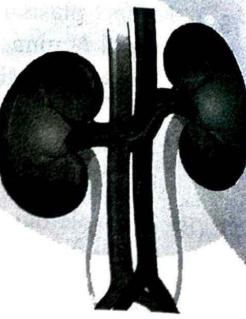


16 Excretory Products and Their Elimination



16.1. Human Excretory System

1. Given below are two statements:

Statement I: In the nephron, the descending limb of loop of Henle is impermeable to water and permeable to electrolytes.

Statement II: The proximal convoluted tubule is lined by simple columnar brush border epithelium and increases the surface area for reabsorption.

In the light of the above statements, choose the correct answer from the options given below:

(A) Both Statement I and Statement II are false.
 (B) Statement I is true but Statement II is false.
 (C) Statement I is false but Statement II is true.
 (D) Both Statement I and Statement II are true.

[NEET 2024]

2. Choose the correct statement given below regarding juxta medullary nephron.

(A) Renal corpuscle of juxta medullary nephron lies in the outer portion of the renal medulla.
 (B) Loop of Henle of juxta medullary nephron runs deep into medulla.
 (C) Juxta medullary nephrons outnumber the cortical nephrons.
 (D) Juxta medullary nephrons are located in the columns of Bertini.

[NEET 2024]

3. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).

Assertion (A): Nephrons are of two types: Cortical and Juxta medullary, based on their relative position in cortex and medulla.

Reason (R): Juxta medullary nephrons have short loop of Henle, whereas cortical nephrons have longer loop of Henle.

In the light of the above statements, choose the correct answer from the options given below:

(A) A is true but R is false.
 (B) A is false but R is true.

(C) Both A and R are true and R is the correct explanation of A.

(D) Both A and R are true but R is NOT the correct explanation of A.

[NEET 2023]

4. Nitrogenous waste is excreted in the form of pellet or paste by:

(A) *Salamandra* (B) *Hippocampus*
 (C) *Pavo* (D) *Ornithorhynchus*

[NEET 2022]

5. Match the items in Column I with those in Column II:

Column I	Column II
(a) Podocytes	(i) Crystallised oxalates
(b) Protonephridia	(ii) Annelids
(c) Nephridia	(iii) Amphioxus
(d) Renal calculi	(iv) Filtration slits

Select the correct option from the following:

(a) (b) (c) (d)
 (A) (iii) (iv) (ii) (i)
 (B) (iii) (ii) (iv) (i)
 (C) (iv) (iii) (ii) (i)
 (D) (iv) (ii) (iii) (i)

[NEET Odisha 2019]

6. In mammals, which blood vessel would normally carry largest amount of urea?

(A) Dorsal Aorta (B) Hepatic Vein
 (C) Hepatic Portal Vein (D) Renal Vein

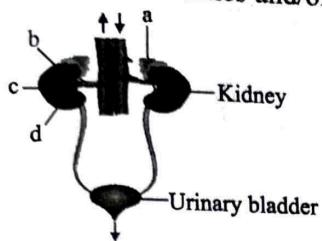
[NEET Phase-I 2016]

7. Select the option which shows correct matching of animal with its excretory organ and excretory product:

(A) Animal - *Labeo* (Rohu); Excretory organ - Nephridial tubes; Excretory product - Ammonia.
 (B) Animal - Salamander; Excretory organ - Kidneys; Excretory product - Urea.
 (C) Animal - Peacock; Excretory organ - Kidneys; Excretory product - Urea.
 (D) Animal - Housefly; Excretory organ - Renal tubules; Excretory product - Uric acid.

[NEET 2013]

8. Figure shows human urinary system with structures labelled (a) to (d). Select option, which correctly identifies them and gives their characteristics and/or functions.



(A) a-adrenal gland-located at the anterior part of kidney. Secrete catecholamines, which stimulate glycogen breakdown.
 (B) b-pelvis-broad funnel shaped space inner to hilum, directly connected to loops of Henle.
 (C) c-medulla-inner zone of kidney and contains complete nephrons.
 (D) d-cortex-outer part of kidney and do not contain any part of nephrons. **[NEET 2013]**

9. Which one of the following options gives the correct categorisation of six animals according to the type of nitrogenous wastes they give out?

(A) Ammonotelic – Pigeon, Humans
 Ureotelic – Aquatic Amphibia, Lizards
 Uricotelic – Cockroach, Frog
 (B) Ammonotelic – Frog, Lizards
 Ureotelic – Aquatic Amphibia, Humans
 Uricotelic – Cockroach, Pigeon
 (C) Ammonotelic – Aquatic Amphibia
 Ureotelic – Frog, Humans
 Uricotelic – Pigeon, Lizards, Cockroach
 (D) Ammonotelic – Aquatic Amphibia
 Ureotelic – Cockroach, Humans
 Uricotelic – Pigeon, Lizards, Frog **[AIPMT 2012]**

10. Uricotelic mode of passing out nitrogenous wastes is found in:

(A) birds and annelids
 (B) amphibians and reptiles
 (C) insects and amphibians
 (D) reptiles and birds. **[AIPMT Screening 2011]**

11. Which one of the following is not a part of a renal pyramid?

(A) Convoluted tubules (B) Collecting ducts
 (C) Loop of Henle (D) Peritubular capillaries **[AIPMT Screening 2011]**

12. The principal nitrogenous excretory compound in humans is synthesised:

(A) in kidneys but eliminated mostly through liver.
 (B) in kidneys as well as eliminated by kidneys.

(C) in liver and also eliminated by the same through bile.
 (D) in the liver, but eliminated mostly through kidneys.

[AIPMT Screening 2010]

13. Uric acid is the chief nitrogenous component of the excretory products of:

(A) man (B) earthworm
 (C) cockroach (D) frog.

