CUET UG Biology Sample Paper - 3

Duration: 1 Hour **Maximum Marks: 250**

Instructions

- This paper contains a total of 50 Multiple Choice Questions.
- Each correct answer carries **+5 marks**.
- Each incorrect answer carries **-1 mark**.
- No negative marking for unattempted questions.

Q1. In a typical angiosperm embryo sac, though 8 nuclei are present, it is 7-celled because:

(A) Two nuclei fuse before fertilization.

(B) Polar nuclei are situated in the large central cell.

(C) Synergids degenerate before the entry of pollen tube.

(D) One nucleus is expelled from the sac.

Q2. Identify the correct sequence of the stages of spermatogenesis:

(A) Spermatogonia → Spermatocyte → Spermatid → Spermatozoa

(B) Spermatid → Spermatocyte → Spermatogonia → Spermatozoa

(C) Spermatogonia → Spermatid → Spermatocyte → Spermatozoa

(D) Spermatocyte → Spermatogonia → Spermatid → Spermatozoa

Q3. **Statement I:** All Reproductive Tract Infections (RTIs) are STIs, but all STIs are not RTIs.
Statement II: Hepatitis-B and HIV can also be transmitted by sharing injection needles.

(A) Both Statement I and II are correct.

(B) Both Statement I and II are incorrect.

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

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

Q4. A thalassemia patient has a defect in the synthesis of globin chains. This is an example of:

(A) Qualitative erythrocyte defect.

(B) Quantitative erythrocyte defect.

(C) Chromosomal aberration.

(D) X-linked recessive disorder.

Q5. If the distance between two genes is high on a chromosome, the recombination frequency will be:

(A) Low

(B) High (Maximum 50%)

(C) Zero

(D) 100%

Q6. Which enzyme is responsible for the removal of RNA primers during DNA replication in E. coli?

(A) DNA Polymerase III

(B) DNA Polymerase I

(C) Helicase

(D) Primase

Q7. In the Lac Operon, the inducer (Lactose) binds to:

(A) Operator

(B) Promoter

(C) Repressor protein

(D) Structural gene Z

Q8. Which of the following is a "stop codon" that terminates translation?

(A) AUG

(B) UGG

(C) UAG

(D) GUG

Q9. Adaptive radiation refers to:

(A) Evolution of different species from a common ancestor in a given geographical area.

(B) Migration of species to different islands.

(C) Adaptation due to geographical isolation only.

(D) Evolution of similar phenotypic features in unrelated lineages.

Q10. In a population at Hardy-Weinberg equilibrium, the frequency of the dominant allele (p) is 0.6. The frequency of heterozygotes ($2pq$) is:

(A) 0.36

(B) 0.16

(C) 0.48

(D) 0.24

Q11. Match List I (Contraceptive) with List II (Category): (a) Lippes Loop, (b) Multiload 375, (c) Saheli, (d) LNG-20; List II: (1) Non-hormonal Pill, (2) Non-medicated IUD, (3) Hormone releasing IUD, (4) Copper releasing IUD.

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

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

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

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

Q12. The primary treatment of sewage involves:

(A) Microbial digestion

(B) Physical removal of large and small particles

(C) Aeration

(D) Neutralization of chemicals

Q13. The "Evil Quartet" is a term associated with:

(A) Population explosion

(B) Four major causes of biodiversity loss

(C) Greenhouse gases

(D) Stages of AIDS

Q14. RNA interference (RNAi) involves silencing of a specific mRNA due to a complementary:

(A) ssDNA

(B) dsRNA

(C) ssRNA

(D) rRNA

Q15. In DNA Fingerprinting, VNTRs belong to a class of satellite DNA referred to as:

(A) Macrosatellite

(B) Minisatellite

(C) Microsatellite

(D) Episomes

Q16. Which of the following restriction enzymes produces "blunt ends"?

(A) EcoRI

(B) HindIII

(C) SmaI

(D) BamHI

Q17. In the process of PCR, the step of 'Annealing' occurs at approximately:

(A) 94°C

(B) 54°C

(C) 72°C

(D) 40°C

Q18. **Assertion (A):** Humulin is considered safer than conventional animal-derived insulin.
Reason (R): It is produced using E. coli and does not trigger immunological reactions in humans.

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

(B) Both A and R are true but R is not the correct explanation of A.

(C) A is true but R is false.

(D) A is false but R is true.

Q19. The pyramid of energy is always upright because:

(A) Energy is lost as heat at each trophic level.

(B) Decomposers return energy to the soil.

(C) Herbivores have more energy than producers.

(D) Energy flow is bidirectional.

Q20. An age pyramid with a broad base indicates:

(A) A declining population.

(B) A stable population.

(C) An expanding population.

(D) A population with high mortality in all age groups.

Q21. In *Mirabilis jalapa*, the cross between red and white flowers results in pink flowers. This is a deviation from Mendel's laws known as:

(A) Codominance

(B) Incomplete dominance

(C) Pleiotropy

(D) Polygenic inheritance

Q22. A transcription unit in DNA is defined primarily by the:

(A) Promoter, Structural gene, and Terminator.

(B) Introns and Exons.

(C) TATA box and Poly-A tail.

(D) Repressor and Inducer.

Q23. During sewage treatment, the "activated sludge" is:

(A) Settled bacterial flocs in the secondary settling tank.

(B) Scum removed during primary treatment.

(C) Large debris removed by filtration.

(D) The effluent from the anaerobic digester.

Q24. Which of the following is an example of *Ex-situ* conservation?

(A) National Park

(B) Sacred Grove

(C) Seed Bank

(D) Wildlife Sanctuary

Q25. The process of loading a 'charged' tRNA with an amino acid is called:

(A) Splicing

(B) Capping

(C) Aminoacylation

(D) Tailing

Q26. Hominid evolution sequence (from oldest to most recent):

(A) Homo habilis → Homo erectus → Homo sapiens

(B) Homo erectus → Homo habilis → Homo sapiens

(C) Ramapithecus → Homo erectus → Australopithecus

(D) Australopithecus → Homo sapiens → Homo erectus

Q27. Match List I (Interaction) with List II (Example): (a) Mutualism, (b) Commensalism, (c) Parasitism, (d) Amensalism; List II: (1) Penicillium and Bacteria, (2) Tick on Dog, (3) Orchid on Mango, (4) Lichen.

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

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

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

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

Q28. In the life cycle of *Plasmodium*, the infectious stage for humans is:

(A) Trophozoite

(B) Sporozoite

(C) Gametocyte

(D) Merozoite

Q29. The enzyme used to join the sticky ends of DNA is:

(A) DNA Polymerase

(B) DNA Ligase

(C) Restriction Endonuclease

(D) Reverse Transcriptase

Q30. Select the correct statement regarding Down's Syndrome:

(A) It is caused by the trisomy of chromosome 21.

(B) It is a Mendelian disorder.

(C) It occurs only in females.

(D) It results in a karyotype of 47, XXY.

Q31. A point mutation in the Beta-globin chain of hemoglobin causing Sickle Cell Anemia involves the substitution of:

(A) Glutamic acid by Valine

(B) Valine by Glutamic acid

(C) Glycine by Alanine

(D) Leucine by Valine

Q32. The 'GIFT' technique is recommended for females:

(A) Who cannot produce an ovum.

(B) Who cannot provide a suitable environment for fertilization.

(C) Whose cervical mucus is hostile to sperm.

(D) Who have blocked Fallopian tubes.

Q33. Which part of the poppy plant is used to obtain the drug "Smack"?

(A) Flowers

(B) Latex

(C) Roots

(D) Leaves

Q34. The primary productivity of an ecosystem is measured in:

(A) g/m^2

(B) $g/m^2/yr$

(C) $kcal/m^2$

(D) kg/m^2

Q35. The formation of the corpus luteum is triggered by a surge in:

(A) Estrogen

(B) Progesterone

(C) LH (Luteinizing Hormone)

(D) FSH

Q36. In a dihybrid cross ($RrYy \times RrYy$), what is the probability of obtaining a recombinant phenotype?

