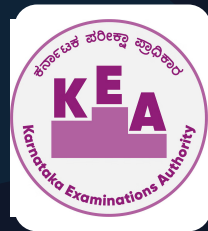


KCET 2026 Biology April 24

Question Paper with Solutions

Conducted by KEA



General Instructions

- (i) **Duration:** The total duration of the examination is 80 minutes.
- (ii) **Total Marks:** The complete paper carries a maximum of 60 marks.
- (iii) **Structure:** The paper has 60 Questions from Physics
- (iv) **Compulsory Questions:** All 60 questions are compulsory.
- (v) Each question has four options. Only **one** option is correct.
- (vi) **Correct Answer:** +1 marks.
- (vii) **Incorrect Answer:** (No Negative marking).
- (viii) **Unanswered/Marked for Review:** 0 marks.

1. A chromosome with an extremely short and a very long arm is called _____.

- (A) Metacentric
- (B) Telocentric
- (C) Acrocentric
- (D) Submetacentric

Correct Answer: (C) Acrocentric

Solution:

Step 1: Understanding the Problem:

Chromosomes are classified into four distinct types based on the exact position of the centromere along the chromosome.

Step 2: Approach and Formula:

The approach is to categorize chromosomes based on the location of the centromere, which dictates the relative lengths of the two arms (the 'p' arm and the 'q' arm).

Step 3: Detailed Explanation:

- Metacentric: The centromere is situated in the exact middle, forming two equal arms.
- Submetacentric: The centromere is positioned slightly away from the middle, resulting in one slightly shorter arm and one slightly longer arm.
- Acrocentric: The centromere is situated very close to its end, forming one extremely short arm and one very long arm.
- Telocentric: The centromere is at the terminal end.

Therefore, the given description perfectly matches an acrocentric chromosome.

Step 4: Final Answer:

The correct option is Acrocentric.

Quick Tip: Remember the mnemonic "M S A T" for centromere positions mapping to arm lengths: Middle (Metacentric), Slightly off (Submetacentric), Almost end (Acrocentric), Terminal (Telocentric).

2. The following statements are the steps in the catalytic action of an enzyme. Arrange them in correct sequence.

- The active site of the enzyme, now in close proximity of the substrate, breaks the chemical bonds of the substrate and the new enzyme product complex is formed.
- The substrate binds tightly to the enzyme, inducing a change in the active site of the enzyme.
- The enzyme releases the products of the reaction and the free enzyme is ready to bind to another molecule of the substrate.
- The substrate binds to the active site of the enzyme.

- (A) c, a, b, d
(B) d, b, a, c
(C) a, b, c, d
(D) d, c, b, a

Correct Answer: (B) d, b, a, c

Solution:

Step 1: Understanding the Problem:

The catalytic cycle of an enzyme's action involves a specific sequence of steps that explain how a substrate is converted into a product using the induced-fit model.

Step 2: Approach and Formula:

Evaluate the standard catalytic cycle of enzymes, identifying the correct chronological order: Substrate binding → Enzyme shape alteration → Bond breaking/forming → Product release.

Step 3: Detailed Explanation:

The correct sequential steps are:

1. The substrate first binds to the active site of the enzyme, fitting into the active site. (Statement d)
2. The binding of the substrate induces the enzyme to alter its shape, fitting more tightly around the substrate. (Statement b)
3. The active site of the enzyme, now in close proximity to the substrate, breaks the chemical bonds of the substrate, and the new enzyme-product complex is formed. (Statement a)
4. The enzyme releases the products of the reaction, and the free enzyme is ready to bind to another molecule of the substrate. (Statement c)

Hence, the correct sequence is d, b, a, c.

Step 4: Final Answer:

The correct sequence is d, b, a, c.

Quick Tip: To easily recall the catalytic cycle, use the sequence: Bind → Induce fit → Break/Form bonds → Release.

3. A diploid cell which has 8 chromosomes undergoes meiosis and produces 4 daughter cells. What is the number of chromosomes present in each daughter cell formed at the end of meiosis-I?

- (A) 8 chromosomes
- (B) 4 chromosomes
- (C) 16 chromosomes
- (D) 32 chromosomes

Correct Answer: (B) 4 chromosomes

Solution:

Step 1: Understanding the Problem:

Meiosis is a type of cell division that consists of two consecutive stages: Meiosis-I and Meiosis-II. The primary purpose of Meiosis-I is the segregation of homologous chromosomes, which halves the genetic content.

Step 2: Approach and Formula:

Since Meiosis-I is a reductional division, the chromosome number is reduced to half:

$$n = \frac{2n}{2}$$

Step 3: Detailed Explanation:

The given parent cell is diploid ($2n$) with 8 chromosomes.

During Meiosis-I, homologous pairs separate. This reductional division creates two daughter cells, each containing half the original number of chromosomes.

Applying the formula:

$$\text{Number of chromosomes} = \frac{8}{2} = 4$$

Therefore, at the end of Meiosis-I, each daughter cell will have 4 chromosomes.

Meiosis-II will follow as an equational division, keeping the chromosome number at 4 in the final 4 daughter cells.

Step 4: Final Answer:

The number of chromosomes present is 4 chromosomes.

Quick Tip: Always remember: Meiosis I is reductional (halves the chromosome number), and Meiosis II is equational (maintains the already halved chromosome number).

4. Cellulose is an important structural component in plants which is made up of

(A) Fructose

- (B) Galactose
- (C) Glucose
- (D) Sucrose

Correct Answer: (C) Glucose

Solution:

Step 1: Understanding the Problem:

Cellulose is a polymeric polysaccharide that forms the major structural component of the primary cell wall of green plants.

Step 2: Approach and Formula:

Identify the primary monomeric unit that polymerizes to form the structural homopolysaccharide, cellulose.

Step 3: Detailed Explanation:

Cellulose is a homopolymer, meaning it is built from a single type of repeating monomer unit. These monomers are β -D-glucose units, linked together by β -1,4-glycosidic bonds. Options like Fructose and Galactose are different monosaccharides, and Sucrose is a disaccharide (made of glucose and fructose). Thus, none of these build cellulose.

Step 4: Final Answer:

Cellulose is made up of Glucose.

Quick Tip: Starch, Glycogen, and Cellulose are all homopolymers of Glucose. Starch/Glycogen are for storage (alpha-glucose), while Cellulose is for structure (beta-glucose).

5. In a healthy individual, the Glomerular Filtration Rate (GFR) is _____.

- (A) 125 ml/minute
- (B) 125 ml/hour
- (C) 126 ml/minute
- (D) 125 ml/second

Correct Answer: (A) 125 ml/minute

Solution:**Step 1: Understanding the Problem:**

Glomerular Filtration Rate (GFR) is defined as the volume of filtrate formed by both kidneys per minute. It is an important indicator of renal health.

Step 2: Approach and Formula:

Recall the standard physiological values for Glomerular Filtration Rate (GFR) in a healthy human adult as mentioned in standard physiological texts.

Step 3: Detailed Explanation:

In a healthy adult human, the kidneys filter approximately 1100-1200 ml of blood per minute. From this blood, the amount of glomerular filtrate formed per minute is about 125 ml. This equals a total of roughly 180 liters of filtrate per day ($125 \text{ ml} \times 60 \text{ mins} \times 24 \text{ hours}$). Looking at the given options, 125 ml/minute is the correct physiological rate.

Step 4: Final Answer:

The GFR is 125 ml/minute.

Quick Tip: Be very careful with units in such questions! Examiners often use the correct number (125) with incorrect time units (hour, second) to confuse students.

6. A hormone that initiates flowering and synchronising fruit set in pineapples is _____.

- (A) Ethylene
- (B) Abscissic Acid
- (C) Auxins
- (D) Gibberellins

Correct Answer: (A) Ethylene

Solution:**Step 1: Understanding the Problem:**

Plant growth regulators (PGRs) control various developmental processes. Both Auxins and Ethylene have distinct agricultural applications regarding flowering in certain plants.

Step 2: Approach and Formula:

Map the specific agricultural applications (specifically "synchronising fruit set" along with

initiating flowering in pineapples) to the correct plant growth regulator.

Step 3: Detailed Explanation:

While Auxins (like NAA and 2,4-D) are known to promote flowering in pineapples, the specific combined function of "initiating flowering" AND "synchronising fruit-set" is a hallmark function of Ethylene.

Ethylene is widely used in agriculture for this precise purpose, ensuring that all pineapple plants in a field flower and produce fruit at the same time, which is highly beneficial for harvesting.

Step 4: Final Answer:

The correct hormone is Ethylene.

Quick Tip: When a question mentions "synchronising fruit set" specifically for pineapples, the answer is always Ethylene. If it merely says "promotes flowering", both Auxin and Ethylene might be considered, but Ethylene is the synchroniser.

7. Identify the incorrect statement regarding respiratory system in man.

- (A) Lungs are covered by double-layered membrane called pleura.
- (B) The alveoli are surrounded by rich blood capillaries.
- (C) The trachea, bronchi and bronchioles are supported by 'O' shaped cartilaginous rings.
- (D) The right lung is slightly larger than the left lung.

Correct Answer: (C) The trachea, bronchi and bronchioles are supported by 'O' shaped cartilaginous rings.

Solution:

Step 1: Understanding the Problem:

The human respiratory tract is a complex anatomical system designed for gas exchange. Its structures include the lungs, pleura, alveoli, and the conducting passage (trachea, bronchi, and bronchioles).

Step 2: Approach and Formula:

Analyze each anatomical statement regarding the human respiratory system to find the structurally inaccurate one.

Step 3: Detailed Explanation:

Let us evaluate each statement:

- Statement (A): The lungs are situated in the thoracic chamber and are protected by a double-layered membrane known as the pleura. This is a true statement.
- Statement (B): The alveoli, being the sites of actual gas exchange, are heavily surrounded by an extensive network of blood capillaries. This is a true statement.
- Statement (C): The trachea, primary, secondary, and tertiary bronchi, and initial bronchioles are indeed supported by cartilaginous rings to prevent collapse. However, these rings are incomplete dorsally, making them 'C' shaped, not 'O' shaped. This statement is incorrect.
- Statement (D): The right lung has three lobes and is generally larger, whereas the left lung has two lobes and is slightly smaller due to the cardiac notch. This is a true statement.

Step 4: Final Answer:

The incorrect statement is (C).

Quick Tip: Remember that the cartilaginous rings in the respiratory tract are 'C' shaped (incomplete dorsally) to allow the esophagus, situated right behind the trachea, to expand easily during swallowing.

8. Consider the following statements with respect to ECG [Electrocardiogram] and choose the correct answer.

Statement I : 'P' wave represents the depolarisation of ventricles.

Statement II : 'T' wave represents the repolarisation of ventricles.

- (A) Statement I and Statement II are wrong.
- (B) Statement I is correct but Statement II is wrong.
- (C) Statement I is wrong but Statement II is correct.
- (D) Statement I and Statement II are correct.

Correct Answer: (C) Statement I is wrong but Statement II is correct.

Solution:

Step 1: Understanding the Problem:

An Electrocardiogram (ECG) is a graphical representation of the electrical activity of the heart during a standard cardiac cycle, featuring distinct waves: P, QRS, and T.

Step 2: Approach and Formula:

Relate the standard ECG waves to their corresponding cardiac cycle events (depolarisation and repolarisation of the atria and ventricles).

Step 3: Detailed Explanation:

- **Statement I:** The 'P' wave on an ECG corresponds to the electrical excitation or depolarisation of the **atria**, which leads to atrial contraction. It does not represent ventricular depolarisation (which is the QRS complex). Therefore, Statement I is wrong.

- **Statement II:** The 'T' wave represents the return of the ventricles from an excited state to a normal state, a process called **repolarisation**. The end of the T-wave marks the end of ventricular systole. Therefore, Statement II is correct.

Since Statement I is false and Statement II is true, the matching option is (C).

Step 4: Final Answer:

Statement I is wrong but Statement II is correct.

Quick Tip: ECG Mnemonic Summary:

P-wave = Atrial Depolarization.

QRS complex = Ventricular Depolarization.

T-wave = Ventricular Repolarization.

