CUET UG Biology Sample Paper - 12

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 7-celled, 8-nucleate embryo sac, the central cell contains:

(A) Single haploid nucleus

(B) Two polar nuclei

(C) Three antipodal cells

(D) One secondary nucleus

Q2. Persistent nucellus in seeds like Black Pepper is known as:

(A) Pericarp

(B) Perisperm

(C) Endosperm

(D) Scutellum

Q3. If the endosperm of an angiosperm has 24 chromosomes, what is the number of chromosomes in its root cells?

(A) 8

(B) 16

(C) 24

(D) 32

Q4. Which of the following ensures autogamy but prevents geitonogamy?

(A) Dioecy

(B) Cleistogamy

(C) Dichogamy

(D) Self-incompatibility

Q5. Double fertilization is a characteristic feature of:

(A) Gymnosperms

(B) Angiosperms

(C) Pteridophytes

(D) Bryophytes

Q6. Which hormone surge is primarily responsible for the rupture of the Graafian follicle and release of the ovum?

(A) FSH

(B) Progesterone

(C) LH

(D) Estrogen

Q7. The correct sequence of cell stages during spermatogenesis is:

(A) Spermatogonia → Spermatids → Secondary spermatocytes → Spermatozoa

(B) Spermatogonia → Primary spermatocytes → Secondary spermatocytes → Spermatids → Spermatozoa

(C) Primary spermatocytes → Spermatogonia → Spermatids → Spermatozoa

(D) Spermatogonia → Secondary spermatocytes → Spermatids → Spermatozoa

Q8. Implantation of the blastocyst usually occurs on which day after fertilization?

(A) 2nd day

(B) 4th day

(C) 7th day

(D) 10th day

Q9. In the human female, the second meiotic division is completed:

(A) At the time of ovulation

(B) At the time of fertilization

(C) Prior to menstruation

(D) During implantation

Q10. The middle piece of the sperm contains:

(A) Nucleus

(B) Acrosome

(C) Mitochondria

(D) Centriole

Q11. Which of the following is a non-hormonal Intrauterine Device (IUD)?

(A) Lippes loop

(B) LNG-20

(C) Progestasert

(D) Multiload 375

Q12. In which Assisted Reproductive Technology (ART) is the embryo with more than 8 blastomeres transferred into the uterus?

(A) GIFT

(B) ZIFT

(C) IUT

(D) ICSI

Q13. "Saheli" is an oral contraceptive for females that contains a non-steroidal preparation called:

(A) Centchroman

(B) Progestogen

(C) Estrogen

(D) Cortisol

Q14. A cross between a tall pea plant (Tt) and a dwarf pea plant (tt) will result in a phenotypic ratio of:

(A) 3:1

(B) 1:1

(C) 9:3:3:1

(D) 1:2:1

Q15. Down's syndrome is caused by the trisomy of which chromosome?

(A) 13

(B) 18

(C) 21

(D) X

Q16. If a person has 47 chromosomes with the karyotype 44+XXY, the syndrome is:

(A) Turner's

(B) Klinefelter's

(C) Down's

(D) Edward's

Q17. In a dihybrid cross, the phenotype ratio 9:3:3:1 is a result of:

(A) Linkage

(B) Independent Assortment

(C) Incomplete Dominance

(D) Segregation

Q18. The recombination frequency between two genes A and B is 5%, and between B and C is 15%. The distance between A and C could be:

(A) 10 or 20 cM

(B) 5 or 15 cM

(C) 20 cM only

(D) 10 cM only

Q19. Thalassemia and Sickle cell anemia are caused due to:

(A) Quantitative and Qualitative defects respectively

(B) Both Qualitative

(C) Qualitative and Quantitative respectively

(D) Both Quantitative

Q20. During DNA replication, Okazaki fragments are used to elongate:

(A) The leading strand towards replication fork

(B) The lagging strand towards replication fork

(C) The leading strand away from replication fork

(D) The lagging strand away from replication fork

Q21. In the Lac Operon, the 'i' gene codes for:

(A) Inducer

(B) Repressor

(C) Beta-galactosidase

(D) Permease

Q22. The process of splicing in Eukaryotes involves the removal of:

(A) Exons

(B) Introns

(C) Promoters

(D) Terminators

Q23. Which codon has a dual function, acting as an initiator and coding for Methionine?