(A) 9/16

(B) 1/16

(C) 6/16

(D) 3/16

Q37. The 'T-DNA' used in plant genetic engineering is derived from:

(A) *Agrobacterium tumefaciens*

(B) *Bacillus thuringiensis*

(C) *Meloidegyne incognita*

(D) *Escherichia coli*

Q38. The region of DNA where RNA polymerase binds is the:

(A) Regulator

(B) Structural gene

(C) Promoter

(D) Operator

Q39. Double fertilization involves:

(A) Syngamy and Triple Fusion.

(B) Two sperms fusing with one egg.

(C) Fusion of two polar nuclei.

(D) Fertilization of two different eggs in one sac.

Q40. Which of the following is a biofertilizer?

(A) *Oscillatoria*

(B) *Trichoderma*

(C) *Bacillus thuringiensis*

(D) *Ladybird*

Q41. The first human-like hominid was:

(A) *Homo habilis*

(B) *Homo erectus*

(C) *Australopithecus*

(D) *Neanderthal man*

Q42. In DNA, the pentose sugar and nitrogenous base are linked by:

(A) Phosphodiester bond

(B) N-glycosidic bond

(C) Hydrogen bond

(D) Peptide bond

Q43. Which technique is used to amplify a specific segment of DNA?

(A) Gel Electrophoresis

(B) PCR

(C) DNA Fingerprinting

(D) Southern Blotting

Q44. High BOD (Biochemical Oxygen Demand) in a water body indicates:

(A) Low organic pollution.

(B) High organic pollution.

(C) High dissolved oxygen.

(D) Absence of microbial activity.

Q45. The sequence of structural genes in the Lac Operon is:

(A) lac y, lac z, lac a

(B) lac z, lac y, lac a

(C) lac a, lac y, lac z

(D) lac i, lac p, lac o

Q46. Which antibody is primarily found in Colostrum?

(A) IgG

(B) IgE

(C) IgA

(D) IgM

Q47. "Cry" genes obtained from *Bacillus thuringiensis* are effective against:

(A) Nematodes

(B) Bollworms

(C) Fungi

(D) Viruses

Q48. An example of a non-sense codon is:

(A) UUU

(B) GGG

(C) UAA

(D) CCC

Q49. 'Sacred Groves' are especially useful in:

(A) Generating environmental awareness.

(B) Preventing soil erosion.

(C) Conserving rare and threatened species.

(D) Year-round water supply.

Q50. If a DNA molecule has 20% Cytosine, the percentage of Adenine will be:

(A) 20%

(B) 30%

(C) 40%

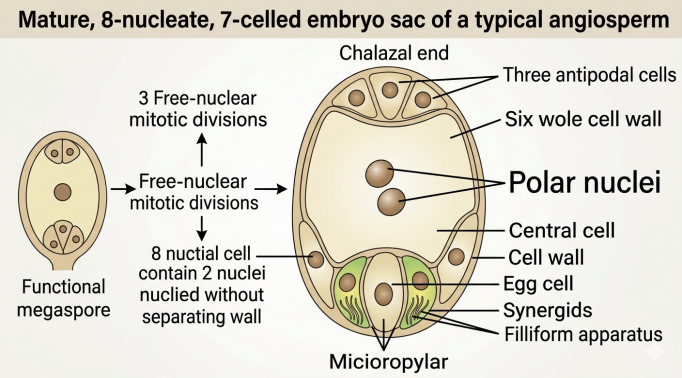
(D) 60%

Detailed Solutions

Q1.

Solution

Concept: The development of the female gametophyte (embryo sac) in angiosperms involves a specific pattern of nuclear division followed by organized cellular distribution.



Solution: 1. **Developmental Process:** A single functional megaspore undergoes three successive mitotic nuclear divisions to produce an 8-nucleate stage. These divisions are free-nuclear, meaning cell walls are not laid down immediately.

2. **Cellular Partitioning:** After the 8-nucleate stage, cytokinesis occurs. Six of the eight nuclei are organized into distinct cells: three at the chalazal end (Antipodal cells) and three at the micropylar end (the Egg apparatus consisting of two synergids and one egg cell).

3. **The Central Cell:** The remaining two nuclei, termed **Polar Nuclei**, do not develop individual cell walls. Instead, they migrate to the center of the embryo sac and remain within the large **Central Cell**.

4. **Logical Conclusion:** Because the central cell contains two nuclei while the other six cells contain one each, the mature embryo sac is described as being **7-celled** yet **8-nucleate**.

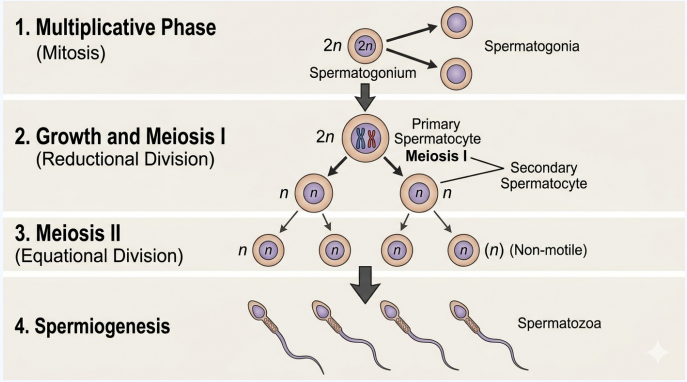
Final Answer: Polar nuclei are situated in the large central cell

Answer: (B)

Q2.

Solution

Concept: Spermatogenesis is the physiological process by which haploid spermatozoa develop from germ cells in the seminiferous tubules of the testes.



Solution: 1. **Multiplication Phase:** The process initiates at puberty with the **Spermatogonia** ($2n$), which are the diploid stem cells present on the inner wall of the seminiferous tubules. They multiply through mitosis to maintain their population.

2. **Growth and Meiosis I:** Some spermatogonia differentiate into **Primary Spermatocytes** ($2n$). These undergo the first meiotic division (reductional division) to produce two equal haploid **Secondary Spermatocytes** (n).

3. **Meiosis II:** The secondary spermatocytes undergo the second meiotic division (equational division) to result in the formation of four haploid **Spermatids** (n).

4. **Spermiogenesis:** These non-motile spermatids undergo structural changes and elongation to transform into mature, motile **Spermatozoa** (sperm cells). Thus, the sequence is: Spermatogonia → Spermatocyte → Spermatid → Spermatozoa.

Final Answer: Spermatogonia → Spermatocyte → Spermatid → Spermatozoa

Answer: (A)

Q3.

Solution

Concept: Distinguishing between Reproductive Tract Infections (RTIs) and Sexually Transmitted Infections (STIs) is essential for understanding pathology and transmission risks.

Solution: 1. **Defining the Relationship:** While most STIs manifest as infections of the reproductive tract (RTIs), the two terms are not synonymous. Some RTIs are caused by non-sexual factors (like fungal candidiasis due to poor hygiene), making Statement I technically incorrect.

2. **Systemic STIs:** Certain STIs, most notably **HIV** and **Hepatitis-B**, are systemic infections. While they can be transmitted sexually, they primarily target the immune system and liver, respectively, rather than just the reproductive tract tissues.

3. **Alternative Transmission:** These specific infections are also classified as blood-borne pathogens. They are commonly transmitted through non-sexual routes such as sharing contaminated injection needles, blood transfusions, or from an infected mother to the fetus.

4. **Conclusion:** Statement I is an overgeneralization and incorrect, whereas Statement II is a scientifically accurate description of medical transmission routes.

Final Answer: Statement I is incorrect but Statement II is correct

Answer: (D)

Q4.

Solution

Concept: Genetic hemoglobinopathies are categorized based on whether the mutation affects the total amount of hemoglobin (Quantitative) or the structural shape (Qualitative).

Solution: 1. **Pathophysiology of Thalassemia:** Thalassemia is an autosomal recessive disorder caused by the mutation or deletion of genes controlling the synthesis of α or β globin chains.

2. **The Quantitative Defect:** The hallmark of this disease is a significantly reduced rate of synthesis of one of the globin chains. Because the body produces a lower "quantity" of these essential chains, the overall amount of functional hemoglobin is insufficient.

3. **Distinction from Qualitative Defects:** In disorders like Sickle Cell Anemia, the body produces a normal amount of globin, but the structure is faulty (qualitative). In Thalassemia, the structure of the chains made is normal, but there simply aren't enough of them.

4. **Medical Classification:** Therefore, Thalassemia is fundamentally classified as a **Quantitative erythrocyte defect**.