9. Aldosterone from adrenal cortex stimulates the reabsorption of water and Na^+ from _____.

- (A) Proximal Convolute Tubule (PCT)
- (B) Ascending limb of loop of Henle
- (C) Distal Convolute Tubule (DCT)
- (D) Descending limb of loop of Henle

Correct Answer: (C) Distal Convolute Tubule (DCT)

Solution:**Step 1: Understanding the Problem:**

Aldosterone is a steroid hormone (mineralocorticoid) produced by the adrenal cortex. It plays a critical role in osmoregulation and blood pressure control.

Step 2: Approach and Formula:

Identify the specific segment of the nephron that acts as the target site for the conditional reabsorption mediated by aldosterone.

Step 3: Detailed Explanation:

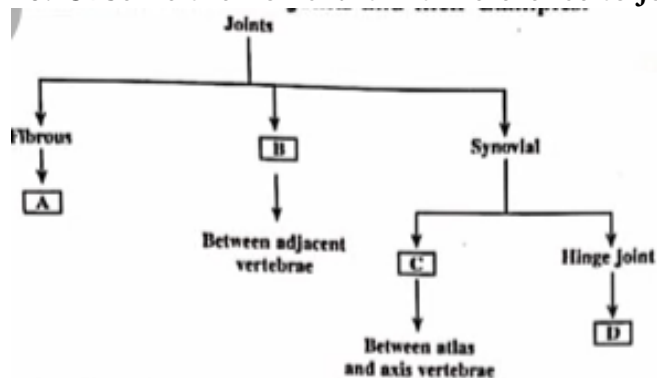
- The Proximal Convolved Tubule (PCT) handles the bulk of unconditional reabsorption, not primarily driven by aldosterone.
- The Loop of Henle maintains the osmotic gradient in the medullary interstitium. The descending limb is permeable to water, and the ascending limb is permeable to electrolytes.
- The Distal Convolved Tubule (DCT) is responsible for the **conditional** reabsorption of Na^+ and water. This conditional action is directly stimulated by the hormone aldosterone, usually activated by the Renin-Angiotensin-Aldosterone System (RAAS) in response to low blood pressure.

Step 4: Final Answer:

Aldosterone acts on the Distal Convolved Tubule (DCT).

Quick Tip: Remember that "Conditional" reabsorption in the DCT depends on hormones: Aldosterone stimulates Na^+ reabsorption, while ADH (Vasopressin) primarily stimulates water reabsorption.

10. Observe the flowchart with reference to joints and their examples.



- (A) A - Cartilaginous joint, B - Pivot joint, C - Knee joint, D - Cranial sutures
(B) A - Pivot joint, B - Knee joint, C - Cranial sutures, D - Cartilaginous joint
(C) A - Saddle joint, B - Cranial sutures, C - Cartilaginous joint, D - Pivot joint
(D) A - Cranial sutures, B - Cartilaginous joint, C - Pivot joint, D - Knee joint

Correct Answer: (D) A - Cranial sutures, B - Cartilaginous joint, C - Pivot joint, D - Knee joint

Solution:

Step 1: Understanding the Problem:

Joints are the junctions where bones meet. Based on their structural composition and the movement they allow, human joints are classified into Fibrous, Cartilaginous, and Synovial joints.

Step 2: Approach and Formula:

Classify the structural types of joints and match them with their specific anatomical examples provided in the flowchart nodes.

Step 3: Detailed Explanation:

Analyzing the implicit branches from standard biology flowcharts:

- **Fibrous Joints** allow no movement. A prime example is the flat skull bones fusing to form the cranium. Thus, **A = Cranial sutures**.
- **Box B** represents a major category parallel to Fibrous and Synovial joints. The example given is "Between adjacent vertebrae". These joints allow limited movement. Thus, **B = Cartilaginous joint**.
- **Synovial Joints** allow considerable movement. The flowchart branches into specific synovial types. One leads to "Between atlas and axis vertebrae". This rotational joint is a pivot type. Thus, **C = Pivot joint**.
- Another branch under Synovial joints is "Hinge joint", which leads to Box D. A classic example of a hinge joint is the knee. Thus, **D = Knee joint**.

Matching all derived components: A - Cranial sutures, B - Cartilaginous joint, C - Pivot joint, D - Knee joint.

Step 4: Final Answer:

The correct option is (D).

Quick Tip: Major Synovial joints to memorize:

Ball & socket: Shoulder/Hip

Hinge: Knee/Elbow

Pivot: Atlas-Axis

Saddle: Carpal-Metacarpal of thumb.

11. Unipolar neurons are found usually in the embryonic stage. They have

- (A) One axon and one dendrite
- (B) Cell body and one axon
- (C) Cell body with one axon and many dendrites
- (D) Neither axon nor dendrites.

Correct Answer: (B) Cell body and one axon

Solution:

Step 1: Understanding the Problem:

Neurons, the functional units of the nervous system, are classified morphologically based on the number of processes (axons and dendrites) that extend from the cell body (soma).

Step 2: Approach and Formula:

Classify neurons structurally and relate the term 'unipolar' to its anatomical definition and specific occurrence in the embryonic stage.

Step 3: Detailed Explanation:

- **Multipolar neurons:** Possess a cell body with one axon and two or more dendrites. These are common in the cerebral cortex.
- **Bipolar neurons:** Have one axon and one dendrite extending from opposite sides. They are found in the retina of the eye.
- **Unipolar neurons:** Have a cell body with a single process extending from it, which functions as an axon. They lack true dendrites directly on the soma. These are typically found in embryonic development stages.
- **Apolar neurons:** Lack distinct axons and dendrites (e.g., Hydra).

Thus, unipolar neurons strictly consist of a cell body and one axon.

Step 4: Final Answer:

They have a cell body and one axon.

Quick Tip: Location mapping for neurons: Unipolar → Embryonic stage; Bipolar → Retina/Olfactory epithelium; Multipolar → Cerebral Cortex.

12. Gastrin is a hormone secreted by gastrointestinal (GI) tract, which stimulates the secretion of

- (A) Hydrochloric acid and pepsinogen

- (B) Pancreatic enzymes and bile juice
- (C) Water and bicarbonate ions
- (D) Bicarbonate ions and pepsinogen

Correct Answer: (A) Hydrochloric acid and pepsinogen

Solution:

Step 1: Understanding the Problem:

The endocrine cells of the gastrointestinal tract secrete several peptide hormones (like Gastrin, Secretin, CCK, and GIP) that regulate the complex processes of digestion.

Step 2: Approach and Formula:

Identify the specific target organ and the resulting primary secretions stimulated by the gastrointestinal hormone Gastrin.

Step 3: Detailed Explanation:

- **Gastrin:** Acts primarily on the gastric glands located in the stomach wall. It strongly stimulates the secretion of gastric juice, which is largely composed of Hydrochloric acid (HCl) and the proenzyme pepsinogen.
- **Secretin:** Acts on the exocrine pancreas, stimulating the secretion of water and bicarbonate ions.
- **Cholecystokinin (CCK):** Acts on both the pancreas and gall bladder, stimulating the release of pancreatic enzymes and bile juice, respectively.

Based on these distinct functions, Gastrin is responsible for HCl and pepsinogen.

Step 4: Final Answer:

Gastrin stimulates the secretion of Hydrochloric acid and pepsinogen.

Quick Tip: Associate the root word "Gastric" with the stomach. Thus, Gastrin acts on Gastric glands to release stomach secretions: HCl and pepsinogen.

13. Choose the correct sequence of wall layers in a microsporangium of an angiosperm.

- (A) Epidermis, Middle layer, Endothecium, Tapetum
- (B) Epidermis, Endothecium, Middle layer, Tapetum
- (C) Epidermis, Tapetum, Middle layer, Endothecium
- (D) Epidermis, Middle layer, Tapetum, Endothecium

Correct Answer: (B) Epidermis, Endothecium, Middle layer, Tapetum

Solution:

Step 1: Understanding the Problem:

A typical microsporangium (which develops into a pollen sac) in an angiosperm is surrounded by four distinct concentric wall layers. These layers function in protection, dehiscence, and nourishment.

Step 2: Approach and Formula:

Recall the histological structure of the microsporangium wall from the outermost protective periphery to the innermost nutritive center.

Step 3: Detailed Explanation:

Moving from the outside to the inside, the layers are arranged as follows:

1. **Epidermis:** The outermost, single-layered protective boundary.
2. **Endothecium:** Situated right below the epidermis, featuring fibrous thickenings that assist in the dehiscence of the anther.
3. **Middle layers:** 1 to 3 layers of short-lived cells lying inside the endothecium.
4. **Tapetum:** The innermost layer consisting of large, specialized cells that nourish the developing microspores (pollen grains).

Therefore, the correct sequential order is Epidermis → Endothecium → Middle layer → Tapetum.

Step 4: Final Answer:

The correct option is (B).

Quick Tip: Mnemonic to remember the sequence from outside to inside: **E E M T** (Epidermis, Endothecium, Middle layers, Tapetum).

14. Which of the following statement is/are correct for cleistogamous flowers?

- a) They have exposed anthers and stigma
- b) They produce assured seed set
- c) They need pollinators for pollination
- d) Variations in traits are not seen in next generation

(A) Only Statement (b) is correct

- (B) Statements (a) and (c) are correct
(C) Statements (b) and (d) are correct
(D) Statements (b) and (c) are correct

Correct Answer: (C) Statements (b) and (d) are correct

Solution:

Step 1: Understanding the Problem:

Plants like *Viola*, *Oxalis*, and *Commelina* produce two types of flowers: chasmogamous (open flowers) and cleistogamous (flowers which do not open at all).

Step 2: Approach and Formula:

Determine the reproductive consequences of cleistogamy in relation to pollination dependency and genetic variation in the offspring.

Step 3: Detailed Explanation:

Let's evaluate each given statement:

- **Statement a:** "They have exposed anthers and stigma." Incorrect. Since cleistogamous flowers never open, their anthers and stigmas are never exposed to the outside environment.
- **Statement b:** "They produce assured seed set." Correct. The anther and stigma lie close to each other internally. Upon dehiscence, pollen lands directly on the stigma, assuring seed set even in the complete absence of external pollinators.
- **Statement c:** "They need pollinators for pollination." Incorrect. They undergo mandatory self-pollination (autogamy) entirely internally, requiring no pollinating agents.
- **Statement d:** "Variations in traits are not seen in next generation." Correct. Because they only undergo autogamy, no new genetic combinations from cross-pollination occur. The progeny remain genetically uniform to the parent.

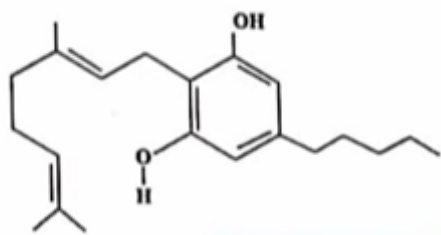
Hence, only statements (b) and (d) are correct.

Step 4: Final Answer:

Statements (b) and (d) are correct.

Quick Tip: Word root: **Cleisto** means 'closed'. Closed flowers → No cross-pollination → Assured seed set but zero genetic variation.

15. Identify the drug molecule from the skeletal structure shown below.



- (A) Opioid
- (B) Cannabinoid
- (C) Coca-alkaloids
- (D) Morphine

Correct Answer: (B) Cannabinoid

Solution:

Step 1: Understanding the Problem:

Psychoactive drugs are classified based on their source and distinct molecular skeletal structures. Key structures typically taught include Morphine (an opioid) and Cannabinoids.

Step 2: Approach and Formula:

Identify the class of the psychoactive drug by visually recognizing the characteristic functional groups and ring systems in the chemical skeleton.

Step 3: Detailed Explanation:

- **Morphine** (and other opioids) features a complex, compact polycyclic alkaloid structure that distinctly contains a nitrogen atom in a piperidine ring, along with two hydroxyl (-OH) groups.
- **Cannabinoids** (such as THC, extracted from *Cannabis sativa*) have a highly distinct structure characterized by a dibenzopyran ring system. Crucially, they lack a nitrogen atom in their core skeletal rings and possess a long, hydrophobic zig-zag hydrocarbon tail (pentyl chain) attached to a phenolic ring.
- The skeletal structure typically presented for this question precisely matches the cannabinoid skeleton, distinctly showing the phenolic -OH group and the long hydrocarbon tail.

Step 4: Final Answer:

The given molecule represents a Cannabinoid.

