dioxide
- Enzymes in sugarcane, a C4 plant have a higher optimum temperature
- Phosphoenol pyruvate has a higher affinity for carbon dioxide than Ribulose 1,5 bisphosphate carboxylase
- More carbon dioxide is absorbed by mesophyll cells resulting on carbon dioxide saturation even at lower carbon dioxide concentration
- Carbon dioxide fixed by Phosphoenol pyruvate carboxylase combines with Phosphoenol pyruvate to form oxaloacetate and can not diffuse back to the atmosphere reducing the energy cost of refixing it back

1(e) In a related investigation, the concentrations of carbon dioxide in air at different heights above the ground in a forest were found to vary over a period of 24 hours. Suggest an explanation for this finding. (08 marks)

- Where there is no light such as nat night, the rate of photosynthesis is zero and there is no carbon dioxide uptake by the plant. However respiration still takes place and carbon dioxide is released this increases the concentration of carbon dioxide in the atmosphere during that time.
- As sun light increases and light compensation point is reached and the concentration of carbon dioxide uptake matches the concentrations of carbon dioxide release from respiration.
- Below the forest canopy where light intensity is lower, the rate of carbon dioxide uptake is lower relative to the upper layers as light becomes limiting factor. This makes the concentration of carbon dioxide in the lower layers of the canopy to be higher relative to the upper layers.

1(f)Describe how microorganism in a forest ecosystem make the carbon in a dead available to photosynthetic leaves of trees

- Microorganisms in the soil convert carbon on dead organisms such as dead worm into carbon dioxide gas through the process of decomposition
- Plant leaves absorb this carbon dioxide during Photosynthesis via the stomata
- Microorganism involved in this process include saprophytic fungi such Rhizopus and bacteria such as methylotrophs

$$\underset{\text{Lactate}}{2CH_3CHOHCOO^-} + SO_4^{2-} \xrightarrow{\textit{Desulfovibrio}} \underset{\text{Acetate}}{2CH_3COO^-} + H_2S + 2HCO_3^-$$

## Section B

Question 2

a) Whate is meant by a codon?

A codon is a triplet sequence nitrogenous bases found on messenger RNA (mRNA). They are complementary to the DNA base sequence of the transcribed strand

b) Compare translation and transcription.

Similarities

i. Both occur in a 5'→3'

ii. Both require ATP to take place

Differences

| Translation | transcription |
|---|---|
| • Purpose is to synthesize proteins used in cellular activities | • purpose is to make RNA copies of individual genes that the cell can use in the biochemistry |
| • products are proteins | • the products are mRNA, tRNA and rRNA |
| • occurs in the cytoplasm of the cell | • occurs in the nucleus of the cell |
| • it is initiates when ribosome subunits, initiation factors and tRNA bind the mRNA near the AUG start codon | • initiated when RNA polymerase protein binds to the DNA and forms a transcription initiation complex |
| • elongation occurs when incoming aminoacyl tRNA binds at the A-site and a peptide bond is formed between new amino acid and the growing chain | • elongation occurs when RNA polymerase adds complementary nucleotides in the 5'→3' direction |
| • found in prokaryotes cytoplasm and in eukaryotes' ribosomes on endoplasmic reticulum | • found in prokaryotes' cytoplasm and eukaryotes' nucleus |
| • termination occurs when the ribosome encounters one of the three stop codons | • Termination occurs when RNA transcript and polymerase detaches from DNA |

(c) to describe properties of DNA that:

i. Allow self-replication to take place

- The two sugar-phosphate backbones are antiparallel which enables purine and pyrimidine nitrogen bases to project towards each other for complimentary pairing.
- Long/large molecule for storage of much information.
- Double stranded for replication to occur semi- conservatively/ strands can act as templates
- There is complementary base pairing / A-T and G-C for accurate replication/identical copies can be made
- There are many hydrogen bonds which increase stability of DNA molecule.
- Weak hydrogen bonds enable unzipping /separation of strands to occur readily.

ii. Suggest it is a suitable genetic material.

- consists of many hydrogen bonds that increase stability of the molecule
- sugar-phosphate back bones form a double helix to protect the nitrogen bases in the interior. This prevents distortion of the genes
- sugar-phosphate backbones are antiparallel, enabling purine and pyrimidine bases to project towards each other for complementary base pairing
- very long molecule to store as much genetic information as possible

Question 3

a) What is meaning of artificial selection?

- This refers to elimination of organisms by man that have undesirable characteristics, leaving only those with desirable characteristics which through several generations, may become a new species;
- this is done through increasing the reproductive potential of the desired organism, increasing chances of passing on their alleles to the next generations; while reducing the reproductive potential of the organism with undesirable characteristics;
- artificial selection is done through selective mating, selective propagation or selective pollination; giving rise to hybrids with a high hybrid vigor.

