UACE biology 2013 paper 2 marking guide

SECTION A

1. In experiment was carried out to investigate the rate of respiration of yeast cells mixed with three different carbohydrates (glucose, sucrose and lactose), using methylene blue as an indicator (methylene blue is in alkaline condition and colorless in acidic condition).

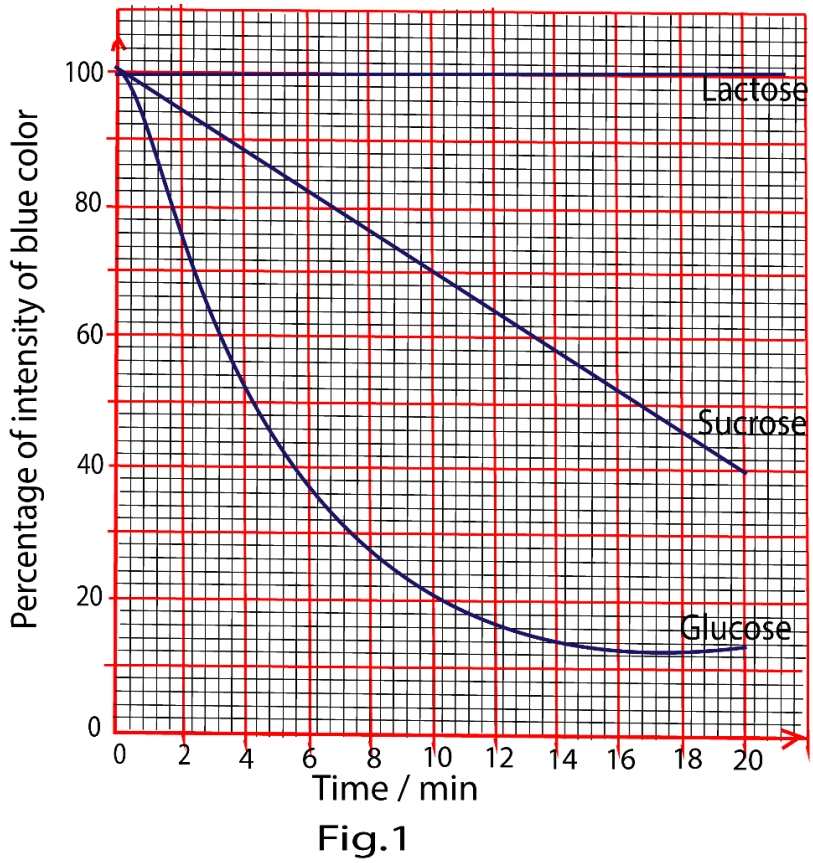

Fig.1

1cm^3 of 0.1m methylene blue was added to a mixture of 5 cm^3 of a suspension of yeast in 10 cm^3 of 0.5% glucose solution in a boiling tube. The boiling tube was placed in a water bath at 30^{0}C for 20 minutes. The rate of respiration was measured as a percentage of the intensity at the blue colour at the beginning of the experiment, at intervals of 2 minutes. The experiment was repeated using 0.5% sucrose and lactose. The results are shown in figure 1. Study the figure and answer the questions that follow.

(a) Calculate the average rate of respiration of yeast in glucose solution during the first four minutes in terms of percentage intensity of the blue colour.

$$\text{Rate of respiration} = \frac{\text{change in percentage intensity of blue colour}}{\text{time taken}}$$

$$= \frac{100-52}{4}$$

$$= \frac{48}{4}$$

Rate of respiration = 12%per minute

Hence the average rate of respiration of yeast in glucose solution during the first four minutes is 12% per minute

(b) Describe the change in the intensity of the blue colour with time, for each carbohydrate.

- Initially, the percentage intensity of blue colour is 100% for all carbohydrates.

  Lactose
- The percentage intensity of blue colour remains the same throughout the time of the experiment.

