

KCET 2026 April 24 Biology

Question Paper with Solutions PDF

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) **Compulsory Questions:** All 60 questions are compulsory.
- (iv) Each question has four options. Only **one** option is correct.
- (v) **Correct Answer:** +1 marks.
- (vi) **Incorrect Answer:** There is no Negative marking for incorrect answers.

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

- (1) Metacentric
- (2) Telocentric
- (3) Acrocentric
- (4) Submetacentric

Correct Answer: (3) Acrocentric

Solution:

Step 1: Understanding the Concept: Chromosomes are classified into four types based on the position of the centromere.

Step 2: Key Formula or Approach: Analyze the position of the centromere and the relative lengths of the resulting p (short) and q (long) arms to identify the correct chromosome type.

Step 3: Detailed Explanation: A metacentric chromosome has a middle centromere, forming

two equal arms.

A submetacentric chromosome has a centromere slightly away from the middle, resulting in one shorter arm and one longer arm.

An acrocentric chromosome has a centromere situated close to its end, forming one extremely short and one very long arm.

A telocentric chromosome has a terminal centromere.

Based on the definitions, a chromosome with an extremely short and a very long arm is acrocentric.

Step 4: Final Answer: The correct option is (3).

Quick Tip: Remember the shapes during anaphase: Metacentric (V-shape), Submetacentric (L-shape), Acrocentric (J-shape), and Telocentric (i-shape).

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

- a) 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.
- b) The substrate binds tightly to the enzyme, inducing a change in the active site of the enzyme.
- c) The enzyme releases the products of the reaction and the free enzyme is ready to bind to another molecule of the substrate.
- d) The substrate binds to the active site of the enzyme.

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

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

Solution:

Step 1: Understanding the Concept: The catalytic cycle of an enzyme action follows a

specific sequential pathway described by the induced-fit model.

Step 2: Key Formula or Approach: Map the biological events from initial contact (substrate binding) to final release (product separation) in a chronological order.

Step 3: Detailed Explanation: The first step is the binding of the substrate to the active site of the enzyme (statement d).

This binding induces a conformational change in the enzyme, making it fit more tightly around the substrate (statement b).

The active site, now in close proximity to the substrate, breaks the chemical bonds of the substrate to form the enzyme-product complex (statement a).

Finally, the enzyme releases the products of the reaction, and the free enzyme is ready to bind to another substrate molecule (statement c).

Thus, the correct sequence is $d \rightarrow b \rightarrow a \rightarrow c$.

Step 4: Final Answer: The correct sequence matches option (2).

Quick Tip: Always start with substrate binding to the active site and end with product release. This simple logic narrows down the options immediately.

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?

- (1) 8 chromosomes
- (2) 4 chromosomes
- (3) 16 chromosomes
- (4) 32 chromosomes

Correct Answer: (2) 4 chromosomes

Solution:

Step 1: Understanding the Concept: Meiosis is a reductional cell division that halves the chromosome number.

Step 2: Key Formula or Approach: The ploidy level after Meiosis-I changes from diploid ($2n$) to haploid (n). Use the formula $n = \frac{2n}{2}$.

Step 3: Detailed Explanation: The parent cell is diploid with $2n = 8$ chromosomes.

Meiosis I is a reductional division, meaning the homologous chromosomes separate into two different daughter cells.

Therefore, the chromosome number is halved in each daughter cell formed at the end of Meiosis I.

The number of chromosomes will be $n = \frac{8}{2} = 4$.

Although each of these 4 chromosomes still consists of two sister chromatids, the chromosome count is based strictly on the number of centromeres.

Step 4: Final Answer: Each daughter cell will have 4 chromosomes.

Quick Tip: Remember that Meiosis I is reductional (halves the chromosome number) while Meiosis II is equational (maintains the haploid chromosome number).

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

- (1) Fructose
- (2) Galactose
- (3) Glucose
- (4) Sucrose

Correct Answer: (3) Glucose

Solution:

Step 1: Understanding the Concept: Cellulose is a complex carbohydrate (polysaccharide) that forms the primary structural component of plant cell walls.

Step 2: Key Formula or Approach: Identify the monomeric repeating unit of the polymer cellulose to determine its composition.

Step 3: Detailed Explanation: Cellulose is a homopolymer, meaning it is made up of only one type of monosaccharide repeating unit.

These repeating monomeric units are exclusively β -D-glucose molecules.

They are linked together by β -1,4-glycosidic bonds to form a long, straight, and unbranched chain.

Therefore, cellulose is entirely made up of glucose units.

Step 4: Final Answer: The correct option is (3).

Quick Tip: Starch, Glycogen, and Cellulose are all homopolymers of glucose, but they differ in the type of glycosidic linkages (α vs β) and branching.

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

- (1) 125 ml/minute
- (2) 125 ml/hour
- (3) 126 ml/minute
- (4) 125 ml/second

Correct Answer: (1) 125 ml/minute

Solution:

Step 1: Understanding the Concept: The Glomerular Filtration Rate (GFR) represents the total volume of filtrate formed by both kidneys per unit of time.

Step 2: Key Formula or Approach: Recall the standard physiological value of GFR for a healthy adult human as stated in standard biology curricula.

Step 3: Detailed Explanation: In a healthy adult human, the kidneys filter blood to produce urine continuously.

The normal value for GFR is approximately 125 milliliters per minute.

This translates to roughly 180 liters of filtrate generated per day ($125 \text{ ml/min} \times 60 \text{ min} \times 24 \text{ hours}$).

The option stating 125 ml/minute exactly matches this established physiological standard.

Step 4: Final Answer: The correct option is (1).

Quick Tip: Always double-check the units! Examinations often trick students by changing "minute" to "hour" or "second", as seen in the distractors here.

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

- (1) Ethylene
- (2) Abscissic Acid
- (3) Auxins
- (4) Gibberellins

Correct Answer: (1) Ethylene

Solution:

Step 1: Understanding the Concept: Plant Growth Regulators (PGRs) have distinct physiological effects and commercial agricultural applications.

Step 2: Key Formula or Approach: Match the specific agricultural function ("synchronising fruit set in pineapples") to the correct plant hormone.

Step 3: Detailed Explanation: While auxins are known to promote flowering in pineapples, ethylene is distinctly and specifically known for both initiating flowering and synchronizing fruit set.

Ethylene application ensures that the entire crop flowers and fruits at the same time, which is highly beneficial for the mass harvesting of pineapples.

This dual function of initiating and synchronizing fruit-set in pineapples is a textbook application of the gaseous hormone ethylene (often applied as Ethephon).

Step 4: Final Answer: The correct option is (1).

Quick Tip: Although Auxin is also used for pineapple flowering, the specific keyword "synchronising fruit set" points strictly to Ethylene in standard biology texts.

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

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

Correct Answer: (3) The trachea, bronchi and bronchioles are supported by 'O' shaped cartilaginous rings.

Solution:

Step 1: Understanding the Concept: The human respiratory system has specific anatomical structures adapted to facilitate breathing, gas exchange, and airway protection.

Step 2: Key Formula or Approach: Evaluate each statement against the standard anatomical facts of the human respiratory system to find the conceptually flawed one.

Step 3: Detailed Explanation: Statement (1) is correct: Lungs are enclosed in a double-layered pleural membrane with pleural fluid between them to reduce friction.

Statement (2) is correct: Alveoli are the primary sites of gas exchange and are thus highly vascularized with a rich network of blood capillaries.

Statement (4) is correct: The right lung has three lobes and is slightly larger than the left lung, which has only two lobes to accommodate the cardiac notch (heart).

Statement (3) is incorrect: The trachea, primary, secondary, tertiary bronchi, and initial bronchioles are supported by incomplete 'C' shaped cartilaginous rings, not complete 'O' shaped rings.

These rings are incomplete dorsally to allow the esophagus to expand during swallowing.

Step 4: Final Answer: The incorrect statement is (3).

Quick Tip: The cartilaginous rings are "incomplete" or "C-shaped" dorsally. This is a common trap in structural biology questions.

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.

- (1) Statement I and Statement II are wrong.
- (2) Statement I is correct but Statement II is wrong.
- (3) Statement I is wrong but Statement II is correct.
- (4) Statement I and Statement II are correct.

Correct Answer: (3) Statement I is wrong but Statement II is correct.

Solution:

Step 1: Understanding the Concept: An Electrocardiogram (ECG) is a graphical representation of the electrical activity of the heart during a standard cardiac cycle.

Step 2: Key Formula or Approach: Associate each wave of the ECG (P, QRS complex, T) with its corresponding electrical event (depolarization or repolarization) in the atria or ventricles.

Step 3: Detailed Explanation: A standard ECG consists of several waves.

The 'P' wave represents the electrical excitation or depolarisation of the **atria**, which leads to the contraction of both atria.

Therefore, Statement I is incorrect because it falsely states that the P wave represents ventricular depolarisation (which is actually represented by the QRS complex).

The 'T' wave represents the return of the ventricles from an excited to a normal resting state, which is called repolarisation.

Therefore, Statement II is completely correct.

Step 4: Final Answer: Statement I is wrong but Statement II is correct.

Quick Tip: Mnemonics for ECG waves: P = Atrial De-polarisation. QRS = Ventricular De-polarisation. T = Ventricular Re-polarisation.

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

- (1) Proximal Convoluted Tubule (PCT)
- (2) Ascending limb of loop of Henle
- (3) Distal Convoluted Tubule (DCT)
- (4) Descending limb of loop of Henle

Correct Answer: (3) Distal Convolved Tubule (DCT)

Solution:

Step 1: Understanding the Concept: Aldosterone is a mineralocorticoid hormone secreted by the adrenal cortex that regulates blood pressure, sodium, and potassium levels in the blood.

