UACE Biology 2014 paper 2

SECTION A

1. Heat losses (-) and gains (+) were monitored recorded, of a naked human being at varying environment temperature. The heat losses and gains by the internal body environment (body core), heat losses and gains by the skin surface as a result of radiation and convection and also heat losses as a result of evaporation, with varying environment temperature, are shown in figure 1

Study the figure and answer the questions that follow.

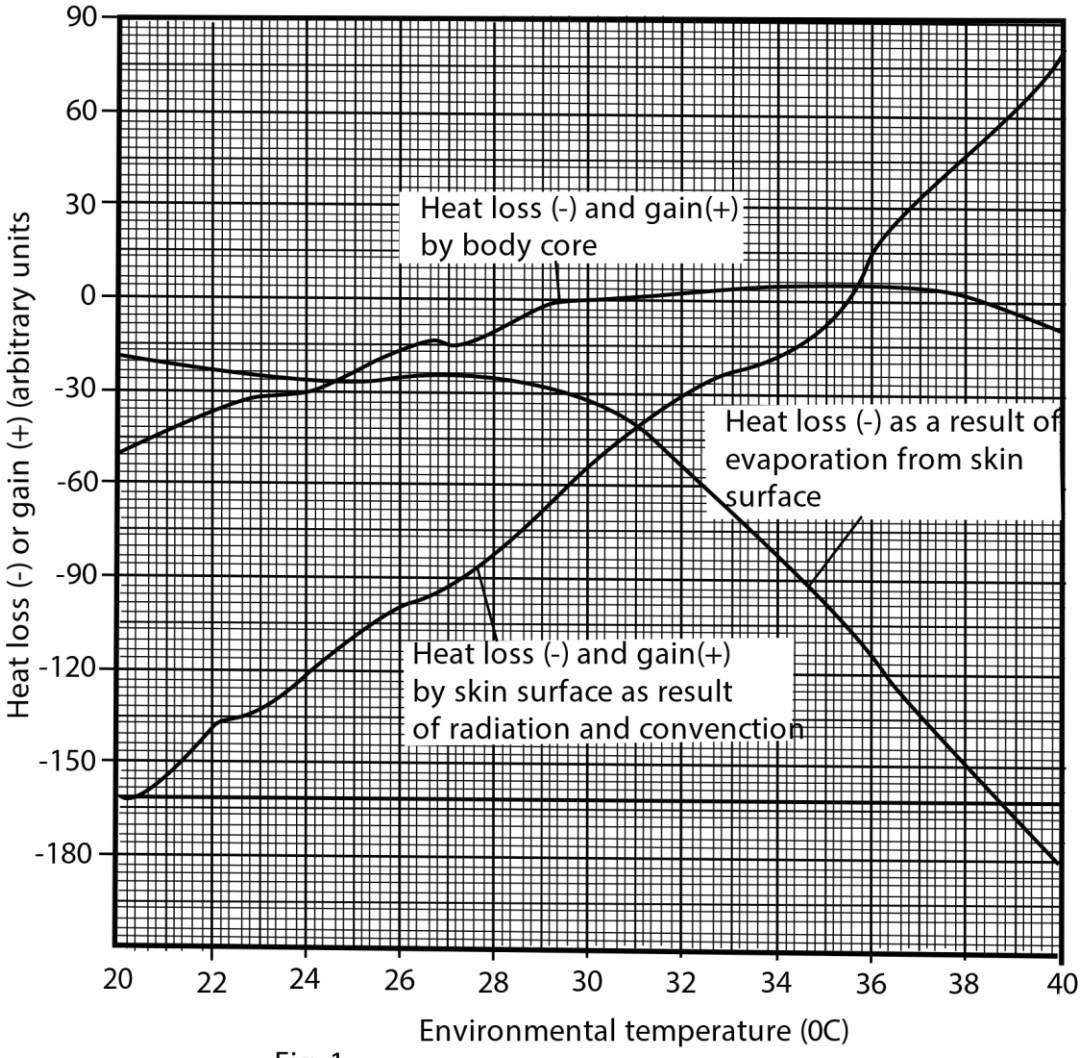

Fig. 1

(a) Describe the relationship between the heat loss and gain by the skin surface as a result of radiation and convection and heat loss as a result of evaporation from the skin.

At 20^0C, heat by radiation and convection is much higher (162 units) than that due to evaporation from the skin (18units)

Between 20-27^0, heat loss by evaporation from the skin increases gradually while loss through radiation and convection decreases rapidly.

Between 27-28.8 ^{0}C, loss through evaporation is constant while loss through radiation and convection continues to reduce.

Between 28.8 -31^0C, evaporation loss begins to increase more rapidly to equal to the due

to radiation and convection by 31^0 C.

