CUET-UG Biology Sample Paper - 21

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. Arrange the following stages of development of a dicot embryo in the correct order of their occurrence: (A) Formation of heart-shaped embryo
(B) Formation of typical dicot embryo
(C) Formation of zygote
(D) Formation of globular embryo
Choose the correct answer from the options given below:

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

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

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

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

Q2. Match List-I with List-II:

Biological Process/Fruit Type	**Example/Equivalent**
(A) Polyembryony	(I) Apple
(B) Parthenocarpy	(II) Female gametophyte
(C) False Fruit	(III) Orange
(D) Embryo Sac	(IV) Banana

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

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

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

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

Q3. Which of the following is true regarding water pollination?

(A) It is very common in all aquatic plants

(B) Pollen grains are often spherical and heavy

(C) It occurs in *Vallisneria* and *Hydrilla*

(D) Flowers are always large and colorful

Q4. Identify the correct statement regarding the 7-celled, 8-nucleate structure of the embryo sac:

(A) The large central cell has three polar nuclei

(B) The egg apparatus consists of two egg cells and one synergid

(C) Synergids have filiform apparatus

(D) Antipodals are located at the micropylar end

Q5. Statement I: In some seeds like black pepper and beet, remnants of nucellus are persistent.
Statement II: This persistent nucellus is called perisperm. In the light of the above statements, choose the correct answer:

(A) Both Statement I and Statement II are true

(B) Both Statement I and Statement II are false

(C) Statement I is true but Statement II is false

(D) Statement I is false but Statement II is true

Q6. Which hormone among the following is **not** secreted by the human placenta?

(A) Estrogen

(B) Progestogen

(C) Human chorionic gonadotropin

(D) Luteinising hormone

Q7. Identify the correct statements regarding the human female menstrual cycle:

(A) First menstruation is menopause

(B) Ovulation occurs at maximum progesterone levels

(C) Corpus luteum degeneration causes menstruation

(D) Menstrual cycle ceases around age 50

Choose the correct answer from the options given below:

(A) (A) and (B) only

(B) (C) and (D) only

(C) (A) and (C) only

(D) (B) and (D) only

Q8. Sequentially arrange the developmental stages of a human spermatozoon:

(A) Secondary Spermatocyte

(B) Spermatid

(C) Spermatozoa

(D) Spermatogonia

(E) Primary spermatocytes

Choose the correct answer from the options given below:

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

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

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

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

Q9. Identify the correct sequence of embryonic development:

(A) Zygote → Morula → Gastrula → Blastocyst

(B) Zygote → Cleavage → Morula → Blastocyst

(C) Zygote → Trophoblast → Morula → Blastocyst

(D) Zygote → Blastocyst → Morula → Gastrula

Q10. Out of the following, which one is **not** a hermaphrodite?

(A) Sponge

(B) Earthworm

(C) Leech

(D) Cockroach

Q11. Match List-I with List-II:

Contraceptive Method	**Category**
(A) Lippes loop	(I) Barrier
(B) Vaults	(II) Hormone releasing device
(C) Periodic abstinence	(III) Non-medicated IUDs
(D) Progestasert	(IV) Natural method

Choose the correct answer from the options given below:

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

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

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

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

Q12. Identify the terminal method used to prevent any more pregnancies:

(A) Lactational amenorrhea

(B) Sterilisation

(C) Intra Uterine Device

(D) Periodic abstinence

Q13. Match the Assisted Reproductive Technology (ART) with its description:

ART Procedure	Description
(A) ZIFT	(I) Sperm injected directly into ovum
(B) GIFT	(II) Zygote transferred to fallopian tube
(C) ICSI	(III) Gametes transferred to fallopian tube
(D) IUI	(IV) Artificial insemination of sperm

Choose the correct answer:

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

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

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

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

Q14. Statement I: Phenylketonuria is an example of Pleiotropy.
Statement II: Affected individuals lack an enzyme which converts phenylalanine into tyrosine. In light of the above statements, choose the most appropriate answer:

(A) Both Statement I and Statement II are correct

(B) Both Statement I and Statement II are incorrect

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

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

Q15. Match the genetic disorder with the correct karyotype:

Genetic Disorder	Karyotype/Characteristic
(A) Down's Syndrome	(I) 45 (XO)
(B) Klinefelter's Syndrome	(II) 47 (XXY)
(C) Turner's Syndrome	(III) Trisomy of 21

Choose the correct answer:

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

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

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

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

Q16. If two genes are very tightly linked on the same chromosome, they show:

(A) High recombination

(B) Very low recombination

(C) Independent assortment

(D) 50% recombination frequency

Q17. In a Mendelian dihybrid cross, the frequency of the genotype 'RRYY' in the F_2 generation is:

(A) 1/16

(B) 2/16

(C) 4/16

(D) 9/16

Q18. Arrange the steps of Griffith's experiment in the correct series:

(A) S strain → Mice die

(B) Heat-killed S strain → Mice live

(C) R strain → Mice live

(D) Heat-killed S + Live R → Mice die

Choose the correct answer:

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

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

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

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

Q19. Match the enzyme with its specific function in DNA replication:

Enzyme	Function
(A) Helicase	(I) Joins DNA fragments
(B) DNA Polymerase	(II) Synthesizes RNA primer
(C) Ligase	(III) Unwinds DNA helix
(D) Primase	(IV) Adds nucleotides to the chain

Choose the correct answer:

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

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

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

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

Q20. In the presence of an inducer (Lactose) in the Lac Operon, the repressor protein:

(A) Binds to the operator

(B) Binds to the promoter

(C) Becomes inactive and cannot bind to the operator

(D) Binds to the structural genes

Q21. Identify the correct order of components in a transcription unit:

(A) Promoter, Structural gene, Terminator

(B) Terminator, Promoter, Structural gene

(C) Structural gene, Terminator, Promoter

(D) Promoter, Terminator, Structural gene

Q22. Arrange the steps of DNA Fingerprinting in the correct sequence: (A) Digestion by restriction endonucleases (B) Hybridisation using labeled VNTR probe (C) Blotting to synthetic membranes (D) Isolation of DNA Choose the correct answer:

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

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

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

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

Q23. In a population at Hardy-Weinberg equilibrium, if the frequency of a recessive allele (q) is 0.4, what is the frequency of the heterozygous genotype ($2pq$)?

(A) 0.16

(B) 0.36

(C) 0.48

(D) 0.24

Q24. Arrange the following in the correct chronological order of hominid evolution:
(A) *Homo erectus* (B) *Australopithecus* (C) Neanderthal man (D) *Homo habilis*
Choose the correct answer:

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

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

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

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

Q25. Which of the following is **not** an example of adaptive radiation?

(A) Darwin's Finches

(B) Australian Marsupials

(C) Eye of Octopus and Mammal

(D) Placental mammals in Australia

Q26. Arrange the stages of the life cycle of *Plasmodium* in humans:
(A) Sporozoites enter the liver cells
(B) RBCs burst releasing haemozoin
(C) Parasites reproduce asexually in liver cells

(D) Female *Anopheles* mosquito bites a human

Choose the correct answer:

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

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

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

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

Q27. Match the types of Immunity:

Type of Immunity	**Characteristic/Example**
(A) Innate Immunity	(I) Memory-based response
(B) Acquired Immunity	(II) Present from the time of birth
(C) Active Immunity	(III) Colostrum (IgA)
(D) Passive Immunity	(IV) Produced after an infection

Choose the correct answer:

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

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

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

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

Q28. HIV attacks which specific cells first to replicate in the human body?

(A) B-lymphocytes

(B) Cytotoxic T-cells

(C) Helper T-lymphocytes (T_H)

(D) Red Blood Cells

Q29. Identify the correct property of cancer cells:

(A) Contact inhibition

(B) Regulated cell division

(C) Metastasis

(D) Controlled apoptosis

Q30. Arrange the stages of sewage treatment in the correct order: (A) Primary settling tank (B) Aeration tank (BOD reduction) (C) Grit removal by filtration (D) Anaerobic sludge digester Choose the correct answer:

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

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

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

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

Q31. Match the Biocontrol agents with their targets:

Biocontrol Agent	**Target Pest/Pathogen**
(A) Ladybird	(I) Butterfly caterpillars
(B) Dragonflies	(II) Aphids
(C) *Bacillus thuringiensis*	(III) Mosquitoes
(D) *Trichoderma*	(IV) Several plant pathogens

Choose the correct answer:

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

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

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

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

Q32. Which of the following acts as an important biofertilizer in paddy fields?

(A) *Rhizobium*

(B) *Azospirillum*

(C) Cyanobacteria (*Anabaena*)

(D) *Glomus*

Q33. In the naming of the restriction enzyme *Eco*RI, the part 'co' stands for:

(A) Colon

(B) Coelom

(C) Coli (Species)

(D) Co-enzyme

Q34. Arrange the steps of a PCR cycle in the correct order: (A) Extension (B) Denaturation (C) Annealing Choose the correct answer:

(A) (B), (C), (A)

(B) (A), (B), (C)

(C) (C), (B), (A)

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

Q35. DNA fragments move toward the anode in gel electrophoresis because:

(A) DNA is positively charged

(B) DNA is negatively charged

(C) The anode is negatively charged

(D) Larger fragments move faster than smaller ones

Q36. The most commonly used bioreactors are of the stirring type primarily because:

(A) They are cheap to maintain

(B) They facilitate oxygen availability throughout the reactor

(C) They do not require any sterilization

(D) They work without any power source

Q37. RNA interference (RNAi) takes place in all eukaryotic organisms as a method of:

(A) Cellular defense

(B) Protein synthesis

(C) Lipid metabolism

(D) DNA replication

Q38. The Bt toxin exists as an inactive protoxin in the bacterium but becomes active in the insect gut due to:

(A) Acidic pH of the gut

(B) Alkaline pH of the gut

(C) High temperature of the gut

(D) Presence of specific enzymes only

Q39. The main challenge in producing human insulin (Humulin) using rDNA technology was:

(A) Getting the A-peptide synthesized

(B) Getting the B-peptide synthesized

(C) Assembling the A and B chains with disulfide bonds

(D) Removing the C-peptide from the pro-hormone

Q40. Match the Population interactions:

Population Interaction	**Interaction Sign (+/-)**
(A) Mutualism	(I) (+, -)
(B) Commensalism	(II) (+, +)
(C) Parasitism	(III) (-, -)
(D) Competition	(IV) (+, 0)

Choose the correct answer:

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

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

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

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

Q41. An age pyramid with a broad base (large pre-reproductive population) indicates:

(A) Declining population

(B) Stable population

(C) Growing population

(D) Zero growth rate

Q42. In which of the following groups does parthenogenesis **not** occur?