[AIPMT Screening 2009]

14. A person who is on a long hunger strike and is surviving only on water, will have:

(A) less amino acids in his urine
 (B) more glucose in his blood
 (C) less urea in his urine
 (D) more sodium in his urine. **[AIPMT 2007]**

15. In ornithine cycle, which of the following wastes are removed from the blood?

(A) CO_2 and urea (B) Ammonia and urea
 (C) CO_2 and ammonia (D) Urea and urine. **[AIPMT 2005]**

16. A terrestrial animal must be able to:

(A) excrete large amounts of water in urine
 (B) conserve water
 (C) actively pump salts out through the skin
 (D) excrete large amounts of salts in urine. **[AIPMT 2004]**

17. In living beings, ammonia is converted into urea through:

(A) ornithine cycle (B) citrulline cycle
 (C) fumarine cycle (D) arginine cycle **[AIPMT 2000]**

18. The basic functional unit of human kidney is:

(A) nephridia (B) Henle's loop
 (C) nephron (D) pyramid **[AIPMT 1997]**

19. Part not belonging to uriniferous tubule is:

(A) glomerulus
 (B) Henle's loop
 (C) distal convoluted tubule
 (D) collecting tubule **[AIPMT 1994]**

20. Two examples in which the nitrogenous wastes are excreted from body in the form of uric acid are:

(A) birds and lizards
 (B) frogs and cartilaginous fish
 (C) insects and bony fish
 (D) mammals and molluscs. **[AIPMT 1994]**

21. Nitrogenous waste products are eliminated mainly as:

(A) urea in tadpole and ammonia in adult frog.
 (B) ammonia in tadpole and urea in adult frog.

(C) urea in both tadpole and adult frog.

(D) urea in tadpole and uric acid in adult frog.

[AIPMT 1991]

22. Proximal and distal convoluted tubules are parts of:

(A) seminiferous tubules (B) nephron

(C) oviduct (D) vas deferens

[AIPMT 1990]

16.2. Urine Formation

23. Match the items given in Column I with those in Column II and select the correct options given.

Column I (Function)	Column II (Part of Excretory System)
(a) Ultrafiltration	(i) Henle's loop
(b) Concentration of urine	(ii) Ureter
(c) Transport of urine	(iii) Urinary bladder
(d) Storage of urine	(iv) Malpighian corpuscle.
	(v) Proximal convoluted tubule

Select the correct option from the following.

(a) (b) (c) (d)

(A) (v) (iv) (i) (ii)

(B) (iv) (i) (ii) (iii)

(C) (iv) (v) (ii) (iii)

(D) (v) (iv) (i) (iii)

[NEET 2018]

24. The net pressure gradient that causes the fluid to filter out of the glomeruli into the capsule is:

(A) 50 mm Hg (B) 75 mm Hg

(C) 20 mm Hg (D) 30 mm Hg.

[AIPMT 2005]

16.3. Function of the Tubules

25. Which of the following statements is correct?

(A) The ascending limb of loop of Henle is impermeable to water.

(B) The descending limb of loop of Henle is impermeable to water.

(C) The ascending limb of loop of Henle is permeable to water.

(D) The descending limb of loop of Henle is permeable to electrolytes.

[NEET 2017]

26. Which one of the following correctly explains the function of a specific part of a human nephron?

(A) Henle's loop – most reabsorption of the major substances from the glomerular filtrate

(B) Distal convoluted – reabsorption of ions into the tubule surrounding blood capillaries

(C) Afferent arteriole – carries the blood away from the glomerulus towards renal vein

(D) Podocytes – create minute spaces (slit pores) for the filtration of blood into the Bowman's capsule

[AIPMT Screening 2011]

27. Which one of the following statements in regard to the excretion by the human kidneys is correct?

(A) Descending limb of loop of Henle is impermeable to water.

(B) Distal convoluted tubule is incapable of reabsorbing HCO_3^- .

(C) Nearly 99 percent of the glomerular filtrate is reabsorbed by the renal tubules.

(D) Ascending limb of loop of Henle is impermeable to electrolytes.

[AIPMT Screening 2010]

28. Glucose is taken back from glomerular filtrate through:

(A) Active transport (B) Passive transport

(C) Osmosis (D) Diffusion [AIPMT 1993]

16.4. Mechanism of

Concentration of the Filtrate

29. Given below are two statements:

Statement I: Concentrated urine is formed due to counter current mechanism in nephron.

Statement II: Counter current mechanism helps to maintain osmotic gradient in the medullary interstitium.

In the light of the above statements, choose the most appropriate answer from the options given below.

(A) Statement I is correct but Statement II is incorrect.

(B) Statement I is incorrect but Statement II is correct.

(C) Both Statement I and Statement II are correct.

(D) Both Statement I and Statement II are incorrect.

[Re-NEET 2024]

30. Which of the following factor is responsible for the formation of concentrated urine?

(A) Maintaining hyperosmolarity towards inner medullary interstitium in the kidneys.

(B) Secretion of erythropoietin by juxtaglomerular complex.

(C) Hydrostatic pressure during glomerular filtration.

(D) Low levels of antidiuretic hormone.

