CUET UG Biology Sample Paper - 5

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. If the sequence of the coding strand in a transcription unit is 5'-ATGCATGC-3', what will be the sequence of the mRNA?

(A) 5'-AUGCAUGC-3'

(B) 5'-UACGUACG-3'

(C) 3'-AUGCAUGC-5'

(D) 5'-TACGTACG-3'

Q2. In an embryo sac of a typical angiosperm, the "Filiform apparatus" is responsible for:

(A) Guiding the entry of pollen tube into the synergid.

(B) Recognizing the compatible pollen on the stigma.

(C) Stimulating the division of the generative cell.

(D) Protecting the egg cell from mechanical shock.

Q3. Which of the following depicts the correct pathway of transport of sperms?

(A) Rete testis -> Efferent ductules -> Epididymis -> Vas deferens

(B) Rete testis -> Epididymis -> Efferent ductules -> Vas deferens

(C) Rete testis -> Vas deferens -> Efferent ductules -> Epididymis

(D) Efferent ductules -> Rete testis -> Vas deferens -> Epididymis

Q4. Which of the following is a non-medicated IUD?

(A) Lippes loop

(B) Multiload 375

(C) LNG-20

(D) Progestasert

Q5. According to the Hardy-Weinberg principle, if the frequency of a dominant allele 'A' is 0.6, what is the frequency of the homozygous recessive individuals (aa)?

(A) 0.36

(B) 0.48

(C) 0.16

(D) 0.4

Q6. The process of "RNA interference" (RNAi) has been used to make tobacco plants resistant to:

(A) Bacillus thuringiensis

(B) Meloidogyne incognita

(C) Agrobacterium tumefaciens

(D) Escherichia coli

Q7. Identify the correct sequence of steps in PCR:

(A) Extension, Denaturation, Annealing

(B) Annealing, Extension, Denaturation

(C) Denaturation, Annealing, Extension

(D) Denaturation, Extension, Annealing

Q8. In the Lac Operon, the 'i' gene codes for:

(A) Inducer

(B) Repressor

(C) β-galactosidase

(D) Permease

Q9. An example of "Commensalism" is:

(A) Orchid growing on a mango branch

(B) Cuscuta growing on a hedge plant

(C) Lichens

(D) Mycorrhizae

Q10. Which enzyme is known as the "Molecular Scissor" in Biotechnology?

(A) DNA Ligase

(B) Restriction Endonuclease

(C) DNA Polymerase

(D) Reverse Transcriptase

Q11. "The Evil Quartet" refers to four major causes of:

(A) Population explosion

(B) Biodiversity loss

(C) Global warming

(D) Air pollution

Q12. The "Stewardship of the atmosphere" or Montreal Protocol was signed to control:

(A) Greenhouse effect

(B) Ozone depletion

(C) Deforestation

(D) Soil erosion

Q13. DNA fingerprinting involves identifying differences in some specific regions in DNA sequence called as:

(A) Repetitive DNA

(B) Non-coding DNA

(C) Satellite DNA

(D) Both A and C

Q14. During the "Follicular Phase" of the menstrual cycle, the regeneration of the endometrium is primarily due to:

(A) Progesterone

(B) Estrogen

(C) LH surge

(D) FSH only

Q15. Identify the odd one out with respect to In-situ conservation:

(A) National Parks

(B) Biosphere Reserves

(C) Botanical Gardens

(D) Wildlife Sanctuaries

Q16. In DNA replication, the discontinuously synthesized fragments are later joined by:

(A) DNA Polymerase III

(B) DNA Ligase

(C) Primase

(D) Helicase

Q17. Bt toxin kills insects by:

(A) Creating pores in the midgut epithelial cells.

(B) Inhibiting protein synthesis.

(C) Damaging the nervous system.

(D) Preventing cell division.

Q18. Thalassemia and Sickle Cell Anemia are caused due to a problem in globin synthesis. Select the correct statement:

(A) Both are qualitative defects.

(B) Both are quantitative defects.

(C) Thalassemia is a quantitative problem, while Sickle Cell Anemia is a qualitative problem.

(D) Thalassemia is a qualitative problem, while Sickle Cell Anemia is a quantitative problem.

Q19. Match the following biocontrol agents with their target pests: (a) Ladybird (i) Aphids (b) Dragonflies (ii) Mosquitoes (c) Bacillus thuringiensis (iii) Butterfly caterpillars

(A) a-i, b-ii, c-iii

(B) a-ii, b-i, c-iii

(C) a-iii, b-ii, c-i

(D) a-i, b-iii, c-ii

Q20. "Humulin" is:

(A) Human Insulin produced by rDNA technology.

(B) A protein obtained from human milk.

(C) A digestive enzyme.

(D) A vaccine for Hepatitis B.

Q21. Which of the following statements is correct regarding the "Lac Operon" in E. coli?

(A) It is an inducible operon where lactose acts as a corepressor.

(B) The repressor protein binds to the operator region in the presence of inducer.

(C) The 'y' gene codes for transacetylase.

(D) Glucose or galactose cannot act as inducers for lac operon.

Q22. In a dihybrid cross ($RrYy \times RrYy$), what is the probability of obtaining offspring with the genotype $rryy$?

(A) $1/16$

(B) $3/16$

(C) $9/16$

(D) $1/4$

Q23. The "Explosion of Population" in India post-independence was primarily due to:

(A) Decrease in MMR and IMR.

(B) Increase in death rate.

(C) Decrease in the number of people in reproducible age.

(D) Increase in IMR but decrease in MMR.

Q24. Which structure provides nutrition to the developing sperms?

(A) Leydig cells
(B) Sertoli cells
(C) Interstitial cells
(D) Epididymis

Q25. The primary productivity of an ecosystem is measured in terms of:

(A) g^{-2} yr^{-1}
(B) $(kcal\ m^{-2})\ yr^{-1}$
(C) $g^{-1}\ m^{-2}$
(D) $kcal\ m^{-3}$

Q26. Select the correctly matched pair:

(A) Turner's Syndrome – 45 with XO
(B) Klinefelter's Syndrome – 44 with YO
(C) Down's Syndrome – 21st Chromosome monosomy
(D) Colour blindness – Y-linked trait

Q27. The first clinical gene therapy was given in 1990 to a 4-year-old girl with which deficiency?

(A) Adenosine deaminase (ADA)
(B) Insulin-dependent diabetes
(C) Cystic fibrosis
(D) Haemophilia

Q28. In the "Big Bang Theory," the universe originated approximately how many years ago?

(A) 20 billion years

(B) 4.5 billion years

(C) 10 billion years

(D) 50 million years

Q29. Which of the following is NOT a feature of the "Genetic Code"?

(A) It is degenerate.

(B) It is ambiguous.

(C) It is universal.

(D) It is nearly universal.

Q30. The "Sacred Grooves" are especially useful in:

(A) Generating environmental awareness.

(B) Preventing soil erosion.

(C) Conserving rare and threatened species.

(D) In-situ conservation of all animals.