(A) Rotifers

(B) Honeybees

(C) Lizards

(D) Mammals

Q43. Which ecological pyramid is **always** upright and can never be inverted?

(A) Pyramid of Number

(B) Pyramid of Biomass

(C) Pyramid of Energy

(D) Pyramid of Species Diversity

Q44. Net Primary Productivity (NPP) is mathematically defined as:

(A) GPP + R

(B) GPP - R

(C) GPP $\times$ R

(D) R - GPP

Q45. Select the correct statements regarding patterns of biodiversity: (A) Tropical Amazon rain forest has the greatest biodiversity (B) Species diversity increases as we move toward the poles (C) Tropical environments are less seasonal and more predictable (D) Species richness decreases with increasing explored area Choose the correct answer:

(A) (A) and (C) only

(B) (B) and (D) only

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

(D) (C) and (D) only

Q46. Match the following conservation methods:

Conservation Method	**Classification**
(A) Sacred Groves	(I) Ex-situ conservation
(B) National Parks	(II) In-situ conservation
(C) Zoological Parks	
(D) Seed Banks	

Choose the correct classification for (A), (B), (C), (D):

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

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

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

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

Q47. Which of the ”Evil Quartet” is considered the most important cause driving extinction?

(A) Over-exploitation

(B) Alien species invasion

(C) Habitat loss and fragmentation

(D) Co-extinctions

Q48. Which of the following is an example of ”In-situ” conservation?

(A) Botanical Garden

(B) Wildlife Safari Park

(C) Biosphere Reserve

(D) Cryopreservation

Q49. In the species-area relationship, the Z value (slope of regression) for very large areas like entire continents is in the range of:

(A) 0.1 to 0.2

(B) 0.6 to 1.2

(C) 1.5 to 2.0

(D) 0.2 to 0.4

Q50. To be designated as a biodiversity hotspot, a region must primarily show high levels of:

(A) Species richness and Endemism

(B) Pollution and Habitat loss

(C) Human population density

(D) Annual rainfall and temperature

Detailed Solutions

Q1.

Solution

Concept:

The process of development of a dicot embryo from a zygote (embryogeny) follows a specific morphological sequence: Zygote → Proembryo → Globular Stage → Heart-shaped Stage → Mature Embryo.

Solution:

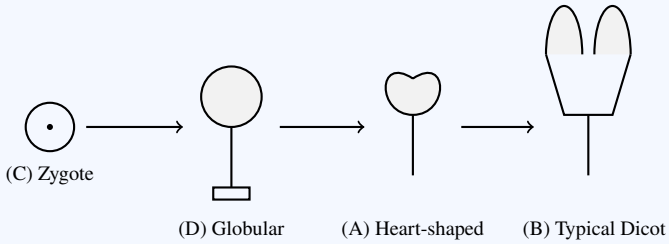
1: The process begins with the formation of the **Zygote (C)** following fertilization.

2: The zygote undergoes mitotic divisions to form a proembryo, which then develops into a spherical **Globular embryo (D)**.

3: As the two cotyledons begin to emerge, the embryo assumes a distinct **Heart-shaped (A)** appearance.

4: Finally, the embryo matures into a **Typical dicot embryo (B)** characterized by a well-developed plumule, radicle, and two cotyledons.

The correct order is (C), (D), (A), (B).



Final Answer:

$\boxed{(A)\ \text{(C), (D), (A), (B)}}$

Answer: (A)

Q2.

Solution

Concept:

Angiosperm reproduction and fruit development involve several specialized biological mechanisms that ensure the propagation of the species. These range from modifications in the fruit-forming process (like parthenocarpy and false fruits) to variations in the reproductive structures themselves (like the embryo sac) and unusual embryo development patterns (like polyembryony). Understanding these requires a clear distinction between the tissues involved and the timing of the processes.

Solution:

1. Polyembryony (A): This refers to the occurrence of more than one embryo in a single seed. In many Citrus species, such as the Orange (III), the nucellar cells surrounding the embryo sac start dividing and protrude into the embryo sac to develop into additional embryos. This results in a seed containing multiple embryos of both gametic and somatic origin.

2. Parthenocarpy (B): This is the physiological process of fruit development without the occurrence of fertilization. Because no fertilization takes place, these fruits are naturally seedless. The Banana (IV) is a classic example of a plant that produces such fruits, which is highly desirable for commercial consumption.

3. False Fruit (C): In most plants, the fruit develops solely from the ovary. However, in "false fruits" or pseudocarps, other floral parts like the thalamus contribute to the fleshy part of the fruit. In an Apple (I), the edible portion is actually the enlarged, fleshy thalamus that surrounds the actual core (ovary).

4. Embryo Sac (D): In the life cycle of an angiosperm, the megaspore undergoes mitotic divisions to form a 7-celled, 8-nucleate structure. This structure is known as the embryo sac and represents the Female gametophyte (II) generation, as it houses the female gamete (egg cell).

5. Matching the items based on these biological definitions: (A) matches with (III), (B) matches with (IV), (C) matches with (I), and (D) matches with (II).

Final Answer: The correct matching is (A)-(III), (B)-(IV), (C)-(I), (D)-(II).

Answer: (A)

Q3.

Solution

Concept:

Water pollination, scientifically known as hydrophily, is a relatively rare mode of pollination occurring in only a small fraction (about 30 genera) of flowering plants. It is important to differentiate between aquatic plants that are truly hydrophilous and those that are merely "water-dwelling" but use wind or insects for pollination. Plants like the water lily or water hyacinth are not water-pollinated because their flowers emerge well above the water surface to attract insects.

Solution:

1. Analysis of Option (A): This statement is incorrect. Most aquatic plants are not pollinated by water. Instead, they produce flowers that emerge above the surface to be pollinated by wind (anemophily) or insects (entomophily). Hydrophily is the exception, not the rule, in the aquatic world.

2. Analysis of Option (B): This statement is incorrect. Pollen grains in water-pollinated plants need to stay suspended in water or float on the surface. Therefore, they are often long, ribbon-like, and have a specific gravity close to that of water to prevent them from sinking. They are not typically spherical or heavy.

3. Analysis of Option (C): This is the correct statement. *Vallisneria* and *Hydrilla* are classic examples of submerged freshwater plants that utilize water for pollination. In *Vallisneria*, the female flower reaches the surface by a long stalk, and male flowers or pollen grains are released onto the surface to be carried by water currents.

4. Analysis of Option (D): This statement is incorrect. Because water-pollinated plants do not need to attract animal vectors, they do not invest energy in making large, colorful, or nectar-rich flowers. Their flowers are typically small and inconspicuous.

5. Additionally, pollen grains in these plants are usually protected from the damaging effects of water by a thick mucilaginous covering.

Final Answer: It occurs in *Vallisneria* and *Hydrilla*.

Answer: (C)

Q4.

Solution

Concept:

The mature female gametophyte (embryo sac) in most angiosperms is a 7-celled, 8-nucleate structure. It contains specific cell types at the micropylar and chalazal poles.

Solution:

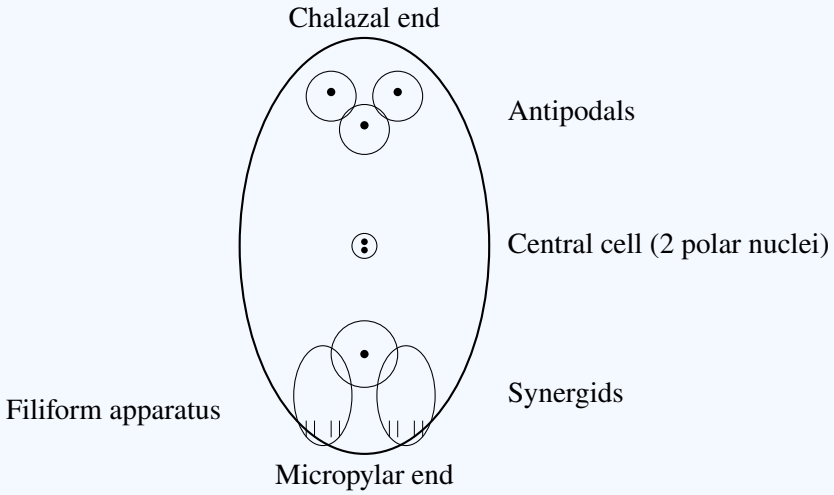
1: The **egg apparatus** is located at the micropylar end and consists of one egg cell and two synergids.

2: **Synergids** possess special cellular thickenings at the micropylar tip called the **filiform apparatus**, which play a vital role in guiding the pollen tube into the synergid.

3: The **central cell** is the largest cell and contains **two** polar nuclei, not three.

4: The **antipodals** are a group of three cells located at the **chalazal end**, opposite to the micropylar end.

Therefore, statement (C) is the only correct statement.



Final Answer:

(C) Synergids have filiform apparatus

Answer: (C)

Q5.

Solution

Concept:

The structure of a seed includes various layers that provide protection and nutrition to the developing embryo. In most plants, the nucellus (the tissue within the ovule that surrounds the embryo sac) is completely consumed as the embryo and endosperm develop. However, in certain specific plant families, the nucellus does not disappear but remains as a persistent, functional tissue layer within the mature seed.