[NEET National 2019]

31. Removal of proximal convoluted tubule from the nephron will result in:
(A) more diluted urine
(B) more concentrated urine
(C) no change in quality and quantity of urine
(D) no urine formation. **[AIPMT Cancelled 2015]**

32. The maximum amount of electrolytes and water (70-80%) from the glomerular filtrate is reabsorbed in which part of the nephron?
(A) Ascending limb of loop of Henle
(B) Distal convoluted tubule
(C) Proximal convoluted tubule
(D) Descending limb of loop of Henle

[AIPMT Screening 2012]

33. If Henle's loop were absent from mammalian nephron, which one of the following is to be expected?
(A) There will be no urine formation.
(B) There will be hardly any change in the quality and quantity of urine formed.
(C) The urine will be more concentrated.
(D) The urine will be more diluted. **[AIPMT 2003]**

34. The ability of the vertebrates to produce concentrated (hyperosmotic) urine usually depends upon the:
(A) area of Bowman's capsule epithelium
(B) length of Henle's loop
(C) length of the proximal convoluted tubule
(D) capillary network forming glomerulus

[AIPMT 2000]

35. Under normal conditions which one is completely reabsorbed in the renal tubule?
(A) Urea (B) Uric acid
(C) Salts (D) Glucose **[AIPMT 1991]**

36. Reabsorption of useful substances from glomerular filtrate occurs in:
(A) collecting tube
(B) loop of Henle
(C) proximal convoluted tubule
(D) distal convoluted tubule **[AIPMT 1989]**

18.5. Regulation of Kidney Function

37. Which of the following statements are correct?
(I) An excessive loss of body fluid from the body switches off osmoreceptors.
(II) ADH facilitates water reabsorption to prevent diuresis.
(III) ANF causes vasodilation.
(IV) ADH causes increase in blood pressure.
(V) ADH is responsible for decrease in GFR.

Choose the correct answer from the options given below:

(A) (I), (II) and (V) only
(B) (III), (IV) and (V) only
(C) (I) and (II) only
(D) (II), (III) and (IV) only

[NEET 2023]

38. The increase in osmolarity from outer to inner medullary interstitium is maintained due to:
(I) close proximity between Henle's loop and vasa recta
(II) counter-current mechanism
(III) selective secretion of HCO_3^- and hydrogen ions in PCT.
(IV) higher blood pressure in glomerular capillaries.

Select the correct option:

(A) Only (II) (B) (III) and (IV)
(C) (I), (II) and (III) (D) (I) and (II)

[NEET Oct. 2020]

39. Select the correct statement:

(A) Atrial Natriuretic Factor increases the blood pressure.
(B) Angiotensin II is a powerful vasodilator.
(C) Counter-current pattern of blood flow is not observed in vasa recta.
(D) Reduction in Glomerular Filtration Rate (GFR) activates JG cells to release renin.

[NEET Oct. 2020]

40. Which of the following would help in prevention of diuresis?
(A) More water reabsorption due to under secretion of ADH.
(B) Reabsorption of Na^+ and water from renal tubules due to aldosterone.
(C) Atrial natriuretic factor causes vasoconstriction.
(D) Decrease in secretion of renin by JG cells.

[NEET 2020]

41. A decrease in blood pressure/volume will not cause the release of:

(A) renin (B) atrial natriuretic factor
(C) aldosterone (D) ADH **[NEET 2017]**

42. Which of the following does not favour the formation of large quantities of dilute urine?

(A) Alcohol (B) Caffeine
(C) Renin (D) Atrial natriuretic factor
[AIPMT Cancelled 2015]

43. Which of the following causes an increase in sodium reabsorption in distal convoluted tubule?

(A) Increase in aldosterone levels.
(B) Increase in antidiuretic hormone levels.
(C) Decrease in aldosterone levels.
(D) Decrease in antidiuretic hormone levels.

[AIPMT 2014]

44. Which one of the following statements is correct with respect to kidney function regulation?

(A) Exposure to cold temperature stimulates ADH release.
 (B) An increase in glomerular blood flow stimulates formation of angiotensin-II.
 (C) During summer when body loses lot of water by evaporation, the release of ADH is suppressed.
 (D) When someone drinks a lot of water ADH release is stopped.

[AIPMT 2011]

45. Angiotensinogen is a protein produced and secreted by:

(A) macula densa cells
 (B) endothelial cells (cells lining the blood vessels)
 (C) liver cells
 (D) Juxtaglomerular (JG) cells

[AIPMT 2006]

16.6. Micturition

46. Human urine is usually acidic because:

(A) the sodium transporter exchanges one hydrogen ion for each sodium ion in peritubular capillaries.
 (B) excreted plasma proteins are acidic.
 (C) potassium and sodium exchange generates acidity.
 (D) hydrogen ions are actively secreted into the filtrate.

[AIPMT Latest July 2015]

47. What will happen if the stretch receptors of the urinary bladder wall are totally removed?

(A) Urine will not collect in the bladder.
 (B) Micturition will continue.
 (C) Urine will continue to collect normally in the bladder.
 (D) There will be no micturition.

[AIPMT 2009 Screening]

48. A person is undergoing prolonged fasting. His urine will be found to contain abnormal quantities of:

(A) fats (B) amino acids
 (C) glucose (D) ketones. [AIPMT 2005]

16.7. Role of other Organs in Excretion

49. Which one of the following is correctly matched pair of the given secretion and its primary role in human physiology?

(A) Sebum – Sexual attraction
 (B) Sweat – Thermoregulation
 (C) Saliva – Tasting food
 (D) Tears – Excretion of salts

[AIPMT 2000]

16.8. Disorders of the

Excretory System

50. Use of an artificial kidney during haemodialysis may result in:

(I) nitrogenous waste build-up in the body.
 (II) non-elimination of excess potassium ions.
 (III) reduced absorption of calcium ions from gastrointestinal tract.
 (IV) reduced RBC production.

Which of the following options is the appropriate?

(A) (II) and (III) are correct
 (B) (III) and (IV) are correct
 (C) (I) and (IV) are correct
 (D) (I) and (II) are correct

[NEET National 2019]

51. Match the items given in Column I with those in Column II and select the correct option given below.

Column I	Column II
(a) Glycosuria	(i) Accumulation of uric acid in joints.
(b) Gout	(ii) Mass of crystallised salts within the kidney.
(c) Renal calculi	(iii) Inflammation in glomeruli
(d) Glomerular nephritis	(iv) Presence of glucose in urine.

Select the correct option from the following.