Q31. Primary sewage treatment is mainly a:

(A) Biological process

(B) Physical process

(C) Chemical process

(D) Physico-chemical process

Q32. The "Ti-plasmid" often used for gene transfer in plants is derived from:

(A) Agrobacterium tumefaciens

(B) Bacillus thuringiensis

(C) Rhizobium

(D) Escherichia coli

Q33. Which of the following is a "Stop Codon"?

(A) AUG
(B) GUG
(C) UAA
(D) UGG

Q34. Presence of which of the following hormones in urine confirms pregnancy?

(A) Progesterone
(B) hCG
(C) Estrogen
(D) LH

Q35. The concept of "Omnis cellula-e cellula" was given by:

(A) Rudolf Virchow
(B) Schwann
(C) Schleiden
(D) Robert Hooke

Q36. An example of a "Homologous organ" is:

(A) Wings of butterfly and wings of bird.
(B) Flippers of penguins and dolphins.
(C) Thorns of Bougainvillea and tendrils of Cucurbita.
(D) Eyes of Octopus and mammals.

Q37. "Saheli," a new oral contraceptive for females, contains a non-steroidal preparation called:

(A) Centchroman

(B) Progestogen

(C) Estrogen

(D) Cortisol

Q38. The linking of antibiotic resistance gene with the plasmid vector became possible with:

(A) DNA Ligase

(B) Exonucleases

(C) DNA Polymerase

(D) Endonucleases

Q39. The structure of the "Antibody molecule" can be represented as:

(A) L_2H_2

(B) L_4H_4

(C) L_1H_1

(D) L_2H_4

Q40. "Malt-Associated Lymphoid Tissue" (MALT) constitutes about what percentage of lymphoid tissue in the human body?

(A) 20

(B) 50

(C) 10

(D) 75

Q41. In the "Double Helix" model of DNA, the two strands are:

(A) Parallel and complementary.

(B) Antiparallel and complementary.

(C) Antiparallel and non-complementary.

(D) Parallel and non-complementary.

Q42. The "Aleurone layer" in maize grain is rich in:

(A) Proteins

(B) Starch

(C) Lipids

(D) Vitamins

Q43. "Pneumatophores" are found in:

(A) Xerophytes

(B) Mesophytes

(C) Mangroves

(D) Hydrophytes

Q44. Which of the following is an example of an "Auto-immune disease"?

(A) Rheumatoid arthritis

(B) Cancer

(C) AIDS

(D) Asthma

Q45. The "Gause's Principle of Competitive Exclusion" states that:

(A) More abundant species will exclude the less abundant ones.

(B) Two closely related species competing for the same resources cannot co-exist indefinitely.

(C) Competition is always between different species.

(D) Larger organisms always exclude smaller organisms.

Q46. "EcoRI" cuts DNA between bases:

(A) G and A

(B) A and T

(C) C and G

(D) G and C

Q47. The "Filiform apparatus" is present in:

(A) Egg cell

(B) Synergids

(C) Antipodals

(D) Central cell

Q48. Which of the following is NOT a method of "Ex-situ" conservation?

(A) Cryopreservation

(B) In-vitro fertilization

(C) National Park

(D) Seed Bank

Q49. "Meselson and Stahl" used which isotope to prove semi-conservative DNA replication?

(A) ^{15}N

(B) ^{31}P

(C) ^{35}S

(D) ^{14}C

Q50. The "Pyramid of Energy" is:

(A) Always inverted.

(B) Always upright.

(C) Spindle shaped.

(D) Urn shaped.

Detailed Solutions

Q1.

Solution

Concept: The central dogma of molecular biology dictates that mRNA is synthesized from DNA. The mRNA sequence is complementary to the template strand and identical to the coding strand (except U replaces T).

Solution: 1. **Identification of Coding Strand:** The given sequence 5'-ATGCATGC-3' is the coding strand, which runs in the 5' to 3' direction.

2. **Rule of Transcription:** During transcription, the mRNA sequence is synthesized exactly like the coding strand because both are complementary to the same template strand.

3. **Base Substitution:** In RNA, the nitrogenous base Thymine (T) is absent and is replaced by Uracil (U).

4. **Final Sequence Determination:** Replacing every 'T' in the coding strand (5'-ATGCATGC-3') with 'U' gives us the mRNA sequence: 5'-AUGCAUGC-3'.

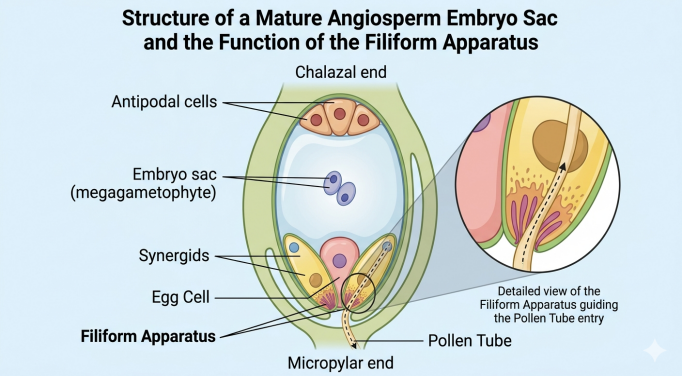
Final Answer: 5'-AUGCAUGC-3'

Answer: (A)

Q2.

Solution

Concept: The Filiform apparatus is a specialized cellular structure found within the synergid cells of the megagametophyte (embryo sac) in flowering plants.



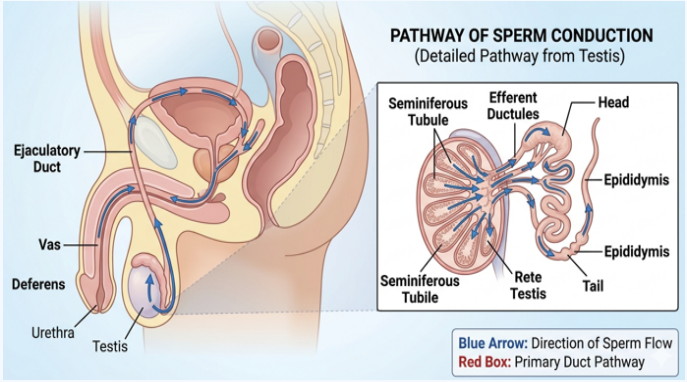
Solution: 1. **Structural Localization:** Synergids are part of the egg apparatus at the micropylar end. They possess finger-like projections known as the filiform apparatus.
2. **Function in Pollination:** These projections play a vital role in chemical signaling. They secrete chemo-attractants that guide the pollen tube's growth.
3. **Directional Entry:** The filiform apparatus ensures the pollen tube enters the synergid successfully to release the male gametes for double fertilization.
4. **Mechanical Role:** While it provides a path, its primary biological significance is the "guidance" rather than mere structural support.
Final Answer: Guiding the entry of pollen tube into the synergid.

Answer: (A)

Q3.

Solution

Concept: The male reproductive system consists of a series of ducts that transport spermatozoa from the site of production (testis) to the exterior.



Solution: 1. **Production Site:** Sperms are formed in the seminiferous tubules. From there, they enter the network called Rete testis.