  Sucrose
- The percentage intensity of blue decreases gradually and linearly with time

  Glucose
- The percentage intensity of blue colour decreases rapidly up to the 8^{th} minute. It then decreases gradually up to the 18^{th} minute after which it remains more or less constant up to the end of the experiment.

(c) Explain the relationship described in (b) for each carbohydrate.

(i) Lactose

Intensity of the blue color remained constant because yeast does not contain specific enzyme /lactase required to hydrolyze lactose. Therefore carbon dioxide was not produced since respiration did not occur and methylene blue remained unoxidized and hence the color did not change

(ii) Sucrose

Sucrose is gradually hydrolyzed by sucrase enzyme found in yeast to fructose and glucose. These are respired to produce energy and carbon dioxide. The gradual decrease in intensity of color is due to gradual hydrolysis of sucrose and eventual respiration of simple sugars to produce carbon dioxide

(iii) Glucose.

Glucose is readily metabolized by yeast enzymes to produce carbon dioxide that lower the pH of solution rapidly reducing the intensity of blue color.

(d) Suggest what would happen to the colour for glucose and sucrose if the experiment continued for 10 more minutes. Give an explanation in each case.

The solution may turn colorless due production of carbon dioxide the lower pH or a pale blue color would persist due to depletion of substrate or due to caesation of further metabolism of glucose because yeast enzymes are poisoned by accumulation of alcohol.

The colour for sucrose would eventually reduce in intensity at a decreasing rate until it becomes constant.

- This is because sucrose would continue to decrease in the medium until it is depleted
- Also, the accumulation of alcohol in the medium would eventually inhibit the action of the enzymes of the yeast cells.

(e) Explain why the boiling tubes were

(i) Kept covered during the experiment.

– to prevent the escape of the carbon dioxide produced during process of yeast reparation.

– To prevent entry of oxygen into the reaction medium. This would lead to rapid aerobic breakdown of the food substrates.

(ii) Placed in a water bath at 30^0C

– to maintain the temperature at a value optimum for the functioning of the yeast enzymes. This is important in order to ensure that only the investigated variables are investigated.

SECTION B

2. (a) Explain how each of the following features contributes to the survival of mammals in cold habitats.

i. Body size.

Mammals in cold habitats usually have a large body size as a result of extra fat deposits under the skin.

- The big size reduces the surface area to volume ratio and therefore reduces the rate of heat loss from their bodies across the surfaces.
- The fat deposits under the skin insulates and prevents heat loss to the environment.

ii. Body extremities.

Mammals in cold habitats usually have body extremities greatly reduced in size with reduced blood supply to them. This greatly reduces heat loss through them since the amount of body heat reaching them is minimized and surface area is reduced.

(b) Describe how a camel is able t overcome the following challenges in its habitat.

i. Water stress.

- It has tissues which are tolerant to desiccation. As such, it can go for as long as two months without drinking water.
- It makes use of metabolic water. The fat in its hump is believed to suit this purpose. Fat metabolism produces a lot of water which the camel uses in conditions of water stress.
- It has long loops of Henle in its kidneys so that it reabsorbs most of the water from its glomerular filtrate and produces concentrated urine
- It has scanty glomeruli and therefore has a very low glomerular filtration rate so that very little water is filtered from its blood into the glomerular filtrate
- It has a waterproof integument, the skin which reduces loss of water from the radiation and convection and not by evaporation as it is in other animals.

ii. Heat stress.

- Possession of tissues which are tolerant to wide ranges of temperature.
- The camel stores heat in its tissues during day when temperature are very high and then loses it during the night by radiation, conduction and convection and not evaporation, when temperatures are low
- During the day, the camel behaves like an actothermic animals, allowing its temperature to get close to those of the environment. This reduces the temperature difference between the hot air of the desert and its body so that the rate of heat gain from the surrounding is reduced.
- The fur that the camels skin acts as an efficient insulating barrier by reducing heat gain and loss by convection and conduction.
- Has light color to reflect heat and reduce heat absorption
- Long legs increase surface to enable heat loss

3. (a) What is the ecological impact of each of the following human activities?