(a) (b) (c) (d)
 (A) (ii) (iii) (i) (iv)
 (B) (i) (ii) (iii) (iv)
 (C) (iii) (i) (iv) (i)
 (D) (iv) (i) (ii) (iii)

[NEET 2018]

52. A condition of failure of kidney to form urine is called:

(A) deamination (B) entropy
 (C) anuria (D) None of these.

[AIPMT 1998]

53. If kidneys fail to reabsorb water the effect on tissue would:

(A) remain unaffected
 (B) shrink and shrivel
 (C) absorb water from blood plasma
 (D) take more O₂ from blood.

[AIPMT 1994]

54. Presence of RBC in urine is:

(A) alkaptonuria (B) urothiasis
 (C) hematuria (D) proteinuria.

[AIPMT 1988]

SOLUTIONS

1. (A) The descending limb of loop of Henle is permeable to water but almost impermeable to electrolytes. The ascending limb is impermeable to water but allows transport of electrolytes actively or passively.

Proximal Convolute Tubule (PCT) is lined by a simple cuboidal brush border epithelium, which increases the surface area for reabsorption.

2. (B) In juxta medullary nephrons, the loop of Henle is very long, starting low in the cortex near the medulla and running deep into the medulla. In humans, about 85% of the nephrons are cortical nephrons and about 15% are juxta medullary nephrons.

Related Theory

- Renal corpuscle of juxta medullary nephron lies in inner cortical region.
- Juxta medullary nephrons are lesser in number than cortical nephrons.
- Juxta medullary nephrons are not present in columns of Bertini.

3. (A) Nephrons are of two types: Cortical and juxta medullary, based on their relative position in the cortex and medulla of the kidney.

However, juxta medullary nephrons have a longer loop of Henle, as compared to cortical nephrons, which have a shorter loop of Henle. The longer loop of Henle in juxta medullary nephrons allows for the production of a more concentrated urine, which is important in maintaining water balance in the body.

4. (C) Animals like reptiles, birds, land snails and insects excrete nitrogenous wastes as uric acid in the form of pellet or paste with a minimum loss of water and are called as uricotelic animals. *Pavo* is the name of the bird, and it is uricotelic in nature, i.e., it excretes out waste in the form of a pellet or paste.

Related Theory

- The three main types of nitrogenous wastes excreted by animals are ammonia, urea, and uric acid. Ammonia is the most toxic type and needs a lot of water to be removed, whereas uric acid is the least harmful and can be eliminated with a small quantity of water loss.

Mnemonics

- Animals are classified according to the types of nitrogenous waste excreted from their bodies. The various types are ammonotelic, uricotelic and ureotelic. Here is a trick that will help students to recall these various types and their examples.

Ammonotelic Animals:

Blood Flowing Across All India

B – Bony

F – Fishes

A – Aquatic
A – Amphibians
I – Insects (aquatic)

Ureotelic Animals:

Money From ATM

M – Marine

F – Fishes

A – Amphibians

T – (Terrestrial)

M – Mammals

Uricotelic Animals:

Land Sold to RBI

L – Land

S – Snails

R – Reptiles

B – Birds

I – Insects

5. (C) Bowman's capsule's epithelial cells, known as podocytes, are arranged in such a way that they leave minute spaces known as filtration slits or slit pores. These membranes filter blood very finely.

Protonephridia, also known as flame cells, are excretory structures found in Platyhelminthes (flatworms, such as *Planaria*), rotifers, annelids, and the cephalochordates like *Amphioxus*. Protonephridia are primarily concerned with the regulation of ionic and fluid volume, also known as osmoregulation.

Earthworms and other annelids have tubular excretory structures called nephridia. Nephridia aids in the removal of nitrogenous wastes as well as the maintenance of fluid and ionic balance.

Kidney stones are another name for renal calculi. They are typically composed of calcium oxalate, but may also contain other compounds.

6. (B) Hepatic vein originates from liver, where urea is synthesised from amino acids. Dorsal aorta is the largest artery that originates from the heart. Hepatic portal vein carries blood from gastrointestinal tract to the liver. Renal vein is present in kidney.

Related Theory

- Urea is a metabolite of amino acids, and is synthesised in liver. Excess ammonium ions are converted to urea. This is then transported to the kidneys, via bloodstream where the blood is filtered and the urea is passed out of the body through urine.

7. (B) Salamander (*Salamandra*) is an amphibian with mesonephric kidneys as the excretory organ. It excretes out urea as the excretory product.

8. (A) (a) Adrenal gland located at the anterior part of kidney, secretes catecholamines, which stimulate glycogen breakdown (Glycogenolysis).

(b) The renal pelvis is the funnel like dilated part of the ureter in the kidney. In humans, the renal pelvis is the point where the two or three major calyces join together.

(c) Medullary zone of kidney - The renal medulla is the innermost part of the kidney. The renal medulla is split up into a number of sections, known as the renal pyramids. Blood enters into the kidney via the renal artery, which then splits up to form the interlobar arteries.

(d) Cortical zone of kidney - The renal cortex is the outer portion of the kidney between the renal capsule and the renal medulla. In the adult, it forms a continuous smooth outer zone with a number of projections (cortical columns) that extend down between the pyramids. The renal cortex is the part of the kidney where ultrafiltration occurs.

9. (C) Ammonotelic organisms are those that expel nitrogenous waste in the form of soluble ammonia. Examples are most aquatic animals, like, amphibians, poriferans, fish, and so on.

Ureotelic organisms produce urea as a nitrogenous waste. Common examples include cartilaginous fish, frogs, humans, adult amphibians, and so on.

Uricotelic organisms excrete nitrogenous waste in the form of uric acid or its salts. Birds, lizards, cockroaches, and other animals are common examples.

