

CUET PG 2025 Zoology Question Paper with Solutions

Time Allowed :1 Hour 45 Mins	Maximum Marks :300	Total Questions :75
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General Instructions

Read the following instructions very carefully and strictly follow them:

1. The examination duration is 90 minutes. Manage your time effectively to attempt all questions within this period.
2. The total marks for this examination are 300. Aim to maximize your score by strategically answering each question.
3. There are 75 mandatory questions to be attempted in the Agro forestry paper. Ensure that all questions are answered.
4. Questions may appear in a shuffled order. Do not assume a fixed sequence and focus on each question as you proceed.
5. The marking of answers will be displayed as you answer. Use this feature to monitor your performance and adjust your strategy as needed.
6. You may mark questions for review and edit your answers later. Make sure to allocate time for reviewing marked questions before final submission.
7. Be aware of the detailed section and sub-section guidelines provided in the exam. Understanding these will aid in effectively navigating the exam.

1. What is the sequence of the template DNA for an mRNA with the sequence?
5'-CAUUGGCCAAGG-3'

- (A) 5'-CATTGGCCAAGG-3'
(B) 5'-CCTTGGCCAATG-3'
(C) 5'-GTAACCGGTTCC-3'
(D) 5'-CAUUGGCCAAGG-3'

Correct Answer: (B) 5'-CCTTGGCCAATG-3'

Solution:

Step 1: Understanding the Concept:

Transcription is the biological process where an mRNA molecule is synthesized from a DNA template. In this process, the template strand of DNA is read from 3' to 5', which directs the creation of a complementary mRNA strand in the 5' to 3' direction. The rules for base pairing are as follows: Adenine (A) on DNA corresponds to Uracil (U) on RNA, Thymine (T) on DNA

corresponds to Adenine (A) on RNA, Guanine (G) on DNA corresponds to Cytosine (C) on RNA, and Cytosine (C) on DNA corresponds to Guanine (G) on RNA.

Step 2: Detailed Explanation:

1. Identify the provided mRNA sequence:

The mRNA sequence given is 5'-CAUUGGCCAAGG-3'.

2. Construct the complementary DNA strand:

To ascertain the template DNA strand, we must apply the base-pairing rules (A-T, G-C, and U in mRNA corresponds to A in DNA) to find the complementary sequence.

mRNA: 5' - C A U U G G C C A A G G
- 3'

 ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓

Template DNA: 3' - G T A A C C G G T T C C
- 5'

3. Convert the template DNA to the conventional 5' to 3' orientation:

By scientific convention, DNA sequences are presented in the 5' to 3' direction. Therefore, we must read the sequence derived in the previous step from right to left.

The sequence is 3'-GTAACCGGTTCC-5'.

When written in the 5' to 3' direction, this becomes 5'-CCTTGGCCAATG-3'.

Step 3: Final Answer:

By comparing our derived sequence with the provided choices, we can conclude that option (B) is the correct match. Option (A) is the coding (sense) strand, with T substituted for U. Option (C) shows the template strand but is written in the non-standard 3' to 5' direction. Option (D) is simply the original mRNA sequence.

Quick Tip

To quickly find the template DNA strand (in 5' to 3' format) from an mRNA sequence, first find the sequence of the coding strand by replacing U with T in the mRNA sequence. Then, find the complementary sequence of the coding strand. For example, mRNA is 5'-CAUUGGCCAAGG-3'. The coding strand is 5'-CATTGGCCAAGG-3'. The complementary (template) strand is 5'-CCTTGGCCAATG-3'.

2. Which type of polymerase activity is shown by the enzyme telomerase?

- (A) DNA-dependent DNA polymerase
- (B) DNA-dependent RNA polymerase
- (C) RNA-dependent DNA polymerase
- (D) RNA-dependent RNA polymerase

Correct Answer: (C) RNA-dependent DNA polymerase

Solution:

Step 1: Understanding the Concept:

Telomerase is a unique enzyme tasked with preserving the length of telomeres, which are repetitive DNA sequences located at the ends of linear chromosomes. Because chromosomes tend to shorten with each cycle of cell division, telomerase plays a vital role by adding telomeric repeats back onto the chromosome ends.

Step 2: Detailed Explanation:

Telomerase is classified as a ribonucleoprotein, indicating it is a complex made of a protein part (TERT - telomerase reverse transcriptase) and an RNA part (TERC - telomerase RNA component).

The enzyme's function involves utilizing its own internal RNA component (TERC) as a blueprint to synthesize DNA.

- Because it synthesizes DNA, it is classified as a DNA polymerase.
 - Because it uses an RNA molecule as its guide, its function is described as RNA-dependent.
- Combining these two points, telomerase is an RNA-dependent DNA polymerase. An enzyme with this function is also termed a reverse transcriptase.

Step 3: Analyzing the Options:

- (A) **DNA-dependent DNA polymerase:** This enzyme type synthesizes a new DNA strand using an existing DNA strand as a guide (e.g., DNA polymerase in DNA replication).
- (B) **DNA-dependent RNA polymerase:** This enzyme synthesizes an RNA strand using a DNA strand as a guide (e.g., RNA polymerase in transcription).
- (C) **RNA-dependent DNA polymerase:** This enzyme synthesizes a DNA strand using an RNA strand as a guide. This is an accurate description of telomerase's function.
- (D) **RNA-dependent RNA polymerase:** This enzyme synthesizes an RNA strand using an RNA strand as a guide (e.g., found in certain viruses).

Step 4: Final Answer:

The function of telomerase is to create DNA using an RNA blueprint, which is defined as RNA-dependent DNA polymerase activity. Therefore, option (C) is the correct choice.

💡 Quick Tip

Remember the name "reverse transcriptase" for RNA-dependent DNA polymerase. Telomerase performs reverse transcription to extend the ends of chromosomes. This is a key concept in both molecular biology and cancer studies, as telomerase is often re-activated in cancer cells.

3. If the growth medium of a bacterial strain contains both glucose and lactose, how does it affect the lac operon?

- A. CAP protein binds lac promoter
- B. Repressor binds lac operator

C. CAP protein does not bind lac promoter

D. Repressor does not bind lac operator

Choose the most appropriate answer from the options given below:

(A) A and B

(B) C and D

(C) A and D

(D) B and C

Correct Answer: (B) C and D

Solution:

Step 1: Understanding the Concept:

The lac operon in *E. coli* serves as a paradigm for gene regulation. Its activity is governed by two primary conditions: the availability of lactose, which acts as an inducer, and the availability of glucose, the cell's preferred fuel. This regulation involves both negative control by the lac repressor and positive control by the Catabolite Activator Protein (CAP).

Step 2: Detailed Explanation:

It is necessary to examine the condition of the lac operon when both glucose and lactose are simultaneously available.

1. Impact of Lactose Presence:

- When lactose is available, it is converted to its isomer, allolactose.
- Allolactose functions as an inducer by attaching to the lac repressor protein.
- This attachment alters the repressor's shape, making it unable to bind to the operator (lacO) site of the operon.
- Consequently, **the Repressor does not bind the lac operator**. This validates statement **D** and invalidates statement **B**.

2. Impact of Glucose Presence (Catabolite Repression):

- The lac operon's activity is also enhanced by the CAP protein. However, CAP requires cyclic AMP (cAMP) to bind to the promoter and stimulate transcription.
- The intracellular concentration of cAMP is inversely related to the concentration of glucose.
- When glucose levels are high, cAMP levels are low.
- In the absence of sufficient cAMP, the CAP protein is unable to attach to its binding site on the lac promoter.
- Consequently, **the CAP protein does not bind the lac promoter**. This validates statement **C** and invalidates statement **A**.

Step 3: Final Answer:

Based on this analysis, when glucose and lactose are both present:

- The CAP protein fails to bind the promoter (Statement C).
- The repressor fails to bind the operator (Statement D).

The correct set of statements is C and D, which corresponds to option (B). The outcome is

that transcription of the lac operon proceeds, but only at a minimal, basal rate due to the lack of positive activation from CAP.

💡 Quick Tip

Remember the hierarchy of control for the lac operon: Glucose is the boss. If glucose is present, the operon is largely off (low transcription), regardless of lactose. For high-level transcription, two conditions must be met: glucose must be absent (so CAP binds) AND lactose must be present (so the repressor unbinds).

4. Which one of the following correctly describes the role of signal recognition particles?

- (A) Aid in the decoding of the information carried by the signal peptide for the secretory protein.
- (B) Aid in recognizing the antigen for inflammatory response.
- (C) Aid in receiving coated vesicles for exocytosis.
- (D) Aid in deciphering the genetic code for protein synthesis.

Correct Answer: (A) Aid in the decoding of the information carried by the signal peptide for the secretory protein.

Solution:

Step 1: Understanding the Concept:

The Signal Recognition Particle (SRP) is a vital ribonucleoprotein complex within the cell's protein-targeting system. Its function is to identify and guide proteins intended for the secretory pathway (e.g., those to be secreted, embedded in membranes, or sent to specific organelles) toward the endoplasmic reticulum (ER).

Step 2: Detailed Explanation:

This mechanism, termed co-translational targeting, unfolds as follows:

1. Translation of an mRNA molecule is initiated by a ribosome. If the resulting protein is meant for the secretory pathway, an N-terminal sequence of amino acids, known as the 'signal peptide', emerges.
 2. The SRP identifies and attaches to this signal peptide, which momentarily halts the translation process.
 3. The whole assembly (SRP, ribosome, and the nascent protein) is then guided to the ER membrane, where the SRP docks with an SRP receptor.
 4. The ribosome then associates with the translocon (a protein channel), translation continues, and the elongating polypeptide is fed through the channel into the ER lumen.
- Essentially, the SRP interprets the signal peptide, recognizing it as an "address label" for delivery to the ER.

Step 3: Analyzing the Options:

- **(A) Aid in the decoding of the information carried by the signal peptide for the secretory protein:** This statement accurately portrays the key role of the SRP. It recognizes the signal peptide and sets the targeting process in motion.
- **(B) Aid in recognizing the antigen for inflammatory response:** This function belongs to components of the immune system, such as antibodies or T-cell receptors.
- **(C) Aid in receiving coated vesicles for exocytosis:** This action is mediated by proteins like SNAREs, which facilitate the fusion of vesicles with the cell membrane.
- **(D) Aid in deciphering the genetic code for protein synthesis:** This is the principal function performed by the ribosome in conjunction with transfer RNAs (tRNAs).

Step 4: Final Answer:

Option (A) delivers the most precise and accurate description of the function of the Signal Recognition Particle.

💡 Quick Tip

Think of the SRP as a postal worker for the cell. It reads the 'zip code' (the signal peptide) on a newly made protein and ensures it gets delivered to the correct 'address' (the endoplasmic reticulum).

5. Which of the following is the most stable DNA configuration under normal physiological conditions?

- (A) A-DNA
- (B) B-DNA
- (C) C-DNA
- (D) Z-DNA

Correct Answer: (B) B-DNA

Solution:**Step 1: Understanding the Concept:**

DNA is capable of adopting various helical structures, referred to as conformations. The predominant forms are A-DNA, B-DNA, and Z-DNA. These conformations are distinguished by their helical direction (right-handed or left-handed), geometric parameters (such as width and pitch), and the spatial arrangement of the nitrogenous bases relative to the central axis of the helix.

Step 2: Detailed Explanation:

- **B-DNA:** This is the canonical right-handed double helix structure famously elucidated by Watson and Crick. It represents the most prevalent form of DNA within cells under standard

physiological conditions, characterized by high hydration levels and moderate salt concentrations. Its inherent stability in this environment makes it the default conformation for the vast majority of DNA sequences in living organisms.

- **A-DNA:** This is another right-handed helix, but it is characterized by being shorter and wider than B-DNA. It is typically found in environments with low water content (dehydrating conditions). Although it is not the primary form of DNA within the cell, this structure is characteristic of DNA-RNA hybrids and double-stranded RNA.

- **Z-DNA:** This is a left-handed helix distinguished by a "zigzag" pattern in its sugar-phosphate backbone. It is thermodynamically less stable than B-DNA and tends to form only under particular circumstances, such as high salt concentrations or within DNA sequences that have alternating purine-pyrimidine bases (e.g., GCGCGC). It is hypothesized to have a role in gene expression regulation.

- **C-DNA:** This is a less frequently observed right-handed conformation that appears under specific low-hydration and salt conditions.

Step 3: Final Answer:

The question specifies the most stable form under "normal physiological conditions," which directly implies the aqueous internal environment of a living cell. In such conditions, the B-DNA structure is the most energetically favorable and, therefore, the most common form. Thus, option (B) is the correct answer.

💡 Quick Tip

Associate B-DNA with 'Biological' or 'Body' conditions. It's the standard, most common form you see in textbook diagrams. A-DNA is for 'Arid' (dry) conditions, and Z-DNA is for 'Zigzag' and is the odd one out, being left-handed.

6. Arrange the following cell cycle stages in the correct order of their occurrence:

- A. S phase
- B. M phase
- C. G1 phase
- D. G2 phase

- (A) D, B, C, A
- (B) A, C, B, D
- (C) C, A, D, B
- (D) B, C, D, A

Correct Answer: (C) C, A, D, B

Solution:

Step 1: Understanding the Concept:

The cell cycle represents the structured sequence of events through which a cell divides to cre-

ate two daughter cells. It consists of two principal phases: Interphase, during which the cell expands and duplicates its DNA, and the Mitotic (M) phase, during which the cell undergoes division.

Step 2: Detailed Explanation:

Interphase itself is segmented into three sequential stages:

1. **G1 phase (Gap 1):** This is the initial stage immediately following cell division. In the G1 phase, the cell increases in size and produces the necessary proteins and mRNA for subsequent DNA replication. This corresponds to letter **C**.
2. **S phase (Synthesis):** After completing the G1 phase, the cell proceeds to the S phase. The defining activity of this stage is the replication of the cell's genetic material (DNA). This corresponds to letter **A**.
3. **G2 phase (Gap 2):** Upon the completion of DNA synthesis, the cell transitions into the G2 phase. During this period, the cell continues to enlarge and synthesize proteins essential for mitosis, effectively preparing for the final division. This corresponds to letter **D**.
Once Interphase (the combination of G1, S, and G2) is finished, the cell moves into the final stage:
4. **M phase (Mitosis):** This stage encompasses the segregation of the duplicated chromosomes (a process called mitosis) and the division of the cell's cytoplasm (cytokinesis), ultimately resulting in two genetically identical daughter cells. This corresponds to letter **B**.

Step 3: Final Answer:

The proper sequence for the stages of the cell cycle is $G1 \rightarrow S \rightarrow G2 \rightarrow M$.

Translating this into the provided letter options, the correct order is $C \rightarrow A \rightarrow D \rightarrow B$.

This sequence aligns with option (C).

💡 Quick Tip

A simple mnemonic to remember the order of the cell cycle is "Go Sally Go! Make Children!". **Go** -> **G1** **Sally** -> **S** phase **Go** -> **G2** **Make Children** -> **M** phase (Cytokinesis)

7. Match LIST-I with LIST-II

LIST-I Types Cancer		LIST-II Tissues involved	
A.	Carcinoma	I.	Muscle
B.	Chondroma	II.	Cartilage
C.	Sarcoma	III.	Blood
D.	Myeloma	IV.	Epithelial Tissue

Choose the most appropriate answer from the options given below:

- (A) A - IV, B - II, C - I, D - III
 (B) A - III, B - II, C - I, D - IV

- (C) A - II, B - I, C - IV, D - III
(D) A - I, B - II, C - IV, D - III

Correct Answer: (A) A - IV, B - II, C - I, D - III

Solution:

Step 1: Understanding the Concept:

This question assesses familiarity with oncological nomenclature, particularly the system for classifying tumors based on the tissue from which they originate. Typically, the suffix "-oma" denotes a tumor, while the prefix specifies the cell or tissue type involved.

Step 2: Detailed Explanation:

We will now pair each cancer type from LIST-I with its tissue of origin from LIST-II.

- **A. Carcinoma:** Carcinomas are malignant neoplasms originating from epithelial cells. Epithelial tissues form the lining of organs and cavities in the body. Thus, Carcinoma corresponds to Epithelial Tissue. (**A** → **IV**).
- **B. Chondroma:** The prefix "chondro-" pertains to cartilage. A chondroma is a benign growth consisting of mature cartilage cells. Thus, Chondroma corresponds to Cartilage. (**B** → **II**).
- **C. Sarcoma:** Sarcomas are malignant neoplasms that originate from mesenchymal tissues. These include connective tissues such as bone, fat, and muscle. Thus, Sarcoma corresponds to Muscle. (**C** → **I**).
- **D. Myeloma:** The prefix "myelo-" is associated with bone marrow. Myeloma, specifically multiple myeloma, is a cancer affecting plasma cells, a type of white blood cell that originates in the bone marrow. Thus, Myeloma corresponds to Blood (as it pertains to blood cells). (**D** → **III**).

Step 3: Final Answer:

The correct associations are: A-IV, B-II, C-I, and D-III. This set of pairings matches option (A).

 Quick Tip

Memorizing common medical prefixes is key for biology exams.

- **Carcino-** = Cancer (from epithelial cells)
- **Sarco-** = Flesh (connective/mesenchymal tissue)
- **Chondro-** = Cartilage
- **Myelo-** = Marrow/Spinal cord
- **Hema-** = Blood

These prefixes can help you quickly deduce the origin of many cancer types.

8. The approximate diameter of actin filaments is:

- (A) 4 micrometer (μm)
- (B) 8 micrometer (μm)
- (C) 4 nanometer (nm)
- (D) 8 nanometer (nm)

Correct Answer: (D) 8 nanometer (nm)

Solution:

Step 1: Understanding the Concept:

The cytoskeleton of a eukaryotic cell is a network composed of three principal types of protein fibers: microfilaments (also known as actin filaments), intermediate filaments, and microtubules. These fibers are distinguished by their protein makeup, structural arrangement, and diameter. The question specifically requests the diameter of actin filaments.

Step 2: Detailed Explanation:

- **Actin Filaments (Microfilaments):** These are the thinnest of the three cytoskeletal components. They are formed from polymers of the actin protein and create a flexible, helical fiber. Their diameter is consistently measured at approximately 7 to 8 nanometers (nm).
- **Intermediate Filaments:** As their name implies, their diameter falls between that of the other two types. Constructed from a variety of proteins (such as keratin, vimentin, and lamin), they have a typical diameter of around 10 nm.
- **Microtubules:** These are the thickest of the cytoskeletal fibers. They are structured as hollow cylinders made from tubulin protein dimers and possess an outer diameter of approximately 25 nm.

Step 3: Final Answer:

The available options are given in both micrometers and nanometers. The micrometer scale is orders of magnitude too large for a single cytoskeletal filament. The correct scale is nanometers. Of the nanometer choices, 8 nm serves as the most accurate approximation for the diameter of an actin filament.