Quick Tip: Visual trick for drug structures:

- Nitrogen atom embedded in a multi-ring cluster = Morphine/Opioid.
- Long zig-zag tail with an OH group on a benzene ring = Cannabinoid.

16. Identify the correct path of milk secretion by the mammary glands.

- (A) Alveoli → mammary duct → ampulla → mammary tubule → lactiferous ducts
(B) Alveoli → mammary tubules → mammary duct → ampulla → lactiferous ducts
(C) Alveoli → ampulla → mammary duct → mammary tubules → lactiferous ducts
(D) Alveoli → lactiferous ducts → mammary duct → ampulla → mammary tubule

Correct Answer: (B) Alveoli → mammary tubules → mammary duct → ampulla → lactiferous ducts

Solution:

Step 1: Understanding the Problem:

The mammary glands are paired structures that contain glandular tissue. This tissue synthesizes and secretes milk, which must travel through a highly organized sequence of ducts to be expelled.

Step 2: Approach and Formula:

Trace the anatomical pathway of milk flow progressively from the site of synthesis (alveoli) to the exterior point of suckling.

Step 3: Detailed Explanation:

The glandular tissue is divided into 15-20 mammary lobes per breast, containing clusters of milk-secreting cells called alveoli.

The flow of milk follows this strict sequence:

1. The cells of the **alveoli** synthesize and secrete milk, which accumulates in their lumens.
2. The alveoli open directly into small ducts called **mammary tubules**.
3. The tubules of each lobe join together to form a wider **mammary duct**.
4. Several mammary ducts unite to form a larger, swollen structure called the **mammary ampulla**.
5. The mammary ampulla is directly connected to the **lactiferous duct**, through which milk is finally drawn out from the nipple.

Thus, the correct path is: Alveoli → Mammary tubules → Mammary duct → Ampulla → Lactiferous ducts.

Step 4: Final Answer:

The correct option is (B).

Quick Tip: Mnemonic for the path of milk: **A T D A L** (Alveoli → Tubules → Duct → Ampulla → Lactiferous duct).

17. Match items in Column-I with Column-II and choose the correct

Column-I	Column-II
a) Acrosome	i) Contains numerous mitochondria which produce energy
b) Head	ii) Facilitates sperm motility
c) Middle piece	iii) Filled with enzymes that help in fertilization
d) Tail	iv) Contains elongated haploid nucleus

Codes:

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

Correct Answer: (D) a - iii, b - iv, c - i, d - ii

Solution:

Step 1: Understanding the Problem:

A mature human spermatozoon is a highly specialized cell composed of four distinct regions: head, neck, middle piece, and tail. Each region hosts specific structures crucial for reproduction.

Step 2: Approach and Formula:

Match the distinct anatomical regions of a human sperm with their specific cellular components and their corresponding physiological functions.

Step 3: Detailed Explanation:

Let's match each component logically:

- **a) Acrosome:** Located at the anterior tip of the sperm head. It contains hydrolytic enzymes (like hyaluronidase) essential for breaking down the ovum's coverings during fertilization. (**a** → **iii**)
- **b) Head:** The main bulky part of the sperm. It houses the genetic material in the form of an elongated haploid nucleus. (**b** → **iv**)

- **c) Middle piece:** This region is packed with numerous mitochondria. They act as power-houses, generating ATP energy to fuel the sperm's movement. (**c** → **i**)

- **d) Tail:** A long flagellum that produces a whip-like motion, facilitating the motility of the sperm through the female reproductive tract. (**d** → **ii**)

Combining these pairs yields: a - iii, b - iv, c - i, d - ii.

Step 4: Final Answer:

The correct matching sequence is (D).

Quick Tip: Quick associations: Acrosome → Enzymes; Nucleus → Head; Mitochondria → Middle piece; Motility → Tail.

18. Which of the following does NOT produce seminal plasma?

- (A) Epididymis
- (B) Bulbourethral glands
- (C) Seminal vesicles
- (D) Prostate gland

Correct Answer: (A) Epididymis

Solution:

Step 1: Understanding the Problem:

Semen consists of sperm cells and a nutrient-rich fluid component called seminal plasma. This plasma is collectively secreted by specific male accessory reproductive glands.

Step 2: Approach and Formula:

Differentiate between the distinct glands that actively secrete the components of seminal plasma and the anatomical structures responsible merely for sperm transport, storage, and maturation.

Step 3: Detailed Explanation:

The seminal plasma is constituted primarily by the secretions of three distinct accessory glands:

1. **Seminal vesicles** (paired): Contribute the largest volume, rich in fructose and prostaglandins.
2. **Prostate gland** (single): Contributes a milky, slightly acidic fluid containing calcium and

enzymes.

3. **Bulbourethral glands** (paired, also called Cowper's glands): Secrete a fluid that helps in the lubrication of the penis.

The **Epididymis** is a tightly coiled tube attached to the testis. While it provides essential secretions for sperm maturation and motility, it is a site for sperm storage, not an accessory gland that produces the major bulk fluid defined clinically as seminal plasma.

Step 4: Final Answer:

The Epididymis does not produce seminal plasma.

Quick Tip: Always group the "Seminal Plasma Makers" together: Seminal Vesicles, Prostate, and Bulbourethral glands. Epididymis is strictly for sperm storage/maturation.

19. Which of the following Sexually Transmitted Infections (STIs) are not completely curable?

- (A) AIDS, Genital warts
- (B) Chlamydiasis, Gonorrhoea
- (C) Genital warts, Hepatitis B
- (D) AIDS, Genital herpes

Correct Answer: (D) AIDS, Genital herpes

Solution:

Step 1: Understanding the Problem:

Sexually Transmitted Infections (STIs) are diseases transmitted primarily through sexual contact. Their curability heavily depends on the nature of the causative pathogen (bacterial vs. viral).

Step 2: Approach and Formula:

Categorize the common sexually transmitted infections into curable (usually bacterial or protozoan) and currently incurable (specific severe viral infections).

Step 3: Detailed Explanation:

Medical texts emphasize that while many STIs are completely curable if detected early and treated adequately (e.g., Syphilis, Gonorrhoea, Chlamydiasis, Trichomoniasis), there are distinct viral exceptions.

Specifically, three viral infections are considered completely incurable with current medical science:

1. **Hepatitis-B** (caused by HBV)
2. **Genital herpes** (caused by HSV)
3. **HIV infection** (which leads to AIDS)

Looking at the options provided, Option (D) lists both "AIDS" and "Genital herpes", forming the correct pair of incurable diseases.

Step 4: Final Answer:

AIDS and Genital herpes are not completely curable.

Quick Tip: Mnemonic for incurable STIs: **The 3 H's** - HIV, Herpes (Genital), Hepatitis-B. All three are viral, chronic, and currently incurable.

20. Which of the following statements is NOT true about 'Saheli'?

- (A) It is a non-steroidal preparation
- (B) It is a 'once-a-week' pill
- (C) It has low contraceptive value
- (D) It has fewer side effects

Correct Answer: (C) It has low contraceptive value

Solution:

Step 1: Understanding the Problem:

'Saheli' is an innovative oral contraceptive pill for females, developed indigenously in India by the Central Drug Research Institute (CDRI) located in Lucknow.

Step 2: Approach and Formula:

Evaluate the distinct pharmacological characteristics, dosage schedule, safety profile, and efficacy of 'Saheli' against the given statements.

Step 3: Detailed Explanation:

Let's analyze the properties of 'Saheli' based on standard literature:

- **Composition:** It is famously a **non-steroidal preparation** (containing centchroman), unlike standard daily birth control pills which contain steroid hormones (estrogen/progesterone).

Statement (A) is true.

- **Dosage:** Due to its unique mechanism, it is prescribed as a '**once-a-week**' pill. Statement (B) is true.

- **Safety:** Being non-steroidal, it is renowned for causing very few to almost **no side effects**. Statement (D) is true.

- **Efficacy:** Despite its low dosage frequency, it exhibits a very **high contraceptive value** (high effectiveness in preventing pregnancy). Therefore, the claim that it has a "low contraceptive value" is factually incorrect.

Step 4: Final Answer:

The statement "It has low contraceptive value" is NOT true.

Quick Tip: Key facts about Saheli: Developed by CDRI (Lucknow), Once-a-week, Non-steroidal, High efficacy (high contraceptive value), and Few side effects.

21. A woman, unable to conceive after many years of regular unprotected coitus, went to a specialized clinic. On complete examination, the woman was found to be normal, while the male partner was diagnosed with Infertility and was unable to inseminate the female due to low sperm count. Suggest the appropriate Assisted Reproductive Technology (ART).

- (A) ZIFT – Zygote Intra Fallopian Transfer
- (B) IUI – Intra Uterine Insemination
- (C) AI – Artificial Insemination
- (D) GIFT – Gamete Intra Fallopian Transfer

Correct Answer: (C) AI – Artificial Insemination

Solution:

Step 1: Understanding the Problem:

Assisted Reproductive Technologies (ART) are medical procedures used to treat infertility. The selection of the specific ART procedure strictly depends on diagnosing the exact anatomical or physiological cause of infertility in either partner.

Step 2: Approach and Formula:

Select the appropriate procedure tailored directly to the specific clinical diagnosis: the female

is fully normal, but the male partner is unable to organically inseminate due to a low sperm count (oligospermia).

Step 3: Detailed Explanation:

- **ZIFT** (Zygote Intra Fallopian Transfer) involves in-vitro fertilization followed by zygote transfer into the fallopian tube. Used mainly when fallopian tubes are blocked or severe gamete issues exist.
- **GIFT** (Gamete Intra Fallopian Transfer) involves transferring a donor ovum into a female who cannot produce one. The female here is normal, so this is unnecessary.
- **Artificial Insemination (AI)** is the precise prescribed technique for cases where the male partner is unable to organically inseminate the female or possesses very low sperm counts. In this procedure, semen collected from the husband (or a healthy donor) is artificially introduced into the female's vagina or uterus.
- While **IUI** (Intra Uterine Insemination) is a specific subtype of AI, AI is the broader and most commonly identified correct textbook categorical answer corresponding directly to the phrase "inability to inseminate".

Step 4: Final Answer:

Artificial Insemination (AI) is the recommended ART.

Quick Tip: Direct NCERT line reference: "Infertility cases either due to inability of the male partner to inseminate the female or due to very low sperm counts... could be corrected by artificial insemination (AI) technique."

22. The genotypes of husband and wife are $I^A I^B$ and $I^A I^O$. Among the blood groups of their children, how many different genotypes and phenotypes are possible?

- (A) 4 genotypes and 4 phenotypes
- (B) 4 genotypes and 3 phenotypes
- (C) 3 genotypes and 4 phenotypes
- (D) 2 genotypes and 3 phenotypes

Correct Answer: (B) 4 genotypes and 3 phenotypes

Solution:

Step 1: Understanding the Problem:

The ABO blood group system is governed by a single gene (I) with three alleles: I^A , I^B , and I^O (or i). Both I^A and I^B exhibit complete dominance over I^O but are co-dominant when present together.

Step 2: Approach and Formula:

Construct a genetic cross using a Punnett square to systematically determine all possible combinations of offspring genotypes, and then map them to their corresponding phenotypes.

Step 3: Detailed Explanation:

Husband's genotype: $I^A I^B \rightarrow$ produces two types of gametes: I^A and I^B .

Wife's genotype: $I^A I^O \rightarrow$ produces two types of gametes: I^A and I^O .

Crossing the gametes yields the following offspring combinations:

1. I^A (from husband) + I^A (from wife) = $I^A I^A$
2. I^A (from husband) + I^O (from wife) = $I^A I^O$
3. I^B (from husband) + I^A (from wife) = $I^A I^B$
4. I^B (from husband) + I^O (from wife) = $I^B I^O$

Counting the unique outcomes:

Genotypes formed:

There are 4 distinct genotypes: $I^A I^A$, $I^A I^O$, $I^A I^B$, and $I^B I^O$.

Phenotypes corresponding to these genotypes:

- $I^A I^A$ expresses as Blood Group A.
- $I^A I^O$ expresses as Blood Group A.
- $I^A I^B$ expresses as Blood Group AB.
- $I^B I^O$ expresses as Blood Group B.

Thus, there are 3 distinct phenotypes observed: A, AB, and B.