(i) Use of pesticides.

- They are nonspecific and may kill other unintended organisms. This reduces the biodiversity of ecosystems.
- Most pesticides are persistent. They accumulate along the food chain and may eventually kill/ damage other unintended organisms at higher trophic levels, including man
- Predators of the organisms targeted by the pesticide may be deprived of their only source of food and therefore upset the food chain.
- Use of broad-spectrum pesticides can lead to pest resurgence after the period of treatment because some pests become resistant yet the pesticide kills the pest and its predator
- Pesticides pollute air, water and soil.
- May lead to resistance and resurgence of pests

(ii) Use of artificial fertilizers.

- Fertilizers applied to crop plants are lost in surface run-off water and pollute soil and water resources.

- Increase in crop yield.
- Decrease in nutrient content in the soil.
- Decrease in the number of microorganisms in the soil such as saprophytic bacteria.
- Nitrogen and phosphate-based fertilizers leach into ground water and increase its toxicity leading to water pollution.
- They change the chemical composition of soil.

(iii) Over fishing

- Extinction of some species of fish.
- Reduction of the population of adult reproductive fish, leaving a population of mainly young individuals because fish are caught as soon as they reach catchable size.
- It may lead to rapid increase in the numbers of fish prey organisms.
- May lead to reduction or even extinction of some aquatic fish predator organisms which may then encroach on terrestrial habitats near water bodies. For example, crocodiles may start hunting terrestrial animals that come close to the water bodies including man.
- Disruption of aquatic food webs.

(b) Describe the advantages of using biological pest control over pesticides in an ecosystem.

- It is highly specific and only affects the organisms intended.
- It is non-toxic
- Does not cause environnemental pollution.
- Organisms used are biodegradable and do not persist in the environment for a long time.
- It is cheap in terms of cost and time.

4. (a) Giving an example in each case, explain how large surface; volume ratio, has been achieved n organisms, for exchange of gases and food materials.

For exchange of gases, a large area to volume ratio has been achieved in the following ways among different organisms.

- Use of the cell surface membrane for gaseous exchange in unicellular organisms such as amoeba. Such organisms naturally have a large area to volume ratio because of their small

size so that diffusion across the cell surface membrane can suffice their respiratory needs.

- In mammals, the respiratory surface is thrown into numerous spherical folds, called alveoli. These greatly increase the surface area over which exchange of gases can occur.
- In aquatic organisms such as fish, the respiratory surface is formed of highly folded lamellate structures called gills. This also increases the surface area over which gaseous exchange can take place.
- In insects, a highly branched system to tubes, called trachea ramifies through all the body tissues so as to increase the surface area over which gaseous exchange between the tissues and the respiratory surface
- In plants, leaves are numerous, flattened and bear numerous pores, called stomata, in their epidermis. This greatly increases the surface area over which gaseous exchange can take place.
- Tadpole have got external gills to increase surface area for gaseous exchange.

For absorption of food materials, a large surface area to volume ratio has been achieved in the following ways in different organisms.

- In planarian worms, the gut gives off numerous blind-ending branches which ramify throughout the body, penetrating into the tissues. Digested food is forced into these branches by muscular action and is thus conveyed to the cells.
- In mammals, such as man, the small intestine (the site of food absorption) is highly elongated and the absorptive surface is thrown into finger like-folds called villi. On the surface of the absorptive cells, the membrane is further highly folded into microvilli. As a result, a large area is presented for the absorption of digested food products.

(b) Explain the importance of changes in turgidity to plants.

When cells gain turgidity:

- Increase in turgor pressure leads cell enlargement which causes growth of cells and the entire plant.
- Increase in turgidity of parenchyma cells provides mechanical support to non-woody plants and non-woody parts of woody plants.

