

**CLASS: FORM 2**

**SUBJECT: BIOLOGY**

**TOPIC 4: EXCRETION AND HOMEOSTASIS.**

1. Define the following terms

**a) Excretion**

-The process by which organisms get rid of waste products which result from chemical process which occur in living cells

**b).Secretion**

-The process by which organisms produce substances which are useful to the body, by glands

**c).Egestion**

-Removal of indigestive materials from the body.

**d).Homeostasis**

-Maintenance of constant internal environment

2. Explain Why excretion is necessary in plants and animals

**-products of excretion are usually harmful while some are toxic**

**- If allowed to accumulate in the cells they would destroy tissues and interfere with normal metabolism**

**- They are therefore removed through excretion**

3. Describe how excretion takes place in green plants

**-Carbon IV oxide, oxygen and water diffuse through the stomata, lenticels and hydathodes**

- Some toxic wastes are converted into non-toxic substances
- These are deposited in certain tissues of the plant or stored in aging structures
- Resins and tannins are exuded through the bark of stem or lost during leaf fall

4. Why do plants lack complex excretory structures like those of animals? **-Plants have lower rates of metabolism.**

**-Plants excrete non-poisonous products derived from carbohydrate metabolism unlike animals which produce toxic wastes derived from protein metabolism. -Plants re-use some of their wastes like nitrogenous wastes used in protein synthesis.**

**-Plants store waste products in roots, fruits and leaves.**

5. State the excretory products of plants and some of their uses to humans.

**-Caffeine from tea and coffee is used in medicine and as a stimulant which is harmful to humans**

**-Quinine used for treating malaria**

**-Cocaine derived from leaves of cocoa plant used as a stimulant by addicts or as a local anesthesia, also causes damage to the brain, may cause addiction if not well used and is an illegal drug**

**-Tannins derived from barks of acacia (wattle bark) trees are used to make ink and tanning (softening) of leather.**

**-Nicotine got from leaves of tobacco plant stimulates the central nervous, may cause addiction if much is used or consumed. It is used to make cigarettes, cigars and is poisonous. It is a precursor of lung cancer**

**-Cannabis sativa (bhang) is used to make drugs**

**-Gum derived from gums is used for sticking substances and making certain jellies**

**-Rubber, a product of latex, got from rubber plant is used to make tyres and synthetic fibres.**

**-Morphine from opium poppy plant is a narcotic and illegal drug as it causes addiction.**

**-Khat and miraa are used as stimulants.**

**-Colchicine used in inducing polyploidy, cancer therapy, treatment of gout in small quantities.**

**-Papain used as meat tenderizer.**

6. Describe excretion in unicellular organisms

**-Examples are amoeba and paramecium**

**-They have to remove waste products such as carbon IV oxide and nitrogenous substances e. g urea and ammonia**

**- These diffuse from the body surface into the surrounding Water**

**- Diffusion is due to large surface area**

7. List excretory organs and products of mammals

**-Kidney excretes urea, water and salts**

**-Skin excretes Water, salts and urea**

**-Lungs excrete carbon IV oxide and water**

**-Liver excretes bile salts**

8. Explain how the mammalian skin is adapted to its functions the skin is made up of dermis and epidermis

### **Epidermis**

**-It is made up of three layers**

**-The outermost layer, cornified layer is made up of dead cells that prevent entry of microorganisms, prevent physical damage.**

**-Granular layer made of living cells gives rise to cornified layer**

**-Malpighian layer is made up of actively dividing cells that give rise to new epidermal cells/granular layer it contains melanin that protects the body against ultra violet rays (radiations)**

### **Dermis**

**-Has several components**

**-Has sweat gland which produce sweat through sweat pores on the skin and the sweat evaporates cooling the body by lowering body temperature. When it is cold, no sweat is produced, conserving water**

**-Sweat contains water, sodium chloride, uric acid and urea hence the skin acts as an excretory organ**

**-Has hair. The hair stands erect to trap air when temperature is low to reduce loss/insulation. It lies flat to allow heat loss when temperature is high. -Has nerve endings which are sensitive to stimuli such as heat, cold, pain, pressure and touch**

