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A PROPOSED GUIDE TO ACEITEKA - BIOLOGY P2 - 2023

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Section A

1 (a) Note: The Question Paper is attached.

Describe the changes in the renal plasma ratio of each solute in different parts of the nephron (09 marks)

(i) Urea

> In the proximal Convoluted tubule, the renal plasma ratio increases gradually with distance towards the Loop of Henle.

> In the loop of Henle, the renal plasma ratio increases rapidly in the first half and later increases gradually in the second half.

> In the distal Convoluted tubule, the renal plasma ratio increases gradually.

> In the collecting duct, the renal plasma ratio increases gradually.

(ii) Too. Glucose

> In the proximal Convoluted tubule, the renal plasma ratio decreases rapidly.

(iii) Sodium and potassium ions

> In the proximal Convoluted tubule, the renal plasma ratio remains constant.

> In the loop of Henle, the renal plasma ratio increases gradually in the first half and later decreases rapidly in the second half.

In the distal Convoluted tubule, renal plasma ratio for K^+ increases rapidly ✓ and for Na^+, renal plasma ratio increases gradually ✓.

In the collecting duct, the renal plasma ratio for K^+ increases rapidly and for Na^+ increases gradually ✓.

Max 09 marks

(b) Explain the changes, described above (10 Marks)

Definition of Renal plasma ratio - Refers to ratio of the Concentration of substance in the renal fluid / tubular fluid to the Concentration of the same substance in the plasma.

(i) for urea:

In the proximal Convoluted tubule, the renal plasma ratio increases gradual due to reabsorption of Na^+, glucose, water, amino acids, which raised the Concentration of urea in the renal fluid and reduce in plasma. ✓

In the First half

In the Loop of Henle, renal plasma ratio of Urea increases rapidly due to reabsorption of water by osmosis into the plasma as the wall of the tubule being permeable to water, increasing the Concentration of urea in renal fluid and reduce in plasma.

As renal fluid continue to flow in the second half of the loop of Henle, the renal plasma ratio increases gradually, due to reabsorption of Sodium ions (Na^+), K^+, and Cl^- by simple diffusion down Concentration gradient and later by active transport using energy from hydrolysis of ATP. therefore and no water reabsorption, hence gradual increase, as urea accumulates less in the tubule.

In the distal Convoluted tubel and Collecting duct

Renal plasma ratio increases gradually, this because there is gradual osmotic reabsorption of water down osmotic gradiet and also under the influence of ADH (Anti-diuretic hormone) which increases the permeability of the walls of the Collecting duct and distal Convoluted tubule to water increasing H_2O reabsorption: increasing urea Concentration in the renal fluid than in plasma. However in some circumstances; there is Na^+ reabsorption from the distal Convoluted tubule into the branches of efferent arteriole under the influence of Aldosterone hormone.

Max 06 marks

For Glucose:

In the proximal Convoluted tubule, renal plasma ratio decreases rapidly due to rapid reabsorption of glucose by the Cells of proximal convoluted tubule by active transport using energy from hydrosis of ATP and by Simple diffusion down Concentration gradiet

Max 04 marks

For Na^+ and K^+.

In the proximal Convoluted tubule, the renal plasma ratio for Na^+ and K^+ remains Constant because there is reabsorption of Na^+ and K^+ by Active transport using energy from hydrolysis of ATP and also by Simple diffusion down Concentration gradient, At the same there is Secretion of Na^+ and K^+ from the plasma into the distal nephrone tubules, making the Concentration of both ions to be relatively the same equal in the plasma.

Ok

In the loop of Henle; "In the first half" to speak

The renal plasma ratio of Na^+ and K^+ increases gradually; this is because as renal fluid flows ~~over~~ across the descending loop of henle, there is water reabsorption by osmosis down osmotic gradient since this wall is permeable to only water. increasing the Concentration of both ions more in renal fluid than in plasma.

As the renal fluid continue to flow in the second half of the loop of henle, the renal plasma ratio of both ions decreases rapidly due to reabsorption of Na^+ and K^+ ions by simple diffusion down Concentration gradient through the thin ascending loop of Henle, and later re-absorbed by active transport ~~the~~ through thick ascending loop of henle using energy from hydrosis of ATP.