Final Answer: Quantitative erythrocyte defect

Answer: (B)

Q5.

Solution

Concept: Recombination frequency is a genetic tool used to determine the relative distance between genes on a chromosome, based on the probability of crossing over.

Solution: 1. **Linear Relationship:** T.H. Morgan and Alfred Sturtevant established that the physical distance between genes on a chromosome is directly proportional to the frequency of recombination between them.

2. **Mechanism of Crossing Over:** Crossing over occurs during Prophase I of meiosis. When genes are located far apart (high distance), the likelihood of a chromosomal break and exchange occurring specifically in the region between those two genes increases.

3. **Frequency Values:** As the distance increases, the recombination frequency rises. However, the maximum possible recombination frequency between any two loci is **50%**.

4. **Independent Assortment:** At a 50% frequency, the genes appear to assort independently, behaving as if they were located on separate chromosomes or very distant ends of the same chromosome. Thus, high distance leads to high recombination.

Final Answer: High (Maximum 50%)

Answer: (B)

Q6.

Solution

Concept: DNA replication is a highly coordinated enzymatic process. Because DNA polymerase cannot initiate a new strand, RNA primers are required, which must eventually be removed and replaced with DNA.

Solution: 1. **The Role of Primase:** During replication, the enzyme Primase synthesizes short RNA sequences called primers. These provide the necessary 3'-OH group for DNA Polymerase III to begin adding deoxyribonucleotides.

2. **The Problem of RNA in DNA:** Once the elongation of the DNA strand is complete, these RNA segments must be removed because they are not chemically compatible with the final DNA double helix and contain Uracil instead of Thymine.

3. **Enzymatic Removal (DNA Polymerase I):** In prokaryotes like *E. coli*, **DNA Polymerase I** (also known as Kornberg enzyme) possesses a unique 5' to 3' exonuclease activity. This allows it to physically "chew away" the RNA primer in front of it.

4. **Replacement and Gap Filling:** As it removes the RNA nucleotides, DNA Polymerase I simultaneously uses its polymerase activity to fill the resulting gap with the correct DNA nucleotides. The remaining nick is later sealed by DNA Ligase.

Final Answer: DNA Polymerase I

Answer: (B)

Q7.

Solution

Concept: The Lac Operon is a classic model for gene regulation in prokaryotes, functioning via an inducible system where the presence of a substrate switches on the metabolic machinery.
Solution: 1. **The Repressor Mechanism:** In the absence of lactose, the *i* gene (regulatory gene) constitutively synthesizes a repressor protein. This repressor binds to the **Operator** region, physically blocking RNA Polymerase from transcribing the structural genes.
2. **The Role of the Inducer:** When lactose (or allolactose) is present in the medium, it acts as an **Inducer**. It enters the cell and interacts directly with the repressor protein.
3. **Inactivation of Repressor:** The binding of the inducer causes a conformational change in the repressor protein, rendering it inactive. In this inactive state, the repressor can no longer bind to the operator.
4. **Transcription Initiation:** With the operator site now free, RNA polymerase can proceed from the promoter to transcribe the structural genes (z, y, a), leading to the production of enzymes required for lactose metabolism.
Final Answer: Repressor protein

Answer: (C)

Q8.

Solution

Concept: The genetic code is degenerate and nearly universal. Out of the 64 possible codons, three do not code for any amino acid and serve as molecular "periods" or stop signs.
Solution: 1. **Translation Termination:** During the process of protein synthesis (translation), the ribosome moves along the mRNA reading codons. Translation continues until the ribosome's A-site encounters a specific sequence known as a stop codon or nonsense codon.
2. **The Three Stop Codons:** There are three specific stop codons in the standard genetic code: **UAA** (Ochre), **UAG** (Amber), and **UGA** (Opal).
3. **Mechanism of Action:** These codons are not recognized by any tRNA molecules. Instead, they are recognized by protein factors called Release Factors. These factors catalyze the hydrolysis of the bond between the completed polypeptide chain and the last tRNA, releasing the protein.
4. **Option Analysis:** Among the given options, **UAG** is a definitive stop codon. AUG is the start codon (Methionine), while UGG codes for Tryptophan and GUG codes for Valine (or occasionally acts as an alternative start codon).
Final Answer: UAG

Answer: (C)

Q9.

Solution

Concept: Adaptive radiation is an evolutionary pattern where a single ancestral species diversifies into many different forms to adapt to various ecological niches.

Solution: 1. **The Core Definition:** Adaptive radiation is the process in which organisms diversify rapidly from an ancestral species into a multitude of new forms, particularly when a change in the environment makes new resources available or creates new challenges.

2. **Geographical Context:** This phenomenon typically starts from a single point and literally "radiates" to different areas of a specific geography or isolated environment, such as an archipelago.

3. **Classic Examples:** Charles Darwin's finches on the Galapagos Islands are the prime example. Starting from a single seed-eating finch ancestor, different species evolved with varying beak shapes to exploit different food sources (insects, cacti, large seeds).

4. **Contrast with Convergent Evolution:** Unlike convergent evolution (where unrelated species look similar), adaptive radiation involves related species becoming different. It is a form of divergent evolution driven by adaptation to different habitats.

Final Answer: Evolution of different species from a common ancestor in a given geographical area

Answer: (A)

Q10.

Solution

Concept: The Hardy-Weinberg Principle provides a mathematical baseline for studying allele and genotype frequencies in a non-evolving population.

Solution: 1. **The Algebraic Formula:** The principle is represented by the equation $p^2 + 2pq + q^2 = 1$, where p is the frequency of the dominant allele and q is the frequency of the recessive allele. Additionally, $p + q = 1$.

2. **Given Data:** The question states that the frequency of the dominant allele (p) is 0.6.

3. **Step 1: Find the Recessive Allele Frequency (q):** Since $p + q = 1$, we can calculate q as: $q = 1 - 0.6 = 0.4$.

4. **Step 2: Calculate the Heterozygote Frequency ($2pq$):** The frequency of heterozygotes in the population is represented by the term $2pq$. Substituting the values: $2 \times (0.6) \times (0.4) = 0.48$.

5. **Interpretation:** This means that 48% of the individuals in this population carry one dominant and one recessive allele for the trait in question.

Final Answer: 0.48

Answer: (C)

Q11.

Solution

Concept: Contraceptive methods are classified into various categories such as natural, barrier, Intrauterine Devices (IUDs), and oral pills based on their mode of action and composition.

Solution: 1. **Non-medicated IUDs:** These act by increasing the phagocytosis of sperms within the uterus. A classic example is the **Lippes Loop**. Thus, (a) matches with (2).

2. **Copper Releasing IUDs:** These release Cu ions which suppress sperm motility and the fertilizing capacity of sperms. **Multiload 375** and CuT belong to this category. Thus, (b) matches with (4).

3. **Non-hormonal Pills:** **Saheli** is a once-a-week, non-steroidal oral contraceptive pill developed by CDRI, Lucknow. It has high contraceptive value with very few side effects. Thus, (c) matches with (1).

4. **Hormone Releasing IUDs:** These make the uterus unsuitable for implantation and the cervix hostile to sperms. Examples include **LNG-20** and Progestasert. Thus, (d) matches with (3).

5. **Consolidation:** The final matching sequence based on the above scientific classification is a-2, b-4, c-1, d-3.

Final Answer: a-2, b-4, c-1, d-3

Answer: (A)

Q12.

Solution

Concept: Sewage treatment is a multi-step process. The primary stage is a mechanical process, whereas the secondary stage is a biological one involving microbial activity.

Solution: 1. **Mechanical Process:** Primary treatment essentially involves the physical removal of large and small particles from the sewage through filtration and sedimentation.

2. **Sequential Filtration:** Initially, floating debris is removed by sequential filtration through wire mesh screens of varying sizes.

3. **Sedimentation:** Following filtration, the grit (soil and small pebbles) is removed by sedimentation in a grit chamber.

4. **Primary Sludge:** All solids that settle down form the primary sludge, and the supernatant forms the primary effluent. No biological or microbial digestion occurs at this specific stage; that is reserved for secondary treatment.

Final Answer: Physical removal of large and small particles

Answer: (B)

Q13.