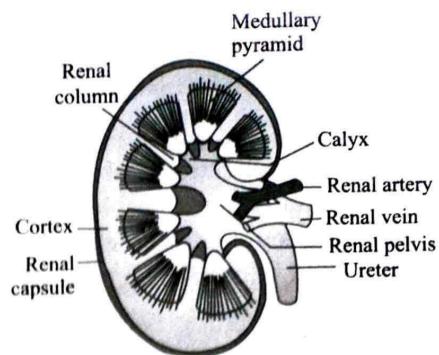
10. (D) Reptiles, birds, land snails and insects excrete nitrogenous waste as uric acid in the form of pellet or paste with a minimum loss of water and are called uricotelic animals.

The process of excreting uric acid is uricotelism. On the other hand, aquatic amphibians, bony fish and aquatic insects exhibit ammonotelism. Marine fishes, mammals and terrestrial amphibians exhibit ureotelism.

11. (A) The medulla of kidney is divided into a number of conical areas, the medullary pyramids or renal pyramids. Peritubular capillaries, loop of Henle and collecting ducts lie in the medulla (renal pyramids), while convoluted tubules lie in the cortex of kidney. It means, proximal and distal convoluted tubules lie in the cortex and loop of Henle lies in the medulla.

Related Theory

Inside the kidney, there are two zones, an outer cortex and an inner medulla. The medulla is divided into a few conical masses called medullary pyramids, projecting into the calyces. The cortex extends in between the medullary pyramids as renal columns called Columns of Bertini.



Longitudinal Section of Kidney

12. (D) The principal nitrogenous compound in humans is urea, synthesised in liver and eliminated by kidneys.

Related Theory

Properties of nitrogenous wastes are:

Ammonia	Urea	Uric Acid
NH_3	$CO(NH_2)_2$	$C_5H_4N_4O_3$
Highly toxic	Moderately toxic	Not very toxic
Highly soluble	Moderately soluble	Insoluble
Excreted mainly by aquatic invertebrates, osteichthyes (bony fish) and tadpoles.	Excreted by chondrichtyes (sharks and rays), terrestrial amphibians and mammals.	Excreted by insects, most reptiles and all birds.

13. (C) Cockroaches are uricotelic, i.e., they excrete uric acid. Man and frog are ureotelic (i.e., they excrete urea) and earthworm is both ammonotelic and ureotelic.

14. (C) Due to a long hunger strike and survival on water, a person will have less urea in his urine because urea comes to kidney as a waste product from liver, and is formed after the breakdown of protein, fat, carbohydrate during hunger. It is not synthesised but the synthesised ones are catabolised.

Related Theory

The normal concentration of sodium in the blood plasma is 150 mEq/L. Excess water intake will cause excess urination. Because nutritional Na is absent on account of hunger, the amount of Na in the blood will decrease.

15. (C) CO_2 and ammonia are the pair of wastes removed from the blood in ornithine cycle. Urea is formed in ornithine cycle or urea cycle, consisting of two molecules of ammonia and one molecule of CO_2 .

16. (B) Terrestrial animals must conserve water to regulate water content in other ways, balancing gains and losses, as they do not naturally have access to fresh water or salt water.

17. (A) The urea cycle or ornithine cycle is a cycle of various biochemical reactions that produces urea from ammonia. During this cycle, ornithine combines with one molecule of NH_3 and CO_2 to produce citrulline. Further, citrulline combines with molecule of aspartate to form arginine. Arginine is broken down into urea and ornithine, which repeats the cycle.

18. (C) The functional unit of each kidney is complex tubular structure called nephron. Each nephron is divided into two parts: the glomerulus and the renal tubule. The nephron's main function is to regulate the concentration of water and soluble substances, like sodium salts in the blood by filtering it, reabsorbing what is needed, and excreting the rest as urine.

Related Theory

→ *Glomerulus is a capillary tuft formed by an afferent arteriole, a fine branch of the renal artery. An efferent arteriole transports blood from the glomerulus. The renal tubule begins with Bowman's capsule, a double-walled cup-like structure that encloses the glomerulus. Glomerulus, together with Bowman's capsule, is referred to as the Malpighian body or renal corpuscle.*

Caution

→ *Students often get confused between options nephridia and nephron. Remember that, nephridia is an invertebrate organ found in pairs that functions similarly to vertebrate kidneys. Nephridia remove metabolic wastes from an animal's body.*

19. (A) Uriniferous tubule refers to the nephrons and collecting ducts together. The structural and functional unit of the kidney is the nephron. The Bowman's capsule, PCT, Henle's loop, and DCT make up the nephron's body. Hence, glomerulus does not belong to the uriniferous tubule. The Bowman's capsule contains a tuft of capillaries known as glomerulus.

Related Theory

→ *About 50 capillaries make up the glomerulus. The glomerular membrane's permeability increases 100–500 times higher than that of a typical capillary due to the numerous tiny pores in its capillary wall.*

20. (A) Birds and lizards are uricotelic, i.e., they excrete nitrogenous waste in the form of uric acid. Due to being insoluble in water, uric acid does not require water for its elimination.

Frogs and cartilaginous fish are ureotelic, i.e., they excrete nitrogenous waste in the form of urea.

The main excretory product of insects is uric acid and of bony fish is ammonia (ammonotelic).

Molluscs may be ammonotelic or uricotelic. Mammals are ureotelic (excretory matter is urea).

21. (B) Ammonia is highly toxic as well as highly soluble in water, so in aquatic animals, e.g., tadpole of frog, the nitrogenous waste products are excreted

in the form of ammonia as large amount of water is required for its excretion. In terrestrial animals, e.g., adult frog, these wastes are excreted in the form of urea.