- Has subcutaneous fat/adipose fat that insulates the body against heat loss. -Has arteries and capillaries (blood vessels) that supply food and oxygen and remove excretory products. Arterioles vasodilate when temperatures are high to lose heat by radiation, and convection. Arterioles constrict when temperatures are low to conserve heat i.e. reduce heat loss
- Has sebaceous glands which secrete sebum, and antiseptic and water repellent that prevents drying and cracking the skin by making the skin supple

9. What is the role of lungs in excretion?

- During respiration oxygen is used up in the body cells to produce energy
- Carbon IV oxide is produced as a by-product
- The carbon IV oxide must be eliminated from the body
- Elimination is through the lungs
- Also, water vapor is formed and must be removed
- This removal is through the lungs-The lung is therefore considered as an excretory organ as it removes carbon IV oxide and water vapor which are byproducts of respiration.

10. State and explain the functions of the liver

#### **i. Excretion**

- In this function the liver is aided by the kidney
- Deamination i.e. excess amino acids converted into urea and uric acid which is transported to skin and kidney for removal
- Detoxification where harmful substances are converted into harmless ones in the liver and transported to kidneys for removal
- Breakdown of worn out blood cells and haemoglobin and the residue excreted through the
- Kidney to give urine a yellow tinge
- Breakdown of sex hormones after they have performed their function and the waste is released through the kidney and bile.

#### **ii) Homeostasis**

- Regulation of blood glucose.
- The normal amount of glucose in blood is about 90mg/ 100.
- Increase in blood sugar is detected by cells of the pancreas which secrete insulin.
- Insulin stimulates the liver to convert excess glucose to glycogen

- Further excess glucose is converted to fats until the normal blood sugar level is attained.
- Excess glucose is oxidized to carbon IV oxide, water and energy. Excess glucose is also used in respiration.
- Decrease in blood sugar level below normal level is detected by the pancreas, which secretes glucagon which stimulates the liver to convert glycogen to glucose until the normal sugar level is attained.
- Fats, amino acids are converted to glucose. -It also leads to reduced oxidation of glucose.

### **iii).Deamination**

- Excess amino acids are deaminated by the removal of amino group
- The amino group is converted to ammonia
- Ammonia combines with carbon IV oxide to form urea
- Urea is excreted in urine through the kidney
- Detoxification
- Poisonous substances are converted to less harmful compounds
- Thermal regulation
- Maintenance of body temperature
- Heat is generated in the liver by chemical activities
- The heat is distributed

11. Describe how the human kidney functions.

- The afferent arterioles, which is a branch of the renal artery, supplies blood to the glomerulus.
- The afferent arteriole has a wider diameter than the efferent arteriole. -This difference in diameter of afferent and efferent vessels causes high pressure leading to ultra-filtration.
- The walls of the blood capillaries are one cell thick hence glucose, amino acids, vitamins, hormones, salts, creatinine, urea and water filter into Bowman's capsule to form glomerular filtrate.
- White blood cells, red blood cells, plasma proteins (such as globulin) and platelets are too large to pass through the capillary walls hence remain in blood capillary.
- The filtrate flows into proximal convoluted tubule where amino acids, vitamins and all glucose are selectively reabsorbed back into the blood stream. -Many mitochondria provide energy for reabsorption of these substances against a concentration gradient by active transport
- The glomerular filtrate flows into the loop of Henle.

- Water in the descending loop moves by osmosis into the blood capillaries.
- Sodium chloride is actively pumped from the ascending arm of the loop of Henle into the blood capillaries
- The glomerular filtrate flows into the distal convoluted tubule
- Water and salts are reabsorbed from distal convoluted tubule into blood capillaries
- The glomerular filtrate flows into collecting tubule (duct) from where more Water is reabsorbed into blood stream.
- Antidiuretic hormone influences the amount of Water reabsorbed depending on osmotic pressure of blood.
- The glomerular filtrate from collecting duct, now referred to as urine, is emptied into pelvis and ureter into bladder and out of body through urethra.
- Urine consists of excess water, salts and nitrogenous wastes.

12. State the adaptations of proximal convoluted tubule to its function.

- Folded to increase surface area for absorption thin epithelium to reduce distance of diffusion micro-villi on inner.
- Lining to increase surface area for absorption folded to reduce speed of flow for efficient absorption numerous mitochondria to provide energy for reabsorption dense capillary network to transport reabsorbed products.