MaX 06 marks

In the distal Convoluted tubule and Collecting ducts,

As the renal fluid flow ~~the~~ through the distal Convoluted tubule and Collecting duct, renal plasma ratio increases; this is due to water reabsorption by osmosis down osmotic gradient and also under the influence of the ~~hormone Anti diuretic~~ ADH which increases the permeability of their walls towards water increasing the Concentration of Na^+ and K^+ in ~~than~~ renal fluid than in plasma.

UACE
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(c) Application of phlorizin chemical

(c) Renal plasma ratio for glucose in the proximal convoluted tubule would increase, due to failure of cells to reabsorb glucose into the plasma by active transport and, simple diffusion and facilitated diffusion.

In the loop of henle, renal plasma ratio would continue to increase because there is no glucose reabsorption and their is water reabsorption by osmosis down osmotic gradient since the tubule is permeable to water.

(d) Using Figure 2

(a) Compare the concentration of solutes in presence and absence of ADH

~~Similarities~~ Similarities for both in presence of ADH and absence of ADH.

In both, the Concentration of Solutes remains Constant in the first Convoluted tubule (proximal convoluted tubule)

In both, the Concentration of Solute attained a peak in the loop of Henle.

In both, the Concentration of Solute increases rapidly in the first half of loop of Henle.

In both, the ~~Conc~~ Concentration of Solute decreases rapidly in the second half of the loop of Henle.

In both, the Concentration of Solutes decreases in the second Convoluted tubule (distal convoluted)

Differences.

Concentration of Solutes in presence of ADH	Concentration of Solute in absence of ADH
Generally higher along the nephrone tubule	Generally lower along the nephrone tubule
– Attained a higher peak in the loop of henle	Attained a higher peak in the loop of henle
– Increases rapidly in the Collecting duct	Decreases slightly / remains almost constant in the Collecting duct
– Increases within the last second convulated tubule	Decreases within the last second convulated tubule

Any 0.3 mark
Max 0.3 marks

(ci) Explain the differences in the Concentration of the fluid in the nephron in different parts in Presence of ADH and absence of ADH

Concentration of Solutes in presence of ADH increases in the last part of the distal convoluted tubule and also in the Collecting duct while Concentration of Solutes in absence of ADH decreases in the last part of the dist Convoluted tubule and remains almost Constant in the Collecting duct ✓

This is because; In presence of ADH increases the permeability of the walls of the distal Convoluted tubule and Collecting duct to water, this increased permeability allows water to move out of the renal fluid into the tissue fluid by osmosis down osmotic gradient. As more water is reabsorbed from the nephrone back into the blood stream, the Concentration of Solutes remaining in the tubules increases leading to higher Solute Concentration. However in absence of ADH, ~~As~~ there is less water reabsorption hence lower Solute Concentration.

Max 5 Marks

(cii) Role of the Vasa recta in H_2O Conservation.

The Vasa recta are a network of specialized blood vessels that run alongside the loop of Henle in the renal medulla. ✓

It's looped arrangement is important because it ensures that, by simple Counter Current exchange, the incoming blood gets first saltier as it passes down into the medulla and then less salty as it leaves for the Cortex. This allows the tissues of the Medulla to retain their high Salt Concentration;

The higher Salt Concentration of tissues in the medulla of kidney creates a Concentration gradient between the tissue fluid and renal fluid allowing more water

reabsorbed from by osmosis from urine So that water losses can be minimised.

Section B

2. Explain how Tilapia overcome their osmoregulatory challenges in a fresh water Tilapia (Latee)

NO 2

Osmoregulatory Challenges of (fresh water teleost)

They experience osmotic influx of water into their body tissues hence dilution of their body tissues across their surface of gill being permeable to water. this movement of water occurs down osmotic pressure gradient, as their Internal osmotic pressure (OPi) is higher than external osmotic pressure (OPe); NB OPi > OPe

This Consequently may result into bursting of tissues, and finally death.

They overcome, the above osmoregulatory challenges by

(i) They get rid of excess water by excreting highly soluble and toxic ammonia; whose elimination from the body leads to a large water loss.