Solution

Concept: Biodiversity loss is not caused by a single factor but by a combination of major anthropogenic pressures, collectively known as the "Evil Quartet" in ecology.

Solution: 1. **Origin of the Term:** The "Evil Quartet" is a term used to describe the four major causes of accelerated rates of species extinction currently being observed globally.

2. **The Four Factors:** These include: (i) Habitat loss and fragmentation (the most important cause), (ii) Over-exploitation for commercial use, (iii) Alien species invasions (like Nile Perch or Lantana), and (iv) Co-extinctions (where the death of one species leads to the death of another).

3. **Impact:** These four factors together act as the primary drivers of the current sixth mass extinction episode caused by human activities.

Final Answer: Four major causes of biodiversity loss

Answer: (B)

Q14.

Solution

Concept: RNA interference (RNAi) is a biological process in which RNA molecules inhibit gene expression or translation by neutralizing targeted mRNA molecules.

Solution: 1. **Natural Defense:** RNAi is a method of cellular defense that takes place in all eukaryotic organisms. It involves the silencing of a specific mRNA.

2. **Trigger Molecule:** The process is triggered by the presence of a double-stranded RNA (**dsRNA**) molecule. This dsRNA can come from viral infections or transposons.

3. **Mechanism of Silencing:** The dsRNA is processed into small interfering RNAs (siRNAs). These siRNAs then bind to a complementary specific mRNA sequence in the cell.

4. **Result:** This binding leads to the degradation of the target mRNA, effectively preventing it from being translated into a protein. This technique is widely used in creating pest-resistant plants, such as those resistant to the nematode *Meloidegyne incognita*.

Final Answer: dsRNA

Answer: (B)

Q15.

Solution

Concept: DNA fingerprinting relies on polymorphism in repetitive DNA sequences. These sequences are categorized based on their base composition and length.

Solution: 1. **Repetitive DNA:** A large portion of the human genome consists of repetitive DNA. During density gradient centrifugation, these sequences separate as "satellite" peaks.

2. **VNTRs:** Variable Number of Tandem Repeats (VNTRs) are a specific type of repetitive DNA where a short nucleotide sequence is organized as a tandem repeat.

3. **Classification:** Satellite DNA is divided into microsatellites and minisatellites. VNTRs are specifically classified as **minisatellites**.

4. **Forensic Utility:** The size of VNTRs varies from 0.1 to 20 kb. The high degree of polymorphism (variation) in VNTRs among individuals makes them excellent markers for identification in forensic science.

Final Answer: Minisatellite

Answer: (B)

Q16.

Solution

Concept: Restriction endonucleases cut DNA at specific palindromic sequences. Depending on the enzyme's cleavage site, they produce either overhanging "sticky ends" or non-overhanging "blunt ends."

Solution: 1. **Cleavage Patterns:** Enzymes like EcoRI, HindIII, and BamHI cut the DNA strands at slightly different positions from the center of the palindrome, leaving single-stranded stretches called sticky ends.

2. **Blunt End Generation:** Certain enzymes, such as **SmaI** (from *Serratia marcescens*), cut exactly in the middle of their recognition sequence (5′-CCCGGG-3').

3. **Resulting Fragments:** This central cut results in fragments where both strands are of equal length at the terminus, with no unpaired bases. These are referred to as blunt or flush ends.

4. **Utility:** While sticky ends are often preferred for their ease of ligation due to base-pairing, blunt ends are useful for "universal" cloning where the vector and insert do not share matching overhangs.

Final Answer: SmaI

Answer: (C)

Q17.

Solution

Concept: The Polymerase Chain Reaction (PCR) involves three temperature-dependent steps: Denaturation, Annealing, and Extension. Each step requires a specific thermal environment for enzymatic and structural efficiency.

Solution: 1. **Denaturation (94°C):** The double-stranded DNA is heated to high temperatures to break the hydrogen bonds and separate the strands.

2. **Annealing ($\approx 50 - 60$°C):** In the second step, the temperature is lowered to allow two sets of primers to bind (anneal) to their complementary sequences on the template DNA strands. The standard optimized temperature for this is approximately **54°C**.

3. **Extension (72°C):** The temperature is raised slightly to the optimum for Taq polymerase, which adds nucleotides to the primers.

4. **Precision:** Maintaining the annealing temperature is critical; if it is too high, primers won't bind; if it is too low, non-specific binding occurs.

Final Answer: 54°C

Answer: (B)

Q18.

Solution

Concept: The production of genetically engineered insulin (Humulin) marked a significant advancement in biotechnology, solving issues related to supply and immunological compatibility.

Solution: 1. **Historical Context:** Previously, insulin for diabetic patients was extracted from the pancreas of slaughtered cattle and pigs. Some patients developed allergies or other types of reactions to the foreign protein.

2. **The Biotech Solution:** Eli Lilly, an American company, prepared DNA sequences corresponding to the A and B chains of human insulin and introduced them into plasmids of *E. coli* to produce insulin chains.

3. **Analysis of Assertion:** Humulin is indeed safer because it is chemically identical to human insulin and does not contain animal contaminants that cause immune responses.

4. **Analysis of Reason:** The reason correctly explains that since it is synthesized using recombinant DNA technology to match the human sequence, it avoids the immunological rejection seen with animal-derived versions.

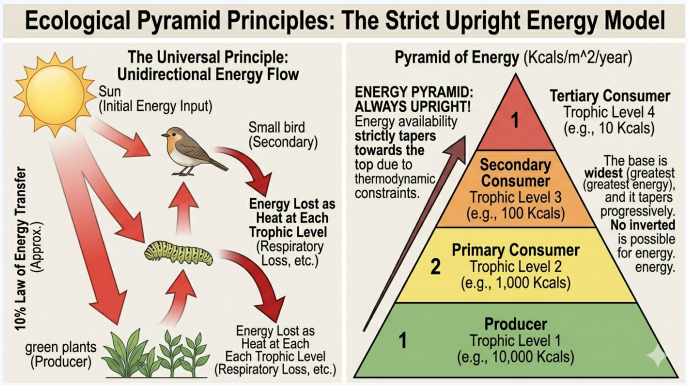
Final Answer: Both A and R are true and R is the correct explanation of A

Answer: (A)

Q19.

Solution

Concept: Ecological pyramids represent the relationship between different trophic levels. While pyramids of biomass or numbers can be inverted, the pyramid of energy remains strictly upright.



Solution: 1. **Energy Flow Direction:** Energy in an ecosystem flows unidirectionally from the sun to producers, then to primary, secondary, and tertiary consumers.

2. **The 10% Law:** According to Lindeman's law, only about 10% of the energy available at one trophic level is transferred to the next level. The rest is lost as heat during respiration and metabolic processes.

3. **Thermodynamic Constraints:** Because energy is continuously dissipated as heat at every transfer, the amount of energy available to a higher trophic level is always less than that of the level below it.

4. **Conclusion:** It is impossible for a higher trophic level to possess more energy than a lower one. Therefore, the base of the energy pyramid is always widest and it tapers toward the top, making it always upright.

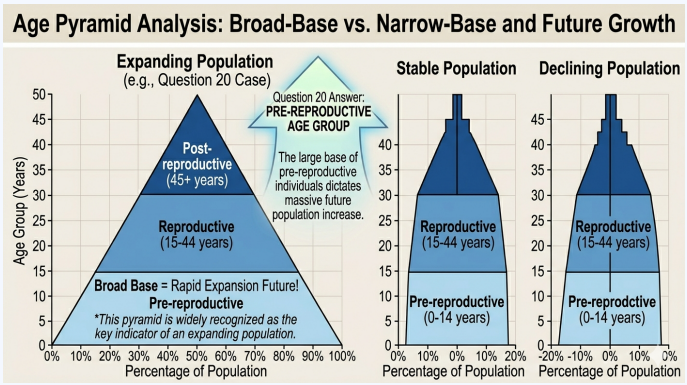
Final Answer: Energy is lost as heat at each trophic level

Answer: (A)

Q20.

Solution

Concept: Age pyramids are graphical representations of the distribution of various age groups in a population, which can be used to predict future growth trends.



