UACE Biology 2006 paper 2 (guide)

Section A

1. Figures 1, 2 and 3 show the immigration and extinction of species on different categories of Virgin Islands.

   Figure 1 shows the rate of immigration of new species on an island nearby the shore and one that is far from the shore.

   Figure 2 shows the rate of extinction of species on a large island and on a small island. Figure 3 shows the rate of immigration and extinction of species on an island. Study the information and use it to answer the questions that follow.

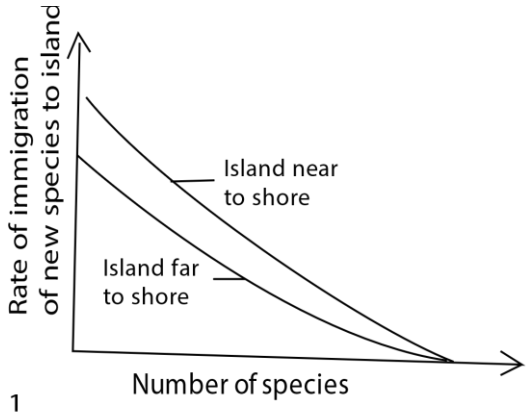

Fig. 1

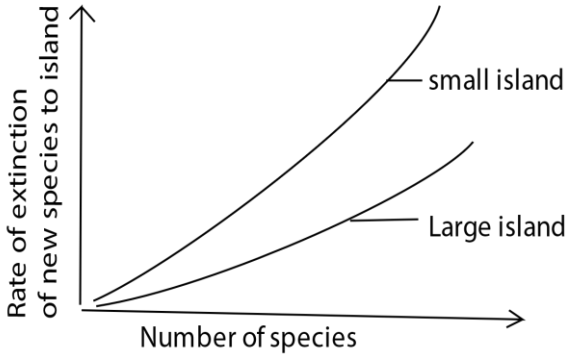

Fig. 2

(a) Explain the rate of

(i) Immigration of new species on an island that is near to the shore and one that from the shore (figure 1). (10)

- At first almost every organism arriving on the island is a new species, so the rate of immigration for the island is high.
- As the number of species on the island increases, many of the organisms arriving are already present so the rate of immigration decreases.
- As the number of species on the islands increase, competition, diseases, predators increase and discourage immigration of other species
- An island near to the shore is reached easily than that which is far away, so immigration rate is higher on the island near the shore than that far away.
- For an island far away from the shore, few species are able to reach it; and the rate of immigration is much lower, even at the beginning of colonization

(ii) Extinction of species on a small island and on a large island (figure 2) (09)

- The rate of extinction of organisms from smaller and large island increases exponentially with increase in the number of species on the island. However, this occurs at a higher rate on a small island than from a large island.
- As the number of species increase on the island completion for resources such as food and shelter, diseases, predators increase wiping out some species that are less adapted species.
- The rate of extinction on Small Island is higher due few available resources such as shelter and food and thus completions are steeper. Secondly diseases spread faster and pollution increases faster.

(iii) Immigration and extinction of species on an island, (figure 3) (07)

- When the number of species on the island is small, the rate of immigration exceeds the rate of extinction
- As the number of species rises, the immigration rate falls but the extinction rate rises due to competition for resources, development of diseases, stresses; eventually the rate of immigration is equal the rate of extinction at equilibrium and when the number of species increase above this point, extinction rate also increases.

(b) From figures 1, 2 and 3 what conclusions can you draw about what determines the number of species on an island? *(05)*

- Size of the island.
- Distance of the island from the shore.
- Rate of immigration of organisms to the island.
- Rate of extinction of organisms from the island.
- Number of species on the island
- Interspecific competition

(c) Describe how factors other than those depicted in the information provided, may affect immigration of new species on an island. (04

- Predation; presence of predators on the island discourage immigration of prey organisms to an island while presence of prey encourage immigration of predators to the island and vice versa.
- Species mobility; species that are capable of flying or swimming are in position to inhabit islands event far from the shore and also to run away from predators or to search for food. All this may determine the immigration rate of such species on an island.
- Environmental conditions such as light, temperature, wind on the island, organisms move to and from places depending on the suitability of their at a time. When the conditions on an island are favorable, organisms immigrate to it in large numbers and vice versa.
- Accidental introduction of new species; immigration of new species of organisms an island can also occur by chance.
- Evolution (mutation) can increase number of species without the requirement of immigration which will make it hard for new species to colonize successfully

(d) Suggest the factors that would cause immigration of new species to a virgin island. (05

- Availability of food on the island.
- Favorable environmental conditions on the island.
- Accidental movement of organisms to the island. For example flying and swimming organisms may be introduced on the wind or water wave respectively.
- Distance of the island from the shore.
- Fleeing from overpopulation in the cradle land.