Step 4: Final Answer:

There are 4 genotypes and 3 phenotypes possible.

Quick Tip: Always sketch a quick Punnett square for blood group problems to avoid overlooking heterozygous overlaps (like $I^A I^O$ and $I^A I^A$, both resulting in the same phenotype, Blood Group A).

23. The classical example of point mutation is

- (A) Haemophilia
- (B) Sickle cell anaemia
- (C) Cystic fibrosis
- (D) Phenyl ketonuria

Correct Answer: (B) Sickle cell anaemia

Solution:

Step 1: Understanding the Problem:

Mutations are alterations in the DNA sequence. A point mutation is a highly specific type of mutation where only a single nucleotide base is changed, inserted, or deleted from the genetic sequence.

Step 2: Approach and Formula:

Recall classical genetic disorders and identify which one is primarily characterized and widely cited in literature as being caused by a single base-pair substitution.

Step 3: Detailed Explanation:

Sickle cell anaemia is universally cited as the textbook classical example of a point mutation. The disease originates from a specific genetic defect: a single nitrogenous base substitution in the DNA sequence that codes for the beta-globin chain of the hemoglobin molecule.

Specifically, an Adenine is replaced by a Thymine (CTC → CAC on the DNA template strand), causing the resulting mRNA codon to change from GAG to GUG.

This seemingly minor single-base change substitutes the amino acid Glutamic acid with Valine at the 6th position of the beta-globin chain, profoundly altering the shape and function of red blood cells under low oxygen conditions.

Step 4: Final Answer:

Sickle cell anaemia is the classical example.

Quick Tip: Memorize the exact codon change for Sickle Cell Anaemia: **GAG → GUG**. It leads to the substitution of **Glutamic acid** by **Valine** at the **6th** position.

24. Read the following statements.

Statement I : In a typical test cross, an organism showing a dominant phenotype is crossed with the recessive parent.

Statement II : The ratio of organisms showing dominant and recessive traits in F1 generation

of a test cross indicates that the organism with unknown genotype is homozygous dominant. Choose the correct option.

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

Correct Answer: (C) Statement I is true but Statement II is false

Solution:

Step 1: Understanding the Problem:

A test cross is a genetic cross designed to determine whether an organism expressing a dominant phenotype is homozygous dominant or heterozygous.

Step 2: Approach and Formula:

Analyze the definition and the expected Mendelian segregation ratios of a typical test cross to validate both statements.

Step 3: Detailed Explanation:

- **Statement I:** The standard procedure for a test cross is to cross the organism with the dominant phenotype (whose genotype is unknown, either TT or Tt) with a homozygous recessive parent (tt). Thus, Statement I accurately defines the methodology and is **true**.
- **Statement II:** The statement claims that observing a ratio of dominant and recessive traits implies a homozygous dominant parent. This is incorrect. If the unknown parent were homozygous dominant (TT), crossing it with (tt) would yield 100% dominant offspring (Tt) in the F_1 generation. There would be no recessive offspring at all. Conversely, if a 1:1 ratio of dominant to recessive offspring appears, it proves the unknown parent is **heterozygous** (Tt). Thus, Statement II is **false**.

Step 4: Final Answer:

Statement I is true but Statement II is false.

Quick Tip: Test Cross Outcomes:

- All (100%) Dominant Offspring → Unknown parent was Homozygous Dominant.
- 50% Dominant, 50% Recessive → Unknown parent was Heterozygous.

25. Thalassemia and Sickle cell anaemia are due to a problem in globin molecule synthesis. Select the correct statement.

- (A) Sickle cell anaemia is due to a quantitative problem of globin molecule.
- (B) Both are due to qualitative defects in globin chain synthesis.
- (C) Both are due to quantitative defects in globin chain synthesis.
- (D) Thalassemia is due to less synthesis of globin molecules.

Correct Answer: (D) Thalassemia is due to less synthesis of globin molecules.

Solution:

Step 1: Understanding the Problem:

While both Thalassemia and Sickle Cell Anaemia are autosomal recessive genetic disorders affecting hemoglobin, they compromise the hemoglobin molecule's function through entirely different mechanisms.

Step 2: Approach and Formula:

Distinguish between the two genetic disorders based on whether the fundamental defect is qualitative (a structural abnormality) or quantitative (a reduced production rate).

Step 3: Detailed Explanation:

- **Sickle Cell Anaemia** is caused by a point mutation leading to a single amino acid substitution. The globin chain produced is structurally defective and abnormal. Therefore, it is a **qualitative** problem.
- **Thalassemia** is caused by mutations or deletions that significantly decrease or entirely stop the synthesis of one of the globin chains (α or β). The chains that are produced are perfectly normal in structure, but there are far too few of them. Therefore, it is a **quantitative** problem characterized by less synthesis.

Evaluating the options:

- (A) Incorrect. Sickle cell is qualitative, not quantitative.
- (B) Incorrect. Thalassemia is not qualitative.
- (C) Incorrect. Sickle cell is not quantitative.
- (D) Correct. Thalassemia is accurately described as being due to less synthesis (a quantitative issue) of normal globin molecules.

Step 4: Final Answer:

The correct statement is (D).

Quick Tip: Remember: "Thalassemia → Too few produced (Quantitative problem)". "Sickle Cell → Shape is wrong (Qualitative problem)".

26. Who amongst the following scientist/s had no contribution in the development of the double-helix model for the structure of DNA?

- (A) Maurice Wilkins
- (B) Rosalind Franklin
- (C) Meselson and Stahl
- (D) Erwin Chargaff

Correct Answer: (C) Meselson and Stahl

Solution:

Step 1: Understanding the Problem:

The famous double-helix structural model of DNA was proposed by James Watson and Francis Crick in 1953. This model integrated critical findings from several other pioneer scientists.

Step 2: Approach and Formula:

Review the historical timeline of genetic discoveries and identify which scientists contributed to the structural blueprint of DNA versus those who contributed to understanding its replication mechanism later.

Step 3: Detailed Explanation:

- **Maurice Wilkins** and **Rosalind Franklin** utilized X-ray crystallography to produce high-resolution diffraction images of DNA, revealing its helical nature and physical dimensions. This was crucial for the model.
- **Erwin Chargaff** established the chemical base-pairing rules (Chargaff's rules), demonstrating that Adenine pairs with Thymine and Guanine pairs with Cytosine, forming the model's core internal structure.
- **Matthew Meselson and Franklin Stahl** conducted their famous density gradient centrifugation experiment in 1958. Their work proved that DNA replicates semi-conservatively. Since their experiment was conducted years *after* the double-helix model was established in 1953, they had no direct contribution to its initial development.

Step 4: Final Answer:

Meselson and Stahl had no contribution in the development of the model.

Quick Tip: Timelines are critical: The Double-helix structure was established in 1953 (Watson, Crick, Franklin, Wilkins, Chargaff). Semi-conservative replication was proven in 1958 (Meselson & Stahl).

27. In a DNA molecule, cytosine is 28%. Calculate the percentage of adenine.

- (A) 56%
- (B) 36%
- (C) 22%
- (D) 18%

Correct Answer: (C) 22%

Solution:

Step 1: Understanding the Problem:

In a double-stranded DNA molecule, nitrogenous bases always pair specifically. According to Chargaff's rules, Adenine (A) always pairs with Thymine (T), and Guanine (G) always pairs with Cytosine (C).

Step 2: Approach and Formula:

Apply Chargaff's formulas:

$$A = T \text{ and } G = C$$

$$\text{Total percentage: } A + T + G + C = 100\%$$

Step 3: Detailed Explanation:

Given that the percentage of Cytosine (C) = 28%.

According to the rule, the percentage of Guanine (G) must be equal to Cytosine.

$$G = 28\%$$

The combined total percentage of Guanine and Cytosine is:

$$G + C = 28\% + 28\% = 56\%$$

The remaining percentage of the entire DNA molecule consists of Adenine and Thymine:

$$A + T = 100\% - 56\% = 44\%$$

Since the amounts of Adenine and Thymine are always equal ($A = T$), we divide the remainder by 2:

$$2A = 44\% \implies A = \frac{44\%}{2} = 22\%$$

Therefore, the percentage of Adenine is 22%.

Step 4: Final Answer:

The percentage of Adenine is 22%.

Quick Tip: A highly useful calculation trick: The sum of any one purine and any one pyrimidine that do not naturally pair (e.g., $A + C$ or $G + T$) always equals exactly 50%. Thus, if $C = 28\%$, $A = 50\% - 28\% = 22\%$.

28. Arrange the below given steps of DNA fingerprinting in sequence by selecting the appropriate option.

- a) Digestion of DNA by restriction endonucleases
- b) Autoradiography
- c) Blotting of DNA fragments to nitrocellulose membrane
- d) Isolation of DNA
- e) Separation of DNA fragments by electrophoresis

- (A) (a), (e), (d), (c), (b)
- (B) (e), (a), (d), (b), (c)
- (C) (d), (a), (e), (c), (b)
- (D) (c), (b), (a), (e), (d)

Correct Answer: (C) (d), (a), (e), (c), (b)

Solution:

Step 1: Understanding the Problem:

DNA fingerprinting is a comprehensive forensic technique utilized to identify individuals based

on variations in their DNA profiles, specifically by analyzing Variable Number of Tandem Repeats (VNTRs).

Step 2: Approach and Formula:

Logically sequence the standard molecular biology procedures required to extract, process, and ultimately visualize a DNA profile.

Step 3: Detailed Explanation:

The correct standard sequential steps involved in DNA fingerprinting are:

1. **Isolation of DNA:** The process begins by extracting the DNA from the biological sample's cells. (Step d)
2. **Digestion of DNA:** The isolated DNA is then cut into smaller, specific fragments using restriction endonucleases. (Step a)
3. **Separation of fragments:** These digested fragments are separated according to their size using gel electrophoresis. (Step e)
4. **Blotting:** The separated double-stranded fragments are denatured into single strands and transferred (Southern blotted) onto a synthetic membrane like nitrocellulose or nylon. (Step c)
5. **Hybridization:** (Not listed as an option here, but occurs at this stage using radioactive VNTR probes).
6. **Autoradiography:** The membrane is exposed to X-ray film. The radioactive probes leave marks on the film, creating the visual "fingerprint" pattern. (Step b)

Thus, the correct chronological order is $d \rightarrow a \rightarrow e \rightarrow c \rightarrow b$.

Step 4: Final Answer:

The correct sequence is (d), (a), (e), (c), (b).

Quick Tip: Mnemonic to remember the entire DNA fingerprinting process: **I D S B H A** (Isolation, Digestion, Separation, Blotting, Hybridization, Autoradiography).

29. Select the statement which is 'NOT' true about Big Bang Theory.

- (A) Big Bang Theory explains the origin of Universe.
- (B) As Universe expanded, the temperature came down.
- (C) Hydrogen and Helium gases formed before the explosion.

(D) The gases condensed under gravitation and formed the galaxies.

Correct Answer: (C) Hydrogen and Helium gases formed before the explosion.

Solution:

Step 1: Understanding the Problem:

The Big Bang Theory is the prevailing cosmological model explaining the origin and subsequent evolution of the universe from an infinitely dense, hot singular point.

Step 2: Approach and Formula:

Evaluate the sequential cosmological events proposed by the theory, particularly noting the timeline regarding the formation of fundamental elements relative to the initial explosion.

Step 3: Detailed Explanation:

- Option (A): It is true that the core purpose of the Big Bang Theory is to explain the origin of the universe.
- Option (B): Immediately following the singular explosion, the universe expanded violently and rapidly. As a direct physical consequence of this expansion, the overall extreme temperature came down. This is true.
- Option (C): It claims Hydrogen and Helium formed *before* the explosion. This is false. During the singularity phase, the extreme heat prevented the existence of any atoms. Matter, and eventually simple atoms like Hydrogen and Helium, formed *sometime after* the explosion as the universe sufficiently cooled down.
- Option (D): Over extensive periods, these newly formed, scattered Hydrogen and Helium gases slowly condensed due to gravitational forces, eventually forming the earliest stars and galaxies. This is true.

Step 4: Final Answer:

The incorrect statement is (C).

Quick Tip: Remember the absolute baseline of the Big Bang: *Nothing* (no matter, no elements, not even time or space as we know it) existed *before* the Big Bang. All elements formed post-explosion.