Solution: 1. **Age Groups:** A population is typically divided into three age groups: Pre-reproductive (young), Reproductive (adults), and Post-reproductive (elderly).
2. **Broad Base Significance:** A broad base indicates a very high proportion of individuals in the **Pre-reproductive** age group.
3. **Growth Prediction:** As these individuals grow and enter the reproductive phase, they will produce a high number of offspring, leading to a rapid increase in the total population size.
4. **Population Status:** A pyramid with a broad base and a tapering top (triangular shape) represents an **Expanding** or growing population, characteristic of many developing nations.
Final Answer: An expanding population

Answer: (C)

Q21.

Solution

Concept: Incomplete dominance occurs when the dominant allele does not completely mask the effects of a recessive allele, resulting in a physical appearance that is a blend of both.

Solution: 1. **Mendelian Expectation:** According to Mendel's Law of Dominance, a cross between a homozygous red (RR) and homozygous white (rr) flower should produce all red flowers (Rr) in the F_1 generation.

2. **The Observation:** In *Mirabilis jalapa* (Four o'clock plant), the F_1 hybrid (Rr) resulting from such a cross is pink. This indicates that the R allele for red color is not completely dominant over the r allele for white color.

3. **Phenotypic Ratio:** When the F_1 pink flowers are self-pollinated, the F_2 generation shows a phenotypic ratio of 1 Red : 2 Pink : 1 White.

4. **Significance:** In this case, both the genotypic and phenotypic ratios are identical (1 : 2 : 1), which is a characteristic feature of **Incomplete Dominance**, distinguishing it from typical Mendelian dominance (3 : 1).

Final Answer: Incomplete dominance

Answer: (B)

Q22.

Solution

Concept: A transcription unit is a stretch of DNA that is transcribed into an RNA molecule. It is defined by specific regulatory and coding sequences that ensure the process starts and stops correctly.

Solution: 1. **The Promoter:** This is a DNA sequence located towards the 5' end (upstream) of the structural gene. It provides the binding site for RNA polymerase and determines which strand will serve as the template.

2. **The Structural Gene:** This is the actual region of DNA that is being transcribed into RNA. In eukaryotes, this may be monocistronic, while in prokaryotes, it is often polycistronic.

3. **The Terminator:** Located towards the 3' end (downstream) of the coding strand, this sequence defines the end of the transcription process and triggers the release of the nascent RNA strand.

4. **Logical Components:** While introns and exons are parts of the structural gene in eukaryotes, the primary defining boundaries of any transcription unit across all organisms are the **Promoter, Structural gene, and Terminator**.

Final Answer: Promoter, Structural gene, and Terminator

Answer: (A)

Q23.

Solution

Concept: Secondary sewage treatment is a biological process that utilizes aerobic microbes to reduce the organic load of waste water.

Solution: 1. **Aeration Tank:** The primary effluent is passed into large aeration tanks where it is constantly agitated, allowing vigorous growth of aerobic microbes into "flocs" (masses of bacteria associated with fungal filaments).

2. **BOD Reduction:** These microbes consume the major part of the organic matter in the effluent, significantly reducing the Biochemical Oxygen Demand (BOD).

3. **Settling Tank:** Once the BOD is reduced, the effluent is passed into a settling tank where the bacterial flocs are allowed to sediment.

4. **Activated Sludge:** This sedimented mass of bacterial flocs is called **Activated Sludge**. A small part of it is pumped back into the aeration tank to serve as inoculum, while the rest is pumped into anaerobic sludge digesters.

Final Answer: Settled bacterial flocs in the secondary settling tank

Answer: (A)

Q24.

Solution

Concept: Conservation strategies are divided into *In-situ* (on-site) and *Ex-situ* (off-site) based on whether the species is protected within its natural habitat or outside it.

Solution: 1. **In-situ Conservation:** This involves protecting the entire ecosystem so that the species is conserved in its natural home. Examples include National Parks, Wildlife Sanctuaries, and Sacred Groves.

2. **Ex-situ Conservation:** This approach involves taking threatened animals and plants out of their natural habitats and placing them in special settings where they can be protected and given special care.

3. **Seed Banks:** **Seed Banks** are classic examples of *Ex-situ* conservation. Large numbers of seeds are stored at very low temperatures (cryopreservation) to maintain their viability for long periods outside their natural environment.

4. **Comparison:** While a National Park protects the whole forest, a Seed Bank or a Zoological Park focuses specifically on the genetic material or individuals in a controlled, artificial setting.

Final Answer: Seed Bank

Answer: (C)

Q25.

Solution

Concept: Translation requires the activation of amino acids and their attachment to specific tRNA molecules, a process that ensures the correct amino acid is brought to the ribosome.

Solution: 1. **Energy Requirement:** Translation is an energy-expensive process. Before an amino acid can be incorporated into a polypeptide chain, it must be "activated" using ATP.

2. **The Enzyme:** This process is catalyzed by the enzyme aminoacyl-tRNA synthetase. There is a specific enzyme for each amino acid.

3. **Charging of tRNA:** The activated amino acid is then linked to its cognate tRNA. This specific process of adding an amino acid to a tRNA is called **Aminoacylation** or "charging" of the tRNA.

4. **Role in Protein Synthesis:** If two such "charged" tRNAs are brought close together on the ribosome, the formation of a peptide bond between the amino acids is energetically favored.

Final Answer: Aminoacylation

Answer: (C)

Q26.

Solution

Concept: Human evolution is characterized by a progressive increase in cranial capacity, the development of bipedal locomotion, and the sophisticated use of tools and fire.

Solution: 1. **Australopithecus:** These lived in East African grasslands about 3-4 million years ago. They were essentially "ape-men" who walked upright but had a small brain capacity (around 450–600 cc).

2. **Homo habilis:** This was the first "human-like" hominid (the "handy man"). They lived about 2 million years ago and had a brain capacity between 650–800 cc. They were the first known to make structured tools.

3. **Homo erectus:** Appearing about 1.5 million years ago, they had a much larger brain (900 cc) and are famous for the migration out of Africa and the discovery/use of fire.

4. **Homo sapiens:** Modern humans evolved in Africa and moved across continents during the Ice Age between 75,000 and 10,000 years ago.

5. **Chronology:** Based on the fossil record, the correct sequence from the earliest to most recent ancestors is Australopithecus → Homo habilis → Homo erectus → Homo sapiens.

Final Answer: Australopithecus → Homo sapiens → Homo erectus (Corrected sequence: Australopithecus → Homo habilis → Homo erectus → Homo sapiens)

Answer: (A)

Q27.

Solution

Concept: Population interactions describe how two different species living in the same community influence each other's survival and reproduction.

Solution: 1. **Mutualism (+/+):** Both species benefit. A classic example is **Lichen**, where a fungus and an alga/cyanobacterium live together in a mutually beneficial relationship. Thus, (a) matches with (4).

2. **Commensalism (+/0):** One species benefits while the other is neither helped nor harmed. An **Orchid growing as an epiphyte on a Mango branch** benefits from the height and support, while the Mango tree is unaffected. Thus, (b) matches with (3).

3. **Parasitism (+/-):** One species (parasite) benefits at the expense of the other (host). A **Tick feeding on a Dog** is a clear example of ectoparasitism. Thus, (c) matches with (2).

4. **Amensalism (-/0):** One species is harmed or inhibited while the other is unaffected. **Penicillium** (fungus) produces chemicals that kill **Bacteria**, but the fungus itself does not gain a direct nutritional benefit from the death of the bacteria. Thus, (d) matches with (1).

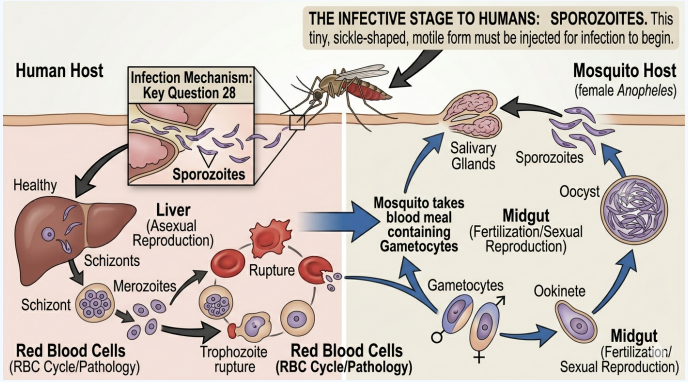
Final Answer: a-4, b-3, c-2, d-1

Answer: (A)

Q28.

