CUET UG Biology Sample Paper - 8

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

Instructions

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

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

(A) Two polar nuclei fuse to form a diploid secondary nucleus before fertilization.

(B) Three antipodals degenerate before the entry of the pollen tube.

(C) The central cell contains two polar nuclei.

(D) The egg cell and synergids share a common wall.

Q2. A plant breeder wants to prevent autogamy but allow geitonogamy in a dioecious plant species. Is this possible?

(A) Yes, by removing the anthers (emasculation).

(B) No, because dioecious plants prevent both autogamy and geitonogamy.

(C) Yes, by bagging only the female flowers.

(D) No, because dioecious plants are hermaphrodites.

Q3. During double fertilization, if the number of chromosomes in the nucellus is 24, what will be the chromosome number in the endosperm and the zygote respectively?

(A) 24 and 36

(B) 36 and 24

(C) 48 and 24

(D) 24 and 24

Q4. Which of the following statements regarding "Cleistogamy" is correct?

(A) It leads to high genetic variability.

(B) It ensures seed set even in the absence of pollinators.

(C) Flowers open only at night to attract moths.

(D) It occurs only in aquatic plants like *Vallisneria*.

Q5. The "Filiform apparatus" is a characteristic feature of:

(A) Egg cell

(B) Central cell

(C) Synergids

(D) Suspensor

Q6. Which of the following is the correct sequence of sperm cell development?

(A) Spermatogonia → Spermatocyte → Spermatid → Spermatozoa

(B) Spermatid → Spermatocyte → Spermatogonia → Spermatozoa

(C) Spermatogonia → Spermatozoa → Spermatocyte → Spermatid

(D) Spermatocyte → Spermatogonia → Spermatid → Spermatozoa

Q7. A sudden surge in LH (LH Surge) triggers ovulation in humans. This happens due to the positive feedback of:

(A) Progesterone

(B) High concentration of Estrogen

(C) FSH

(D) GnRH

Q8. The process of "Capacitation" occurs in:

(A) Epididymis

(B) Vas deferens

(C) Female reproductive tract

(D) Rete testis

Q9. Identify the incorrect statement regarding the Blastocyst stage:

(A) The Trophoblast layer gets attached to the endometrium.

(B) The Inner Cell Mass (ICM) gives rise to the embryo.

(C) Implantation occurs roughly 7 days after fertilization.

(D) The blastomeres in the blastocyst are called Morula.

Q10. If the corpus luteum degenerates, it leads to:

(A) Rise in Progesterone levels.

(B) Maintenance of the endometrial lining.

(C) Disintegration of the endometrium and start of menstruation.

(D) Inhibition of FSH and LH.

Q11. Match the following:

Column A	List I	Column B	List II
(1)	Multiload 375	(a)	Non-medicated IUD
(2)	Lippes Loop	(b)	Hormone-releasing IUD
(3)	Progestasert	(c)	Copper-releasing IUD

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

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

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

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

Q12. A woman has blocked fallopian tubes but a functional uterus. Which ART technique is most suitable using her own ovum and her husband's sperm?

(A) GIFT (Gamete Intra-Fallopian Transfer)

(B) ZIFT (Zygote Intra-Fallopian Transfer)

(C) IVF-ET (In Vitro Fertilization - Embryo Transfer)

(D) AI (Artificial Insemination)

Q13. How do oral contraceptive pills prevent pregnancy?

(A) By creating a physical barrier.

(B) By inhibiting ovulation and implantation.

(C) By increasing phagocytosis of sperms in the uterus.

(D) By killing the sperms in the vagina.

Q14. A cross between a red-flowered plant and a white-flowered plant produces all pink-flowered offspring. If these pink flowers are self-pollinated, the phenotypic ratio will be:

(A) 3:1

(B) 1:2:1

(C) 9:3:3:1

(D) 1:1

Q15. Distance between gene 'A' and 'B' is 10 cM, 'B' and 'C' is 15 cM, and 'A' and 'C' is 5 cM. The sequence of genes on the chromosome is:

(A) A-B-C

(B) B-A-C

(C) A-C-B

(D) C-B-A

Q16. A man with blood group 'A' marries a woman with blood group 'B'. They have a child with blood group 'O'. What is the probability that their next child will have blood group 'AB'?

(A) 0%

(B) 25%

(C) 50%

(D) 100%

Q17. Which of the following is caused by the trisomy of the 21st chromosome?

(A) Klinefelter's Syndrome

(B) Turner's Syndrome

(C) Down's Syndrome

(D) Thalassemia

Q18. In sickle cell anemia, Glutamic acid is replaced by Valine at the 6th position of the beta-globin chain. This is an example of:

(A) Frame-shift mutation

(B) Point mutation

(C) Polyploidy

(D) Deletion

Q19. A person with karyotype 44+XXY suffers from:

(A) Turner's syndrome (Sterile Female)

(B) Klinefelter's syndrome (Sterile Male)

(C) Down's syndrome (Mental Retardation)

(D) Edward syndrome

Q20. If a double-stranded DNA has 20% Adenine, what will be the percentage of Cytosine?

(A) 20%

(B) 30%

(C) 40%

(D) 80%

Q21. During DNA replication, Okazaki fragments are joined by:

(A) DNA Polymerase I

(B) Helicase

(C) DNA Ligase

(D) Primase

Q22. In the Lac Operon, the repressor protein binds to:

(A) Promoter gene

(B) Operator gene

(C) Structural gene z

(D) Regulator gene

Q23. Which of the following is NOT a stop codon?

(A) UAA

(B) UAG

(C) UGG

(D) UGA

Q24. The tailing process of hnRNA involves the addition of:

(A) Methyl guanosine triphosphate at 5' end.

(B) Adenylate residues at 3' end in a template-independent manner.

(C) Introns to the exons.

(D) Poly-A tail at 5' end.

Q25. The satellite DNA is important in DNA fingerprinting because:

(A) It codes for enzymes needed for DNA replication.

(B) It shows a high degree of polymorphism.

(C) It is the same in all members of a species.

(D) It codes for proteins of the cell membrane.

Q26. Semi-conservative replication of DNA was first demonstrated in *E. coli* by:

(A) Hershey and Chase

(B) Meselson and Stahl

(C) Watson and Crick

(D) Avery, MacLeod, and McCarty

Q27. The function of "Aminoacyl tRNA synthetase" is:

(A) Splicing of mRNA

(B) Attachment of amino acid to tRNA

(C) Synthesis of rRNA

(D) Binding of mRNA to Ribosomes

Evolution

Q28. In a population of 1000 individuals, 360 belong to genotype AA, 480 to Aa and the remaining 160 to aa. Based on this data, the frequency of allele A in the population is:

(A) 0.4

(B) 0.5

(C) 0.6

(D) 0.7

Q29. The "Darwin's Finches" of Galapagos Islands are an excellent example of:

(A) Convergent evolution

(B) Adaptive radiation

(C) Parallel evolution

(D) Saltation

Q30. Which of the following hominids had a cranial capacity of approximately 900cc?

(A) *Homo habilis*

(B) *Homo erectus*

(C) *Neanderthal man*

(D) *Australopithecus*

Q31. The "Industrial Melanism" observed in the peppered moth (*Biston betularia*) proves that:

(A) The dark melanic form was a new species.

(B) The environment does not influence survival.

(C) Natural selection favors the variant that is best adapted to the environment.

(D) Pollution causes mutations directly.

Q32. In the life cycle of *Plasmodium*, where does the sexual stage (gametocytes) develop?

(A) Liver cells of human

(B) RBCs of human

(C) Salivary glands of Mosquito

(D) Gut of Mosquito

Q33. When a quick immune response is required (e.g., Tetanus), we inject pre-formed antibodies. This type of immunization is called:

(A) Active immunization

(B) Passive immunization

(C) Innate immunity

(D) Humoral immunity

Q34. Which of the following is an "autoimmune" disease?

(A) AIDS

(B) Cancer

(C) Rheumatoid arthritis

(D) Typhoid

Q35. "Malignant tumors" are more dangerous than "Benign tumors" because of:

(A) Contact inhibition

(B) Metastasis

(C) High differentiation

(D) Slow growth

Q36. During sewage treatment, the "Activated Sludge" is:

(A) The sediment in the primary settling tank.

(B) The bacterial flocs settled in the secondary settling tank.

(C) The floating debris.

(D) The effluent sent to the water bodies.

Q37. Match the Microbe with the Product: (a) *Aspergillus niger* | (i) Statins; (b) *Monascus purpureus* | (ii) Citric acid; (c) *Trichoderma polysporum* | (iii) Cyclosporin A

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

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

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

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

Q38. *Bacillus thuringiensis* (Bt) is used as a:

(A) Biofertilizer

(B) Biocontrol agent

(C) Natural herbicide

(D) Sewage decomposer

Q39. The DNA molecule is negatively charged. In Gel Electrophoresis, it moves towards:

(A) The Anode (Positive electrode)

(B) The Cathode (Negative electrode)

(C) It remains stationary

(D) Moves towards the center

Q40. In pBR322, if a foreign DNA is ligated at the *BamHI* site of the Tetracycline resistance gene (tet^R), the transformants will:

(A) Lose resistance to Ampicillin.