30. According to Hugo De Vries, speciation is due to

- (A) Accumulation of small variations
- (B) Intraspecific breeding

- (C) Interspecific breeding
(D) Single-step large mutation

Correct Answer: (D) Single-step large mutation

Solution:

Step 1: Understanding the Problem:

Hugo de Vries conducted extensive experiments on the evening primrose plant (*Oenothera lamarckiana*) and subsequently proposed the Mutation Theory of evolution.

Step 2: Approach and Formula:

Identify the primary mechanism of evolution (speciation) proposed specifically by Hugo De Vries and contrast it with Darwinian principles.

Step 3: Detailed Explanation:

Charles Darwin posited that evolution was driven by the gradual accumulation of minor, continuous, directional variations over long periods.

In stark contrast, Hugo de Vries proposed a radically different mechanism. He suggested that evolution and the formation of entirely new species (speciation) occur suddenly due to massive, discontinuous genetic changes.

He introduced the term **Saltation** to describe this specific phenomenon, which he definitively defined as a "single-step large mutation."

According to his theory, these mutations are entirely random and directionless, rapidly generating new species.

Step 4: Final Answer:

According to Hugo de Vries, speciation is due to a single-step large mutation.

Quick Tip: Key contrasts to memorize:

- Darwin → Gradual, small, continuous, and directional variations.
- Hugo de Vries → Sudden, large, discontinuous, random, and directionless mutations (Saltation).

31. Identify the correct order of stages in Human evolution.

- a) *Homo habilis*
- b) *Homo erectus*
- c) *Australopithecus*
- d) Neanderthal man

e) Dryopithecus

- (1) $c \rightarrow e \rightarrow a \rightarrow d \rightarrow b$
- (2) $e \rightarrow c \rightarrow a \rightarrow b \rightarrow d$
- (3) $d \rightarrow e \rightarrow b \rightarrow c \rightarrow a$
- (4) $d \rightarrow c \rightarrow a \rightarrow e \rightarrow b$

Correct Answer: (2) $e \rightarrow c \rightarrow a \rightarrow b \rightarrow d$

Solution:

Step 1: Understanding the Problem:

Human evolution is characterized by a sequential progression of hominid species over millions of years, leading from ape-like ancestors to modern humans.

Step 2: Approach and Formula:

Analyze the chronological timeline of human ancestors based on fossil records, placing them in order of appearance from oldest to most recent.

Step 3: Detailed Explanation:

- **Dryopithecus (e):** One of the earliest known ancestors, existing about 15 million years ago. They were more ape-like.
- **Australopithecus (c):** Appeared around 2 to 4 million years ago in East African grasslands.
- **Homo habilis (a):** The first human-like hominid, living about 2 million years ago.
- **Homo erectus (b):** Evolved around 1.5 million years ago; known for a larger brain and likely use of fire.
- **Neanderthal man (d):** Lived near East and Central Asia between 1,00,000 to 40,000 years back.

Therefore, the correct evolutionary sequence is Dryopithecus $\rightarrow$ Australopithecus $\rightarrow$ Homo habilis $\rightarrow$ Homo erectus $\rightarrow$ Neanderthal man. This matches the sequence $e \rightarrow c \rightarrow a \rightarrow b \rightarrow d$.

Step 4: Final Answer:

The correct option is (2).

Quick Tip: Mnemonic for Human Evolution: **Dr. Ram And His Excellent Nephew Speak** (Dryopithecus, Ramapithecus, Australopithecus, Homo habilis, Homo erectus, Neanderthal, Homo sapiens).

32. Pollen grains are well preserved as fossils because of the presence of _____.

- (1) Cellulose
- (2) Sporopollenin
- (3) Lignocellulose
- (4) Pectocellulose

Correct Answer: (2) Sporopollenin

Solution:

Step 1: Understanding the Problem:

The outer hard layer of a pollen grain, known as the exine, is highly resistant to environmental degradation, which allows pollen to survive for millions of years as fossils.

Step 2: Approach and Formula:

Identify the specific chemical substance forming the exine of pollen grains that provides this extreme resistance.

Step 3: Detailed Explanation:

- The exine of pollen grains is primarily composed of **Sporopollenin**.
- Sporopollenin is one of the most resistant organic materials known in the biological world.
- It can withstand extreme temperatures, strong acids, and strong alkalis. Furthermore, no known enzymes can degrade sporopollenin.
- Because of this incredible resistance to decomposition, pollen grains are perfectly preserved as microfossils in geological strata.

Step 4: Final Answer:

Pollen grains are well preserved due to Sporopollenin.

Quick Tip: Always associate the extreme durability and fossilization capability of pollen grains exclusively with the compound Sporopollenin in the exine layer.

33. The causative organism of Pneumonia is _____.

- (1) Wuchereria malayi
- (2) Haemophilus influenza
- (3) Salmonella typhi
- (4) Trichophyton

Correct Answer: (2) *Haemophilus influenza*

Solution:

Step 1: Understanding the Problem:

Pneumonia is an infectious respiratory disease that primarily affects the alveoli of the lungs. It is caused by specific pathogenic bacteria.

Step 2: Approach and Formula:

Match the given diseases to their respective causative organisms to isolate the correct pathogen for Pneumonia.

Step 3: Detailed Explanation:

- *Wuchereria malayi* is a filarial worm responsible for causing Filariasis (Elephantiasis).
- *Salmonella typhi* is the pathogenic bacterium responsible for causing Typhoid fever.
- *Trichophyton* is a genus of fungi that causes ringworm infections.
- *Haemophilus influenzae* (along with *Streptococcus pneumoniae*) is the primary bacterium responsible for causing Pneumonia in humans. It infects the alveoli, causing them to fill with fluid.

Step 4: Final Answer:

The causative organism of Pneumonia is *Haemophilus influenza*.

Quick Tip: Do not confuse *Haemophilus influenzae* with the viral Influenza (flu). *H. influenzae* is a bacterium that commonly causes pneumonia and meningitis.

34. Select the option that contains only secondary lymphoid organs.

- (1) Spleen, Tonsils, Thymus
- (2) Lymph nodes, Appendix, Tonsils
- (3) Peyer's patches, Tonsils, Bone marrow
- (4) Tonsils, Thymus, Lymph nodes

Correct Answer: (2) Lymph nodes, Appendix, Tonsils

Solution:

Step 1: Understanding the Problem:

The human immune system features lymphoid organs which are categorized into primary and secondary. Primary organs are sites of lymphocyte origin and maturation, while secondary organs are sites where lymphocytes interact with antigens.

Step 2: Approach and Formula:

Filter the options by identifying and eliminating any group that contains a primary lymphoid organ (Bone marrow or Thymus).

Step 3: Detailed Explanation:

- Primary lymphoid organs include the **Bone marrow** and the **Thymus**.
- Secondary lymphoid organs include the Spleen, Lymph nodes, Tonsils, Peyer's patches of the small intestine, and the Appendix.
- Option (1) contains Thymus (Primary) → Incorrect.
- Option (3) contains Bone marrow (Primary) → Incorrect.
- Option (4) contains Thymus (Primary) → Incorrect.
- Option (2) contains Lymph nodes, Appendix, and Tonsils, all of which are exclusively secondary lymphoid organs.

Step 4: Final Answer:

The correct option is (2).

Quick Tip: Remember the two "Primary" sites: Bone Marrow (B-cell maturation) and Thymus (T-cell maturation). Every other lymphoid organ is secondary.

35. Identify the biological response modifier substance which activates the immune system and helps in destroying the tumor.

- (1) Histamine
- (2) α -Interferon
- (3) Serotonin
- (4) α -Lactalbumin

Correct Answer: (2) α -Interferon

Solution:

Step 1: Understanding the Problem:

Tumor cells can often evade detection and destruction by the immune system. In certain cancer therapies, patients are given substances called biological response modifiers to stimulate their immune response.

Step 2: Approach and Formula:

Identify the specific cytokine used clinically in immunotherapy to activate the immune system against cancer cells.

Step 3: Detailed Explanation:

- Histamine and Serotonin are chemicals involved in inflammation and allergic reactions, not primarily in destroying tumors.
- α -Lactalbumin is a protein found in milk, notably produced in transgenic animals (like the Rosie cow), and is unrelated to cancer therapy.
- α -**Interferon** is a potent cytokine that acts as a biological response modifier. When administered to cancer patients, it rapidly activates the immune system (such as Natural Killer cells and macrophages) to identify and effectively destroy tumor cells.

Step 4: Final Answer:

The correct substance is α -Interferon.

Quick Tip: Immunotherapy for cancer relies heavily on Biological Response Modifiers like α -Interferon. Think "Interferon = Interferes with viral and tumor growth".

36. The conversion of milk into curd by LAB increases the nutritional value by producing _____.

- (1) Vitamin A
- (2) Vitamin B₁₂
- (3) Vitamin C
- (4) Vitamin D

Correct Answer: (2) Vitamin B₁₂

Solution:

Step 1: Understanding the Problem:

Lactic Acid Bacteria (LAB), such as *Lactobacillus*, are responsible for fermenting milk into curd. This process not only changes the physical state of the milk but also enhances its nutritional profile.

Step 2: Approach and Formula:

Recall the specific vitamin synthesized by LAB during the coagulation and partial digestion of milk proteins.

Step 3: Detailed Explanation:

During the fermentation process, Lactic Acid Bacteria produce lactic acid, which coagulates and partially digests milk proteins (casein).

Alongside this, the metabolic activities of LAB synthesize a significant amount of certain vitamins, most notably **Vitamin B₁₂** (Cyanocobalamin).

Thus, curd is nutritionally superior to raw milk specifically due to its significantly higher Vitamin B₁₂ content, which is essential for nerve function and blood formation.

Step 4: Final Answer:

The correct option is Vitamin B₁₂.

Quick Tip: LAB improves nutritional quality specifically by increasing Vitamin B₁₂. They also play a beneficial role in checking disease-causing microbes in our stomach.

37. BOD of polluted water is estimated by measuring the amount of _____.

- (1) Total organic matter
- (2) Oxygen evolution
- (3) Oxygen consumption
- (4) Biodegradable organic matter

Correct Answer: (3) Oxygen consumption

Solution:

Step 1: Understanding the Problem:

Biochemical Oxygen Demand (BOD) is a standard measure of water pollution, specifically

relating to the concentration of organic matter present in a water body.

Step 2: Approach and Formula:

Define BOD technically: It relies on measuring the activity of aerobic microbes decomposing organic matter. Determine what is physically measured during this process.

Step 3: Detailed Explanation:

- BOD is defined as the amount of oxygen that would be consumed if all the organic matter in one liter of water were oxidized by bacteria.
- While BOD gives an indirect estimate of the biodegradable organic matter present in the water, the actual physical quantity that is estimated/measured in the laboratory test is the **amount of oxygen consumption** over a period of 5 days at 20°C.
- A higher rate of oxygen consumption signifies a higher BOD, which in turn implies that the water is highly polluted with organic waste.

Step 4: Final Answer:

BOD is estimated by measuring oxygen consumption.

Quick Tip: Remember: BOD is an *indirect* measure of organic matter, but it is *directly* estimated by measuring **oxygen consumption** by microbes.

38. Given below are two statements.

Statement I: Baculoviruses are pathogens that attack nematodes.

Statement II: Baculoviruses are used as biological control agents in ecologically sensitive areas as they are species-specific in their action.

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

- (1) Both Statement I and Statement II are true
- (2) Both Statement I and Statement II are false
- (3) Statement I is true, but Statement II is false
- (4) Statement I is false, but Statement II is true

Correct Answer: (4) Statement I is false, but Statement II is true

Solution:

Step 1: Understanding the Problem:

Baculoviruses are important biological control agents used in integrated pest management (IPM) programs.

Step 2: Approach and Formula:

Verify the target organism profile and the ecological characteristics of Baculoviruses according to standard biological literature.

Step 3: Detailed Explanation:

- **Statement I:** Baculoviruses (mostly under the genus *Nucleopolyhedrovirus*) are pathogens that specifically attack **insects and other arthropods**, not nematodes. Fungi like *Pochonia* or specific bacteria are often used against nematodes. Therefore, Statement I is false.
- **Statement II:** Baculoviruses are excellent candidates for species-specific, narrow-spectrum insecticidal applications. They have no negative impacts on plants, mammals, birds, fish, or even non-target beneficial insects, making them ideal for use in ecologically sensitive areas. Therefore, Statement II is true.