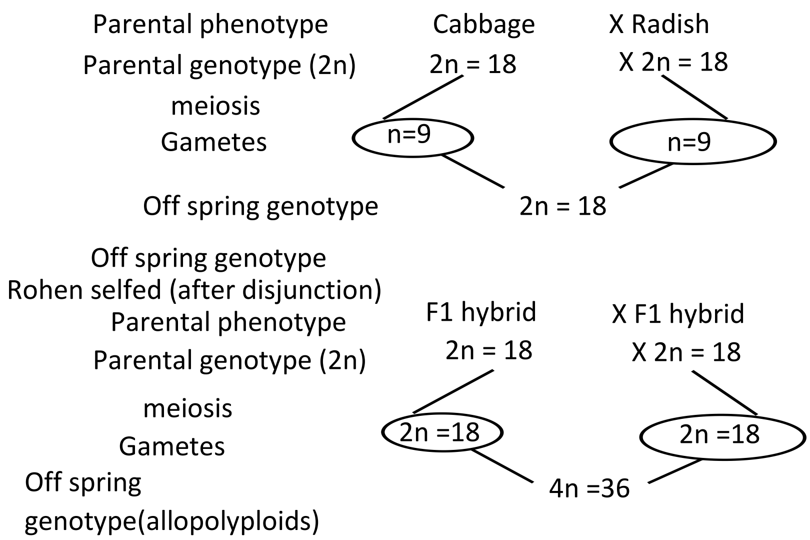
b) Explain how polyplody arises in sexually reproducing organisms

- Polyploidy refers to an accident in meiosis that results in one one or more sets of chromosomes in a cell.

(c)Description using cabbage whose diploid number (2n = 18) and radish whose (2n = 18) and both plants are sexually reproducing

- In the process of hybridization, the f1 off springs are sterile although they possess 2n = 18. This is because the chromosomes are non homologous.
- During gametogenesis in the f1 off springs, there may be a non disjunction of chromosomes during meiosis and each gamete will contain 2n = 18 instead of n=9
- during fertilization each f2 offspring will possess 4n = 36. The f2 off springs are fertile since the chromosomes are homologous hence, are called allopolyploids

Illustration




c)To Describe how polyploidy may lead to speciation.

Speciation refers to the formation of new species from preexisting species

- Interspecific polyploidy which occurs in organisms of the same species; may result into formation of F1 springs having an odd number of chromosomes. This means that this new F1 offspring organism cannot successfully interbreed with any of the parent species, making it a separate species

- Intraspecific polyploidy in citrus plants has resulted into formation of seedless orange varieties such as Valencia. These can only reproduce vegetatively, making it a new species
- Intraspecific polyploidy results into formation sterile off springs that vegetatively for example a cross between Spartima martima and S.alternifola results into formation of S.townsandii, a separate species
- In animals, polyploidy has resulted into formation of a sterile offspring called mule from a cross between a horse and a donkey. This being unable to mate with any of its parent species, makes it a different species hence speciation

Question 4

a) To outline the various ways in which efficiency of receptors is ensured.

- Sensory cells with variable threshold values.
- Transduction
- Precision
- Inhibitory synaptic connections with inhibitory neurons
- summation.and Convergence
- Spontaneous Activity.
- Feedback control of Receptors.

b) To Explain the differences in acuity and sensitivity to light by different parts of the retina.

- Difference in acuity and sensitivity to light by the different parts of the retina depend on the relative distribution of cones and rods in it
- The cones are concentrated in a small area in the centre of the retina called fovea centralis.
- Cones are arranged such that each cell synapses with its bipolar cell, which in turn synapses with its own optic neuron.
- Being closely packed light form two close points on the object can fall on two separate cones so that these can be visualized as separate. Hence, higher visual acuity. Rods are scattered in the periphery of the retina. With a single bipolar cell, in a phenomenon of convergence.
- Due to this convergence, rods are more sensitive to light than the cones; low intensity of light which cannot stimulate a single rod or cone is able to stimulate the bipolar neuron connected to the rods as a result of summation.
- As a result, acuity is greatest at the fovea which is normally at the centre of the field of vision and gradually decreases towards the periphery of the retina which forms edges of our field of vision.

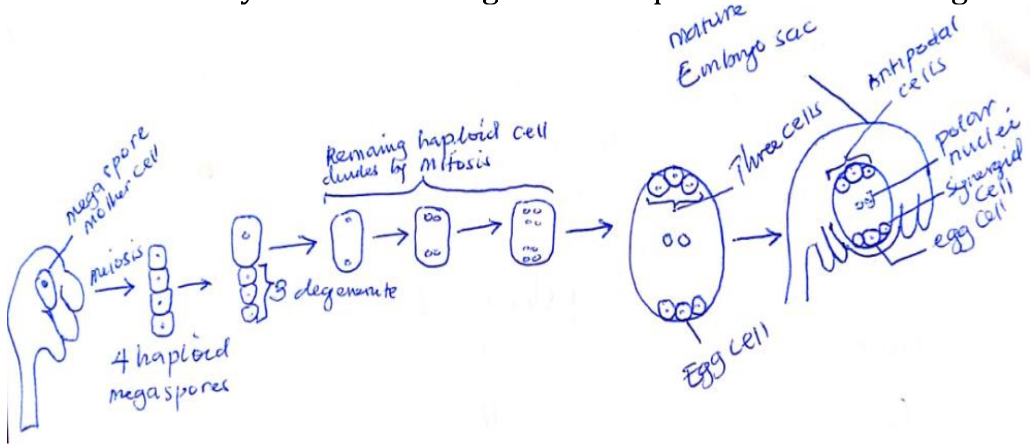
**Question 5**

a) How plants are adapted to reproduction on land? (2 marks each for any explained 5)