(A) UAA

(B) AUG

(C) GUG

(D) UAG

Q24. In DNA Fingerprinting, VNTRs belong to a class of satellite DNA referred to as:

(A) Microsatellite

(B) Minisatellite

(C) Macrosatellite

(D) Non-satellite

Q25. The enzyme DNA-dependent RNA polymerase catalyzes polymerization in which direction?

(A) 3' $\rightarrow$ 5'

(B) 5' $\rightarrow$ 3'

(C) Both directions

(D) Randomly

Q26. Termination of translation occurs when the ribosome encounters:

(A) AUG

(B) UAA

(C) UGG

(D) GUG

Q27. The sequence of structural genes in the Lac Operon is:

(A) z, y, a

(B) a, y, z

(C) y, z, a

(D) z, a, y

Q28. In a population in Hardy-Weinberg equilibrium, the frequency of the recessive allele 'q' is 0.4. The frequency of heterozygotes (2pq) is:

(A) 0.16

(B) 0.36

(C) 0.48

(D) 0.24

Q29. The evolution of different species in a given geographical area starting from a point and radiating to other habitats is called:

(A) Convergent evolution

(B) Adaptive radiation

(C) Saltation

(D) Genetic drift

Q30. The first hominid with a brain capacity between 650-800cc was:

(A) Homo erectus

(B) Homo habilis

(C) Neanderthal

(D) Australopithecus

Q31. Analogous structures are a result of:

(A) Divergent evolution

(B) Convergent evolution

(C) Genetic bottleneck

(D) Founder effect

Q32. The "Infective stage" of Plasmodium for humans is:

(A) Trophozoite

(B) Sporozoite

(C) Gametocyte

(D) Merozoite

Q33. Which type of immunity is responsible for the rejection of a kidney transplant?

(A) Humoral immunity

(B) Cell-mediated immunity

(C) Innate immunity

(D) Passive immunity

Q34. HIV targets which specific cells in the human body?

(A) B-lymphocytes

(B) Cytotoxic T-cells

(C) Helper T-lymphocytes

(D) Erythrocytes

Q35. The "Contact Inhibition" property is lost in:

(A) Normal cells

(B) Benign tumors

(C) Malignant tumors

(D) Stem cells

Q36. Which of the following is used as a biocontrol agent against butterfly caterpillars?

(A) Trichoderma

(B) Baculovirus

(C) Bacillus thuringiensis

(D) Ladybird

Q37. In sewage treatment, the "activated sludge" contains:

(A) Anaerobic bacteria

(B) Flocs of aerobic bacteria and fungi

(C) Inorganic waste

(D) Viruses

Q38. Statins, used for lowering blood cholesterol, are produced by:

(A) Monascus purpureus

(B) Trichoderma polysporum

(C) Aspergillus niger

(D) Acetobacter aceti

Q39. The restriction enzyme EcoRI cuts the DNA at which specific palindromic sequence?