Step 2: Key Formula or Approach: Identify the specific target site (segment of the nephron) where aldosterone exerts its primary physiological effect.

Step 3: Detailed Explanation: Aldosterone acts primarily on the later parts of the nephron, specifically the Distal Convolved Tubule (DCT) and the collecting duct.

It stimulates the active "conditional" reabsorption of sodium ions (Na^+) and, consequently, water from the filtrate back into the blood plasma.

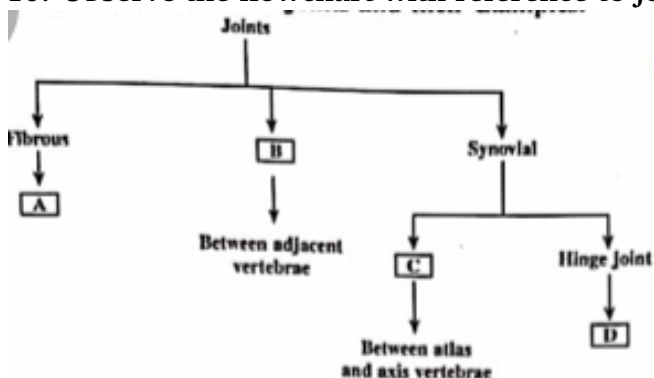
It also promotes the excretion of potassium (K^+) and phosphate ions into the urine.

The Proximal Convolved Tubule (PCT) is responsible for bulk reabsorption, while the Loop of Henle is involved in creating a concentration gradient, but they are not the primary targets for aldosterone.

Step 4: Final Answer: The correct option is (3).

Quick Tip: Remember the RAAS mechanism. Aldosterone facilitates the conditional reabsorption of Na^+ and water specifically in the DCT.

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



- (1) A - Cartilaginous joint, B - Pivot joint, C - Knee joint, D - Cranial sutures
- (2) A - Pivot joint, B - Knee joint, C - Cranial sutures, D - Cartilaginous joint
- (3) A - Saddle joint, B - Cranial sutures, C - Cartilaginous joint, D - Pivot joint
- (4) A - Cranial sutures, B - Cartilaginous joint, C - Pivot joint, D - Knee joint

Correct Answer: (4) A - Cranial sutures, B - Cartilaginous joint, C - Pivot joint, D - Knee joint

Solution:

Step 1: Understanding the Concept: Joints are points of contact between bones, classified into three major structural forms: Fibrous, Cartilaginous, and Synovial.

Step 2: Key Formula or Approach: Systematically decode each branch of the flowchart by matching the joint type with its definition and standard biological examples.

Step 3: Detailed Explanation:

For [A]: Fibrous joints do not allow any movement. An example is the flat skull bones which fuse end-to-end to form the cranium. Thus, [A] is Cranial sutures.

For [B]: The joint "Between adjacent vertebrae" permits limited movement and the bones are joined together with the help of cartilages. Thus, [B] is a Cartilaginous joint.

For [C]: The joint "Between atlas and axis vertebrae" is a specific type of synovial joint that allows rotational movement. Thus, [C] is a Pivot joint.

For [D]: A classic example of a Hinge joint (a type of synovial joint allowing movement in one plane) is the knee joint or elbow joint. Thus, [D] is a Knee joint.

Matching these findings, we get: A - Cranial sutures, B - Cartilaginous joint, C - Pivot joint, D - Knee joint.

Step 4: Final Answer: The correct sequence matches option (4).

Quick Tip: Identify the easiest match first. "Fibrous joint = immovable = cranial sutures" quickly eliminates options 1, 2, and 3.

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

- (1) One axon and one dendrite
- (2) Cell body and one axon
- (3) Cell body with one axon and many dendrites
- (4) Neither axon nor dendrites.

Correct Answer: (2) Cell body and one axon

Solution:

Step 1: Understanding the Concept: Neurons are classified structurally based on the number of processes (axons and dendrites) extending from their cell body (soma).

Step 2: Key Formula or Approach: Use the prefix of the neuron's classification ("uni-", "bi-", "multi-") to deduce the number of extending processes.

Step 3: Detailed Explanation: A unipolar neuron has a single process extending from its cell body.

This single process acts exclusively as an axon, and there are no true dendrites emerging directly from the cell body.

These types of neurons are typically found only in the early embryonic stage of human development.

In contrast, bipolar neurons have one axon and one dendrite (e.g., in the retina), and multipolar neurons have one axon and multiple dendrites (e.g., in the cerebral cortex).

Step 4: Final Answer: A unipolar neuron consists of a cell body and one axon, making option (2) correct.

Quick Tip: Prefix logic: Uni = 1 process (axon only). Bi = 2 processes (1 axon + 1 dendrite). Multi = many processes (1 axon + many dendrites).

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

- (1) Hydrochloric acid and pepsinogen
- (2) Pancreatic enzymes and bile juice
- (3) Water and bicarbonate ions
- (4) Bicarbonate ions and pepsinogen

Correct Answer: (1) Hydrochloric acid and pepsinogen

Solution:

Step 1: Understanding the Concept: The gastrointestinal tract secretes several local hormones (like gastrin, secretin, CCK) that regulate the release of digestive juices.

Step 2: Key Formula or Approach: Match the origin of the hormone to its specific target organ and subsequent physiological secretion.

Step 3: Detailed Explanation: Gastrin is produced by the G-cells located in the pyloric region of the stomach mucosa.

It acts locally on the gastric glands and stimulates them to secrete gastric juice.

The two main components of gastric juice stimulated by gastrin are Hydrochloric acid (HCl), secreted from parietal (oxyntic) cells, and the proenzyme pepsinogen, secreted from chief (peptic) cells.

Secretin and CCK are the hormones responsible for stimulating pancreatic enzymes, bile juice, and bicarbonate ions.

Step 4: Final Answer: Gastrin stimulates the secretion of Hydrochloric acid and pepsinogen.

Quick Tip: Etymology helps: "Gastrin" relates to "gastric" (stomach). Therefore, it naturally stimulates stomach secretions (HCl and pepsinogen).

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

- (1) Epidermis, Middle layer, Endothecium, Tapetum
- (2) Epidermis, Endothecium, Middle layer, Tapetum
- (3) Epidermis, Tapetum, Middle layer, Endothecium
- (4) Epidermis, Middle layer, Tapetum, Endothecium

Correct Answer: (2) Epidermis, Endothecium, Middle layer, Tapetum

Solution:

Step 1: Understanding the Concept: The microsporangium (pollen sac) in an angiosperm anther is surrounded by four distinct wall layers that protect and nourish the developing pollen grains.

Step 2: Key Formula or Approach: Recall the anatomical arrangement of the anther wall

layers from the outermost periphery to the innermost core.

Step 3: Detailed Explanation: From the outermost surface to the innermost lining, the sequence of layers is as follows:

1. Epidermis: The outermost single layer of protective cells.
2. Endothecium: The layer situated just below the epidermis, usually with fibrous thickenings that aid in anther dehiscence.
3. Middle layers: Consists of 1 to 3 layers of short-lived cells.
4. Tapetum: The innermost layer, which is crucial for providing nourishment to the developing pollen grains.

Therefore, the correct sequence from outside to inside is Epidermis, Endothecium, Middle layers, and Tapetum.

Step 4: Final Answer: The correct sequence is given in option (2).

Quick Tip: Visualize the structure from outside in with the acronym 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

- (1) Only Statement (b) is correct
- (2) Statements (a) and (c) are correct
- (3) Statements (b) and (d) are correct
- (4) Statements (b) and (c) are correct

Correct Answer: (3) Statements (b) and (d) are correct

Solution:

Step 1: Understanding the Concept: Cleistogamous flowers are a special type of flower that

never open, enforcing a strict mechanism of self-pollination.

Step 2: Key Formula or Approach: Analyze the biological implications of a flower that remains permanently closed on pollination, seed setting, and genetic variation.

Step 3: Detailed Explanation: Because cleistogamous flowers never open, their anthers and stigmas are permanently enclosed and not exposed (making statement 'a' incorrect).

Since they are closed, pollen from the anther falls directly onto the stigma of the same flower, leading to an assured seed set even in the complete absence of pollinators (making statement 'b' correct and statement 'c' incorrect).

Because they undergo obligate autogamy (self-pollination), there is no genetic recombination from different individuals.

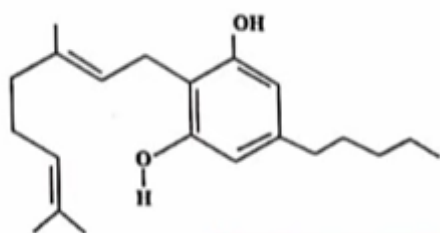
As a result, no new genetic variations are introduced, meaning variations in traits are generally not seen in the next generation (making statement 'd' correct).

Therefore, only statements (b) and (d) are factually true.

Step 4: Final Answer: The correct option is (3).

Quick Tip: "Cleisto" means closed. Closed flowers = 100% self-pollination = no pollinators needed = guaranteed seeds = zero genetic variation.

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



- (1) Opioid
- (2) Cannabinoid
- (3) Coca-alkaloids
- (4) Morphine

Correct Answer: (2) Cannabinoid

Solution:

Step 1: Understanding the Concept: Different classes of drugs have distinct chemical structures that determine their pharmacological effects and are often tested visually in biology exams.

Step 2: Key Formula or Approach: Identify the key functional groups and ring structures in the provided image to match it with standard drug classes.

Step 3: Detailed Explanation: The given skeletal structure features a substituted dibenzopyran framework.