2. **Exit from Testis:** The Rete testis leads to several small ducts known as the Efferent ductules (Vasa efferentia), which pierce the tunica albuginea.

3. **Maturation Site:** The efferent ductules open into the highly coiled Epididymis, where sperms gain motility and are stored temporarily.

4. **Upward Transport:** The Epididymis continues as the Vas deferens, which loops over the urinary bladder to eventually reach the ejaculatory duct.

Final Answer: Rete testis -> Efferent ductules -> Epididymis -> Vas deferens

Answer: (A)

Q4.

Solution

Concept: Intrauterine Devices (IUDs) are contraceptive devices inserted into the uterus. They are categorized as non-medicated, copper-releasing, or hormone-releasing.

Solution: 1. **Definition of Non-medicated:** These IUDs do not release chemicals or hormones. They act as foreign bodies to increase phagocytosis of sperms.

2. **Lippes Loop:** This is the classic example of a non-medicated, plastic double-S-shaped IUD used historically to prevent pregnancy.

3. **Comparison with Medicated IUDs:** Multiload 375 releases Copper ions, while LNG-20 and Progestasert release hormones (Progestogens).

4. **Efficacy:** The Lippes loop relies solely on the local inflammatory response of the uterine lining to inhibit sperm transport.

Final Answer: Lippes loop

Answer: (A)

Q5.

Solution

Concept: Hardy-Weinberg equilibrium provides a mathematical framework to calculate genotypic frequencies based on allelic frequencies: $p^2 + 2pq + q^2 = 1$.

Solution: 1. **Allele Identification:** Let 'p' be the frequency of the dominant allele (A) and 'q' be the frequency of the recessive allele (a).

2. **Given Value:** The problem states the frequency of dominant allele 'A' (p) is 0.6.

3. **Calculating q:** Using the formula $p + q = 1$, we find $q = 1 - 0.6 = 0.4$.

4. **Genotype Frequency:** The frequency of homozygous recessive individuals (aa) is represented by q^2. Therefore, $0.4 \times 0.4 = 0.16$.

Final Answer: 0.16

Answer: (C)

Q6.

Solution

Concept: RNA interference (RNAi) is a biological process in which RNA molecules inhibit gene expression or translation, used in biotechnology to develop pest-resistant plants.

Solution: 1. **The Pest:** The nematode *Meloidogyne incognita* infects the roots of tobacco plants, causing a great reduction in yield.

2. **Mechanism:** Using Agrobacterium vectors, nematode-specific genes were introduced into the host plant. The introduction of DNA produced both sense and anti-sense RNA in the host cells.

3. **Silencing:** These two complementary RNAs formed a double-stranded RNA (dsRNA) that initiated RNAi and silenced the specific mRNA of the nematode.

4. **Result:** The parasite could not survive in a transgenic host expressing specific interfering RNA, making the tobacco plant resistant to the nematode.

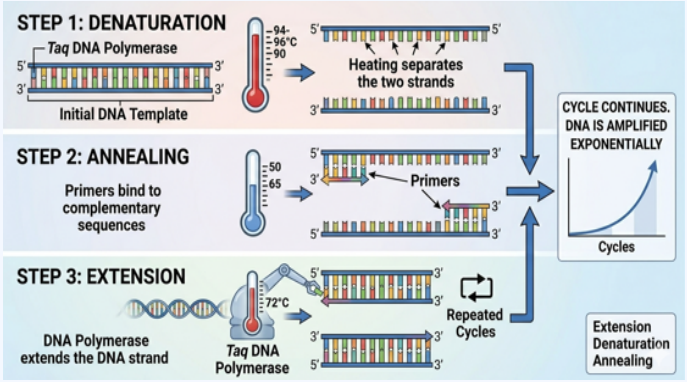
Final Answer: Meloidogyne incognita

Answer: (B)

Q7.

Solution

Concept: Polymerase Chain Reaction (PCR) is a technique used to amplify a specific DNA segment into billions of copies through a series of temperature-controlled cycles.



Solution: 1. **Denaturation:** The first step involves heating the target DNA to a high temperature (about $94°C$) to separate the two strands by breaking hydrogen bonds.

2. **Annealing:** In the second step, the temperature is lowered (about $50 - 65°C$) to allow two sets of primers to bond (anneal) to their complementary sequences on the single-stranded DNA templates.

3. **Extension:** In the final step, the temperature is raised (about $72°C$), and the enzyme Taq polymerase adds nucleotides to the primers, extending the DNA strand using the template.

4. **Cycle Completion:** These three steps are repeated for many cycles to achieve exponential amplification of the DNA.

Final Answer: Denaturation, Annealing, Extension

Answer: (C)

Q8.

Solution

Concept: The Lac Operon is a classic model for gene regulation in prokaryotes, consisting of structural genes and regulatory elements.

Solution: 1. **Regulatory Gene:** The 'i' gene in the Lac Operon is the regulatory gene. The 'i' stands for 'inhibitor,' not inducer.

2. **Constitutive Expression:** The 'i' gene is expressed constitutively (all the time) and synthesizes the repressor protein.

3. **Repressor Action:** In the absence of an inducer (lactose), the repressor protein binds to the operator region, preventing RNA polymerase from transcribing the structural genes.

4. **Structural Genes Contrast:** In contrast, the 'z', 'y', and 'a' genes code for enzymes like β-galactosidase, permease, and transacetylase respectively.

Final Answer: Repressor

Answer: (B)

Q9.

Solution

Concept: Commensalism is a type of population interaction where one species benefits while the other is neither harmed nor benefited (+/0 interaction).

Solution: 1. **Definition:** In commensalism, the "commensal" receives a benefit such as transportation, shelter, or food, while the "host" remains unaffected.

2. **Example Analysis:** An orchid growing as an epiphyte on a mango branch is a classic example. The orchid gets a physical perch and better sunlight (benefit).

3. **Host Status:** The mango tree does not derive any nutrition from the orchid, nor is it physically hampered by it (no effect).

4. **Comparison:** Cuscuta is a parasite (-/+) as it steals nutrients; Lichens and Mycorrhizae are mutualistic (+/+) as both partners benefit.

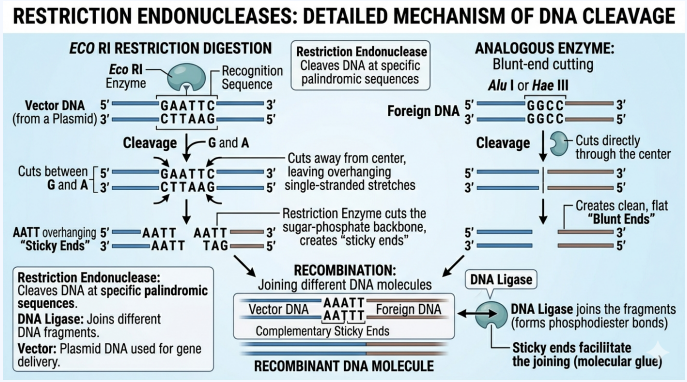
Final Answer: Orchid growing on a mango branch

Answer: (A)

Q10.