Consequently, option (D) is the correct answer.

Quick Tip

Remember the relative sizes: Actin Filaments ; Intermediate Filaments ; Microtubules. A good way to remember the approximate diameters is 7-8 nm (Actin), 10 nm (Intermediate), and 25 nm (Microtubules). Be careful with units: 1 micrometer (μm) = 1000 nanometers (nm).

9. Match LIST-I with LIST-II

LIST-I Mitochondrial Compartments		LIST-II Enzymes present	
A.	Matrix	I.	ATP synthetase
B.	Inner membrane	II.	Monoamine oxidase
C.	Space between inner and outer membranes	III.	Citrate synthetase
D.	Outer membrane	IV.	Adenylate kinase

Choose the most appropriate answer from the options given below:

- (A) A - IV, B - II, C - III, D - I
 (B) A - III, B - I, C - IV, D - II
 (C) A - II, B - I, C - IV, D - III
 (D) A - I, B - IV, C - III, D - II

Correct Answer: (B) A - III, B - I, C - IV, D - II

Solution:

Step 1: Understanding the Concept:

The mitochondrion, a double-membraned organelle, is organized into distinct compartments. Each compartment houses a specific collection of enzymes that facilitate its designated roles in cellular respiration and metabolism. This question evaluates knowledge regarding the specific locations of key mitochondrial enzymes.

Step 2: Detailed Explanation:

Let's associate each mitochondrial location with its representative enzyme.

- **A. Matrix:** As the innermost compartment, the matrix is the location for the Krebs cycle (also known as the citric acid cycle) and the oxidation of fatty acids. **Citrate synthetase** is the enzyme that initiates the Krebs cycle by catalyzing its first reaction. It is therefore found in the matrix. (**A** → **III**).
- **B. Inner membrane:** This membrane, characterized by its extensive folding into cristae, is the site of the electron transport chain and oxidative phosphorylation. **ATP synthetase** (also known as ATP synthase or Complex V) is an enzyme complex embedded within the inner mitochondrial membrane, where it harnesses the proton gradient to generate ATP. (**B** → **I**).
- **C. Space between inner and outer membranes (Intermembrane space):** This compartment holds several enzymes that interact with the ATP being exported from the matrix. **Adenylate kinase**, a phosphotransferase enzyme located here, catalyzes the equilibrium reaction $2 \text{ ADP} \rightleftharpoons \text{ATP} + \text{AMP}$. (**C** → **IV**).
- **D. Outer membrane:** The outer membrane is highly permeable and contains a variety of enzymes. Among them is **Monoamine oxidase**, which is involved in degrading neurotransmitters. (**D** → **II**).

Step 3: Final Answer:

The correct pairings are determined to be: A-III, B-I, C-IV, D-II. This set corresponds exactly with option (B).

💡 Quick Tip

Associate the main function with the compartment to remember enzyme locations:

- **Matrix** → Krebs Cycle → Citrate Synthetase.
- **Inner Membrane** → ATP Production → ATP Synthase.
- **Outer Membrane** → Acts as a boundary, has specific enzymes like Monoamine Oxidase.
- **Intermembrane Space** → "In-between" reactions → Adenylate Kinase.

10. Which of these are executioner caspases?

A. Caspase 3

B. Caspase 6

C. Caspase 8

D. Caspase 5

Choose the most appropriate answer from the options given below:

(A) A and B only

(B) B and C only

(C) C and D only

D) A and D only

Correct Answer: (A) A and B only

Solution:

Step 1: Understanding the Concept:

Caspases, which are cysteine-aspartic proteases, represent a family of enzymes that hold critical roles in the process of apoptosis (programmed cell death). They are generally categorized into two primary groups according to their position and function within the apoptotic signaling cascade: initiator caspases and executioner (or effector) caspases.

Step 2: Detailed Explanation:

- **Initiator Caspases:** This group of caspases (including Caspase-2, -8, -9, -10) becomes activated at the start of the apoptotic sequence in response to specific death signals. Upon activation, their function is to cleave and thereby activate the downstream executioner caspases.

- **Executioner Caspases:** This group (including Caspase-3, -6, -7) is activated by the initiator caspases. Their role is to perform the "execution" phase of apoptosis. They do this by cleaving a wide range of cellular proteins, which results in the hallmark morphological and biochemical features of a cell undergoing apoptosis, such as DNA fragmentation and membrane blebbing.

Step 3: Classifying the Given Caspases:

- **A. Caspase 3:** This is a principal **executioner** caspase, frequently regarded as the most

important executioner.

- **B. Caspase 6:** This is also classified as an **executioner** caspase.
- **C. Caspase 8:** This is a key **initiator** caspase, which is activated through the extrinsic (death receptor-mediated) pathway of apoptosis.
- **D. Caspase 5:** This caspase is categorized as an inflammatory caspase (along with Caspase-1 and -4 in humans). Its main function is related to the activation of pro-inflammatory cytokines, rather than direct participation in the execution of apoptosis.

Step 4: Final Answer:

According to this classification, Caspase 3 (A) and Caspase 6 (B) are identified as the executioner caspases from the choices provided. Therefore, the correct option is (A).

💡 Quick Tip

A simple way to remember the main caspases:

- **Initiators:** Caspase-8 (Extrinsic path), Caspase-9 (Intrinsic path). Think of them as the "generals" giving the order.
- **Executioners:** Caspase-3, -6, -7. Think of them as the "soldiers" carrying out the order. Caspase-3 is the main soldier.

11. Which larval form of *Fasciola hepatica* has a motile tail?

- (A) Miracidium
- (B) Redia
- (C) Sporocyst
- (D) Cercaria

Correct Answer: (D) Cercaria

Solution:

Step 1: Understanding the Concept:

Fasciola hepatica, also known as the common liver fluke, undergoes a complex life cycle that features several distinct larval stages and an intermediate host, usually a snail. The question requires identifying the specific larval stage notable for possessing a motile tail used for movement.

Step 2: Detailed Explanation of Larval Stages:

The life cycle progresses through the following sequence:

1. **Miracidium:** This is the initial larval form that emerges from the egg in an aquatic environment. While it is a free-swimming larva, its movement is powered by the coordinated beating of numerous cilia covering its surface, not by a tail. Its objective is to locate and penetrate a suitable snail host.

2. **Sporocyst:** After entering the snail, the miracidium transforms into a sac-like, non-motile sporocyst. This stage undergoes asexual reproduction to generate either more sporocysts or the subsequent stage, the rediae.
3. **Redia:** This stage forms inside the sporocyst. It is more developed, possessing a mouth and pharynx, but it remains non-motile within the snail's tissues. It also reproduces asexually, producing either more rediae or cercariae.
4. **Cercaria:** This is the larval form that exits the snail host and returns to the water. A key characteristic of the cercaria is its structure, which consists of a distinct body (or head) and a long, propulsive tail. The tail facilitates swimming, enabling the cercaria to navigate the water and encyst on nearby aquatic plants.
5. **Metacercaria:** The cercaria sheds its tail and secretes a protective cyst on vegetation, transforming into a metacercaria. This is the stage that is infective to the definitive host (such as sheep, cattle, or humans).

Step 3: Final Answer:

Among the choices provided, the **Cercaria** is the singular larval form that features a prominent, motile tail for the purpose of swimming. Thus, option (D) is the correct answer.

💡 Quick Tip

Remember the motile stages in the fluke life cycle:

- **Miracidium:** Motile by **cilia**.
- **Cercaria:** Motile by a **tail**.

The stages inside the snail (Sporocyst, Redia) are non-motile sacs for asexual reproduction.

12. In the life cycle of a *Plasmodium*, once the sporozoite enters the blood of the host, it invades the hepatic portal system, resulting in occurrence of change in the host body, leading to malaria

- A. Sporozoite enters the hepatocytes and divides by schizogony leading to formation of cryptomerozoites
- B. Inside RBCs, the micro-metacryptozoites become rounded and modify into a young trophozoites.
- C. As the trophozoite grows in size, a central vacuole is developed so that the nucleus is pushed to one side into the peripheral cytoplasm, leading to amoeboid stage.
- D. In Amoeboid stage the small red eosinophils granules appear in the cytoplasm of the host corpules as Schuffner's granules

Choose the most appropriate answer from the options given below:

- (A) A, B and D only
- (B) A, B and C only
- (C) A, B, C and D

(D) B, C and D only

Correct Answer: (C) A, B, C and D

Solution:

Step 1: Understanding the Concept:

The question requires an evaluation of statements that describe the sequence of events in the life cycle of the *Plasmodium* parasite after it is introduced into a human host. The human phase of the parasite's life cycle is divided into two primary stages: the exo-erythrocytic stage in the liver and the erythrocytic stage in the red blood cells.

Step 2: Analyzing each statement:

- **Statement A: Correct.** When sporozoites are introduced into the human bloodstream by a mosquito bite, they quickly travel to the liver and infect liver cells (hepatocytes). Within these cells, they undergo a process of asexual reproduction called schizogony, producing thousands of merozoites (also known as cryptomerozoites or metacryptozoites). This phase is known as the pre-erythrocytic or exo-erythrocytic cycle.

- **Statement B: Correct.** Following the liver stage, the merozoites (specifically, metacryptozoites) are released into the bloodstream, where they infect red blood cells (RBCs). Upon entering an RBC, the parasite develops into a feeding stage known as a trophozoite, initiating the erythrocytic phase of the cycle.

- **Statement C: Correct.** The young trophozoite ingests hemoglobin, forming a large food vacuole. This vacuole displaces the parasite's nucleus and cytoplasm to the edge, giving it the characteristic "signet ring" look. As the parasite matures and enlarges, it takes on a more irregular, motile form referred to as the amoeboid stage. This description is accurate.

- **Statement D: Correct.** During infections with specific malaria species, particularly *Plasmodium vivax* and *P. ovale*, the cytoplasm of the infected red blood cell exhibits distinctive fine, reddish (eosinophilic) stippling known as Schuffner's granules or dots. These are an important diagnostic marker.

Step 3: Final Answer:

All four statements (A, B, C, and D) provide accurate descriptions of various stages and phenomena that take place during the life cycle of the malaria parasite within the human body. Therefore, the most comprehensive and correct answer must include all of them.

💡 Quick Tip

To understand the *Plasmodium* life cycle in humans, break it down:

1. **Liver Stage (Exo-erythrocytic):** Sporozoite → Hepatocyte → Schizont → Merozoites.
2. **Blood Stage (Erythrocytic):** Merozoite → RBC → Trophozoite (ring, amoeboid) → Schizont → New Merozoites (cause fever) OR Gametocytes (infect next mosquito).

This framework helps organize the sequence of events.

13. During the process of conjugation in Paramecium, how many daughter Paramecia are formed from 2 parents?

- (A) 2
- (B) 4
- (C) 8
- (D) 16

Correct Answer: (C) 8

Solution:

Step 1: Understanding the Concept:

Conjugation in *Paramecium* is a method of sexual reproduction. It is essential to recognize that conjugation itself involves the exchange of genetic material between two individuals (the conjugants) and does not immediately result in an increase in their number. The population growth occurs through cell division *after* the conjugants have separated.

Step 2: Detailed Explanation:

1. **Genetic Exchange:** Two parent *Paramecia* align and exchange haploid micronuclei.
2. **Separation:** Following this exchange, the two individuals detach. At this point, they are termed exconjugants. Each exconjugant now possesses a new diploid zygote nucleus (a synkaryon) containing a novel combination of genes.
3. **Nuclear Reorganization:** Within each exconjugant, the old macronucleus disintegrates while the new synkaryon undergoes several mitotic divisions to generate new micronuclei and macronuclei.
4. **Cell Division (Fission):** After this internal reorganization is complete, each of the two exconjugants undergoes two consecutive binary fissions, which results in the formation of four daughter cells from each exconjugant.
5. **Calculation:** Since there are two exconjugants and each one produces four daughter cells, the total number of new *Paramecia* is calculated as follows:

$$\text{Total daughters} = (\text{Number of exconjugants}) \times (\text{Daughters per exconjugant})$$

$$\text{Total daughters} = 2 \times 4 = 8$$

Step 3: Final Answer:

From the two initial parent cells, a total of 8 daughter cells are ultimately produced after the processes of conjugation and subsequent cell divisions are complete. Thus, option (C) is correct.

💡 Quick Tip

A common mistake is to confuse conjugation with binary fission. Remember, conjugation is for genetic recombination, not for reproduction. The reproduction (multiplication) happens via binary fission *after* conjugation is complete. Each of the two parents gives rise to four offspring, making a total of eight.

14. Which one of the following is a larval form of jelly fish?

- (A) Amphiblastula
- (B) Ephyra
- (C) Redia
- (D) Rhabditiform

Correct Answer: (B) Ephyra

Solution:

Step 1: Understanding the Concept:

This question probes knowledge of the life histories of different invertebrate groups to pinpoint the specific larva associated with jellyfish (Phylum Cnidaria, Class Scyphozoa).

Step 2: Detailed Explanation of Options:

- **Amphiblastula:** This is a type of free-swimming larva found in the life cycle of certain sponges (Phylum Porifera).
- **Ephyra:** This is a juvenile, free-swimming medusa (the familiar jellyfish form) that is produced asexually. It buds off from a stationary polyp stage known as a scyphistoma in a process called strobilation. The ephyra subsequently grows and develops into the adult jellyfish.
- **Redia:** This is one of the larval stages in the life cycle of parasitic flukes (Phylum Platyhelminthes, Class Trematoda), and it develops inside a snail host.
- **Rhabditiform:** This term describes the first-stage larva characteristic of many nematodes (Phylum Nematoda), including species like hookworms and roundworms.

Step 3: Final Answer:

Following the analysis of the options, the ephyra is correctly identified as the larval or juvenile form that is part of the jellyfish life cycle. Therefore, option (B) is the correct answer.

💡 Quick Tip

Associate key larval forms with their phyla:

- **Cnidaria (Jellyfish):** Planula, Ephyra
- **Porifera (Sponges):** Parenchymula, Amphiblastula
- **Platyhelminthes (Flukes):** Miracidium, Sporocyst, Redia, Cercaria
- **Nematoda (Roundworms):** Rhabditiform, Filariform

Knowing these associations is very helpful for matching-type questions.

15. Match LIST-I with LIST-II

LIST-I Type of cell in Porifera		LIST-II Functions	
A.	Collar cells	I.	Line the sphincters
B.	Trophocytes	II.	Special nurse cells
C.	Pinacocytes	III.	Help to form spermatocyst
D.	Thesocytes	IV.	Food storage

Choose the most appropriate answer from the options given below:

- (A) A - I, B - II, C - III, D - IV
(B) A - I, B - III, C - II, D - IV
(C) A - I, B - II, C - IV, D - III
(D) A - III, B - II, C - I, D - IV

Correct Answer: (D) A - III, B - II, C - I, D - IV

Solution:

Step 1: Understanding the Concept:

Sponges, belonging to the Phylum Porifera, exhibit a cellular level of body organization, meaning they are composed of various cell types that are specialized to perform distinct functions. This question tests the understanding of these specific cell types and their corresponding roles.

Step 2: Detailed Matching:

- **A. Collar cells (Choanocytes):** These are flagellated cells that generate water currents for feeding and gas exchange. They are also involved in reproduction; they can differentiate into spermatocytes or envelop developing sperm to **form a spermatocyst**. Thus, **A corresponds to III**.

- **B. Trophocytes:** These are motile, amoeboid cells tasked with the digestion and distribution of nutrients to other cells. They effectively act as **special nurse cells**, providing nourishment to various cells, including developing reproductive cells. Thus, **B corresponds to II**.

- **C. Pinacocytes:** These are flat, epithelial-like cells that constitute the outer layer (pinacoderm) of the sponge. They possess contractility, allowing them to regulate the openings of

pores and the osculum, thereby functioning like **sphincters** to manage water flow. Thus, **C corresponds to I**.

- **D. Thesocytes:** These are amoeboid cells specifically adapted for **food storage**. They accumulate nutritional reserves such as glycogen, lipids, and proteins. Thus, **D corresponds to IV**.

Step 3: Final Answer:

The correct set of associations is A-III, B-II, C-I, D-IV. This combination matches option (D).

💡 Quick Tip

Break down the names of the cells to remember their function:

- **Pinacocyte:** Think "Pin" or "Plate" - flat cells forming the outer layer.
- **Choanocyte:** Think "Collar" - collar cells.
- **Trophocyte:** Troph means "nourishment" (like in autotroph) - nurse cells.
- **Thesocyte:** Think "Thesaurus" or "Thesis" - a place for storage - food storage cells.

16. In the life history and development of sea star, numerous larval forms are formed. Arrange them in the order of their occurrence:

A. Dipleurula

B. Branchiolaria

C. Bipinnaria

Choose the most appropriate answer from the options given below:

(A) A, B, C

(B) A, C, B

(C) B, A, C

(D) C, B, A

Correct Answer: (B) A, C, B

Solution:

Step 1: Understanding the Concept:

The life cycle of sea stars (Class Asteroidea) is characterized by indirect development, which involves passing through a sequence of distinct, free-swimming larval stages that are bilaterally symmetrical, before they metamorphose into the radially symmetrical adult form.

Step 2: Detailed Explanation of the Order:

1. **Dipleurula (A):** The dipleurula is regarded as the hypothetical ancestral larval form for all echinoderms. The initial, early larva of a sea star that emerges from the gastrula stage is of a dipleurula type, which subsequently develops into the bipinnaria. It represents the starting

point of larval development.

2. **Bipinnaria (C):** This is the first clearly defined larval stage of the sea star. It develops from the earlier dipleurula-type larva and is identified by its bilateral symmetry and the presence of ciliated bands used for movement and feeding. This stage lacks any arms for attachment.

3. **Brachiolaria (B):** The bipinnaria larva transforms into the brachiolaria larva, which is the final larval stage. It is distinguished from the bipinnaria by the development of three additional, short, non-ciliated arms (known as brachiolar arms) at its anterior end, along with an adhesive disc. These structures are crucial for attaching to a surface before the larva undergoes metamorphosis.

Step 3: Final Answer:

The correct chronological sequence of larval development is Dipleurula (the early larval concept) → Bipinnaria → Brachiolaria. This corresponds to the letter sequence A, C, B. Therefore, option (B) is correct.

💡 Quick Tip

Remember the alphabetical order trick for the main sea star larvae: **B**ipinnaria comes before **B**rachiolaria. The dipleurula is the conceptual starting form for all echinoderm larvae. So, Dipleurula → Bipinnaria → Brachiolaria.