Specifically, it contains a phenolic ring with an OH group and an aliphatic (pentyl) side chain. This is the characteristic skeletal structure of a cannabinoid molecule, typically representing tetrahydrocannabinol (THC) or its derivatives, obtained from the hemp plant **Cannabis sativa**. Opioids (like morphine) have a much more complex multi-ring structure with a distinctive tertiary nitrogen atom.

Coca-alkaloids (like cocaine) have a distinct bicyclic tropane ring structure.

Therefore, the given structure uniquely identifies as a cannabinoid.

Step 4: Final Answer: The correct option is (2).

Quick Tip: Memorize the visual shapes from the textbook: Morphine (complex, multi-ring with Nitrogen), Cannabinoid (two main rings, one with -OH, and a long tail), and Cocaine (tropane skeleton).

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

- (1) Alveoli → mammary duct → ampulla → mammary tubule → lactiferous ducts
- (2) Alveoli → mammary tubules → mammary duct → ampulla → lactiferous ducts
- (3) Alveoli → ampulla → mammary duct → mammary tubules → lactiferous ducts
- (4) Alveoli → lactiferous ducts → mammary duct → ampulla → mammary tubule

Correct Answer: (2) Alveoli → mammary tubules → mammary duct → ampulla → lactiferous ducts

Solution:

Step 1: Understanding the Concept: The human mammary gland consists of glandular tissue arranged in lobes and a complex ductal system for the synthesis, storage, and transport of milk.

Step 2: Key Formula or Approach: Trace the anatomical pathway of milk from its site of production deep within the gland to its point of exit at the nipple.

Step 3: Detailed Explanation: Milk is secreted by the specialized cells of the alveoli, which are clustered in the mammary lobes.

The milk is temporarily stored in the lumen (cavities) of these alveoli.

From the alveoli, the milk passes into smaller ducts called mammary tubules.

The mammary tubules of each lobe join to form a wider collective tube called a mammary duct.

Several mammary ducts then unite to form a dilated, wider structure called the mammary ampulla.

Finally, the ampulla is connected to the lactiferous duct, through which milk is ultimately sucked out from the nipple.

Thus, the correct sequential pathway is: Alveoli → mammary tubules → mammary duct → ampulla → lactiferous ducts.

Step 4: Final Answer: The correct option is (2).

Quick Tip: A highly useful mnemonic for the pathway is AT-DAL: 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:

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

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

Solution:

Step 1: Understanding the Concept: A mature mammalian sperm cell is a specialized cell divided into four main functional regions: head, neck, middle piece, and tail.

Step 2: Key Formula or Approach: Match the anatomical structure of the sperm with its specific physiological function during fertilization.

Step 3: Detailed Explanation:

(a) The **Acrosome** is a cap-like structure covering the anterior portion of the sperm head. It is filled with hydrolytic enzymes (like hyaluronidase) that help dissolve the egg membranes during fertilization. Thus, a matches with iii.

(b) The **Head** of the sperm primarily contains the genetic material in the form of an elongated haploid nucleus. Thus, b matches with iv.

(c) The **Middle piece** is packed with numerous mitochondria, which generate the ATP (energy) required to power the movement of the tail. Thus, c matches with i.

(d) The **Tail** is a long flagellum that beats in a whip-like motion to propel the sperm forward, facilitating sperm motility. Thus, d matches with ii.

Combining these correct associations, we get: a-iii, b-iv, c-i, d-ii.

Step 4: Final Answer: The correct option is (4).

Quick Tip: Remember associations: Mitochondria = Middle piece (Energy). Acrosome = Apex (Enzymes for egg entry). Nucleus = Head (Genetics).

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

- (1) Epididymis
- (2) Bulbourethral glands
- (3) Seminal vesicles
- (4) Prostate gland

Correct Answer: (1) Epididymis

Solution:

Step 1: Understanding the Concept: Semen is composed of sperm cells suspended in a nutrient-rich liquid medium known as seminal plasma.

Step 2: Key Formula or Approach: Identify which of the listed structures are accessory glands (which secrete fluid) and which are merely ducts (for transport/storage).

Step 3: Detailed Explanation: Seminal plasma is the combined fluid secretion of the male accessory reproductive glands.

These active secreting glands include the paired seminal vesicles, the single prostate gland, and the paired bulbourethral (Cowper's) glands.

Their secretions are rich in fructose, calcium, and certain enzymes essential for sperm survival.

The epididymis is a highly coiled tube located along the posterior surface of the testis.

Its primary function is the temporary storage, functional maturation, and acquiring motility of the sperm, but it does NOT secrete the bulk fluid known as seminal plasma.

Step 4: Final Answer: Therefore, the Epididymis is the correct answer.

Quick Tip: The male accessory glands that produce seminal plasma are the Seminal vesicles, Prostate, and Bulbourethral glands. The epididymis and vas deferens are just structural ducts.

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

- (1) AIDS, Genital warts
- (2) Chlamydia, Gonorrhoea
- (3) Genital warts, Hepatitis B
- (4) AIDS, Genital herpes

Correct Answer: (4) AIDS, Genital herpes

Solution:

Step 1: Understanding the Concept: While most sexually transmitted infections (STIs) can be completely cured if detected early and treated with antibiotics, some viral infections remain

lifelong.

Step 2: Key Formula or Approach: Identify the STIs from the given options that are caused by specific viruses known to integrate into the host system and evade complete eradication.

Step 3: Detailed Explanation: According to standard medical knowledge and NCERT textbooks, diseases such as syphilis, gonorrhoea, chlamydiasis, and trichomoniasis are completely curable with proper medical treatment.

However, specific viral infections like Hepatitis-B, Genital herpes, and HIV infection (which causes AIDS) are currently considered not completely curable.

Option (4) lists both AIDS and Genital herpes, making it the only pair where both diseases are strictly non-curable.

While genital warts (caused by HPV) can be persistent, they are treatable and often clear up, whereas HIV, Herpes, and Hep-B are strictly categorized together as non-curable STIs in textbooks.

Step 4: Final Answer: The correct option is (4).

Quick Tip: Remember the "3 H's" for non-curable viral STIs: HIV (AIDS), Herpes (Genital), and Hepatitis B.

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

- (1) It is a non-steroidal preparation
- (2) It is a 'once-a-week' pill
- (3) It has low contraceptive value
- (4) It has fewer side effects

Correct Answer: (3) It has low contraceptive value

Solution:

Step 1: Understanding the Concept: 'Saheli' is a highly successful oral contraceptive pill developed specifically for females in India by the Central Drug Research Institute (CDRI).

Step 2: Key Formula or Approach: Evaluate each characteristic of 'Saheli' against its known

pharmacological profile to find the false statement.

Step 3: Detailed Explanation: 'Saheli' is unique worldwide because it is a non-steroidal preparation (centchroman), unlike traditional birth control pills which contain steroid hormones like estrogen and progesterone.

It is highly convenient as it needs to be taken only once a week (a 'once-a-week' pill).

Because it lacks conventional steroids, it exhibits very few side effects.

Most importantly, despite its mild and non-steroidal formulation, it has a very HIGH contraceptive value.

Therefore, the statement claiming it has a "low contraceptive value" is factually incorrect.

Step 4: Final Answer: The incorrect statement is (3).

Quick Tip: Saheli is famous for its ideal combination: Non-steroidal, Once-a-week, High efficacy, and Low 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).

- (1) ZIFT – Zygote Intra Fallopian Transfer
- (2) IUI – Intra Uterine Insemination
- (3) AI – Artificial Insemination
- (4) GIFT – Gamete Intra Fallopian Transfer

Correct Answer: (3) AI – Artificial Insemination

Solution:

Step 1: Understanding the Concept: Assisted Reproductive Technologies (ART) are advanced medical procedures used to overcome specific infertility issues in either the male or female partner.

Step 2: Key Formula or Approach: Analyze the specific diagnosis (female is normal, male

has low sperm count / inability to inseminate) and match it to the corresponding targeted ART procedure.

Step 3: Detailed Explanation: In this scenario, the female is perfectly normal, meaning she can ovulate, undergo fertilization naturally, and carry a pregnancy.

The core problem lies solely with the male partner, who has a low sperm count (oligospermia) and is unable to inseminate the female naturally.

Such cases are directly treated by the Artificial Insemination (AI) technique.

In AI, the semen is collected from the husband (or a healthy donor) and is artificially introduced into the vagina or uterus of the female.

While Intra Uterine Insemination (IUI) is a specific variant of AI, Artificial Insemination (AI) is the primary overarching category explicitly taught as the direct answer for "inability to inseminate or low sperm counts" in foundational biology texts. Given the general nature of the question's phrasing from the textbook, AI is the intended broader answer.

Step 4: Final Answer: The correct option is (3).

Quick Tip: Key ART matchings:

Female infertility (normal uterus but cannot produce eggs) → GIFT.

Male infertility (low sperm count or inability to inseminate) → AI.

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?

- (1) 4 genotypes and 4 phenotypes
- (2) 4 genotypes and 3 phenotypes
- (3) 3 genotypes and 4 phenotypes
- (4) 2 genotypes and 3 phenotypes

Correct Answer: (2) 4 genotypes and 3 phenotypes

Solution:

Step 1: Understanding the Concept: Human ABO blood grouping is controlled by the gene I

which exhibits multiple allelism and codominance through three alleles: I^A , I^B , and I^O (or i).

Step 2: Key Formula or Approach: Perform a standard Mendelian genetic cross using a Punnett square between the given parental genotypes: $I^A I^B \times I^A I^O$.

Step 3: Detailed Explanation:

The possible gametes for the husband ($I^A I^B$) are I^A and I^B .

The possible gametes for the wife ($I^A I^O$) are I^A and I^O .