(A) GGATCC

(B) GAATTC

(C) AGCT

(D) GATC

Q40. In PCR, the correct sequence of steps is:

(A) Annealing → Denaturation → Extension

(B) Extension → Denaturation → Annealing

(C) Denaturation → Annealing → Extension

(D) Denaturation → Extension → Annealing

Q41. While isolating DNA, the enzyme used to break the bacterial cell wall is:

(A) Cellulase

(B) Lysozyme

(C) Chitinase

(D) Protease

Q42. A bioreactor provides optimal growth conditions by controlling:

(A) Temperature

(B) pH

(C) Oxygen

(D) All of these

Q43. RNA interference (RNAi) involves the silencing of specific mRNA using:

(A) ssDNA

(B) dsRNA

(C) ssRNA

(D) dsDNA

Q44. The 'C-peptide' in human insulin is:

(A) Part of mature insulin

(B) Removed during maturation of pro-insulin

(C) Responsible for its activity

(D) A disulfide bridge

Q45. Bt toxin crystals are not toxic to the Bacillus itself because:

(A) The toxin is immature

(B) The toxin exists as an inactive protoxin

(C) The bacteria lacks the target

(D) The bacteria is resistant

Q46. Which of the following population interactions is represented by (+, 0)?

(A) Mutualism

(B) Parasitism

(C) Commensalism

(D) Amensalism

Q47. Which part of the population pyramid represents a declining population?

(A) Triangular

(B) Bell-shaped

(C) Urn-shaped

(D) Rectangular

Q48. An inverted pyramid of biomass is typically found in:

(A) Grassland

(B) Forest

(C) Sea/Marine

(D) Desert

Q49. In the "Evil Quartet", which factor is considered the most important cause of extinction?

(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 Park

(B) Wildlife Sanctuary

(C) Zoological Park

(D) Biosphere Reserve

Detailed Solutions

Q1.

Solution

Concept: The typical angiosperm embryo sac at maturity is 7-celled but 8-nucleate. This structure consists of three antipodal cells at the chalazal end, an egg apparatus (one egg cell and two synergids) at the micropylar end, and a large central cell.

Solution: The central cell is the largest cell of the embryo sac. It initially contains two haploid polar nuclei. These two nuclei stay together in the cytoplasm of the central cell and eventually fuse to form a diploid secondary nucleus before fertilization. Therefore, the characteristic components of the central cell in this stage are the two polar nuclei.

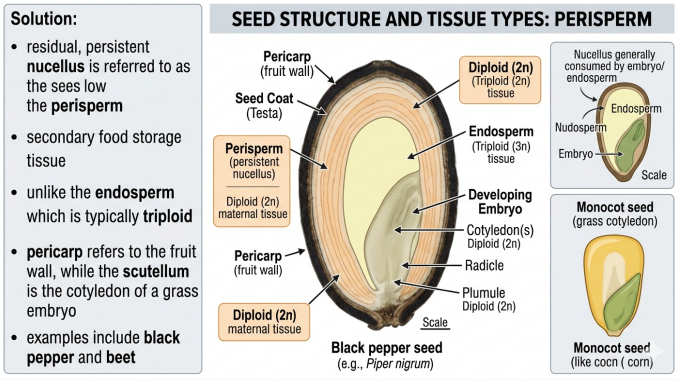
Final Answer: Two polar nuclei

Answer: (B)

Q2.

Solution

Concept: During the development of a seed, the nucellus is generally consumed by the developing embryo or endosperm. However, in certain species, the nucellus remains as a persistent layer surrounding the endosperm, serving as a secondary food storage tissue.



Solution: In seeds like black pepper and beet, the residual, persistent nucellus is referred to as the perisperm. It is a diploid ($2n$) maternal tissue, unlike the endosperm which is typically triploid ($3n$) in angiosperms. The pericarp refers to the fruit wall, while the scutellum is the cotyledon of a grass embryo.

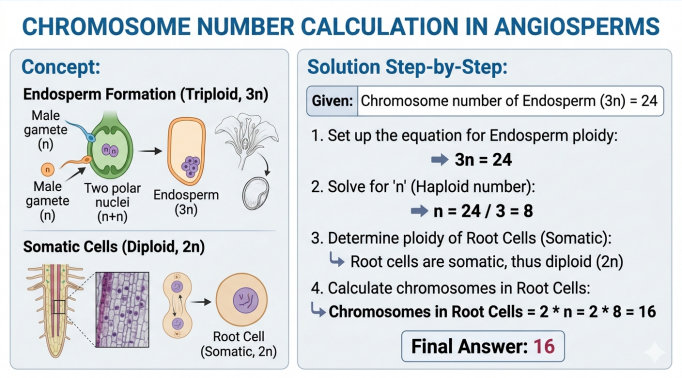
Final Answer: Perisperm

Answer: (B)

Q3.