Solution:

1. Analysis of Statement I: In some specific botanical examples, such as black pepper (*Piper nigrum*) and beet (*Beta vulgaris*), the nucellus tissue is not fully utilized during the seed's development. Instead, a residual portion of this diploid maternal tissue remains surrounding the embryo/endosperm complex. This is a well-known anatomical characteristic of these specific plants. Thus, Statement I is correct.

2. Analysis of Statement II: When the nucellus remains persistent in a mature seed, it serves as a storage tissue and is technically referred to as the perisperm. It is important to distinguish this from the endosperm; while endosperm is triploid and formed from the fusion of a sperm and polar nuclei, perisperm is diploid and derived directly from the maternal nucellar tissue. Thus, Statement II is correct.

3. Relationship between statements: Statement I provides the observation of a specific phenomenon in nature (persistent nucellus in pepper and beet), and Statement II provides the scientific nomenclature for that exact phenomenon.

4. Since both statements are factually accurate and align with the principles of plant anatomy and seed morphology, the correct conclusion is that both are true.

Final Answer: Both Statement I and Statement II are true.

Answer: (A)

Q6.

Solution

Concept:

The human placenta is a temporary endocrine organ formed during pregnancy that facilitates the exchange of nutrients, gases, and waste products between the mother and the fetus. Beyond its transport functions, the placenta is a vital endocrine gland that synthesizes and secretes several hormones necessary for maintaining pregnancy, promoting fetal growth, and preparing the mother's body for childbirth and lactation. Understanding which hormones are placental in origin versus those that originate from the pituitary gland is essential for reproductive biology.

Solution:

1. During pregnancy, the placenta takes over the role of hormone production to ensure the uterine environment remains stable. It secretes Human Chorionic Gonadotropin (hCG), which is the first hormone produced and is often used as a marker for pregnancy tests. hCG maintains the corpus luteum so it continues to produce progesterone.

2. The placenta also produces Human Placental Lactogen (hPL), which plays a role in metabolism and prepares the mammary glands for lactation. Additionally, it secretes significant amounts of Estrogens (Option A) and Progestogens (Option B) to maintain the uterine lining and prevent menstruation during gestation.

3. Luteinising Hormone (LH) (Option D), however, is a gonadotropin produced and secreted by the anterior pituitary gland. Its primary roles include triggering ovulation in the menstrual cycle and stimulating the production of testosterone in males. While LH is chemically similar to hCG, it is not synthesized by the placental tissue.

4. Therefore, while the placenta secretes hCG, hPL, estrogen, and progesterone, it does not secrete LH.

Final Answer: Luteinising hormone.

Answer: (D)

Q7.

Solution

Concept:

The menstrual cycle is a complex rhythmic process in human females involving the ovaries and the uterus, regulated by hormones from the pituitary gland and the ovaries. The cycle consists of the menstrual phase, follicular phase, ovulatory phase, and luteal phase. Significant physiological changes occur during these stages, such as the thickening of the endometrium and the release of an egg, which eventually ceases as a woman reaches a certain age.

Solution:

1. Analysis of Statement (A): The first menstruation is called ”menarche,” not menopause. Menopause refers to the permanent cessation of the menstrual cycle. Therefore, statement (A) is incorrect.

2. Analysis of Statement (B): Ovulation is triggered by a sudden surge in Luteinising Hormone (LH), known as the LH surge, around the middle of the cycle (day 14). At this point, progesterone levels are actually low; progesterone levels only peak during the subsequent luteal phase. Therefore, statement (B) is incorrect.

3. Analysis of Statement (C): After ovulation, the ruptured follicle transforms into the corpus luteum, which secretes progesterone. If fertilization does not occur, the corpus luteum degenerates. This leads to a sharp drop in progesterone levels, causing the breakdown of the endometrial lining and resulting in menstruation. Therefore, statement (C) is correct.

4. Analysis of Statement (D): In human females, the menstrual cycles cease around 50 years of age, a stage termed menopause. This marks the end of the reproductive phase. Therefore, statement (D) is correct.

5. Conclusion: Since statements (C) and (D) are the only accurate descriptions of the cycle, the correct option is (B).

Final Answer: (C) and (D) only.

Answer: (B)

Q8.

Solution

Concept:

Spermatogenesis is the biological process by which haploid spermatozoa develop from germ cells in the seminiferous tubules of the testes. This process involves three main stages: mitosis (to increase cell numbers), meiosis (to reduce chromosome numbers to haploid), and spermiogenesis (the transformation of circular spermatids into motile spermatozoa). Understanding the sequential order of these cell types is fundamental to male reproductive physiology.

Solution:

1. The process begins at the basement membrane of the seminiferous tubules with the Spermatogonia (D). These are diploid stem cells that multiply by mitosis to maintain their population and provide cells that will differentiate.

2. Some spermatogonia differentiate into Primary spermatocytes (E), which are also diploid. These cells then undergo the first meiotic division (Meiosis I) to reduce the chromosome number.

3. The result of Meiosis I is the formation of two haploid Secondary Spermatocytes (A). These cells are short-lived and quickly enter the second meiotic division (Meiosis II).

4. Completion of Meiosis II produces four haploid cells called Spermatids (B). These cells are initially non-motile and circular in shape.

5. Finally, through a process called spermiogenesis, the spermatids undergo significant morphological changes to become mature, motile Spermatozoa (C) or sperm cells.

6. The correct sequence is thus: (D) Spermatogonia → (E) Primary spermatocytes → (A) Secondary spermatocytes → (B) Spermatids → (C) Spermatozoa.

Final Answer: (D), (E), (A), (B), (C).

Answer: (B)

Q9.

Solution

Concept:

Human embryonic development follows a specific chronological sequence starting from fertilization in the ampulla of the fallopian tube to implantation in the uterus.

Solution:

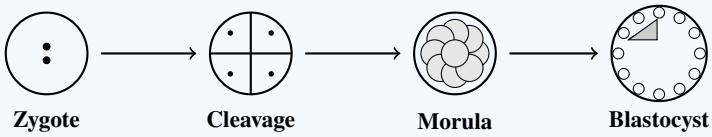
1: The process begins with the **Zygote**, a single diploid cell formed by the fusion of sperm and ovum.

2: The zygote undergoes **Cleavage**, a series of rapid mitotic divisions that increase the cell number without increasing the overall size of the embryo.

3: A solid ball of 8–16 blastomeres is formed, known as the **Morula** (resembling a mulberry).

4: The morula continues to divide and transforms into a **Blastocyst**, which consists of an outer trophoblast layer and an inner cell mass. This is the stage that implants into the endometrium.

5: Comparing the sequences, Option (B) correctly maps this progression.



Final Answer:

(B) Zygote → Cleavage → Morula → Blastocyst

Answer: (B)

Q10.

Solution

Concept:

In the animal kingdom, organisms can be classified based on their reproductive systems. Hermaphrodites (or monoecious organisms) are individuals that possess both male and female reproductive organs, allowing them to produce both eggs and sperm. Conversely, dioecious organisms have separate sexes, where an individual is either male or female. Many lower invertebrates exhibit hermaphroditism, whereas most arthropods and vertebrates have separate sexes.

Solution:

1. Sponges (Option A): Most sponges are hermaphrodites. They typically function as both male and female, though often at different times to ensure cross-fertilization.

2. Earthworms (Option B): Earthworms are classic examples of hermaphroditic animals. Each individual possesses both testes and ovaries, although they still require a partner to exchange sperm during mating.

3. Leech (Option C): Like earthworms, leeches belong to the phylum Annelida and are also hermaphrodites, possessing both sets of reproductive organs within a single body.

4. Cockroach (Option D): Cockroaches belong to the phylum Arthropoda. Unlike the other examples, cockroaches are dioecious, meaning they have distinct male and female individuals. Male cockroaches have testes and a phallomere, while females have ovaries and a spermathaeca.

5. Therefore, the cockroach is the only organism in the list that is not a hermaphrodite.

Final Answer: Cockroach.

Answer: (D)

Q11.

Solution

Concept:

Contraceptive methods are divided into several categories based on their mechanism of action to prevent conception. Natural methods involve avoiding the chance of ovum and sperm meeting. Barrier methods use physical blocks like condoms or diaphragms. Intrauterine Devices (IUDs) are inserted into the uterus and can be non-medicated, copper-releasing, or hormone-releasing. Understanding the specific classification of each device is crucial for medical and biological accuracy.

Solution:

1. Lippes loop (A): This is a plastic double-S-shaped device. It belongs to the category of non-medicated IUDs (III). It works by increasing the phagocytosis of sperm within the uterus without the use of added chemicals or hormones.

2. Vaults (B): These are hemispherical rubber caps that are inserted into the female reproductive tract to cover the cervix during coitus. They act as a physical block to prevent sperm from entering the uterus, thus falling under the Barrier (I) category.

3. Periodic abstinence (C): This is a practice where couples avoid or abstain from coitus from day 10 to 17 of the menstrual cycle when ovulation could be expected. Since it relies on the biological rhythm of the body without any external devices or chemicals, it is a Natural method (IV).

4. Progestasert (D): This is a specific type of IUD that releases the hormone progesterone. By altering the cervical mucus and the uterine lining, it prevents fertilization and implantation. Therefore, it is classified as a Hormone releasing device (II).

5. Matching these based on the categories: (A)-(III), (B)-(I), (C)-(IV), (D)-(II).

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

Answer: (A)

Q12.

Solution

Concept:

Contraceptive methods can be temporary or permanent. Temporary methods like IUDs, barriers, and natural methods are used to space children or delay pregnancy and are reversible. Terminal methods, also known as sterilization, are surgical procedures intended to provide a permanent solution for individuals who do not wish to have any more children. These methods have very high efficacy but are generally considered irreversible.

Solution:

1. Lactational amenorrhea (Option A): This is a natural, temporary method based on the fact that ovulation does not occur during the period of intense lactation following childbirth. It is only effective for a maximum period of six months.