Crossing these gametes gives the following offspring combinations:

- I^A from husband + I^A from wife = $I^A I^A$ (Genotype 1 → Phenotype A)
- I^A from husband + I^O from wife = $I^A I^O$ (Genotype 2 → Phenotype A)
- I^B from husband + I^A from wife = $I^A I^B$ (Genotype 3 → Phenotype AB)
- I^B from husband + I^O from wife = $I^B I^O$ (Genotype 4 → Phenotype B)

Counting the unique combinations, we clearly see 4 distinct genotypes: $I^A I^A$, $I^A I^O$, $I^A I^B$, and $I^B I^O$.

Looking at the observable traits (phenotypes), we have 3 distinct groups: Blood Group A, Blood Group B, and Blood Group AB.

Step 4: Final Answer: The cross results in 4 genotypes and 3 phenotypes.

Quick Tip: Always map out the cross completely. Notice that $I^A I^A$ and $I^A I^O$ yield the same phenotype (Blood type A), which reduces the phenotype count compared to the genotype count.

23. The classical example of point mutation is

- (1) Haemophilia
- (2) Sickle cell anaemia
- (3) Cystic fibrosis
- (4) Phenyl ketonuria

Correct Answer: (2) Sickle cell anaemia

Solution:

Step 1: Understanding the Concept: A point mutation is a specific type of genetic mutation

where a single nucleotide base is altered (changed, inserted, or deleted) in a DNA or RNA sequence.

Step 2: Key Formula or Approach: Identify which of the given genetic disorders is fundamentally caused by a single base substitution at the molecular level.

Step 3: Detailed Explanation: Sickle cell anaemia is the universally taught classical example of a point mutation.

It is caused by the substitution of a single nitrogenous base in the DNA sequence coding for the β -globin chain of hemoglobin.

Specifically, an Adenine is replaced by a Thymine (the sequence GAG mutates to GTG in DNA, leading to GAG changing to GUG in the mRNA).

This single base change results in the substitution of the amino acid glutamic acid with valine at the 6th position of the β -globin chain.

This slight change drastically alters the physical shape of the red blood cell under low oxygen tension, causing it to become sickle-shaped.

Step 4: Final Answer: The correct option is (2).

Quick Tip: Sickle cell anaemia = Point Mutation (Transversion from GAG to GUG). Frame-shift mutations are caused by insertions or deletions, not simple single base substitutions.

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 F_1 generation of a test cross indicates that the organism with unknown genotype is homozygous dominant.

Choose the correct option.

- (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 Concept: A test cross is a fundamental genetic cross designed to determine the exact, unknown genotype of an organism exhibiting a dominant phenotype.

Step 2: Key Formula or Approach: Analyze the definition of a test cross and the logical implications of its resulting phenotypic ratios.

Step 3: Detailed Explanation: Statement I correctly defines a standard test cross: it involves crossing an organism with a dominant phenotype (which could be TT or Tt) with a homozygous recessive individual (tt). Thus, Statement I is completely true.

Statement II discusses interpreting the phenotypic results of this test cross.

If the test cross produces a ratio containing BOTH dominant and recessive traits (e.g., a 1:1 ratio), it logically implies that the unknown parent had to pass down a recessive allele, meaning it was heterozygous (Tt), NOT homozygous dominant.

Conversely, if the unknown organism is homozygous dominant (TT), all F₁ offspring will be heterozygous (Tt) and show ONLY the dominant trait (100% dominant, 0% recessive), yielding no mixed ratio.

Therefore, observing a mixed ratio indicates a heterozygous genotype, making Statement II false.

Step 4: Final Answer: Statement I is true, and Statement II is false.

Quick Tip: Test cross outcomes mapping:

All dominant offspring → Unknown parent is Homozygous dominant.

1:1 ratio of dominant to recessive → Unknown parent is Heterozygous.

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

- (1) Sickle cell anaemia is due to a quantitative problem of globin molecule.
- (2) Both are due to qualitative defects in globin chain synthesis.
- (3) Both are due to quantitative defects in globin chain synthesis.
- (4) Thalassaemia is due to less synthesis of globin molecules.

Correct Answer: (4) Thalassemia is due to less synthesis of globin molecules.

Solution:

Step 1: Understanding the Concept: Both Thalassemia and Sickle Cell Anaemia are genetic disorders affecting the hemoglobin molecule, but their fundamental molecular mechanisms differ entirely.

Step 2: Key Formula or Approach: Distinguish between a "quantitative" defect (amount produced) and a "qualitative" defect (structure produced) for both diseases.

Step 3: Detailed Explanation: Thalassemia is a genetic disorder resulting in a significantly reduced rate of synthesis of one of the globin chains (α or β).

Because it fundamentally affects the amount or quantity of globin synthesized, Thalassemia is defined strictly as a **quantitative** problem.

Conversely, Sickle cell anaemia is caused by a point mutation that produces a structurally abnormal, but normally quantified, globin chain (valine instead of glutamic acid).

Because it affects the structural quality and function of the hemoglobin molecule rather than its quantity, Sickle cell anaemia is defined as a **qualitative** problem.

Looking at the options, statement (4) correctly states that Thalassemia is due to "less synthesis" (which is a quantitative issue).

Step 4: Final Answer: The correct statement is (4).

Quick Tip: Thalassemia = Quantitative (too few chains produced).

Sickle Cell Anaemia = Qualitative (chains are produced in normal amounts, but they are defective/mutated).

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

- (1) Maurice Wilkins
- (2) Rosalind Franklin
- (3) Meselson and Stahl
- (4) Erwin Chargaff

Correct Answer: (3) Meselson and Stahl

Solution:

Step 1: Understanding the Concept: The groundbreaking discovery of the DNA double helix model in 1953 by Watson and Crick was built upon the crucial findings of several other contemporary scientists.

Step 2: Key Formula or Approach: Identify the scientific contributions of each listed scientist to separate the structural discoverers from those who studied DNA function later.

Step 3: Detailed Explanation: Maurice Wilkins and Rosalind Franklin produced critical X-ray diffraction images of DNA, which provided direct physical evidence of its helical structure. Erwin Chargaff formulated "Chargaff's rules," observing that in double-stranded DNA, the ratio of Adenine to Thymine and Guanine to Cytosine is always equal, which hinted strongly at base pairing.

Watson and Crick used all these findings to propose the double helix model.

However, Matthew Meselson and Franklin Stahl conducted their famous experiment later, in 1958.

Their experiment brilliantly proved that DNA replication is semi-conservative, but they did not contribute to the initial structural modeling of the double helix itself.

Step 4: Final Answer: The scientists with no contribution to the structural model are Meselson and Stahl.

Quick Tip: Timeline trick: The Double Helix structure was proposed in 1953. Meselson and Stahl proved semi-conservative replication later, in 1958.

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

- (1) 56%
- (2) 36%
- (3) 22%
- (4) 18%

Correct Answer: (3) 22%

Solution:

Step 1: Understanding the Concept: According to Chargaff's rules for double-stranded DNA, the amount of adenine (A) strictly equals the amount of thymine (T), and the amount of guanine (G) equals the amount of cytosine (C).

Step 2: Key Formula or Approach:

Use the mathematical formula:

$$A + T + G + C = 100\%$$

Since $A = T$ and $G = C$, we can deduce:

$$2A + 2C = 100\% \implies A + C = 50\%$$

Step 3: Detailed Explanation:

We are given that Cytosine (C) constitutes 28% of the bases.

According to Chargaff's rule, Guanine (G) must also be 28%.

The total combined percentage of G + C is $28\% + 28\% = 56\%$.

The remaining percentage must be completely made up of Adenine and Thymine.

Total percentage of A + T = $100\% - 56\% = 44\%$.

Since Adenine equals Thymine ($A = T$), the percentage of Adenine alone is exactly half of this remainder.

$$\text{Adenine} = \frac{44\%}{2} = 22\%$$

Alternatively, using the direct shortcut formula derived in step 2: $A = 50\% - C = 50\% - 28\% = 22\%$.

Step 4: Final Answer: The percentage of adenine is 22%.

Quick Tip: Quick mathematical rule for base pairing percentages: Any single purine + any single pyrimidine pair (e.g., A + C or T + G) always adds up to 50%. If C = 28%, then A = $50\% - 28\% = 22\%$.

28. Arrange the below given steps of DNA fingerprinting in sequence by selecting the appropri-

ate 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

(1) (a), (e), (d), (c), (b)

(2) (e), (a), (d), (b), (c)

(3) (d), (a), (e), (c), (b)

(4) (c), (b), (a), (e), (d)

Correct Answer: (3) (d), (a), (e), (c), (b)

Solution:

Step 1: Understanding the Concept: DNA fingerprinting is an advanced laboratory technique used to establish a link between biological evidence and a suspect, involving a highly specific series of molecular biology steps.

Step 2: Key Formula or Approach: Arrange the laboratory procedures logically from the initial collection of the raw sample to the final visualization of the results.

Step 3: Detailed Explanation: The process developed by Alec Jeffreys follows a precise chronological order:

1. First, you must obtain the raw genetic material. This is the Isolation of DNA (step d).
2. The long, continuous DNA strands are then cut into smaller, manageable fragments using specific enzymes. This is the Digestion of DNA by restriction endonucleases (step a).
3. These fragments of varying sizes need to be sorted. This is achieved by Separation of DNA fragments by electrophoresis (step e).
4. The separated DNA bands on the fragile agar gel are then transferred to a much sturdier medium. This is the Blotting of DNA fragments to synthetic membranes like nitrocellulose or nylon (step c).
5. After hybridization with a radioactive probe, the final step is to capture the image of the bands on an X-ray film. This is called Autoradiography (step b).