Solution

Concept: Restriction Endonucleases are enzymes used in recombinant DNA technology to cut DNA at specific palindromic sequences.



Solution: 1. **Function:** These enzymes "inspect" the length of a DNA sequence and bind to specific recognition sites to cut the sugar-phosphate backbone.

2. **Naming Logic:** They are called "molecular scissors" because they allow scientists to cut DNA into fragments with precision.

3. **Mechanism:** They cut the two strands of the double helix at specific points, often leaving "sticky ends" that facilitate the joining of foreign DNA.

4. **Other Enzymes:** DNA Ligase acts as "molecular glue" to join fragments, while DNA Polymerase synthesizes new DNA strands.

Final Answer: Restriction Endonuclease

Answer: (B)

Q11.

Solution

Concept: The "Evil Quartet" is a term used to describe the four major causes of biodiversity losses attributed to human activities.

Solution: 1. Habitat Loss and Fragmentation: This is the most important cause driving animals and plants to extinction, such as the tropical rainforests.

2. Over-exploitation: When "need" turns to "greed," it leads to the over-harvesting of species, causing the extinction of animals like Steller's sea cow.

3. Alien Species Invasions: Introduction of non-native species (like the Nile perch in Lake Victoria) causes the decline or extinction of indigenous species.

4. Co-extinctions: When a species becomes extinct, the plant and animal species associated with it in an obligatory way also become extinct.

Final Answer: Biodiversity loss

Answer: (B)

Q12.

Solution

Concept: International treaties are designed to protect the environment. The Montreal Protocol specifically targets the protection of the ozone layer in the stratosphere.

Solution: 1. Origin: The Montreal Protocol was signed at Montreal, Canada, in 1987 (effective in 1989) to curb the emission of ozone-depleting substances.

2. Target Substances: It focuses on reducing the production and consumption of chlorofluorocarbons (CFCs) and other chemicals that break down the O_3 layer.

3. Environmental Impact: By protecting the ozone layer, it prevents harmful UV-B radiation from reaching the Earth's surface, which causes skin cancer and cataracts.

4. Global Cooperation: It is considered one of the most successful environmental treaties because of the near-total phase-out of targeted chemicals globally.

Final Answer: Ozone depletion

Answer: (B)

Q13.

Solution

Concept: DNA fingerprinting relies on the identification of specific regions of DNA that show a high degree of polymorphism (variations).

Solution: 1. Repetitive DNA: A major portion of human DNA consists of sequences that are repeated many times. These are separated as "Satellite DNA" during density gradient centrifugation.

2. Satellite DNA: This DNA does not code for proteins but forms a large portion of the human genome. It shows high polymorphism, which is the basis of DNA fingerprinting.

3. VNTRs: Variable Number of Tandem Repeats (VNTRs) are a type of satellite DNA used as probes in the process.

4. Conclusion: Since satellite DNA is a form of repetitive DNA and both are fundamental to the technique, both terms are contextually correct in defining the regions identified.

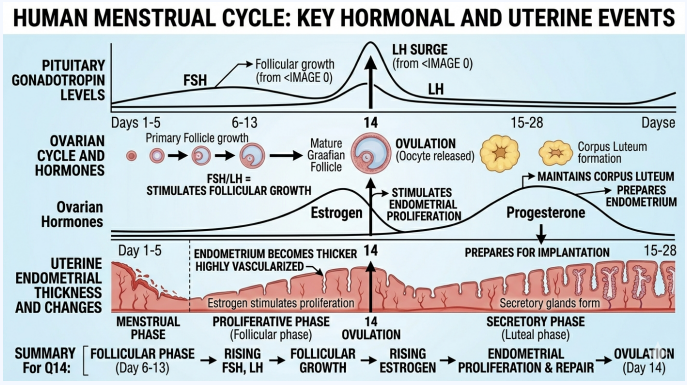
Final Answer: Both A and C

Answer: (D)

Q14.

Solution

Concept: The follicular phase (or proliferative phase) is a stage of the menstrual cycle where the primary follicles in the ovary grow and the uterine lining is repaired.



Solution: 1. Hormonal Trigger: During this phase, the secretion of gonadotropins (LH and FSH) increases, stimulating follicular development and the secretion of estrogens.

2. Endometrial Repair: Estrogen acts on the uterus to stimulate the proliferation of the endometrium, which was shed during the previous menstrual phase.

3. Vascularization: The lining becomes thicker and highly vascularized in preparation for potential implantation of a fertilized egg.

4. Feedback: The rising levels of estrogen eventually lead to an LH surge, which triggers ovulation, marking the end of the follicular phase.

Final Answer: Estrogen

Answer: (B)

Q15.

Solution

Concept: Biodiversity conservation is categorized into In-situ (on-site) and Ex-situ (off-site) methods based on whether the species is protected within or outside its natural habitat.

Solution: 1. In-situ Conservation: This involves protecting the whole ecosystem so that the species is protected in its natural home (e.g., National Parks, Biosphere Reserves, and Wildlife Sanctuaries).

2. Ex-situ Conservation: This involves taking threatened animals and plants out of their natural habitat and placing them in special settings where they can be protected (e.g., Zoological Parks and Botanical Gardens).

3. Analysis: National Parks and Biosphere Reserves allow the species to live and evolve naturally in the wild.

4. Odd One Out: Botanical Gardens are man-made, controlled environments where plants are kept for study and conservation, making it an ex-situ method.

Final Answer: Botanical Gardens

Answer: (C)

Q16.

Solution

Concept: DNA replication is semi-discontinuous because the two strands of the DNA double helix are antiparallel, and DNA polymerase can only synthesize DNA in the 5' to 3' direction.

Solution: 1. Leading and Lagging Strands: On the template strand with 3' to 5' polarity, replication is continuous. On the 5' to 3' template, replication is discontinuous, forming short segments called Okazaki fragments.

2. Enzymatic Requirement: These discontinuous fragments need to be covalently linked to form a continuous daughter strand.

3. Role of DNA Ligase: DNA ligase is the specific enzyme that catalyzes the formation of a phosphodiester bond between the 3'-OH end of one fragment and the 5'-phosphate end of the next.

4. Molecular Glue: For this reason, DNA ligase is often referred to as the molecular glue of the cell, essential for maintaining the structural integrity of the newly synthesized lagging strand.

Final Answer: DNA Ligase

Answer: (B)

Q17.

Solution

Concept: Bacillus thuringiensis (Bt) produces specific protein crystals during a particular phase of their growth. These crystals contain a toxic insecticidal protein.

Solution: 1. Protoxin State: The Bt toxin exists as an inactive protoxin in the bacterium, which prevents the bacterium itself from being killed.

2. Activation: Once an insect ingests the inactive toxin, it is converted into an active form of toxin due to the alkaline pH of the insect's gut.

3. Cellular Impact: The activated toxin binds to the surface of midgut epithelial cells.

4. Pore Formation: It creates pores in these cells, causing swelling and lysis (bursting), which eventually leads to the death of the insect.

Final Answer: Creating pores in the midgut epithelial cells.

Answer: (A)

Q18.