(B) Lose resistance to Tetracycline.

(C) Become resistant to all antibiotics.

(D) Not grow on any medium.

Q41. What is the correct sequence of steps in a PCR cycle?

(A) Extension → Denaturation → Annealing

(B) Annealing → Extension → Denaturation

(C) Denaturation → Annealing → Extension

(D) Denaturation → Extension → Annealing

Q42. "Stirred-tank bioreactors" are designed for:

(A) Purification of the product.

(B) Ensuring oxygen availability throughout the process.

(C) Addition of preservatives.

(D) Drying of the culture.

Q43. Bt toxin does not kill the *Bacillus* bacterium itself because:

(A) The toxin is immature.

(B) The toxin exists as an inactive protoxin.

(C) The bacterium has a thick wall.

(D) The bacterium is resistant to its own toxin.

Q44. RNA interference (RNAi) involves silencing of a specific mRNA due to a complementary ____ molecule.

(A) ssDNA

(B) dsRNA

(C) ssRNA

(D) dsDNA

Q45. The first clinical gene therapy was given in 1990 to a 4-year-old girl for the deficiency of:

(A) Insulin

(B) Adenosine deaminase (ADA)

(C) Tyrosinase

(D) Phenylalanine hydroxylase

Q46. A population growing in a habitat with limited resources shows a sigmoid curve. This type of growth is described by the Verhulst-Pearl equation. The "K" in this equation stands for:

(A) Intrinsic rate of natural increase

(B) Carrying capacity

(C) Environmental resistance

(D) Population density

Q47. An interaction where one species is benefited and the other is neither harmed nor benefited (e.g., orchid on a mango branch) is:

(A) Mutualism

(B) Amensalism

(C) Commensalism

(D) Parasitism

Q48. In an ecosystem, the rate of production of organic matter during photosynthesis is called ____, while the available biomass for the consumption to heterotrophs is called ____.

(A) NPP, GPP

(B) GPP, NPP

(C) Secondary productivity, GPP

(D) GPP, Secondary productivity

Q49. Which of the following is considered the most important cause driving animals and plants to extinction (The "Evil Quartet")?

(A) Over-exploitation

(B) Alien species invasion

(C) Habitat loss and fragmentation

(D) Co-extinctions

Q50. Which of the following is an example of "Ex-situ" conservation?

(A) National Parks

(B) Wildlife Sanctuaries

(C) Zoological Parks (Zoos)

(D) Biosphere Reserves

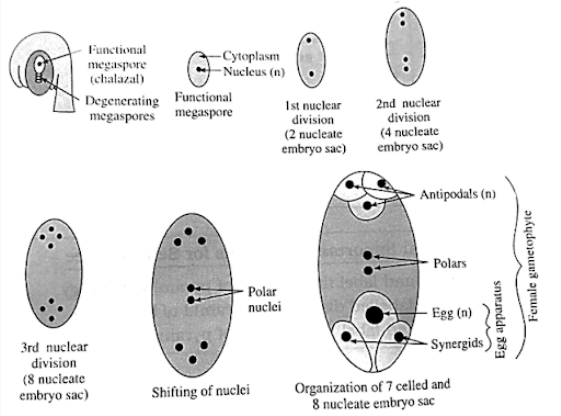
Detailed Solutions

Q1.

Solution

Concept: Organization and development of the Female Gametophyte (Embryo Sac) in Angiosperms.

Solution: The development of the female gametophyte in most angiosperms starts from a single functional megaspore, a process known as monosporic development. The nucleus of this functional megaspore undergoes three successive rounds of free-nuclear mitotic divisions.



1. The first division produces two nuclei which move to opposite poles (micropylar and chalazal).

2. The second and third divisions result in a total of eight nuclei (four at each pole).

3. Following these nuclear divisions, cell walls are laid down around six of the eight nuclei. Three nuclei at the micropylar end are organized into the "egg apparatus" (one egg cell and two synergids). Three nuclei at the chalazal end form the "antipodal cells."

4. The remaining two nuclei, known as "polar nuclei," do not develop individual cell walls. Instead, they migrate to the center and are shared within the large "central cell." Consequently, because the central cell contains two distinct nuclei, the mature embryo sac is described as being 8-nucleate but 7-celled.

Final Answer : "The central cell contains two polar nuclei."

Answer: (C)

Q2.

Solution

Concept: Types of Pollination and Sexuality in Plants (Dioecy vs. Monoecy).

Solution: To understand why a plant breeder cannot allow geitonogamy in a dioecious species, we must look at how these plants are structured:

1. **Autogamy:** This is self-pollination occurring within a single flower. It requires the flower to be bisexual (hermaphrodite).

2. **Geitonogamy:** This involves the transfer of pollen from the anther of one flower to the stigma of another flower on the same plant. While genetically similar to autogamy, it is functionally cross-pollination.

3. **Dioecious Plants:** In dioecious species (like papaya or date palm), an individual plant is strictly male (bearing only staminate flowers) or strictly female (bearing only pistillate flowers).

Because a single plant in a dioecious species never possesses both male and female reproductive organs, it is physically impossible for pollen to travel from one flower to another on the same plant. Therefore, dioecy is a strategy used by plants to prevent both autogamy and geitonogamy, ensuring mandatory cross-pollination (xenogamy).

Final Answer : "No, because dioecious plants prevent both autogamy and geitonogamy."

Answer: (B)

Q3.

Solution

Concept: Ploidy levels of various tissues and the process of Double Fertilization.

Solution: In the life cycle of an angiosperm, different tissues have different sets of chromosomes based on whether they are sporophytic or gametophytic:

1. **Nucellus:** This is the diploid sporophytic tissue ($2n$) that makes up the bulk of the ovule. If the nucellus has 24 chromosomes, then $2n = 24$. From this, we find the haploid number ($n = 24/2 = 12$).

2. **Zygote:** The zygote is formed via syngamy, which is the fusion of one haploid male gamete (n) and one haploid egg cell (n). Thus, the zygote is diploid ($2n$). Calculation: $12+12 = 24$.

3. **Endosperm:** In angiosperms, the endosperm is formed via "triple fusion," where the second haploid male gamete (n) fuses with the diploid secondary nucleus (or two polar nuclei, $n + n$). Thus, the endosperm is triploid ($3n$). Calculation: $12 \times 3 = 36$. The question asks for the chromosome numbers for the endosperm and zygote respectively, which results in 36 and 24.

Final Answer : "36 and 24"

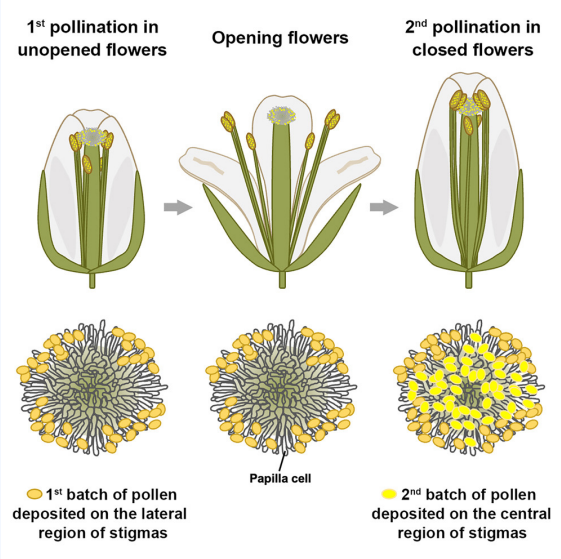
Answer: (B)

Q4.

Solution

Concept: Mechanisms of Self-Pollination (Cleistogamy).

Solution: Cleistogamy refers to the production of flowers that never open, even at maturity.



1. In these flowers, the anthers and stigma are situated very close to each other. When the anthers dehisce within the closed flower bud, pollen grains inevitably land on the stigma of the same flower.

2. Because the flower remains sealed, there is no chance of cross-pollen entering, making the flower invariably autogamous.

3. This mechanism is highly advantageous for survival in unstable environments because it guarantees the production of seeds (assured seed set) even in the total absence of pollinators like bees, butterflies, or wind.

4. Examples of plants exhibiting this include *Viola*, *Oxalis*, and *Commelina*. While it ensures reproduction, the main disadvantage is the lack of genetic variation due to continuous inbreeding.

Final Answer : "It ensures seed set even in the absence of pollinators."

Answer: (B)

Q5.

Solution

Concept: Structure of the Synergids and Pollen-Pistil Interaction.