Solution

Concept: In angiosperms, the endosperm is a triploid ($3n$) tissue formed by the fusion of a male gamete (n) with two polar nuclei ($n + n$). Somatic tissues, such as root cells, are diploid ($2n$) as they develop from the zygote.



Solution: Given the chromosome number of the endosperm is 24, we set up the equation $3n = 24$. Solving for n, we find the haploid number is 8. Since root cells are somatic cells, they are diploid ($2n$). Therefore, the number of chromosomes in the root cells is $2 \times 8 = 16$.

Final Answer: 16

Answer: (B)

Q4.

Solution

Concept:

- **Autogamy:** Transfer of pollen from the anther to the stigma of the same flower.
- **Geitonogamy:** Transfer of pollen from the anther to the stigma of another flower on the same plant.
- **Cleistogamy:** Flowers that never open, ensuring that only pollen from the same flower can reach the stigma.

Solution: Cleistogamous flowers are closed flowers. Because the reproductive organs are never exposed to the outside environment, pollen from the same flower is the only possible source for pollination. This strictly ensures autogamy and completely prevents geitonogamy (and xenogamy) because no external pollen can enter.

Final Answer: Cleistogamy

Answer: (B)

Q5.

Solution

Concept: Double fertilization is a unique reproductive process where two male gametes participate: one fuses with the egg cell to form a zygote (syngamy), and the other fuses with two polar nuclei to form the triploid endosperm (triple fusion).

Solution: This process is a defining characteristic of Angiosperms (flowering plants). In Gymnosperms, Pteridophytes, and Bryophytes, while fertilization occurs, the specific "double" event involving the formation of a triploid endosperm is absent.

Final Answer: Angiosperms

Answer: (B)

Q6.

Solution

Concept: The menstrual cycle is regulated by pituitary and ovarian hormones. Ovulation is the process where a mature Graafian follicle ruptures to release the secondary oocyte.

Solution: A rapid rise in the concentration of Luteinizing Hormone (LH), known as the "LH surge," occurs mid-cycle (around day 14). This surge triggers the final maturation and rupture of the Graafian follicle, leading to ovulation.

Final Answer: LH

Answer: (C)

Q7.

Solution

Concept: Spermatogenesis is the process of sperm formation in the seminiferous tubules of the testes, involving mitotic and meiotic divisions.

Solution: The sequence is: 1. **Spermatogonia** (2n) undergo mitosis. 2. Some differentiate into **Primary spermatocytes** (2n). 3. These undergo Meiosis I to form **Secondary spermatocytes** (n). 4. These undergo Meiosis II to form **Spermatids** (n). 5. Spermatids undergo spermiogenesis to become **Spermatozoa** (n).

Final Answer: Spermatogonia $\rightarrow$ Primary spermatocytes $\rightarrow$ Secondary spermatocytes $\rightarrow$ Spermatids $\rightarrow$ Spermatozoa

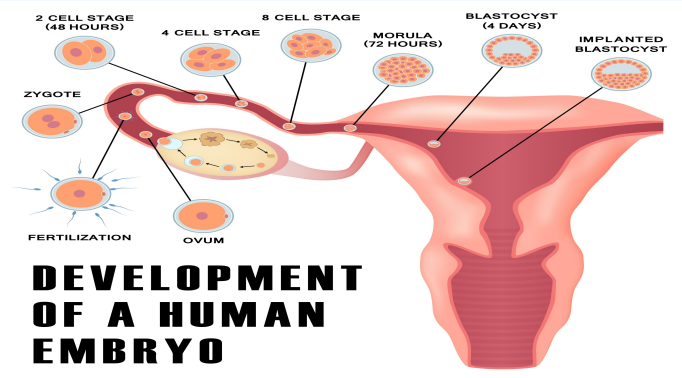
Answer: (B)

Q8.