13. Name the common kidney diseases

- Nephritis
- Kidney stones -Cystitis.
- Kidney failure.

14. Why is homeostatic control necessary?

- This provides a constant internal environment so that the cells of the body have the optimum (best) condition for their survival.

15. What is internal environment?

- Immediate surroundings of body cells.**
- Refers to tissue fluid within an organism.**

16. Why is constant body temperature maintained by mammals?

- Most enzymes in the body function within a narrow range of temperature. -High temperature denatures enzymes low temperature inactivates and inhibits enzymes.**

17. Explain the advantage gained by possessing a constant body temperature.

- Animals remain active despite fluctuations in environmental temperature. -Higher chances of survival in various environments ie they colonize various environments.**
- Chemical processes in their body continues at an optimum rate.**

18. How do mammals regulate body temperature?

- The body temperature of a mammal is kept constant to maintain this temperature the mammal must be able to balance its heat loss against the heat gain.**
- Body temperature is controlled by the hypothalamus, a specialized part of the brain.**
- Changes in the temperature within the body and the surrounding are detected by the hypothalamus it transmits impulses to the skin and the blood stream in response to temperature changes hypothalamus acts as a thermostat for the body.**
- A mammal loses heat by breathing out, urine, faeces and skin by radiation and by evaporation of sweat.**
- A mammal generates heat by the activity of its muscles, by general metabolism in respiration, or chemical activities.**
- In hot conditions the hypothalamus stimulates responses that increase heat loss from the body hence lowering the body temperature**

**-Such responses include sweating, vasodilation, keeping its hair flat on the surface of skin and reduction of metabolic rate**

**-In cold conditions the hypothalamus stimulates responses that generate heat gain in the body and reduce heat loss to the environment**

**-Such responses include shivering, vasoconstriction, raising its hair to trap a layer of air around the skin because still air is a good insulator of heat and by generation of heat by increasing metabolic rate.**

19. Why does body temperature of a healthy person rise up to  $37^{\circ}\text{C}$  on a hot humid day?

**-Sweat evaporation is reduced hence cooling is less therefore more heat is retained in the body causing temperature to rise.**

20. State the advantages that organisms with small surface area to volume ratio experience over those with larger.

**-Heat loss slow hence their body temperature can increase to intolerable levels -Heat gain from surrounding slower hence may remain inactive for a long time. -Need specialized and complex transport system and also gaseous exchange system**

21. Explain why individuals with smaller sizes require more energy per unit body weight than those with larger sizes.

**-Surface area to volume ratio is higher in smaller individuals than larger ones, therefore smaller heat is lost faster by smaller ones than larger ones they therefore require more energy per unit body weight to maintain body temperature.**

22. What is the meaning of osmoregulation?

**-Mechanism which regulates osmotic pressure of internal environment of an organism.**

**-The regulation/maintenance of salt/solute-water balance of an internal environment.**



23. State the importance of osmoregulation.

**-Maintenance of constant level of water and salts (osmotic pressure) for optimum/suitable conditions for metabolism suitable for cellular functions.**

25. Explain why some desert animals excrete uric acid rather than Water

**-Uric acid is less toxic than ammonia, hence elimination of uric acid requires less water than ammonia therefore more water conserved**

**-Uric acid being less toxic is safer to excrete where there is less water/desert.**

26. Explain why eating a meal with too much salt leads to production of a small volume of concentrated urine.

**-The concentration of salts in the blood rises leading to production of more ADH hence higher rate of water reabsorption by kidney tubules.**

27. Explain how marine fish regulate their osmotic pressure.

**-Swallow plenty of sea water to increase amount of water in the body.**

**-Have chloride excretory cells in their gills to remove excess salts**

**-Eliminate nitrogenous wastes in form of trimethylamine oxide which requires little water for elimination**

**-Few/small glomeruli thus slow filtration rate in the kidneys retain nitrogenous wastes in form of urea to raise osmotic pressure of body fluids.**

28. What is the biological significance of maintaining a relatively constant sugar level in a human body?

**-Body cells are surrounded by tissue fluids that are isotonic/same osmotic pressure as cytoplasm**

**-If sugar level is high/hypertonic, cell will lose water by osmosis to the surrounding, thus increasing the concentration of the contents this changes the physiology of the cell**