Therefore, the correct chronological sequence is $d \rightarrow a \rightarrow e \rightarrow c \rightarrow b$.

Step 4: Final Answer: The correct sequence matches option (3).

Quick Tip: Follow the logical physical flow: Isolate it → Cut it → Separate it → Transfer it → Photograph it.

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

- (1) Big Bang Theory explains the origin of Universe.
- (2) As Universe expanded, the temperature came down.
- (3) Hydrogen and Helium gases formed before the explosion.
- (4) The gases condensed under gravitation and formed the galaxies.

Correct Answer: (3) Hydrogen and Helium gases formed before the explosion.

Solution:

Step 1: Understanding the Concept: The Big Bang Theory is the leading cosmological explanation about how the universe began from a singularity.

Step 2: Key Formula or Approach: Analyze each statement against the standard timeline of events proposed by the Big Bang cosmological model.

Step 3: Detailed Explanation: Statement (1) is true: The theory is primarily concerned with explaining the singular huge explosion that resulted in the origin of the universe.

Statement (2) is true: The universe immediately expanded following the explosion, and as it expanded, its temperature drastically dropped.

Statement (4) is true: The elements formed eventually condensed under the force of gravitation to form stars and galaxies.

Statement (3) is NOT true: According to the theory, there was no matter in the form of actual gases "before" the Big Bang. The universe was a singular, infinitely dense, hot point. The simple gases Hydrogen and Helium were formed **after** the explosion as the universe expanded and cooled down sufficiently for subatomic particles to combine into actual atoms.

Step 4: Final Answer: Statement (3) is the incorrect statement.

Quick Tip: Fundamental cosmology concept: Nothing material (no atoms, no gases) existed before the Big Bang. Matter formation is a direct consequence of the cooling universe after the expansion began.

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

- (1) Accumulation of small variations
- (2) Intraspecific breeding
- (3) Interspecific breeding
- (4) Single-step large mutation

Correct Answer: (4) Single-step large mutation

Solution:

Step 1: Understanding the Concept: Different evolutionary biologists historically proposed different mechanisms for how new species arise, a process known as speciation.

Step 2: Key Formula or Approach: Differentiate the evolutionary mechanism proposed by Hugo de Vries from that proposed by Charles Darwin.

Step 3: Detailed Explanation: Charles Darwin believed that evolution was a slow, gradual process driven by natural selection acting on minor, heritable variations accumulated over many generations.

In stark contrast, Hugo de Vries based his theory on his extensive experiments with evening primrose (*Oenothera lamarckiana*).

He proposed that new species arise suddenly in a single generation due to large, sudden, unpredictable genetic changes.

He specifically coined the term "saltation" to describe a single-step large mutation that leads directly to speciation, bypassing the need for gradual accumulation.

Step 4: Final Answer: According to de Vries, speciation is driven by a single-step large mutation.

Quick Tip: Darwin = Gradual, small, directional variations over long periods.

De Vries = Sudden, large, random, directionless mutations (Saltation) in a single step.

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 Concept: The human evolutionary tree follows a general chronological sequence from early ape-like ancestors to modern humans, reconstructed primarily based on fossil records.

Step 2: Key Formula or Approach: Arrange the given hominid species sequentially based on their timeline of emergence and evolutionary advancement.

Step 3: Detailed Explanation: The universally accepted chronological sequence of human ancestors is:

1. **Dryopithecus** (e): The oldest common ancestor of apes and humans, existing approximately 15 million years ago.
2. **Australopithecus** (c): The first true hominids, walking upright in East African grasslands approximately 2-4 million years ago.
3. **Homo habilis** (a): The first definitive human-like being, the handy man with a brain capacity of 650-800 cc, emerging around 2 million years ago.
4. **Homo erectus** (b): Appeared about 1.5 million years ago, had a larger brain (900 cc) and is known to have discovered fire.
5. **Neanderthal man** (d): Lived near East and Central Asia much later, between 100,000 to 40,000 years back.

Putting the listed options in their proper chronological order yields: $e \rightarrow c \rightarrow a \rightarrow b \rightarrow d$.

Step 4: Final Answer: The correct sequence matches option (2).

Quick Tip: Mnemonic for human evolution sequence: "Doctor Ram And Hanuman Evaluated Neanderthals Secretly" → 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 Concept: Pollen grains possess a highly specialized two-layered wall, with the outer layer uniquely adapted for extreme environmental durability.

Step 2: Key Formula or Approach: Identify the specific organic chemical compound that confers extreme resistance to degradation in the outer pollen wall.

Step 3: Detailed Explanation: The outer prominent layer of the pollen grain is called the exine.

The exine is made up of a highly complex organic polymer called sporopollenin.

Sporopollenin is widely renowned as one of the most resistant organic materials known in the biological world.

It can effortlessly withstand extremely high temperatures, strong acids, and strong alkalis.

Furthermore, no known biological enzyme has been discovered that can successfully degrade sporopollenin.

Because of this unparalleled chemical resistance, pollen grains remain intact over millions of years and are exceptionally well preserved as microfossils in geological strata.

Step 4: Final Answer: The presence of sporopollenin is directly responsible for this

preservation.

Quick Tip: Sporopollenin is specifically associated with the EXINE (outer layer) of the pollen. The inner layer (intine) is made of relatively fragile pectocellulose.

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 Concept: Different infectious diseases in humans are caused by specific pathogenic agents (such as bacteria, viruses, fungi, or parasites).

Step 2: Key Formula or Approach: Match the given disease name with its medically identified causative pathogen.

Step 3: Detailed Explanation: Let's systematically analyze the given pathogens:

Wuchereria malayi is a parasitic filarial worm responsible for causing filariasis (elephantiasis).

Salmonella typhi is a pathogenic bacterium responsible for causing systemic typhoid fever.

Trichophyton is a genus of fungi responsible for causing superficial ringworm infections.

Haemophilus influenzae (along with Streptococcus pneumoniae) is a specific bacterium responsible for infecting the alveoli of the lungs, causing the severe respiratory disease Pneumonia.

Step 4: Final Answer: Therefore, Haemophilus influenzae is the correct causative organism for Pneumonia.

Quick Tip: Do not be fooled by the name. Despite its name containing "influenza" (which might make you think of the viral flu), *Haemophilus influenzae* is a BACTERIUM that primarily causes bacterial 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 Concept: The human immune system relies on lymphoid organs, which are broadly categorized into primary and secondary organs based on their specific function in lymphocyte development.

Step 2: Key Formula or Approach: Differentiate between primary organs (sites of maturation) and secondary organs (sites of interaction), and scan the options to exclude any primary organs.

Step 3: Detailed Explanation: Primary lymphoid organs are the foundational sites where immature lymphocytes originate, mature, and become antigen-sensitive. The only two primary lymphoid organs in humans are the Bone Marrow and the Thymus.

Secondary lymphoid organs are the functional sites where these mature lymphocytes migrate to interact with antigens, subsequently proliferating to become effector cells. Classical examples include the Spleen, Lymph nodes, Tonsils, Peyer's patches of the small intestine, and the Appendix.

Looking at the given options:

Option (1) contains Thymus (Primary).

Option (3) contains Bone marrow (Primary).

Option (4) contains Thymus (Primary).

Option (2) consists solely of Lymph nodes, Appendix, and Tonsils, all of which are correctly classified as secondary lymphoid organs.

Step 4: Final Answer: The correct option is (2).

Quick Tip: To solve quickly, just remember the 2 Primary organs: Bone Marrow and Thymus. Any option containing either of these is immediately incorrect for a "secondary only" question.

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 Concept: Modern cancer treatment often involves immunotherapy, which utilizes specific substances called biological response modifiers to enhance the body's natural defense mechanisms against tumors.

Step 2: Key Formula or Approach: Identify the therapeutic agent used clinically to boost the immune response against cancer cells among the given biological molecules.

Step 3: Detailed Explanation: Tumor cells frequently exhibit sophisticated mechanisms to evade detection and destruction by the host's immune system.

To counteract this evasion, cancer patients are administered biological response modifiers.

α -Interferon is a classic clinical example of such a modifier.

When administered, α -Interferon rapidly activates the patient's immune system, specifically enhancing the activity of natural killer (NK) cells and cytotoxic T-cells, which in turn helps in recognizing and aggressively destroying the tumor cells.

Histamine and Serotonin are general inflammatory mediators and neurotransmitters, not specific anti-tumor agents.

α -Lactalbumin is a simple nutritional protein found in milk.

Step 4: Final Answer: The correct option is (2).

Quick Tip: While interferons generally "interfere" with viral replication, α -Interferon specifically is highly utilized in cancer immunotherapy to wake up the immune system against tumors.

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 Concept: Lactic Acid Bacteria (LAB), such as Lactobacillus, are extensively used industrially and domestically to convert milk into curd.

Step 2: Key Formula or Approach: Recall the specific nutritional enhancement (vitamin synthesis) associated with the lactic acid fermentation process of milk.

Step 3: Detailed Explanation: During the fermentation process, LAB produce lactic acid which coagulates and partially digests the complex milk proteins, transforming liquid milk into semi-solid curd.

A highly beneficial metabolic side effect of this microbial growth is a significant enhancement in the overall nutritional quality of the product.

Specifically, LAB actively synthesize and significantly increase the concentration of Vitamin B₁₂ in the curd compared to the original raw milk.

Vitamin B₁₂ (Cobalamin) is a crucial nutrient required for nerve tissue health, optimal brain function, and the production of red blood cells.

Step 4: Final Answer: The correct option is (2).

Quick Tip: This is a direct and very frequently asked standard textbook line. LAB primarily increases Vitamin B₁₂ and also functionally checks disease-causing microbes in the 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 Concept: Biochemical Oxygen Demand (BOD) is a standard environmental parameter used to quantitatively evaluate the level of organic pollution in a given water body.