17. Which one of the following belongs to class-Diplopoda?

- (A) Balanus
- (B) Sacculina
- (C) Scolopendra
- (D) Julus

Correct Answer: (D) Julus

Solution:

Step 1: Understanding the Concept:

The inquiry requires identifying which of the listed organisms is classified under Class Diplopoda. This class encompasses the millipedes, which are a group within the Subphylum Myriapoda.

Step 2: Detailed Explanation of Options:

- **Balanus:** This genus represents acorn barnacles, which are classified under the Class Crustacea.
- **Sacculina:** This genus consists of parasitic barnacles, which, like Balanus, are members of the Class Crustacea.
- **Scolopendra:** This is a genus comprising large centipedes. Centipedes are assigned to the Class Chilopoda. A key distinguishing feature from Diplopoda is that they possess only a single pair of legs per body segment.

- **Julus:** This is a genus of millipedes. The defining characteristic of millipedes, and thus the Class Diplopoda, is the presence of two pairs of legs on most body segments, which are known as diplosegments.

Step 3: Final Answer:

Since *Julus* is a millipede, it is correctly placed in the Class Diplopoda. Therefore, option (D) is the correct answer.

 Quick Tip

To differentiate Myriapod classes:

- **Diplopoda** = **Di** (two) pods (feet) → Millipedes (two pairs of legs per segment).
- **Chilopoda** = Centipedes (one pair of legs per segment).

Remembering that "milli" means thousand (an exaggeration) and "centi" means hundred helps distinguish the two groups.

18. How many somatic cells are present in *C. elegans*?

- (A) 969
- (B) 859
- (C) 959
- (D) 979

Correct Answer: (C) 959

Solution:

Step 1: Understanding the Concept:

Caenorhabditis elegans, a type of nematode (roundworm), serves as a significant model organism in the field of developmental biology. A notable characteristic it possesses is eutely, meaning that as an adult, it has a predetermined and constant number of somatic cells. The question seeks this exact number.

Step 2: Detailed Explanation:

The entire cell lineage of *C. elegans* from a single-celled zygote to a fully developed adult has been precisely documented.

- Throughout the development of a hermaphrodite individual, a total of 1090 somatic cells are produced.
- However, a specific and unvarying subset of 131 of these cells is eliminated through the process of programmed cell death, known as apoptosis.
- This developmental program results in an adult hermaphrodite that consistently contains an invariant number of somatic cells.

- The final calculation is $1090 - 131 = 959$ somatic cells.

While the adult male worm has a different count (1031), the number 959 is the standard and widely recognized figure for the hermaphrodite.

Step 3: Final Answer:

An adult hermaphrodite of *C. elegans* is composed of precisely 959 somatic cells. Consequently, option (C) is the correct answer.

 Quick Tip

The number 959 is a classic factoid in molecular and developmental biology related to *C. elegans*. It's one of those specific numbers worth memorizing for competitive exams, as it highlights the concept of eutely and the precision of developmental programs.

19. How many different type of gametes can potentially be produced by an organism with the genotype aaBbccdd?

- (A) 2
- (B) 4
- (C) 8
- (D) 16

Correct Answer: (A) 2

Solution:

Step 1: Understanding the Concept:

The diversity of gametes that an organism can form is dictated by the quantity of heterozygous gene pairs within its genotype. Gene pairs that are homozygous (such as aa, cc, dd) only contribute a single type of allele to the gametes and therefore do not increase the variety of possible gametes.

Step 2: Key Formula or Approach:

The formula for determining the number of distinct gamete types is:

$$\text{Number of gamete types} = 2^n$$

where n represents the number of heterozygous gene pairs.

Step 3: Detailed Explanation:

1. **Examine the genotype:** The provided genotype is aaBbccdd.
2. **Determine the number of heterozygous pairs (n):** We must inspect each gene pair individually:
 - aa: This pair is homozygous.

- Bb: This pair is heterozygous.
- cc: This pair is homozygous.
- dd: This pair is homozygous.

There is only a single heterozygous pair (Bb). Thus, $n = 1$.

3. Compute the number of gametes:

Applying the formula 2^n with $n = 1$:

$$\text{Number of gametes} = 2^1 = 2$$

The two distinct types of gametes that can be produced are **aBcd** and **abcd**.

Step 4: Final Answer:

The organism is capable of producing 2 different kinds of gametes. Therefore, option (A) is correct.

💡 Quick Tip

To quickly solve these problems, just scan the genotype and count how many pairs have one capital and one lowercase letter (like Bb). Ignore any pairs with two capital (BB) or two lowercase (bb) letters. Then, calculate 2 to the power of that count.

20. What is the difference between gynandromorphs and intersexes in *Drosophila*?

- (A) Intersexes are genetically similar throughout their bodies, whereas gynandromorph consists of two genetically different tissues
- (B) Intersexes are not genetically similar throughout their bodies, whereas gynandromorph genetically similar throughout their bodies
- (C) Intersexes are sterile, whereas gynandromorphs are genetically similar throughout their bodies
- (D) Intersexes are genetically similar throughout their bodies, whereas gynandromorph consists of four genetically different tissues

Correct Answer: (A) Intersexes are genetically similar throughout their bodies, whereas gynandromorph consists of two genetically different tissues

Solution:

Step 1: Understanding the Concept:

This question concerns two distinct forms of abnormal sexual development in the fruit fly, *Drosophila*, which arise from different underlying genetic causes.

Step 2: Detailed Explanation:

- **Intersexes:** In *Drosophila*, an individual's sex is determined by the ratio of X chromosomes to the number of autosomal sets (X/A ratio). An intersex fly possesses an X/A ratio that

falls between the normal male ratio (0.5) and the normal female ratio (1.0), such as 0.67 (resulting from 2X chromosomes and 3 autosomal sets). A critical point is that every cell in an intersex fly's body shares the same abnormal genetic makeup. Consequently, they are **genetically uniform throughout their bodies** but exhibit an intermediate sexual appearance.

- **Gynandromorphs:** A gynandromorph is a mosaic organism, meaning it is built from cells of different genotypes. In *Drosophila*, this condition typically arises when an early female (XX) embryo loses one X chromosome from a single cell during mitosis. This event generates two distinct cell lineages: one that remains XX (genetically female) and a new one that is XO (genetically male). As these cell lines proliferate, the organism develops with discrete patches of male tissue and female tissue. Thus, a gynandromorph is an individual that **is composed of two genetically distinct tissues**.

Step 3: Analyzing the Options:

- (A) This option correctly states the distinction: intersex flies are genetically uniform, while gynandromorphs are mosaics of two different genetic tissues.
- (B) This option incorrectly reverses the descriptions of the two conditions.
- (C) Although intersexes are often sterile, the second part of the statement incorrectly asserts that gynandromorphs are genetically uniform.
- (D) This option correctly describes intersexes but is incorrect in stating that gynandromorphs have four different tissues; the typical number is two.

Step 4: Final Answer:

Option (A) offers the most accurate differentiation between intersexes and gynandromorphs.

💡 Quick Tip

Remember the prefixes:

- **Inter-** means "between," so intersexes have a phenotype between male and female, caused by a uniform but abnormal genetic ratio.
- **Gyn-** means female and **andro-** means male. A gynandromorph is a single organism with both male and female parts, resulting from a genetic mosaic.

21. Match LIST-I with LIST-II

LIST-I Law/Principle/Gene interaction		LIST-II Genes distribution/Ratio	
A.	Law of segregation	I.	12:3:1
B.	Principle of independent assortment	II.	Genes are distributed without mixing.
C.	Complementary gene interaction	III.	Genes on different chromosomes are distributed independently during meiosis.
D.	Dominant epistasis	IV.	9:7

Choose the most appropriate answer from the options given below:

- (A) A - II, B - III, C - IV, D - I
 (B) A - I, B - III, C - II, D - IV
 (C) A - II, B - I, C - IV, D - III
 (D) A - III, B - IV, C - I, D - II

Correct Answer: (A) A - II, B - III, C - IV, D - I

Solution:

Step 1: Understanding the Concept:

This question requires pairing fundamental principles of genetics and specific types of gene interactions with their appropriate descriptions or characteristic phenotypic ratios from a dihybrid cross.

Step 2: Detailed Matching:

- **A. Law of Segregation:** This Mendelian principle posits that the two alleles for a heritable character separate from each other during the formation of gametes, ensuring that each gamete ends up with only one allele. This implies that **genes are distributed without mixing**. Thus, **A matches with II**.
- **B. Principle of Independent Assortment:** This principle asserts that the alleles of genes located on non-homologous chromosomes sort into gametes independently of one another. This is well-described as **genes on different chromosomes are distributed independently during meiosis**. Thus, **B matches with III**.
- **C. Complementary Gene Interaction:** This is a form of genetic interaction where two separate genes collaborate to determine a single trait. For the dominant phenotype to be expressed, a dominant allele must be present at both gene loci. A dihybrid cross under this interaction yields a phenotypic ratio of **9:7**. Thus, **C matches with IV**.
- **D. Dominant Epistasis:** This interaction happens when a dominant allele at one gene locus conceals the phenotypic expression of the alleles at a different locus. A dihybrid cross involving dominant epistasis produces a distinctive phenotypic ratio of **12:3:1**. Thus, **D matches with I**.

Step 3: Final Answer:

The correct pairings are A-II, B-III, C-IV, and D-I. This set of matches corresponds to option (A).

💡 Quick Tip

For matching questions involving genetic ratios, it's highly beneficial to memorize the key dihybrid cross ratios:

- **9:3:3:1** - Standard Independent Assortment
- **9:7** - Complementary Genes
- **12:3:1** - Dominant Epistasis
- **9:3:4** - Recessive Epistasis
- **15:1** - Duplicate Dominant Genes

22. Which of the following statements are true?

- A. When two or more genes co-exist on the same chromosome, they may violate the principle of independent assortment during meiosis.
- B. Positive interference occurs when the presence of one chiasma increases the possibility of another chiasma occurring in the immediate vicinity.
- C. The proportion of crossovers never exceeds 50%.
- D. The Chi-square test can be used for segregation ratios and detection of linkage.
- Choose the most appropriate answer from the options given below:

- (A) A, B and D only
- (B) A, B and C only
- (C) A, B, C and D
- (D) A, C and D only

Correct Answer: (D) A, C and D only

Solution:

Step 1: Understanding the Concept:

This question evaluates comprehension of several central topics in classical and statistical genetics, including gene linkage, genetic interference, recombination limits, and the application of the Chi-square test.

Step 2: Analyzing each statement:

- **Statement A: True.** Genes that are located on the same chromosome are considered linked. Due to their physical proximity, they tend to be inherited as a single unit and do not assort independently, which contradicts Mendel's Principle of Independent Assortment.
- **Statement B: False.** This statement inaccurately describes positive interference; it actually defines negative interference. **Positive interference** is the correct term for the phenomenon where the formation of one crossover event (chiasma) *inhibits* or decreases the probability of a second crossover happening nearby.
- **Statement C: True.** Recombination frequency represents the percentage of offspring with

recombinant phenotypes. For linked genes, this value can range from nearly 0- **Statement D: True.** The Chi-square (χ^2) test is a statistical tool used to assess the "goodness of fit" between observed and expected data. In genetics, it is frequently employed to determine if the observed results of a cross align with the ratios predicted by a specific hypothesis (e.g., Mendelian 9:3:3:1 segregation). A significant deviation from the expected ratio suggests the hypothesis is likely incorrect, a method often used to infer the presence of gene linkage.

Step 3: Final Answer:

Statements A, C, and D are correct, whereas statement B is incorrect. Therefore, the appropriate choice is option (D).

 Quick Tip

Remember the definitions of interference:

- **Positive interference:** One crossover DECREASES the chance of another nearby (the common case).
- **Negative interference:** One crossover INCREASES the chance of another nearby (rarer).

Think "positive" = inhibiting/suppressing effect.

23. Based on the threshold range, at the X/A ratio of 0.67, the sex of *Drosophila* will be:

- (A) Intersex
- (B) Superfemale
- (C) Supermale
- (D) Male

Correct Answer: (A) Intersex

Solution:

Step 1: Understanding the Concept:

The sexual phenotype of the fruit fly, *Drosophila melanogaster*, is governed by the Genic Balance Theory, which was formulated by Calvin Bridges. This theory proposes that sex is established by the balance between the number of X chromosomes and the number of autosomal sets, expressed as the X/A ratio.

Step 2: Key Formula or Approach:

The sexual phenotype is determined by specific thresholds of the X/A ratio:

- **X/A Ratio ≥ 1.0 :** This results in a female phenotype (e.g., XX chromosomes with 2

sets of autosomes gives a ratio of 1.0). An X/A ratio greater than 1.0 (e.g., XXX/2A = 1.5) produces a Superfemale (or metafemale), which is typically weak and sterile.

- **X/A Ratio = 0.5:** This results in a male phenotype (e.g., XY chromosomes with 2 sets of autosomes gives a ratio of 0.5).
- **X/A Ratio ; 0.5:** This results in a Supermale (or metamale), which is also weak and sterile.
- **X/A Ratio between 0.5 and 1.0:** This results in an Intersex phenotype. These individuals exhibit a combination of male and female traits.

Step 3: Detailed Explanation:

The question specifies an X/A ratio of 0.67. To determine the sex, we compare this value against the established thresholds:

$$0.5 < 0.67 < 1.0$$

Because this ratio is situated between the value for a standard male (0.5) and a standard female (1.0), the resulting fly will display an Intersex phenotype. A fly with two X chromosomes and three sets of autosomes ($2X/3A \approx 0.67$) would exemplify this condition.

Step 4: Final Answer:

In *Drosophila*, an X/A ratio of 0.67 leads to the development of an Intersex individual. Hence, option (A) is correct.

💡 Quick Tip

Memorize the key X/A ratio points for *Drosophila*: 1.0 is female, 0.5 is male. Anything between is intersex. Anything above 1.0 is superfemale, and below 0.5 is supermale. The Y chromosome in flies is important for male fertility but not for sex determination itself.

24. In a population under Hardy Weinberg Equilibrium, out of a total of 592 people, 44 people were affected by a rare autosomal recessive disorder whereas the rest of the population was normal. How many individuals in this population have the heterozygous and homozygous dominant genotypes for this trait?

- (A) 233 and 315, respectively.
- (B) 315 and 233, respectively.
- (C) 0.27 and 0.73, respectively.
- (D) 0.73 and 0.27, respectively.

Correct Answer: (A) 233 and 315, respectively.

Solution:

Step 1: Understanding the Concept:

This problem utilizes the principles of the Hardy-Weinberg Equilibrium (HWE), which models the relationship between allele and genotype frequencies in a stable, non-evolving population. The fundamental equations are $p + q = 1$ for allele frequencies and $p^2 + 2pq + q^2 = 1$ for genotype frequencies.

Step 2: Key Formula or Approach:

- Define p as the frequency of the dominant allele (A) and q as the frequency of the recessive allele (a).
- The frequency of the homozygous recessive genotype (aa), representing the affected individuals, is q^2 .
- The frequency of the homozygous dominant genotype (AA) is p^2 .
- The frequency of the heterozygous genotype (Aa) is $2pq$.
- The total population size is $N = 592$.
- The number of affected individuals (genotype aa) is 44.

Step 3: Detailed Calculation:

1. **Determine the frequency of the homozygous recessive genotype (q^2):**

$$q^2 = \frac{\text{Number of affected individuals}}{\text{Total population}} = \frac{44}{592} \approx 0.07432$$

2. **Determine the frequency of the recessive allele (q):**

$$q = \sqrt{q^2} = \sqrt{\frac{44}{592}} \approx \sqrt{0.07432} \approx 0.2726$$

3. **Determine the frequency of the dominant allele (p):**

$$p = 1 - q = 1 - 0.2726 \approx 0.7274$$

4. **Determine the expected number of heterozygous individuals (Aa):**

The frequency of heterozygotes is given by $2pq$.

$$\text{Number of Aa} = 2pq \times N = (2 \times 0.7274 \times 0.2726) \times 592 \approx 0.3965 \times 592 \approx 234.7$$

This value rounds to approximately 235 individuals. 5. **Determine the expected number of homozygous dominant individuals (AA):**

The frequency of homozygous dominants is given by p^2 .

$$\text{Number of AA} = p^2 \times N = (0.7274)^2 \times 592 \approx 0.5291 \times 592 \approx 313.2$$

This value rounds to approximately 313 individuals.

Step 4: Final Answer:

The calculated number of heterozygous individuals is about 235, and the number of homozygous dominant individuals is about 313. The question asks for the counts of heterozygous and homozygous dominant individuals, in that order. Option (A), with values of 233 and 315, is the closest match to our calculations. Checking the sum: $233(\text{Aa}) + 315(\text{AA}) + 44(\text{aa}) = 592$, which confirms the total population. The minor differences from the calculated values are likely due to rounding in the problem's design. Thus, option (A) is the intended answer.

💡 Quick Tip

In HWE problems, always start with the information you have about the homozygous recessive group (q^2), as their genotype is unambiguously known from their phenotype. From q^2 , find q , then p , and then you can calculate all other genotype frequencies (p^2 and $2pq$).

25. Match LIST-I with LIST-II

LIST-I Period		LIST-II Genra of horse	
A.	Pleistocene	I.	Eohippus
B.	Eocene	II.	Mesohippus
C.	Miocene	III.	Equus
D.	Oligocene	IV.	Merychippus

Choose the most

appropriate answer from the options given below:

- (A) A - I, B - II, C - III, D - IV
- (B) A - III, B - I, C - IV, D - II
- (C) A - I, B - II, C - IV, D - III
- (D) A - III, B - IV, C - I, D - II

Correct Answer: (B) A - III, B - I, C - IV, D - II

Solution:

Step 1: Understanding the Concept:

This question assesses knowledge of the evolutionary lineage of the horse, a canonical example of evolution demonstrated through the fossil record. The task is to correctly pair the geological epochs with the corresponding ancestral horse genera that lived during those times.

Step 2: Detailed Matching:

The evolutionary progression of the horse can be traced chronologically as follows:

- **Eocene Epoch:** The earliest known ancestor, *Eohippus* (also named *Hyracotherium*), emerged during this period. It was a small, dog-sized creature with multiple toes on each foot. Therefore, **B matches with I.**
- **Oligocene Epoch:** Following *Eohippus*, *Mesohippus* appeared. This genus was larger and possessed three toes on each foot, with the central toe being more developed than the others. Therefore, **D matches with II.**
- **Miocene Epoch:** The genus *Merychippus* evolved. This animal was more distinctly horse-like, adapted for grazing in grasslands, and supported its weight primarily on its middle toe, with the side toes significantly reduced. Therefore, **C matches with IV.**
- **Pleistocene Epoch:** The modern horse genus, *Equus*, came into existence. This genus includes all modern horses, donkeys, and zebras, all of which are characterized by a single hoof on each leg. Therefore, **A matches with III.**

Step 3: Final Answer:

By assembling the correct pairings: A-III, B-I, C-IV, D-II, we find that this combination corresponds to option (B).