Solution: The "Filiform apparatus" is a specialized structure found within the female gametophyte of flowering plants.

1. Within the embryo sac, the egg apparatus is located at the micropylar end and consists of one egg cell and two accompanying cells called synergids.

2. The synergids feature highly thickened, finger-like cellular projections at their micropylar tip; this is the filiform apparatus.

3. Its primary biological function is to act as a guide for the pollen tube. As the pollen tube grows through the style and enters the ovule, the filiform apparatus secretes chemicals and provides a physical path that directs the pollen tube to enter one of the synergids to release its male gametes for fertilization.

Final Answer : "Synergids"

Answer: (C)

Q6.

Solution

Concept: The process of Spermatogenesis in the human male reproductive system.

Solution: Spermatogenesis is the multi-step process of producing mature male gametes within the seminiferous tubules of the testes. The sequence is as follows:

1. **Spermatogonia:** These are the immature germ cells (diploid, $2n$) found on the inner wall of the tubules. They increase in number through mitotic division.

2. **Spermatocytes:** Some spermatogonia differentiate into "Primary Spermatocytes" ($2n$), which then undergo the first meiotic division to produce haploid "Secondary Spermatocytes" (n).

3. **Spermatids:** The secondary spermatocytes undergo the second meiotic division to produce four equal, haploid, non-motile cells called spermatids.

4. **Spermatozoa:** The spermatids undergo a final transformation process called *spermiogenesis*, where they develop a tail and become motile, mature sperm cells (spermatozoa).

Therefore, the correct chronological sequence of development is: Spermatogonia → Spermatocyte → Spermatid → Spermatozoa.

Final Answer : "Spermatogonia → Spermatocyte → Spermatid → Spermatozoa"

Answer: (A)

Q7.

Solution

Concept: Hormonal Regulation of the Menstrual Cycle and the LH Surge.

Solution: The menstrual cycle is governed by a complex interplay of hormones between the hypothalamus, anterior pituitary, and ovaries.

1. During the follicular phase, Follicle Stimulating Hormone (FSH) promotes the growth of primary follicles into mature Graafian follicles. These developing follicles secrete **Estrogen**.

2. Under normal circumstances throughout most of the cycle, Estrogen exerts a negative feedback effect on the pituitary. However, as the Graafian follicle reaches maximum maturity, it secretes Estrogen in very high concentrations.

3. When Estrogen levels exceed a critical threshold for approximately 48 hours, the feedback mechanism shifts from negative to **Positive Feedback**.

4. This high concentration of Estrogen signals the anterior pituitary to release a massive, sudden burst of Luteinizing Hormone (LH). This phenomenon is known as the "LH Surge."

5. The LH Surge is the ultimate trigger that causes the Graafian follicle to rupture and release the secondary oocyte into the fallopian tube, a process called **Ovulation**.

Final Answer : "High concentration of Estrogen"

Answer: (B)

Q8.

Solution

Concept: Sperm Maturation and Capacitation in the Female Reproductive Tract.

Solution: While sperm cells are morphologically mature when they leave the testes and gain motile potential in the epididymis, they are not immediately capable of fertilizing an egg. They must undergo a final physiological "activation" process called **Capacitation**.

1. Capacitation occurs naturally only after the sperm has been residing within the **Female Reproductive Tract** (specifically the uterus and the isthmus of the fallopian tube) for several hours.

2. During this time, the secretions of the female tract (such as enzymes and vaginal fluids) act upon the sperm. These secretions remove various "de-capacitation factors," inhibitory proteins, and cholesterol deposits from the plasma membrane covering the acrosome (the head of the sperm).

3. This process leads to two major changes:

- **Increased Permeability:** The membrane becomes more permeable to Calcium ions (Ca^{2+}), which leads to "hyperactivation," where the sperm tail beats more forcefully and rapidly.
- **Acrosome Preparation:** The membrane is weakened so that when the sperm contacts the egg's *zona pellucida*, it can easily release its digestive enzymes (the acrosome reaction) to penetrate the egg.

Without capacitation, fertilization cannot occur even if the sperm reaches the egg.

Final Answer : "Female reproductive tract"

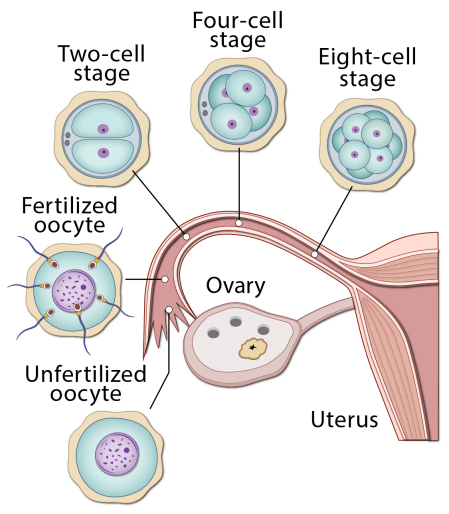
Answer: (C)

Q9.

Solution

Concept: Embryonic Development and the Stages of Pre-implantation.

Solution: To identify the incorrect statement, we must analyze the progression of the early embryo:



1. **Zygote to Morula:** After fertilization, the zygote undergoes rapid mitotic divisions called cleavage. It forms a solid ball of 8 to 16 cells called the **Morula**.

2. **Blastocyst Formation:** As the morula continues to divide, it develops a fluid-filled cavity (the blastocoel) and transforms into a **Blastocyst**. At this stage, the cells differentiate into two distinct groups: the outer **Trophoblast** and the **Inner Cell Mass (ICM)**.

3. **Statement A (Correct):** The Trophoblast layer is specialized for nutrition and attachment. It secretes enzymes to digest the uterine lining, allowing the embryo to attach to the endometrium.

4. **Statement B (Correct):** The Inner Cell Mass (ICM) contains pluripotent stem cells that will eventually differentiate into all the tissues and organs of the developing fetus.

5. **Statement C (Correct):** Implantation typically begins approximately 6–7 days after fertilization.

6. **Statement D (Incorrect):** The individual cells in both the morula and the blastocyst are called **Blastomeres**. However, the "Morula" refers specifically to the 8–16 cell solid-ball stage. Once the cavity forms and the cells differentiate, the stage is called a Blastocyst, not a Morula. Therefore, identifying the blastocyst stage as "Morula" is terminologically incorrect.

Final Answer : "The blastomeres in the blastocyst are called Morula."

Answer: (D)

Q10.

Solution

Concept: The Luteal Phase and the Role of Progesterone in Menstruation.

Solution: After ovulation, the ruptured Graafian follicle transforms into a yellowish endocrine structure known as the **Corpus Luteum** (Yellow Body).

1. The primary function of the Corpus Luteum is to secrete high levels of **Progesterone** and some Estrogen. Progesterone is known as the "pregnancy-maintaining hormone" because it prepares and maintains the uterine endometrium, making it thick, vascular, and glandular for the potential implantation of a fertilized egg.

2. If fertilization does *not* occur, the lack of Human Chorionic Gonadotropin (hCG) from a developing embryo causes the Corpus Luteum to degenerate into a non-functional scar tissue called the *corpus albicans*.

3. The **degeneration of the Corpus Luteum** leads to a sharp decline in blood Progesterone and Estrogen levels.

4. Without Progesterone to support it, the thickened endometrial lining undergoes vasospasm (constriction of blood vessels) and ischemia. This leads to the **disintegration of the endometrium**, which is sloughed off along with blood and unfertilized ovum, marking the start of **Menstruation**.

Final Answer : "Disintegration of the endometrium and start of menstruation."

Answer: (C)

Q11.

Solution

Concept: Classification and Mechanism of Intrauterine Devices (IUDs).

Solution: Intrauterine Devices (IUDs) are one of the most effective forms of reversible contraception. They are categorized based on whether they release active chemicals or hormones:

1. **Non-medicated IUDs:** These are typically made of plastic or stainless steel. They work by inducing a local inflammatory response in the uterus, which increases the phagocytosis (destruction) of sperm cells. The most famous example is the **Lippes Loop**. (Match: b $\rightarrow$ i)

2. **Copper-releasing IUDs:** These devices release copper ions (Cu^{2+}) into the uterine environment. Copper ions act as a spermicide by suppressing sperm motility and reducing their ability to fertilize the ovum. Examples include the Copper T (CuT), Cu7, and **Multiload 375**. (Match: a $\rightarrow$ iii)

3. **Hormone-releasing IUDs:** These devices (like **Progestasert** or LNG-20) release small amounts of progestogens. They work by making the endometrium unsuitable for implantation and by increasing the viscosity of cervical mucus, which prevents sperm from entering the uterus. (Match: c $\rightarrow$ ii) Based on this, the correct matching is a-iii, b-i, and c-ii.

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

Answer: (B)

Q12.

Solution

Concept: In Vitro Fertilization and Embryo Transfer (IVF-ET).