Solution

Concept: After fertilization in the ampulla, the zygote undergoes cleavage while moving toward the uterus. It transforms into a morula and then a blastocyst. Implantation is the process where the blastocyst attaches to the endometrial lining of the uterus.

Solution: The journey from the fallopian tube to the uterus takes several days. The blastocyst typically reaches the uterine cavity and begins to embed itself into the endometrium approximately 6 to 9 days after fertilization. Among the given options, the 7th day is the most accurate representation of this physiological window.



Final Answer: 7th day

Answer: (C)

Q9.

Solution

Concept: Oogenesis is an interrupted process. The primary oocyte is arrested in Prophase I until puberty. After the first meiotic division, the secondary oocyte is arrested again in Metaphase II.

Solution: The second meiotic division (Meiosis II) is only triggered and completed when a sperm penetrates the secondary oocyte during fertilization. This division results in the formation of a large ootid (ovum) and a second polar body. If fertilization does not occur, the cell degenerates without ever completing meiosis.

Final Answer: At the time of fertilization

Answer: (B)

Q10.

Solution

Concept: A mature human sperm consists of a head, neck, middle piece, and tail. Each section has a specialized function for reproduction and motility.

Solution: The middle piece of the sperm is packed with numerous mitochondria spirally arranged around the axial filament (Nebenkern). These mitochondria provide the energy (ATP) required for the movement of the tail, facilitating the sperm's journey toward the ovum.

Final Answer: Mitochondria

Answer: (C)

Q11.

Solution

Concept: Intrauterine Devices (IUDs) are classified into three types:

- **Non-medicated/Non-hormonal:** Act by increasing phagocytosis of sperms (e.g., Lippes loop).
- **Copper-releasing:** Release Cu ions to suppress sperm motility (e.g., Multiload 375, CuT).
- **Hormone-releasing:** Make the uterus unsuitable for implantation (e.g., Progestasert, LNG-20).

Solution: Lippes loop is a plastic double-S loop that does not release hormones or copper; it is a non-medicated IUD. LNG-20 and Progestasert are hormone-releasing, while Multiload 375 is a copper-releasing IUD.

Final Answer: Lippes loop

Answer: (A)

Q12.

Solution

Concept: In Vitro Fertilization (IVF) is followed by Embryo Transfer (ET). The site of transfer depends on the stage of the embryo:

- **ZIFT (Zygote Intra Fallopian Transfer):** Zygote or early embryo (up to 8 blastomeres) is transferred into the fallopian tube.
- **IUT (Intra Uterine Transfer):** Embryos with more than 8 blastomeres are transferred directly into the uterus.

Solution: Since the question specifies an embryo with **more than 8 blastomeres**, the correct procedure is Intra Uterine Transfer (IUT). GIFT involves gametes, and ICSI is a method to form an embryo, not the transfer process itself.
Final Answer: IUT

Answer: (C)

Q13.

Solution

Concept: "Saheli" is a unique oral contraceptive pill developed by the Central Drug Research Institute (CDRI) in Lucknow, India. It is known for being a "once-a-week" pill with very few side effects.
Solution: Unlike traditional pills that use steroidal hormones (estrogen/progestogen) to prevent ovulation, Saheli contains **Centchroman** (also known as Ormeloxifene). This is a non-steroidal Selective Estrogen Receptor Modulator (SERM) that prevents implantation by modifying the endometrium.
Final Answer: Centchroman

Answer: (A)

Q14.

Solution

Concept: This is a **test cross** involving a monohybrid trait. A test cross is performed by crossing an individual with a dominant phenotype (but unknown genotype, here Tt) with a homozygous recessive individual (tt).