💡 Quick Tip

A mnemonic to remember the order of the epochs and the key genera is "Eat On My Plate".

- **E**at (**E**ocene) → **E**ohippus
- **O**n (**O**ligocene) → **M**esohippus
- **M**y (**M**iocene) → **M**erychippus
- **P**late (**P**leistocene) → **P**liohippus/**E**quus

26. Which of the following phenomena can lead to microevolution?

A. Natural Selection

B. Sexual Selection

C. Genetic Drift

Choose the most appropriate answer from the options given below:

- (A) A and B only
- (B) B and C only
- (C) A and C only
- (D) A, B and C

Correct Answer: (D) A, B and C

Solution:

Step 1: Understanding the Concept:

Microevolution is the change in the frequencies of alleles within a population across generations. This represents evolution on its smallest scale, occurring within a single species. The question asks to identify which of the listed mechanisms drive these changes.

Step 2: Detailed Explanation:

- **A. Natural Selection:** This is the process whereby individuals possessing certain advantageous heritable traits have higher rates of survival and reproduction. This differential success leads to an increase in the frequency of favorable alleles over time, making it a major force of microevolution.
- **B. Sexual Selection:** This is a form of natural selection where success in obtaining mates is the determining factor for passing on genes. Traits that enhance an organism's reproductive success become more prevalent in subsequent generations, thereby altering allele frequencies.

- **C. Genetic Drift:** This term describes random changes in allele frequencies that occur from one generation to the next due to chance events. Its effects are most significant in small populations. It is a non-adaptive process that can cause alleles to become lost or fixed, thus resulting in microevolutionary change.

Step 3: Final Answer:

All three listed processes—Natural Selection, Sexual Selection, and Genetic Drift—are well-established mechanisms that alter the allele frequencies within a population. Consequently, all three contribute to microevolution. The correct choice is option (D).

 Quick Tip

Remember the five main fingers of evolution that cause changes in allele frequency (microevolution):

1. Small population size (Genetic Drift)
2. Non-random mating (Sexual Selection)
3. Mutation
4. Gene Flow (Migration)
5. Natural Selection (Adaptation)

All options in the question are on this list.

27. Which of the following statements are correct about the phenomenon of genetic drift?

- A. It occurs in a small population.**
- B. It leads to the loss of genetic variation within population.**
- C. It doesn't change the allele frequency randomly.**
- D. It occurs in a large population.**

Choose the most appropriate answer from the options given below:

- (A) A and B only
- (B) A and C only
- (C) B and D only
- (D) C and D only

Correct Answer: (A) A and B only

Solution:

Step 1: Understanding the Concept:

Genetic drift is an evolutionary mechanism involving random fluctuations in allele frequencies

within a population's gene pool, driven primarily by chance events rather than selection.

Step 2: Analyzing each statement:

- **Statement A: True.** The consequences of genetic drift are most significant and observable in small populations. In a smaller gene pool, chance events (such as the random death of an individual or failure to reproduce) can have a much larger proportional effect on the frequencies of alleles.
- **Statement B: True.** Over time, genetic drift can cause alleles to become fixed (reach a frequency of 100- **Statement C: False.** The fundamental characteristic of genetic drift is that it alters allele frequencies **at random**. It is a stochastic, directionless process, unlike natural selection, which is directional because it favors adaptive traits.
- **Statement D: False.** Although genetic drift happens in any population of finite size, its influence in large populations is minimal and often negligible. In large populations, random sampling errors tend to balance out, and allele frequency changes are predominantly driven by more deterministic forces like natural selection.

Step 3: Final Answer:

Statements A and B provide accurate descriptions of genetic drift, while statements C and D are incorrect. Therefore, the correct choice is (A).

 Quick Tip

Think of genetic drift like flipping a coin. If you flip it 1000 times (large population), you'll get very close to 50% heads. If you only flip it 4 times (small population), it's much more likely you'll get a skewed result like 75% or 100% heads just by chance. That's genetic drift!

28. The increase in the beak depth of Galápagos finches with a relative abundance of large seeds, is an example of

- (A) Disruptive selection
- (B) Directional selection
- (C) Stabilizing selection
- (D) Balancing selection

Correct Answer: (B) Directional selection

Solution:

Step 1: Understanding the Concept:

This question references a famous study of natural selection conducted by Peter and Rosemary Grant on the Galápagos Islands. The central task is to identify the mode of selection that occurs when an environmental change favors one extreme of a trait's distribution.

Step 2: Detailed Explanation:

- The described scenario indicates that a plentiful supply of large seeds resulted in an increase in average beak depth. This implies that finches with deeper, more robust beaks—representing one extreme of the beak depth variation—were more successful at cracking the available seeds, leading to higher rates of survival and reproduction.
- This pattern, where selective pressures favor individuals at one end of the phenotypic spectrum, is the definition of **directional selection**. Over time, it causes the population's average trait value to shift in that favored direction.
- **Disruptive selection** would instead favor individuals at both extremes of the trait (e.g., both very shallow and very deep beaks) while selecting against the intermediate forms.
- **Stabilizing selection** would favor the intermediate phenotype (e.g., beaks of average depth) and select against individuals at both extremes.
- **Balancing selection** refers to processes that maintain multiple alleles or phenotypes within a population over time.

Step 3: Final Answer:

The situation described is a classic illustration of directional selection, in which the average beak depth of the finch population evolves in a specific direction due to a change in the environment. Thus, option (B) is correct.

💡 Quick Tip

Visualize the population's trait distribution as a bell curve.

- **Directional:** The whole curve shifts to the left or right.
- **Stabilizing:** The curve becomes narrower and taller in the middle.
- **Disruptive:** The curve splits into two peaks at the ends, with a valley in the middle.

29. How many jaws are present in Aristotle's Lantern?

- (A) 3
- (B) 5
- (C) 6
- (D) 4

Correct Answer: (B) 5

Solution:

Step 1: Understanding the Concept:

Aristotle's Lantern is the name given to the intricate and well-developed feeding apparatus characteristic of sea urchins (Class Echinoidea). It is a cone-shaped structure situated within

the mouth that is utilized for scraping algae off surfaces and for chewing food particles.

Step 2: Detailed Explanation:

The architecture of Aristotle's Lantern is a direct reflection of the five-part (pentamerous) radial symmetry that defines the phylum Echinodermata. This complex structure is composed of an assembly of muscles and calcareous plates that anchor five hard, sharp, tooth-like elements. These five "teeth" or "jaws" can be extended from the mouth to perform scraping and chewing actions.

Step 3: Final Answer:

Aristotle's Lantern is constructed with five jaws. Consequently, the correct option is (B).

💡 Quick Tip

Echinoderms (like sea stars, brittle stars, and sea urchins) are famous for their five-part radial symmetry. If you see a question about the number of parts in an echinoderm structure, 5 is a very common answer. In this case, the 5 jaws of Aristotle's Lantern reflect this fundamental body plan.

30. The technique to mark, release and recapture is a practical method for

- (A) Estimating the endangered species in a population.
- (B) Estimating the population size of mobile animals
- (C) Estimating the population size of umbrella species.
- (D) Estimating the population size of indicator animals.

Correct Answer: (B) Estimating the population size of mobile animals

Solution:

Step 1: Understanding the Concept:

The mark-release-recapture method is a standard ecological procedure used to estimate the total abundance of a population when a direct enumeration of every individual is impractical. The process entails capturing a sample of individuals, marking them harmlessly, releasing them back into the population, and then, after a sufficient time for mixing, capturing a second sample.

Step 2: Detailed Explanation:

The fundamental principle of this method is often expressed by the Lincoln-Petersen index:

$$\text{Estimated Population Size (N)} = \frac{(\text{Number captured and marked initially}) \times (\text{Total number in second capture})}{(\text{Number of marked individuals recaptured})}$$

For this estimation to be reliable, several assumptions must be satisfied. A crucial assumption is that the marked individuals have had adequate time to disperse and integrate randomly

with the unmarked members of the population. This random mixing inherently requires that the animals are **mobile**. The method is not appropriate for sessile (stationary) organisms like plants or corals. While the technique can certainly be applied to species that are endangered, umbrella, or indicator types (options A, C, D), its most fundamental prerequisite and broadest application is for estimating the population size of **mobile animals**.

Step 3: Final Answer:

The most accurate and general description of the mark-release-recapture technique's purpose is for estimating the population size of mobile animals. Option (B) is the most suitable answer.

💡 Quick Tip

Remember that mark-recapture relies on the "mixing bowl" assumption. You mark some, release them, and assume they mix evenly throughout the entire population. This can only happen if the animals move around. Therefore, the technique is fundamentally linked to the mobility of the species.

31. Any species that have been accidentally or deliberately transferred from their usual habitat to a new habitat whose abiotic conditions are also suitable for them are known as:

- (A) Alien or invasive species
- (B) Indicator species
- (C) Threatened species
- (D) Endangered species

Correct Answer: (A) Alien or invasive species

Solution:

Step 1: Understanding the Concept:

The question requires the correct term for species that have been introduced into a new environment outside of their natural geographic range.

Step 2: Detailed Explanation:

- **Alien species** (also referred to as exotic, non-native, or introduced species) are organisms relocated by human activity, whether intentionally or unintentionally, to a new region where they do not naturally occur.
- If such an alien species successfully establishes itself and begins to spread in a way that causes ecological or economic damage, it is then classified as an **invasive species**. The description in the question perfectly matches the definition of an alien species, which is the necessary first step to becoming invasive. Therefore, the combined term "Alien or invasive species" is the most fitting choice.
- An **Indicator species** is an organism whose status (presence, absence, or abundance) serves

as a proxy for a specific environmental condition.

- **Threatened** and **Endangered species** are conservation categories established by the IUCN Red List, which classify species based on their risk of global extinction.

Step 3: Final Answer:

The definition provided in the question accurately describes an alien species, which has the potential to become invasive. Thus, option (A) is the correct term.

 Quick Tip

Remember the progression: A species introduced to a new area is **alien**. If it establishes a self-sustaining population, it is **naturalized**. If it then spreads and causes harm, it becomes **invasive**.

32. The populations, showing relatively constant density around the carrying capacity of the environment, is called

- (A) r-selected
- (B) m-selected
- (C) k-selected
- (D) p-selected

Correct Answer: (C) k-selected

Solution:

Step 1: Understanding the Concept:

This question pertains to the r/K selection theory, an ecological model that contrasts two different life history and reproductive strategies. The variable 'K' in this model represents the carrying capacity of an environment.

Step 2: Detailed Explanation:

- **K-selected species** are organisms adapted to live in stable, predictable environments where their population size tends to be close to the carrying capacity (K). Their life history is typically characterized by a low number of offspring, longer lifespans, substantial parental care, and population sizes that remain relatively stable near the K value. Examples include large mammals like elephants, whales, and primates.

- **r-selected species**, in contrast, are adapted to fluctuating, unpredictable environments. They emphasize a high intrinsic rate of increase (r) by producing a large number of offspring, usually with minimal parental investment. Their populations often experience large boom-and-bust cycles and typically exist far below the carrying capacity. Examples include bacteria, many insects, and annual plants.

- The terms 'm-selected' and 'p-selected' do not represent standard classifications within this

ecological framework.

Step 3: Final Answer:

The description of a population maintaining a relatively stable density near its environment's carrying capacity is the hallmark of a K-selected population. Therefore, option (C) is correct.

💡 Quick Tip

Associate the letters with their meaning:

- **K** → **K**arrying **K**apacity. These species are good competitors in crowded conditions.
- **r** → rate of population increase. These species are good at reproducing quickly in uncrowded conditions.

33. Which one of the following statements is correct for Mollisol?

- (A) It is the fertile soil found in low precipitation areas.
- (B) It is the infertile soil found in high precipitation areas.
- (C) It is the fertile soil found in high precipitation areas.
- (D) It is the infertile soil found in low precipitation areas

Correct Answer: (A) It is the fertile soil found in low precipitation areas.

Solution:

Step 1: Understanding the Concept:

The question concerns Mollisol, which is one of the twelve soil orders in the USDA classification system. It asks for the defining features of this soil type in terms of its fertility and the climatic conditions under which it forms.

Step 2: Detailed Explanation:

- **Fertility:** Mollisols are recognized as some of the world's most productive soils. Their name, derived from the Latin 'mollis' for soft, alludes to their characteristic soft, dark surface horizon (mollic epipedon) that is rich in humus. This high organic matter content is the reason for their exceptional agricultural utility.
- **Climatic Conditions:** Typically, Mollisols develop beneath grassland ecosystems in temperate zones with semi-arid to sub-humid climates. These regions experience moderate to low levels of rainfall, which is adequate to support robust grass growth but not so high as to cause significant leaching of essential nutrients from the soil, thus preserving their fertility.
- Consequently, Mollisols are defined as fertile soils that form in regions with relatively low precipitation.

Step 3: Final Answer:

When this information is compared against the given choices, option (A) accurately describes Mollisol as a fertile soil located in areas with low precipitation.

💡 Quick Tip

Think of the world's great breadbaskets: the North American prairies, the Argentinian pampas, the Russian steppes. These are all grasslands with Mollisol soils, known for their incredible fertility and moderate-to-low rainfall.

34. Match LIST-I with LIST-II

LIST-I ACT		LIST-II Year of Enactment	
A.	Environmental Pollution Act	I.	1981
B.	The Air (Prevention and Control of pollution) Act	II.	1986
C.	The Water (Prevention and Control of Pollution) Act	III.	1972
D.	The Wildlife Protection and Conservation Act	IV.	1974

Choose the most appropriate answer from the options given below:

- (A) A - IV, B - III, C - II, D - I
 (B) A - II, B - I, C - IV, D - III
 (C) A - III, B - II, C - IV, D - I
 (D) A - I, B - IV, C - III, D - II

Correct Answer: (B) A - II, B - I, C - IV, D - III

Solution:

Step 1: Understanding the Concept:

This question assesses familiarity with the enactment years of key environmental laws in India. It is important to note that the "Environmental Pollution Act" is the common term for the Environment (Protection) Act.

Step 2: Detailed Matching:

- **A. The Environment (Protection) Act:** This overarching piece of legislation was enacted in **1986**, largely in response to the Bhopal Gas Tragedy. Thus, **A corresponds with II.**
- **B. The Air (Prevention and Control of Pollution) Act:** This law, aimed at preventing and controlling air pollution, was passed in **1981**. Thus, **B corresponds with I.**
- **C. The Water (Prevention and Control of Pollution) Act:** Enacted in **1974**, this was among India's first major environmental laws. Thus, **C corresponds with IV.**

- **D. The Wildlife Protection and Conservation Act:** This legislation, which provides a framework for protecting wild animals, birds, and plants, was passed in **1972**. Thus, **D corresponds with III**.

Step 3: Final Answer:

The correct set of matches is determined to be A-II, B-I, C-IV, and D-III. This set aligns with option (B).

 Quick Tip

Remember the chronological order: First protect the **wildlife** (1972), then the **water** (1974), then the **air** (1981), and finally, a comprehensive act for the entire **environment** (1986).

35. Arrange the given events to correct sequence in relation to translation:

- A. Adenylation of amino acid and aminoacyl-tRNA charging.**
 - B. Formation of Peptide bond.**
 - C. Recruitment of ribosome to the mRNA.**
 - D. Correct positioning of charged tRNA into the P-site of the ribosome.**
- Choose the most appropriate answer from the options given below:**

- (A) A, B, C, D
- (B) A, C, D, B
- (C) B, A, D, C
- (D) C, B, D, A

Correct Answer: (B) A, C, D, B

Solution:

Step 1: Understanding the Concept:

The question requires arranging the principal events of protein synthesis (translation) into their correct chronological order.

Step 2: Detailed Explanation of the Sequence:

- 1. A. Adenylation of amino acid and aminoacyl-tRNA charging:** This is a preparatory step essential for translation. An enzyme, aminoacyl-tRNA synthetase, must first attach the correct amino acid to its corresponding tRNA molecule. This "charging" process occurs continuously within the cytoplasm and must happen before any tRNA can participate in protein synthesis.
- 2. C. Recruitment of ribosome to the mRNA:** This marks the beginning of translation, known as initiation. The small ribosomal subunit binds to the mRNA strand and moves along it to locate the start codon (AUG).

3. **D. Correct positioning of charged tRNA into the P-site of the ribosome:** Upon finding the start codon, the initiator tRNA (which carries methionine and has been previously charged as in Step A) binds to the P-site on the ribosome. This action finalizes the assembly of the initiation complex.

4. **B. Formation of Peptide bond:** This is the initial event in the elongation phase. A second charged tRNA enters the A-site of the ribosome. The ribosome then catalyzes the creation of a peptide bond between the amino acid at the P-site (methionine) and the newly arrived amino acid at the A-site. This cycle of tRNA binding, peptide bond formation, and ribosome translocation is repeated to elongate the polypeptide chain.

Step 3: Final Answer:

The logical progression of these events is $A \rightarrow C \rightarrow D \rightarrow B$, which corresponds to option (B).

💡 Quick Tip

Think of translation like building with LEGOs:

- **A (Charging):** Get your specific LEGO bricks (amino acids) and attach them to the delivery trucks (tRNA).
- **C (Recruitment):** Bring the workbench (ribosome) to the blueprint (mRNA).
- **D (Positioning):** The first delivery truck (initiator tRNA) parks at the starting position (P-site).
- **B (Peptide bond):** The next truck arrives, and you connect the LEGO bricks.

36. The WBC count of a group of athletes in a team was estimated to be 7900, 9000, 7800, 8300, 2900, 4545, 5100, 3700, 9900 and 4545 per mm³ of blood. Calculate the median WBC count of this group of individuals.

- (A) 2900 per mm³
- (B) 4545 per mm³
- (C) 6369 per mm³
- (D) 6450 per mm³

Correct Answer: (D) 6450 per mm³

Solution:

Step 1: Understanding the Concept:

The median represents the central value of a dataset once the data points have been sorted by size. It effectively splits the dataset into two equal halves.

Step 2: Key Formula or Approach:

1. The data must be sorted in either ascending or descending order.

2. The total number of observations (N) is counted.
3. For an odd number of observations, the median is the value at the $(\frac{N+1}{2})$ th position.
4. For an even number of observations, the median is the average of the two central values, found at the $(\frac{N}{2})$ th and $(\frac{N}{2} + 1)$ th positions.