Solution

Concept: Mendelian blood disorders can be classified based on whether the defect lies in the amount of protein produced or the functional quality of the protein.

Solution: 1. Thalassemia: This is a quantitative problem. It occurs because too few globin molecules (either alpha or beta) are synthesized, leading to an imbalance in the hemoglobin chains.

2. Sickle Cell Anemia: This is a qualitative problem. It occurs due to a point mutation that changes a single amino acid (Glutamic acid to Valine), resulting in an incorrectly functioning hemoglobin molecule that changes shape under low oxygen.

3. Comparison: Thalassemia involves "how much" is made, while Sickle Cell Anemia involves "how well" it works.

4. Genetics: Both are autosomal recessive disorders, but their biochemical manifestations are fundamentally different in this specific regard.

Final Answer: Thalassemia is a quantitative problem, while Sickle Cell Anemia is a qualitative problem.

Answer: (C)

Q19.

Solution

Concept: Biological control (Biocontrol) refers to the use of biological methods for controlling plant diseases and pests, reducing the reliance on toxic chemicals.

Solution: 1. Ladybird: This familiar beetle with red and black markings is a predator that is very useful in controlling Aphids.

2. Dragonflies: These are effective in controlling the population of Mosquitoes in and around water bodies.

3. Bacillus thuringiensis: This bacterium is widely used to control butterfly caterpillars. It is available in sachets as dried spores which are sprayed onto vulnerable plants.

4. Alignment: Matching (a) to (i), (b) to (ii), and (c) to (iii) provides the correct ecological management strategy.

Final Answer: a-i, b-ii, c-iii

Answer: (A)

Q20.

Solution

Concept: Humulin is the brand name for the first biosynthetic "human" insulin developed using recombinant DNA technology.

Solution: 1. Historical Context: Traditionally, insulin was extracted from the pancreas of slaughtered cows and pigs, which often caused allergic reactions in some patients.

2. Technological Breakthrough: In 1983, Eli Lilly, an American company, prepared two DNA sequences corresponding to the A and B chains of human insulin.

3. Production: These sequences were introduced into plasmids of E. coli to produce insulin chains separately.

4. Assembly: The chains (A and B) were extracted and combined by creating disulfide bonds to form the mature, active human insulin molecule known as Humulin.

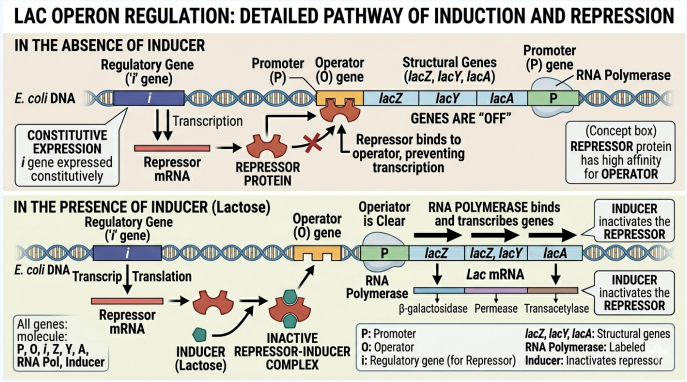
Final Answer: Human Insulin produced by rDNA technology.

Answer: (A)

Q21.

Solution

Concept: The Lac Operon is a regulated system in E. coli where the presence of a specific substrate (lactose) induces the transcription of genes required for its metabolism.



Solution: 1. **Inducible System:** The Lac Operon is inducible, meaning it is usually "off" but can be turned "on" in the presence of an inducer. Lactose (or allolactose) acts as the inducer, not a corepressor.

2. **Repressor Interaction:** The repressor protein, produced by the 'i' gene, has a high affinity for the operator. When the inducer is present, it binds to the repressor, changing its shape so it cannot bind to the operator.

3. **Structural Gene Functions:** The 'z' gene codes for β-galactosidase, the 'y' gene codes for permease (which increases cell permeability to β-galactosides), and the 'a' gene codes for transacetylase.

4. **Carbon Source Preference:** Bacteria prefer glucose. Even if lactose is present, if glucose is also available, the operon stays at a very low level of expression because glucose is not an inducer.

Final Answer: Glucose or galactose cannot act as inducers for lac operon.

Answer: (D)

Q22.

Solution

Concept: Dihybrid crosses involve two pairs of contrasting traits. According to the Law of Independent Assortment, the alleles of different traits distribute into gametes independently.
Solution: 1. **Parental Genotypes:** Both parents are heterozygous for both traits ($RrYy$).
2. **Gamete Formation:** Each parent produces four types of gametes: RY, Ry, rY, ry, each with a probability of $1/4$.
3. **Punnett Square Logic:** A 4×4 Punnett square results in 16 possible combinations of offspring.
4. **Specific Genotype Calculation:** The double homozygous recessive genotype ($rryy$) occurs only when a 'ry' gamete from the father meets a 'ry' gamete from the mother.
5. **Probability:** The math is $(1/4) \times (1/4) = 1/16$. In the standard $9:3:3:1$ ratio, the '1' represents the $rryy$ phenotype/genotype.
Final Answer: 1/16

Answer: (A)

Q23.

Solution

Concept: Population growth or explosion is determined by the balance between birth rates (natality) and death rates (mortality), along with healthcare improvements.
Solution: 1. **Historical Context:** After independence, improved living conditions and better health facilities led to a sharp decline in death rates.
2. **Specific Metrics:** A significant factor was the rapid decline in the Maternal Mortality Rate (MMR) and the Infant Mortality Rate (IMR).
3. **Reproductive Age Group:** Simultaneously, there was an increase in the number of individuals entering the reproductive age bracket, which sustained high birth rates.
4. **Net Result:** When death rates (especially among mothers and infants) fall while birth rates remain high, the population size increases exponentially.
Final Answer: Decrease in MMR and IMR.

Answer: (A)

Q24.

Solution

Concept: The seminiferous tubules contain two types of specialized cells: male germ cells (spermatogonia) and Sertoli cells.

Solution: 1. **Sertoli Cells:** These are large, elongated cells found in the germinal epithelium of the seminiferous tubules. They are often called "nurse cells."

2. **Supportive Role:** Their primary function is to provide structural support, protection, and essential nutrients to the developing germ cells (spermatocytes and spermatids).

3. **Phagocytosis:** They also consume the excess cytoplasm discarded by the spermatids during the process of spermiogenesis.

4. **Contrast with Other Cells:** Leydig cells (interstitial cells) are located outside the tubules and produce testosterone, while the Epididymis is a storage and maturation duct.

Final Answer: Sertoli cells

Answer: (B)

Q25.

Solution

Concept: Productivity in an ecosystem refers to the rate of biomass production. It is expressed in units that account for both weight (or energy) and area over a specific time period.

Solution: 1. **Biomass vs Energy:** Productivity can be measured as the mass of organic matter produced (grams) or the energy accumulated (calories/joules).

2. **Standard Units:** To compare the productivity of different ecosystems, we use a standard unit of area (square meters) and time (per year).

3. **Dimensional Analysis:** Thus, the unit becomes $g/m^2/yr$ or $kcal/m^2/yr$.

