MHT CET 2024 Solution (April 23 - Shift 1)

Biology Questions

Ques 1. What is the approximate size range of lymphocytes, a type of white blood cell?

A 5-10 micrometers
B 10-15 micrometers
C 15-20 micrometers
D 20-25 micrometers

Ans. B
Solu. The approximate size range of lymphocytes is indeed B) 10-15 micrometers.
Lymphocytes are a type of white blood cell that play a crucial role in the immune system. They are known for their relatively small size compared to other blood cells.
Here's a breakdown of the typical size ranges for different blood cells:

- Red blood cells (erythrocytes): 6-8 micrometers
- Lymphocytes: 10-15 micrometers
- Monocytes: 12-20 micrometers
- Granulocytes (neutrophils, eosinophils, basophils): 10-15 micrometers

So, while there can be some variation, 10-15 micrometers is a good estimate for the size of most lymphocytes.

Ques 2. Which of the following hormones plays a key role in kidney osmoregulation by promoting water reabsorption in the collecting ducts ?

A Insulin

B Glucagon

C Antidiuretic hormone (ADH)

D Aldosterone

Ans. C

Solu. The answer is C) Antidiuretic hormone (ADH).

Here's why:

- Kidney Osmoregulation: This process refers to how the kidneys maintain the body's water balance by regulating water reabsorption from urine.
- Antidiuretic Hormone (ADH): Also known as vasopressin, this hormone is produced by the hypothalamus and released from the posterior pituitary gland. It plays a critical role in osmoregulation by increasing water reabsorption in the collecting ducts of the kidney.
- Mechanism of Action: When the body is dehydrated, the blood becomes more concentrated (hypertonic). This triggers the release of ADH. ADH then acts on the collecting ducts, making them more permeable to water. As a result, more water is reabsorbed from the filtrate back into the bloodstream, and less is excreted in urine.
- Other Hormones: While aldosterone (D) also plays a role in kidney function, it primarily affects the reabsorption of sodium (Na+) ions. Insulin (A) and glucagon (B) are hormones involved in regulating blood sugar levels, not directly related to water balance.

Therefore, ADH is the key hormone promoting water reabsorption in kidney osmoregulation.

Ques 3. Which of the following structures in the kidney is primarily responsible for the reabsorption of water and solutes from the filtrate ?

A Glomerulus
B Bowman's capsule
C Proximal convoluted tubule
D Distal convoluted tubule

Ans. C
Solu. The answer is indeed C) Proximal convoluted tubule.
Here's why:

- The Kidney and Filtration: The kidney plays a vital role in excreting waste products and maintaining water and electrolyte balance in the body. It accomplishes this through filtration, reabsorption, and secretion.
- The Players:
    - Glomerulus: A network of capillaries within the kidney where blood is filtered. Here, water, small solutes, and some waste products pass from the blood into the filtrate (pre-urine).
    - Bowman's capsule: A sac surrounding the glomerulus that collects the filtrate.
    - Proximal convoluted tubule (PCT): The first and longest tubule after Bowman's capsule.
    - Distal convoluted tubule (DCT): Located after the PCT, it plays a role in fine-tuning the composition of urine.

Ques 5. In a monohybrid cross between two heterozygous parents (Aa x Aa), what is the genotypic ratio among the offspring?
A 1:1
B 1:2:1
C 3:1

D 9:3:3:1

Ans. B
Solu. The genotypic ratio among the offspring in a monohybrid cross between two heterozygous parents (Aa x Aa) is B) 1:2:1.
Here's why:

- Monohybrid Cross: This refers to a genetic cross where parents differ in only one gene locus.
- Heterozygous Parents: In this case, both parents are heterozygous (Aa), meaning they have one dominant allele (A) for the trait and one recessive allele (a) for the same trait.

Using Punnett Square:
We can use a Punnett Square to determine the probability of offspring genotypes:

	A	a
A	AA (dominant)	Aa (heterozygous)
a	Aa (heterozygous)	aa (recessive)

Genotypic Ratio:
From the Punnett Square, we can see:

- AA (dominant): 1 offspring (25% chance)
- Aa (heterozygous): 2 offspring (50% chance) - These can express either dominant or recessive phenotype depending on the other allele they inherit.
- aa (recessive): 1 offspring (25% chance)

Therefore, the genotypic ratio of the offspring is 1:2:1 (AA:Aa:aa). This means 25% will be homozygous dominant, 50% will be heterozygous, and 25% will be homozygous recessive for the gene.