From 31 -40^0C, loss through evaporation increases very rapidly while that through radiation and convection decreases more gradually to zero at 35.0^0C and then the body starts gaining heat through radiation and convection rapidly up to 40^0C.

(b) How does the relationship in (a) affect the losses and gains heat by the body core?

At 20^0C, the body core is losing heat at a rate of 51units.
Heat loss decreases gradually from 20^0C until it reaches zero at 30^0C
From 30 -33^0C, the body core gains heat gradually and then at a constant rate between 34^0C and 37.4^0C.
Between 37.4 -40^0C, the body loses heat gradually.

(c) Explain the trend of heat losses and gains by the

(i) Skin surface as result of radiation and convection

At 20 ^{0}C, the body is at a much higher temperature than surrounding and so the temperature gradient is high, favoring loss of heat from the body surface mainly by radiation convection.

As environment temperature increases, the temperature gradient reduce so that heat loss through radiation and convection reduces.
Between 32 -35.4^0C, the temperature gradient is so small that heat loss through radiation and convection reduces more gradually until it reaches zero at 35.4^0C.

Between 35.4 -40^0C, now the temperature gradient reverses so that environment temperature becomes higher than body temperature. As a result, the body starts to gain heat by radiation and convection from the environment.

(ii) Skin surface as a result of evaporation

At 20^0C, external temperature is very low compared to the normal human body temperature. As a result, the skin surface blood vessels constrict to reduce blood flow to the skin and also the rate of sweating is greatly reduced by the thermoregulatory Centre. As such, loss of heat by evaporation from the skin surface is low.

At the same time, the erector muscles and skin surface hairs are standing on end. This traps a layer of air close the surface, which on top of being insulator, also traps vapour close to the skin

As a result, the rate of evaporation from the skin surface is very low.

As temperature increases, between 20 -27^0C, the vapour trapped in the hairs evaporates and also the rate of blood flow to the skin improves and therefore heat loss by evaporation increases gradually.

(iii) Body core.

Heat loss from body core occurs by a combination of radiation, convection, evaporation and conduction however, the body has regulatory mechanisms that resist subtle changes in core body temperature.

At 20^0C, body is losing heat by a combination of evaporation, radiation and convection. However, much of the heat is lost through radiation and convection.

To resist subtle drop in core body temperature, metabolic rate of the body core increase and the individual starts to shiver. These activates generate heat within the body core to make up for the losses from the body surface.

As a response to low core body temperature, the hypothalamus triggers a reduction in sweat production, reduction in blood flow to the skin surface and contraction of the erector pili muscles so that the surface hairs stand on end.

All these events reduce heat loss from the body core from the body core until is it

zero at 30^0C

As environment temperature comes close to the core body temperature remains constant for the range 34.8 – 37.4^0C

Above 37.4^0C, events are reversed in order to prevent subtle increases in core body temperature.

The erector muscles relax so that the surface hairs lie flat on the skin surface, trapping no air between them.

Blood flow to the skin surface is increased and

Sweating increases so that heat loss from the body surface by evaporation increases greatly.

Metabolic heat production and shivering stop.

The end result is that the body core starts to lose heat to the environment from 38-40^oC in order to give off the excess heat and maintain a constant body temperature

(d) What is the importance of maintaining body temperature in animals?

Temperature must be maintained at a value optimum for the action of enzymes upon which the organized functioning of cells depends.

Enzymes are protein in nature. If temperature s rise above a certain critical valve, they are denatured.

On the other hand, very low temperature inactivates the enzymes, thereby slowing down metabolic activities.

SECTION B

2 (a) Describe the significance of physical properties of water to organism.

- Water has low viscosity; this allows for easy flow of water and easy transport of aquatic organisms
- Water is transparent; this allows penetration of light for photosynthesis and visibility
- Water has high surface tension that allows movement of animals on the surface of water and ascending of water through the xylem.
- Water has high latent heat of vaporization; this allows cooling of organisms when sweat evaporates. It also prevents drying aquatic habitat during hot climate
- Water has high latent heat of fusion; this prevent freezing of aquatic habitat during cold climate
- Water has high specific heat capacity which prevent temperature rise or fall in an organism during hot or cold weather respectively
- Water molecules have adhesive and cohesive forces; these create enough capillarity force for transport I narrow tubes of biological systems..
- Water is a good solvent; it enables biological reactions and transport
- Water is incompressible hence it is used in hydrostatic skeleton in lower animals such as earthworms.

(b) Explain why lipids are better storage material in animals than carbohydrates

- They are insoluble in water so can be stored without being lost in solution
- They have a high calorific valve and therefore store a large amount of energy in a small space than carbohydrates.
- They are highly compacted and store more energy in a relatively small space compared to carbohydrates.
- They have high hydrogen but low oxygen content and so can yield a lot of energy and water on oxidation.
- They are lighter in weight than carbohydrates so keep the weight of the organism lower even with large energy deposits.