- Ability to produce seeds that are
- Protect the embryo from desiccation
- Adapted for dispersal from the parent plant to other areas for colonization
- Contain food reserves in either endosperm for monocots or cotyledons for dicots fo the developing embryo
- Remain dormant and survive adverse conditions
- Sensitive to favorable conditions to germinate
- Being able to undergo parthenocarpy which is the development of fruit without fertilization resulting into a large number of offsprings in a short time
- Vivipary; the continuous growth of offspring when still attached on the parent plant thereby increasing chances of survival of the offspring
- Ability to reproduce vegetatively allows faster colonization of terrestrial habitats
- The fertilized ovule (seed) is retained for some time on the parent plant called sporophyte from which it obtains protection and food before dispersal
- Fertilization is not dependent on water thereby reducing necessity for water inside the sporophyte which is well adapted for terrestrial life

b) To describe how female gametes are formed in dicotyledonous plants

- The female gamete is known as the embryo sac. Formation of the embryo sac takes place in ovary of the carpel. In the ovary, ovules develop.
- Development of an ovule starts as a small bulge of parenchymatous tissue called nucellus which grows out from the placenta on the inside of the ovary wall and the ovule is attached to the placenta by the funicle.
- The ovule is the megaspore. A single large cell called embryo sac mother cell (or megaspore mother cell) divides by meiosis and produces four haploid megaspores, three of which disintegrate and are reabsorbed by the nucellus.
- The fourth enlarges and its nucleus divides by mitosis three more times to produce eight haploid nuclei forming a structure called embryo sac.
- Inside the embryo sac, the nuclei arrange themselves in 2-3-2-3 patten as follows; three at the micropyle end develop cell walls and become separate cells, one is the egg cell and the other two become the synergids
- Three at the opposite end develop cell walls and become the antipodal cells
- The two nuclei remain in the central position and do not become surrounded by cell walls and are called polar nuclei.
- It is the embryo sac at this stage which represents the female gametophyte




Question 6

**a)** What is meant by a food chain (2 marks)

this refers to a linear sequence of energy flow from producers through a series of organisms in which there is repeated eating and being eaten. It may be grazing food chain, which starts with green plants which convert carbon dioxide & water into chemical compounds.

or detritus food chain in which a dead tree log is fed upon by wood lice which are then fed upon by toad and toad is finally fed on by python.

**b)** Explain how energy flows through an ecosystem (8 marks)

- Solar energy is absorbed by autotrophs (producers) such as green plants and fixed into energy containing organic molecules in the process of photosynthesis.
- This energy incorporated into the organic molecules is called gross primary production (GPP). Some of the energy is lost as heat in respiration of the producer so that the amount of energy, called net primary production (NPP) becomes available to the primary consumer
- This energy is then transferred in from organic molecules to primary consumer, then secondary and tertiary consumer through feeding in various food chains and food webs in an ecosystem.
- At each trophic level energy is lost as heat in respiration, through death or decaying of organic matter or undigested waste materials.
- Energy transferred is therefore reduce from producers through to tertiary consumers.
- However, the energy lost from organism through death and decay and through waste materials (egesta and excreta) is not last from the ecosystem. This energy is transferred to

decomposers and detrivores when they feed on dead or decaying organic matter or on the waste materials.

- The energy then flows in the decomposer and detritus food chains, some of which is recycled to some tertiary consumer which feed on decomposers/detritus feeder.
- The rest of the energy is completely lost from ecosystem as heat in respiration of decomposers and detrivores.

**c)** How does temperature influences the distribution of organisms

- Different animal species require different optimum temperatures for their reproductive stages (breeding). Thus, temperatures impose a restriction on the distribution of species-based reproduction preference.
- Animals like camel that are tolerant to high temperature can survive in deserts whiles others cannot, so live in cooler places
- Endotherms such mammals and bird that maintain their body temperatures, have wide distribution in different environment condition compared to ectoderm such as reptiles that cannot regulate their body temperature.
- Temperature also influences the geographical distribution of animals through its effect on plants as primary producers in a food chains. The ecological range of most animal species, except insects, birds and mammals which are able to migrate, is determined by the local availability of food.
- Temperate plants are distributed in cool regions whose temperature do not usually exceed $25^0$C while plants such as xerophytes that can withstand higher temperatures are more abundant in the tropics and deserts where temperatures are usually above $25^0$C.
- C4 plants have a wide distribution range in hot climatic regions because, they are more efficient at fixing carbon dioxide at high temperatures. On the other hand, C3 plants, which fix carbon dioxide more efficiently at lower temperature, are more abundant in cooler climatic regions.
- some aquatic plants can withstand very high temperatures and can thrive in hot springs while those that can with stand very low temperatures thrive in snow. The biggest percentage of plants survive in moderate temperatures which support their metabolic activities.

END