2. Sterilisation (Option B): This is the terminal method. In males, it is called vasectomy (ligation of the vasa deferentia), and in females, it is called tubectomy (ligation of the fallopian tubes). These procedures block gamete transport and thereby prevent conception permanently.

3. Intra Uterine Device (Option C): IUDs are highly effective contraceptives, but they are temporary. They can be removed by a doctor whenever the woman decides she wants to conceive again.

4. Periodic abstinence (Option D): As discussed previously, this is a natural method involving the avoidance of intercourse during the fertile window. It is temporary and has a high failure rate compared to surgical methods.

5. Therefore, sterilization is the only procedure in the list that serves as a permanent, terminal solution to end the reproductive phase.

Final Answer: Sterilisation.

Answer: (B)

Q13.

Solution

Concept:

Assisted Reproductive Technologies (ART) include a variety of specialized techniques used to help individuals or couples conceive when natural conception is not possible. These techniques involve the handling of eggs, sperm, or embryos outside the body (in vitro) or aiding their meeting inside the body (in vivo). Each acronym represents a specific protocol tailored to different causes of infertility.

Solution:

1. ZIFT (A): This stands for Zygote Intra Fallopian Transfer. In this procedure, the egg is fertilized with sperm in a laboratory (In Vitro Fertilization). The resulting zygote (up to the 8-blastomere stage) is then transferred into the fallopian tube (II).

2. GIFT (B): This stands for Gamete Intra Fallopian Transfer. This technique is used for women who cannot produce ova but can provide a suitable environment for fertilization. An ovum collected from a donor is transferred into the fallopian tube (III) along with sperm.

3. ICSI (C): This stands for Intra Cytoplasmic Sperm Injection. It is a highly specialized form of IVF used primarily for male infertility. A single sperm is injected directly into the cytoplasm of the ovum (I) in the laboratory to form an embryo.

4. IUI (D): This stands for Intra-Uterine Insemination. It is a form of artificial insemination (IV) where processed and concentrated sperm are placed directly into the woman's uterus around the time of ovulation to increase the chances of fertilization.

5. The correct matches are: (A)-(II), (B)-(III), (C)-(I), (D)-(IV).

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

Answer: (A)

Q14.

Solution

Concept:

Pleiotropy is a genetic phenomenon where a single gene influences multiple, seemingly unrelated phenotypic traits. A mutation in a pleiotropic gene can have a widespread effect on various systems of the body. Phenylketonuria (PKU) is a classic example of an autosomal recessive metabolic disorder that exhibits pleiotropy, affecting the brain, skin pigmentation, and hair.

Solution:

1. Analysis of Statement I: Phenylketonuria is indeed a primary example of pleiotropy. The disorder is caused by a mutation in a single gene (the PAH gene). This single genetic defect leads to multiple phenotypic expressions, including mental retardation and a reduction in hair and skin pigmentation. Therefore, Statement I is correct.

2. Analysis of Statement II: The biochemical basis of PKU is the lack of the hepatic enzyme phenylalanine hydroxylase. This enzyme is responsible for the metabolic conversion of the amino acid phenylalanine into the amino acid tyrosine. Without this enzyme, phenylalanine accumulates and is converted into phenylpyruvic acid and other derivatives. Therefore, Statement II is correct.

3. The accumulation of these substances in the brain causes mental retardation, and the lack of tyrosine (a precursor for melanin) leads to the pigmentation issues described.

4. Since both the genetic classification (pleiotropy) and the biochemical mechanism (conversion of phenylalanine to tyrosine) are described correctly, both statements are true.

Final Answer: Both Statement I and Statement II are correct.

Answer: (A)

Q15.

Solution

Concept:

Chromosomal disorders are caused by the absence, excess, or abnormal arrangement of one or more chromosomes. These are typically identified through karyotyping.

Solution:

1: **Down's Syndrome (A)** is caused by the presence of an additional copy of chromosome number 21 (Trisomy). Thus, (A) matches with (III).

2: **Klinefelter's Syndrome (B)** is caused by the presence of an additional X-chromosome in males, resulting in a karyotype of 47, XXY. Thus, (B) matches with (II).

3: **Turner's Syndrome (C)** is caused by the absence of one of the X-chromosomes in females, resulting in a karyotype of 45 with XO. Thus, (C) matches with (I).

4: Matching the pairs: (A)-(III), (B)-(II), (C)-(I).

Disorder	Karyotype / Basis
Down's	21 21 21 Trisomy 21 (3 copies)
Klinefelter's	XXY (47 chromosomes)
Turner's	XO (45 chromosomes)

Final Answer:

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

Answer: (A)

Q16.

Solution

Concept:

Linkage and recombination are fundamental concepts in classical genetics that describe the behavior of genes located on the same chromosome. According to Thomas Hunt Morgan's work on *Drosophila*, linkage refers to the physical association of two or more genes on a chromosome. Recombination describes the generation of non-parental gene combinations through crossing over during meiosis. The frequency of recombination is directly proportional to the physical distance between the genes on the chromosome.

Solution:

1. When genes are located on the same chromosome, they are said to be linked. The strength of this linkage depends on how close the genes are to one another.

2. If two genes are very tightly linked, it means they are physically located very close to each other. Because they are so close, the probability of a crossover event occurring between them during prophase I of meiosis is extremely low.

3. In such cases, the parental gene combinations are inherited together much more frequently than non-parental combinations. This results in very low recombination (Option B).

4. Conversely, if genes are loosely linked (far apart), they show higher recombination frequencies. If they are on different chromosomes or very far apart on the same chromosome, they show independent assortment (Option C) with a maximum recombination frequency of 50%.

5. Therefore, tight linkage is characterized by a significant deviation from independent assortment, favoring parental types and resulting in minimal recombinant offspring.

Final Answer: Very low recombination.

Answer: (B)

Q17.

Solution

Concept:

A Mendelian dihybrid cross involves the study of the inheritance of two pairs of contrasting traits simultaneously. In the classic example using pea plants, Gregor Mendel crossed pure-breeding plants with round-yellow seeds ($RRYY$) and wrinkled-green seeds ($rryy$). The F_1 generation is uniformly dihybrid ($RrYy$). When F_1 individuals are self-pollinated, they produce 16 possible combinations in the F_2 generation, usually represented in a 4x4 Punnett square.

Solution:

1. In the F_2 generation of a dihybrid cross ($RrYy \times RrYy$), four types of gametes are produced by each parent: RY, Ry, rY, and ry.

2. The total number of squares in the Punnett square is $4 \times 4 = 16$. Each square represents a genotype in the F_2 generation.

3. The genotype 'RRYY' (homozygous dominant for both traits) can only be formed by the fusion of an 'RY' gamete from the male and an 'RY' gamete from the female.

4. Looking at the Punnett square, there is only one such combination ($RY \times RY$) out of the 16 total possible zygotic combinations.

5. Therefore, the frequency of the 'RRYY' genotype is $1/16$. Note that this is different from the phenotypic frequency of round-yellow plants, which is $9/16$.

Final Answer: $1/16$.

Answer: (A)

Q18.

Solution

Concept:

Frederick Griffith's experiment in 1928, known as the "Transforming Principle" experiment, was a milestone in identifying the genetic material. He worked with *Streptococcus pneumoniae*, which has two strains: the virulent S-strain (smooth/capsulated) and the non-virulent R-strain (rough/non-capsulated). The experiment demonstrated that some "transforming principle" from the heat-killed S-strain could convert the live R-strain into virulent S-strain.

Solution:

1. Griffith first established the nature of the two strains. When he injected the live S-strain (A) into mice, the mice developed pneumonia and died.

2. When he injected the live R-strain (C) into mice, they remained healthy and lived, proving that the R-strain was non-pathogenic.

3. Next, he observed the effect of heat. When he injected the heat-killed S-strain (B) into mice, they lived, showing that the heat treatment had destroyed the ability of the bacteria to cause disease.

4. In the final crucial step, he injected a mixture of heat-killed S-strain and live R-strain (D). Surprisingly, the mice died, and he recovered live S-strain bacteria from the dead mice.

5. The logical sequence of his scientific investigation was to test the live strains first, then the heat-killed version, and finally the combined mixture. This corresponds to the sequence (A), (C), (B), (D).

Final Answer: (A), (C), (B), (D).

Answer: (A)

Q19.

Solution

Concept:

DNA replication is a highly coordinated semi-conservative process requiring an array of specific enzymes. Each enzyme has a specialized role, ensuring that the double helix is opened, the new strands are synthesized with high fidelity, and any gaps are sealed. Understanding these enzymatic functions is key to understanding molecular genetics.

Solution:

1. Helicase (A): Its primary function is to act as a ”zipper” breaker. It uses energy from ATP to break the hydrogen bonds between the nitrogenous bases, thereby unwinding the DNA helix (III) and creating the replication fork.

2. DNA Polymerase (B): This is the main enzyme of replication. It catalyzes the polymerization of deoxynucleotides. It adds nucleotides to the growing DNA chain (IV) in the $5' \rightarrow 3'$ direction, using the existing strand as a template.

3. Ligase (C): This enzyme acts as molecular ”glue.” Its role is to join DNA fragments (I) together. It is particularly important on the lagging strand for sealing the gaps between Okazaki fragments by forming phosphodiester bonds.

4. Primase (D): DNA polymerase cannot initiate DNA synthesis from scratch; it requires a primer. Primase is an RNA polymerase that synthesizes a short RNA primer (II) to provide a $3' - OH$ group for DNA polymerase to start adding nucleotides.

5. Matching the pairs: (A)-(III), (B)-(IV), (C)-(I), (D)-(II).

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

Answer: (A)

Q20.

Solution

Concept:

The Lac Operon is a classic model of gene regulation in prokaryotes (*E. coli*), proposed by Jacob and Monod. It consists of structural genes (z, y, a), an operator, a promoter, and a regulatory gene (i). The operon is typically in the "off" state because a repressor protein, produced by the i gene, binds to the operator and prevents RNA polymerase from transcribing the structural genes.