- If the blood sugar is lower than the normal, the cytoplasm gains water by osmosis,**
- Diluting the cell contents, thus altering the physiology of the cell.**

29. Discuss the role of the following hormones in blood sugar control.

### **Insulin**

- Insulin is produced when there is increase in blood sugar concentration. -It converts glucose to glycogen which is in the liver or muscle thus lowering sugar level.**

### **Glucagon**

- When glucose level decreases glucagon is produced, which causes the breakdown of glycogen to glucose thus raising blood sugar level.**

30. Explain the part played by antidiuretic hormone in homeostasis.

- Produced when there is less water (high osmotic pressure above normal level of salt concentration) in the blood.**
- It acts on kidney tubules (nephron) thus increasing water reabsorption from tubules to the blood stream, thus restoring osmotic pressure -When there is more water(lower osmotic pressure) or decreased salt concentration in blood, little or no ADH is produced, less water reabsorbed hence water loss in urine (more dilute urine) hence raising the osmotic pressure in body fluids/blood.**

31. What is the role of blood clotting in homeostasis?

- When a blood vessel is cut, there is exposure of blood platelets to the air**
- This triggers fibrinogen to be converted to fibrin**
- The fibrin forms a clot that prevents body fluids e. g. blood from being lost, therefore the clot conserves water and salts in the body.**

32. Describe the role of the following hormones in homeostasis

### **i. Aldosterone**

- Concerned with regulation of ionic balance**
  - Secreted by the cortex of adrenal glands**
  - It increases sodium ion uptake by the gut and promotes the reabsorption of sodium ions (and therefore water) in the kidneys)**
  - This is accompanied by elimination of potassium ions**
  - This raises the overall level of sodium and lowers the overall level of potassium in the blood as sodium ions are absorbed in the blood, chlorine ions follow so as to neutralize the effect of sodium ions**
  - The production of aldosterone is regulated by the concentration of sodium ions which has an inhibiting effect, and a fall in sodium ions has a stimulating effect on the adrenal cortex**
  - The flow of aldosterone is stimulated by the adreno-cortic-tropic hormone (ACTH) produced in the anterior of the pituitary gland however, the main method of control is dependent on the fact that adrenal cortex itself is somehow sensitive to the relative concentration of potassium and sodium in the blood**
- ii. Adrenaline**

- Produced by adrenal glands in high concentrations, it increases hydrolysis of glycogen and increases blood sugar.**
- It is usually released in emergency cases to increase glucose level for respiration.**
- This releases energy for the emergency.**

33. Distinguish between diabetes mellitus and diabetes insipidus.

- Diabetes mellitus is a condition resulting from insufficient production of insulin causing hyperglycemia and presence of glucose in urine**
- Diabetes insipidus is a condition whereby less or no antidiuretic hormone is secreted hence a high volume of water is passed out in urine in a condition called diuresis**

34. How can high blood sugar level in a person be controlled?

- Administer insulin.**

35. Why does glucose not normally appear in urine even though it is filtered in the mammalian Bowman's capsule?

**-Glucose molecules are actively reabsorbed in the proximal convoluted tubules.**

36. When is glycogen which is stored in the liver converted into glucose and released into the blood?

**-After activity/when blood sugar (glucose) falls below normal then glucagon stimulates the liver/when glucagon is produced after strenuous/vigorous activity, during starvation.**

37. How would one find out from a sample of urine whether a person is suffering from diabetes mellitus?

**-Test or react urine in Benedict's solution positive result i.e. orange or red precipitate, Positive result is an indication of diabetes mellitus.**

38. State six common uses of excretory products in plants.

**Quinine - Used to treat malaria;**

**Caffeine - A mild stimulant;**

**Cocaine - Local anesthetic;**

**Nicotine - In manufacture of insecticides and cigarettes;**

**Papain - Protein enzyme used as a meat tenderizer;**

**Rubber - Has latex used in the manufacture of shoes; and tyres;**

**Opiates - In manufacture of painkillers;**

**Gum Arabica - Used in food processing and in the printing industry;**

39. Describe the process of excretion in the kidney.

**- Ultra filtration takes place in the Bowman's capsule.**

**-The efferent arteriole is narrower than the afferent arteriole; making pressure in the Bowman's capsule high. High pressure causes ultrafiltration to occur within the glomerulus;**