4. **Mathematical Representation:** This is written as $g \cdot m^{-2} \cdot yr^{-1}$ or $kcal \cdot m^{-2} \cdot yr^{-1}$. Option B correctly identifies the energy-based unit.

Final Answer: $(\text{kcal}\, m^{-2})\, yr^{-1}$

Answer: (B)

Q26.

Solution

Concept: Chromosomal disorders are caused by the absence, excess, or abnormal arrangement of one or more chromosomes, often resulting from non-disjunction during cell division.

Solution: 1. Turner's Syndrome: This is a disorder caused by the absence of one of the X chromosomes. The individual has 45 chromosomes with the XO genotype, leading to sterile females with rudimentary ovaries.

2. Down's Syndrome: This is caused by the presence of an additional copy of chromosome number 21 (trisomy 21), not a monosomy.

3. Klinefelter's Syndrome: This is caused by an additional X chromosome resulting in a karyotype of 47, XXY. These individuals are males with feminine features and are sterile.

4. Colour Blindness: This is a sex-linked (X-linked) recessive disorder, not a Y-linked trait. Therefore, the matching for Turner's Syndrome is the only correct pair.

Final Answer: Turner's Syndrome – 45 with XO

Answer: (A)

Q27.

Solution

Concept: Gene therapy is a collection of methods that allows the correction of a gene defect that has been diagnosed in a child or embryo by delivering normal genes into the individual.

Solution: 1. The First Case: The first clinical gene therapy was performed in 1990 on a four-year-old girl.

2. Target Disease: She was suffering from Adenosine Deaminase (ADA) deficiency. This enzyme is crucial for the immune system to function properly.

3. The Procedure: Lymphocytes from the patient's blood were grown in a culture outside the body. A functional ADA cDNA was then introduced into these lymphocytes using a retroviral vector.

4. Limitations: Since these cells are not immortal, the patient requires periodic infusion of such genetically engineered lymphocytes unless the gene is introduced into bone marrow cells at early embryonic stages.

Final Answer: Adenosine deaminase (ADA)

Answer: (A)

Q28.

Solution

Concept: The Big Bang Theory attempts to explain to us the origin of the universe, describing a singular, huge explosion unimaginable in physical terms.

Solution: 1. Timing of Origin: According to this theory, the universe originated approximately 20 billion years ago.

2. Expansion: Following the explosion, the universe expanded and the temperature came down. Hydrogen and Helium formed sometime later.

3. Galaxy Formation: The gases condensed under gravitation and formed the galaxies of the present-day universe.

4. Earth's Timeline: In the solar system of the Milky Way galaxy, earth was formed about 4.5 billion years ago, which is much later than the origin of the universe itself.

Final Answer: 20 billion years

Answer: (A)

Q29.

Solution

Concept: The genetic code is the set of rules by which information encoded within genetic material (DNA or mRNA sequences) is translated into proteins by living cells.

Solution: 1. Degeneracy: Some amino acids are coded by more than one codon; hence the code is degenerate.

2. Universality: The code is nearly universal. For example, from bacteria to humans, UUU would code for Phenylalanine (with some exceptions in mitochondrial codons).

3. Unambiguous and Specific: One codon codes for only one specific amino acid; hence it is unambiguous.

4. Conclusion: The option stating the code is "ambiguous" is incorrect because a specific codon never codes for multiple different amino acids.

Final Answer: It is ambiguous.

Answer: (B)

Q30.

Solution

Concept: Sacred groves are tracts of forest which are set aside, and all the trees and wildlife within are venerated and given total protection by local communities.

Solution: 1. Cultural Significance: These are found in various parts of India, such as the Khasi and Jaintia Hills in Meghalaya or the Western Ghat regions of Karnataka and Maharashtra.

2. Conservation Role: In many regions, the sacred groves are the last refuges for a large number of rare and threatened plants.

3. In-situ Strategy: Because they protect the species in their natural habitat through traditional practices, they represent a highly effective form of in-situ conservation.

4. Human Impact: They serve as examples where human cultural belief systems directly contribute to the preservation of high biodiversity areas.

Final Answer: Conserving rare and threatened species.

Answer: (C)

Q31.

Solution

Concept: Sewage treatment is divided into primary (physical), secondary (biological), and tertiary (chemical) treatments to remove various types of pollutants.

Solution: 1. Physical Removal: Primary treatment 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. Then, the grit (soil and small pebbles) is removed by sedimentation.

3. Primary Sludge: All solids that settle form the primary sludge, and the supernatant forms the primary effluent.

4. Contrast: Unlike secondary treatment, which uses microbes (aerobic and anaerobic) to consume organic matter, primary treatment relies solely on mechanical and physical forces.

Final Answer: Physical process

Answer: (B)

Q32.

Solution

Concept: Plant genetic engineering often utilizes natural vectors to deliver foreign DNA into host cells. The Ti-plasmid is the most widely used vector for dicot plants.

Solution: 1. Source Organism: The Ti (Tumor-inducing) plasmid is found in Agrobacterium tumefaciens, a soil-borne bacterium.

2. Natural Engineer: In nature, this bacterium infects plants and transfers a piece of its DNA (T-DNA) to transform normal plant cells into tumor cells.

3. Modification: For biotechnology, the Ti-plasmid is "disarmed." The genes causing tumors are removed, but the ability to transfer DNA into the plant genome is retained.

4. Application: This disarmed plasmid is then used as a delivery vehicle to introduce desirable genes into a wide variety of plants.

Final Answer: Agrobacterium tumefaciens

Answer: (A)

Q33.

Solution

Concept: During translation, the process of protein synthesis must be terminated when the polypeptide chain is complete. This is signaled by specific nonsense codons.

Solution: 1. Termination Signals: There are 64 codons in the genetic code, but 3 of them do not code for any amino acid. These are known as stop codons or termination codons.

2. The Three Codons: The stop codons are UAA (Ochre), UAG (Amber), and UGA (Opal).

3. Mechanism: When the ribosome encounters one of these codons on the mRNA, no tRNA can bind to it. Instead, release factors bind, causing the polypeptide to be released.

4. Contrast: AUG and GUG are often start (initiation) codons, and UGG codes for the amino acid Tryptophan.

Final Answer: UAA

Answer: (C)

Q34.

Solution

Concept: After implantation, the trophoblast layer of the blastocyst and the uterine tissue secrete specific hormones to maintain the pregnancy and support fetal growth.

Solution: 1. hCG Secretion: Human Chorionic Gonadotropin (hCG) is produced by the placenta shortly after the embryo attaches to the uterine lining.

2. Maintenance of Corpus Luteum: hCG signals the corpus luteum to continue producing progesterone, which prevents the shedding of the uterine lining (menstruation).

3. Clinical Detection: Because hCG is produced only during pregnancy and is excreted in the mother's urine, it serves as the primary marker for home pregnancy test kits.

4. Specificity: While Progesterone and Estrogen levels are high during pregnancy, they are also present during the normal menstrual cycle, making them unreliable for a simple "yes/no" pregnancy test.

Final Answer: hCG

Answer: (B)

Q35.