Solution:

1. In the absence of lactose, the repressor protein is active. It binds to the operator region, physically blocking the RNA polymerase from moving onto the structural genes. No enzymes (beta-galactosidase, permease, transacetylase) are produced.

2. When an inducer, such as lactose or allolactose, is present, it enters the cell. The inducer molecules bind to the repressor protein.

3. This binding causes a conformational change in the repressor protein, rendering it inactive. Because of this change, the repressor becomes inactive and cannot bind to the operator (Option C).

4. With the operator now clear, RNA polymerase can bind to the promoter and proceed with the transcription of the structural genes, allowing the cell to metabolize lactose.

5. Thus, the role of the inducer is to "neutralize" the repressor so that the operon can be switched on.

Final Answer: Becomes inactive and cannot bind to the operator.

Answer: (C)

Q21.

Solution

Concept:

A transcription unit is a segment of DNA that is transcribed into an RNA molecule. In molecular biology, this unit is defined by specific boundary sequences that dictate where transcription should begin and where it should end. It consists of three primary regions: a region that facilitates the binding of RNA polymerase, a region that contains the actual genetic information to be copied, and a region that signals the termination of the process.

Solution:

1. The first component is the Promoter. This is a specific DNA sequence located towards the 5′-end (upstream) of the structural gene. It serves as the binding site for RNA polymerase and determines which strand acts as the template.

2. The second component is the Structural gene. This is the actual area of the DNA between the promoter and the terminator that is transcribed into RNA. In a polycistronic unit (prokaryotes), it may code for multiple proteins, while in monocistronic units (eukaryotes), it typically codes for one.

3. The third component is the Terminator. This sequence is located towards the 3′-end (downstream) of the structural gene. It provides the signal to the RNA polymerase to stop transcription and release the newly synthesized RNA strand.

4. Therefore, the physical arrangement on the DNA strand always follows the linear order: Promoter followed by the Structural gene, and ending with the Terminator.

Final Answer: Promoter, Structural gene, Terminator.

Answer: (A)

Q22.

Solution

Concept:

DNA Fingerprinting, developed by Alec Jeffreys, is a technique used to identify individuals based on unique patterns in their DNA, specifically Variable Number Tandem Repeats (VNTRs). The process involves a series of laboratory steps that move from raw biological samples to a visual representation (autoradiogram) of the DNA fragments. Accuracy in the sequence of these steps is vital for the success of the analysis.

Solution:

1. The process must begin with the Isolation of DNA (D) from the cells (e.g., blood, hair follicle, or skin). The DNA is then purified to remove proteins and other cellular debris.

2. Once the DNA is isolated, it is subjected to Digestion by restriction endonucleases (A). these ”molecular scissors” cut the DNA into fragments of varying lengths, including the satellite DNA regions.

3. The fragments are separated by gel electrophoresis and then transferred to a synthetic membrane (like nitrocellulose or nylon) in a process called Blotting to synthetic membranes (C). This makes the fragments accessible for the next step.

4. Finally, the membrane is exposed to radioactive or fluorescent probes in a called Hybridisation using labeled VNTR probe (B). The probes bind to complementary sequences, which are then visualized using autoradiography.

5. The correct logical and technical sequence is: (D) Isolation → (A) Digestion → (C) Blotting → (B) Hybridisation.

Final Answer: (D), (A), (C), (B).

Answer: (A)

Q23.

Solution

Concept:

The Hardy-Weinberg principle provides a mathematical model to study the genetic structure of a non-evolving population. It states that allele frequencies (p and q) and genotype frequencies (p^2, $2pq$, and q^2) remain constant from generation to generation in the absence of evolutionary influences. The fundamental equations are $p + q = 1$ (for alleles) and $p^2 + 2pq + q^2 = 1$ (for genotypes), where $2pq$ represents the frequency of the heterozygotes.

Solution:

1. We are given the frequency of the recessive allele, denoted as $q = 0.4$.

2. According to the first equation of the Hardy-Weinberg equilibrium ($p + q = 1$), we can calculate the frequency of the dominant allele (p):

$$p = 1 - q = 1 - 0.4 = 0.6$$

3. The frequency of the heterozygous genotype in the population is represented by the term $2pq$ in the expansion of $(p + q)^2$.

4. Now, substitute the values of p and q into the formula:

$$2pq = 2 \times (0.6) \times (0.4)$$

5. Performing the calculation:

$$2 \times 0.24 = 0.48$$

6. Thus, 48% of the population consists of heterozygous individuals. To verify, $p^2(0.36) + 2pq(0.48) + q^2(0.16) = 1.0$.

Final Answer: 0.48.

Answer: (C)

Q24.

Solution

Concept:

Hominid evolution is the evolutionary process leading to the appearance of modern humans. It is characterized by progressive changes in brain capacity, tool use, bipedalism, and facial structure. Fossil evidence allows us to map the chronological appearance of different ancestors within the genus *Homo* and its predecessors. Understanding the timeline from the early ape-like ancestors to modern *Homo sapiens* is essential for physical anthropology.

Solution:

1. The earliest group in this list is *Australopithecus* (B). They lived around 2 to 4 million years ago in East African grasslands. They were bipedal but had a small brain capacity (about 400–600 cc).

2. Next came *Homo habilis* (D), the "handy man." Appearing about 2 million years ago, they were the first to be classified under the genus *Homo* and were the first known tool-makers, with a brain capacity of 650–800 cc.

3. This was followed by *Homo erectus* (A) about 1.5 million years ago. They had a larger brain (around 900 cc), ate meat, and were likely the first to use fire and migrate extensively out of Africa.

4. Much later, Neanderthal man (C) appeared (around 100,000 to 40,000 years ago). They had a very large brain capacity (1400 cc) and lived in near East and Central Asia, exhibiting complex behaviors like burying their dead.

5. The chronological order is therefore: *Australopithecus* → *Homo habilis* → *Homo erectus* → Neanderthal man.

Final Answer: (B), (D), (A), (C).

Answer: (A)

Q25.

Solution

Concept:

Adaptive radiation is an evolutionary process where an ancestral species evolves into an array of different forms that occupy different ecological niches. This usually happens when a single lineage enters a new environment with diverse resources. Conversely, convergent evolution occurs when different lineages evolve similar features independently to adapt to similar environmental pressures.

Solution:

1. Darwin's Finches (Option A): These are the classic example of adaptive radiation. A single ancestral finch from the mainland reached the Galapagos Islands and diversified into many species with different beak shapes to exploit various food sources.

2. Australian Marsupials (Option B): A number of different marsupials, each evolved from an ancestral stock, exist in the Australian continent. This is another prime example of adaptive radiation within an isolated landmass.

3. Placental mammals in Australia (Option D): Like the marsupials, placental mammals in Australia also exhibit adaptive radiation. When a marsupial and a placental mammal evolve similar traits (e.g., Flying phalanger and Flying squirrel), it is called convergent evolution, but within their own groups, they radiated.

4. Eye of Octopus and Mammal (Option C): This is a classic example of Convergent Evolution, not adaptive radiation. The octopus (a mollusk) and the mammal (a vertebrate) have very similar eye structures, but they do not share a recent common ancestor with that eye type. They evolved similar structures to solve the same problem (vision).

5. Therefore, the eye of the octopus and mammal is the outlier in this list.

[Image comparing the eyes of an octopus and a mammal as an example of convergent evolution]

Final Answer: Eye of Octopus and Mammal.

Answer: (C)

Q26.

Solution

Concept:

The life cycle of the malarial parasite, *Plasmodium*, is a complex biological process that requires two hosts: the female *Anopheles* mosquito (vector) and humans. In humans, the parasite undergoes asexual reproduction (schizogony), primarily within the liver and then the red blood cells (RBCs). The symptoms of malaria, such as recurring high fever and chills, are directly linked to the periodic rupture of RBCs and the release of metabolic toxins.

Solution:

1. The infection begins when an infected female *Anopheles* mosquito bites a human (D). During the bite, the infectious stage of the parasite, called sporozoites, is injected into the human bloodstream along with the mosquito's saliva.

2. These sporozoites travel through the blood and quickly enter the liver cells (A) within 30 minutes of the bite to escape the host's immune system.

3. Inside the hepatocytes, the parasites reproduce asexually in liver cells (C), producing thousands of merozoites. This stage is known as the pre-erythrocytic cycle and is asymptomatic.

4. Eventually, the liver cells burst, and the parasites enter the bloodstream to attack the erythrocytes. As they multiply within the blood, the RBCs burst releasing haemozoin (B) and new merozoites. Haemozoin is the toxic substance responsible for the characteristic malarial chills and high fever.

5. Therefore, the logical progression is: Mosquito bite $\rightarrow$ Liver entry $\rightarrow$ Asexual reproduction in liver $\rightarrow$ RBC rupture.

Final Answer: (D), (A), (C), (B).

Answer: (A)

Q27.

Solution

Concept:

Immunity is the overall ability of the host to fight disease-causing organisms. It is categorized into two main types: Innate (non-specific, present from birth) and Acquired (pathogen-specific, developed after exposure). Furthermore, acquired immunity can be Active (the body produces its own antibodies) or Passive (ready-made antibodies are transferred from another source). These distinctions are vital for understanding how the body defends itself and how vaccines work.

Solution:

1. Innate Immunity (A): This is the first line of defense and is non-specific. It consists of various barriers (physical, physiological, cellular, and cytokine) and is present from the time of birth (II).

2. Acquired Immunity (B): Unlike innate immunity, this is characterized by memory. When the body encounters a pathogen for the first time, it produces a primary response and stores the information. This is a memory-based response (I).

3. Active Immunity (C): This occurs when the host is exposed to antigens (living or dead microbes) and the host's own body produces antibodies. This usually happens naturally produced after an infection (IV) or through vaccination.

4. Passive Immunity (D): This involves the direct transfer of pre-formed antibodies to the individual. A natural example is the transfer of Colostrum (IgA) (III) from mother to infant through breast milk, providing immediate protection.