Solution: When a woman has blocked fallopian tubes, the natural site for fertilization (the ampullary-isthmic junction) is inaccessible to sperm, and the path for the embryo to reach the uterus is closed. To bypass this, Assisted Reproductive Technology (ART) must be used:

1. **GIFT (Gamete Intra-Fallopian Transfer):** This involves placing both sperm and unfertilized eggs into the fallopian tube. This is **not possible** here because the tubes are blocked.

2. **ZIFT (Zygote Intra-Fallopian Transfer):** This involves fertilizing the egg in a lab and then placing the zygote into the fallopian tube. This is also **not possible** because the tubes are blocked.

3. **Artificial Insemination (AI):** This involves placing sperm into the uterus, but it still requires open tubes for the sperm to find the egg.

4. **IVF-ET (In Vitro Fertilization - Embryo Transfer):** This is the gold standard for tubal factor infertility. Eggs are retrieved from the woman's ovaries and fertilized with the husband's sperm in a culture medium in the laboratory (In Vitro). Once the embryo reaches the 8-cell stage or the blastocyst stage, it is **transferred directly into the uterus** (Embryo Transfer). This completely bypasses the blocked fallopian tubes.

Final Answer : "IVF-ET (In Vitro Fertilization - Embryo Transfer)"

Answer: (C)

Q13.

Solution

Concept: Hormonal Contraception and its Physiological Effects.

Solution: Oral contraceptive pills (OCPs), such as the combined pill containing progestogens and estrogens, prevent pregnancy through multiple physiological pathways:

1. **Inhibition of Ovulation:** This is the primary mechanism. The exogenous (external) hormones provide negative feedback to the hypothalamus and the anterior pituitary gland. This inhibits the release of GnRH, FSH, and LH. Without the FSH stimulus, no follicle matures, and without the LH surge, ovulation is prevented.

2. **Inhibition of Implantation:** The hormones alter the quality of the uterine endometrium (the lining of the uterus). It becomes thin, atrophic, and secretory-deficient, making it highly unreceptive to a blastocyst if fertilization were somehow to occur.

3. **Alteration of Cervical Mucus:** Progestogens cause the cervical mucus to become thick, viscous, and hostile. This creates a physical and chemical "mucus plug" at the cervix, preventing the entry of sperm into the upper reproductive tract.

By combining these effects, OCPs are highly effective at preventing conception.

Final Answer : "By inhibiting ovulation and implantation."

Answer: (B)

Q14.

Solution

Concept: Incomplete Dominance in inheritance patterns.

Solution: In this scenario, neither the red allele nor the white allele is completely dominant over the other. This is a classic case of incomplete dominance (often seen in plants like *Mirabilis jalapa* or *Antirrhinum majus*).

1. When a homozygous red-flowered plant (RR) is crossed with a homozygous white-flowered plant (rr), all offspring in the F_1 generation are heterozygous (Rr) and exhibit a pink phenotype.

2. When these F_1 pink flowers (Rr) are self-pollinated ($Rr \times Rr$), the resulting F_2 generation genotypes follow the ratio: $1RR$ (Red) : $2Rr$ (Pink) : $1rr$ (White).

3. Because the phenotype directly reflects the genotype in incomplete dominance, the phenotypic ratio is 1 : 2 : 1.

Final Answer : 1:2:1

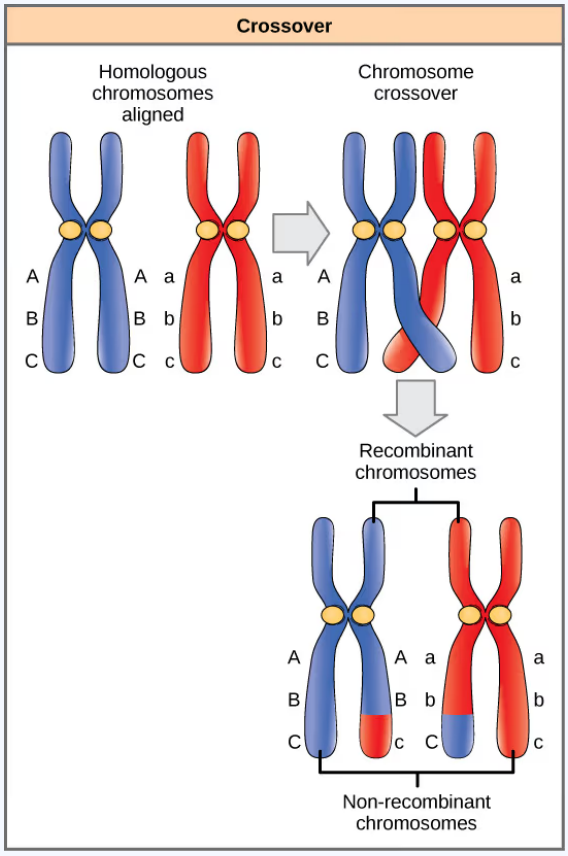
Answer: (B)

Q15.

Solution

Concept: Genetic Mapping and Gene Linkage.

Solution: Gene mapping is based on the principle that the distance between genes is proportional to the frequency of recombination between them. One centimorgan (cM) represents a 1% recombination frequency. To determine the sequence:



1. Identify the two genes with the greatest distance between them. Here, 'B' and 'C' are 15 cM apart, which means they are the flanking (outermost) genes.

2. Look at the distance from the third gene 'A'. 'A' is 10 cM from 'B' and 5 cM from 'C'.

3. Check the additive property: $Distance(B-A) + Distance(A-C) = 10\text{ cM} + 5\text{ cM} = 15\text{ cM}$, which matches the total distance between B and C.

4. This confirms that 'A' must be located between 'B' and 'C'. Therefore, the sequence is B-A-C (or C-A-B).

Final Answer : B-A-C

Answer: (B)

Q16.

Solution

Concept: Multiple Alleles and ABO Blood Grouping.
Solution: The blood group is determined by three alleles: I^A, I^B, and i.

1. A man with blood group 'A' can have genotype I^AI^A or I^Ai. A woman with blood group 'B' can have I^BI^B or I^Bi.

2. They have a child with blood group 'O' (genotype ii). This is only possible if both parents carry the recessive allele 'i'. Therefore, the father must be I^Ai and the mother must be I^Bi.

3. To find the probability of the next child being 'AB', we use a Punnett Square for $I^Ai \times I^Bi$:
- I^AI^B (AB blood group) - 25%
- I^Ai (A blood group) - 25%
- I^Bi (B blood group) - 25%
- ii (O blood group) - 25%

4. The probability of having a child with blood group 'AB' is 1 out of 4, or 25%.

Final Answer : 25%

Answer: (B)

Q17.

Solution

Concept: Aneuploidy and Chromosomal Disorders.
Solution: Chromosomal disorders occur due to the addition or loss of one or more chromosomes.

1. Down's Syndrome: This is caused by the trisomy of the 21st chromosome, meaning the individual has three copies of chromosome 21 instead of two. This results in a total chromosome count of 47. Symptoms include mental retardation and specific physical features.

2. Klinefelter's Syndrome: Caused by trisomy of sex chromosomes (44+XXY).

3. Turner's Syndrome: Caused by monosomy of sex chromosomes (44+XO).

4. Thalassemia: This is a Mendelian (genetic) disorder related to hemoglobin synthesis, not a chromosomal trisomy.

Final Answer : Down's Syndrome

Answer: (C)

Q18.

Solution

Concept: Molecular Basis of Mutations.
Solution: Mutation is a phenomenon which results in alteration of DNA sequences.

1. In sickle cell anemia, a substitution occurs in the DNA sequence coding for the beta-globin chain. The codon GAG (which codes for Glutamic acid) is replaced by GUG (which codes for Valine).

2. This change occurs at the 6th position of the beta-globin chain.

3. Since this change involves the substitution of only a single base pair in the DNA, it is classified as a Point Mutation.

4. Frame-shift mutations involve insertions or deletions that shift the entire reading frame, which is not the case here. Polyploidy involves an increase in a whole set of chromosomes.

Final Answer : Point mutation

Answer: (B)

Q19.

Solution

Concept: Sex Chromosome Abnormalities.
Solution: The karyotype 44+XXY describes an individual with 47 chromosomes, including two X chromosomes and one Y chromosome.

1. The presence of the Y chromosome triggers male development, but the extra X chromosome leads to feminine traits.

2. This condition is known as Klinefelter's syndrome.

3. Individuals are phenotypically male but typically have small testes, are sterile (cannot reproduce), and may develop breast tissue (gynaecomastia).

4. Turner's syndrome is 44+XO (female). Down's syndrome is trisomy 21 (affects both sexes). Edward syndrome is trisomy 18.