22. (B) The structural and functional unit of the kidney is the nephron. Bowman's capsule makes up the body of the nephron, and the renal tubule is connected to it with three distinct regions: the proximal convoluted tubule (PCT), the loop of Henle, and the distal convoluted tubule (DCT). The proximal convoluted tubule is the name given to the first area. The second area, the Henle's loop, is connected to the proximal convoluted tubule. A descending limb and an ascending limb makes up the Henle's loop. The distal convoluted tubule is the third section of the nephron tubule.

23. (B) Ultrafiltration or glomerular filtration is carried out in glomerular capillaries found in Malpighian corpuscle. This process is carried out under high pressure. Henle's loop absorbs water from glomerular filtrate leading to concentration of urine. Ureters transport urine from kidney to urinary bladder. Urinary bladder is a muscular, sac-like structure, which stores urine until there is a urge to pass it out of the body.

24. (C) Kidneys help in the formation of urine, from the blood flowing through glomerular capillaries. About 20% of plasma fluid filters out into the Bowman's capsule through a thin glomerular-capsular membrane due to a net or effective filtration pressure of about 20 mm Hg.

Mnemonics

→ *Urine formation involves three main processes and it can be learned as:
Goat Ran Speedily
Goat – Glomerular filtration
Ran – Reabsorption
Speedily – Secretion*

25. (A) The ascending limb of loop of Henle is impermeable to water and permeable to K^+ , Cl^- , and Na^+ ions and partially permeable to urea. Due to this, sodium, potassium, calcium, magnesium and chloride are reabsorbed here making the filtrate hypotonic. The descending limb of the loop of Henle is permeable to water, but almost impermeable to electrolytes.

Related Theory

→ *The principal function of the loop of Henle is in the recovery of water and sodium chloride from urine. The loop of Henle can be divided into three main segments: the thin descending limb, the thin ascending limb, and the thick ascending limb. The primary site of sodium reabsorption is the thick ascending limb. Sodium reabsorption in the thin ascending limb is passive. It occurs paracellularly due to the difference in osmolarity between the tubule and the interstitium.*

The descending limb is highly permeable to water, with reabsorption occurring passively. Very low amounts of urea, Na^+ and other ions are also reabsorbed.

26. (D) Podocytes are cells in the epithelial lining of Bowman's capsule in the kidneys that wrap around capillaries of the glomerulus. They create minute pores (slit pores) for the filtration of blood into the Bowman's capsule. Most reabsorption of the major substances from the glomerular filtrate takes place in proximal convoluted tubule (PCT). In DCT, selective secretion of H^+ and K^+ occur to maintain pH and $\text{Na}-\text{K}$ balance in blood. Afferent arteriole carries the blood towards the glomerulus.



Related Theory

In the loop of Henle, the permeability of the membrane changes. The descending limb is permeable to water, not solutes; the opposite is true for the ascending limb. Additionally, the loop of Henle invades the renal medulla, which is naturally high in salt concentration. It tends to absorb water from the renal tubule and concentrate the filtrate.

27. (C) A comparison of the volume of filtrate formed per day (180 litre) with urine released (1.5 litre), suggests that nearly 99 percent of the filtrate is reabsorbed by the renal tubules. The descending limb of loop of Henle is permeable to water, but almost impermeable to electrolytes. The ascending limb is impermeable to water, but allows transport of electrolytes actively or passively. Conditional reabsorption of Na^+ and water takes place in distal convoluted tubule. It is also capable of reabsorption of HCO_3^- .

28. (A) Active transport is the movement of molecules from low to high concentrations, while expending energy. If a substance passes through the glomerular capillary endothelial cells, the glomerular basement membrane, and the podocytes, it enters the tubule lumen and is referred to as glomerular filtrate. The kidney's next function is tubular reabsorption. It happens in the PCT section of the renal tubule. Almost all nutrients are reabsorbed, either passively or actively. The glucose that was filtered out by the glomerulus is completely reabsorbed in the blood capillary. Active transport is responsible for the reabsorption of glucose and mineral ions from the nephron. The cells that make up the nephron's wall have a folded membrane (which provides a large surface area) and a large number of mitochondria (to supply the energy for active transport). On the other hand, reabsorption of water takes place passively by diffusion (osmosis).

29. (C) The countercurrent mechanism in the loop of Henle of nephron helps concentrate urine by allowing for the reabsorption of water and salts, and thus, forming concentrated urine. The countercurrent

mechanism creates and maintains an osmotic gradient in the medullary interstitium, which is essential for the reabsorption of water and the production of concentrated urine.

30. (A) The factors responsible for the formation of concentrated urine includes loop of Henle and ADH. The loop of Henle creates negative water potential in medullary region, to absorb more water in collecting duct. The proximity between the loop of Henle and vasa recta and counter-current mechanism maintains high osmolarity towards inner medullary interstitium, which in turn concentrate the urine. Erythropoietin from JG cells helps in RBCs production. Glomerular blood hydrostatic pressure (GBHP) promotes filtration. It pushes water and solutes in blood plasma through the glomerular filtrate. Low levels of anti-diuretic hormone will cause the kidneys to excrete too much water resulting in dilute urine.

31. (A) PCT is involved in the reabsorption of Na^+ from blood, which increases the osmolarity of the urine, i.e., makes it concentrated. However, if the PCT is removed, the absorption of sodium ions does not occur and hence, the urine becomes more diluted.



Related Theory

During excretion, Proximal Convolute Tubules (PCT) reabsorb water, ions and nutrients. They remove toxins and help in maintaining the ionic balance and pH of the body fluids by secretion of potassium, hydrogen and ammonia to filtrate and reabsorbing bicarbonate ions from the filtrate. Descending limb of loop of Henle is permeable to water and the filtrate gets concentrated as it is impermeable to electrolytes. Ascending limb of loop of Henle is impermeable to water and permeable to electrolytes.