5. Correlating these: (A)-(II), (B)-(I), (C)-(IV), (D)-(III).

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

Answer: (A)

Q28.

Solution

Concept:

Human Immunodeficiency Virus (HIV) is a retrovirus that targets the immune system, specifically cells that carry the CD4 receptor. Upon entering the human body, the virus acts as a parasite of the immune system's coordination center. It uses an enzyme called reverse transcriptase to convert its RNA genome into DNA, which then integrates into the host cell's genome to produce more viral particles.

Solution:

1. After entering the body, HIV first enters macrophages, which act as an "HIV factory." However, the critical depletion that leads to the symptoms of AIDS occurs in a different cell type.

2. The virus specifically targets and attacks Helper T-lymphocytes (T_H) (Option C). These cells are essential for coordinating the immune response by activating both B-cells (for antibody production) and Cytotoxic T-cells.

3. Inside the Helper T-cells, the virus replicates and produces progeny viruses. These new viruses are released into the blood and attack other Helper T-lymphocytes.

4. This progressive decrease in the number of Helper T-lymphocytes weakens the immune system so significantly that the person becomes vulnerable to even minor opportunistic infections (like *Mycobacterium*, fungi, and parasites like *Toxoplasma*).

5. While it may interact with other cells, its primary and most devastating target for replication and depletion is the Helper T-lymphocyte.

Final Answer: Helper T-lymphocytes (T_H).

Answer: (C)

Q29.

Solution

Concept:

Cancer is a disease characterized by the breakdown of normal regulatory mechanisms that control cell growth and division. Normal cells show a property where they stop growing when they come into contact with other cells. Cancer cells lose this control, leading to the formation of masses of cells called tumors. These tumors can be benign (localized) or malignant (invasive).

Solution:

1. Contact inhibition (Option A): This is a property of **normal** cells. When normal cells come in contact with other cells, their further uncontrolled growth is inhibited. Cancer cells lose this property.

2. Regulated cell division (Option B): In cancer, the mechanisms that regulate the cell cycle and division are broken. Cancer cells divide in an unregulated, continuous manner.

3. Metastasis (Option C): This is the most feared and characteristic property of malignant cancer cells. Cells sloughed from primary tumors reach distant sites through the blood and start a new tumor there. This ability to spread to other organs is called metastasis.

4. Controlled apoptosis (Option D): Apoptosis is ”programmed cell death.” Normal cells undergo apoptosis when they are damaged or old. Cancer cells often develop mutations that allow them to evade apoptosis, leading to their ”immortality.”

5. Therefore, metastasis is the definitive property that distinguishes malignant cancer cells from normal cells and benign tumors.

Final Answer: Metastasis.

Answer: (C)

Q30.

Solution

Concept:

Sewage treatment is a multi-process designed to reduce the organic and pathogenic load of municipal wastewater before it is discharged into natural water bodies. It involves physical removal of particles (Primary Treatment) and biological degradation of organic matter by microbes (Secondary Treatment). The efficiency of the treatment is often measured by the reduction in Biochemical Oxygen Demand (BOD).

Solution:

1. The first involves physical removal of large and small particles. Floating debris is removed by sequential filtration, followed by Grit removal by filtration (C) and sedimentation to remove soil and small pebbles.

2. The sewage then passes into the Primary settling tank (A). Here, the floating solids are removed, and the ”primary sludge” settles down, while the supernatant forms the primary effluent.

3. The primary effluent is then passed into large Aeration tanks (B). Constant agitation and air pumping allow ”flocs” (masses of bacteria and fungal filaments) to grow. These microbes consume the organic matter, leading to significant BOD reduction.

4. Finally, the effluent is passed to a settling tank where the bacterial flocs settle (activated sludge). A part of this is pumped into Anaerobic sludge digester (D), where anaerobic bacteria digest the sludge, producing biogas.

5. The correct sequence of operations is: Grit removal → Primary settling → Aeration → Anaerobic digestion.

[Image of the stages of sewage treatment plant]

Final Answer: (C), (A), (B), (D).

Answer: (C)

Q31.

Solution

Concept:

Microbes play a significant role in various industrial and household processes. Each microorganism has a unique metabolic pathway that produces specific chemicals, enzymes, or bioactive molecules as byproducts. For example, some fungi produce cholesterol-lowering agents, while certain bacteria are utilized for their ability to produce organic acids or enzymes that dissolve blood clots. Understanding these specific associations is a core part of industrial microbiology.

Solution:

1. Aspergillus niger (A): This is a filamentous fungus. It is commercially used for the large-scale production of Citric acid (III). Citric acid is widely used in the food and beverage industry as a preservative and flavoring agent.

2. Acetobacter aceti (B): This is a Gram-negative bacterium. It is well-known for its ability to oxidize ethanol into acetic acid, making it the primary microbe used in the production of Vinegar (IV).

3. Trichoderma polysporum (C): This is a fungus from which a very important bioactive molecule, Cyclosporin A (I), is extracted. Cyclosporin A is an effective immunosuppressive agent used to prevent organ rejection in transplant patients.

4. Monascus purpureus (D): This yeast is used to produce Statins (II). Statins are bioactive molecules that act as competitive inhibitors of the enzyme responsible for cholesterol synthesis, thus helping to lower blood cholesterol levels.

5. Correlating the microbe with its respective product: (A)-(III), (B)-(IV), (C)-(I), (D)-(II).

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

Answer: (A)

Q32.

Solution

Concept:

In Biotechnology, restriction endonucleases (often called ”molecular scissors”) are used to cut DNA at specific palindromic sequences. The nomenclature of these enzymes follows a standardized rule based on the organism from which they are isolated. For example, in the enzyme EcoRI, ’E’ stands for the genus, ’co’ for the species, ’R’ for the strain, and ’I’ for the order of discovery.

Solution:

1. Analysis of the Source: The enzyme HindII was the first restriction endonuclease to be isolated and characterized. It is obtained from the bacterium *Haemophilus influenzae*.

2. Understanding the Name: In the name HindII: - ”H” represents the genus *Haemophilus*.
- ”in” represents the species *influenzae*.
- ”d” represents the strain (Rd).
- ”II” (Roman numeral) indicates the order in which the enzyme was isolated from that strain.

3. Function: HindII recognizes a specific sequence of six base pairs and always cuts the DNA at a particular point within that sequence. It produces ”blunt ends” rather than ”sticky ends.”

4. Therefore, among the choices provided, *Haemophilus influenzae* is the correct biological source of this historically significant enzyme.

Final Answer: Haemophilus influenzae.

Answer: (A)

Q33.

Solution

Concept:

The process of recombinant DNA technology involves several precise steps to isolate, manipulate, and multiply a specific DNA fragment. Gel electrophoresis is a fundamental technique used to separate DNA fragments based on their size. Since DNA is negatively charged due to its phosphate backbone, it moves toward the positive electrode (anode) when placed in an electric field.

Solution:

1. The first in the procedure is the Digestion of DNA by restriction endonucleases (C). This breaks the long DNA molecule into smaller fragments of various lengths.

2. Next, these fragments are loaded into a gel (usually agarose) for Separation of DNA fragments by electrophoresis (A). Smaller fragments move faster and further through the gel pores than larger ones.

3. Once separated, the DNA is invisible to the naked eye. It must be stained with Ethidium bromide (D) and then visualized under ultraviolet (UV) light. This makes the DNA appear as bright orange-colored bands.

4. Finally, the desired DNA band is cut out from the agarose gel and the DNA is extracted from the gel piece. This specific extraction process is known as Elution (B).

5. The correct logical sequence of these laboratory operations is: Digestion $\rightarrow$ Separation $\rightarrow$ Staining $\rightarrow$ Elution.

Final Answer: (C), (A), (D), (B).

Answer: (A)

Q34.

Solution

Concept:

Polymerase Chain Reaction (PCR) is a technique used to amplify a specific segment of DNA into millions of copies in a very short time. It relies on a thermostable DNA polymerase (like Taq polymerase) and a series of temperature changes. The process consists of three main steps that are repeated for 20 to 30 cycles.

Solution:

1. Denaturation (A): This is the first where the double-stranded DNA is heated to a high temperature (around 94°C). This high heat breaks the hydrogen bonds between the two strands, causing them to separate into single strands.

2. Annealing (B): The temperature is lowered (around 50°C to 65°C) to allow two sets of primers (small chemically synthesized oligonucleotides) to bind (anneal) to their complementary sequences on the single-stranded DNA templates.

3. Extension (C): The temperature is raised slightly (around 72°C), and the enzyme DNA polymerase (Taq polymerase) adds nucleotides to the 3′-end of the primers, using the genomic DNA as a template. This extends the primers into full-length strands.

4. By repeating these three steps (Denaturation → Annealing → Extension) multiple times, the target DNA segment can be amplified exponentially.

Final Answer: Denaturation, Annealing, Extension.

Answer: (A)

Q35.

Solution

Concept:

Bt cotton is a genetically modified (GM) crop that has been engineered to be resistant to specific pests, primarily the cotton bollworm. This is achieved by incorporating genes from the soil bacterium *Bacillus thuringiensis*. These genes (known as *cry* genes) encode for a crystalline protein that acts as an insecticide.

Solution:

1. Analysis of Statement I: *Bt* cotton is indeed created by the expression of specific genes from *Bacillus thuringiensis*. For example, the genes *cryIAc* and *cryIIAb* are specifically used to control cotton bollworms. Therefore, Statement I is correct.

2. Analysis of Statement II: The *Bt* toxin protein exists as an inactive protoxin in the bacterium and within the plant tissues. It does not harm the plant or the bacteria. However, once an insect ingests the plant tissue, the protoxin is converted into its active form due to the alkaline pH of the insect's gut. The active toxin then binds to the surface of the midgut epithelial cells, creating pores that cause cell swelling and lysis, eventually leading to the death of the insect. Thus, Statement II is correct.