Step 3: Detailed Calculation:

1. **The dataset provided is:** 7900, 9000, 7800, 8300, 2900, 4545, 5100, 3700, 9900, 4545.
2. **The total number of observations (N) is 10.**
3. **Sorting the data in ascending order yields:**
2900, 3700, 4545, 4545, **5100, 7800**, 7900, 8300, 9000, 9900
4. **Determining the median:** As N is an even number (10), the median is the average of the 5th and 6th values in the sorted list. The 5th value is 5100, and the 6th value is 7800.

$$\text{Median} = \frac{5100 + 7800}{2} = \frac{12900}{2} = 6450$$

Step 4: Final Answer:

The median WBC count for this group of individuals is calculated to be 6450 per mm^3 . Therefore, option (D) is the correct choice.

💡 Quick Tip

The most common mistake when calculating the median is forgetting to order the data first. Always arrange the numbers from smallest to largest before finding the middle value.

37. Which of the following statements is not applicable to the mode of a dataset?

- (A) There can be more than one mode for a particular dataset.
- (B) It is affected by extreme values in the dataset.
- (C) It represents the most frequently occurring value of the dataset.
- (D) It is calculated by inspection method and grouping method.

Correct Answer: (B) It is affected by extreme values in the dataset.

Solution:

Step 1: Understanding the Concept:

The mode is a statistical measure of central tendency that identifies the value that appears most often in a dataset. The question requires identifying a statement that is not a true property of the mode.

Step 2: Analyzing the statements:

- **(A) A dataset can have more than one mode.** This statement is accurate. A dataset can be described as bimodal if it has two modes, multimodal if it has several, or it may have

no mode if every value occurs with equal frequency.

- **(B) It is influenced by extreme values in the dataset.** This statement is inaccurate. The mode is determined solely by the frequency of occurrence. Outliers or extreme values do not alter the mode unless they are, by coincidence, the most frequent value. The mean is highly sensitive to extreme values, whereas the median is robust against them.

- **(C) It signifies the most frequently occurring value in the dataset.** This statement is accurate, as this is the very definition of the mode.

- **(D) It is determined by inspection and grouping methods.** This statement is accurate. For simple datasets, the mode can be found by just observing the data. In the case of grouped data, more formal grouping techniques or formulas are employed to identify the modal class.

Step 3: Final Answer:

The assertion that the mode is affected by extreme values is incorrect. Thus, option (B) is the correct answer.

💡 Quick Tip

Remember how different measures of central tendency react to outliers:

- **Mean:** Very sensitive to outliers.
- **Median:** Not sensitive to outliers (it only cares about the middle position).
- **Mode:** Not sensitive to outliers (it only cares about frequency).

38. The number of fish caught each day by a fisherman for 10 consecutive days was reported to be 62, 58, 56, 57, 62, 59, 62, 57, 64, 63. What is the standard deviation of this dataset?

- (A) 2.9
- (B) 8.44
- (C) 3.60
- (D) 76

Correct Answer: (A) 2.9

Solution:

Step 1: Understanding the Concept:

Standard deviation quantifies the extent of variation or spread within a set of data values. A small standard deviation implies that the data points are clustered closely around the mean, whereas a large standard deviation indicates a wider distribution.

Step 2: Key Formula or Approach:

The calculation for the sample standard deviation (s) is given by the formula:

$$s = \sqrt{\frac{\sum_{i=1}^N (x_i - \bar{x})^2}{N - 1}}$$

where x_i represents each data point, $\bar{x}$ is the sample mean, and N is the number of data points.

Step 3: Detailed Calculation:

1. **Given Data:** 62, 58, 56, 57, 62, 59, 62, 57, 64, 63. The sample size is $N = 10$.

2. **Compute the mean ($\bar{x}$):**

$$\bar{x} = \frac{62 + 58 + 56 + 57 + 62 + 59 + 62 + 57 + 64 + 63}{10} = \frac{598}{10} = 59.8$$

3. **Compute the sum of squared differences from the mean, $\sum (x_i - \bar{x})^2$:**

The squared differences are: $(2.2)^2 = 4.84$, $(-1.8)^2 = 3.24$, $(-3.8)^2 = 14.44$, $(-2.8)^2 = 7.84$, $(2.2)^2 = 4.84$, $(-0.8)^2 = 0.64$, $(2.2)^2 = 4.84$, $(-2.8)^2 = 7.84$, $(4.2)^2 = 17.64$, and $(3.2)^2 = 10.24$. The sum is $4.84 + 3.24 + 14.44 + 7.84 + 4.84 + 0.64 + 4.84 + 7.84 + 17.64 + 10.24 = 76.4$.

4. **Compute the sample variance (s^2):**

$$s^2 = \frac{76.4}{10 - 1} = \frac{76.4}{9} \approx 8.489$$

5. **Compute the sample standard deviation (s):**

$$s = \sqrt{8.489} \approx 2.91$$

Step 4: Final Answer:

The resulting standard deviation is approximately 2.91, which corresponds to option (A).

💡 Quick Tip

In competitive exams, be careful whether the question implies a "sample" or a "population". Usually, a small dataset like this is treated as a sample, so you divide the sum of squares by $N - 1$. If you divided by N (for a population), you would get $\sqrt{7.64} \approx 2.76$, which is also close but 2.9 is a better fit for the sample calculation.

39. Which one of the following animals belongs to the oviparous mammal group?

- (A) Macropus
- (B) Pteropus
- (C) Rattus
- (D) Platypus

Correct Answer: (D) Platypus

Solution:

Step 1: Understanding the Concept:

The question requires the identification of a mammal that is oviparous, meaning it lays eggs. While the vast majority of mammals are viviparous (giving birth to live young), a small, primitive group follows an egg-laying reproductive strategy.

Step 2: Detailed Explanation:

- Based on their mode of reproduction, the class Mammalia is categorized into three primary groups: 1. **Monotremes:** This is the only group of mammals that is oviparous. It comprises the platypus and echidnas. 2. **Marsupials:** These mammals are viviparous but give birth to an extremely immature (altricial) newborn, which then undergoes further development within a maternal pouch. Kangaroos (*Macropus*), koalas, and opossums are examples. 3. **Placental Mammals (Eutherians):** These viviparous mammals allow the fetus to develop completely within the mother's uterus, supported by a placenta. This is the most numerous group of mammals and includes bats (*Pteropus*), rats (*Rattus*), and humans.

- Evaluating the given choices: - (A) *Macropus* (kangaroo) is a marsupial. - (B) *Pteropus* (flying fox) is a placental mammal. - (C) *Rattus* (rat) is a placental mammal. - (D) The *Platypus* is a well-known monotreme and an egg-laying mammal.

Step 3: Final Answer:

Among the provided options, the platypus is the sole oviparous mammal. Thus, option (D) is the correct answer.

💡 Quick Tip

There are only five living species of monotremes in the world: the duck-billed platypus and four species of echidna. If you see "egg-laying mammal" on an exam, the answer will almost certainly be one of these two.

40. How is the mean deviation calculated for a given dataset?

- (A) Adding all the values of the given dataset.
- (B) Dividing the sum of all the values of the given dataset by the number of observations in the dataset.
- (C) Dividing the sum of all the deviations from the mean by the number of observations in the dataset.
- (D) Dividing the sum of squares of all the deviations from mean by the number of observations in the dataset.

Correct Answer: (C) Dividing the sum of all the deviations from the mean by the number of observations in the dataset.

Solution:**Step 1: Understanding the Concept:**

The question seeks the correct definition or calculation method for mean deviation. The mean

deviation, also known as the mean absolute deviation, measures the average distance of each data point from the central mean of the dataset.

Step 2: Analyzing the options:

- (A) **Summing all the values in the dataset.** This action yields the total sum of the data, not a measure of its spread.
- (B) **Dividing the total sum of the values... by the count of observations...** This procedure defines the arithmetic **mean**.
- (C) **Dividing the sum of all deviations from the mean... by the count of observations...** This is the definition of **mean deviation**. It is important to clarify that "deviations" in this context refers to the absolute values of the differences from the mean, $|x_i - \bar{x}|$, because the simple sum of deviations, $\sum(x_i - \bar{x})$, is mathematically always zero. Among the given options, this is the intended correct description. The formula is: $MD = \frac{\sum |x_i - \bar{x}|}{N}$.
- (D) **Dividing the sum of the squares of all deviations from the mean... by the count of observations...** This defines the population **variance** (σ^2).

Step 3: Final Answer:

The description in option (C) correctly explains the calculation of the mean deviation.

💡 Quick Tip

Keep the key statistical definitions straight:

- **Mean:** Sum of values / Number of values.
- **Mean Deviation:** Sum of absolute deviations from mean / Number of values.
- **Variance:** Sum of squared deviations from mean / Number of values (or N-1 for sample).

41. Ciliated simple columnar epithelium located at: -

- A. Lining of some bronchioles of the respiratory tract
- B. Cover surface of ovary
- C. Larger ducts of many glands
- D. Ventricles of brain

Choose the most appropriate answer from the options given below:

- (A) A and D only
- (B) B and C only
- (C) A, B, C and D
- (D) B, C and D only

Correct Answer: (A) A and D only

Solution:

Step 1: Understanding the Concept:

Ciliated simple columnar epithelium is a tissue type composed of a single layer of tall, column-like cells featuring motile cilia on their free surface. These cilia beat in a synchronized fashion to propel substances across the tissue surface. The task is to identify where this specific tissue is located in the body.

Step 2: Detailed Explanation:

- **A. Lining of some bronchioles of the respiratory tract:** This is a correct location. Here, the cilia form part of the mucociliary escalator, which functions to transport mucus and entrapped particles upward and out of the airways.
- **B. Covering the surface of the ovary:** This is incorrect. The ovary's surface is lined by simple cuboidal epithelium, also known as germinal epithelium.
- **C. In the larger ducts of many glands:** This is incorrect. Although larger ducts may feature columnar epithelium, it is typically either non-ciliated or stratified, not ciliated and simple.
- **D. In the ventricles of the brain:** This is a correct location. The brain ventricles and the central canal of the spinal cord are lined with ependymal cells. These cells form a ciliated simple cuboidal to columnar epithelium, and their cilia aid in the circulation of cerebrospinal fluid (CSF).

Step 3: Final Answer:

Based on this analysis, ciliated simple columnar epithelium is located in certain bronchioles (A) and the brain's ventricles (D). Thus, the correct option is (A).

💡 Quick Tip

Associate cilia with the movement of fluid or mucus. Key locations to remember are the respiratory tract (moving mucus), the fallopian tubes (moving the ovum), and the brain ventricles/spinal cord canal (moving cerebrospinal fluid).

42. Which one of the following statements is applicable to satellite cells?

- (A) These cells encircle PNS axons. They form the myelin sheath around the axons.
- (B) These are the flat cells surrounding the cell bodies of neurons in PNS ganglia.
- (C) These are cuboidal to columnar cells arranged in a single layer that possess microvilli and cilia.
- (D) These are small cells with slender processes that give off numerous spinelike projections.

Correct Answer: (B) These are the flat cells surrounding the cell bodies of neurons in PNS ganglia.

Solution:

Step 1: Understanding the Concept:

Satellite cells are a specific type of glial cell located within the peripheral nervous system (PNS). Glial cells are non-neuronal support cells that protect and maintain neurons. The question asks for the accurate description of these satellite cells.

Step 2: Detailed Explanation:

- **Statement 1:** This statement describes Schwann cells, which are the PNS glial cells responsible for wrapping around axons to form the myelin sheath.
- **Statement 2:** This is the accurate definition of satellite cells. They are flattened cells that encapsulate the cell bodies (soma) of neurons situated inside the ganglia of the PNS. Their function is to provide structural support and regulate the neuronal microenvironment.
- **Statement 3:** This description pertains to a type of epithelial tissue, not a glial cell.
- **Statement 4:** This is the classic description of microglia, which function as the primary immune cells of the central nervous system (CNS).

Step 3: Final Answer:

The statement that correctly characterizes satellite cells is their role as flat cells enveloping neuronal cell bodies in PNS ganglia. Consequently, option (B) is correct.

💡 Quick Tip

Remember the two main glial cells of the PNS and their primary associations:

- **Schwann Cells** → **Axons** (myelination)
- **Satellite Cells** → **Cell bodies** (support in ganglia)

43. The trigeminal nerve is the largest nerve with following branches:

- A. Olfactory**
- B. Ophthalmic**
- C. Maxillary**
- D. Mandibular**

Choose the most appropriate answer from the options given below:

- (A) A, B and D only
- (B) B, C and D only
- (C) A, B, C and D
- (D) A, C and D only

Correct Answer: (B) B, C and D only

Solution:

Step 1: Understanding the Concept:

The trigeminal nerve, designated as the fifth cranial nerve (CN V), is the largest of the cranial

nerves and serves both sensory and motor functions (a mixed nerve). It is the main source of sensation for the face and controls muscles for chewing. The question requires the identification of its primary branches.

Step 2: Detailed Explanation:

The trigeminal nerve is divided into three main branches:

- **Ophthalmic nerve (V1):** A sensory branch that provides sensation to the skin of the forehead, scalp, upper eyelid, and the anterior part of the nose. This corresponds to **B**.
- **Maxillary nerve (V2):** A sensory branch that supplies the skin covering the maxilla (upper jawbone), the lower eyelid, and the upper lip. This corresponds to **C**.
- **Mandibular nerve (V3):** A mixed branch with both sensory and motor fibers. It provides sensation to the skin over the mandible (lower jawbone) and the side of the head, and its motor component innervates the muscles of mastication (chewing). This corresponds to **D**.
- The **Olfactory nerve (A)** is a separate nerve, the first cranial nerve (CN I), dedicated to the sense of smell, and is not a part of the trigeminal nerve.

Step 3: Final Answer:

The three main divisions of the trigeminal nerve are the ophthalmic, maxillary, and mandibular nerves. Thus, B, C, and D are the correct components, which aligns with option (B).

💡 Quick Tip

The name "trigeminal" itself means "three-twin," referring to its three major branches. You can remember the branches by the part of the face they serve: V1 Ophthalmic (eye area), V2 Maxillary (upper jaw), and V3 Mandibular (lower jaw).

44. What is Ferritin?

- (A) It is an iron storage protein in muscle fibers, liver cells and macrophages of the spleen and liver. Iron detaches from transferrin and attaches to ferritin.
- (B) It is a non-iron portion of heme which is converted to biliverdin.
- (C) It is plasma protein which transfers free iron into the blood stream.
- (D) It is an iron-containing molecule which transports oxygen from the blood stream to the tissues.

Correct Answer: (A) It is an iron storage protein in muscle fibers, liver cells and macrophages of the spleen and liver. Iron detaches from transferrin and attaches to ferritin.

Solution:

Step 1: Understanding the Concept:

This question seeks the definition of ferritin, a crucial protein in the body's management of iron.

Step 2: Detailed Explanation of Options:

- **Statement 1:** This provides the accurate definition. Ferritin is the body's primary intracellular iron-storage protein, abundant in tissues like the liver, spleen, and skeletal muscle. Iron is carried in the bloodstream by transferrin; upon arrival at a cell for storage, it is released from transferrin and sequestered within the ferritin protein shell.
- **Statement 2:** This describes the catabolism of the heme molecule from old red blood cells. After iron is removed, the remaining porphyrin structure is converted first to biliverdin and then to bilirubin.
- **Statement 3:** This describes Transferrin, which is the primary plasma protein responsible for transporting iron through the circulation.
- **Statement 4:** This describes Hemoglobin, the iron-containing protein within red blood cells that is responsible for transporting oxygen from the lungs to the tissues.

Step 3: Final Answer:

The correct characterization of ferritin is as the principal protein for intracellular iron storage. Therefore, option (A) is the right answer.

💡 Quick Tip

Remember the key proteins in iron metabolism:

- **Hemoglobin:** Oxygen **transport** in blood.
- **Transferrin:** Iron **transport** in blood.
- **Ferritin:** Iron **storage** in cells.

45. Calculate the Harmonic Mean of the following data:

10 20 40 60 120

- (A) 25
- (B) 27.5
- (C) 32.5
- (D) 50

Correct Answer: (A) 25

Solution:

Step 1: Understanding the Concept:

The harmonic mean is a specific type of statistical average. It is computed by taking the reciprocal of the average of the reciprocals of the data points. This measure is especially useful when averaging rates or ratios.

Step 2: Key Formula or Approach:

The formula to calculate the Harmonic Mean (HM) is as follows:

$$HM = \frac{n}{\sum_{i=1}^n \frac{1}{x_i}}$$

where n represents the total number of observations, and x_i denotes each individual value.

Step 3: Detailed Calculation:

1. **Identify the data points and n:** The given values are 10, 20, 40, 60, 120. The total number of observations, n , is 5.
2. **Compute the reciprocal of each value:** The reciprocals are $\frac{1}{10}, \frac{1}{20}, \frac{1}{40}, \frac{1}{60}, \frac{1}{120}$.
3. **Calculate the sum of the reciprocals ($\sum \frac{1}{x_i}$):** To perform this addition, a common denominator of 120 is used.

$$\sum \frac{1}{x_i} = \frac{12}{120} + \frac{6}{120} + \frac{3}{120} + \frac{2}{120} + \frac{1}{120} = \frac{12+6+3+2+1}{120} = \frac{24}{120}$$

This fraction simplifies to $\frac{1}{5}$ or 0.2.

4. **Compute the Harmonic Mean:**

$$HM = \frac{n}{\sum \frac{1}{x_i}} = \frac{5}{\frac{1}{5}} = 5 \times 5 = 25$$

Step 4: Final Answer:

The Harmonic Mean for the provided dataset is 25. Thus, option (A) is the correct answer.

💡 Quick Tip

For any set of positive numbers, the Harmonic Mean $\leq$ Geometric Mean $\leq$ Arithmetic Mean. For this dataset, the Arithmetic Mean is $(10+20+40+60+120)/5 = 50$. The HM must be less than 50. This can help eliminate incorrect higher options.

46. What is the correct sequence of four steps of the contraction cycle in muscles?

- A. Power stroke
- B. Attachment of myosin to actin
- C. ATP hydrolysis
- D. Detachment of myosin from actin

Choose the most appropriate answer from the options given below:

- (A) A, B, C, D
- (B) A, C, B, D
- (C) C, B, A, D
- (D) C, B, D, A

Correct Answer: (C) C, B, A, D

Solution:

Step 1: Understanding the Concept:

The cycle of muscle contraction, often termed the cross-bridge cycle, outlines the sequence of molecular interactions between actin and myosin filaments that generate muscle force.

Step 2: Detailed Explanation of the Sequence:

The cycle is typically considered to start with the myosin head prepared for binding.