**- The filtrate consists of urea, glucose, amino acids, mineral salts and water;**

**- Large molecular particles such as plasma proteins and blood cells are not filtered;**

**- In the proximal convoluted tubule useful substances such as glucose, amino acids, some water and vitamins; are selectively reabsorbed into the blood by active transport and diffusion;**

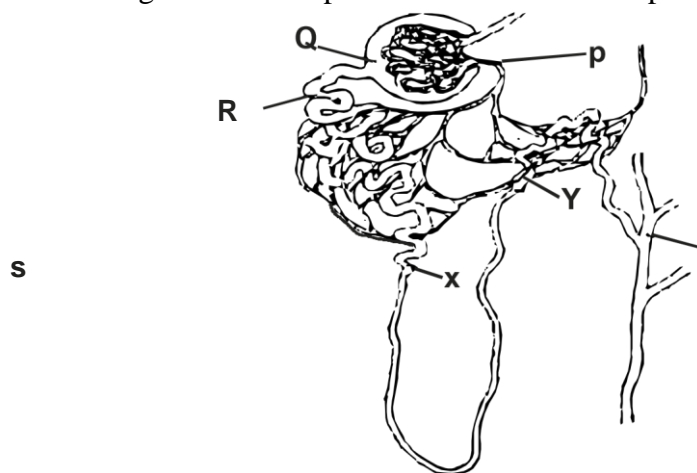
**-Selective reabsorption uses energy provided by the mitochondria found in cells lining the tubules;**

- In the loop of Henle, salts are reabsorbed into the blood by active transport; water is reabsorbed by osmosis
- In the distal convoluted tubule, hydrogen ions are absorbed from the blood into the urine for excretion. This happens when there is a high concentration of the ions in the blood;
- Reabsorption of salts occurs under the influence of aldosterone; and reabsorption of water occurs under the influence of the anti-diuretic hormone; in the distal convoluted tubule salt and water are reabsorbed; In the collecting duct water and mineral salts are reabsorbed;
- The urine formed passes into the collecting duct which leads to the pelvis, then to the ureter and to the bladder.
- Urea is not reabsorbed into the blood.
- In a healthy person, glucose and amino acids are completely reabsorbed into the blood.
- Reabsorption of water also takes place in the collecting duct by osmosis as the renal fluid flows down.

40. Describe the physiological process that help in regulation of the body temperature in man on a hot day.

- ☐ Hairs lie flat on the skin;
- ☐ Vasodilation;
- ☐ Increased sweat production;
- Reduced metabolic activities;

41. The diagram below represents a mammalian nephron.



a) Name the;

i) Structure labelled P. **Efferent arteriole/vessel;** ii) Portion of nephron between x and y.

**Loop of Henle;**

b) Name the process that takes place at point Q.

**Ultra-Filtration;**

c) Name one substance present at point R but absent at point S in a healthy mammal.

**Glucose/Blood sugar; amino acids**

d) The appearance of the substance you have mentioned in (c) above is a symptom of a certain disease caused by a hormone deficiency. Name the i) Disease.

**Diabetes mellitus/sugar diabetes;**

ii) Hormone.

**Insulin hormone;**

42. State the structural modification of nephron in the desert mammals.

**Small Bowman's capsule/Glomerus;**

**Long loop of Henle**

43. Name the plant excretory product which is used for

i).Treatment of malaria

**-Quinine**

beverage

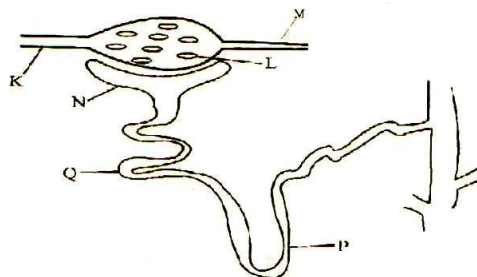
**-Caffeine**

ii).As

44. Explain why lactic acid is not considered as an excretory product though it is toxic to tissues

**Lactic acid is oxidized to carbon (IV) oxide, water and energy when oxygen is available**

45. The diagram below is a functional unit of a mammalian kidney



a) Name the process that occurs in

**L– Ultra filtration**

**P– Reabsorption**

b). (i) state the structural difference between K and M

**K has a wide lumen**

**M has a narrow lumen**

(ii) How does the structural difference above help in the process that occurs in L