3. Conclusion: Both statements accurately reflect the biotechnological and physiological mechanisms that make *Bt* cotton an effective pest-resistant crop.

Final Answer: Both Statement I and Statement II are correct.

Answer: (A)

Q36.

Solution

Concept:

The human insulin molecule is a protein hormone that plays a critical role in regulating glucose metabolism. In its functional form, it is a relatively small protein consisting of 51 amino acids arranged in two short polypeptide chains: Chain A and Chain B. These chains are linked together by strong covalent bonds known as disulphide bridges. Understanding the structural differences between ”pro-insulin” and ”mature insulin” was a key challenge in the development of recombinant DNA-derived insulin (Humulin).

Solution:

1. In humans and other mammals, insulin is synthesized as a ”pro-hormone” or pro-insulin. This precursor molecule contains an extra stretch of polypeptide called the C-peptide (Connecting peptide).

2. During the maturation of pro-insulin into functional insulin, this C-peptide is proteolytically removed. Therefore, mature, active insulin circulating in the blood does not contain the C-peptide.

3. The mature insulin molecule consists of two polypeptide chains: Chain A (21 amino acids) and Chain B (30 amino acids).

4. These two chains are held together by two inter-chain disulphide bonds (S-S bonds). Specifically, these bonds form between the cysteine residues of the respective chains. There is also an intra-chain disulphide bond within Chain A.

5. In 1983, the American company Eli Lilly succeeded in producing human insulin using E. coli by separately synthesizing Chain A and Chain B and then joining them by creating disulphide bonds in a laboratory setting.

6. Based on this structural data, the correct statement is that mature insulin consists of two polypeptide chains linked by disulphide bonds.

Final Answer: Two short polypeptide chains are linked together by disulphide bridges.

Answer: (A)

Q37.

Solution

Concept:

In ecology, the interactions between different species in a community are classified based on the effect each species has on the other. These interactions can be beneficial (+), detrimental (-), or neutral (0). Commensalism is a unique type of interaction where one species (the commensal) benefits, while the other species (the host) is neither significantly helped nor harmed by the association.

Solution:

1. Analysis of Cattle egret and grazing cattle (Option A): As the cattle move and graze, they flush out insects from the grass. The egrets follow the cattle and catch these insects. The egret benefits (gets food), while the cattle are unaffected. This is a classic example of Commensalism.

2. Analysis of Sea anemone and Clownfish (Option B): The clownfish lives among the stinging tentacles of the sea anemone. This provides the fish with protection from predators that avoid the anemone. The fish benefits, while the sea anemone does not appear to derive any clear benefit or harm. This is also Commensalism.

3. Analysis of Mango branch and Orchid (Option C): An epiphytic orchid grows on the branch of a mango tree to gain better access to sunlight. The orchid benefits, while the mango tree is not significantly harmed or helped. This is another example of Commensalism.

4. Analysis of Cuscuta and Host plant (Option D): *Cuscuta* (dodder) is a parasitic plant that lacks chlorophyll. It develops haustoria that penetrate the host plant's tissues to derive nutrition. In this case, *Cuscuta* benefits (+), but the host plant is harmed (-). This interaction is Parasitism, not commensalism.

5. Therefore, *Cuscuta* is the outlier as it represents a parasitic relationship.

Final Answer: *Cuscuta* and host plant.

Answer: (D)

Q38.

Solution

Concept:

Ecological pyramids provide a graphical representation of the trophic structure and function of an ecosystem. They can represent number, biomass, or energy at each trophic level. In most terrestrial ecosystems, these pyramids are ”upright,” meaning the base (producers) is larger than the successive levels. However, in certain specific environments, the pyramid of biomass can be ”inverted” due to the rapid turnover and high productivity of the lower trophic levels.

Solution:

1. Pyramid of Numbers in a Grassland (Option A): This is typically upright, as a large number of grass plants support a smaller number of herbivores, which in turn support fewer carnivores.

2. Pyramid of Biomass in a Forest (Option B): This is also upright. The total dry weight of the massive trees far exceeds the biomass of the herbivores (insects, birds, deer) and top carnivores (tigers, hawks).

3. Pyramid of Biomass in a Sea (Option C): This is a unique exception. In the ocean, the primary producers are tiny phytoplankton. Although they have a very high rate of reproduction, their ”standing crop” biomass at any single moment is much lower than the biomass of the larger, long-lived consumers like fish. This results in an inverted pyramid.

4. Pyramid of Energy (Option D): According to the laws of thermodynamics and the 10% law, energy is always lost as heat at each trophic level. Therefore, the pyramid of energy is always upright in every ecosystem, without exception.

5. Thus, the sea ecosystem is the one that typically exhibits an inverted pyramid of biomass.

Final Answer: Pyramid of biomass in a sea.

Answer: (C)

Q39.

Solution

Concept:

Decomposition is a complex biological process where decomposers (bacteria, fungi, and detritivores) break down complex organic matter (detritus) into simpler inorganic substances like carbon dioxide, water, and nutrients. This process is essential for nutrient cycling in an ecosystem. Decomposition involves several simultaneous stages: fragmentation, leaching, catabolism, humification, and mineralization.

Solution:

1. Fragmentation (A): This is the first where detritivores, such as earthworms, break down the detritus into smaller particles. This increases the surface area for microbial action. (III)

2. Leaching (B): In this process, water-soluble inorganic nutrients from the detritus pass down into the soil profile and become precipitated as unavailable salts. (IV)

3. Catabolism (C): Bacterial and fungal enzymes degrade the detritus (and smaller particles) into simpler inorganic substances. This is the primary chemical breakdown step. (I)

4. Mineralization (D): This is the final where the humus is further degraded by some microbes, resulting in the release of inorganic nutrients back into the soil for plant uptake. (II)

5. Note: Humification is the process that leads to the accumulation of a dark-colored, amorphous substance called humus, which is highly resistant to microbial action.

6. Matching the terms: (A)-(III), (B)-(IV), (C)-(I), (D)-(II).

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

Answer: (A)

Q40.

Solution

Concept:

The "Evil Quartet" is a term used in conservation biology to describe the four major causes of biodiversity loss. These drivers are responsible for the accelerated rates of extinction observed globally in recent centuries. Identifying and understanding these causes is the first in developing effective conservation strategies to protect the Earth's remaining biological diversity.

Solution:

1. Habitat loss and fragmentation: This is considered the single most important cause driving animals and plants to extinction. When large habitats are broken into small fragments due to human activities, species with large territories and those with specific migratory habits are badly affected.

2. Over-exploitation: When humans "over-harvest" natural resources for food or commerce beyond the population's ability to recover (e.g., Steller's sea cow, passenger pigeon), it leads to extinction.

3. Alien species invasions: When non-native species are introduced (intentionally or accidentally) into a new area, they may become invasive and cause the decline or extinction of indigenous species (e.g., Nile perch in Lake Victoria).

4. Co-extinctions: When a species becomes extinct, the plant and animal species associated with it in an obligatory way also become extinct. For example, if a host fish becomes extinct, its unique assemblage of parasites also meets the same fate.

5. Analysis of options: Habitat loss (Option A), Alien species (Option B), and Co-extinctions (Option C) are all members of the Evil Quartet. Pollution (Option D), while a threat to ecosystems, is not historically categorized as one of the "big four" in the Evil Quartet framework.

Final Answer: Pollution.

Answer: (D)

Q41.

Solution

Concept:

The structure of a typical microsporangium in an angiosperm anther is generally circular in outline and is surrounded by four distinct wall layers. These layers, from the outermost to the innermost, are the epidermis, endothecium, middle layers, and the tapetum. Each layer has a specialized role, ranging from providing physical protection to the developing pollen to ensuring the successful release of mature pollen grains through dehiscence.

Solution:

1. The outer three layers (Epidermis, Endothecium, and Middle layers) share a common primary function. They provide a physical protective barrier for the microsporangium and help in the dehiscence of the anther to release the pollen.

2. The Epidermis is the single outermost protective layer.

3. The Endothecium is the layer below the epidermis, which often develops fibrous thickenings that assist in the mechanical opening of the anther.

4. The Middle layers consist of two to three layers of cells that usually degenerate as the anther matures.

5. The Tapetum (Option D) is the innermost wall layer. It is characterized by cells having dense cytoplasm and generally possessing more than one nucleus (multi-nucleated). Its primary biological role is to provide nourishment to the developing pollen grains (microspores).

6. Therefore, while the first three layers are protective and mechanical, the tapetum is strictly nutritive.

Final Answer: Tapetum.

Answer: (D)

Q42.

Solution

Concept:

In many flowering plants, the ovary develops into a fruit following fertilization. However, in some species, the ovary contains a tissue called the nucellus that may not be completely consumed during the development of the embryo and endosperm. When this diploid maternal tissue persists in the mature seed, it forms a specialized storage layer. Understanding this structure is key to identifying seed types in specific families like Piperaceae.

Solution:

1. In most angiosperm seeds, the nucellus is used up as a source of nutrition for the developing embryo.

2. In certain seeds, such as those of Black pepper (*Piper nigrum*) and Beet, the nucellus remains as a persistent, thin layer surrounding the endosperm.

3. This persistent nucellar tissue is scientifically referred to as the perisperm (Option C).

4. It is important to distinguish this from the endosperm (Option B), which is a triploid tissue formed by triple fusion. The perisperm is diploid because it is part of the original ovule tissue (nucellus).

5. The tegmen (Option A) is the inner layer of the seed coat derived from the inner integument, and the hilum (Option D) is the scar on the seed coat where it was attached to the stalk (funiculus).

6. Thus, the correct term for the residual nucellus is perisperm.

Final Answer: Perisperm.

Answer: (C)

Q43.

Solution

Concept:

Human reproduction involves several accessory ducts and glands that support the maturation, transport, and survival of gametes. In the male reproductive system, the pathway for sperm transport consists of a series of interconnected ducts starting from the testes. Knowledge of this anatomical sequence is essential for understanding how sperm reaches the exterior of the body during ejaculation.