- Opening and closure of stomata is regulated by changes in the turgidity of the guard cells. When their turgidity is high, the stomata open, otherwise they close. Loss of cell turgor in plant leaves that occurs in conditions of water stress closes the stomata and folds up the leaves (wilting). This helps to reduce the effects of water stress on the plant.
- Cause testa of seeds to rapture for emergence of radical/plumule
- Enable fly trap an insectivorous plant to open so as to catch prey

When plant cell lose turgidity

- Stomata close and transpiration reduces
- Cause wilting and drooping of plant
- Cause fly trap to close so as to trap the prey

5. (a) Describe the relationship between organisms in the lichen.

   Lichen is an association between a fungus and green algae. The fungus forms the outer covering that protects the algae in the interior of the lichen.

   The fungus also provides the algae with water and inorganic nutrients and anchorage. In return, the algae photosynthesize and provide the fungus with organic nutrients and oxygen.

   (b) Compare mutualism and parasitism

(a) Similarities

- Both are close association between two living organisms of different species.
- In both, one organism is smaller and lives in or on the larger organism.
- In both, the smaller organism may be aerobic or anaerobic.
- Both organisms tend to be specific to each other

Differences.

Mutualism	Parasitism
• Both organisms benefit • No organisms is harmed • Produces nutrients important to other organisms in nature • Usually important in nutrient recycling in nature. • Does not require secondary host	• Only one organism (the parasite) benefits • The host suffers harm form the parasite. • Does not produce any useful nutrients in the environment. • No important in nutrient recycling. • May require secondary host

(c) Explain how termites are able to feed on wood.

Termite's breakup the wood into tiny pieces using their sharp and strong mandibles which they swallow easily. On reaching the crop, protozoa in the crop ingest the swallowed food by phagocytosis. The secrete cellulose into their food vacuoles, thereby digesting the cellulose in the termites' diet.

Some soluble products of digestion such as glucose diffuse out of the protozoa and are absorbed by the termite.

6. (a) How does each of the following explain the movement of water and mineral salts up the xylem?

(i) Cohesion and tension theory.

Evaporation of water from the cells of the leaves is responsible for raising water from the roots.

Evaporation results in reduced water potential in the cells next to the xylem in the leaves. Water therefore enters these cells from xylem sap which has a higher water potential, passing through the moist cellulose walls of the xylem vessels at the ends of the veins.

Xylem vessels are full of water and, as water leaves them, a tension is set up in the column of water. This is transmitted back down the stem all the way to the roots by cohesion of water

molecules. They also tend to stick to the vessel walls by a force called adhesion. The high cohesion of water molecules means that the water column has a high tensile strength.

The tension in the xylem vessels builds up a force capable of pulling the whole water column upwards by mass flow and water enters the base of the columns in the roots from neighboring root cells.

(ii) Root pressure

Accumulation of water in the roots by osmosis creates hydrostatic pressure that pushes water up the plant through the xylem. Root pressure occurs because mineral salts actively pumped into the root xylem causing absorption of water

(b) Describe the characteristics of the open and closed circulatory systems.

- Both systems have a circulatory fluid, the blood which flows in a particular direction together with its dissolved and suspended materials.
- Both systems have a contractile, pumping device, the heart, to propel the blood around the body in a given direction.

In open circulatory systems;

- Blood flows freely within the body cavity (haemocoel) or in sinuses located within organs and therefore bathes the body tissues.
- Blood flows slowly and at a low pressure throughout the system
- Blood has no respiratory pigment
- There little control and regulation of flow and distribution

In closed circulatory systems;

- Blood is confined to blood vessels through which it flows throughout its movement in the body and never comes in direct contact with the body tissues.
- Have valves to prevent backflow of the blood.
- The blood has a respiratory pigment that transports respiratory gases.
- Blood flows at a higher speed and higher pressure.
- There is muscular pump

- Flow is regulated