1. **C. ATP hydrolysis:** The myosin head contains an ATP-binding site and functions as an ATPase. It breaks down ATP into ADP and inorganic phosphate (Pi). The energy liberated by this reaction energizes the myosin head, moving it into a "cocked" or high-energy conformation.
2. **B. Attachment of myosin to actin:** In its high-energy state, the myosin head binds to an exposed site on the actin filament, creating what is known as a cross-bridge.
3. **A. Power stroke:** The release of inorganic phosphate (Pi) from the myosin head initiates the power stroke. During this step, the myosin head pivots, pulling the thin actin filament toward the center of the sarcomere (the M line). Following this, ADP is released.
4. **D. Detachment of myosin from actin:** The binding of a fresh ATP molecule to the myosin head causes it to detach from the actin filament. The cycle is then poised to repeat, starting with the hydrolysis of the newly bound ATP (returning to step C).

Step 3: Final Answer:

The proper sequence for these four stages is $C \rightarrow B \rightarrow A \rightarrow D$, which aligns with option (C).

💡 Quick Tip

Remember the two key roles of ATP in the cycle:

- **Splitting ATP (Hydrolysis)** → Energizes/Cocks the myosin head.
- **Binding of new ATP** → Causes detachment of myosin from actin. Rigor mortis occurs after death because there is no new ATP to cause detachment.

47. Arrange the following enzymes of the citric acid cycle in the correct sequence.

- A. Aconitase
- B. Fumarase
- C. Malate dehydrogenase
- D. Isocitrate dehydrogenase

Choose the most appropriate answer from the options given below:

- (A) D, A, B, C
- (B) B, D, C, A
- (C) C, D, A, B
- (D) A, D, B, C

Correct Answer: (D) A, D, B, C

Solution:

Step 1: Understanding the Concept:

The citric acid cycle, also called the Krebs cycle, consists of a sequence of eight enzymatic reactions central to cellular respiration. The question requires ordering a specific subset of these enzymes according to their appearance in the cycle. It is noted that option B, labeled "Fumarate," should represent the enzyme "Fumarase."

Step 2: Detailed Explanation of the Sequence:

Let's position the given enzymes within the sequence of the complete cycle:

- (Reaction 1: Citrate Synthase)
- **Reaction 2: A. Aconitase** – This enzyme isomerizes citrate into isocitrate.
- **Reaction 3: D. Isocitrate dehydrogenase** – This enzyme oxidizes isocitrate, forming α -ketoglutarate and producing NADH.
- (Reaction 4: α -Ketoglutarate dehydrogenase)
- (Reaction 5: Succinyl-CoA synthetase)
- (Reaction 6: Succinate dehydrogenase)
- **Reaction 7: B. Fumarase** – This enzyme adds water to fumarate to produce malate.
- **Reaction 8: C. Malate dehydrogenase** – This enzyme oxidizes malate back to oxaloacetate, yielding NADH and regenerating the initial reactant of the cycle.

Step 3: Final Answer:

The correct operational sequence for the provided enzymes within the citric acid cycle is Aconitase, followed by Isocitrate dehydrogenase, then Fumarase, and finally Malate dehydrogenase. This order corresponds to the sequence A, D, B, C. Therefore, option (D) is the correct choice.

Quick Tip

A helpful mnemonic for the substrates of the Krebs cycle is: "***C**itrate **I**s **K**rebs' **S**tarting **S**ubstrate **F**or **M**aking **O**xaloacetate."

- Aconitase acts on Citrate.
- Isocitrate dehydrogenase acts on Isocitrate.
- Fumarase acts on Fumarate.
- Malate dehydrogenase acts on Malate.

This helps confirm the sequence A, D, B, C.

48. In Glycolipids and sphingolipids, glycerol is replaced by which amino alcohol?

- (A) Sphingomyelins
- (B) Gangliosides
- (C) Sphingosine

(D) Sulfatides

Correct Answer: (C) Sphingosine

Solution:

Step 1: Understanding the Concept:

Biological membranes are largely constructed from lipids, which are categorized into two major classes based on their foundational structure: glycerophospholipids, which utilize a glycerol backbone, and sphingolipids. The question asks to identify the specific molecule that serves as the backbone for sphingolipids, taking the place of glycerol.

Step 2: Detailed Explanation:

- **Sphingosine** is the correct molecule. It is an 18-carbon amino alcohol containing an unsaturated hydrocarbon tail, and it serves as the defining structural backbone for all sphingolipids.
- A sphingolipid is created when a fatty acid is attached to sphingosine through an amide bond, resulting in a molecule called a ceramide. Different head groups can then be added to this ceramide base.
- The other choices listed are all specific categories of complex sphingolipids, rather than the backbone molecule itself:
- **Sphingomyelins** are formed when a phosphocholine or phosphoethanolamine head group is attached to a ceramide.
- **Gangliosides** and **Sulfatides** are examples of glycolipids (specifically, glycosphingolipids), in which the head group consists of a complex sugar chain.

Step 3: Final Answer:

Within the structure of sphingolipids, the glycerol backbone characteristic of glycerophospholipids is substituted by the amino alcohol sphingosine. Consequently, option (C) is the correct answer.

💡 Quick Tip

The name of the class of lipids often gives a clue to its structure. Just as **glycerolipids** have a **glycerol** backbone, **sphingolipids** have a **sphingosine** backbone. The other options are examples of complex sphingolipids, not the fundamental building block.

49. At low substrate concentration, the initial velocity of reaction is described as _____. However, as substrate concentration increases, the reaction saturates and reaches a _____.

- (A) Hyperbola and Plateau
- (B) Plateau and Hyperbola
- (C) Straight line and Hyperbola

(D) Straight line and straight line

Correct Answer: (A) Hyperbola and Plateau

Solution:

Step 1: Understanding the Concept:

This question pertains to the characteristic features of a Michaelis-Menten graph, which illustrates the relationship between the initial reaction rate (V_0) and the concentration of the substrate ($[S]$) for a reaction catalyzed by an enzyme.

Step 2: Detailed Explanation:

The relationship is described by the Michaelis-Menten equation: $V_0 = \frac{V_{max}[S]}{K_m + [S]}$.

- At **very low substrate concentrations** (where $[S]$ is much less than K_m), the reaction behaves as if it is first-order with respect to $[S]$, and the initial segment of the plot is nearly linear.
- As the **substrate concentration continues to rise**, the rate of velocity increase diminishes because the enzyme's active sites become progressively occupied. The overall geometric shape of this V_0 versus $[S]$ curve is a rectangular **hyperbola**.
- At **very high substrate concentrations** (where $[S]$ is much greater than K_m), the enzyme becomes saturated with the substrate. At this point, the reaction rate is no longer dependent on $[S]$ and asymptotically approaches its maximum velocity (V_{max}). This saturation effect is visualized on the graph as the curve leveling off to form a **plateau**.

Step 3: Final Answer:

The question seeks a description of the overall shape of the reaction velocity curve and the state it achieves at saturation. The curve's shape is a hyperbola, and it culminates in a plateau. Therefore, option (A) provides the most accurate description. (It is worth noting that while the initial portion of the curve is almost a straight line, the entire curve is best described as hyperbolic).

💡 Quick Tip

Remember the two extremes of Michaelis-Menten kinetics:

- **Low $[S]$:** First-order kinetics (rate depends on $[S]$). Graph is a line.
- **High $[S]$:** Zero-order kinetics (rate is independent of $[S]$). Graph is a plateau at V_{max} .
- **Overall Shape:** A hyperbola that connects these two extremes.

50. Cellulose is a homopolymer of:

- (A) Alpha glucose
- (B) Beta glucose
- (C) Alpha fructose
- (D) Beta fructose

Correct Answer: (B) Beta glucose

Solution:

Step 1: Understanding the Concept:

A homopolymer is a large molecule formed from repeating identical monomer subunits. Cellulose, a primary structural component of plant cell walls, is such a polymer. The question asks to identify its specific monomer.

Step 2: Detailed Explanation:

- Polysaccharides are polymers built from monosaccharide units. Starch and cellulose are the two most prevalent polysaccharides composed of glucose.
- Their distinct properties arise from the specific isomeric form of the glucose monomer and the type of glycosidic bond that links them.
- **Starch** and its animal equivalent, **glycogen**, are polymers of **alpha-glucose**, connected by α -1,4 glycosidic linkages. This bonding geometry creates a helical structure, which is efficient for energy storage.
- **Cellulose** is a polymer of **beta-glucose**, connected by β -1,4 glycosidic linkages. This type of bond results in long, unbranched, straight chains. These chains can align parallel to one another, forming strong intermolecular hydrogen bonds, which create rigid microfibrils suitable for a structural role.
- Fructose is a distinct monosaccharide (a ketose), whereas glucose is an aldose.

Step 3: Final Answer:

Cellulose is a straight-chain homopolymer made up of repeating beta-glucose units. Therefore, option (B) is correct.

💡 Quick Tip

Remember the key difference: α -glucose polymers (starch, glycogen) are for energy storage and are generally digestible by animals. β -glucose polymers (cellulose) are for structure and are generally indigestible by animals without the help of symbiotic microorganisms.

51. Match LIST-I with LIST-II

LIST-I		LIST-II	
Name of the amino acid		One letter abbreviation/name	
A.	Methionine	I.	D
B.	Aspartic acid	II.	K
C.	Lysine	III.	E
D.	Glutamine	IV.	M

Choose the correct answer from the options given below:

- (A) A - II, B - III, C - I, D - IV
 (B) A - IV, B - I, C - II, D - III
 (C) A - I, B - II, C - IV, D - III
 (D) A - III, B - IV, C - I, D - II

Correct Answer: (B) A - IV, B - I, C - II, D - III

Solution:

Step 1: Understanding the Concept:

The inquiry requires pairing common amino acids with their standard single-letter codes. This nomenclature is fundamental for interpreting protein sequence data.

Step 2: Detailed Matching:

- **A. Methionine:** Its one-letter symbol is M. Thus, **A corresponds to IV.**
- **B. Aspartic acid:** Its one-letter symbol is D (derived from asparDic acid). Thus, **B corresponds to I.**
- **C. Lysine:** Its one-letter symbol is K. Since L is used for Leucine, K, the letter preceding L, was assigned. Thus, **C corresponds to II.**
- **D. Glutamine:** Its one-letter symbol is Q. However, Q is not an option in LIST-II. LIST-II contains **E**, which is the symbol for **Glutamic acid**. It is probable that "Glutamine" in LIST-I is a typographical error and should be "Glutamic acid". Proceeding with this assumption, the code for Glutamic acid is E. Thus, **D corresponds to III.**

Step 3: Final Answer:

Applying the standard one-letter codes and accounting for the probable typographical error, the correct pairings are A-IV, B-I, C-II, and D-III. This combination matches option (B).

💡 Quick Tip

For amino acids whose names don't start with a unique letter, the codes can be tricky. Memorize these: Aspartic Acid (D), Glutamic Acid (E), Asparagine (N), Glutamine (Q), Phenylalanine (F), Tyrosine (Y), Tryptophan (W), Lysine (K).

52. Match LIST-I with LIST-II

LIST-I Parts of Mesoderm		LIST-II Body parts formed	
A.	Intermediate Mesoderm	I.	Notochord
B.	Chorda Mesoderm	II.	Circulatory system
C.	Paraxial Mesoderm	III.	Kidney
D.	Lateral Plate Mesoderm	IV.	Skeletal Muscle

Choose the most appropriate answer from the options given below:

- (A) A - I, B - II, C - III, D - IV
 (B) A - III, B - I, C - IV, D - II
 (C) A - II, B - IV, C - I, D - III
 (D) A - IV, B - III, C - I, D - II

Correct Answer: (B) A - III, B - I, C - IV, D - II

Solution:

Step 1: Understanding the Concept:

In the course of embryonic development, the mesoderm, one of the three foundational germ layers, subdivides into several distinct regions. Each of these regions is fated to develop into specific tissues and organs. This question tests knowledge of the developmental fates of these mesodermal subdivisions.

Step 2: Detailed Matching:

- **A. Intermediate Mesoderm:** This subdivision lies between the paraxial and lateral plate mesoderm and is the precursor to the urogenital system, which includes the **kidneys** and reproductive organs. Thus, **A matches with III.**
- **B. Chorda Mesoderm:** This is the most central, or axial, mesoderm. It forms the **notochord**, which is a crucial signaling structure that guides the development of the nervous system and the vertebral column. Thus, **B matches with I.**
- **C. Paraxial Mesoderm:** This region is situated alongside the neural tube and segments into structures called somites. The somites further differentiate to form the myotome (which gives rise to **skeletal muscle**), the sclerotome (which forms the vertebrae), and the dermatome (which forms the dermis). Thus, **C matches with IV.**
- **D. Lateral Plate Mesoderm:** As the outermost portion of the mesoderm, it splits to form the lining of the body cavity. It is the origin of the heart, blood vessels, and blood cells of the **circulatory system**, as well as the smooth muscle of the digestive tract and limb bones. Thus, **D matches with II.**

Step 3: Final Answer:

The accurate set of pairings is A-III, B-I, C-IV, and D-II. This corresponds to option (B).

💡 Quick Tip

Create a mental map of the mesoderm cross-section from the center outwards:

- **Center/Axial (Chorda):** Notochord
- **Next to center (Paraxial):** Somites (muscle, vertebrae)
- **In between (Intermediate):** Kidneys/Gonads
- **Outermost (Lateral Plate):** Circulatory system, Body cavity lining

53. What is the full form of the IMZ abbreviation?

- (A) Invaginating marginal zone
- (B) Involuting marginal zone
- (C) Ingression marginal zone
- (D) Inducing marginal zone

Correct Answer: (B) Involuting marginal zone

Solution:

Step 1: Understanding the Concept:

Within developmental biology, especially concerning amphibian gastrulation, the embryo is partitioned into several distinct zones. The marginal zone is situated between the animal and vegetal poles. The abbreviation IMZ refers to a particular section of this zone that participates in a fundamental movement during gastrulation.

Step 2: Detailed Explanation:

- Gastrulation is the developmental stage where the single-layered blastula is restructured into a three-layered gastrula, comprising the ectoderm, mesoderm, and endoderm, through a series of complex cellular movements.
- **Involution** is a specific type of cell movement characterized by a sheet of cells turning inward and then spreading across an internal surface.
- The **Involuting Marginal Zone (IMZ)** is the specific band of cells within the amphibian embryo that rolls inward over the dorsal lip of the blastopore during the gastrulation process. These cells are destined to become future mesodermal tissues, such as the notochord and somites.
- Other terms like *invagination* (an infolding of a cell sheet) and *ingression* (the inward migration of individual cells) describe different types of gastrulation movements.

Step 3: Final Answer:

The acronym IMZ represents the Involuting Marginal Zone, a term that precisely reflects this region's role in gastrulation. Therefore, option (B) is correct.

💡 Quick Tip

Associate the key cell movements with their definitions:

- **Involute:** A sheet of cells rolls inward. (IMZ in amphibians)
- **Invaginate:** A sheet of cells folds in on itself. (Sea urchin endoderm formation)
- **Ingress:** Individual cells detach and migrate inward. (Sea urchin mesoderm formation)

54. What is the function of yolk sac?

- (A) It contains blood vessels that exchange gases with the outside environment.
- (B) It stores waste products.
- (C) It enables the embryo to float in a fluid environment that protects it from desiccation.
- (D) It enables nutrient uptake and the development of the circulatory system.

Correct Answer: (D) It enables nutrient uptake and the development of the circulatory system.

Solution:

Step 1: Understanding the Concept:

The yolk sac is one of the four extraembryonic membranes that provide support to the developing embryo in amniotes, which include reptiles, birds, and mammals. Each of these membranes has a distinct, specialized function.

Step 2: Detailed Explanation of Functions:

- **Yolk Sac:** Its main function is to contain the yolk, which is the primary source of nutrition for the embryo. It forms a dense network of blood vessels to absorb these nutrients and deliver them to the embryo. In mammals, it is also the initial site of blood cell formation. This description aligns with option (D).
- **Chorion and Allantois:** The chorion is the outermost membrane, and in birds and reptiles, it fuses with the allantois to form the chorioallantoic membrane, which is the primary organ for gas exchange with the external environment (related to option A).
- **Allantois:** This sac-like structure serves to store metabolic waste products, especially uric acid (option B).
- **Amnion:** This membrane encloses the amniotic fluid, creating a protective, liquid-filled cushion around the embryo that guards against mechanical injury and dehydration (option C).

Step 3: Final Answer:

The primary role of the yolk sac involves enabling nutrient absorption from the yolk and initiating the development of the circulatory system for nutrient transport. Therefore, option (D) is the correct answer.

💡 Quick Tip

Remember the 'A, B, C' of extraembryonic membranes:

- **A**mnion = **A**quatic environment (protection).
- **B**ladder (Allantois) = Stores waste.
- **C**horion = Gas exchange (**C**overing).
- **Y**olk Sac = Food source.

55. In Amphibia, gastrulation begins at:

- (A) The part of the egg opposite to the entry of the sperm.
- (B) Animal pole
- (C) Vegetal pole
- (D) Dorsal blastopore lip.

Correct Answer: (D) Dorsal blastopore lip.

Solution:

Step 1: Understanding the Concept:

Gastrulation is the developmental process that establishes the three primary germ layers. In amphibian embryos, this process commences at a very specific point on the blastula's surface.

Step 2: Detailed Explanation:

- The start of gastrulation in an amphibian is marked by the appearance of a crescent-shaped groove, the blastopore.
- The initial part of this structure to form is known as the **dorsal blastopore lip**. This is the exact location where the first group of cells begins to involute, or roll inward, to form the future mesoderm and endoderm.
- The position of the dorsal blastopore lip is established earlier in development. The point of sperm entry initiates a rotation of the egg's cortex, which sets up the future dorsal-ventral axis. The dorsal blastopore lip subsequently forms in the gray crescent region, which is located on the side of the embryo opposite to where the sperm entered.
- Although option (A) correctly describes the general location relative to sperm entry, option (D) provides the specific anatomical name of the structure where the cellular movements of gastrulation physically start. As such, (D) is the more precise and accurate answer. The animal and vegetal poles (B and C) are simply the top and bottom ends of the embryo and are not the initiation site.

Step 3: Final Answer:

The process of gastrulation commences at the distinct structure called the dorsal blastopore lip. This region is also famously identified as the "Spemann-Mangold organizer" for its critical role in orchestrating the development of the entire embryonic body plan. Option (D) is the

correct answer.

 Quick Tip

The dorsal blastopore lip is the "director" of gastrulation. It's not just a location, but an active organizer that initiates and controls the complex cell movements that shape the embryo.

56. Which one of the following zones is absent in pond ecosystems?

- (A) Littoral Zone
- (B) Limnetic Zone
- (C) Profundal Zone
- (D) Euphotic Zone

Correct Answer: (C) Profundal Zone

Solution:

Step 1: Understanding the Concept:

Lentic ecosystems, which are bodies of standing water like lakes and ponds, are vertically stratified into zones based on the depth of sunlight penetration. The question asks to identify which of these zones is not typically found in a pond.