Final Answer : Klinefelter's syndrome (Sterile Male)

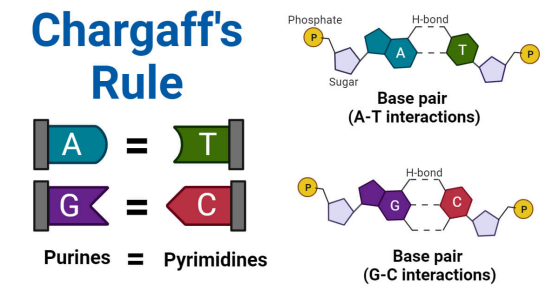
Answer: (B)

Q20.

Solution

Concept: Chargaff's Rule of Base Pairing.

Solution: Erwin Chargaff proposed that in a double-stranded DNA molecule, the ratio between Adenine (A) and Thymine (T) and between Guanine (G) and Cytosine (C) are constant and equal.



1. According to the rule: $\%A = \%T$ and $\%G = \%C$.

2. Given $\%A = 20\%$. Therefore, $\%T$ must also be 20%.

3. The sum of Adenine and Thymine is: $20\% + 20\% = 40\%$.

4. The remaining percentage of the DNA must be Guanine and Cytosine: $100\% - 40\% = 60\%$.

5. Since $\%G = \%C$, we divide the remaining percentage by 2: $60\%/2 = 30\%$.

6. Thus, the percentage of Cytosine is 30%.

Final Answer : 30%

Answer: (B)

Q21.

Solution

Concept: Mechanisms of DNA Replication: Synthesis of the Lagging Strand.

Solution: DNA replication is a semi-discontinuous process because the enzyme DNA polymerase can only add nucleotides in the $5' \rightarrow 3'$ direction.

1. Leading vs. Lagging Strand: On the template strand with $3' \rightarrow 5'$ polarity, replication is continuous (Leading strand). On the template strand with $5' \rightarrow 3'$ polarity, replication is discontinuous, occurring in small stretches called Okazaki fragments.

2. The Role of Ligase: Once these fragments are synthesized, the RNA primers are removed and replaced with DNA. However, there remains a "nick" or a break in the sugar-phosphate backbone between these newly synthesized fragments.

3. The Enzyme: DNA Ligase (specifically DNA ligase I in eukaryotes) catalyzes the formation of a covalent phosphodiester bond between the $3'$-hydroxyl group of one DNA fragment and the $5'$-phosphate group of the next.

4. Conclusion: This process effectively stitches the fragments together to form a single, continuous DNA strand. Without DNA ligase, the lagging strand would remain as fragmented pieces of DNA, and the genome would be unstable.

Final Answer : DNA Ligase

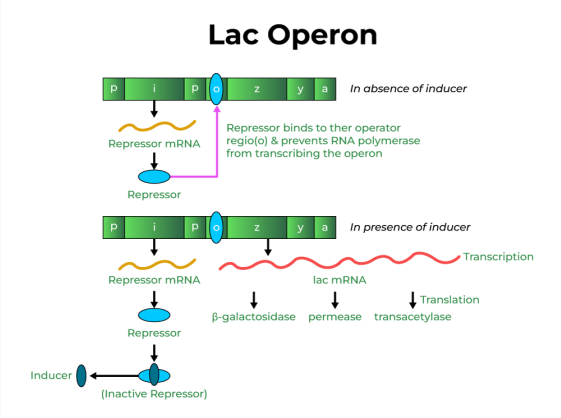
Answer: (C)

Q22.

Solution

Concept: Regulation of Gene Expression: The Lac Operon Model.

Solution: The Lac Operon is the classic model for transcriptional regulation in prokaryotes, specifically *E. coli*. It consists of regulatory genes and structural genes (z, y, a).



1. The Regulatory Gene: The i gene (Inhibitor gene) codes for the repressor protein. This protein is produced constitutively (all the time).

2. The Binding Site: The repressor protein has a specific spatial configuration that allows it to bind tightly to the Operator gene (o) sequence.

3. Mechanism of Repression: When the repressor is bound to the operator, it creates a physical obstruction on the DNA. This prevents RNA polymerase (which binds at the Promoter) from sliding down the DNA to transcribe the structural genes.

4. Induction: In the presence of an inducer like lactose (or allolactose), the inducer binds to the repressor, changing its shape so it can no longer bind to the operator. This "unblocks" the operon.

5. Therefore, the binding site for the repressor protein is specifically the operator gene.

Final Answer : Operator gene

Answer: (B)

Q23.

Solution

Concept: The Genetic Code: Termination (Stop) Codons.

Solution: The genetic code is a set of rules used by living cells to translate information encoded within genetic material into proteins. There are 64 possible triplet codons.

1. Sense Codons: 61 codons code for specific amino acids. For example, AUG codes for Methionine and also acts as the start codon.

2. Stop Codons: 3 codons do not code for any amino acid and signal the termination of the polypeptide chain during translation. These are: - UAA (also known as Ochre) - UAG (also known as Amber) - UGA (also known as Opal)

3. The Exception: UGG is a sense codon. It specifically and uniquely codes for the essential amino acid Tryptophan.

4. Since UGG codes for an amino acid, it allows the ribosome to continue translation rather than stopping it. Thus, it is NOT a stop codon.

Final Answer : UGG

Answer: (C)

Q24.

Solution

Concept: Post-Transcriptional Modifications: Tailing of hnRNA.

Solution: In eukaryotic cells, the initial product of transcription is heterogeneous nuclear RNA (hnRNA), which is a precursor to mature mRNA. This hnRNA must undergo processing before it can be exported to the cytoplasm for translation.

1. Splicing: Removal of non-coding introns and joining of coding exons.

2. Capping: The addition of an unusual nucleotide, methyl guanosine triphosphate, to the 5′ end.

3. Tailing: This involves the addition of a "Poly-A tail" to the 3′ end of the transcript. This tail consists of about 200 to 300 adenylate (adenosine) residues.

4. Template-Independence: A key feature of this process is that it is template-independent. This means there is no sequence of poly-thymine on the DNA template that dictates this tail; instead, the enzyme Poly-A Polymerase adds these residues directly to the RNA strand.

5. The tailing process is essential for mRNA stability, protection from exonucleases, and facilitating the export of mRNA from the nucleus.

Final Answer : Adenylate residues at 3' end in a template-independent manner.

Answer: (B)

Q25.

Solution

Concept: DNA Fingerprinting and Repetitive DNA Sequences.

Solution: DNA fingerprinting (DNA profiling) is a technique used to distinguish between individuals based on their unique DNA sequences.

1. Satellite DNA: When genomic DNA is centrifuged in a density gradient, the bulk DNA forms a major peak, while small peaks called satellite DNA are formed by highly repetitive sequences.

2. Polymorphism: These repetitive sequences do not code for proteins, but they exhibit a high degree of polymorphism. Polymorphism refers to genetic variation where different individuals have a different number of repeats at specific loci (often called VNTRs—Variable Number Tandem Repeats).

3. Why it matters: While the coding DNA is nearly 99.9% identical between two humans, the satellite DNA regions vary significantly. This variation is so specific that the probability of two unrelated individuals having the same pattern is extremely low.

4. Because these polymorphisms are inheritable, they are used to establish biological relationships (paternity) and identify individuals in forensic investigations.

Final Answer : It shows a high degree of polymorphism.

Answer: (B)

Q26.

Solution

Concept: Experimental Evidence for Semi-conservative DNA Replication.

Solution: The semi-conservative model of DNA replication suggests that during replication, the two strands of the parent DNA separate, and each serves as a template for the synthesis of a new complementary strand.

1. The Researchers: This was experimentally proven by Matthew Meselson and Franklin Stahl in 1958.

2. The Experiment: They grew *E. coli* in a medium containing $^{15}NH_4Cl$ (heavy isotope of nitrogen) for many generations until all DNA was "heavy." They then transferred the bacteria to a medium with $^{14}NH_4Cl$ (normal light isotope).

3. The Results: - After one generation (20 minutes), the DNA was found to be of "hybrid" density (^{14}N-^{15}N). - After two generations (40 minutes), the DNA was composed of equal amounts of hybrid DNA and light DNA.

4. Significance: These results were only possible if each daughter DNA molecule retained one old strand and one new strand.

5. Note: Watson and Crick proposed the structure; Hershey and Chase proved DNA is the genetic material; Avery et al. proved the transforming principle is DNA.

Final Answer : Meselson and Stahl

Answer: (B)

Q27.

Solution

Concept: The Role of Aminoacyl tRNA Synthetase in Translation.

Solution: Translation is the process of synthesizing a polypeptide chain from an mRNA template. For this to occur, amino acids must be linked to their appropriate "adapter" molecules, the tRNAs.

1. The Charging Process: This process is called "aminoacylation of tRNA" or "charging of tRNA."

2. The Enzyme: Aminoacyl tRNA synthetase is the enzyme responsible for this. There is a specific synthetase enzyme for each of the 20 amino acids.