Step 4: Final Answer:

Statement I is false, but Statement II is true.

Quick Tip: Baculovirus = Genus *Nucleopolyhedrovirus* = Narrow-spectrum insecticide = Attacks only targeted Arthropods/Insects.

39. Technique to alter the chemistry of genetic materials, DNA and RNA, to introduce these into host organism and change the phenotype of the host is

- (1) Bioprocess engineering
- (2) Cloning
- (3) Genetic engineering
- (4) Transformation

Correct Answer: (3) Genetic engineering

Solution:

Step 1: Understanding the Problem:

Modern biotechnology is founded upon two core techniques: Genetic engineering and Bioprocess engineering.

Step 2: Approach and Formula:

Match the provided definition exactly with the textbook definitions of the core principles of biotechnology.

Step 3: Detailed Explanation:

- **Bioprocess engineering:** The maintenance of sterile (microbial contamination-free) environments to enable the growth of only desired microbes or eukaryotic cells in large quantities for the manufacture of biotechnological products like vaccines, enzymes, etc.
- **Genetic engineering:** This refers to the specific techniques utilized to physically alter the chemistry of genetic material (DNA and RNA). The altered genetic material is then introduced into a host organism, which consequently changes the phenotype of that host organism.
- While "Transformation" is a step in this process, "Genetic engineering" is the broad foundational technique that encompasses altering the DNA chemistry itself.

Step 4: Final Answer:

The described technique is Genetic engineering.

Quick Tip: Altering DNA/RNA chemistry = Genetic Engineering. Maintaining a sterile growth environment = Bioprocess Engineering.

40. Given below are two statements.

Statement I: Restriction enzyme BamHI has its recognition site in tetR region of pBR322.

Statement II: E.coli having pBR322 with a desired DNA if inserted at BamHI site can grow in medium containing tetracycline.

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

- (1) Both Statement I and Statement II are true
- (2) Both Statement I and Statement II are false
- (3) Statement I is true, but Statement II is false
- (4) Statement I is false, but Statement II is true

Correct Answer: (3) Statement I is true, but Statement II is false

Solution:

Step 1: Understanding the Problem:

pBR322 is a widely used cloning vector in *E. coli*. It contains two antibiotic resistance genes: amp^R (ampicillin resistance) and tet^R (tetracycline resistance), which contain unique recognition sites for various restriction enzymes.

Step 2: Approach and Formula:

Analyze the principle of "insertional inactivation" based on the exact locations of restriction sites in the pBR322 vector.

Step 3: Detailed Explanation:

- **Statement I:** The restriction endonucleases BamHI and SalI have their unique recognition sites situated entirely within the tet^R (tetracycline resistance) gene region of pBR322. Therefore, Statement I is true.
- **Statement II:** If a desired foreign DNA is inserted at the BamHI site, the tet^R gene gets disrupted. This phenomenon is known as **insertional inactivation**. Because the resistance gene is no longer functional, the recombinant *E. coli* loses its resistance to tetracycline and will **not** be able to grow in a medium containing tetracycline. Therefore, Statement II is false.

Step 4: Final Answer:

Statement I is true, but Statement II is false.

Quick Tip: Insertional Inactivation Rule: Inserting DNA at BamHI/SalI destroys Tetracycline resistance. Inserting at PvuI/PstI destroys Ampicillin resistance.

41. Match List I with List II

List I

- a) Visualization of DNA in gel electrophoresis
- b) Precipitation of DNA
- c) Breaking of cell wall of bacteria
- d) Breaking of cell wall of fungus

List II

- i) Chitinase
- ii) Lysozyme

iii) Chilled ethanol

iv) Ethidium bromide

Codes:

(1) a - iv, b - iii, c - ii, d - i

(2) a - iii, b - i, c - i, d - ii

(3) a - iv, b - i, c - ii, d - iii

(4) a - iii, b - ii, c - iv, d - i

Correct Answer: (1) a - iv, b - iii, c - ii, d - i

Solution:

Step 1: Understanding the Problem:

Various reagents and enzymes are employed during the different steps of recombinant DNA technology to isolate, visualize, and manipulate nucleic acids.

Step 2: Approach and Formula:

Match the specific molecular biology procedures with their corresponding chemical reagents or enzymatic agents.

Step 3: Detailed Explanation:

- **a) Visualization of DNA:** DNA fragments separated on an agarose gel cannot be seen under visible light. They are stained with **Ethidium bromide** and viewed under UV light, appearing as bright orange bands. (a → iv)
- **b) Precipitation of DNA:** After extracting DNA from the cell and removing proteins/RNA, the highly purified DNA is ultimately precipitated out of the aqueous solution by the addition of **chilled ethanol**. (b → iii)
- **c) Breaking of cell wall of bacteria:** To extract DNA from a bacterial cell, its peptidoglycan cell wall is broken down using the enzyme **Lysozyme**. (c → ii)
- **d) Breaking of cell wall of fungus:** Fungal cell walls are made of chitin, which is degraded by the specific enzyme **Chitinase** to release the internal genetic material. (d → i)

Matching all options: a-iv, b-iii, c-ii, d-i.

Step 4: Final Answer:

The correct matching sequence is (1).

Quick Tip: Enzyme-Cell Wall pairs: Bacteria → Lysozyme; Plant → Cellulase/Pectinase; Fungi → Chitinase.

42. The human protein obtained from transgenic animals used to treat emphysema is

- (1) Insulin
- (2) α - Lactalbumin
- (3) α - 1 antitrypsin
- (4) β - Lactalbumin

Correct Answer: (3) α - 1 antitrypsin

Solution:

Step 1: Understanding the Problem:

Transgenic animals are extensively used as bioreactors to produce useful biological products (human proteins) in their milk or blood, which can be harvested for medical treatments.

Step 2: Approach and Formula:

Identify the specific recombinant human protein explicitly synthesized for the treatment of the respiratory disorder emphysema.

Step 3: Detailed Explanation:

- **Insulin** is usually produced using transgenic bacteria (*E. coli*), not primarily transgenic animals.
- **α -Lactalbumin** is a human-like protein enriched in the milk of the transgenic cow 'Rosie', making it nutritionally more balanced for human babies.
- **α -1 antitrypsin** is a human protein produced by transgenic sheep/animals. It functions as a protease inhibitor and is clinically utilized as a replacement therapy to treat **Emphysema**, a chronic lung disease.

Step 4: Final Answer:

The correct protein is α -1 antitrypsin.

Quick Tip: Direct memorization point: Emphysema treatment = α -1 antitrypsin. Better milk for babies = α -Lactalbumin (Rosie the cow).

43. Given below are the sequence of events in the production of human insulin by Eli Lilly.

- a) Preparation of two DNA sequences corresponding to chain A and B of human insulin.
- b) Production of chain A and B separately.
- c) Introduction of chains in plasmids of *E.coli*.
- d) Extraction of chain A and B combining them by creating disulphide bonds.

Choose the correct sequence of events.

- (1) (a), (b), (c), (d)
- (2) (a), (c), (b), (d)
- (3) (a), (b), (d), (c)
- (4) (a), (d), (b), (c)

Correct Answer: (2) (a), (c), (b), (d)

Solution:

Step 1: Understanding the Problem:

In 1983, the American company Eli Lilly successfully prepared the first recombinant human insulin (Humulin) by independently synthesizing its two short polypeptide chains.

Step 2: Approach and Formula:

Sequence the experimental steps taken by Eli Lilly according to the standard workflow of Recombinant DNA Technology.

Step 3: Detailed Explanation:

The sequential procedure executed by Eli Lilly was:

1. First, they artificially **prepared two DNA sequences** corresponding strictly to the amino acid sequences of chain A and chain B of human insulin (Step a).
2. Next, they **introduced these DNA sequences into plasmids** and transformed them into *E. coli* bacterial cells (Step c).
3. Inside the bacterial host, the recombinant genes were expressed, resulting in the **production of chain A and chain B separately** in different bacterial cultures (Step b).
4. Finally, they **extracted the separated chains** from the bacteria and covalently **combined them by creating disulfide bonds** to form fully mature, functional human insulin (Step d).

Therefore, the chronological order is (a) → (c) → (b) → (d).

Step 4: Final Answer:

The correct sequence is (2).

Quick Tip: Logical flow: You must first create the DNA (a), put it into bacteria (c), let the bacteria produce the proteins (b), and finally extract and join them (d).

44. Given below are two statements

Statement I: Adenosine deaminase is crucial for the immune system to function.

Statement II: Adenosine deaminase deficiency can be cured only by bone marrow transplantation.

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

- (1) Both Statement I and Statement II are true
- (2) Both Statement I and Statement II are false
- (3) Statement I is true, but Statement II is false
- (4) Statement I is false, but Statement II is true

Correct Answer: (3) Statement I is true, but Statement II is false

Solution:

Step 1: Understanding the Problem:

Adenosine Deaminase (ADA) deficiency is an autosomal recessive metabolic disorder that leads to Severe Combined Immunodeficiency (SCID).

Step 2: Approach and Formula:

Evaluate the biological role of ADA and carefully analyze the validity of the word "only" regarding its available medical treatments.

Step 3: Detailed Explanation:

- **Statement I:** The enzyme Adenosine Deaminase is absolutely crucial for the proliferation and maturation of lymphocytes (T-cells and B-cells). Without it, toxic metabolic byproducts accumulate and destroy these immune cells, crippling the immune system. Thus, Statement I is true.

- **Statement II:** The statement claims it can be cured **only** by bone marrow transplantation. This is factually incorrect. ADA deficiency can be treated through Enzyme Replacement Therapy (ERT) and Bone Marrow Transplantation, though neither is completely curative. A more permanent cure is achievable via **Gene Therapy** (introducing functional ADA cDNA using a retroviral vector) especially if administered during early embryonic stages. Since BMT

is not the "only" treatment/cure, Statement II is false.

Step 4: Final Answer:

Statement I is true, but Statement II is false.

Quick Tip: Always be cautious with absolute words like "only" or "always" in biology statements. They often make the statement false.

45. Which of the following is not correct with reference to exponential growth model?

- (1) Resources are limited
- (2) Population grows in a geometric fashion
- (3) A stationary phase is never reached
- (4) Population grows beyond carrying capacity

Correct Answer: (1) Resources are limited

Solution:

Step 1: Understanding the Problem:

The exponential (or geometric) growth model describes how a population grows when it is subjected to completely ideal environmental conditions.

Step 2: Approach and Formula:

Analyze the core assumptions underlying the exponential growth equation: $\frac{dN}{dt} = rN$.

Step 3: Detailed Explanation:

- The fundamental premise of the exponential growth model is that resources (food, space) in the habitat are **unlimited**. Because resources are infinite, competition does not stall growth.
- Under these unlimited conditions, the population grows at an ever-accelerating rate in a **geometric/exponential fashion** (J-shaped curve). (Option 2 is correct for the model).
- Because there is no resource limitation, the curve never levels off; hence, a **stationary phase is never reached**. (Option 3 is correct for the model).
- The concept of "carrying capacity" (K) is relevant only to logistic growth. In an exponential model, the population continuously shoots upward, effectively **growing beyond any natural carrying capacity** constraints (since K is assumed infinite). (Option 4 is effectively true in the context of the model's unrestrained nature).

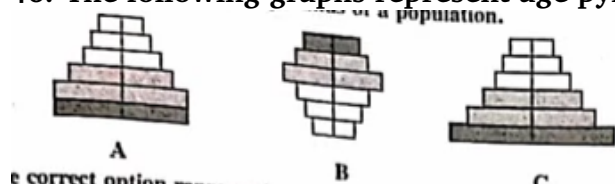
- Therefore, the assertion that "Resources are limited" directly contradicts the fundamental assumption of the exponential model.

Step 4: Final Answer:

"Resources are limited" is not correct.

Quick Tip: Exponential Growth = J-curve = Unlimited resources. Logistic Growth = S-curve (Sigmoid) = Limited resources = Reaches a carrying capacity (K).