32. (C) Proximal convoluted tubule helps in the reabsorption of most electrolytes and water from the glomerular filtrate, independent of hormones. They are reabsorbed mostly by Na^+ , K^+ transport and water is reabsorbed due to the presence of many aquaporins. The loop of Henle is responsible for reabsorption of Na^+ and Cl^- and only 15% water is reabsorbed from the loop of Henle. Distal convoluted tubule regulates water and electrolyte absorption only in presence of the hormone aldosterone and vasopressin. So, only fewer amounts of electrolyte and water are reabsorbed.



Related Theory

GFR is one of the many ways in which homeostasis of blood volume and blood pressure may occur. In particular, low GFR is one of the variables that will activate the renin-angiotensin feedback system, a complex process that will increase blood volume, blood pressure, and GFR. This system is also activated by low blood pressure itself, and sympathetic nervous stimulation, in addition to low GFR.

Caution

→ Students usually choose the option *distal convoluted tubule (DCT)*. Remember that this option is wrong and correct option is *proximal convoluted tubule (PCT)*. Always memorise that *PCT* is lined by *simple cuboidal brush border epithelium*, which increases the surface area for reabsorption.

33. (D) The principal function of the loop of Henle appears to be the recovery of water and sodium chloride from the urine. This function allows production of urine, that is more concentrated than blood, limiting the amount of water needed as intake for survival. Thus, if Henle's loop were absent in mammalian nephron, urine will be more diluted.

Related Theory

→ Mammalian kidneys have the loop of Henle and length of the loop in the kidney determines how concentrated the final urine is. Birds and reptiles don't have long loops of Henle in their kidneys. They use their cloaca to pull water from their faeces and urine.

34. (B) The concentration of urine is controlled by Henle's loop. The descending limb is impermeable to electrolytes; and water is absorbed into the surrounding tissue. As it descends, the urine becomes more concentrated. As a result, longer the Henle's loop, more concentrated is the urine. After filtration, nutrients in the blood are absorbed by the capillary network.

35. (D) The surface area for reabsorption is increased in the proximal convoluted tubule by simple cuboidal brush border epithelium. This segment reabsorb nearly all essential nutrients as well as 70-80 percent of electrolytes and water. Under normal circumstances, glucose is completely reabsorbed from PCT. However, in conditions such as diabetes mellitus, glucose is not completely reabsorbed in the renal tubule, resulting in glucose in the urine. The presence of glucose in the urine is referred to as glycosuria.

36. (C) The proximal convoluted tubule is responsible for the reabsorption of ions, water, and nutrients from the glomerular filtrate. It also aids in the removal of toxins and the maintenance of ionic balance. It accomplishes this by reabsorbing bicarbonate ions in the filtrate and secreting ammonia, hydrogen, and potassium into it. On the other hand, collecting tubes helps in the absorption of water and transportation of urine. It has no function of reabsorption. Loop of Henle reabsorbs electrolytes and sodium chloride from urine and not from glomerular filtrate. Distal convoluted tubules are involved in reabsorption of water and sodium ions. It has more or less similar functions as PCT. But, it does not reabsorb from glomerular filtrate itself.

37. (D) Osmoreceptors in the hypothalamus detect changes in the osmotic pressure of the blood and regulate the secretion of ADH from the posterior pituitary gland. An excessive loss of body fluid from the body would activate osmoreceptors, not switch them off.

ADH is not responsible for a decrease in GFR (glomerular filtration rate). GFR is primarily controlled by the constriction or dilation of the afferent and efferent arterioles in the kidney.

38. (D) The close proximity between the Henle's loop and vasa recta as well as the counter-current in them help in maintaining an increasing osmolarity towards the inner medullary interstitium, i.e., from $300 \text{ mOsmol L}^{-1}$ (outside) to about $1200 \text{ mOsmol L}^{-1}$ in the inner medulla (inside).

39. (D) The JGA performs a complex regulatory function. A decrease in glomerular blood flow/glomerular blood pressure/GFR can activate JG cells, causing them to release renin, which converts angiotensinogen in the blood to angiotensin I and then to angiotensin II.

Related Theory

→ Atrial Natriuretic Factor (ANF) can cause vasodilation (dilation of blood vessels) and thereby decrease the blood pressure.

→ Angiotensin II, a potent vasoconstrictor, raises glomerular blood pressure and thus, the GFR.

→ Counter-current pattern of blood flow is observed in vasa recta.

40. (B) Diuresis occurs when the kidneys filter an excessive amount of body fluid. As a result, the body produces more urine and requires more frequent bathroom visits. In this case, the adrenal cortex secretes aldosterone (a steroid hormone), which causes reabsorption of Na^+ and water from the distal parts of the tubule and thus, prevents diuresis.

41. (B) Atrial Natriuretic Factor (ANF) is a peptide hormone secreted by the heart's atrial walls. It is primarily secreted in response to hypertension (high blood pressure). This hormone works as a vasodilator, lowering blood pressure. It also lowers the concentration of water and sodium in the circulatory system. On the other hand, Renin is an enzyme released by the juxtaglomerular cells of the kidney. It is released when the kidney receives a low volume of blood. Aldosterone is a steroid hormone, which regulates the sodium and potassium level in blood. It is a part of the Renin-Angiotensin-Aldosterone system (RAAS). An increase in the levels of aldosterone can cause high blood pressure. Antidiuretic hormone affects the kidney function by its constrictory effect on the blood vessels and this causes an increase in the blood pressure. ADH released by the neurohypophysis is present in the hypothalamus.

42. (C) Renin is secreted by JGA, regulates the GFR by inducing RAAS (Renin-Angiotensin-Aldosterone System). This in turn increases the absorption of sodium and water making urine more concentrated. Alcohol and caffeine decrease vasopressin level, lowering the absorption of water, thus making urine more dilute. ANF causes vasodilation and hence, diluting the urine concentration.