Solution:

1. Sperm production occurs in the seminiferous tubules of the testes. From there, the sperm first enters a network of tubules called the Rete testis.

2. From the rete testis, the sperm travels through the Vasa efferentia, which lead out of the testis and open into the Epididymis.

3. The Epididymis is a long, coiled tube located along the posterior surface of each testis where sperm are stored and undergo maturation.

4. The epididymis then leads into the Vas deferens (Option B), which ascends into the abdominal cavity and loops over the urinary bladder.

5. The vas deferens receives a duct from the seminal vesicle and opens into the urethra as the ejaculatory duct.

6. The Vagina (Option A), Cervix (Option C), and Fallopian tubes (Option D) are all components of the female reproductive system and are not involved in the male duct system.

Final Answer: Vas deferens.

Answer: (B)

Q44.

Solution

Concept:

The development of the human embryo follows a precise timeline during the nine months of pregnancy. Each month is characterized by the formation of specific organs or physical features. Doctors and embryologists use these milestones to monitor the healthy progress of gestation. One of the earliest and most significant signs of a developing fetus is the initiation of its circulatory system.

Solution:

1. In humans, after one month of pregnancy, the embryo's heart (Option A) is formed. This is the first functional organ to develop, and its heartbeat can be detected using a stethoscope or ultrasound.

2. By the end of the second month of pregnancy, the fetus develops limbs and digits (Option B).

3. By the end of twelve weeks (first trimester), most of the major organ systems are formed, and the external genitalia (Option D) become well-developed.

4. During the fifth month, the first movements of the fetus are observed, and hair appears on the head.

5. By the end of the second trimester (24 weeks), the body is covered with fine hair, eyelids separate, and eyelashes (Option C) are formed.

6. Therefore, the very first major milestone at the end of the first month is the formation of the heart.

Final Answer: Heart.

Answer: (A)

Q45.

Solution

Concept:

Medical Termination of Pregnancy (MTP) refers to the intentional or voluntary termination of pregnancy before full term. It is also commonly known as induced abortion. In many countries, including India, MTP is legalized but regulated by strict conditions to prevent misuse (such as female foeticide) and to ensure the safety of the mother. The safety of the procedure depends heavily on the stage of pregnancy at which it is performed.

Solution:

1. MTPs are considered relatively safe only during a specific window of the pregnancy.

2. The first trimester, which covers the period up to 12 weeks of pregnancy (Option A), is the safest time for an induced abortion. During this stage, the procedure is surgically simpler and carries fewer risks of maternal complications.

3. Second-trimester abortions (after 12 weeks and up to 24 weeks) are much more risky and complicated, as the fetus is more developed and the connection to the maternal tissues is stronger.

4. Many legal frameworks, such as the MTP Act in India, require the opinion of one registered medical practitioner for a first-trimester MTP, but two practitioners for a second-trimester MTP due to the increased health risks.

5. Terminations after the second trimester (Option D) are generally not performed unless there is a severe threat to the life of the mother or significant fetal abnormalities.

Final Answer: First trimester.

Answer: (A)

Q46.

Solution

Concept:

Mendelian genetics is built upon the observation of inheritance patterns in pea plants. The "Law of Segregation" states that allele pairs separate or segregate during gamete formation, and randomly unite at fertilization. A "Test Cross" is a specific genetic cross used to determine the unknown genotype of an individual expressing a dominant phenotype. This is achieved by crossing the individual with a homozygous recessive parent for the same trait.

Solution:

1. If we have a pea plant with a dominant phenotype (e.g., Violet flowers), its genotype could be either homozygous dominant (WW) or heterozygous (Ww).

2. To identify the genotype, we perform a test cross by crossing it with a homozygous recessive plant (White flowers, ww).

3. Case 1: If the unknown plant is WW, all offspring of the cross ($WW \times ww$) will be Ww and express the dominant phenotype (100% Violet).

4. Case 2: If the unknown plant is Ww, the offspring of the cross ($Ww \times ww$) will be 50% Ww (Violet) and 50% ww (White). This 1:1 ratio confirms the heterozygosity of the parent.

5. The Monohybrid cross (Option A) and Dihybrid cross (Option B) are general terms for crossing one or two traits. Back cross (Option C) is a broader term that includes crossing the F_1 with *any* of the parents, whereas a test cross specifically uses the recessive parent.

6. Therefore, the test cross is the definitive diagnostic tool in classical genetics for determining zygosity.

Final Answer: Test cross.

Answer: (D)

Q47.

Solution

Concept:

DNA is a long polymer of deoxyribonucleotides. The structural unit, a nucleotide, consists of three components: a nitrogenous base, a pentose sugar (deoxyribose), and a phosphate group. The nitrogenous bases are categorized into Purines (Adenine and Guanine) and Pyrimidines (Cytosine and Thymine). In RNA, Thymine is replaced by Uracil. The specific arrangement and pairing of these bases form the genetic code.

Solution:

1. Purines are double-ringed heterocyclic nitrogenous bases. Adenine (A) and Guanine (G) are the two purines found in both DNA and RNA.

2. Pyrimidines are single-ringed structures. Cytosine (C), Thymine (T), and Uracil (U) belong to this group.

3. In a DNA molecule, according to Chargaff's rule, a purine always pairs with a pyrimidine. Adenine pairs with Thymine via two hydrogen bonds, and Guanine pairs with Cytosine via three hydrogen bonds.

4. Looking at the options provided: - Option A: Adenine and Guanine (Both are Purines).
- Option B: Cytosine and Thymine (Both are Pyrimidines).
- Option C: Adenine and Thymine (Purine and Pyrimidine).
- Option D: Guanine and Cytosine (Purine and Pyrimidine).

5. The question specifically asks for the set of "Purines." Therefore, the correct set is Adenine and Guanine.

[Image of the chemical structures of Adenine, Guanine, Cytosine, and Thymine]

Final Answer: Adenine and Guanine.

Answer: (A)

Q48.

Solution

Concept:

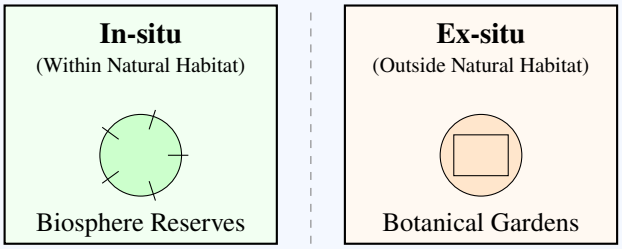
Biodiversity conservation strategies are divided into two categories: 1. **In-situ (On-site):** Conserving the entire ecosystem so that the species is protected in its natural habitat (e.g., National Parks, Biosphere Reserves). 2. **Ex-situ (Off-site):** Protecting threatened species by removing them from their natural habitat and placing them in special settings (e.g., Zoological Parks, Botanical Gardens, Seed Banks).

Solution:

1: **Botanical Gardens (A)** and **Wildlife Safari Parks (B)** are areas where plants and animals are kept under human care outside their natural homes. These are Ex-situ methods.

2: **Cryopreservation (D)** involves preserving gametes or embryos at extremely low temperatures ($-196^{\circ}C$) in a lab setting, which is an Ex-situ method.

3: **Biosphere Reserves (C)** are large areas of protected land meant for the conservation of wild populations and their natural genetic resources in their original environment. This is an In-situ method.



Final Answer:

(C) Biosphere Reserve

Answer: (C)

Q49.

Solution

Concept:

Evolutionary biology distinguishes between structures that share a common ancestry (homology) and structures that share a common function but different ancestry (analogy). Homologous organs are a result of "divergent evolution," where a common ancestral structure evolved into different forms to adapt to different environmental needs. This is a key piece of evidence for the theory of common descent.

Solution:

1. Homologous organs have the same basic anatomical structure and embryonic origin but perform different functions in different organisms.

2. Forelimbs of Human, Cheetah, Bat, and Whale (Option A): These are classic examples of homology. Although a human arm is for grasping, a cheetah's leg is for running, a bat's wing is for flying, and a whale's flipper is for swimming, they all share the same skeletal pattern (humerus, radius, ulna, carpals, metacarpals). This is the correct answer.

3. Wings of Butterfly and Bird (Option B): These perform the same function (flying) but have completely different structures (chitinous vs. bony/feathery). This is Analogy.

4. Eye of Octopus and Mammal (Option C): These have similar functions and optics but different retinal structures and origins. This is Analogy.

5. Flippers of Penguins and Dolphins (Option D): These are both used for swimming, but one is a modified wing (bird) and the other is a modified limb (mammal). This is also Analogy.

Final Answer: Forelimbs of Human, Cheetah, Bat, and Whale.

Answer: (A)

Q50.

Solution

Concept:

Down's Syndrome is a genetic disorder caused by an error in cell division called "nondisjunction." This results in an individual having three copies of a specific chromosome instead of the usual two. It is an example of autosomal aneuploidy. The condition was first clinically described by Langdon Down in 1866 and is associated with distinct physical and mental characteristics.

Solution:

1. In a normal human cell, there are 23 pairs of chromosomes (46 total).

2. Down's Syndrome occurs when there is an additional copy of chromosome number 21. This state is known as trisomy. Therefore, the total chromosome count becomes 47.

3. The specific genetic cause is the Trisomy of the 21st chromosome (Option B). This extra genetic material interferes with the normal course of development.

4. Symptoms typically include a short stature, a small round head, a furrowed tongue, a partially open mouth, and physical, psychomotor, and mental development being retarded.

5. Trisomy of the 18th chromosome (Option A) causes Edwards syndrome. A single X chromosome (45, XO) causes Turner's syndrome (Option C). An extra X chromosome in males (47, XXY) causes Klinefelter's syndrome (Option D).

6. Thus, the correct chromosomal basis for Down's syndrome is the 21st trisomy.

Final Answer: Trisomy of 21st chromosome.

Answer: (B)

Answer Key

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