Step 2: Key Formula or Approach: Analyze the definition of BOD to understand the exact physical parameter that is directly measured during the laboratory test.

Step 3: Detailed Explanation: BOD is technically defined as the amount of dissolved oxygen needed (or continuously consumed) by aerobic biological organisms to break down the organic material present in a given water sample at a specific temperature over a specific time period. Because microorganisms actively consume oxygen as they metabolize and decompose the biodegradable organic matter, we can infer the amount of pollution indirectly.

We do not directly measure the physical mass of the organic matter itself. Instead, we measure the rate of oxygen uptake (consumption) by the microbes in the sealed water sample.

A higher rate of oxygen consumption strictly indicates a higher BOD, which in turn reflects a higher level of polluting organic matter in the water.

Step 4: Final Answer: Therefore, BOD is estimated directly by measuring the amount of oxygen consumption.

Quick Tip: BOD acts as an indirect proxy: we physically measure the **demand for oxygen** (oxygen consumed) to mathematically estimate the amount of biodegradable organic matter.

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 Concept: Baculoviruses are biological control agents used extensively in integrated pest management programs.

Step 2: Key Formula or Approach: Analyze each statement against standard textbook facts regarding the specific target organisms and ecological applications of Baculoviruses.

Step 3: Detailed Explanation: Statement I states that Baculoviruses are pathogens that attack nematodes.

This is factually incorrect because Baculoviruses (specifically the genus Nucleopolyhedrovirus) are pathogens that exclusively attack insects and other arthropods, not nematodes.

Statement II states that they are used as biological control agents in ecologically sensitive areas because of their species-specific action.

This statement is completely true, as they have a very narrow-spectrum insecticidal application. They have been shown to have no negative impacts on plants, mammals, birds, fish, or even on non-target insects.

Therefore, Statement I is false, while Statement II is true.

Step 4: Final Answer: The correct option is (4).

Quick Tip: Always remember: Baculoviruses target arthropods/insects only. They are the ideal candidates for species-specific, narrow-spectrum insecticidal applications in IPM.

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 Concept: Biotechnology relies on fundamental core techniques to alter and utilize biological systems.

Step 2: Key Formula or Approach: Match the textbook definition provided in the question to the correct terminology among the options.

Step 3: Detailed Explanation: The definition provided precisely describes "Genetic engineering."

Genetic engineering involves the direct manipulation of an organism's genes, which includes altering the chemistry of genetic materials (DNA and RNA).

These modified genetic materials are then introduced into host organisms to alter their phenotype.

Bioprocess engineering refers to the maintenance of sterile (microbial-free) ambient conditions to enable the growth of only the desired microbe/eukaryotic cell in large quantities.

Cloning and Transformation are specific steps or methods utilized within the broader field of genetic engineering, but they do not encompass the entire definition given.

Step 4: Final Answer: The described technique is Genetic engineering.

Quick Tip: Biotechnology has two core principles: Genetic Engineering (altering DNA/RNA) and Bioprocess Engineering (maintaining sterile environments for mass production).

40. Given below are two statements.

Statement I: Restriction enzyme BamHI has its recognition site in tet^R 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 Concept: The plasmid pBR322 is a widely used cloning vector that contains specific antibiotic resistance genes with designated restriction sites.

Step 2: Key Formula or Approach: Recall the map of pBR322 and apply the concept of insertional inactivation to determine the survival of recombinant bacteria.

Step 3: Detailed Explanation: Statement I states that BamHI has its recognition site in the tetracycline resistance (tet^R) region of pBR322.

This is factually true; both BamHI and SalI are located within the tet^R gene.

Statement II claims that E.coli having pBR322 with a desired DNA inserted at the BamHI site can still grow in a medium containing tetracycline.

This is false due to "insertional inactivation."

When foreign DNA is inserted at the BamHI site, the tet^R gene gets disrupted and loses its function.

Consequently, the recombinant E.coli will lose resistance to tetracycline and will not be able to grow in a tetracycline-containing medium.

Step 4: Final Answer: Statement I is true, and Statement II is false.

Quick Tip: Insertional inactivation means putting a gene inside a resistance gene destroys that resistance.
Insertion in BamHI → loss of Tetracycline 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 Concept: Various biochemical agents and enzymes are utilized at different stages of DNA isolation and processing.

Step 2: Key Formula or Approach: Match each specific laboratory technique or biological barrier with its corresponding chemical reagent or degrading enzyme.

Step 3: Detailed Explanation:

(a) To visualize separated DNA fragments in gel electrophoresis, the gel is stained with the fluorescent dye **Ethidium bromide** (iv) followed by exposure to UV radiation.

(b) During DNA isolation, purified DNA is ultimately precipitated out of the solution by the addition of **Chilled ethanol** (iii).

(c) The bacterial cell wall, primarily made of peptidoglycan, is degraded using the enzyme **Lysozyme** (ii) to release the cellular contents.

(d) The fungal cell wall, which is composed of chitin, requires the enzyme **Chitinase** (i) to break it open.

Therefore, the correct matching sequence is a-iv, b-iii, c-ii, d-i.

Step 4: Final Answer: The correct sequence corresponds to option (1).

Quick Tip: Remember target-enzyme pairs: Bacteria = Lysozyme, Plant = Cellulase, 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 Concept: Transgenic animals are often genetically modified to produce valuable biological products for human medicinal use.

Step 2: Key Formula or Approach: Recall the specific therapeutic proteins produced by transgenic animals and the human diseases they target.

Step 3: Detailed Explanation: Emphysema is a chronic respiratory disease characterized by the degradation of alveolar walls, often due to a deficiency in a specific protective enzyme.

To treat this, transgenic sheep and other animals have been developed to produce a specific human protein in their milk.

This therapeutic protein is **α -1 antitrypsin**.

Insulin is used for diabetes and is generally produced by recombinant bacteria (*E. coli*).

α -Lactalbumin is a protein enriched in the milk of the transgenic cow 'Rosie' to make it nutritionally superior for human babies.

Step 4: Final Answer: The correct option is (3).

Quick Tip: A1AT (α -1 antitrypsin) is the standard textbook answer for treating emphysema via transgenic animal products.

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 Concept: The commercial production of synthetic human insulin (Humulin) involves specific recombinant DNA techniques pioneered by the American company Eli Lilly in 1983.

Step 2: Key Formula or Approach: Arrange the distinct steps of recombinant protein production in logical chronological order.

Step 3: Detailed Explanation: The logical sequence of biotechnological events is as follows: First, the scientists had to prepare the specific genetic codes, meaning the preparation of two DNA sequences corresponding to chain A and chain B of human insulin (Step a).

Second, these synthesized DNA sequences were introduced into the plasmids of E. coli bacteria to serve as vectors (Step c).

Third, the engineered E. coli were cultured, leading to the biological production of chain A

and chain B separately within the bacterial cells (Step b).

Finally, these synthesized chains were extracted from the bacteria, purified, and then chemically combined by creating disulfide bonds to form mature, functional human insulin (Step d).

The correct chronological sequence is $a \rightarrow c \rightarrow b \rightarrow d$.

Step 4: Final Answer: The correct option is (2).

Quick Tip: You must put the genes into the bacteria (c) before the bacteria can produce the protein chains (b). This naturally orders $a \rightarrow c \rightarrow b \rightarrow d$.

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 Concept: Adenosine Deaminase (ADA) deficiency is a genetic disorder that severely compromises the immune system, often leading to SCID (Severe Combined Immunodeficiency).

Step 2: Key Formula or Approach: Evaluate the validity of each statement by recalling the physiological role of the ADA enzyme and the various available treatments.

Step 3: Detailed Explanation: Statement I declares that ADA is crucial for the immune system to function.

This is absolutely true, as the ADA enzyme is essential for the maturation and proliferation of lymphocytes (T-cells and B-cells).

Statement II claims that ADA deficiency can be cured "only" by bone marrow transplantation. This is false. While bone marrow transplantation is one treatment option, it is not the only one. Other treatments include enzyme replacement therapy (where functional ADA is regularly injected) and gene therapy.

Furthermore, standard textbooks explicitly state that neither standard bone marrow transplantation nor enzyme replacement therapy is completely curative unless performed at early embryonic stages.

Thus, the absolute word "only" makes Statement II factually incorrect.

Step 4: Final Answer: Statement I is true, but Statement II is false.

Quick Tip: Watch out for extreme keywords like "only" or "always" in biology statements. ADA deficiency has multiple treatment avenues (Enzyme replacement, BMT, Gene therapy).

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 Concept: In ecology, population growth is modeled primarily in two ways: exponential (geometric) growth and logistic growth.

Step 2: Key Formula or Approach: Recall the fundamental environmental assumption required for a population to experience pure exponential growth.

Step 3: Detailed Explanation: The exponential growth model ($dN/dt = rN$) mathematically assumes that the environment provides absolutely **unlimited** resources (food, space, etc.).

Because resources are unlimited, the population grows in a geometric or exponential fashion (statement 2 is correct).

In this theoretical model, a stationary phase is never reached because there is no environmental resistance to slow the growth (statement 3 is correct).

Since the concept of a carrying capacity (K) only applies when resources are limited, a population modeled exponentially will mathematically grow to infinity, effectively growing beyond any real-world carrying capacity limits (statement 4 is conceptually correct for this model).