- They are relatively inert compared to carbohydrates do that they are kept unaltered over a long time.

3 (a) Describe the hormonal interaction in the human female from conception to birth

After fertilization, the fertilized egg becomes implanted in the uterine wall and pregnancy results.

The cells of the forming placenta produce the hormone, human chorionic gonadotrophin (HCG) which preserve the corpus luteum. Corpus luteum continues to secrete progesterone which, together with a small steady secretion of oestrogen from the ovary, maintains the continued development of the uterus and prevents miscarriages.

Progesterone and oestrogen also inhibit the anterior pituitary so that it stops producing FSH. This prevents any further follicles from developing during pregnancy.

After the first three or four months of pregnancy, the corpus luteum begins to disintegrate and the placenta takes over the job secreting progesterone and oestrogen.
Progesterone and oestrogen stimulate the increase in the size of the breast during pregnancy due to development of mammary glands.
Oestrogen makes the uterine walls more sensitive to the effects of oxytocin. Oxytocin causes the smooth muscles of the uterus to contract
Progesterone and oestrogen inhibit the secretion of prolactin and therefore formation of milk.
The decrease in progesterone after birth allows prolactin to stimulate the alveoli to secrete milk

(b) Suggest possible cases of infertility in humans.

Causes of female infertility include:

- Failure to ovulate so that there is so egg to be fertilized
- Damage to the oviducts, causing tubal blockage. As such, the ovum cannot move to the site of fertilization for the ovary.

- Uterine damage due to events such as uterine fibroids and cancer. The uterus becomes unable to maintain a pregnancy.
- Damage to the cervix, especially as a result of unsafe abortions. The cervix becomes unable to maintain the pregnancy up to birth and most pregnancies end in later miscarriages or premature deliveries.
- Hormonal disorders such as hypopituitarism and hypogonadism.
- Antibodies against sperm so that all he husband's sperm cells are rejected

Causes of male infertility includes:

- Impotence
- Low sperm count
- Absence of sperm cells in the ejaculated semen (azoospermia)
- Abnormal sperm morphology.
- Abnormal sperm motility.
- Hypogonadism
- Antibodies against the man's own sperms (autoimmunity)

4. (a) Distinguish between plasmolysis and wilting

Plasmolysis is the separation of cell's protoplast from the cell wall as a result of water loss by osmosis.
Wilting is the loss of rigidity of non-woody parts of plant. It is characterized by drooped leaves due to excessive transpiration.

Plasmolysis cannot occur naturally while wilting is a natural protective process.

b) How are xerophyes adapted to survive water shortages?
Xerophytes live in dry condition such as the desert. These plants run the risk of drastic dehydration and must avoid this happing in order to survive. They are adapted to surviving draught in the following ways;

- They have shiny leaf surfaces to reflect much of the incident light rays to avoid overheating.
- They have thick cuticle impermeable to water. This reduces water loss from the plant surfaces.
- Some have leaves reduced into spikes to reduce water loss.
- Some have reduced total number of stomata and are succulent to conserve water for the plant.
- In some Xerophytes, the stomata open at night and close during day to reduce water loss during day.
- Some plants produce spore and others seeds, which withstand the dry conditions and help the plant to survive the long dry periods.
- Most xerophytes reproduce by vegetative propagation, reducing the need for favorable conditions from germination.
- They have tissues tolerant to desiccation.
- Some have stomata sunken into a hairy leaf surface to reduce water loss by transpiration.
- They develop a deep extensive root system to exploit as much area as possible for water absorption.
- Some shed their leaves occasionally to reduce water loss.
- Some have short life cycle that avoid draughts.
- Some species of plants roll their leaves with the lower surface inside during dry conditions. This reduces water loss through transpiration.

5. (a) what is meant by genetic drift?

Genetic drift is a change in the genetic makeup of a population which occurs by chance (random) events. It is common mainly in small isolated populations or when few individuals mate. It usually causes alteration in the frequency of small populations, by chance.

(b) How can the genetic equilibrium of a population be upset?

- When there is non-random mating; this increases the likelihood of some alleles in the population especially as a result of sexual selection. Individual with certain characteristics become more likely than others to mate and successfully fertilize their

gametes. Alleles held such individuals will increase in the population while the others will reduce.

- When population size is small, leading to genetic drift; in this case, changes in allele frequencies occur simply by chance. For example, it is possible for chance events such as accidental premature death prior to mating of an organism which is the sole possessor of a particular allele to result in the elimination of that allele in the population. Also it is possible for the frequency of an allele to increase population, simply by chance.
- When gene flow occurs between populations; gene flow may occur in close populations as a result of interbreeding between members of the two populations. The random introduction of new alleles into the recipient population and their removal from the donor population affects the allele frequency of both population and leads to increased genetic variation.