(ii) Their numerous nephrons have numerous and large glomeruli, which offer a large surfice area for high rate of glomerular filtration, thereby producing large volumes of highly diluted urine

(iii) They extensively reabsorb a large amount of salts from the kidney tubules into the blood capillaries by both diffusion and active transport

(iv) They use their chloride secretory cells of the gills to actively pump salts from the external medium into the body.

A+ X 10 Marks

No 2 (b)

Describe the elimination of nitrogenous wastes from the insects body (10 marks)

Insects excrete uric acid.

Insects excrete uric acid which is non-toxic and insoluble in water that it's elimination from the body doesn't lead to the water loss.

When cells produce uric acid, it diffuses into the Coelomic Cavity, or haemolymph and reacts with potassium bicarbonate and water to form potassium urate and Carbon dioxide.

The potassium urate is actively pumped into the lumen of malpighian tubule, Carbon dioxide diffuses into the tubule while water enter the tubule by osmosis.

- Inside the tubule potassium urate reacts with Carbon dioxide and water to form uric acid, potassium bicarbonate and water.
- Potassium bicarbonate is actively pumped into the Coelomic cavity, water is reabsorbed by osmosis while uric acid is deposited in the tubule lumen.
- As uric acid moves from the distal to the proximal end of the malpighian tubule, water is vigorously taken back into blood ~~into back~~ into in the haemocoel, causing a fall in the pH of the lumen of the tubule.

This fall in pH causes the uric acid to form crystals, in which state it is passed into the hindgut and mixed with feaces. The crystalline uric acid moves out of body via the cloaca.

Max 10 marks

3 (a) outline the adaptation of transfer cells (05 marks)

- Numerous Mitochondria for synthesis of large amount of energy required for active loading and unloading of sugars into sieve tubes and from the sieve tubes. ✓
- Numerous proton pumps in their membranes for active pumping of protons from their cytoplasm into mesophyll cells using energy from hydrolysis of ATP. ✓
- Numerous symporter carriers that transport protons H+ together with sugars into ther cytoplasm from mesophyll cells by facilitated diffusion. ✓
- Numerous plasmodesmata for passage of sugars from their cytoplasm into the sieve tubes at the source and from the sieve tubes into their cytoplasm at the sink. ✓
- Numerous cell membrane and cell wall highly folded to increase surface area for rapid uptake of sugars from mesophyll cells. ✓

Max 05 marks

(b) Describe the mechanism of Stomatal closure basing on proton ion's changes (15 marks)

(b) At night, the stomata close, because there is no light, thus ATPase enzyme is not activated, and no ATp produced, therefore no active transport is taking place, Potassium ions diffuses out of the guard cells, into the neighbouring epidermal cells down concentration gradient. This raises the osmotic pressure of the epidermal cells, forcing water to move out of the guard cells into the epidermal cells by osmosis, making the guard cells to become flaccid and the Stomata close.

Max 10 marks

Alternatively

At night the Stomata close, Carbon dioxide accumulates since no photosynthesis, which reacts with water to form Carbon acid, which dissociates to form protons/hydrogen ions and lowers the PH. This activates the enzymatic Conversion of Sugars into starch which is osmotically inactive, in the guard cells. This raises the water potential of the guard cells, therefore they is Osmotic efflux of water into the neighbouring epidermal cells, which makes the guard cells to become flaccid and the Stomata close.

Max 10 marks

(c) Mention three kleakness and two evidences of the photosynthetic theory of stomatal movements (05 marks)

Kleakness

~~Stomatal pace~~ use ⇒ Stomata of CAM plants open at night and close during day. ✓

⇒ The rate of stomatal opening is higher than the rate of sugars accumulation during photosynthesis. ✓

⇒ Patches of variegated leaves without chlorophyll have their stomata opening and closing ✓

⇒ Cannot explain ~~with out~~ without Stomatal Movement in guard cells chloroplasts. ✓

Any 03

Max 03 marks

Evidences

⇒ Presence of chloroplasts in the guard cells indicate that they photosynthesize.

⇒ The Concentration of sugars in the guard cells being higher during day.