Step 2: Detailed Explanation of Zones:

- **Littoral Zone:** This is the shallow, near-shore region where sunlight reaches the bottom, allowing rooted aquatic plants to grow. All ponds possess a littoral zone.
- **Limnetic Zone:** This zone comprises the open, sunlit surface waters away from the shore and is primarily inhabited by plankton. Ponds also have this zone.
- **Euphotic Zone:** This term refers to the entire upper layer of the water body that receives sufficient sunlight to support photosynthesis. It includes both the littoral and limnetic zones. By their nature, ponds are almost entirely within the euphotic zone.
- **Profundal Zone:** This is the deep, dark region of water below the limnetic zone that does not receive any sunlight (aphotic). Photosynthesis cannot occur here. Because ponds are defined as shallow water bodies, sunlight usually penetrates to the bottom. Consequently, ponds do not have a true, permanently dark profundal zone, which is a characteristic feature of deep lakes.

Step 3: Final Answer:

Because of their limited depth, a profundal zone is typically absent in ponds. Therefore, option (C) is the correct answer.

 Quick Tip

Associate the zone names with their meaning: "Littoral" relates to the shore. "Limnetic" comes from the Greek for lake. "Euphotic" means "well-lit." "Profundal" comes from "profound," meaning deep. Since ponds are not deep, they lack a profundal zone.

57. Match LIST-I with LIST-II

LIST-I Interaction Type		LIST-II Example	
A.	Mutualism	I.	Chlorella vulgaris and Diatoms
B.	Commensalism	II.	Termites and Trichonympha
C.	Proto-cooperation	III.	Intestine of Man and Entamoeba coli
D.	Antibiosis	IV.	Adamsia pallia and hermit crab

Choose the most appropriate answer from the options given below:

- (A) A - II, B - III, C - IV, D - I
(B) A - I, B - III, C - II, D - IV
(C) A - I, B - II, C - IV, D - III
(D) A - III, B - IV, C - I, D - II

Correct Answer: (A) A - II, B - III, C - IV, D - I

Solution:

Step 1: Understanding the Concept:

This inquiry involves pairing different forms of ecological interactions with their representative biological examples.

Step 2: Detailed Matching:

- **A. Mutualism (+/+):** This is a relationship where both participating species derive a benefit, and the interaction is obligatory, meaning they depend on each other for survival. The association between **Termites and Trichonympha** is a classic case; the termite provides shelter and wood fibers, while the protozoan digests the cellulose in the wood. Thus, **A matches II.**
- **B. Commensalism (+/0):** In this type of interaction, one species benefits while the other is unaffected. The presence of **Entamoeba coli**, a non-harmful amoeba in the human intestine that feeds on available contents without causing disease, exemplifies this. Thus, **B matches III.**
- **C. Proto-cooperation (+/+):** This is a form of mutualism that is not obligatory; both species benefit from the interaction but are capable of surviving independently. The relationship between the sea anemone **Adamsia pallia and a hermit crab** is a well-known example. The crab gains protection and camouflage, and the anemone gains mobility to access new food sources. Thus, **C matches IV.**

- **D. Antibiosis (-/0):** This is a type of amensalism where one organism produces a substance that is harmful to another. A specific example is allelopathy. In certain aquatic environments, algae like **Chlorella** and **Diatoms** compete, and one may release chemicals that inhibit the growth of the other, fitting the description of antibiosis. Thus, **D matches I**.

Step 3: Final Answer:

The correct combination of matches is A-II, B-III, C-IV, and D-I. This corresponds to option (A).

 Quick Tip

Differentiate Mutualism and Proto-cooperation by asking: "Is it required for survival?" If yes, it's Mutualism (e.g., Termite-Trichonympha). If no, it's Proto-cooperation (e.g., Hermit crab-Anemone).

58. Arrange the following stages of ecological succession in the correct sequence

- A. Ecesis**
- B. Nudation**
- C. Aggregation**
- D. Reaction**

Choose the most appropriate answer from the options given below:

- (A) A, B, C, D
- (B) A, C, B, D
- (C) B, A, C, D
- (D) C, B, D, A

Correct Answer: (C) B, A, C, D

Solution:

Step 1: Understanding the Concept:

Ecological succession describes the predictable process of change over time in the species composition of an ecological community. This process unfolds in a series of recognizable stages.

Step 2: Detailed Explanation of the Sequence:

1. **B. Nudation:** This is the initial stage, involving the creation of a bare, lifeless area. This can be caused by events such as a volcanic eruption, landslide, fire, or flood.
2. **A. Ecesis:** This stage refers to the successful establishment of a species in the new, bare area. It includes the germination of seeds or spores, subsequent growth, and the survival of the initial colonizing (pioneer) species.
3. **C. Aggregation:** After successful establishment (ecesis), the individuals of the pioneer species begin to reproduce and increase their population, leading to the formation of clusters

or aggregations.

4. **D. Reaction:** As the pioneer species flourish and aggregate, they start to modify their own environment. This modification is termed reaction. They alter factors such as soil composition, light conditions, and moisture. This process often makes the environment less favorable for themselves but more favorable for the establishment of new, more competitive species.

Step 3: Final Answer:

The proper temporal sequence for the stages of succession is Nudation → Ecesis → Aggregation → Reaction. This order corresponds to the sequence B, A, C, D. Therefore, option (C) is correct.

 Quick Tip

Remember the succession sequence as a story of colonization:

1. **Bare land** (Nudation)
2. **First settlers arrive and establish** (Ecesis)
3. **Settlers multiply and form a village** (Aggregation)
4. **The village changes the landscape** (Reaction)

59. Which of the following statements are correct with reference to Photochemical Smog?

- A. It is an oxidizing smog.
 - B. It is formed by the reaction between NO_2 and hydrocarbons.
 - C. It is a reducing smog.
 - D. It is formed in the presence of UV-radiation.
- Choose the most appropriate answer from the options given below:

- (A) A, B and D only
- (B) A and B only
- (C) C and D only
- (D) B, C and D only

Correct Answer: (A) A, B and D only

Solution:

Step 1: Understanding the Concept:

Photochemical smog, often called Los Angeles-type smog, is a form of air pollution prevalent in sunny, industrial cities with heavy automotive traffic. The question asks for its defining properties.

Step 2: Analyzing each statement:

- **Statement A: True.** A key characteristic of photochemical smog is its high concentration

of oxidizing agents, most notably ozone (O_3), which makes it an oxidizing smog.

- **Statement B: True.** The formation of photochemical smog is initiated by primary pollutants, specifically nitrogen oxides (NO_x , such as NO_2) and volatile organic compounds (VOCs), which are a class of hydrocarbons primarily from vehicle emissions.

- **Statement C: False.** This contradicts statement A. A reducing smog, also known as classical or London-type smog, is characterized by high concentrations of sulfur dioxide (SO_2) and has a reducing chemical character.

- **Statement D: True.** The term "photochemical" signifies the requirement of sunlight. Energy from the sun's ultraviolet (UV) radiation is necessary to drive the chemical reactions between NO_x and VOCs that produce the secondary pollutants, like ozone, which constitute the smog.

Step 3: Final Answer:

The accurate statements are A, B, and D. Therefore, option (A) is the correct choice.

💡 Quick Tip

Break down the name "Photochemical Smog":

- **Photo:** Needs sunlight (UV radiation).
- **Chemical:** Involves chemical reactions of primary pollutants ($\text{NO}_x + \text{VOCs}$).
- **Smog:** Forms a haze containing secondary pollutants, which are strong **oxidizing** agents (Ozone).

60. The Air Quality Index is measured using the Criteria Pollutants. Which one of the following is not a Criteria Pollutant?

- (A) Sulfur Dioxide
- (B) Lead
- (C) Carbon dioxide
- (D) Ozone

Correct Answer: (C) Carbon dioxide

Solution:

Step 1: Understanding the Concept:

The term "criteria air pollutants" refers to a specific group of six widespread and common air pollutants identified as harmful to public health and the environment. The Air Quality Index (AQI) is a metric calculated based on the concentrations of these specific pollutants.

Step 2: Identifying the Criteria Pollutants:

The six designated criteria air pollutants are:

1. Ground-level Ozone (O_3)
2. Particulate Matter ($PM_{2.5}$ and PM_{10})
3. Carbon Monoxide (CO)
4. Sulfur Dioxide (SO_2)
5. Nitrogen Dioxide (NO_2)
6. Lead (Pb)

Step 3: Analyzing the Options:

- **(A) Sulfur Dioxide (SO_2):** This is included in the list of criteria pollutants.
- **(B) Lead (Pb):** This is included in the list of criteria pollutants.
- **(C) Carbon dioxide (CO_2):** While a major greenhouse gas contributing to climate change, it is **not** considered a criteria air pollutant because it does not pose a direct toxicity risk to humans at typical outdoor concentrations.
- **(D) Ozone (O_3):** Ground-level ozone is included in the list of criteria pollutants.

Step 4: Final Answer:

Carbon dioxide (CO_2) is absent from the list of criteria pollutants utilized in AQI calculations. Therefore, option (C) is the correct answer.

 Quick Tip

Be careful to distinguish between direct air pollutants and greenhouse gases. The AQI measures pollutants that cause immediate health effects like asthma (Ozone, SO_2 , PM). Carbon Dioxide (CO_2) is the primary driver of global warming but is not an AQI component. However, Carbon *Monoxide* (CO) **is** a criteria pollutant.

61. Which of the following factors can influence the process of weathering?

- A. Rock type and structure
- B. Slope
- C. Climatic Conditions
- D. Time

Choose the most appropriate answer from the options given below:

- (A) A, C and D only
- (B) A and C only
- (C) A, B, C and D
- (D) A and D only

Correct Answer: (C) A, B, C and D

Solution:

Step 1: Understanding the Concept:

Weathering is the breakdown and alteration of rocks at or near the Earth's surface through physical and chemical processes. This process is governed by a combination of geological, topographical, climatic, and temporal variables.

Step 2: Detailed Explanation:

- **A. Rock type and structure:** This is a fundamental factor. The resistance of a rock to weathering depends on its mineralogical composition (e.g., quartz is highly resistant, whereas calcite is susceptible to chemical weathering). A rock's physical structure, including features like cracks, joints, and layers, provides more surface area for weathering agents to act upon, thereby speeding up the process.
- **B. Slope:** The gradient of a slope affects weathering. On steep inclines, gravity can contribute to physical weathering via rockfalls. Slope also dictates the balance between water infiltration and surface runoff. Additionally, on steeper slopes, weathered debris is removed more rapidly, exposing fresh rock surfaces to continued weathering.
- **C. Climatic Conditions:** Climate is often considered the most significant factor. Temperature and moisture regimes determine both the type and the rate of weathering. For example, cold and wet climates promote physical weathering processes like frost action, whereas warm and humid climates favor rapid chemical weathering.
- **D. Time:** Weathering is a gradual process. The longer a rock is exposed to environmental forces, the greater the extent of its weathering will be.

Step 3: Final Answer:

Each of the four factors listed—rock type and structure, slope, climatic conditions, and time—significantly influences the weathering process. Therefore, the correct option is (C).

Quick Tip

Think of weathering as "rock decay." Just like a wooden fence decays, the rate depends on the type of wood (rock type), whether it's on a hill (slope), the local weather (climate), and how long it's been outside (time).

62. Match LIST-I with LIST-II

LIST-I		LIST-II	
Replication Enzymes in E coli		Replication Enzymes in Human	
A.	β -clamp	I.	RPA
B.	SSB	II.	PCNA
C.	Gyrase	III.	DNA polymerase alpha
D.	DnaG	IV.	Topo-I, II

Choose the most appropriate answer from the options given below:

- (A) A - I, B - II, C - III, D - IV
- (B) A - I, B - III, C - II, D - IV

- (C) A - I, B - II, C - IV, D - III
(D) A - II, B - I, C - IV, D - III

Correct Answer: (D) A - II, B - I, C - IV, D - III

Solution:

Step 1: Understanding the Concept:

This question involves matching essential DNA replication proteins from the prokaryote *E. coli* with their functional equivalents (homologs) in a eukaryote (Human). While the protein names differ, their functions within the replication machinery are highly conserved.

Step 2: Detailed Matching:

- **A. β -clamp:** In *E. coli*, this ring-shaped protein acts as a sliding clamp, encircling the DNA to tether the DNA polymerase to the template strand, which ensures high processivity. Its human equivalent is **PCNA** (Proliferating Cell Nuclear Antigen). Thus, **A matches with II**.
- **B. SSB (Single-Strand Binding protein):** In *E. coli*, this protein binds to the unwound single strands of DNA, preventing them from re-pairing and protecting them from nuclease degradation. The human homolog with this function is **RPA** (Replication Protein A). Thus, **B matches with I**.
- **C. Gyrase:** This enzyme is a type II topoisomerase in *E. coli* that introduces negative supercoils and relieves the positive supercoiling strain that builds up ahead of the replication fork. In humans, this role is carried out by **Topoisomerases I and II (Topo-I, II)**. Thus, **C matches with IV**.
- **D. DnaG:** This is the specific name for the primase enzyme in *E. coli*, which synthesizes short RNA primers to initiate DNA synthesis. In humans, the primase function is performed by a complex that includes **DNA polymerase alpha**. This complex synthesizes an RNA primer and then adds a short sequence of DNA nucleotides. Thus, **D matches with III**.

Step 3: Final Answer:

The correct combination of pairings is A-II, B-I, C-IV, and D-III. This corresponds to option (D).

 Quick Tip

To remember the sliding clamps: think of the Greek letter Beta (β) for **B**acteria (*E. coli*) and PCNA, which sounds like a clinical term, for more complex organisms like humans.

63. Monoclonal antibodies differ from polyclonal antibodies in their property of reacting with specific

- (A) Antigen
(B) Clone of cell

- (C) Epitope
- (D) Antibody

Correct Answer: (C) Epitope

Solution:

Step 1: Understanding the Concept:

The question asks to identify the key difference in binding specificity between monoclonal and polyclonal antibodies. An antigen is a large molecule that can trigger an immune response and typically possesses multiple distinct recognition sites on its surface, known as epitopes.

Step 2: Detailed Explanation:

- **Polyclonal antibodies** represent a heterogeneous mixture of antibodies produced by many different B-cell clones. Consequently, this collection of antibodies recognizes and binds to *multiple different epitopes* located on the surface of a single antigen.
- **Monoclonal antibodies** are a uniform population of identical antibodies, all produced by a single B-cell clone (typically through hybridoma technology). Every antibody in a monoclonal preparation is exactly the same and binds to *one single, specific epitope* on the antigen.
- Both antibody types react with a specific **antigen**. However, their fundamental difference lies in their specificity at the **epitope** level. Monoclonals are specific to a single epitope, whereas polyclonals react with various epitopes on the antigen.

Step 3: Final Answer:

The characteristic that differentiates monoclonal from polyclonal antibodies is their specific binding to a single, unique epitope. Therefore, option (C) is correct.

 Quick Tip

Think of it this way: An antigen is a whole car. Polyclonal antibodies are like a group of people who recognize the car by its wheels, doors, headlights, and logo. Monoclonal antibodies are like a specialist who only recognizes the car by its specific hood ornament (the epitope).

64. Which of the following diseases is not an autoimmune disease?

- (A) Rheumatoid arthritis
- (B) Lupus erythematosus
- (C) Grave's disease
- (D) Bovine spongiform encephalitis

Correct Answer: (D) Bovine spongiform encephalitis

Solution:

Step 1: Understanding the Concept:

An autoimmune disease is a condition resulting from the body's immune system erroneously attacking its own healthy cells and tissues. The question requires identifying which of the listed conditions is not caused by autoimmunity.

Step 2: Detailed Explanation of Options:

- **Rheumatoid arthritis:** This is a classic autoimmune disorder where the immune system primarily targets the synovial membranes surrounding the joints, leading to inflammation and damage.
- **Lupus erythematosus:** This is a systemic autoimmune condition in which the immune system attacks various tissues throughout the body, causing widespread inflammation and potential organ damage.
- **Grave's disease:** This is an autoimmune condition that results in an overactive thyroid (hyperthyroidism). The immune system generates antibodies that stimulate the thyroid gland, causing it to produce an excess of thyroid hormones.
- **Bovine spongiform encephalitis (BSE):** Commonly known as "mad cow disease," this is a type of transmissible spongiform encephalopathy (TSE). It is a fatal neurodegenerative disorder caused by infectious, misfolded proteins called **prions**, not by an immune system attack.

Step 3: Final Answer:

Bovine spongiform encephalitis is classified as a prion disease rather than an autoimmune disorder. Therefore, option (D) is the correct answer.

 Quick Tip

Remember that autoimmune diseases involve the immune system (antibodies, T-cells) attacking "self." Diseases caused by other agents like bacteria, viruses, fungi, or prions are infectious or degenerative, not autoimmune.

65. Which of the following cells instruct the abnormal or virally infected cells to commit suicide?

- (A) Natural killer cells
- (B) B-cells
- (C) Dendritic cells
- (D) T-cells

Correct Answer: (D) T-cells

Solution:

Step 1: Understanding the Concept:

The process of signaling a cell to undergo programmed cell death, or apoptosis, is a vital immune function for eliminating cancerous or virally infected cells. This capability is a cornerstone of cell-mediated cytotoxicity.

Step 2: Detailed Explanation of Options:

- **B-cells:** Their main role is in humoral immunity, which involves producing and secreting antibodies to target pathogens outside of cells. They do not directly kill infected cells.
- **Dendritic cells:** These are specialized antigen-presenting cells (APCs). Their primary job is to process antigens and present them to T-cells, thereby initiating an adaptive immune response.
- **Natural Killer (NK) cells:** As part of the innate immune system, these lymphocytes can identify and destroy abnormal cells (such as tumor cells or certain virally infected cells) that lack the self-identifying MHC class I molecules. They induce apoptosis and are, in a general sense, a correct answer.
- **T-cells:** Specifically, the subset known as **Cytotoxic T Lymphocytes (CTLs or CD8+ T-cells)** are the main agents of the adaptive cell-mediated immune response. They are trained to recognize a particular viral or tumor antigen presented on an MHC class I molecule of an infected cell. Upon recognition, the CTL delivers signals that "instruct" the target cell to undergo apoptosis.
- **Comparison of NK cells and T-cells:** Although both cell types can trigger apoptosis, the highly specific "instruction" delivered by a T-cell after recognizing a specific antigen-MHC complex is a defining feature of the adaptive immune response. Among the given choices, "T-cells" is the most encompassing and appropriate answer representing this critical function.

Step 3: Final Answer:

As part of the adaptive immune response, Cytotoxic T-cells are the main immune cells that identify and signal virally infected or abnormal cells to initiate apoptosis. Therefore, option (D) is the most appropriate answer.