- When genotypes are not equally fertile so that there is a genetic load. Harmful recessive alleles usually exist in heterozygous genotypes as the genetic load of a population. Through harmful in homozygous state, they may be carried in the heterozygous genotype and confer selective advantage on the phenotype in certain environmental conditions so that they are more favored.

(c). Explain how humans influence the evolution of species.

- Through artificial selection

  Human beings are able to select and allow breeding of animals or plants with characteristics at the expense of others. This may lead to emergence of bred animals or plants with the desired characteristics and extinction of the others.

- Through pollution

  Pollutants such as pesticides and industrial chemicals act as a selection pressure on the survival of organisms in the environment. Organisms often develop characteristics which allow them to survive the pollution. As a result, a new strain of organisms may arise.

- Through genetic engineering

  Man has developed a number of techniques through which he may introduce new allelesinto population of organisms. Such organisms usually exhibit characteristics which make them better adapted to the environment than the others an therefore selected for.

- Through man-made major environmental disruptions.

  Fire outbreaks, over grazing, over fishing, swamp reclamation and bomb blasts may lead to death of organisms which are sole possessor of certain genes in the population leading to their extinction. On the other hand, some organism may develop characteristic that allow them to withstand these stresses and therefore survive and reproduce leading to evolution of a new strain of organisms.

6. (a) Distinguish between a bacterium and a plant.

bacterium	Plant
Unicellular organism	Multicellular organism
Nuclear membrane absent	Nuclear membrane present in all cells
DNA is circular and lies free in the cytoplasm	DNA is linear and contained in a nucleus
Membrane bound organelles absent	Membrane bound organelles present
DNA is naked	DNA is associated with proteins to form chromosomes.
Ribosomes are smaller (70S	Ribosomes are larger (80S)
Ribosomes lie free in the cytoplasm	Ribosomes may be attached to

	endoplasmic reticulum
Mitochondria absent. Respiration carried out by mesosomes	Mitochondria are responsible for aerobic respiration
When present, cell wall is the non-cellulose type, composed of amino sugars and muramic acid.	The cell wall is composed of cellulose

(b) Explain the ecological significance of the nutritional types of bacteria

- Chemo-heterotrophic bacteria use chemical substance obtained externally as their source of food and energy. They are of vital ecological importance depending on their activities in the ecosystem as illustrated;
- Saprophytic bacteria; these derive organic materials from dead decaying organic matter. Examples include, putrefying bacteria. These bacteria are the main organisms to decay. They decompose dead bodies of plants and animals and covert their complex compounds into simpler substances which are taken up by green plants for the synthesis of new complex organic compounds, in this way, these bacteria help in the cycling of matter which would otherwise have been lost from the ecosystem.
- Symbiotic bacteria; several bacteria are found in nature in symbiotic relationship with man and other animals. Cellulose-producing bacteria in the gut of wood-eating ants offer the best example. In exchange for shelter provided by the ants, these bacteria help to produce cellulose enzyme that helps these organisms to utilize cellulose in their diet. As a result, they help in recycling of nutrients locked in the cellulose of wood. Also the bacterium, rhizobium, fixes nitrogen in a symbiotic association with roots of leguminous plants such as peas and beans. This increases the nitrate content of the soil and can be utilized by organisms in the ecosystem.
- Parasitic bacteria; these are important in causing disease to organisms in the ecosystem. Examples include; cocci and bacilli. By causing disease, they may lead to death of some non-resistant organisms in the ecosystem leading to population regulation and reducing

competition for resources in the ecosystem.

- Chemo autotrophic bacteria are more commonly known as chemosynthetic bacteria. They use carbon dioxide as the source of carbon but obtain their energy from chemical reactions. Examples include nitrifying bacteria (nitrosomonas, nitrococcus and nitrobacter), iron bacteria, hydrogen bacteria etc. they enrich the soil with nitrogen through their oxidative reactions.
- Photo autotrophic bacteria are also referred to as photosynthetic bacteria. They use sun light energy as their source of energy and carbon dioxide as the source of carbon. They are important in introducing oxygen to the atmosphere and also providing organic materials for heterotrophic micro-organisms in the environment.

(c). Explain how a leguminous plant and the bacteria in its nodules benefit from their relationship.

- The roots of leguminous plants often have nodules in which are numerous rhizobium bacteria. The two organisms live together in mutualistic relations, i.e., both organisms benefit and none is harmed.
- The leguminous plant provides water, shelter, protection and nutrients (organic and inorganic) to the bacteria.
- The rhizobium bacteria have the ability of fixing nitrogen, in the form of nitrates into the soil from the atmosphere. The nitrates are absorbed and utilized by the leguminous plant.