3. Two-Step Reaction: - First, the enzyme facilitates the reaction between an amino acid and ATP to form an activated aminoacyl-AMP complex. - Second, the enzyme transfers the amino acid to the 3′ end of the specific tRNA molecule.

4. Function: By ensuring that the correct amino acid is attached to the tRNA with the matching anticodon, this enzyme maintains the fidelity of the genetic code. Without this attachment, the ribosome would have no way to incorporate the correct amino acid according to the mRNA sequence.

Final Answer : Attachment of amino acid to tRNA

Answer: (B)

Q28.

Solution

Concept: Population Genetics and Allele Frequency Calculation.

Solution: To find the frequency of the allele 'A' in a population, we can use the formula for allele frequency based on the number of individuals of each genotype.

1. Identify the Given Data: - Total population (N) = 1000 individuals. - Individuals with genotype AA = 360. - Individuals with genotype Aa = 480. - Individuals with genotype aa = 160.

2. Calculate the Total Number of Alleles: Since every individual is diploid, the total number of alleles in the gene pool is $1000 \times 2 = 2000$.

3. Count the 'A' Alleles: - Each AA individual has 2 'A' alleles: $360 \times 2 = 720$. - Each Aa individual has 1 'A' allele: $480 \times 1 = 480$. - Total 'A' alleles = 720 + 480 = 1200.

4. Calculate Frequency (p): - Frequency of allele $A(p) = \frac{\text{Total number of A alleles}}{\text{Total number of all alleles}} = \frac{1200}{2000} = 0.6$.

5. Alternatively, using the Hardy-Weinberg equilibrium notation where p^2 is the frequency of AA: $p^2 = 360/1000 = 0.36$. Therefore, $p = \sqrt{0.36} = 0.6$.

Final Answer : 0.6

Answer: (C)

Q29.

Solution

Concept: Adaptive Radiation and Divergent Evolution.

Solution: During his voyage on the H.M.S. Beagle, Charles Darwin observed a remarkable variety of small black birds on the Galapagos Islands, now known as "Darwin's Finches."

1. Observation: He realized that all these varieties evolved on the same island from an original seed-eating ancestral stock.

2. Mechanism: As the birds migrated to different islands with different environmental niches and food sources, their beaks underwent modifications. Some became insectivorous, others vegetarian, and some cactus-eaters.

3. Definition: This process of evolution of different species in a given geographical area starting from a point and literally radiating to other areas of geography (habitats) is called Adaptive Radiation.

4. It is a prime example of divergent evolution, where related species become more different over time as they adapt to different environmental pressures.

Final Answer : Adaptive radiation

Answer: (B)

Q30.

Solution

Concept: Stages of Human Evolution and Cranial Capacities.

Solution: Cranial capacity is a measure of the volume of the interior of the skull, which provides a rough estimate of brain size in hominids.

1. Australopithecus: These early hominids had a relatively small brain, with a cranial capacity of approximately 450–600cc.

2. Homo habilis: Known as the "handy man," they were the first tool-makers and had a cranial capacity between 650–800cc.

3. Homo erectus: This species appeared about 1.5 million years ago. They had a much larger brain with a cranial capacity of approximately 900cc. They are also known for being the first to use fire and migrate extensively out of Africa.

4. Neanderthal man: Lived in near East and central Asia, they had a very large brain capacity of about 1400cc.

5. Based on these evolutionary records, the hominid with 900cc is *Homo erectus*.

Final Answer : Homo erectus

Answer: (B)

Q31.

Solution

Concept: Natural Selection and Industrial Melanism.

Solution: Industrial melanism in the peppered moth (*Biston betularia*) in England is a classic case study of natural selection in action.

1. Pre-Industrialization: Before the 1850s, white-winged moths were more abundant because they could camouflage against white lichens on tree trunks, while dark (melanic) moths were easily spotted and eaten by birds.

2. Post-Industrialization: Due to industrial smoke and soot, tree trunks became dark and lichens died. Now, the dark-colored moths were camouflaged and survived better, while the white-winged moths were predated upon.

3. The Result: The population of dark moths increased significantly. This does not mean a new species was created, nor that pollution caused the mutation; rather, the environment changed the survival advantage.

4. This proves that natural selection favors the variant that is best adapted to the prevailing environmental conditions. Those that fit better survive and reproduce more.

Final Answer : Natural selection favors the variant that is best adapted to the environment.

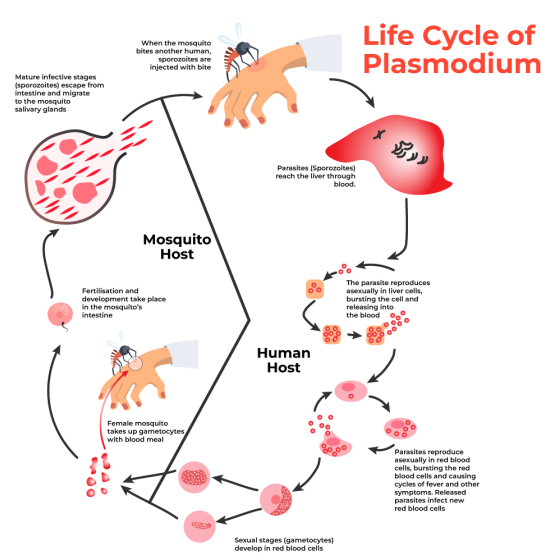
Answer: (C)

Q32.

Solution

Concept: Life Cycle of the Malarial Parasite (Plasmodium).

Solution: The life cycle of *Plasmodium* involves two hosts: Humans and the Female *Anopheles* mosquito.



1. Infection: Sporozoites are injected into the human by a mosquito bite and first travel to the liver cells to multiply asexually.

2. Asexual Cycle: They then enter the Red Blood Cells (RBCs), where they continue to multiply. The rupture of RBCs releases toxins (hemozoin) causing fever.

3. Gametocyte Development: Within the human RBCs, some of the parasites differentiate into sexual stages called gametocytes (male and female).

4. Transmission: When a mosquito bites an infected human, it takes up these gametocytes. 5. Sexual Cycle: The actual fertilization and further development (sexual reproduction) of these gametes occur in the mosquito's gut, not in the human body.

6. Therefore, the development of the sexual stage (gametocytes) occurs in the human RBCs.

Final Answer : RBCs of human

Answer: (B)

Q33.

Solution

Concept: Types of Acquired Immunity: Active vs. Passive.

Solution: Immunization is the process of making an individual immune or resistant to an infectious disease.

1. Active Immunization: Occurs when the body's own immune system is stimulated to produce antibodies (e.g., by natural infection or by a vaccine containing weakened pathogens). This takes time to develop.

2. Passive Immunization: Involves the direct injection of pre-formed antibodies (or antitoxins) into the body. This provides immediate protection because the body does not have to wait to produce its own response.

3. Tetanus Example: Tetanus is a deadly disease where a quick response is vital. Waiting for active immunity would be too slow. Therefore, we inject pre-formed antibodies (Tetanus Antitoxin) to neutralize the toxin immediately.

4. Because the body is a "passive" recipient of antibodies, this is called Passive immunization.

Final Answer : Passive immunization

Answer: (B)

Q34.

Solution

Concept: Autoimmunity and Immune System Malfunction.

Solution: In higher vertebrates, the immune system has the unique ability to distinguish between "self" and "non-self" cells. However, sometimes due to genetic or unknown reasons, the body's immune system loses this ability.

1. Autoimmune Disease: This occurs when the immune system starts attacking the body's own cells and tissues, leading to damage.

2. Rheumatoid Arthritis: This is a classic example of an autoimmune disease where the immune system attacks the linings of the joints, causing chronic inflammation and pain.

3. Other Options: - AIDS: An infectious disease caused by the HIV virus (immunodeficiency). - Cancer: A disease of uncontrolled cell division (loss of contact inhibition). - Typhoid: A bacterial infection caused by *Salmonella typhi*.

4. Therefore, Rheumatoid arthritis is the correct choice.

Final Answer : Rheumatoid arthritis

Answer: (C)

Q35.

Solution

Concept: Characteristics of Cancerous Tumors: Metastasis.

Solution: Tumors are classified into two types: Benign and Malignant.

1. Benign Tumors: These remain confined to their original location and do not spread to other parts of the body. They generally cause little damage.

2. Malignant Tumors: These are masses of proliferating cells called neoplastic or tumor cells. They grow very rapidly and invade surrounding normal tissues.

3. Metastasis: This is the most feared and dangerous property of malignant tumors. Cells slough off from the primary tumor and reach distant sites through the blood or lymphatic system. Wherever they get lodged in the body, they start a new tumor.

4. This ability to spread and form secondary tumors (metastasis) is what makes malignant tumors significantly more lethal and difficult to treat than benign ones.