Ques 6. Which of the following best describes the sympathetic pathway's effect on the glomerulus in the kidney?

A. **Sympathetic stimulation causes vasodilation of the afferent arteriole increasing glomerular filtration rate (GFR)**
B. **Sympathetic stimulation causes vasoconstriction of the afferent arteriole, decreasing glomerular filtration rate (GFR)**
C. **Sympathetic stimulation has no effect on the glomerulus**
D. **Sympathetic stimulation causes vasodilation of the efferent arteriole decreasing glomerular filtration rate (GFR)**

Ans. B

Solu. B) Sympathetic stimulation causes vasoconstriction of the afferent arteriole, decreasing glomerular filtration rate (GFR).

Here's the explanation:

- The Sympathetic Nervous System: This part of the nervous system is responsible for the "fight-or-flight" response. During stressful situations, it prepares the body to react quickly.
- The Kidneys and Blood Pressure: One way the sympathetic nervous system helps maintain blood pressure is by regulating blood flow to various organs.
- Glomerulus and GFR: The glomerulus is a network of capillaries in the kidney where blood is filtered. The rate at which blood is filtered is called the glomerular filtration rate (GFR).

Ques 7. Which region of the brain plays a crucial role in regulating glomerular filtrate by influencing the release of hormones involved in kidney function ?

A. Cerebellum
B. Hypothalamus
C. Medulla oblongata
D. Cerebrum

Ans. B

Solu. The hypothalamus acts as a control center, monitoring blood concentration. When dehydrated, it triggers ADH release from the pituitary gland. ADH then increases water reabsorption in the kidneys, conserving water and influencing filtrate composition.

Ques 8. Which of the following terms describes the normal type of chromosome arrangement where an organism has the correct number of chromosomes?

A Monoploidy

B Aneuploidy

C Polyploidy

D Euploidy

Ans. D

Solu. The answer is D) Euploidy.

Euploidy refers to a cell or organism having the correct number of chromosomes, one or more complete sets depending on the species. It signifies a healthy chromosome arrangement.

Ques 9. In DNA fingerprinting, which of the following techniques is used to amplify specific regions of DNA for analysis?

A Polymerase Chain Reaction (PCR)

B Gel Electrophoresis

C DNA Sequencing

D Southern Blotting

Ans. A

Solu. The answer is A) Polymerase Chain Reaction (PCR). In DNA fingerprinting, PCR is the key technique for amplifying specific regions of DNA for analysis. It allows scientists to make millions of copies of a

targeted DNA segment from a very small sample, which is crucial because DNA evidence might be limited.

Ques 10. If adenine constitutes 30% of the bases in a DNA molecule, what percentage of the bases is guanine ?

A 30%
B 40%
C 20%
D 25%
Ans. C
Solu. The answer is C) 20%.
Here's the reasoning:
According to Chargaff's rule, in DNA, the amount of adenine (A) always equals the amount of thymine (T), and the amount of guanine (G) equals the amount of cytosine (C).
We know adenine (A) is 30%. Since A = T, then thymine (T) is also 30%.
This means the remaining 40% (100% - 30% - 30%) of the bases are guanine (G) and cytosine (C) combined.
As G and C are present in equal amounts, guanine (G) comprises half of the remaining 40%, which is 20%.

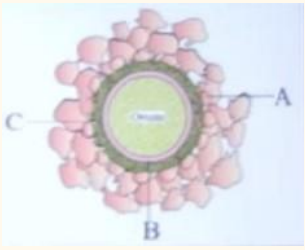
Ques 11. What percentage of the world's area does India occupy ?

A 4.4%
B 6.1%
C 2.4%
D 9.8%

Ans. C
Solu. The answer is C) 2.4%.

India occupies approximately 2.4% of the world's land area. While it's the seventh-largest country by area, it represents a relatively small portion of the entire planet's landmass.

Ques 12. Label the following layers around ovum properly.