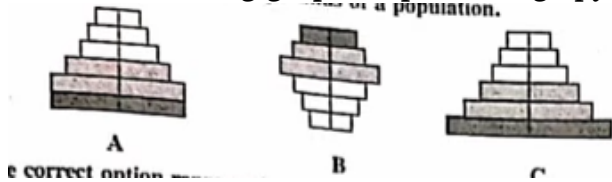
Therefore, the statement "Resources are limited" fundamentally contradicts the exponential growth model; it is the defining characteristic of the **logistic** growth model instead.

Step 4: Final Answer: The incorrect statement is (1).

Quick Tip: Exponential Growth = J-shaped curve, UNLIMITED resources.

Logistic Growth = S-shaped curve, LIMITED resources (incorporates 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: (3) A - stable, B - declining, C - expanding

Solution:

Step 1: Understanding the Concept: Age pyramids graphically depict the age distribution within a population. The shape of the pyramid indicates whether the population is growing, stable, or shrinking.

Step 2: Key Formula or Approach: Analyze the width of the bottom tier (pre-reproductive

age group) relative to the middle tier (reproductive age group) for each pyramid.

Step 3: Detailed Explanation:

In Pyramid A, the base (pre-reproductive individuals) is roughly equal in width to the tier above it (reproductive individuals). This bell-shaped structure indicates zero growth, meaning the population is **stable**.

In Pyramid B, the base is distinctly narrower than the middle reproductive section. This urn-shaped structure indicates that fewer offspring are being produced than are needed to replace the current generation, meaning the population is **declining**.

In Pyramid C, the base is very broad and significantly wider than the reproductive tier. This typical pyramid shape indicates a high birth rate and a rapidly **expanding** population.

Matching these shapes to their statuses gives: A - stable, B - declining, C - expanding.

Step 4: Final Answer: The correct option is (3).

Quick Tip: Look solely at the bottom block (children) versus the middle block (parents).

Bottom = Middle → Stable.

Bottom < Middle → Declining.

Bottom > Middle → Expanding.

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 Concept: Decomposition is the process by which complex organic detritus is broken down into simpler inorganic substances. It involves several distinct, overlapping steps.

Step 2: Key Formula or Approach: Recall the chronological sequence of physical and chemical processes that detritus undergoes in an ecosystem.

Step 3: Detailed Explanation: The process begins with **Fragmentation**, where detritivores (like earthworms) physically break down large pieces of detritus into smaller particles.

Next, water-soluble inorganic nutrients wash down into the soil horizon and precipitate as unavailable salts. This step is called **Leaching**.

Bacterial and fungal enzymes then further chemically degrade the remaining detritus into simpler inorganic substances; this is termed **Catabolism**.

These three processes operate simultaneously on the detritus. As it decomposes, it transforms into a dark, amorphous substance through **Humification**.

Finally, this humus is further degraded by some microbes to release inorganic nutrients, completing the cycle in a step called **Mineralization**.

Therefore, the correct standard sequence is Fragmentation → Leaching → Catabolism → Humification → Mineralization.

Step 4: Final Answer: The correct sequence corresponds to option (2).

Quick Tip: Use the mnemonic F-L-C-H-M: Frogs Like Catching Huge Moths (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 Concept: Net Primary Productivity (NPP) is the available biomass

generated by autotrophs (plants and photosynthetic organisms) across the entire biosphere over a year.

Step 2: Key Formula or Approach: Recall the specific statistical figures provided in standard ecological data concerning global productivity distribution.

Step 3: Detailed Explanation: According to NCERT and standard biological data, the annual net primary productivity of the entire global biosphere is approximately 170 billion tons (dry weight) of organic matter.

Despite occupying nearly 70% of the earth's surface, the productivity of the oceans is surprisingly low, contributing only about 55 billion tons.

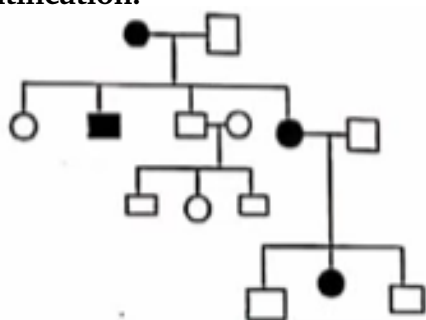
The rest of the productivity, which is generated on land, is calculated as the total minus the oceanic productivity: $170 - 55 = 115$ billion tons.

The question asks for the values on **land** and **ocean** respectively. Therefore, the sequence must be 115 followed by 55.

Step 4: Final Answer: The correct option is (2).

Quick Tip: Always read the requested order carefully! The question asks for Land first, then Ocean.
Land = 115, Ocean = 55.

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: (2) Autosomal dominant

Solution:

Step 1: Understanding the Concept: Pedigree analysis is a tool used to track the inheritance pattern of a specific genetic trait through generations in a family.

Step 2: Key Formula or Approach: Analyze the inheritance from affected parents to their offspring to deduce if the trait is dominant or recessive, and whether it is autosomal or sex-linked.

Step 3: Detailed Explanation:

Looking at the chart, in the first generation, both the father and the mother are affected (shaded).

They have some children who are completely unaffected (unshaded).

This is the hallmark of a **dominant** trait. If the trait were recessive, both affected parents would have the genotype "aa", meaning they could only produce "aa" (affected) children. Since they produce unaffected offspring, both parents must be heterozygous carriers of a dominant trait ($Aa \times Aa$), capable of producing "aa" (unaffected) children.

Next, we determine if it is autosomal or sex-linked.

If it were an X-linked dominant trait, an affected father ($X^A Y$) would pass his affected X chromosome to ALL his daughters, making them 100% affected.

However, the chart clearly shows the affected father has an unaffected daughter. This explicitly rules out X-linked dominant inheritance.

Therefore, the inheritance pattern must be Autosomal dominant.

Step 4: Final Answer: The correct identification is Autosomal dominant.

Quick Tip: Golden rules for pedigrees:

Affected parents → Unaffected child = Dominant.

Unaffected parents → Affected child = Recessive.

Affected father → Unaffected daughter eliminates X-linked dominant.

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 Concept: The latitudinal gradient of biodiversity describes the pattern where species richness generally increases as one moves from the poles towards the equator.

Step 2: Key Formula or Approach: Evaluate each statement against established ecological principles regarding global biodiversity distribution and climate stability.

Step 3: Detailed Explanation: Statement I asserts that there is less species biodiversity in tropical latitudes compared to temperate regions.

This is fundamentally false. The tropics actually harbor the highest levels of biodiversity on Earth, far exceeding temperate regions.

Statement II states that tropical environments are less seasonal, relatively more constant, and predictable.

This is a true ecological fact. Unlike temperate regions which suffer from severe glaciations and drastic seasonal changes, tropical latitudes have remained relatively undisturbed for millions of years. This constant and predictable environment promotes niche specialization and leads to higher species richness.

Therefore, Statement I is false, and Statement II is completely true.

Step 4: Final Answer: The correct option is (4).

Quick Tip: Tropics = High Biodiversity. Why? Because they have more solar energy, longer evolutionary time (undisturbed), and constant/predictable seasonal environments.

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 $K_{(5)}C_{(5)}A_5\underline{G}_{(2)}$
 (2) \oplus Bisexual $K_c \overbrace{CA} G \dots$
 (3) \oplus Bisexual $K_{(5)}C_{(5)}A_5\overline{G}_{(2)}$
 (4) \oplus Bisexual $K_{(5)}\overbrace{C_{(5)}A_5} \underline{G}_{(2)}$

Correct Answer: (4) \oplus Bisexual $K_{(5)}\overbrace{C_{(5)}A_5} \underline{G}_{(2)}$

Solution:

Step 1: Understanding the Concept: A floral formula uses specific symbols to concisely represent the morphological features, numbers, and arrangements of floral parts in a plant.

Step 2: Key Formula or Approach: Translate each given descriptive morphological term directly into its corresponding standard botanical symbol.

Step 3: Detailed Explanation: Let's break down the given description:

- Actinomorphic: Represented by the symbol \oplus .
- Bisexual: Represented by the combined male/female symbol.
- Pentamerous, gamosepalous: Calyx (K) has 5 sepals, and they are united. Represented as $K_{(5)}$.
- Gamopetalous: Corolla (C) has 5 petals (due to pentamerous condition), united. Represented as $C_{(5)}$.
- 5 stamens in epipetalous condition: Androecium (A) has 5 free stamens (A_5). Epipetalous means stamens are attached to petals, indicated by an arc connecting C and A . Thus, $\overbrace{C_{(5)}A_5}$.
- Bicarpellary syncarpous superior ovary: Gynoecium (G) has 2 carpels, united (syncarpous), and superior (line below G). Represented as $\underline{G}_{(2)}$.

Combining all these parts, the correct floral formula is \oplus Bisexual $K_{(5)}\overbrace{C_{(5)}A_5} \underline{G}_{(2)}$.

This formula is characteristic of the family Solanaceae.

Step 4: Final Answer: The correctly assembled formula is found in option (4).

Quick Tip: Parentheses () = United/fused parts.

Arc over symbols \widehat{CA} = Adhesion between different whorls (like epipetalous).

Underline \underline{G} = Superior ovary (floral parts attached below it).

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 Concept: Mitosis is divided into four main stages (Prophase, Metaphase, Anaphase, Telophase), each characterized by specific chromosomal movements.

Step 2: Key Formula or Approach: Identify the unique defining cellular events listed in the observations and match them to the corresponding phase of the cell cycle.

Step 3: Detailed Explanation:

In Prophase, chromosomes condense, and the nuclear envelope breaks down.

In Metaphase, chromosomes align flawlessly at the cellular equator (metaphase plate).

In **Anaphase**, the centromere holding the sister chromatids together undergoes sudden splitting. The newly separated sister chromatids (now considered individual daughter chromosomes) are rapidly pulled apart and migrate toward opposite poles of the cell by the shortening spindle fibers.