46. The following graphs represent age pyramids of a population.



- (1) A - stable, B - expanding, C - declining
(2) A - expanding, B - stable, C - declining
(3) A - stable, B - declining, C - expanding
(4) A - declining, B - stable, C - expanding

Correct Answer: (2) A - expanding, B - stable, C - declining

Solution:

Step 1: Understanding the Problem:

An age pyramid is a graphical illustration that shows the distribution of various age groups (pre-reproductive, reproductive, and post-reproductive) in a population.

Step 2: Approach and Formula:

Analyze the relative width of the pre-reproductive base compared to the reproductive middle to determine the population's growth trajectory.

Step 3: Detailed Explanation:

Based on standard ecological age pyramids:

- **Pyramid A (Triangular shape):** The base (pre-reproductive group) is very broad and significantly larger than the reproductive group. This indicates a high birth rate and a rapidly **expanding** population.
- **Pyramid B (Bell shape):** The base and the middle sections are almost equal in width. This

indicates that the pre-reproductive and reproductive age groups are roughly equal, meaning the population size remains constant or **stable**.

- **Pyramid C (Urn shape):** The base is notably narrower than the reproductive middle section. This indicates fewer births and an aging population, meaning the population is **declining**. Thus, A is expanding, B is stable, and C is declining.

Step 4: Final Answer:

The correct option is (2).

Quick Tip: Look strictly at the bottom tier (pre-reproductive). Wider than middle = Expanding. Equal to middle = Stable. Narrower than middle = Declining.

47. Which one of the following options represents the steps of decomposition in sequence?

- (1) Fragmentation → Humification → Leaching → Catabolism → Mineralization
- (2) Fragmentation → Leaching → Catabolism → Humification → Mineralization
- (3) Fragmentation → Humification → Mineralization → Leaching → Catabolism
- (4) Fragmentation → Catabolism → Humification → Mineralization → Leaching

Correct Answer: (2) Fragmentation → Leaching → Catabolism → Humification → Mineralization

Solution:

Step 1: Understanding the Problem:

Decomposition is the complex, multi-step process by which complex organic matter (detritus) is broken down into simple inorganic substances by decomposers.

Step 2: Approach and Formula:

Identify the chronological sequence of the physical, chemical, and biological steps that detritus undergoes as outlined in standard ecology texts.

Step 3: Detailed Explanation:

The process of decomposition involves five major sequential/simultaneous steps. The logical physiological sequence presented typically flows as:

1. **Fragmentation:** Detritivores (like earthworms) physically break down the detritus into smaller particles, increasing the surface area.
2. **Leaching:** Water-soluble inorganic nutrients seep down into the soil horizon and get

precipitated as unavailable salts.

3. **Catabolism:** Bacterial and fungal enzymes chemically degrade the fragmented detritus into simpler inorganic substances.

4. **Humification:** Accumulation of a dark-coloured, highly resistant amorphous substance called humus in the soil.

5. **Mineralization:** The final slow degradation of humus by certain microbes to release inorganic nutrients back into the soil.

Therefore, the broadly accepted ordered sequence is Fragmentation → Leaching → Catabolism → Humification → Mineralization.

Step 4: Final Answer:

The correct sequence is option (2).

Quick Tip: Mnemonic: **F L C H M** (Fragmentation, Leaching, Catabolism, Humification, Mineralization).

48. The Annual Net Primary Productivity on land and ocean respectively are _____ and _____ billion tons.

- (1) 170, 107
- (2) 115, 55
- (3) 55, 115
- (4) 107, 170

Correct Answer: (2) 115, 55

Solution:

Step 1: Understanding the Problem:

Net Primary Productivity (NPP) is the available biomass produced by photosynthetic organisms. The global NPP is distributed across terrestrial and aquatic ecosystems.

Step 2: Approach and Formula:

Recall the specific global data values for Earth's annual NPP provided in standard ecosystem chapters and calculate the individual distributions.

Step 3: Detailed Explanation:

- The total annual Net Primary Productivity of the entire biosphere is estimated to be approximately **170 billion tons** (dry weight) of organic matter.
- Despite covering about 70% of the Earth's surface, the oceans contribute surprisingly little to this total, producing only about **55 billion tons**.
- The remainder is produced by the land (terrestrial ecosystems). This is calculated as:

$$\text{Land NPP} = \text{Total NPP} - \text{Ocean NPP}$$

$$\text{Land NPP} = 170 - 55 = 115 \text{ billion tons}$$

Therefore, the NPP on land is 115 billion tons, and in the ocean, it is 55 billion tons.

Step 4: Final Answer:

The correct option is 115, 55.

Quick Tip: Remember that despite the ocean's vast area (70%), its productivity is low (55 billion tons) primarily due to sunlight penetration limits and nutrient scarcity in open oceans.

49. In a practical examination, the below given pedigree chart was given as spotter for identification.

- (1) Autosomal recessive
- (2) Autosomal dominant
- (3) Sex-linked dominant
- (4) Sex-linked recessive

Correct Answer: (1) Autosomal recessive

Solution:

Step 1: Understanding the Problem:

A pedigree chart shows the inheritance of a particular trait across generations. Analyzing the pattern of affected vs. unaffected individuals helps deduce the trait's mode of inheritance.

Step 2: Approach and Formula:

Use standard pedigree analysis rules:

- If unaffected parents have affected offspring → the trait is strictly Recessive.
- Check for gender bias to determine Autosomal vs. Sex-linked.

Step 3: Detailed Explanation:

- Looking at the visual chart: In the first generation, both parents (square for male, circle for female) are unaffected (white/unshaded).
- However, they produce an affected daughter (shaded circle) and an affected son (shaded square) in the second generation.
- This specific pattern—where the disease "skips a generation" and unaffected carriers produce an affected child—is the absolute hallmark of a **recessive** trait. (If it were dominant, at least one parent must have been affected).
- Furthermore, because an unaffected father passes the disease to his daughter, it **cannot** be an X-linked recessive trait. (In X-linked recessive, an affected daughter must inherit an affected X from a completely affected father).
- Therefore, the trait must be inherited via an autosome.

Step 4: Final Answer:

The pedigree represents an Autosomal recessive trait.

Quick Tip: Golden Rule of Pedigrees: If normal parents have an affected child, it is **always RECESSIVE**.
If an affected girl has a normal father, it is **always AUTOSOMAL**.

50. Given below are two statements.

Statement I: There is less species biodiversity in tropical latitudes than in temperate region

Statement II: Tropical environments unlike temperate ones are less seasonal, relatively more constant and predictable.

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

- (1) Both Statement I and Statement II are true
- (2) Both Statement I and Statement II are false
- (3) Statement I is true, but Statement II is false
- (4) Statement I is false, but Statement II is true

Correct Answer: (4) Statement I is false, but Statement II is true

Solution:

Step 1: Understanding the Problem:

Global biodiversity exhibits distinct latitudinal gradients. Species richness strongly correlates with latitude and environmental stability.

Step 2: Approach and Formula:

Evaluate the known ecological patterns of global biodiversity distribution and the climatic hypotheses that explain them.

Step 3: Detailed Explanation:

- **Statement I:** This statement claims that tropical latitudes have "less" species biodiversity than temperate regions. This is fundamentally incorrect. The universally observed latitudinal gradient shows that species diversity is highest at the equator (tropics) and decreases as one moves toward the poles (temperate and arctic regions). Thus, Statement I is false.
- **Statement II:** This statement provides one of the core ecological reasons why tropics are more diverse. Temperate environments were subjected to frequent glaciations and are highly seasonal and unpredictable. In contrast, tropical environments have remained relatively undisturbed for millions of years and are characterized by being less seasonal, relatively more constant, and highly predictable. This environmental stability promotes niche specialization and greater species richness. Thus, Statement II is true.

Step 4: Final Answer:

Statement I is false, but Statement II is true.

Quick Tip: Tropics = High solar energy, high stability, predictability → Maximum Biodiversity.

51. A student was given a bisexual, actinomorphic pentamerous, gamosepalous and gamopetalous with 5 stamens in epipetalous condition and bicarpellary syncarpous superior ovary and asked to state the floral formula. Which one of the following is the correct floral formula for the given flower?

- (1) $\oplus$ Bisexual $K_{(5)}C_{(5)}A_5\overline{G}_{(2)}$
- (2) $\oplus$ Bisexual $K_c\widehat{CAG}\dots$
- (3) $\oplus$ Bisexual $K_{(5)}C_{(5)}A_5\overline{G}_{(2)}$
- (4) $\oplus$ Bisexual $K_{(5)}\widehat{C_{(5)}A_5}\underline{G}_{(2)}$

Correct Answer: (4) $\oplus$ Bisexual $K_{(5)}\widehat{C_{(5)}A_5}\underline{G_{(2)}}$

Solution:

Step 1: Understanding the Problem:

A floral formula is a highly compressed symbolic representation of the structure of a flower, detailing its symmetry, sexuality, and the whorls (calyx, corolla, androecium, and gynoecium).

Step 2: Approach and Formula:

Translate each descriptive botanical term systematically into its corresponding standard floral symbol.

Step 3: Detailed Explanation:

Let's decode the given description sequentially:

- **Actinomorphic:** Represented by $\oplus$.
- **Bisexual:** Represented by the standard symbol or word (Bisexual).
- **Gamosepalous, pentamerous:** 5 fused sepals (Calyx). Represented by $K_{(5)}$ (brackets denote fusion).
- **Gamopetalous, pentamerous:** 5 fused petals (Corolla). Represented by $C_{(5)}$.
- **5 stamens:** Androecium with 5 free stamens. Represented by A_5 .
- **Epipetalous condition:** Stamens are attached to the petals. Represented by an arc or tie connecting C and A: $\widehat{CA}$.
- **Bicarpellary syncarpous:** 2 fused carpels. Represented by $G_{(2)}$.
- **Superior ovary:** The gynoecium sits above the other whorls. Represented by a line drawn exactly below the G: $\underline{G}$.

Combining these elements precisely yields the formula for the Solanaceae family: $\oplus$ Bisexual $K_{(5)}\widehat{C_{(5)}A_5}\underline{G_{(2)}}$.

Step 4: Final Answer:

The correct option is (4).

Quick Tip: Remember line placements for ovary position:

Line below G ($\underline{G}$) = Superior ovary (Hypogynous flower).

Line above G ($\overline{G}$) = Inferior ovary (Epigynous flower).

52. A student was asked to identify a permanent slide of mitosis. He made the following observations.

- (i) Splitting of centromere and formation of daughter chromatids.
(ii) Chromatids are migrating towards the opposite poles.

The stage would be

- (1) Metaphase
- (2) Telophase
- (3) Anaphase
- (4) Prophase

Correct Answer: (3) Anaphase

Solution:

Step 1: Understanding the Problem:

Mitosis is divided into four main sequential stages: Prophase, Metaphase, Anaphase, and Telophase. Each stage is characterized by specific, recognizable chromosomal behaviors.

Step 2: Approach and Formula:

Identify the unique cytological markers provided in the observation and match them to the defining events of the specific mitotic phase.

Step 3: Detailed Explanation:

- **Prophase:** Condensation of chromatin into visible chromosomes; nuclear envelope breaks down.
- **Metaphase:** Chromosomes reach maximum condensation and align perfectly at the equatorial plate.
- **Anaphase:** The hallmark event is the sudden and simultaneous **splitting of the centromeres**. The sister chromatids separate to become individual daughter chromosomes and immediately begin **migrating towards the opposite poles** of the cell.
- **Telophase:** Chromosomes reach the poles and begin to decondense; nuclear envelope reforms.

The observations (splitting of centromeres and polar migration) distinctly describe Anaphase.

Step 4: Final Answer:

The stage is Anaphase.

Quick Tip: Key action words for mitosis phases:

Metaphase = **Align** (at equator).

Anaphase = **Split and Separate** (pulling to poles).

53. With respect to binomial nomenclature, identify the incorrect statement.

- (1) Biological names are generally in Latin and written in italics.
- (2) The first word in the name represents specific epithet and the second component denotes genus.
- (3) Both the words in the name when handwritten are separately underlined.
- (4) The first word starts with capital letter, while the second word starts with small letter.

Correct Answer: (2) The first word in the name represents specific epithet and the second component denotes genus.