Solution

Concept: The Cell Theory was originally proposed by Schleiden and Schwann, but it was later refined to explain the origin of new cells.

Solution: 1. Initial Theory: Matthias Schleiden and Theodore Schwann proposed that all living organisms are composed of cells and products of cells. However, they could not explain how new cells were formed.

2. Virchow's Contribution: In 1855, Rudolf Virchow first explained that cells divide and new cells are formed from pre-existing cells.

3. Latin Maxim: He summarized this concept in the famous phrase, "Omnis cellula-e cellula."

4. Modern Cell Theory: This addition completed the cell theory, which now states that all living beings are made of cells and all cells arise from pre-existing ones.

Final Answer: Rudolf Virchow

Answer: (A)

Q36.

Solution

Concept: Homology refers to structures that share a common embryonic origin and basic anatomical plan, despite performing different functions in different species.

Solution: 1. Divergent Evolution: Homologous organs are the result of divergent evolution, where a common ancestral structure evolved along different paths to adapt to different environmental needs.

2. Anatomical Evidence: The thorns of Bougainvillea and the tendrils of Cucurbita both arise from the axillary position (modified axillary buds).

3. Functional Variation: While they share the same origin, the thorn is for protection against herbivores, and the tendril is for climbing support.

4. Contrast: Wings of birds and butterflies, or flippers of penguins and dolphins, are analogous organs because they have different origins but perform similar functions (convergent evolution).

Final Answer: Thorns of Bougainvillea and tendrils of Cucurbita.

Answer: (C)

Q37.

Solution

Concept: Saheli is a unique oral contraceptive for females that was developed by scientists at the Central Drug Research Institute (CDRI) in Lucknow, India.

Solution: 1. Chemical Composition: Unlike traditional birth control pills that contain steroids (estrogen-progesterone combinations), Saheli is a non-steroidal preparation.

2. Active Ingredient: It contains a compound called Centchroman (ormeloxifene), which acts as a Selective Estrogen Receptor Modulator (SERM).

3. Dosage Schedule: It is a "once-a-week" pill, which significantly reduces the side effects associated with daily steroidal intake.

4. Mechanism: It prevents pregnancy by interfering with the implantation of the blastocyst in the uterus without disrupting the normal hormonal balance of the body.

Final Answer: Centchroman

Answer: (A)

Q38.

Solution

Concept: The construction of the first recombinant DNA involved the isolation of an antibiotic resistance gene and its insertion into a vector.

Solution: 1. Gene Isolation: Scientists isolated the gene granting resistance to an antibiotic from the native plasmid of Salmonella typhimurium.

2. Cutting DNA: Restriction enzymes were used to cut the source DNA and the vector DNA (plasmid) at specific points.

3. Joining Fragments: To link the antibiotic resistance gene with the plasmid vector, the enzyme DNA ligase was used.

4. Function: DNA ligase acts on the cut DNA molecules and facilitates the joining of their ends by catalyzing the formation of phosphodiester bonds, much like a glue.

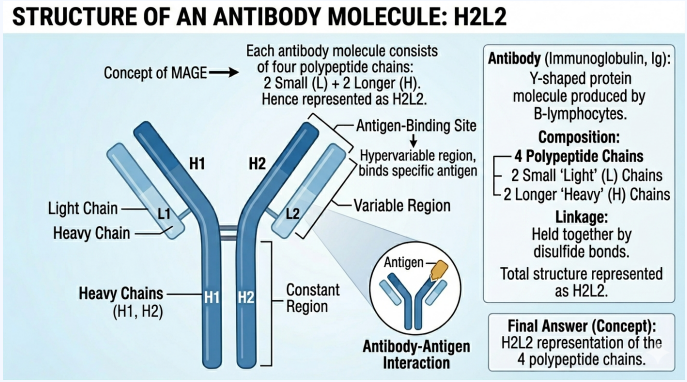
Final Answer: DNA Ligase

Answer: (A)

Q39.

Solution

Concept: Antibodies, also known as Immunoglobulins (Ig), are Y-shaped protein molecules produced by B-lymphocytes in response to pathogens.



Solution: 1. **Chain Composition:** Each antibody molecule consists of four polypeptide chains.

2. **Chain Types:** Two of these are small and are called light (L) chains, and two are longer and are called heavy (H) chains.

3. **Representation:** Because of this specific composition, an antibody molecule is represented by the formula H_2L_2.

4. **Linkage:** These four chains are held together by disulfide bonds to form a stable Y-shaped structure capable of binding to specific antigens.

Final Answer: H_2L_2

Answer: (A)

Q40.

Solution

Concept: The lymphoid system consists of various tissues and organs that produce and mature lymphocytes. These are categorized into primary and secondary lymphoid organs.

Solution: 1. Definition of MALT: Mucosa-Associated Lymphoid Tissue (MALT) is a collection of lymphoid tissue located within the mucosal lining of major tracts like the respiratory, digestive, and urogenital tracts.

2. Distribution: Since these tracts have a vast surface area exposed to the external environment, they require significant immune protection.

3. Proportionality: In the human body, MALT is so extensive that it constitutes about 50 percent of the total lymphoid tissue.

4. Examples: Tonsils, Peyer's patches in the small intestine, and the appendix are well-known components of this system.

Final Answer: 50

Answer: (B)

Q41.

Solution

Concept: The double helix model of DNA, proposed by Watson and Crick, describes the spatial arrangement and chemical orientation of the two polynucleotide chains.

Solution: 1. **Antiparallel Orientation:** The two strands run in opposite directions; if one strand has the polarity 5' → 3', the other has the polarity 3' → 5'.

2. **Complementary Base Pairing:** The bases on the two strands are paired through hydrogen bonds. Adenine always pairs with Thymine, and Guanine always pairs with Cytosine.

3. **Structural Stability:** This complementary nature ensures that if the sequence of one strand is known, the sequence of the other can be predicted.

4. **Helix Geometry:** The two strands are coiled in a right-handed fashion around a common central axis, forming the ladder-like structure of the DNA molecule.

Final Answer: Antiparallel and complementary.

Answer: (B)

Q42.

Solution

Concept: The aleurone layer is the outermost layer of the endosperm in monocot seeds, such as maize, and plays a critical role during seed germination.

Solution: 1. **Anatomy of the Seed:** In a maize grain, the embryo is small and situated in a groove at one end of the bulky endosperm.

2. **The Separation Layer:** The endosperm is surrounded by a specialized proteinaceous layer called the aleurone layer.

3. **Biochemical Composition:** This layer is highly rich in proteins and stores various enzymes, such as amylase, which are activated by gibberellic acid during germination.

4. **Nutritional Value:** While the main body of the endosperm stores starch, the aleurone layer provides the necessary nitrogenous reserves for the developing embryo.

Final Answer: Proteins

Answer: (A)

Q43.

Solution

Concept: Plants growing in swampy or saline areas face a lack of oxygen in the soil. To survive, they develop specialized respiratory roots.

Solution: 1. **Environment:** In areas like the Sundarbans (mangroves), the soil is waterlogged and anaerobic (lacking oxygen), which makes it difficult for roots to breathe.