⇒ Guard cells are more rigid during day than at night

Any 02

Max 02 Marks

Notes Describe the Functioning of ecdysone hormone (06 mks)

Ecdysone diffuses into the cytoplasm of its target cells; mainly the epidermal cells across the cell membrane; and attach on the receptor sites to form the ecdysone receptor site complex; The complex moves from the cytoplasm into the nucleus; via the nuclear pore. Ecdysone activates the gene; to provide the DNA ~~temp~~ template strand for assembling of mRNA; which move from the nucleus to the cytoplasm via the nuclear pore.

Messenger RNA attaches on the ribosome and codes for the synthesis of proteins including enzymes used for breakdown of the old cuticle and for synthesis of an adult new cuticle.

Max of marks

b) Describe hormonal control of spermatogenesis in human testes. (10 marks)

- Interaction of hormones; from the hypothalamus and anterior pituitary gland working together to control spermatogenesis.
- From the hypothalamus; gonadotropin-releasing hormone (GnRH) stimulate the anterior pituitary gland to secrete two gonadotrophins (gonad stimulating hormones) ie Follicle stimulating hormone (FSH) and luteinising hormone (LH)
- FSH stimulates spermatogenesis by causing Sertoli cells to complete the development of spermatozoa from spermatids (spermatids)
- FSH also causes Sertoli cells to release a peptide hormone inhibin that specifically inhibits FSH secretion.
- LH stimulates the leydig cells of the testes to secrete testosterone.
- ~~Testerone~~ Testosterone stimulates the growth and development of germinal epithelial cells (spermatogonia) to form sperm.

MAX 10 marks

(c) What is the role of the dartos muscle (2marks)

In the scrotum, the dartos muscles works to regulate the temperature of the testicles; which promote spermatogenesis. It does this by contracting during cold temperatures reducing surface area available for heat loss, thus reducing heat loss and warming the testicles. Also they relax thereby lowering the testes from the body causing excess heat to be removed.

Max 02 marks

5(a) Describe the main summer seasonal changes in a deep temperate lake (10 marks)

In summer there is seasonal thermal water stratification; whereby the water body is divided into 3 layers of varying temperatures which include the warm oxygen rich circulating layer of water at the surface called epilimnion, separated from the bottom cold oxygen poor hypolimnion layer; by a broad zone of rapid temperature change called thermocline.

The thermocline prevents diffusion of epilimnion oxygen to the hypolimnion layer; because the warm ~~epithe~~ epilimnion water is less denser than the hypolimnion water (layer); it floats at the surface without sinking.

The epilimnion water is supplied with warm stream and river water enriched with nutrients, due to high temperature and dissolved nutrients; excessive production of phytoplanktons in epilimnion; occurs which when dead; sink to the hypolimnion and their decomposition into nutrients consumes up large amount of oxygen by the decomposers;

This results into anoxic condition and death of some aerobic aquatic organisms;

Max 10 marks

b) Compare oligotropic and eutrophic lakes.
(10 marks)

Similarities:
- Both have nutrients ✓
- Both are productive ✓
- Both have dissolved oxygen.
- Both may possess algal bloom
- Both possess different species of organisms. ✓

Differences

Eutrophic lakes	oligotrophic Lakes
Have excessive nutrients	Have low nutrient level ✓
Have low oxygen levels	Have high oxygen ~~Content~~ levels
Are shallow	Are deep ✓
Highly turbid	less turbid ✓
Have a high biochemical oxygen demand	Have a low BOD ✓
Have Frequent alga bloom	Have rare algal blooms ✓
Have high animal production	Have low animal production
- Have a shorter life span	Have a longer life span ✓
- Have high rate of sedimentation	Have low rates of sedimentation.

Max 05 marks

6 (a) What is Meant by the following terms

(i) ~~Poly pot~~ Polyploidy (03 marks)

Polyploidy is a genetic Condition Characterized by having extra sets of chromosomes in an organisms Cell. The Cell is therefore no longer diploid (2n), but can be triploid (3n), if there are three (3) sets, ~~tetra p~~ tetraploid (4n), if there are four sets.