- Natural disaster
- Running away from predators
- Climate change
- Change in biological rhythms
- Availability of breeding sites
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SECTION B

2. (a) Describe the physiological changes that occur in a seed during germination (10 marks)

- Germination starts with the rapid uptake of water by the seed through the micropyle by a process called ambition. Water then moves from cell by osmosis.
- The water causes swelling of the embryonic tissue thereby rapturing the seed coat and also activates gibberellins.
- Gibberellins diffuse to the aleurone layer whereby they cause the synthesis and activation of hydrolytic enzymes such as amylase and proteases.
- Amylase catalyzes the breakdown of starch to glucose while proteases catalyze hydrolysis of proteins to amino acids.
- Glucose and amino acids are translocated from the storage centre (endosperm or cotyledon) of the seed to the growing regions of the embryo.
- Here glucose is used in respiration and in the formation of cellulose and other cell wall materials. Amino acids are used to make proteins, which are enzymes and structural components of protoplasm.

(b) Giving reasons, suggest suitable conditions under which seeds for planting should be stored (06 marks)

- dry condition; too much water may cause rotting
- dry seeds; seed with high content promotes diseases
- optimum temperature; high temperature promotes pests and diseases
- low humidity; high humidity promotes pests and diseases

(c). Even when supplied with suitable conditions for germination, some seeds remain dormant, explain the importance of dormancy in seeds. (04 marks)

- Dormancy allows for seed dispersal.

- Seeds are able to survive unfavorable conditions like drought.
- Dormancy prevents seeds from germination in the pods.
- The low metabolic rate during dormancy enables seeds to stay viable for a long time.
- Prevents the seeds from germinating in fruit ponds
- Allow for internal changes to occur, an after ripening period so that the embryo mature
- Allow for the quantity of water and growth inhibitors in the embryo to reduce

3. (a) Describe the adaptations of blood in terrestrial animals living in the following environmental conditions

(i) Extreme oxygen tensions (08 marks)

Extremes of oxygen tension can the very high or very low values of oxygen partial pressure. In all these conditions, the blood of terrestrial animals must be adapted to deliver adequate oxygen efficiently to the tissues.

At high oxygen partial pressure,

- The hemoglobin concentration in blood is lower but adequate, since enough oxygen is always available to the mammal.
- The number of red blood cells is also lower.

At low oxygen tensions;

- The volume of blood is higher in order to increase the amount of oxygen carried to the tissues in a unit time.
- The hemoglobin concentration of blood increases. This increases the oxygen carrying of the blood.
- The number of red blood cells increases in order to increase the oxygen carrying capacity of blood.
- The hemoglobin/respiratory pigment has a high affinity for oxygen so as to pick up a lot of oxygen.

(ii) High altitudes (04 marks)

At high altitude the oxygen tension is very low. Thus, the adaptations of blood are the same as those for the mammal at a low oxygen tension.

- The hemoglobin concentration of blood increases. This increases the oxygen carrying capacity of the blood.
- The number of red blood cells increases in order to increase the oxygen carrying capacity of the blood.
- The hemoglobin/respiratory pigment has a high affinity for oxygen so as to pick up a lot of oxygen.

(b) Explain how each of the following affects the dissociation of hemoglobin in the mammalian blood, suggesting in each case, the physiological advantage of the effect.

(i) Increased body temperature (04 marks)

Increased body temperature shifts the oxygen dissociation curve to the right. This is because the bond hemoglobin and oxygen is thermal liable and breaks easily at high temperatures.

Physiological advantage.

At a higher temperature the metabolic rate is high and thus producing a lot of carbon dioxide is produce. Shift of the dissociation curve to the right makes hemoglobin to release oxygen to the tissue and easily pick up the carbon dioxide produce.

(ii) Small body size (04 marks)

(a) Small body size shifts the oxygen dissociation curve to the right

Physiological advantage.

Smaller organisms have a large surface area to volume ratio and thus are bound to lose more heat from the body surface. To counter this, they have a high metabolic rate which requires continuous supply of oxygen. The required oxygen is then readily supplied by the hemoglobin of lower affinity.

4. (a) Explain the factors that influence the type of nitrogenous waste excreted by animals (16marks)

- Availability of water; animals in fresh water bodies have enough water available for dissolving any water products. They are able to dilute and excrete ammonia. For animals in terrestrial habitats, where acquisition of water is a problem, the nitrogen nous waters produced are less soluble. Animals excrete urea while insects which take in less water excrete uric acid.
- Solubility of nitrogen wastes; aquatic animals excrete more water-soluble ammonia while those in terrestrial habitat excrete less soluble urea or uric acid depending on the amount of water available to them. Terrestrial animals that are able to drink water excrete urea while those that depend on metabolic water such as insects excrete the insoluble uric acid
- Toxicity of the waste products; animals excrete nitrogenous waste with toxicity that either can be withstood by their tissues or that can easily be detoxified in the body. In most terrestrial animals, ammonia is very toxic. It is first converted to urea in the body by combining it with carbon dioxide. Urea is less toxic and can safely be excreted from the body without harming the body tissues. Freshwater animals however, excrete the toxic ammonia because they have enough water available for its dilution before excretion. Insect excrete uric acid which is least toxic.
- Animal body size; all organisms with big surface area to volume ratio excrete nitrogenous wastes that are more soluble in water and therefore can easily diffuse out through the body surface. For example, amoeba and other unicellular animals excrete ammonia. For large organisms, with small surface area to volume ratio, the other factors determine the nature of nitrogenous wastes excreted
- Production of enzymes necessary to convert ammonia to either uric acid and/or urea
  Higher animals such as birds and mammals possess these enzymes and can excrete uric acid in birds and mainly urea in mammals