2. **Modification:** Many roots come out of the ground and grow vertically upwards against the force of gravity. These are called pneumatophores.

3. **Function:** These roots have tiny pores called lenticels on their surface which help the plant obtain oxygen from the atmosphere for respiration.

4. **Example:** Rhizophora is a classic example of a mangrove plant that utilizes these "breathing roots" for survival in marshy habitats.

Final Answer: Mangroves

Answer: (C)

Q44.

Solution

Concept: Auto-immunity is a condition where the body's immune system loses the ability to distinguish between "self" cells and "non-self" (foreign) cells.

Solution: 1. **Immune Malfunction:** In a healthy body, the immune system attacks only pathogens. In auto-immune diseases, it starts attacking its own cells and tissues.

2. **Rheumatoid Arthritis:** This is a chronic inflammatory disorder where the immune system attacks the lining of the joints, leading to painful swelling and bone erosion.

3. **Etiology:** The exact cause is often unknown, but it is believed to be a combination of genetic factors and environmental triggers.

4. **Contrast:** AIDS is an immunodeficiency (loss of immunity), Cancer is uncontrolled cell division, and Asthma is an allergic reaction (hyper-sensitivity).

Final Answer: Rheumatoid arthritis

Answer: (A)

Q45.

Solution

Concept: Competition in ecology occurs when resources are limited. Gause's Principle focuses on the outcome of intense competition between closely related species.

Solution: 1. **The Principle:** It states that two species competing for the exact same limiting resources cannot coexist indefinitely in the same niche.

2. **The Outcome:** The competitively superior species will eventually eliminate the other species from that habitat.

3. **Condition:** This holds true only if the resources are actually limiting; if resources are abundant, both might survive.

4. **Real-world Context:** While this principle is a fundamental rule, in nature, species often avoid exclusion through "Resource Partitioning," where they choose different feeding times or patterns.

Final Answer: Two closely related species competing for the same resources cannot co-exist indefinitely.

Answer: (B)

Q46.

Solution

Concept: EcoRI is a restriction endonuclease enzyme isolated from the bacterium Escherichia coli RY 13. It recognizes a specific palindromic sequence to cut DNA.

Solution: 1. **Recognition Sequence:** EcoRI specifically recognizes the 6-base pair sequence 5'-GAATTC-3' on the DNA strand.

2. **Cleavage Site:** The enzyme does not cut exactly in the middle of the recognition site. Instead, it cuts both strands of the DNA between the same two bases: Guanine (G) and Adenine (A).

3. **Sticky Ends:** Because it cuts between G and A, but away from the center, it leaves overhanging single-stranded stretches called "sticky ends" (AATT).

4. **Application:** These sticky ends are crucial in biotechnology as they easily form base pairs with complementary sticky ends produced by the same enzyme on a different DNA molecule, allowing for the creation of recombinant DNA.

Final Answer: G and A

Answer: (A)

Q47.

Solution

Concept: The filiform apparatus is a specialized structure consisting of chemical-secreting cellular thickenings found in the egg apparatus of the embryo sac.

Solution: 1. **Egg Apparatus Components:** A typical angiosperm embryo sac contains an egg apparatus at the micropylar end, consisting of one egg cell and two synergids.

2. **Structure:** The synergids have special cellular thickenings at their micropylar tip, which is collectively called the filiform apparatus.

3. **Physiological Role:** It acts as a guide for the pollen tube. As the pollen tube approaches the embryo sac, the filiform apparatus directs its entry into one of the synergids.

4. **Degeneration:** Upon the entry of the pollen tube, the synergid containing the filiform apparatus usually degenerates, allowing for the release of the male gametes.

Final Answer: Synergids

Answer: (B)

Q48.

Solution

Concept: Ex-situ conservation involves the protection of threatened species outside their natural habitats in man-made, controlled environments.

Solution: 1. **Ex-situ Examples:** Methods like Cryopreservation (storing gametes at very low temperatures), Seed Banks (storing seeds for future use), and In-vitro fertilization are all examples of conservation away from the wild.

2. **In-situ Definition:** In-situ conservation means "on-site" protection. It involves protecting the entire habitat so that the species can live, interact, and evolve naturally.

3. **National Parks:** A National Park is a strictly protected area where the ecosystem is conserved as a whole. Since the animals and plants remain in their original natural environment, it is an In-situ method.

4. **Conclusion:** Therefore, National Parks are the odd one out when listing Ex-situ strategies.

Final Answer: National Park

Answer: (C)

Q49.

Solution

Concept: The semi-conservative nature of DNA replication states that each daughter DNA molecule contains one parental strand and one newly synthesized strand.

Solution: 1. **The Experiment:** In 1958, Matthew Meselson and Franklin Stahl performed an experiment using E. coli to test this hypothesis.

2. **Heavy Isotope:** They grew E. coli in a medium containing $^{15}NH_4Cl$ (^{15}N is the heavy isotope of nitrogen). This resulted in ^{15}N being incorporated into the newly synthesized DNA.

3. **Centrifugation:** They then shifted the cells into a medium with normal $^{14}NH_4Cl$ and analyzed the DNA density using Cesium Chloride (CsCl) density gradient centrifugation.

4. **Results:** The first generation showed a hybrid density, and the second generation showed both hybrid and light densities, proving that replication is semi-conservative. Note that ^{15}N is a heavy isotope, not a radioactive one.

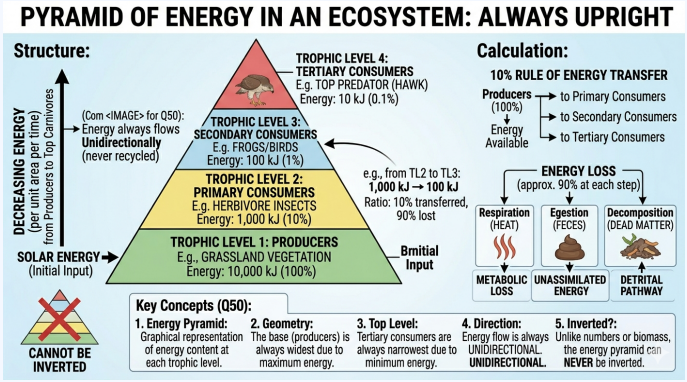
Final Answer: ^{15}N

Answer: (A)

Q50.

Solution

Concept: An ecological pyramid is a graphical representation of the relationship between different organisms in an ecosystem at various trophic levels.



Solution: 1. **Energy Flow:** According to the 10 percent law of energy transfer, only about 10
2. **Directionality:** Energy always flows from producers (bottom) to top carnivores (top). It is never recycled back to the producers.
3. **Geometric Result:** Because energy is lost as heat at every step, the base of the pyramid (producers) is always the widest, and the top (tertiary consumers) is always the narrowest.
4. **Consistency:** Unlike the pyramids of numbers or biomass, which can be inverted (e.g., in a tree ecosystem or a marine ecosystem), the pyramid of energy can never be inverted. It is always upright.

Final Answer: Always upright.

Answer: (B)

Answer Key

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