43. (A) Aldosterone is a hormone secreted by the outer layer of the adrenal gland (cortex part). Aldosterone secretion is triggered by decreased blood volume and interstitial fluid level, which leads to decreased blood pressure. When aldosterone is present in the blood, the collecting duct epithelial cells increase Na^+ reabsorption in the filtrate. Retaining Na^+ raises blood osmotic pressure and decreases water loss from the body. When aldosterone is absent, some Na^+ remains in the filtrate and is excreted with the urine.

44. (D) The neurohypophysis secretes antidiuretic hormone (ADH) or vasopressin. This hormone promotes water reabsorption from latter parts of the tubule, preventing diuresis. An increase in body fluid volume (for e.g., when someone drinks lot of water) can switch off the osmoreceptors and suppress the ADH release to complete the feedback.

45. (C) Angiotensinogen is a protein produced and released by the liver. Renin, a kidney-produced enzyme, then breaks this down to form angiotensin I. This form of the hormone has no known biological function in itself, but it is an important precursor for angiotensin II. It is metabolised further in the bloodstream by the action of angiotensin-converting enzyme as it travels through the lungs and kidneys to produce angiotensin II.

46. (D) In kidney, the PCT regulates the pH of the filtrate by the exchange of hydrogen ions. The kidneys excrete a variable amount of hydrogen ions into the urine and conserve bicarbonate ions, which are important buffer in the blood. Both of these activities help regulate blood pH. The tubule cell secretes the H^+ ion and the ammonia into the renal filtrate, and two Na^+ ions are reabsorbed in exchange. As the Na^+ ions are returned to the blood in the peritubular capillaries, HCO_3^- ions follow. With two H^+ ions excreted in urine, two Na^+ ions and two HCO_3^- ions are returned to the blood. This mechanism helps in preventing acidic outflow of body fluids.

Related Theory

→ Fresh urine is usually acidic with pH range of 5.5 to 7.

47. (D) Micturition, or urination, is the act of emptying the bladder (voluntarily). Urination is the act of passing urine, which is a reflex phenomenon. As urine accumulates in the bladder, the stretch receptors

are activated that pass the stimulus to the CNS. The CNS passes on motor neurous and messages to initiate the contraction of smooth muscles of the bladder and simultaneous relaxation of the urethral sphincter causing the release of urine. Therefore, in the absence of stretch receptors, the urine would get collected and probably overflow and there will be no micturition.

Related Theory

→ When the bladder is full of urine, stretch receptors in the bladder wall trigger the micturition reflex. The detrusor muscle that surrounds the bladder contracts. The internal urethral sphincter relaxes, allowing for urine to pass out of the bladder into the urethra. Both of these reactions are involuntary. The external urethral sphincter is voluntary. It is relaxed for urine to flow through the urethra and outside the body.

48. (D) The fat when burned to get energy, releases many ketones in the blood and so in urine. This process of producing energy by the fats is fatty acid catabolism. Hence, a large amount of the ketones get eliminated in the urine causing ketonuria.

Related Theory

→ A condition in which abnormally high amounts of ketones and ketone bodies (a byproduct of the breakdown of cells) are present in the urine is called ketonuria. It is a sign seen in extreme case of diabetes mellitus.

49. (B) Sweat glands are coiled tubular glands located in the dermis and connected to a sweat duct that opens as a pore on the skin's surface. Sweat is a watery fluid containing NaCl , small amounts of urea, lactic acid, and other substances. Sweat's primary function is to provide a cooling effect on the body's surface; it also aids in the removal of some of the wastes mentioned above. On the other hand, the primary role of sebum is to lubricate the skin to protect against friction and makes it more impervious to moisture. Saliva has the function of washing away food debris and bacteria remaining in the mouth, which leads to the prevention of caries and gingivitis. Tears keep the eyes wet and smooth, and help focus light. They also protect the eyes from infections and irritating things, like dirt and dust.

Related Theory

Thermoregulation is the process by which the body maintains its internal core temperature. All thermoregulation mechanisms aim to restore the body's homeostasis. This is called an equilibrium state.

50. (B) Use of an artificial kidney during haemodialysis may result in reduced absorption of calcium ions from gastro intestinal tract and reduced RBC production. This occurs due to low levels of erythropoietin hormone by juxtaglomerular cells and elimination of calcium ions along with phosphate ions during dialysis. Haemodialysis is used to eliminate the nitrogenous wastes, build up in the body.

51. (D) Increased level of glucose in blood results in glycosuria. This results in presence of glucose in urine. Gout is a form of arthritis, characterised by severe pain and tenderness in joints. It is due to the accumulation of uric acid crystals in joints. Renal calculi or kidney stones are small masses of crystalline salts within the kidneys. These stones can be of calcium, uric acid, struvite, etc. Glomerular nephritis is the inflammation of filtering units, i.e., glomerulus of kidney. It is also known as Bright's disease. It may cause hematuria (blood in urine) and proteinuria (protein in urine).

Caution

Students generally misinterpret the meaning of disease glycosuria. They often get confused and think that glycogen level of the body increases in this disease. But it is not the correct explanation, as this disease is characterised by an excess of sugar in the urine and it is typically associated with diabetes or kidney.

52. (C) The term anuria refers to absence of urine or to the condition when urine volume is less than 100 mL in 24 hours. It is mostly caused due to the failure of kidneys. Owing to kidney failure, there is no urine production and empty bladder leads to no urge for urination.

53. (B) If kidneys fail to reabsorb water, the volume of blood decreases. The concentration of plasma increases so the urine becomes diluted causing the condition of polyuria (frequent urination). Due to frequent urination, the body tissues get dehydrated and the cell will lose water content and shrink.

54. (C) Hematuria, is the medical term if red blood cells (erythrocytes) are present in the urine. It may occur due to kidney stone or a tumor in the urinary tract (kidneys, ureters, urinary bladder, prostate, and urethra), ranging from normal to lethal.