Solution: Using a Punnett square for the cross $Tt \times tt$:

- Gametes from Tt: T and t
- Gametes from tt: t and t

The offspring genotypes are: Tt, Tt, tt, and tt.

- 50% Tall (Tt)
- 50% Dwarf (tt)

The phenotypic ratio is $1 : 1$.

Final Answer: 1:1

Answer: (B)

Q15.

Solution

Concept: Aneuploidy is a condition where there is an abnormal number of chromosomes. Trisomy refers to the presence of an extra copy of a specific chromosome ($2n + 1$).

Solution: Down's syndrome is a genetic disorder caused by the presence of an additional copy of **chromosome number 21**. This results in a total of 47 chromosomes instead of the usual 46. It was first described by Langdon Down in 1866 and is characterized by short stature, a round head, and mental retardation.

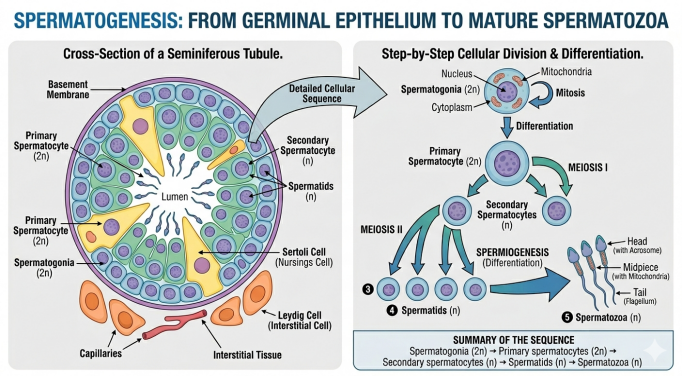
Final Answer: 21

Answer: (C)

Q16.

Solution

Concept: Chromosomal disorders can occur due to the gain or loss of sex chromosomes. Klinefelter's syndrome is a genetic condition that results when a male is born with an extra copy of the X chromosome.



Solution: The karyotype $44 + XXY$ (total 47 chromosomes) indicates the presence of an additional X chromosome in a male. Individuals with this syndrome typically have masculine development but also express feminine traits (such as gynaecomastia) and are usually sterile. Turner's syndrome, by contrast, is $44 + X$ (45 chromosomes).

Final Answer: Klinefelter's

Answer: (B)

Q17.

Solution

Concept: Mendel's second law, the Law of Independent Assortment, states that the alleles of two (or more) different genes get sorted into gametes independently of one another.

Solution: In a dihybrid cross between two heterozygous parents ($RrYy \times RrYy$), the four types of gametes combine randomly. This results in four distinct phenotypes in the ratio of $9 : 3 : 3 : 1$. This ratio only occurs because the genes for the two traits are located on different chromosomes (or far apart on the same chromosome), allowing them to assort independently. If linkage were present, this ratio would be significantly distorted.

Final Answer: Independent Assortment

Answer: (B)

Q18.

Solution

Concept: Recombination frequency is directly proportional to the physical distance between genes on a chromosome, measured in centiMorgans (cM). 1% recombination frequency equals 1 cM. The order of genes can vary, leading to different possible total distances.

Solution: We are given: $d(A,B) = 5$ cM and $d(B,C) = 15$ cM. There are two possible arrangements for gene B relative to A and C:

(a) **B is between A and C:** The sequence is $A\text{-}B\text{-}C$. $d(A,C) = d(A,B)+d(B,C) = 5+15 = 20$ cM.

(b) **A is between B and C:** The sequence is $B\text{-}A\text{-}C$. $d(A,C) = d(B,C)-d(B,A) = 15-5 = 10$ cM.

Final Answer: 10 or 20 cM

Answer: (A)

Q19.

Solution

Concept: Both disorders are Mendelian blood disorders involving hemoglobin, but they arise from different types of mutations.