Solution:

Step 1: Understanding the Problem:

Binomial nomenclature, formalized by Carolus Linnaeus, is the universally accepted system of naming organisms using a two-part scientific name. It follows strict international conventions.

Step 2: Approach and Formula:

Evaluate each statement against the universal rules of binomial nomenclature to identify the factual error regarding the order of the naming components.

Step 3: Detailed Explanation:

Let's review the universal rules:

- Biological names are generally derived from Latin (regardless of their origin) and are printed in italics to indicate their Latin origin. (Statement 1 is correct).
- When handwritten, both the genus and specific epithet words must be separately underlined. (Statement 3 is correct).
- The first word representing the genus must start with a capital letter, and the second word representing the specific epithet must start with a small letter (e.g., *Mangifera indica*). (Statement 4 is correct).
- The **first word** in a biological name always represents the **genus** (generic name), while the **second word** denotes the **specific epithet** (species name). Statement 2 erroneously claims the exact reverse order.

Step 4: Final Answer:

The incorrect statement is (2).

Quick Tip: Always remember the order: Genus comes first (capitalized), then Species (lowercase).
e.g., *Homo sapiens*.

54. Organism 'X' is a multicellular, heterotrophic, eukaryote with a chitinous cell wall. In which kingdom will you place it?

- (1) Monera
- (2) Animalia
- (3) Protista
- (4) Fungi

Correct Answer: (4) Fungi

Solution:

Step 1: Understanding the Problem:

R.H. Whittaker's Five Kingdom Classification system categorizes living organisms based on cell structure, body organization, mode of nutrition, and cell wall composition.

Step 2: Approach and Formula:

Cross-reference the four specific distinguishing traits provided (multicellular, heterotrophic, eukaryotic, chitinous wall) against the characteristics of the five kingdoms.

Step 3: Detailed Explanation:

- **Monera:** Unicellular, prokaryotic organisms. (Mismatches "eukaryote").
- **Protista:** Primarily unicellular eukaryotes. While some are heterotrophic, they lack chitinous walls.
- **Animalia:** Multicellular, heterotrophic eukaryotes, but they strictly **lack any cell wall**.
- **Fungi:** They are eukaryotes, predominantly multicellular (except yeast), strictly heterotrophic (absorptive/saprophytic), and critically, their cell walls are composed of a tough, complex sugar called **chitin**.

All four traits uniquely and exclusively point to Kingdom Fungi.

Step 4: Final Answer:

The organism belongs to Kingdom Fungi.

Quick Tip: Cell wall materials define the kingdoms: Plantae = Cellulose; Fungi = Chitin; Monera = Peptidoglycan; Animalia = Absent.

55. Read the following statements about *Funaria* and select the options which are correct.

- a) Gametophyte is the dominant plant body.
- b) The sporophyte is differentiated into foot, seta and capsule.
- c) The gemmae are asexual, green, multicellular buds found on the thallus.
- d) The sporophyte has independent existence.

(1) a and b

(2) a and c

(3) b and c

(4) c and d

Correct Answer: (1) a and b

Solution:

Step 1: Understanding the Problem:

Funaria is a common moss belonging to the division Bryophyta. Bryophytes have a unique life cycle with distinct morphological characteristics separating them from higher plants.

Step 2: Approach and Formula:

Evaluate each statement against the specific botanical life cycle features of mosses (like *Funaria*) vs. liverworts (like *Marchantia*).

Step 3: Detailed Explanation:

- **Statement a:** In all bryophytes, including *Funaria*, the main, dominant, photosynthetic, free-living plant body is the haploid **gametophyte**. (True).
- **Statement b:** Following fertilization, the diploid zygote develops into a **sporophyte**, which in mosses is well-differentiated into a foot, seta, and capsule. (True).
- **Statement c:** Gemmae are asexual reproductive buds. However, they are characteristic features of **liverworts** (like *Marchantia*), not mosses like *Funaria*. Mosses primarily reproduce asexually by fragmentation or budding in the secondary protonema. (False).

- **Statement d:** The sporophyte in bryophytes is **not independent**. It is physically attached to, and nutritionally dependent (partially or fully) on, the photosynthetic gametophyte. (False). Therefore, only statements 'a' and 'b' are correct.

Step 4: Final Answer:

The correct option is (1).

Quick Tip: Remember the division of Bryophytes: Mosses (*Funaria*, *Sphagnum*) have a leafy gametophyte and protonema stage. Liverworts (*Marchantia*) have a flat thallus and reproduce asexually using Gemma cups.

56. Match the animals given in List-I with their excretory organs in List-II.

List-I	List-II
a) Leech	i) Flame cells
b) Locust	ii) Proboscis gland
c) Liver fluke	iii) Nephridia
d) Balanoglossus	iv) Malpighian tubules

- (1) a - ii, b - i, c - iv, d - iii
(2) a - i, b - ii, c - iii, d - iv
(3) a - iii, b - iv, c - i, d - ii
(4) a - iv, b - iii, c - ii, d - i

Correct Answer: (3) a - iii, b - iv, c - i, d - ii

Solution:

Step 1: Understanding the Problem:

Different animal phyla have evolved highly specialized anatomical structures to handle the physiological processes of excretion and osmoregulation.

Step 2: Approach and Formula:

Match the specific animal examples to their corresponding phyla, and then link them to the excretory organs characteristic of that phylum.

Step 3: Detailed Explanation:

- **a) Leech:** Belongs to the phylum Annelida. Annelids typically utilize coiled tubular structures called **Nephridia** for excretion. (a → iii)
- **b) Locust:** Belongs to the phylum Arthropoda (specifically Class Insecta). Insects utilize

Malpighian tubules to excrete uric acid. (**b** → **iv**)

- **c) Liver fluke:** (*Fasciola*) Belongs to the phylum Platyhelminthes (flatworms). They possess specialized cells known as **Flame cells** (protonephridia) for osmoregulation and excretion. (**c** → **i**)

- **d) Balanoglossus:** Belongs to the phylum Hemichordata. The characteristic excretory organ situated in the proboscis is the **Proboscis gland**. (**d** → **ii**)

Consolidating the matches: a-iii, b-iv, c-i, d-ii.

Step 4: Final Answer:

The correct option is (3).

Quick Tip: Key phylum-excretory organ pairs: Platyhelminthes → Flame cells; Annelida → Nephridia; Insects → Malpighian tubules; Hemichordata → Proboscis gland.

57. Identify the flower with polyadelphous condition.

- (1) Mustard
- (2) Chinarose
- (3) Citrus
- (4) Pea

Correct Answer: (3) Citrus

Solution:

Step 1: Understanding the Problem:

The term "adelphous" refers to a condition where the filaments of the stamens in a flower are fused together, but their anthers remain completely free.

Step 2: Approach and Formula:

Classify the degree of stamen filament fusion (monadelphous, diadelphous, polyadelphous) and match the condition to its classic botanical examples.

Step 3: Detailed Explanation:

- **Monadelphous:** Filaments are fused into a single bundle or tube. Classic example: **Chinarose** (Hibiscus).
- **Diadelphous:** Filaments are fused into two distinct bundles (typically 9+1 arrangement).

Classic example: **Pea**.

- **Polyadelphous**: Filaments are fused into more than two separate bundles. The classic textbook example for this highly branched condition is **Citrus**.
- (Mustard exhibits a tetradynamous condition—6 free stamens, 4 long and 2 short, not fused bundles).

Step 4: Final Answer:

The polyadelphous condition is found in Citrus.

Quick Tip: Mnemonic to remember stamen fusions: **Mono-China** (Monadelphous → Chinrose), **Di-Pea** (Diadelphous → Pea), **Poly-Citrus** (Polyadelphous → Citrus).

58. The large empty colourless cells seen on the upper epidermis in grasses which facilitate the curling of leaves to minimise water loss are _____

- (1) Guard cells
- (2) Bulliform cells
- (3) Subsidiary cells
- (4) Mesophyll cells

Correct Answer: (2) Bulliform cells

Solution:

Step 1: Understanding the Problem:

Grasses (isobilateral monocot leaves) possess specialized epidermal structures to adapt to water stress environments.

Step 2: Approach and Formula:

Identify the specific motor cells in the epidermis that control the physical folding/rolling mechanism of grass leaves based on turgor pressure.

Step 3: Detailed Explanation:

- In the leaves of grasses, certain adaxial (upper) epidermal cells along the veins modify themselves into large, empty, colourless cells.
- These specialized structures are called **Bulliform cells** (or motor cells).
- When these cells are completely turgid (full of water), the leaf surface is fully exposed to

light.

- When the plant faces severe water stress, these cells become rapidly flaccid due to water loss. This physical deflation causes the leaf margins to curl inwards (roll up), drastically reducing the exposed surface area and thereby minimizing further water loss via transpiration.
- Guard cells and subsidiary cells manage stomatal pores, while mesophyll cells are photosynthetic.

Step 4: Final Answer:

These are Bulliform cells.

Quick Tip: Associate "Grasses + Curling/Rolling of leaves + Empty colourless cells" directly with Bulliform cells. They act as the plant's hydraulic hinges.

59. Find the incorrect statement among the following with respect to digestive system of frog.

- (1) Food is captured by a bilobed tongue.
- (2) Oesophagus is a long tube that opens into the stomach and continues as intestine.
- (3) Liver secretes bile that is stored in gall bladder.
- (4) The undigested solid waste moves into rectum and passes out through cloaca.

Correct Answer: (2) Oesophagus is a long tube that opens into the stomach and continues as intestine.

Solution:

Step 1: Understanding the Problem:

The frog has a well-developed, complete digestive system adapted to its carnivorous diet, featuring specific anatomical variations compared to humans.

Step 2: Approach and Formula:

Review the anatomical morphology of the frog's digestive tract, particularly analyzing the spatial constraints of the amphibian body plan.

Step 3: Detailed Explanation:

- Statement (1): Frogs possess a muscular, highly sticky, **bilobed tongue** attached at the front of the mouth, explicitly adapted to flick out and capture insect prey. (True).
- Statement (3): Similar to humans, the frog's **liver secretes bile juice**, which is concentrated

and temporarily stored in the **gall bladder**. (True).

- Statement (4): Post-digestion, the remaining undigested solid waste enters the rectum and is eventually expelled out of the body through a common exit chamber called the **cloaca**. (True).
- Statement (2): Frogs essentially lack a true neck. Because of this compressed anatomy, the distance between the mouth and the stomach is extremely short. Consequently, the **oesophagus is a very short tube**, not a "long tube" as the statement claims.

Step 4: Final Answer:

The incorrect statement is (2).

Quick Tip: A frog has no neck. Therefore, its oesophagus (food pipe) must anatomically be a very **short tube**.

60. Which of the following is not the function of plasma membrane?

- (1) Endocytosis
- (2) Formation of intercellular junctions
- (3) Secretion
- (4) DNA synthesis

Correct Answer: (4) DNA synthesis

Solution:

Step 1: Understanding the Problem:

The plasma membrane is the dynamic, selectively permeable phospholipid bilayer surrounding a cell. It serves crucial roles in cell communication, transport, and structural integrity.

Step 2: Approach and Formula:

Differentiate between the physiological functions occurring at the cell boundary versus those highly conserved biochemical processes occurring strictly inside specific internal organelles.

Step 3: Detailed Explanation:

- **Endocytosis:** The plasma membrane actively invaginates to engulf large macromolecules and fluids from the extracellular environment. (It is a membrane function).
- **Formation of intercellular junctions:** The plasma membrane features specific integral proteins (like cadherins and occludins) that form tight junctions, desmosomes, and gap

junctions to connect neighboring cells. (It is a membrane function).

- **Secretion:** Exocytosis involves the fusion of internal vesicles with the plasma membrane to secrete substances out of the cell. (It involves the membrane).

- **DNA synthesis:** The replication of genetic material (DNA) is a highly complex process that occurs exclusively inside the **nucleus** (in eukaryotes) or the cytoplasm/nucleoid region (in prokaryotes). The plasma membrane plays no enzymatic or structural role in synthesizing DNA.

Step 4: Final Answer:

DNA synthesis is not a function of the plasma membrane.

Quick Tip: The fluid-mosaic plasma membrane handles boundary transport (Endo/Exocytosis) and communication (junctions). Core genetic mechanisms (Replication/Transcription) occur safely shielded inside the Nucleus.