Solution

Concept: The life cycle of *Plasmodium* (the malaria parasite) is digenetic, requiring two hosts: the female *Anopheles* mosquito and humans.



Solution: 1. **Infection Mechanism:** When an infected female *Anopheles* mosquito bites a human, it injects the parasite into the bloodstream along with its saliva.

2. **The Infective Stage:** The specific form of the parasite that is transmitted to humans is the **Sporozoite**. These are tiny, sickle-shaped, motile forms.

3. **Liver Phase:** Once inside the human body, the sporozoites travel through the blood directly to the liver, where they multiply asexually (schizogony) before attacking red blood cells.

4. **Other Stages:** Trophozoites and Merozoites are stages found within the human host's blood cells, while Gametocytes are the stages that the mosquito picks up during a blood meal to continue the cycle.

Final Answer: Sporozoite

Answer: (B)

Q29.

Solution

Concept: Recombinant DNA technology relies on "molecular glue" to join DNA fragments together by reforming the sugar-phosphate backbone.

Solution: 1. **DNA Fragmentation:** Restriction enzymes (molecular scissors) are used to cut DNA at specific sites, often leaving single-stranded overhanging "sticky ends."

2. **Ligation Requirement:** For these sticky ends to be permanently joined, the phosphodiester bonds between the sugar and phosphate groups of the DNA backbone must be restored.

3. **The Enzyme:** The enzyme **DNA Ligase** catalyzes the formation of this covalent bond. It "links" or "ligates" the two DNA segments, provided they have complementary base pairs at their ends.

4. **Utility:** This enzyme is essential in gene cloning to insert a foreign gene into a plasmid vector, creating a single, continuous recombinant DNA molecule.

Final Answer: DNA Ligase

Answer: (B)

Q30.

Solution

Concept: Chromosomal disorders result from the gain or loss of one or more chromosomes (aneuploidy) due to the failure of chromatid segregation during cell division.

Solution: 1. **Etiology:** Down's Syndrome is caused by the presence of an additional copy of chromosome number 21. This condition is known as **trisomy of 21**.

2. **Chromosomal Count:** A normal human has 46 chromosomes. An individual with Down's syndrome has 47 chromosomes (45 + XX or 45 + XY).

3. **Clinical Features:** It was first described by Langdon Down in 1866. Affected individuals typically show short stature, a small round head, a furrowed tongue, and partially open mouth, along with physical and mental retardation.

4. **Analysis of Options:** It is not a Mendelian disorder (those are caused by single-gene mutations). It occurs in both males and females. 47, XXY refers to Klinefelter's Syndrome, not Down's. Thus, the statement regarding trisomy of 21 is the only correct one.

Final Answer: It is caused by the trisomy of chromosome 21

Answer: (A)

Q31.

Solution

Concept: Sickle Cell Anemia is a classic example of a point mutation where a single base change in the DNA results in a specific amino acid substitution in the protein product.

Solution: 1. **The Molecular Defect:** This genetic disorder is caused by a substitution of a single nitrogenous base (Adenine to Thymine) in the sixth codon of the β-globin gene (GAG to GUG).

2. **The Amino Acid Change:** In the normal β-globin chain, the sixth amino acid is **Glutamic acid**. Due to the mutation, it is replaced by **Valine**.

3. **Physiological Impact:** Under low oxygen tension, this substitution causes the mutant hemoglobin molecule to undergo polymerization. This changes the shape of the Red Blood Cell (RBC) from a flexible biconcave disc to a rigid, sickle-like structure.

4. **Consequences:** These sickle-shaped cells can clog small blood vessels and have a significantly shorter lifespan, leading to chronic anemia and tissue damage.

Final Answer: Glutamic acid by Valine

Answer: (A)

Q32.

Solution

Concept: Assisted Reproductive Technologies (ART) include various specialized techniques used to assist couples who are unable to conceive naturally.

Solution: 1. **Defining GIFT:** Gamete Intra-Fallopian Transfer (GIFT) involves the collection of an ovum (egg) from a donor and its transfer into the Fallopian tube of another female.

2. **The Clinical Indication:** This specific method is employed for females who **cannot produce an ovum** of their own but can provide a suitable and healthy environment for fertilization and the subsequent development of the embryo within the uterus.

3. **The Process:** Unlike IVF (where fertilization happens in a lab), in GIFT, the egg and sperm are placed directly into the Fallopian tube so that fertilization occurs naturally inside the woman's body (In-vivo).

4. **Comparison:** If the issue were blocked Fallopian tubes, a different technique like ZIFT (Zygote Intra-Fallopian Transfer) or IVF-ET would be required, as fertilization would need to happen outside the tube.

Final Answer: Who cannot produce an ovum

Answer: (A)

Q33.

Solution

Concept: Many drugs of abuse are derived from plants. Opioids are a class of drugs that bind to specific opioid receptors in our central nervous system and gastrointestinal tract.

Solution: 1. **Source of Heroin:** "Smack" is the common name for Heroin, which is chemically diacetylmorphine. It is a white, odorless, bitter crystalline compound.

2. **The Plant Origin:** Heroin is synthesized by the acetylation of morphine, which is extracted from the **Latex** of the poppy plant, *Papaver somniferum*.

3. **Extraction Process:** The unripe seed pods of the poppy are scored, and the milky white sap (latex) that oozes out is collected and processed to obtain opium, from which morphine and heroin are derived.

4. **Effect on Body:** Heroin acts as a depressant and slows down body functions, making it a highly addictive and dangerous substance.

Final Answer: Latex

Answer: (B)

Q34.

Solution

Concept: Primary productivity refers to the rate at which solar energy is captured by producers and converted into organic matter (biomass) through photosynthesis.

Solution: 1. **Definition of Rate:** Since productivity is a measure of "production over time," it must be expressed as a rate rather than just a total amount.

2. **Units of Measurement:** It can be expressed in terms of energy (kcal/m^2/yr) or in terms of dry weight (biomass).

3. **Standard Unit:** When measuring the accumulation of biomass per unit area over a year, the standard unit used is **g/m^2/yr** (grams per square meter per year).

4. **Variable Factors:** Primary productivity varies in different ecosystems depending on the plant species, environmental factors (light, temperature), and availability of nutrients.

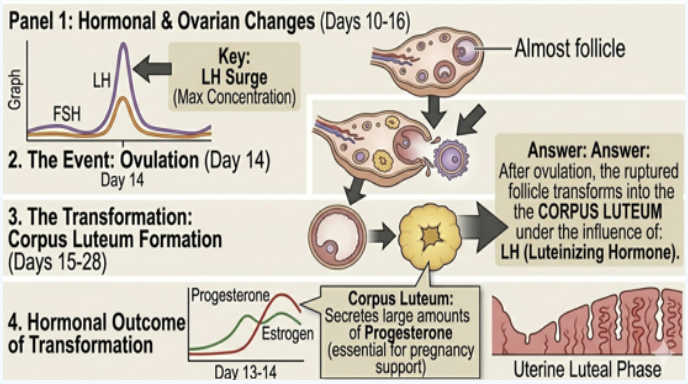
Final Answer: g/m^2/yr

Answer: (B)

Q35.

Solution

Concept: The menstrual cycle is regulated by a complex interplay of pituitary hormones (FSH and LH) and ovarian hormones (Estrogen and Progesterone).



Solution: 1. **Follicular Phase:** FSH stimulates the growth of ovarian follicles. As they grow, they secrete estrogen.

2. **The LH Surge:** Around the middle of the cycle (day 14), both LH and FSH attain a peak level. The rapid secretion of LH leading to its maximum concentration is called the **LH Surge**.

3. **Ovulation and Beyond:** This LH surge induces the rupture of the Graafian follicle and the release of the ovum (ovulation).

4. **Corpus Luteum Formation:** Following ovulation, the remaining parts of the ruptured Graafian follicle transform into a yellow glandular body called the **Corpus Luteum**, primarily under the continued influence of **LH (Luteinizing Hormone)**. The corpus luteum then begins secreting large amounts of progesterone.

Final Answer: LH (Luteinizing Hormone)

Answer: (C)

Q36.

Solution

Concept: Recombinants are offspring that exhibit combinations of traits different from either of the parents, resulting from the independent assortment of genes or crossing over.