The extra set of chromosomes may arise from member of the same species (autoploidy) or from Members of different species (alloploidy)

MaX 03 marks

(ii) Artifical selection (04 marks)

Artificial selection refers to the human intervention to ensure that only organism with desired characteristics are made to breed and pass on their genes to successive generations while those with undesired characteristics are denied chance to pass on their undesired characteristics to the next generation. The main aspects of artificial selection is selective breeding.

MaX 04 marks.

b) Explain how polyploidy arise in sexually reproducing plants (05 marks)

Mitotic Chromosomal non-disjunction; secondary to failure of spindle fibre formation which is either natural or artificially induced by Colchicine; Somatic doubling of the chromosomes occurs; self-fertilization of these forms a tetraploid.

Non disjunction of the sex Chromosomes leads to gametic non-reduction during meiosis. ~~Un reduced characteristics are~~ Unreduced 2n gametes are formed. Fusion of these gametes forms polyploids.

Polyspermy; In which the female gamete is fertilized by more than one male gamete.

Endo - duplication; DNA replication but with failed cytokinesis. Fusion of such cells forms polyploids ✓

Max 05 marks)

(c) Describe how polyploidy and Artificial Selection lead to formation of new species

Polyploids have higher hybrid vigor than normal diploids do, therefore they exhibit greater resistance to pests and diseases, have greater hardness, greater drought resistance, early maturity, increased size and yield. Polyploids thus possess more selective advantage able to overcome several selection pressures than the normal diploids. Polyploidy with an even number are fertile breed to pass on their genes to the next generation, their numbers increase and over successive generations become the majority of population eventually forming new species.

Max 05 marks)

Artificial selection.

Artificially selected organisms being with superior genes possess advantageous characteristics; outcompete those with inferior genes. Therefore they thus breed to pass on their genes to the next generation; their numbers increase and over successive generations, become the majority of the population eventually forming new species. Those with undesired characteristics being denied chance to pass on their inferior genes get eliminated.

max 04 marks)

P530/2
Biology
Paper 2
June/July 2023
2½ Hours

ACEITEKA JOINT MOCK EXAMINATIONS 2023

UGANDA ADVANCED CERTIFICATE OF EDUCATION

BIOLOGY PAPER 2

(Theory)

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 questions carefully, organize their answers and present them precisely and logically, illustrating with well labeled diagrams wherever necessary.

Section A (40 Marks)

1. **Figure 1** below shows changes in renal plasma ratio of individual solutes in different parts of the nephron. **In figure 2,** curve A shows changes in the concentration of solutes on administering **Antidiuretic hormone (ADH)** while **curve B** shows changes in concentration of the solutes in **absence of ADH.**