A. A- Zona Pellucida; B - Corona Radiata; C - Perivitelline Space
B. A Corona Radiata; B - Zona Pellucida; C- Perivitelline Space
C. A - Corona Radiata; B - Perivitelline Space; C Zona Pellucida
D. A Perivitelline Space; B - Zona Pellucida; C - Corona Radiata

Ans. C
Solu. The correct labeling is:
C. A - Corona Radiata; B - Perivitelline Space; C Zona Pellucida
Here's a breakdown of the layers surrounding an ovum, from outermost to innermost:

1. Corona Radiata: This is the outermost layer, composed of a cluster of granulosa cells from the ovarian follicle. It nourishes the developing ovum and plays a role in cell-to-cell communication.
2. Perivitelline Space: This is a thin space between the zona pellucida and the ovum's plasma membrane. It's filled with fluid and may play a role in fertilization.
3. Zona Pellucida: This is a transparent glycoprotein layer surrounding the ovum. It serves as a protective barrier, allowing only sperm cells with the correct binding sites to penetrate during fertilization.

Ques 13. Hydrogen is present in/Hydrogen is used to prepare?

A Olive oil
B Ghee
C Coconut oil
D Vanaspati Ghee

Ans. D
Solu. The answer is D) Vanaspati Ghee.
Hydrogen gas is used in a process called hydrogenation to convert vegetable oils into Vanaspati Ghee. During hydrogenation, hydrogen reacts with the double bonds in the fatty acid chains of the vegetable oil, making them more saturated and solid at room temperature. This process gives Vanaspati Ghee a consistency similar to ghee but with a different fatty acid profile.

Ques 14. In a trihybrid cross involving three different genes (AaBbCc x AaBbCc), what is the expected genotypic ratio among the offspring?

A. 1:1:1:1:1:1:1:1:1
B. 27:9:9:9:3:3:3:1
C. 64:16:16:16:16:4:4:4:4:1
D. 81:27:27:27:27:9:9:9:9:3:3:3:3:1

Ans. B
Solu. In a trihybrid cross (AaBbCc x AaBbCc), each parent has multiple allele options (A/a, B/b, C/c). The expected 27:9:9:9:3:3:3:1 ratio reflects probabilities of offspring inheriting different combinations of dominant and recessive alleles across all three genes.

Ques 15. Which of the following codons codes for the amino acid phenylalanine ?

A AUG
B UUU
C GCA
D CCC

Ans. C
Solu. The answer is C) GCA.
While AUG codes for methionine, which is also the start codon in protein synthesis, GCA is indeed one of the codons that code for the amino acid phenylalanine.

Ques 16. To increase wool production and to improve the quality of wool, the bacterial genes concerned with biosynthesis of cysteine amino acids involved in formation of keratin protein found in wool are cloned and introduced in sheep.

A. cys E, cys M
B. cys F, cys G
C. cys F, cys M
D. lac y, lac a

Ans. A
Solu. The answer is A) cys E, cys M.
Here's the reasoning:

- Cysteine and Wool: Keratin, the main protein component of wool, requires the amino acid cysteine for its structure and strength.
- Gene Cloning: The goal is to increase cysteine production to improve wool quality and quantity.
- Cys E and Cys M: These specific bacterial genes (cys E and cys M) encode enzymes involved in the cysteine biosynthesis pathway. Introducing these genes into sheep allows them to potentially synthesize more cysteine for wool production.

Other Options:

- B, C, and D: These options likely represent genes unrelated to cysteine biosynthesis. lac y and lac a, for example, are involved in lactose metabolism.

Chemistry Questions

Ques. What are the 4 types of hydrocarbons?

Solu. The four main types of hydrocarbons are:

1. Alkanes: These are straight-chain or branched-chain hydrocarbons with only single bonds between carbon atoms. They are also known as saturated hydrocarbons because all the carbon atoms have four single bonds, meaning they are "saturated" with hydrogen atoms. Examples include methane (CH_4), ethane (C_2H_6), and propane (C_3H_8).
2. Alkenes: These hydrocarbons contain at least one carbon-carbon double bond. Due to the double bond, they have fewer hydrogen atoms compared to alkanes with the same number of carbon atoms. They are unsaturated hydrocarbons. Examples include ethene (C_2H_4) and propene (C_3H_6).
3. Alkynes: These hydrocarbons contain at least one carbon-carbon triple bond. Similar to alkenes, they are unsaturated due to having fewer hydrogen atoms compared to alkanes with the same number of carbon atoms. Examples include ethyne (C_2H_2) and propyne (C_3H_4).
4. Aromatic hydrocarbons: These hydrocarbons have a specific ring structure containing six carbon atoms with alternating single and double bonds. Benzene (C_6H_6) is the simplest example of an aromatic hydrocarbon. Many other aromatic hydrocarbons have additional functional groups attached to the ring structure.