In Telophase, chromosomes decondense at the poles, and nuclear envelopes reform.

The observations provided exactly describe the key events of Anaphase.

Step 4: Final Answer: The stage identified is Anaphase.

Quick Tip: Remember key actions: Metaphase = Middle (alignment), Anaphase = Apart (splitting and migration).

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 Concept: Binomial nomenclature, introduced by Carl Linnaeus, is the universally accepted formal system of naming biological species.

Step 2: Key Formula or Approach: Review the universal rules of binomial nomenclature to identify the syntactically or structurally flawed statement.

Step 3: Detailed Explanation: Statement (1) is correct: Biological names are derived from Latin and printed in italics to indicate their Latin origin.

Statement (3) is correct: When handwritten, both words must be separately underlined.

Statement (4) is correct: The genus name is always capitalized, and the specific epithet is entirely in lowercase.

Statement (2) is incorrect: In a binomial name (e.g., **Homo sapiens**), the first word always represents the **genus** (generic name), and the second word represents the **specific epithet** (species name), not the other way around.

Step 4: Final Answer: The incorrect statement is (2).

Quick Tip: Always remember the order: Genus comes first (Capitalized), then the specific epithet (lowercase). E.g., **Mangifera indica**.

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 Concept: R.H. Whittaker's five-kingdom classification system categorizes organisms based on cell structure, body organization, mode of nutrition, and evolutionary relationships.

Step 2: Key Formula or Approach: Use the given traits (multicellular, heterotrophic, eukaryotic, chitinous wall) as a diagnostic checklist to isolate the correct kingdom.

Step 3: Detailed Explanation:

Let's evaluate the options based on the characteristics of organism 'X':

- Monera: Consists of strictly prokaryotic organisms (bacteria). 'X' is a eukaryote, so this is ruled out.
- Protista: Consists of primarily unicellular eukaryotes. While some can have cell walls, they are usually cellulosic or siliceous. Since 'X' is multicellular, this is ruled out.
- Animalia: Consists of multicellular, heterotrophic eukaryotes. However, animal cells completely lack a cell wall. Thus, this is ruled out.
- **Fungi:** Consists of multicellular (mostly), heterotrophic (saprophytic/parasitic) eukaryotes. Most distinctively, they possess a rigid cell wall predominantly made of a complex polysaccharide called **chitin**.

All given traits perfectly align with the Kingdom Fungi.

Step 4: Final Answer: Organism 'X' should be placed in Kingdom Fungi.

Quick Tip: Cell wall composition is a major diagnostic tool: Plants = Cellulose, Fungi = Chitin, Bacteria = Peptidoglycan, Animals = No cell wall.

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 Concept: *Funaria* is a common moss, belonging to the division Bryophyta. Bryophytes have specific life cycle characteristics distinguishing them from higher plants.

Step 2: Key Formula or Approach: Evaluate each morphological and life-cycle statement against the established biological facts for mosses.

Step 3: Detailed Explanation:

Statement a: Correct. In all bryophytes, including *Funaria*, the main, dominant, free-living, and photosynthetic plant body is the haploid gametophyte.

Statement b: Correct. Following fertilization, the zygote develops into a multicellular sporophyte which is morphologically differentiated into three parts: a basal foot, a stalk-like seta, and a terminal capsule containing spores.

Statement c: Incorrect. Gemmae (asexual reproductive buds) are characteristic features of Liverworts (like *Marchantia*), not mosses like *Funaria*. Mosses reproduce vegetatively mainly by fragmentation and budding in the secondary protonema.

Statement d: Incorrect. The sporophyte in bryophytes is not free-living. It remains physically attached to and nutritionally dependent on the photosynthetic gametophyte for its entire existence.

Therefore, only statements 'a' and 'b' are correct.

Step 4: Final Answer: The correct option is (1).

Quick Tip: Remember that in Bryophytes (mosses and liverworts), the Gametophyte is the 'boss' (dominant, independent), while the Sporophyte is a parasite dependent on it.

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 Concept: Different animal phyla have evolved specialized anatomical structures to carry out osmoregulation and excretion of nitrogenous wastes.

Step 2: Key Formula or Approach: Identify the biological phylum/class of each animal and match it to its characteristic excretory organ.

Step 3: Detailed Explanation:

(a) **Leech:** Belongs to Phylum Annelida. Annelids primarily excrete through coiled tubular structures called **Nephridia** (iii).

(b) **Locust:** An insect belonging to Phylum Arthropoda. Insects excrete predominantly via numerous fine tubules called **Malpighian tubules** (iv) which empty into the gut.

(c) **Liver fluke:** A flatworm belonging to Phylum Platyhelminthes. Flatworms utilize specialized ciliated protonephridia known as **Flame cells** (i) for osmoregulation and excretion.

(d) **Balanoglossus:** An acorn worm belonging to Phylum Hemichordata. They possess a specialized excretory structure located in the proboscis, simply called the **Proboscis gland** (ii).

Matching them up yields: a-iii, b-iv, c-i, d-ii.

Step 4: Final Answer: The correct matching corresponds to option (3).

Quick Tip: Common excretory match-ups: Platyhelminthes = Flame cells; Annelids = Nephridia; Insects = Malpighian tubules; Crustaceans = Green/Antennal glands.

57. Identify the flower with polyadelphous condition.

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

Correct Answer: (3) Citrus

Solution:

Step 1: Understanding the Concept: In angiosperms, the filaments of stamens can fuse together while their anthers remain free. This fusion can result in single or multiple distinct bundles.

Step 2: Key Formula or Approach: Differentiate between monadelphous, diadelphous, and polyadelphous stamen arrangements and recall their classic plant examples.

Step 3: Detailed Explanation:

If the filaments of all stamens unite into a single solid tube or bundle, the condition is called monadelphous (e.g., China rose/Hibiscus).

If they unite into exactly two separate bundles, it is called diadelphous (e.g., Pea, where arrangement is typically 9+1).

If the stamens unite into more than two separate bundles, the condition is referred to as **polyadelphous**.

The classic textbook example given for the polyadelphous condition is the **Citrus** flower (lemon/orange).

Mustard generally exhibits a tetradynamous free stamen arrangement.

Step 4: Final Answer: The correct option is (3).

Quick Tip: Adelpous memory trick: Mono = 1 bundle (China rose); Di = 2 bundles (Pea); Poly = many bundles (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 Concept: Monocot leaves (like grasses) have evolved specialized anatomical adaptations in their epidermis to cope with severe water stress.

Step 2: Key Formula or Approach: Match the morphological description and physiological function provided in the question to the correct specialized cell type.

Step 3: Detailed Explanation: In grasses, certain adaxial (upper) epidermal cells along the veins modify themselves into large, empty, bubble-like, and colorless cells.

These specialized cells are known as **bulliform cells** (or motor cells).

When they are turgid (filled with water), they keep the leaf surface exposed to light.

However, when they become flaccid due to water stress, they collapse, which mechanically forces the leaf to curl inwards. This curling reduces the effective surface area exposed to the sun and significantly minimizes water loss via transpiration.

Guard cells regulate stomatal opening, subsidiary cells support guard cells, and mesophyll cells conduct photosynthesis.

Step 4: Final Answer: The correct option is (2).

Quick Tip: "Bull" means bubble. Bulliform cells act like water-filled bubbles. When they pop/deflate (lose water), the leaf curls up to save itself.

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 Concept: The anatomy of a frog is highly adapted to its environment and body shape, resulting in specific structural differences compared to mammals.

Step 2: Key Formula or Approach: Critically evaluate the provided anatomical statements against the known specific morphology of a frog's digestive tract.

Step 3: Detailed Explanation: Statement (1) is correct: Frogs have a muscular, sticky, bilobed tongue attached at the front of the mouth used to snap at and capture prey.

Statement (3) is correct: Just like in humans, the frog's liver secretes bile which is temporarily stored in the gall bladder before being released.

Statement (4) is correct: The digestive tract ends with the rectum, which opens into a common chamber called the cloaca, from which solid waste is expelled.

Statement (2) is incorrect: While the oesophagus does connect the mouth to the stomach, it is fundamentally a very **short** tube in frogs, primarily because frogs completely lack a defined neck. Therefore, describing it as a "long tube" is anatomically wrong.

Step 4: Final Answer: The incorrect statement is (2).

Quick Tip: Frogs lack a neck entirely. Therefore, any anatomical structure connecting the head to the body cavity (like the oesophagus) must inherently be very short.

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 Concept: The plasma membrane is a dynamic, semi-permeable lipid bilayer that acts as the boundary of the cell and mediates cellular interactions.

Step 2: Key Formula or Approach: Review the functional repertoire of the plasma membrane versus the internal organelles of a cell.

Step 3: Detailed Explanation: The plasma membrane serves several critical functions at the cell surface.

It facilitates the bulk intake of materials via vesicular invagination, known as Endocytosis (Option 1).

It contains specialized proteins that link adjacent cells together, resulting in the Formation of intercellular junctions like tight junctions and desmosomes (Option 2).

It is actively involved in exocytosis, which facilitates the Secretion of cellular products into the extracellular space (Option 3).

However, **DNA synthesis** (replication) is a highly regulated genetic process that occurs strictly within the intracellular compartment—specifically inside the nucleus in eukaryotes, or within the nucleoid region of the cytoplasm in prokaryotes. The plasma membrane is entirely uninvolved in the biochemical synthesis of DNA.

Step 4: Final Answer: DNA synthesis is not a function of the plasma membrane.

Quick Tip: Plasma membrane = Boundary management (transport, secretion, communication, joining). Genetic processes (DNA/RNA synthesis) belong to the internal core (nucleus).