5. Contact inhibition is a property of normal cells that is lost in both types of cancer.

Final Answer : Metastasis

Answer: (B)

Q36.

Solution

Concept: Secondary or Biological Treatment of Sewage and the role of Activated Sludge.

Solution: Sewage treatment is a multi-step process designed to reduce the organic load of wastewater before it is discharged.

1. The Aeration Process: After primary treatment removes physical grit, the liquid effluent is passed into large aeration tanks. Here, it is constantly agitated and air is pumped into it. This allows the vigorous growth of useful aerobic microbes into flocs. Flocs are masses of bacteria associated with fungal filaments that form mesh-like structures.

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

3. The Settling Stage: Once the BOD is significantly lowered, the effluent is passed into a secondary settling tank. In this tank, the bacterial flocs are allowed to sediment due to gravity.

4. Definition of Activated Sludge: This sedimented mass of bacterial flocs is specifically called Activated Sludge. A small portion of this sludge is pumped back into the aeration tank to serve as the "inoculum" (starter culture), while the rest is sent to anaerobic sludge digesters where it is broken down further to produce biogas.

Final Answer : The bacterial flocs settled in the secondary settling tank.

Answer: (B)

Q37.

Solution

Concept: Industrial use of Microbes for the production of Organic Acids and Bioactive Molecules.
Solution: Microorganisms are utilized on a large scale to produce various chemicals and medicines.

1. ***Aspergillus niger*:** This is a filamentous fungus (ascomycete) used extensively in industry for the production of Citric acid. Citric acid is widely used as a preservative and flavoring agent in the food and beverage industry. (Matches with ii).

2. ***Monascus purpureus*:** This is a species of yeast. It is used to produce Statins. Statins are medically significant because they act as blood-cholesterol lowering agents. They work through competitive inhibition of the enzyme HMG-CoA reductase, which is responsible for synthesizing cholesterol in the liver. (Matches with i).

3. ***Trichoderma polysporum*:** This is a fungus used to produce Cyclosporin A. Cyclosporin A is a vital bioactive molecule used as an immunosuppressive agent in organ-transplant patients. It helps prevent the patient's immune system from rejecting the new organ by inhibiting T-cell activation. (Matches with iii).

4. Reviewing the matches: (a)-(ii), (b)-(i), (c)-(iii).

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

Answer: (A)

Q38.

Solution

Concept: Microbes as Biocontrol Agents in Integrated Pest Management.

Solution: Biocontrol refers to the use of biological organisms to control pests and plant diseases, as opposed to using chemical pesticides which can be harmful to the environment.

1. Bacillus thuringiensis (Bt): This is a soil-dwelling bacterium that is used as a highly specific Biocontrol agent. It is particularly effective against larvae of certain insects such as butterflies (caterpillars), beetles, and flies.

2. Mechanism of Action: The bacterium produces specific protein crystals (Cry proteins) during its sporulation phase. These crystals contain a toxin that is initially inactive (pro-toxin).

3. Toxin Activation: When a target insect larva ingests the bacteria or the toxin crystals, the alkaline pH of the insect's midgut solubilizes the crystals and converts the pro-toxin into an active toxin.

4. Cell Lysis: The active toxin binds to the surface of midgut epithelial cells and creates pores. This causes cell swelling, lysis, and eventually the death of the insect. Because it is a living organism (or a product thereof) used to control a pest, it is a biological control method.

Final Answer : Biocontrol agent

Answer: (B)

Q39.

Solution

Concept: Principles of Gel Electrophoresis and DNA Migration.

Solution: Gel electrophoresis is the standard technique used to separate and analyze macromolecules like DNA, RNA, and proteins based on their size and charge.

1. Charge of the Molecule: DNA molecules are fundamentally negatively charged. This is due to the presence of phosphate groups (PO_4^{3-}) in the sugar-phosphate backbone of every nucleotide.

2. The Electric Field: In an electrophoresis setup, an electric field is applied to an agarose gel containing the DNA samples.

3. Direction of Migration: Because like charges repel and opposite charges attract, the negatively charged DNA fragments will migrate away from the negative electrode and toward the positive electrode.

4. Terminology: In an electrolytic cell setup used for electrophoresis, the Anode is the positive electrode and the Cathode is the negative electrode.

5. Separation: As the DNA moves toward the Anode, the agarose gel acts as a sieve. Smaller DNA fragments move through the pores more easily and thus travel further, while larger fragments move more slowly and remain closer to the starting point (the wells).

Final Answer : The Anode (Positive electrode)

Answer: (A)

Q40.

Solution

Concept: Vector Features and the Principle of Insertional Inactivation.

Solution: pBR322 is a widely used cloning vector in *E. coli*. It contains two important antibiotic resistance genes that serve as "selectable markers": amp^R (ampicillin resistance) and tet^R (tetracycline resistance).

1. Restriction Mapping: The vector has specific recognition sites for restriction endonucleases. One such site, for the enzyme BamHI, is located right in the middle of the coding sequence for the tetracycline resistance (tet^R) gene.

2. The Ligation Process: If a piece of foreign (target) DNA is inserted into the vector using the *BamHI* enzyme, it will be ligated into the tet^R gene sequence.

3. Insertional Inactivation: The insertion of foreign DNA breaks the continuity of the tet^R gene. This makes the gene non-functional, meaning it can no longer produce the protein required to protect the bacteria from tetracycline. This is called "insertional inactivation."

4. Selection Result: Consequently, the recombinant plasmids will still provide resistance to ampicillin (because the amp^R gene was not touched), but they will lose their resistance to tetracycline. By plating the bacteria on different media, scientists can identify which colonies contain the recombinant DNA.

Final Answer : Lose resistance to Tetracycline.

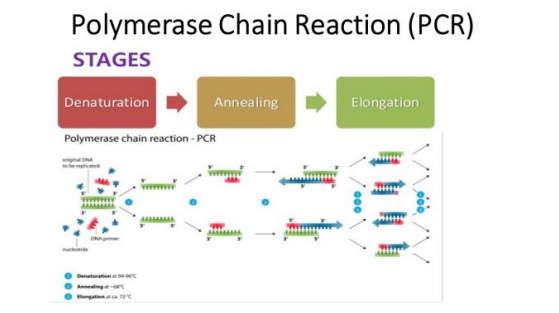
Answer: (B)

Q41.

Solution

Concept: The Three-Step Cycle of Polymerase Chain Reaction (PCR).

Solution: PCR is a molecular biology technique used to make billions of copies of a specific DNA segment. The process is performed in a thermal cycler and consists of a repeating cycle of three main steps:



1. Step 1: Denaturation: The reaction mixture is heated to a high temperature (about 94 – 96°C). This high heat breaks the hydrogen bonds between the complementary base pairs of the double-stranded DNA, causing the two strands to separate into single strands. These serve as templates.

2. Step 2: Annealing: The temperature is lowered to approximately 50 – 65°C. This allows the DNA primers (short, synthetic DNA sequences) to bind or "anneal" to their complementary sequences on the 3′ ends of the single-stranded DNA templates.

3. Step 3: Extension (or Polymerization): The temperature is raised to the optimal working temperature of the DNA polymerase (usually 72°C for Taq Polymerase). The enzyme adds dNTPs (nucleotides) to the 3′ end of the primers, synthesizing a new DNA strand complementary to the template.

4. Therefore, the sequence is always: Denaturation → Annealing → Extension.

Final Answer : Denaturation → Annealing → Extension

Answer: (C)

Q42.

Solution

Concept: Large-scale Culturing and the Design of Bioreactors.

Solution: When a recombinant protein or a specific metabolite needs to be produced on a commercial scale, small laboratory flasks are insufficient. Bioreactors, which can hold 100 to 1000 liters of culture, are used instead.

1. The Stirred-Tank Design: The most common type of bioreactor is the "stirred-tank" bioreactor. It is usually a cylindrical vessel with a curved base to facilitate better mixing.

2. The Role of the Impeller: The reactor is equipped with a stirrer (impeller) that rotates constantly. The primary purpose of this agitation is to ensure that the culture medium is completely homogenous.

3. Oxygenation: Most industrial fermentations are aerobic, meaning the microbes require a constant supply of oxygen to grow and produce the desired product. The stirring action ensures oxygen availability throughout the bioreactor by breaking up air into small bubbles and distributing them evenly.

4. Control Systems: These bioreactors also include sophisticated systems to monitor and control temperature, pH, foam, and pressure to maintain the "optimal" environment for the cells. While other factors like purification are part of downstream processing, the core design of the tank itself is focused on mixing and oxygenation.

Final Answer : Ensuring oxygen availability throughout the process.

Answer: (B)

Q43.

Solution

Concept: Mode of Action and Selective Toxicity of Bt Toxin.