(b) Describe osmoregulation in a terrestrial insect. (04marks)

Water must be carefully conserved since most terrestrial insects are unable to drink and depend on metabolic water

- During excretion, the urine passes from the Malpighian tubules into the ileum and is mixed with feces with which it is then excreted via the rectum. In the rectum, the rectal glands absorb all the water into the body and uric acid is then excreted in solid from. The water deficit is made up by metabolic water.
- The salt fraction is regulated by the Malpighian tubules. In the proximal half, sodium and potassium ions are extracted from the blood, but carefully returned in the distal half with precipitation of uric acid. The uric acid passes in the urine to the ileum for excretion via rectum.

5. (a) Compare DNA and RNA molecules

Similarities between DNA and RNA

- Both contain purines adenine and guanine and the pyrimidine base cytosine
- Both contain phosphate groups.
- They both have a basic sugar- phosphate backbone in their chains
- Both contain polynucleotide chains.

Differences between DNA and RNA

DNA	RNA
• Double stranded structure. • Found only in the nucleus. • The sugar molecule is deoxyribose. • Contains a pyrimidine base thymine • Giant molecules with very high molecular weight • Has hydrogen bonds in its structure	• Single stranded structure • Found in both nucleus and cytoplasm • Found both sugar molecular is ribose • Contains a pyrimidine base uracil • Short, small with low molecular weight • Has no hydrogen bonds in its structure

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(b) Describe the role of mRNA in the protein synthesis in a cell.

mRNA caries genetic information in form of nitrogenous bases from chromosomal DNA in the nucleus to the ribosomal RNA in the in the cytoplasm. It acts as a template

for protein synthesis. It has complementary DNA base sequence to part of DNA from which it is transcribed. As a result, mRNA directs the synthesis of proteins as directed by the base sequence on the segment of DNA from it is copied, a process called translation

(c) How does the molecular structure of proteins relate to their functions?

Solution:

(a) According to molecular structure, proteins can be classified as follows in relation to function;

- Fibrous proteins from a long, tough, fibre insoluble in water. They therefore function as structural and supporting proteins and include; keratin, collagen, elastin, e.t.c
- Globular proteins have a globular shape but lack contractile properties. They contain polypeptide chains coiled about them. They therefore act as regulatory molecules and as food storage molecules in plants. Soluble globular proteins are amphipathic and therefore act as buffers of body fluid pH.
- Conjugated proteins consist of a simple protein united with some non-protein substance. Examples include; glycoproteins which form mucin of saliva that helps in softening food; chromo proteins combined with a pigment such as hemoglobin, an oxygen carrying molecule; metallo-proteins which act as enzymes.

6. Discuss how structure and function are related for each of the following tissues

(a) Voluntary muscle tissue

- Voluntary muscle tissues in animals act as a component of the locomotory apparatus. They are usually attached to bone, a strategic for to be involved in locomotion
- Each muscle fibre consists of numerous fibres containing numerous, long cylindrical, unbranched and elastic myofibrils.
  This allows the muscle to exert a wide range of influence when it contracts. The elasticity also allows it to regains its original length after stretching.
- The myofibrils are arranged parallel to one another. This allows them to slide over one another during contraction and relaxation.

- Each muscle fibre has intimate connection with the motor portion of the voluntary nervous system. This enable it to respond to actions of this section of the nervous system in response to changes in the environment.
- The muscle has a dense network of blood capillaries. This ensures efficient supply of oxygen and nutrient to, and removal of waste product of respiration from, the muscle. This improves efficiency of the muscle.
- Muscle fibre is surrounded by T-tubule that facilitates potential propagation.
- The muscle contains myoglobin instead of haemoglobin in the blood. Myoglobin has a higher affinity for oxygen than haemoglobin. This ensures that enough oxygen is provided to muscle even at low oxygen tensions of the blood flowing through the muscle.
- The fluid bathing the myofibrils contains numerous glycogen granules and mitochondria. This ensures that enough energy, in form of ATP, is always available to the muscle for use in contraction.

(b) Parenchyma tissue in plants

- Parenchyma tissue is an aggregate of living isodiametric calls which forms the background tissues. It is the major component of stems of non-woody plants.
- In the peripheral region of green plants, certain parenchyma cells contain chloroplast and called collenchyma. Here it takes part in the manufacture of food by the plants.
- Parenchyma's have a cellulose cell wall that allows passage of water during water transport.
- The inelasticity of cellulose provides support to the plant when the parenchyma is rigid.
- In many aquatic plants and petioles of some land plants, parenchyma cells develop large intercellular species called aerenchyma. This provides buoyancy and help in floating. It also allows for gaseous exchange.
- Parenchyma cells have an inelastic cellulose wall such that when they elongate and become turgid after absorption of water, the parenchyma is rigid, this makes the stems turgid and offer support to non-woody plants.
- Succulent parenchyma found in xerophytes has large stores of water and functions as water storages tissue.