Solution: 1. **The Cross:** A dihybrid cross between $RrYy \times RrYy$ (Round Yellow seeds) follows Mendel's Law of Independent Assortment.

2. **The Punnett Square:** This cross produces a total of 16 possible zygotic combinations in a 9 : 3 : 3 : 1 phenotypic ratio. - 9 Round Yellow (Parental) - 3 Round Green (Recombinant) - 3 Wrinkled Yellow (Recombinant) - 1 Wrinkled Green (Parental)

3. **Identifying Recombinants:** The parental phenotypes are Round Yellow and Wrinkled Green. Any phenotype other than these two is a recombinant. In this case, Round Green (3) and Wrinkled Yellow (3) are the recombinants.

4. **Calculation:** The total number of recombinant individuals is 3 + 3 = 6. Therefore, the probability or proportion of obtaining a recombinant phenotype is 6 out of 16.

Final Answer: 6/16

Answer: (C)

Q37.

Solution

Concept: Nature has provided sophisticated "genetic engineers" in the form of certain bacteria that can naturally transfer DNA into plant cells to modify their physiology.

Solution: 1. **The Pathogen:** *Agrobacterium tumefaciens* is a soil-dwelling bacterium that causes "Crown Gall" disease in several dicot plants by delivering a specific piece of DNA into the plant cell.

2. **The Ti Plasmid:** This bacterium contains a large plasmid called the **Ti (Tumor inducing) plasmid**. A specific segment of this plasmid, known as **T-DNA** (Transfer DNA), is integrated into the plant genome.

3. **Biotech Utility:** Scientists have "disarmed" this plasmid by removing the genes that cause tumors while keeping the machinery that transfers DNA. This makes it an excellent vector for delivering desirable genes into host plants.

4. **Transformation:** The T-DNA is the specific region that is engineered to carry the gene of interest, which is then automatically carried into the plant's chromosomal DNA during infection.

Final Answer: *Agrobacterium tumefaciens*

Answer: (A)

Q38.

Solution

Concept: The initiation of transcription requires a specific interaction between the RNA polymerase enzyme and the DNA template at a designated regulatory site.

Solution: 1. **Transcription Unit:** A transcription unit in DNA is defined by three regions: a Promoter, a Structural gene, and a Terminator.

2. **The Promoter Site:** The **Promoter** is a specific DNA sequence located upstream (towards the 5' end of the coding strand) of the structural gene.

3. **Enzyme Interaction:** This region serves as the binding site for **RNA polymerase**. The specific sequence of the promoter determines the strength of the binding and the frequency of transcription.

4. **Orientation:** By binding to the promoter, the enzyme also "decides" which of the two DNA strands will act as the template (3' $\rightarrow$ 5') and where exactly the synthesis of RNA should begin.

Final Answer: Promoter

Answer: (C)

Q39.

Solution

Concept: Double fertilization is a unique and characteristic feature of angiosperms (flowering plants) involving two distinct fusion events within the embryo sac.

Solution: 1. **Entry of Gametes:** The pollen tube releases two male gametes into the cytoplasm of a synergid. These gametes then move towards different targets.

2. **Syngamy:** One male gamete (n) moves towards the egg cell (n) and fuses with its nucleus. This fusion is called syngamy and results in the formation of a diploid zygote ($2n$), which eventually develops into the embryo.

3. **Triple Fusion:** The second male gamete (n) moves towards the two polar nuclei ($n + n$) located in the central cell and fuses with them. This produces a triploid Primary Endosperm Nucleus (PEN, $3n$). Because three haploid nuclei are involved, it is called triple fusion.

4. **Defining the Term:** Since two types of fusions—Syngamy and Triple Fusion—take place in an embryo sac, the phenomenon is termed **Double Fertilization**.

Final Answer: Syngamy and Triple Fusion

Answer: (A)

Q40.

Solution

Concept: Biofertilizers are organisms that enrich the nutrient quality of the soil, providing a sustainable and eco-friendly alternative to chemical fertilizers.

Solution: 1. **Types of Biofertilizers:** The main sources of biofertilizers are bacteria, fungi, and cyanobacteria. They function by fixing atmospheric nitrogen or solubilizing phosphorus.

2. **Cyanobacteria:** These are autotrophic microbes widely distributed in aquatic and terrestrial environments. Many of them, such as *Anabaena*, *Nostoc*, and ***Oscillatoria***, can fix atmospheric nitrogen.

3. **Utility in Paddy Fields:** In rice (paddy) fields, cyanobacteria serve as an important biofertilizer, adding organic matter to the soil and increasing fertility significantly.

4. **Analysis of Other Options:** *Trichoderma* is a biocontrol agent (fungus) against plant pathogens; *Bacillus thuringiensis* is a biopesticide; and the Ladybird is a predatory insect used to control aphids.

Final Answer: *Oscillatoria*

Answer: (A)

Q41.

Solution

Concept: The transition from ape-like ancestors to modern humans involved several intermediate forms, with the earliest members of the genus *Homo* showing significant behavioral and structural shifts.

Solution: 1. **The First Hominid:** While *Australopithecus* showed bipedal features, ***Homo habilis*** is considered the first "human-like" hominid. The name itself means "handy man," referring to their ability to create and use primitive stone tools.

2. **Cranial Capacity:** They possessed a brain capacity ranging between 650–800 cc, which is significantly higher than that of the earlier *Australopithecines* but lower than *Homo erectus*.

3. **Dietary Habits:** Based on fossil evidence and dental structure, it is believed that *Homo habilis* probably did not eat meat, distinguishing them from later predatory hominids.

4. **Chronology:** They lived in East Africa approximately 2 million years ago. Their fossils provided the first clear evidence of a hominid that possessed enough human characteristics to be classified under our own genus, *Homo*.

Final Answer: *Homo habilis*

Answer: (A)

Q42.

Solution

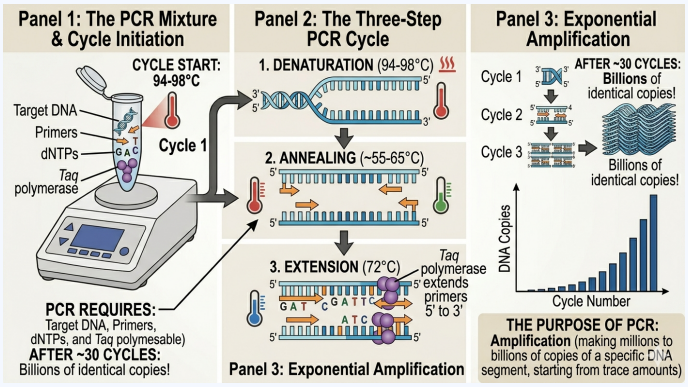
Concept: The DNA molecule is a polymer of nucleotides. Each nucleotide is formed through specific chemical linkages between a nitrogenous base, a pentose sugar, and a phosphate group.
Solution: 1. **Nucleoside Formation:** A nitrogenous base (Purine or Pyrimidine) is linked to the 1′ carbon atom of the pentose sugar (deoxyribose in DNA). This linkage is a covalent bond called an **N-glycosidic bond**.
2. **Nucleotide Formation:** When a phosphate group is linked to the 5′-OH of this nucleoside through a phosphoester linkage, a corresponding nucleotide is formed.
3. **Polynucleotide Chain:** Successive nucleotides are joined together by 3′–5′ phosphodiester bonds to form the backbone of the DNA strand.
4. **Base Pairing:** Hydrogen bonds are responsible for holding the two strands together by connecting complementary nitrogenous bases across the helix, but the internal connection within a single nucleotide between the base and sugar is the N-glycosidic bond.
Final Answer: N-glycosidic bond

Answer: (B)

Q43.

Solution

Concept: Amplification of DNA is necessary when the available sample is too small for analysis. Biotechnology provides a method to create billions of copies of a specific DNA segment in a very short time.



Solution: 1. **The Technique:** **PCR (Polymerase Chain Reaction)** is an *in-vitro* technique used to generate multiple copies (amplify) of a specific region of DNA.

2. **The Components:** The process requires the target DNA, two sets of primers (small chemically synthesized oligonucleotides), and a thermostable enzyme called Taq polymerase.