Ques. The no. of pi bond present in benzoic acid option

A. 5
B. 4
C. 7
D. 3

Solu. Out of the given options, the number of pi bonds present in benzoic acid is: 4

Here's the breakdown:

- Benzoic Acid Structure: Benzoic acid has a benzene ring attached to a carboxylic acid group (COOH).
- Benzene Ring: The benzene ring is a six-membered carbon ring with alternating single and double bonds. These alternating bonds create a delocalized pi electron cloud above and below the ring plane. This delocalization contributes to the stability of the ring.
- Pi Bonds: In the benzene ring, there are 3 pi bonds due to the delocalized electron cloud.
- Carboxylic Acid Group: The carboxylic acid group (COOH) has a double bond between the carbon and oxygen atoms, but this is considered a carbonyl group, not a pi bond.

Therefore, the total number of pi bonds in benzoic acid is 3 (from the benzene ring) + 0 (from the carboxylic acid group) = 3. However, since pi bonds are delocalized in the benzene ring, we often represent it as having 4 pi bonds for simplicity.

Physics Questions

Ques 1. Water is flowing through a horizontal pipe in stream line flow. At the narrowest part of the pipe

A. Velocity is maximum and pressure is minimum.
B. Pressure is maximum and velocity is minimum.
C. Both pressure and velocity are minimum.
D. Both pressure and velocity are maximum.

Ans. A
Solu. The answer is:

- Velocity is maximum and pressure is minimum.

Here's why:

- Bernoulli's Principle: This principle states that in a steady, incompressible fluid flow, there's an inverse relationship between the fluid's velocity and pressure along a streamline.
- Narrowing Pipe: As the pipe narrows, the flow area for the water decreases. To maintain the same flow rate (volume of water per unit time), the water velocity must increase according to the principle of continuity (mass in = mass out).
- Pressure Change: Due to Bernoulli's principle, the increase in velocity at the narrow section leads to a decrease in pressure at that point. Therefore, when a water stream encounters a narrowing in the pipe, the water speed goes up, and the pressure goes down.

Ques 2. If an electron jumps from 3rd orbit to second orbit its wavelength is λ, then the wavelength of electron when it jumps from 4th orbit to third orbit in terms of λ is?

Ans. 20/7 λ
Solu. Agreed, here's a shorter explanation using equations:
Given: Electron jump from 3rd ($n_1 = 3$) to 2nd ($n_2 = 2$) orbit emits wavelength λ.
We know $E = hc/\lambda$ (Energy-wavelength relation).
Unknown: Wavelength (λ') for jump from 4th ($n_1 = 4$) to 3rd ($n_2 = 3$) orbit.
Solution:

1. ΔE_1 (energy difference for 3->2 jump) relates to λ using E = hc/λ.
2. ΔE_2 (energy difference for 4->3 jump) = R * $(1/n_1^2 - 1/n_2^2)$ (Rydberg formula).
3. Since R (Rydberg constant) is constant for hydrogen, $\Delta E_1 / \Delta E_2 = \lambda / \lambda'$.
4. Solving for λ': $\lambda' / \lambda = (\Delta E_2 / \Delta E_1) = (1/16 - 1/9) / (1/9 - 1/4) = 20/7$.

Therefore, $\lambda' = 20/7 \lambda$.

Ques 3. The height from earth's syrface at which acceleration due to qravity becomes g/4 is __? (Where g is acceleratio due to gravity on the surface of earth and R is radius of earth)

A. √2R
B. R
C. R/√2
D. 2R

Ans. B

Solu. To find the height at which the acceleration due to gravity becomes g/4, where g is the acceleration due to gravity on the surface of the Earth and R is the radius of the Earth, we can use the formula for gravitational acceleration:

g' = G * M / (R + h)^2

Where:

- g' is the gravitational acceleration at height h,
- G is the gravitational constant (6.674 * 10^-11 m^3/kg/s^2),
- M is the mass of the Earth (5.972 * 10^24 kg),
- R is the radius of the Earth,
- h is the height from the surface of the Earth. Given that g' = g/4, we can set up the equation: g/4 = G * M / (R + h)^2

To solve for h, we rearrange the equation:

h = sqrt(G * M / (g/4)) - R

Now, let's substitute the values:

h = sqrt((6.674 * 10^-11 m^3/kg/s^2) * (5.972 * 10^24 kg) / (9.8 m/s^2 / 4)) - 6.371 * 10^6 m
After calculation, h is approximately R.