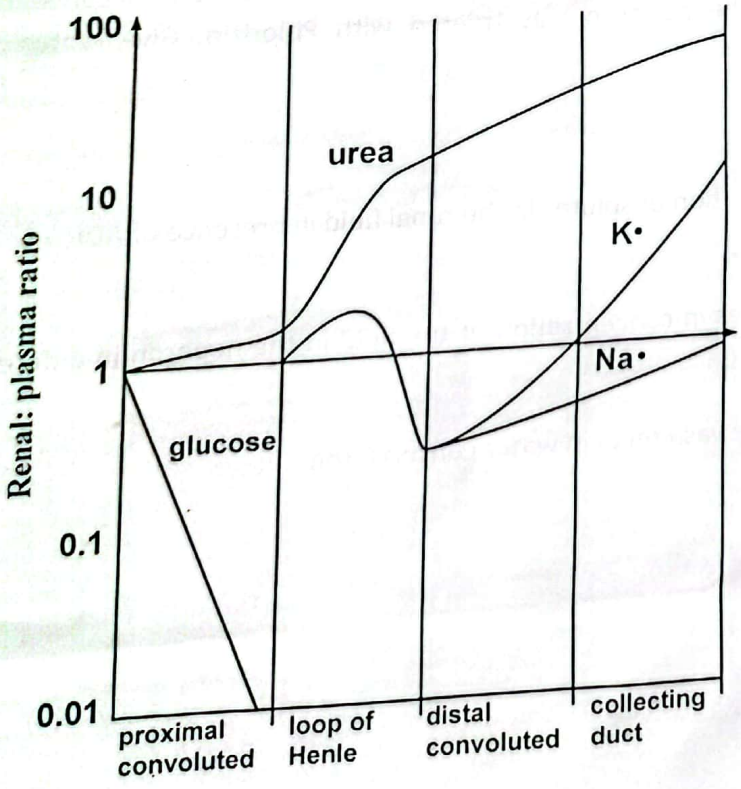

Figure 1

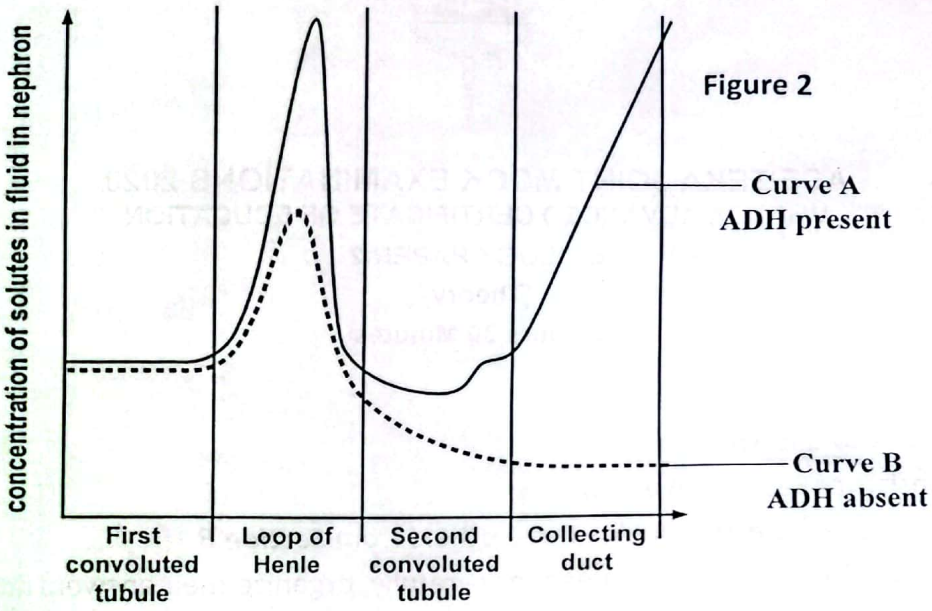

Figure 2

a) Describe the changes in the renal plasma ratio of each solute in different parts of the nephron **(09 marks)**

b) Explain the changes you have describe in a) above **(10 marks)**

c) Phlorizin is a chemical which makes the wall of the tubules impermeable to glucose. Predict how the renal plasma ratio would change for glucose within the proximal convoluted tubule and loop of Henle if the nephron was treated with Phlorizin. Give reasons for your answer. **(04 marks)**

d) **Using Figure 2,**

i) Compare the concentration of solutes in the renal fluid in presence of ADH and in absence of ADH. **(06 marks)**

ii) Explain the differences in concentration of the fluid in the nephron in different parts in presence of ADH and absence of ADH **(07 marks)**

iii) Explain the role of the vasa recta in water conservation **(04 marks)**

Section B (60 Marks)

2. a) Explain how Tilapia overcome their osmoregulatory challenges in a fresh water lake like Lake Victoria. **(05marks)**

b) Describe elimination of nitrogenous wastes from the insect's body. **(10marks)**

3. a) Outline the adaptations of transfer cells. **(05marks)**

b) Describe the mechanism of stomatal closure basing on proton ions' changes. **(10marks)**

c) Mention three weaknesses and two evidences of the photosynthetic theory of stomatal movements. **(05marks)**

4. a) Describe the functioning of ecdysone hormone. **(06 marks)**

b) Describe hormonal control of spermatogenesis in human testes. **(10 marks)**

c) What is the role of the dartos muscles? **(04 marks)**

5. a) Describe the main summer season changes in a deep temperate lake. **(10 marks)**

b) Compare oligotropic and eutrophic lakes. **(10 marks)**

6. a) What is meant by the following terms? **(03 marks)**

i) Polyploidy **(04 marks)**

ii) Artificial selection **(05 marks)**

b) Explain how polyploidy arises in sexually reproducing plants. **(08 marks)**

c) Describe how polyploidy and artificial selection lead to formation of new species.

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