💡 Quick Tip

Remember the killers of the immune system:

- **Cytotoxic T-cells (adaptive):** Specific killers. They need to be activated and recognize a specific antigen on the target cell.
- **Natural Killer (NK) cells (innate):** Non-specific killers. They are part of the first line of defense and look for cells that appear "abnormal" or are missing self-markers.

Both induce apoptosis.

66. Which one of the following immunoglobulin is responsible for atopic allergy?

- (A) IgG
- (B) IgM
- (C) IgE
- (D) IgA

Correct Answer: (C) IgE

Solution:

Step 1: Understanding the Concept:

Atopic allergy, which is also known as a type I hypersensitivity reaction, is an allergic response that is orchestrated by a particular class of antibodies, or immunoglobulins. The question asks to name this specific class.

Step 2: Detailed Explanation:

- **IgE:** This class of immunoglobulin is the primary mediator of allergic reactions. In an individual with allergies, the immune system generates IgE antibodies in response to an allergen (like pollen or dust). These IgE antibodies then attach to the surface of mast cells and basophils. When the person is re-exposed to the same allergen, the allergen binds to and cross-links the IgE on these cells, triggering them to release inflammatory chemicals like histamine, which cause the symptoms of an allergic reaction.
- **IgG:** This is the most prevalent immunoglobulin in the bloodstream and is vital for fighting off bacterial and viral infections.
- **IgM:** This is the first antibody type produced during a primary immune response and is very effective at activating the complement system.
- **IgA:** This is the principal immunoglobulin found in mucosal fluids such as saliva, tears, and breast milk, where it acts as a first line of defense.

Step 3: Final Answer:

IgE is the immunoglobulin class accountable for atopic allergies. Therefore, option (C) is correct.

 Quick Tip

Remember the mnemonic "IgE for **E**mergency" or "Allerg**E**". This helps associate the IgE isotype with immediate hypersensitivity and allergic reactions.

67. Class I MHC molecules present peptides to which of the following cell type?

- (A) CD8+ cytotoxic T-cells
- (B) CD4+ T-helper cells
- (C) Dendritic cells
- (D) Macrophages

Correct Answer: (A) CD8+ cytotoxic T-cells

Solution:

Step 1: Understanding the Concept:

Major Histocompatibility Complex (MHC) molecules are proteins on the cell surface that display antigenic peptides to T-cells. The two main types, MHC Class I and MHC Class II, are specialized to present peptides to different classes of T-cells.

Step 2: Detailed Explanation:

- **MHC Class I:** These molecules are expressed on the surface of nearly all nucleated cells in the body. Their main job is to display *endogenous* antigens—peptides derived from proteins made within the cell, such as viral proteins or mutated tumor proteins—to **CD8+ cytotoxic T-cells**. This interaction serves as a signal for the cytotoxic T-cell to eliminate the presenting cell.

- **MHC Class II:** These molecules are restricted to the surface of professional Antigen-Presenting Cells (APCs), which include dendritic cells, macrophages, and B-cells. They display *exogenous* antigens—peptides from pathogens that have been engulfed and processed—to **CD4+ T-helper cells**. This interaction is crucial for activating the T-helper cell, which then helps coordinate the overall immune response.

Step 3: Final Answer:

Peptides are presented by MHC Class I molecules specifically to CD8+ cytotoxic T-cells. Therefore, option (A) is correct.

 Quick Tip

Use the "rule of 8" to remember the MHC-T cell interactions:

- MHC Class **I** binds to CD8 T-cells ($1 \times 8 = 8$).
- MHC Class **II** binds to CD4 T-cells ($2 \times 4 = 8$).

68. Which one of the following best describes the innate immune response?

- (A) It is an immediate and relatively broad acting response.
- (B) It is a delayed response but highly specific.
- (C) It is acquired by vaccination.
- (D) It is acquired in life.

Correct Answer: (A) It is an immediate and relatively broad acting response.

Solution:

Step 1: Understanding the Concept:

The immune system is composed of two primary divisions: the innate and the adaptive immune systems, which are distinguished by their speed, specificity, and ability to form memory. This question asks for the most accurate description of the innate response.

Step 2: Detailed Explanation:

- **Innate Immunity:** This is the body's first line of defense, present from birth. Its principal characteristics are an **immediate** response time (minutes to hours) and a **broad-acting** or non-specific nature, as it recognizes general molecular patterns shared by many pathogens. It does not generate immunological memory.

- **Adaptive Immunity:** This is the second line of defense. It is characterized by a **delayed** initial response (several days), **high specificity** for particular antigens, and the development of **memory**, which allows for a much faster and more effective response to subsequent encounters with the same pathogen. Vaccination and natural infection are methods of acquiring adaptive immunity.

- **Analyzing the options:**

- (A) "Immediate and relatively broad acting" is a perfect summary of innate immunity.

- (B) "Delayed response but highly specific" accurately describes adaptive immunity.

- (C) and (D) The concepts of being "acquired by vaccination" or "acquired in life" are defining features of adaptive immunity.

Step 3: Final Answer:

The most fitting description for the innate immune response is that it is both immediate and acts broadly against pathogens. Therefore, option (A) is correct.

💡 Quick Tip

Remember the key differences: **Innate** = **In**born, **I**mmEDIATE, **N**on-specific. **Adaptive** = **A**cquired, **A**ntigen-specific, has memory.

69. What are chemokines?

- (A) Cell surface receptors
- (B) Specialized chemotactic cytokine
- (C) Any foreign antigen
- (D) Chemical based antibodies

Correct Answer: (B) Specialized chemotactic cytokine

Solution:

Step 1: Understanding the Concept:

Chemokines represent a family of small signaling proteins that are instrumental in the immune

system's function, particularly in directing cellular traffic.

Step 2: Detailed Explanation:

- **Cytokines** are a wide-ranging class of proteins that serve as intercellular messengers, especially within the immune system.
- **Chemokines** are a specific sub-family of cytokines. Their defining function is to induce **chemotaxis**, which is the directed migration of cells along a chemical concentration gradient.
- Immune cells, such as neutrophils and lymphocytes, possess receptors for chemokines. By following the chemokine gradient, these cells can navigate from the bloodstream into tissues, moving toward sites of infection or injury.
- Thus, a chemokine is best defined as a cytokine that has specialized chemotactic (cell-attracting) properties.

Step 3: Final Answer:

The most accurate definition of chemokines is that they are specialized chemotactic cytokines. Therefore, option (B) is correct.

 Quick Tip

Break down the word "chemokine": **Chemotactic** + cytok**ine**. It literally means a cytokine that causes chemical-guided movement.

70. Which one of the following best describes the application of DNA microarray?

- (A) To investigate the level of gene expression in a cancerous cell
- (B) To separate small biomolecules based on their charge.
- (C) To amplify a DNA sequence.
- (D) To study the protein synthesis in a cell.

Correct Answer: (A) To investigate the level of gene expression in a cancerous cell

Solution:

Step 1: Understanding the Concept:

A DNA microarray is a high-throughput molecular biology tool, consisting of a solid substrate (like a glass slide) on which thousands of distinct DNA sequences (probes) are arranged in an orderly grid.

Step 2: Detailed Explanation:

- The principal use of DNA microarrays is to measure the **expression levels of thousands of genes simultaneously**. This is achieved by quantifying the amount of mRNA produced by each gene in a cell population.
- The typical procedure involves extracting mRNA from two different cell samples (for example,

cancerous cells and normal cells), converting this mRNA into fluorescently labeled complementary DNA (cDNA), and then allowing this cDNA to hybridize with the DNA probes on the microarray.

- By comparing the fluorescence intensity at each spot, researchers can identify which genes are more active (upregulated) or less active (downregulated) in one condition relative to the other. This makes the technique highly suitable for exploring the molecular changes in diseases like cancer.
- Option (B) describes electrophoresis.
- Option (C) describes the Polymerase Chain Reaction (PCR).
- Option (D) would involve techniques such as ribosome profiling or proteomics, not DNA microarrays.

Step 3: Final Answer:

The most accurate description of a DNA microarray's use is for investigating gene expression levels, such as in a cancerous cell. Therefore, option (A) is correct.

💡 Quick Tip

Associate "microarray" with a massive-scale analysis of gene activity. It gives a snapshot of which genes are "on" or "off" in a cell at a specific moment, making it perfect for comparing different cell states like healthy vs. diseased.

71. What is the correct sequence of steps in the genetic engineering of *E.coli* for insulin production?

- A. Obtaining a copy of the human insulin gene by isolating mRNA
- B. Switching on gene action.
- C. Identifying transformed bacteria prior to cloning
- D. Inserting the DNA into a plasmid vector and inserting the plasmid vector into the host bacterium

Choose the most appropriate answer from the options given below:

- (A) A,B,C, D
- (B) A,C,B,D
- (C) A,D,C,B
- (D) C,B,D,A

Correct Answer: The correct sequence is $A \rightarrow D \rightarrow C \rightarrow B$.

Solution:

Step 1: Understanding the Concept:

The question requires ordering the key steps involved in producing a human protein (insulin)

in a bacterial system (*E. coli*) through the process of recombinant DNA technology.

Step 2: Detailed Explanation of the Sequence:

1. **A. Obtaining a copy of the human insulin gene by isolating mRNA:** This is the initial and crucial step. The genetic blueprint for insulin must be acquired from a human source. Typically, mRNA is extracted from pancreatic cells and used as a template by the enzyme reverse transcriptase to synthesize a complementary DNA (cDNA) version of the gene. This cDNA is preferred because it lacks introns, which bacterial cells cannot remove.
2. **D. Inserting the DNA into a plasmid vector and inserting the plasmid vector into the host bacterium:** After obtaining the insulin cDNA, it is inserted (ligated) into a circular DNA molecule called a plasmid vector. This newly formed recombinant plasmid is then introduced into the host bacteria (*E. coli*) in a process known as transformation.
3. **C. Identifying transformed bacteria prior to cloning:** Not all bacteria will successfully take up the plasmid during transformation. It is therefore necessary to select or screen for the bacteria that have been successfully transformed. This is commonly achieved using a selectable marker, such as an antibiotic resistance gene, located on the plasmid.
4. **B. Switching on gene action:** Once the transformed bacteria have been identified, they are grown in large quantities (cloned). To get these bacteria to produce the insulin protein, the expression of the inserted insulin gene must be induced, or "switched on." This is typically controlled by an inducible promoter on the plasmid that can be activated by adding a specific substance to the growth medium.

Step 3: Final Answer:

The logical and correct progression of steps to produce recombinant insulin is $A \rightarrow D \rightarrow C \rightarrow B$.

💡 Quick Tip

Think of the process like a recipe:

1. **Get the gene** (Isolate the recipe - Step A).
2. **Put the gene in a carrier and get it into the factory** (Put the recipe in a cookbook and give it to the chef - Step D).
3. **Find the factory that accepted the gene** (Make sure the chef got the right cookbook - Step C).
4. **Tell the factory to start producing** (Tell the chef to start cooking - Step B).

72. A multiple cloning site:

- (A) Contains several copies of a cloned gene.
- (B) Allows multiple choices for choosing organisms for cloning.
- (C) Allows multiple choices for choosing restriction enzymes for cloning.
- (D) Contains multiple copies of the same restriction enzyme.

Correct Answer: (C) Allows multiple choices for choosing restriction enzymes for cloning.

Solution:

Step 1: Understanding the Concept:

A Multiple Cloning Site (MCS), also called a polylinker, is a specifically engineered short DNA sequence inserted into a cloning vector, such as a plasmid. It is designed to simplify the process of inserting foreign DNA into the vector.

Step 2: Detailed Explanation:

- The defining characteristic of an MCS is that it contains a high density of recognition sites for many different restriction enzymes, all located in a single, compact region.
- This feature provides a researcher with a broad array of options when selecting restriction enzymes to cut the vector and insert a target DNA fragment. This versatility ensures that the vector is compatible with various restriction sites that may be present on the DNA insert.
- Reviewing the options:
 - (A) is incorrect. The MCS is the location *for* cloning a gene; it does not initially contain the gene.
 - (B) is incorrect. The choice of host organism for cloning depends on factors unrelated to the MCS.
 - (C) is correct. This is the main purpose of an MCS: to provide a selection of unique restriction enzyme sites.
 - (D) is incorrect. An MCS contains sites for many *different* restriction enzymes, not multiple sites for the same one.

Step 3: Final Answer:

The purpose of a multiple cloning site is to offer a variety of choices for restriction enzymes during the cloning procedure. Therefore, option (C) is correct.

 Quick Tip

Break down the name: "Multiple Cloning Site". It's a single **site** for **cloning** that offers **multiple** options. The options are the different restriction enzyme recognition sequences it contains.

73. Southern blotting procedure does not include:

- (A) Digestion and separation of DNA fragments using agarose gel electrophoresis.
- (B) Ligation of the target DNA into a cloning vector.
- (C) Transfer of DNA fragments to a nitrocellulose membrane.
- (D) Hybridization of the membrane with a labelled probe.

Correct Answer: (B) Ligation of the target DNA into a cloning vector.

Solution:

Step 1: Understanding the Concept:

Southern blotting is a laboratory technique used to identify a specific DNA sequence within a large, complex DNA sample. The question asks to identify a step that is not part of this analytical method.

Step 2: Detailed Explanation:

The typical workflow for a Southern blot involves these steps:

1. **Digestion and Electrophoresis:** The DNA sample is cut into fragments with restriction enzymes. These fragments are then separated based on their size by agarose gel electrophoresis. (This corresponds to option A).
2. **Transfer (Blotting):** The size-separated DNA fragments are transferred from the fragile gel onto a more durable solid membrane, such as nitrocellulose. (This corresponds to option C).
3. **Hybridization:** The membrane is treated with a labeled DNA probe that has a sequence complementary to the target DNA. This probe will bind (hybridize) specifically to the target fragment on the membrane. (This corresponds to option D).
4. **Detection:** The label on the probe is visualized, revealing the presence and size of the specific DNA fragment being sought.
 - The procedure described in option (B), "Ligation of the target DNA into a cloning vector," is a fundamental step in **molecular cloning**, which is a process for constructing new recombinant DNA molecules. It is a synthetic procedure, whereas Southern blotting is a diagnostic or analytical procedure.

Step 3: Final Answer:

The ligation of DNA into a cloning vector is not a component of the Southern blotting technique. Therefore, option (B) is the correct answer.

💡 Quick Tip

Remember the purpose of the main DNA techniques:

- **Cloning/Ligation:** To build or create new DNA molecules.
- **PCR:** To amplify or make many copies of DNA.
- **Southern Blot:** To detect or find a specific DNA sequence.

74. The brain and spinal cord develop from ectoderm arranged in a tubular structure called the neural tube. The anterior part of the neural tube expands, and constrictions appear that create multiple regions. Arrange the parts of the embryonic brain chambers in a 5 week embryo from top to bottom.

- A. Diencephalon
- B. Myelencephalon

C. Metencephalon

D. Mesencephalon

E. Telencephalon

Choose the most appropriate answer from the options given below:

(A) A, B, C, D, E

(B) A, E, C, D, B

(C) E, A, D, C, B

(D) C, B, D, A, E

Correct Answer: (C) E, A, D, C, B

Solution:

Step 1: Understanding the Concept:

The central nervous system originates from the neural tube. The anterior (or rostral) portion of this tube differentiates to form the brain. Initially, three primary brain vesicles arise: the prosencephalon (forebrain), the mesencephalon (midbrain), and the rhombencephalon (hindbrain). By the fifth week of human development, these primary vesicles subdivide into five secondary vesicles. The question requires ordering these five secondary vesicles from anterior to posterior (top to bottom).

Step 2: Detailed Explanation of the Sequence:

The developmental progression from three to five vesicles occurs as follows:

- The **Prosencephalon (forebrain)** divides into: 1. **E. Telencephalon** (the most anterior part), which develops into the cerebral hemispheres. 2. **A. Diencephalon**, which forms structures like the thalamus and hypothalamus. - The **Mesencephalon (midbrain)** does not divide and remains as: 3. **D. Mesencephalon**. - The **Rhombencephalon (hindbrain)** divides into: 4. **C. Metencephalon**, which develops into the pons and cerebellum. 5. **B. Myelencephalon** (the most posterior part), which becomes the medulla oblongata.

Step 3: Final Answer:

When these five secondary vesicles are arranged in sequence from top (anterior) to bottom (posterior), the order is: Telencephalon → Diencephalon → Mesencephalon → Metencephalon → Myelencephalon.

This corresponds to the letter sequence E, A, D, C, B. Therefore, option (C) is correct.

 Quick Tip

Remember the alphabetical and hierarchical order. The forebrain divides into T and D. The midbrain (Mesencephalon) stays the same. The hindbrain divides into Met- and Mye-. Alphabetically, Met- comes before Mye-. This gives the sequence T, D, Mes, Met, Mye.

75. Which one of the following diseases can be corrected by gene therapy?

- (A) Sleeping sickness
- (B) Measles
- (C) AIDS
- (D) Cystic fibrosis

Correct Answer: (D) Cystic fibrosis

Solution:

Step 1: Understanding the Concept:

Gene therapy is a therapeutic strategy that aims to treat or prevent disease by addressing the root genetic cause. It is most directly suited for conditions caused by a single defective gene (monogenic disorders), where a functional version of the gene can be delivered to cells to compensate for the faulty one.

Step 2: Detailed Explanation of Options:

- **Sleeping sickness:** This is an infectious disease caused by a parasitic protozoan, *Trypanosoma brucei*. Its treatment involves anti-parasitic medications, not gene therapy.
- **Measles:** This is an infectious disease caused by a virus. It is effectively prevented through vaccination.
- **AIDS (Acquired Immunodeficiency Syndrome):** This is an infectious disease resulting from the Human Immunodeficiency Virus (HIV). It is managed using antiretroviral medications. Although gene therapy is an area of active research for treating HIV, it is not a standard corrective treatment.
- **Cystic fibrosis:** This is a prime example of an inherited monogenic disease. It results from mutations in the CFTR gene, which disrupt the function of a crucial protein channel. Gene therapy for cystic fibrosis aims to deliver a correct copy of the CFTR gene to the patient's cells, especially in the lungs, to restore normal function.

Step 3: Final Answer:

Among the choices provided, cystic fibrosis is the genetic disease that can be addressed by introducing a functional gene, which is the fundamental principle of gene therapy. Therefore, option (D) is correct.

 Quick Tip

The key to this question is identifying the **genetic** disease versus the **infectious** diseases. Gene therapy is designed to fix faulty genes. Sleeping sickness, measles, and AIDS are caused by external pathogens (parasite, virus), not an inherited faulty gene from the patient's parents.