**Blood coming in is at high pressure; M provides resistance to blood flowing out creating high pressure that allows small molecules to be filtered out.** c). State two adaptations of

structure Q to its functions

**-It is highly coiled to allow slow movement of filtrate for reabsorption; -Have micro villi to increase surface area for re-absorption; cell have numerous mitochondria to provide energy for reabsorption.**

46. Why is excretion of nitrogenous wastes more of a problem to animals than plants?

☐ **Plants are able to store the wastes in their bodies in non-toxic forms.**

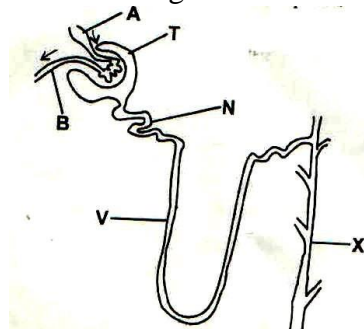
☐ **Plants are stationary and therefore less active hence realize less toxic wastes compared to plants which produce a lot.**

☐ **Plants utilize simple inorganic substance to make their foods in amount required by the body hence less wastes while animals consume complex compounds whose breakdown releases more toxic wastes.**

47. Explain why sweat accumulates on a person's skin in a hot humid environment.

**Sweat produced does not evaporate due to high humidity and the body does not cool hence more sweat produced leading to accumulation.**

48. Shown below is a section through the mammalian nephron.



a) Name the structures labelled:

**A- Afferent arteriole**

**N – Proximal convoluted tubule.**

b) Name all structures in a nephron which are normally present in the cortex region of kidney.

**Bowman's capsule, proximal convoluted tubule, distal convoluted tubule**

c) Which region in the nephron deals with conservation of body water?

**Loop of Henle**

d) Name one hormone that has an effect on part labelled X.

**Antidiuretic hormone / vasopresin**

e). How is part labelled N adapted to its function.

- i). **Cell lining tubule have numerous mitochondria which provide energy for reabsorption**
- iii). **Tubule long / highly coiled to increase surface area**
- iv). **Coiling of tubule reduce speed of flow of filtrate to allow more time for efficient reabsorption**
- v). **Tubule is well supplied with blood capillaries for efficient transport / reabsorption**

49. Name the main nitrogenous wastes excreted by:

- i) Birds -**Uric acid**
- ii) Shark. - **Ammonia**
- iii) Cow -**Urea**

50. The table below shows percentage composition of blood plasma and urine from different substances.

Substance	Blood plasma %	Urine %
Water	90	90
Plasma proteins	8	0
Glucose	0.2	0.1
Urea	0.03	2

a) Explain why;

i) There are no plasma proteins in the urine.

**Plasma proteins are too large to filter through the blood capillaries in the glomerulus;**

ii) Urea concentration is greater in the urine than in the blood plasma. **Along the tubules water is reabsorbed while urea is not;**

iii) There is glucose in the urine

**-The individual is suffering from diabetes mellitus;**

**-The pancreas doesn't secrete sufficient insulin which stimulates liver cells to convert excess glucose to glycogen /fats hence excess glucose is excreted in urine;**

51. Describe the role of the mammalian liver in carbohydrate metabolism.



- The liver plays an important role in regulating blood glucose level; under the influence of insulin; and glucagon hormone liver cells/hepatocytes regulate blood glucose level;
- When blood glucose level is above normal/above  $90\text{mg}/100\text{cm}^3$  of blood; the pancreas secretes hormone insulin; which acts on hepatocytes to convert excess glucose for storage; converts excess glucose to fats for storage; Increase oxidation rate of excess glucose to energy, carbon IV oxide and water;
- The glucose level is thus lowered to normal;
- When blood glucose level is below normal/below  $90\text{mg}/100\text{cm}^3$  of blood; the pancreas secretes glucagon hormone;
- Glucagon stimulates the liver cells/hepatocytes to: convert stored glycogen to glucose; convert stored fats to glucose; decrease the metabolism of glucose to yield energy; blood sugar level rise to normal;