3. **The Cycle:** Each cycle consists of three steps: Denaturation, Annealing, and Extension. By repeating these cycles (usually 30 times), the DNA segment can be amplified approximately a billion times.

4. **Utility:** This technique is used extensively in DNA fingerprinting, diagnosing genetic disorders, detecting pathogens (like HIV or Coronavirus), and in forensic investigations where only a trace amount of DNA is found.

Final Answer: PCR

Answer: (B)

Q44.

Solution

Concept: Biochemical Oxygen Demand (BOD) is a critical parameter used to measure the level of organic pollution in water bodies and the effectiveness of sewage treatment.

Solution: 1. **Definition of BOD:** BOD refers to the amount of oxygen that would be consumed if all the organic matter in one liter of water were oxidized by bacteria.

2. **Relationship with Pollution:** The more organic matter (sewage or waste) present in the water, the more oxygen the aerobic microbes will require to decompose it. Therefore, a **high BOD** value directly indicates **high organic pollution**.

3. **Effect on Aquatic Life:** When BOD is high, the Dissolved Oxygen (DO) in the water decreases rapidly, which can lead to the suffocation and death of fish and other aquatic organisms.

4. **Treatment Indicator:** In sewage treatment plants, the treatment is continued until the BOD of the effluent is significantly reduced, indicating that the water is safe enough to be released into natural water bodies.

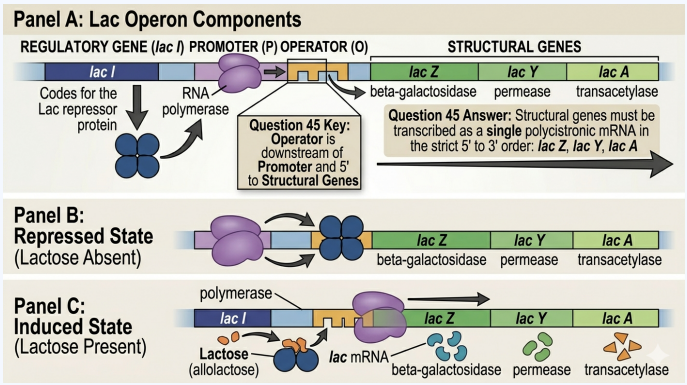
Final Answer: High organic pollution

Answer: (B)

Q45.

Solution

Concept: The Lac Operon consists of regulatory genes and a cluster of structural genes that code for the enzymes required for the transport and metabolism of lactose in *E. coli*.



Solution: 1. **Structural Genes:** The lac operon contains three structural genes that are transcribed as a single polycistronic mRNA.

2. **The z gene:** This gene codes for **beta-galactosidase**, which is primarily responsible for the hydrolysis of the disaccharide lactose into its monomeric units, galactose and glucose.

3. **The y gene:** This gene codes for **permease**, which increases the permeability of the cell to beta-galactosides (lactose).

4. **The a gene:** This gene encodes a **transacetylase**, which assists in the metabolic process.

5. **Linear Arrangement:** On the DNA strand, these genes are arranged in the specific order of **lac z, lac y, and lac a**. The *i* gene, promoter, and operator are regulatory elements located upstream of this sequence.

Final Answer: lac z, lac y, lac a

Answer: (B)

Q46.

Solution

Concept: Passive immunity can be naturally acquired when antibodies are transferred from a mother to her offspring, providing immediate protection during the early stages of life.

Solution: 1. **The Nature of Colostrum:** The yellowish fluid secreted by the mother during the initial days of lactation is called colostrum. It is highly nutritious and contains essential protective factors.

2. **Antibody Content:** Colostrum is specifically rich in **IgA** (Immunoglobulin A) antibodies. These antibodies are dimeric in nature and are specialized for protecting mucosal surfaces.

3. **Mechanism of Protection:** These antibodies are absorbed by the infant's digestive tract and provide localized immunity against pathogens that might enter through the respiratory or gastrointestinal systems.

4. **Significance:** This transfer of IgA is crucial for the newborn, whose own immune system is not yet fully developed. It is a classic example of naturally acquired passive immunity.

Final Answer: IgA

Answer: (C)

Q47.

Solution

Concept: *Bacillus thuringiensis* (Bt) produces specific protein crystals during a particular phase of its growth that contain insecticidal proteins used in genetic engineering.

Solution: 1. **The Protoxin:** The bacteria synthesize "cry" proteins (crystal proteins). These exist as inactive protoxins in the bacterial cell and do not harm the bacteria themselves.

2. **Activation:** When an insect ingests these crystals, the alkaline pH of its midgut solubilizes the crystals, converting the protoxin into an active form.

3. **Mode of Action:** The activated toxin binds to the surface of midgut epithelial cells, creating pores. This causes cell swelling and lysis, eventually leading to the death of the insect.

4. **Specificity:** Different cry genes code for toxins specific to different groups of insects. For example, the proteins encoded by genes *cryIAc* and *cryIIAb* are specifically effective against **Bollworms**, which are major pests of cotton crops.

Final Answer: Bollworms

Answer: (B)

Q48.

Solution

Concept: Nonsense codons are specific triplets in the genetic code that do not specify any amino acid and act as signals to stop the process of translation.

Solution: 1. **The Genetic Code:** There are 64 codons in the genetic code. 61 codons (sense codons) specify 20 different amino acids, while 3 codons (nonsense codons) serve as termination signals.

2. **Identification:** The three nonsense or stop codons are: - **UAA** (Ochre) - **UAG** (Amber) - **UGA** (Opal)

3. **Function:** During translation, when the ribosome encounters one of these three codons in the A-site, no aminoacyl-tRNA can bind. This triggers the binding of release factors and the termination of the polypeptide chain.

4. **Analysis:** Among the given options, **UAA** is one of the three universal stop codons. UUU codes for Phenylalanine, GGG for Glycine, and CCC for Proline.

Final Answer: UAA

Answer: (C)

Q49.

Solution

Concept: Sacred Groves represent a traditional and cultural form of *in-situ* biodiversity conservation where forest patches are protected by local communities due to religious beliefs.

Solution: 1. **Definition:** Sacred groves are tracts of forest that are set aside and all the trees and wildlife within them are venerated and given total protection by local communities.

2. **Ecological Role:** In many regions, these groves represent the last remaining patches of "climax" vegetation or pristine forest that have been undisturbed for centuries.

3. **Biodiversity Refuge:** Because they are protected from human interference (like logging or hunting), they serve as vital refuges for **rare, endemic, and threatened species** of plants and animals that might have disappeared from the surrounding landscape.

4. **Examples:** Notable examples in India include the Khasi and Jaintia Hills in Meghalaya, the Aravalli Hills of Rajasthan, and the Western Ghat regions of Karnataka and Maharashtra.

Final Answer: Conserving rare and threatened species

Answer: (C)

Q50.

Solution

Concept: Erwin Chargaff's rules state that in a double-stranded DNA molecule, the ratio of purines to pyrimidines is constant and the amount of certain bases is always equal to their pairing partners.

Solution: 1. **Chargaff's Rule 1 (Base Pairing):** In any double-stranded DNA, the amount of Adenine (A) is equal to Thymine (T), and the amount of Guanine (G) is equal to Cytosine (C). Mathematically: $[A] = [T]$ and $[G] = [C]$.

2. **Given Data:** The DNA molecule contains 20% Cytosine.

3. **Calculating Guanine:** According to the rule, if $C = 20\%$, then **Guanine (G)** must also be **20%**.

4. **Calculating A + T:** The total percentage of all four bases must be 100%. $A+T+G+C = 100\%$ $A + T + 20\% + 20\% = 100\%$ $A + T = 60\%$

5. **Calculating Adenine:** Since Adenine must equal Thymine ($A = T$), we divide the remaining 60% by 2: $A = 60\%/2 = 30\%$.

Final Answer: 30%

Answer: (B)

Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	B	2	A	3	D	4	B	5	B
6	B	7	C	8	C	9	A	10	C
11	A	12	B	13	B	14	B	15	B
16	C	17	B	18	A	19	A	20	C
21	B	22	A	23	A	24	C	25	C
26	A	27	A	28	B	29	B	30	A
31	A	32	A	33	B	34	B	35	C
36	C	37	A	38	C	39	A	40	A
41	A	42	B	43	B	44	B	45	B
46	C	47	B	48	C	49	C	50	B