Solution: The bacterium *Bacillus thuringiensis* (Bt) produces a specific proteinaceous insecticidal crystal during its sporulation phase. This protein is lethal to certain insects but does not harm the bacterium that produces it for several biological reasons:

1. The Inactive State: Inside the bacterial cell, the protein is synthesized and stored as an inactive protoxin. In this crystalline state, the molecule is chemically stable and biologically inert, meaning it does not interact with the cellular machinery of the *Bacillus*.

2. The Activation Trigger: The conversion of the protoxin into an active toxin requires a specific environment—specifically a high alkaline pH.

3. Biological Mechanism: When a susceptible insect ingests these protein crystals, they move into the insect's midgut. The midgut of many insect larvae (like Lepidopterans) is highly alkaline. This alkaline environment solubilizes the crystals and facilitates proteolytic cleavage by specific gut proteases.

4. Lethal Effect: Only after this cleavage does the "active" toxin bind to the surface of midgut epithelial cells, creating pores that cause osmotic swelling and lysis. Since the bacterium's internal environment is not alkaline and lacks the specific activation proteases, the protoxin remains harmless to the host.

Final Answer : The toxin exists as an inactive protoxin.

Answer: (B)

Q44.

Solution

Concept: RNA Interference (RNAi) and Post-Transcriptional Gene Silencing.

Solution: RNA interference (RNAi) is a biological process in which RNA molecules inhibit gene expression or translation, typically by causing the destruction of specific mRNA molecules.

1. A Cellular Defense: It occurs in all eukaryotic organisms as a method of cellular defense against viruses that have RNA genomes and mobile genetic elements (transposons) that replicate via an RNA intermediate.

2. The Role of dsRNA: The process is initiated by the presence of double-stranded RNA (dsRNA) within the cell. This dsRNA is recognized as "foreign" or "regulatory" and is cleaved by an enzyme called Dicer into small fragments (siRNAs).

3. Formation of RISC: These fragments are then incorporated into a multi-protein complex known as the RNA-induced silencing complex (RISC). The RISC complex uses one strand of the dsRNA as a guide to find and bind to a complementary mRNA sequence.

4. Silencing Mechanism: Once the complementary mRNA is bound by the RISC-guide RNA complex, the mRNA is either sliced (cleaved) or its translation is blocked. Consequently, the specific protein coded by that mRNA is not produced, effectively "silencing" the gene.

Final Answer : dsRNA

Answer: (B)

Q45.

Solution

Concept: Gene Therapy and Adenosine Deaminase (ADA) Deficiency.

Solution: Gene therapy represents a revolutionary approach to medicine where defective genes are replaced or supplemented by functional ones to treat genetic disorders.

1. The Landmark Case: The first successful clinical application of gene therapy took place in 1990 at the National Institutes of Health. The patient was a four-year-old girl suffering from a life-threatening condition.

2. The Disorder: She suffered from a form of Severe Combined Immunodeficiency (SCID) caused by a mutation in the gene for the enzyme Adenosine deaminase (ADA).

3. Physiological Role: ADA is critical for the metabolism of purines and the development/maintenance of the immune system. Without it, T-lymphocytes and B-lymphocytes fail to function, leaving the patient completely vulnerable to infections.

4. The Procedure: Scientists extracted lymphocytes from the girl's blood, grew them in a laboratory culture, and used a retroviral vector to insert a functional human ADA cDNA into these cells. These genetically corrected lymphocytes were then infused back into her body. 5. Because lymphocytes have a finite lifespan, the treatment provided significant improvement but required periodic repeat infusions.

Final Answer : Adenosine deaminase (ADA)

Answer: (B)

Q46.

Solution

Concept: Logistic Growth Models and Environmental Carrying Capacity.

Solution: In ecology, population growth is limited by the availability of resources such as food, water, and space. This reality is modeled by the Logistic Growth (Verhulst-Pearl) equation.

1. The Model: Unlike exponential growth, which assumes infinite resources, logistic growth accounts for "environmental resistance."

2. The Sigmoid Curve: The population initially grows slowly (lag phase), then rapidly (log phase), and eventually slows down (deceleration phase) as it nears the limits of the habitat, forming an S-shaped or sigmoid curve.

3. The Variable 'K': The mathematical formula is $dN/dt = rN[(K - N)/K]$. In this context, K stands for Carrying Capacity.

4. Definition of K: Carrying capacity is the maximum population size of a biological species that can be sustained by that specific environment, given the food, habitat, water, and other available necessities.

5. As the population size (N) approaches K, the term $(K - N)/K$ approaches zero, which causes the growth rate (dN/dt) to stop, indicating that the population has reached equilibrium with its environment.

Final Answer : Carrying capacity

Answer: (B)

Q47.

Solution

Concept: Types of Interspecific Interactions: Commensalism.

Solution: Interspecific interactions arise from the interaction of populations of two different species. They can be beneficial, detrimental, or neutral.

1. Defining Commensalism: This is an interaction where one species (the commensal) derives a benefit, while the other species (the host) is neither helped nor harmed. It is mathematically represented as a (+, 0) interaction.

2. The Orchid/Mango Case: An epiphytic orchid growing on a branch of a mango tree is a classic example. The orchid benefits by being physically supported in a position where it can receive better sunlight and moisture from the air. However, the orchid does not penetrate the tree's vascular system or steal its nutrients. The mango tree is neither deprived of resources nor physically damaged; hence it is unaffected.

3. Comparison: This differs from Mutualism (+, +) where both benefit, and Parasitism (+, -) where one benefits at the expense of the other (e.g., a tick on a dog or Cuscuta on a hedge plant).

Final Answer : Commensalism

Answer: (C)

Q48.

Solution

Concept: Primary Productivity: Gross vs. Net.

Solution: Productivity is the rate of biomass production in an ecosystem, which is essential for supporting all life forms.

1. Gross Primary Productivity (GPP): This is the total amount of solar energy that producers (green plants) capture and convert into chemical energy (organic matter) through photosynthesis within a specific area over a specific time. It is the "gross" or total output of the ecosystem's producers.

2. The Metabolic Cost: Plants are living organisms that require energy for their own survival, growth, and maintenance. They use a significant portion of the organic matter they produce for their own cellular respiration (R).

3. Net Primary Productivity (NPP): This is the remaining biomass after the plant's respiratory losses have been subtracted from the total production ($NPP = GPP - R$).

4. Trophic Significance: NPP is the most critical metric for the rest of the food web because it represents the actual biomass available for consumption by heterotrophs (herbivores, carnivores, and decomposers).

5. Secondary productivity, by contrast, is the rate of formation of new organic matter by the consumers themselves.

Final Answer : GPP, NPP

Answer: (B)

Q49.

Solution

Concept: The "Evil Quartet" and Major Threats to Biodiversity.

Solution: Human activities are currently causing species to go extinct at a rate 100 to 1000 times higher than natural background rates. Ecologists have identified four primary drivers of this loss, famously termed "The Evil Quartet."

1. The Quartet Members: The four drivers are (i) Habitat loss and fragmentation, (ii) Over-exploitation (over-hunting/fishing), (iii) Alien species invasions (invasive species), and (iv) Co-extinctions.

2. The Primary Driver: Of these four, Habitat loss and fragmentation is considered the most significant and devastating.

3. Impact of Habitat Loss: When humans destroy natural forests for agriculture, urbanization, or industry, species lose their homes, breeding grounds, and food sources.

4. Fragmentation: Even if the habitat is not entirely destroyed, breaking it into small, isolated patches (fragmentation) makes it difficult for large-range animals (like tigers or elephants) and migratory species to survive. This leads to a rapid decline in population size and eventual extinction. A prime example is the shrinking of the Amazon rain forest, often called the "Lungs of the planet."

Final Answer : Habitat loss and fragmentation

Answer: (C)

Q50.

Solution

Concept: Biodiversity Conservation: In-situ vs. Ex-situ Strategies.

Solution: Conservation strategies are broadly categorized based on where the protection occurs.

1. In-situ Conservation (On-site): This involves the protection of species within their natural ecosystem. The goal is to preserve the habitat so the species can thrive naturally. Examples include National Parks, Wildlife Sanctuaries, Biosphere Reserves, and Sacred Groves. These protect the entire community of organisms.

2. Ex-situ Conservation (Off-site): This is an approach used for species that are facing an extremely high risk of extinction in the wild and need urgent, human-managed intervention. The organisms are removed from their natural habitat and placed in specialized facilities.

3. Zoological Parks (Zoos) as Ex-situ: Zoological Parks (Zoos), Botanical Gardens, and Wildlife Safari Parks are prime examples. In a Zoo, animals are kept in enclosures, provided with medical care, and often part of captive breeding programs to increase their numbers before potential reintroduction to the wild.

4. Other Ex-situ examples: Cryopreservation of gametes, in-vitro fertilization, and seed banks for plants are also sophisticated forms of ex-situ conservation.

Final Answer : Zoological Parks (Zoos)

Answer: (C)

Answer Key

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