- **Quantitative defect:** Reduced synthesis of one of the globin chains.
- **Qualitative defect:** Synthesis of an incorrectly functioning (abnormal) globin chain.

Solution:

- **Thalassemia** is a **quantitative** problem because too few globin molecules are synthesized.
- **Sickle cell anemia** is a **qualitative** problem because a single amino acid substitution (Glutamic acid to Valine) creates an abnormal hemoglobin shape (HbS).

Final Answer: Quantitative and Qualitative defects respectively

Answer: (A)

Q20.

Solution

Concept: DNA polymerase can only synthesize DNA in the $5' \rightarrow 3'$ direction. Because the two strands of the DNA double helix are antiparallel, one strand (the lagging strand) must be synthesized discontinuously in short stretches called Okazaki fragments.

Solution: The replication fork opens in one direction. The **lagging strand** has a $5' \rightarrow 3'$ polarity relative to the fork's movement, meaning its synthesis must occur in the direction **away from the replication fork** to maintain the required enzymatic polarity. These fragments are later joined by DNA ligase.

Final Answer: The lagging strand away from replication fork

Answer: (D)

Q21.

Solution

Concept: The Lac Operon is a polycistronic system used by *E. coli* to metabolize lactose. It consists of regulatory genes and structural genes (z, y, a).

Solution: The **'i' gene** is the regulatory gene. The "i" does not stand for inducer; it stands for **inhibitor**. It constitutively synthesizes an mRNA that produces the **repressor** protein. This repressor binds to the operator region to prevent RNA polymerase from transcribing the structural genes when lactose is absent.

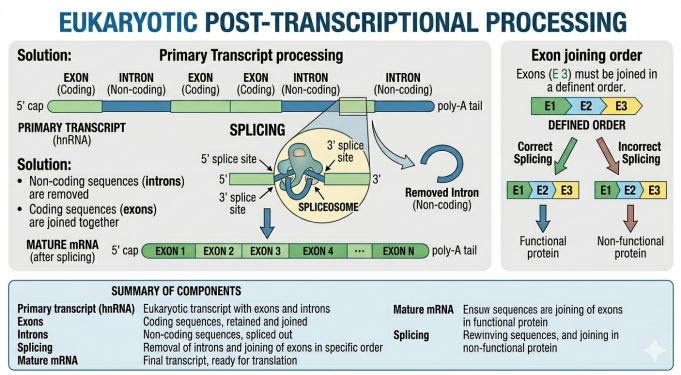
Final Answer: Repressor

Answer: (B)

Q22.

Solution

Concept: In eukaryotes, the primary transcript (hnRNA) contains both functional and non-functional sequences. Before it can be translated, it must undergo post-transcriptional processing.



Solution: **Splicing** is the process where the non-coding sequences, called **introns**, are removed, and the coding sequences, called **exons**, are joined together in a defined order to form mature mRNA.

Final Answer: Introns

Answer: (B)

Q23.

Solution

Concept: The genetic code is nearly universal and degenerate. Most amino acids are coded by more than one codon, but some codons serve specific regulatory roles in protein synthesis.

Solution: The codon **AUG** serves two distinct purposes:

(a) It acts as the **initiation (start) codon**, signaling the ribosome to begin translation.

(b) It codes for the amino acid **Methionine** (Met).

In contrast, UAA and UAG are stop codons (nonsense codons) that terminate translation.

Final Answer: AUG

Answer: (B)

Q24.

Solution

Concept: Repetitive DNA constitutes a large portion of the human genome. Based on the size of the repeat unit and the number of repeats, satellite DNA is classified into different categories used in forensic analysis.

Solution: **Variable Number of Tandem Repeats (VNTRs)** are used in DNA fingerprinting because they show high degrees of polymorphism. VNTRs belong to the class of **minisatellites**, which typically have repeat units ranging from 10 to 60 base pairs. Microsatellites (SSRs), by contrast, have much shorter repeat units (1–6 bp).

Final Answer: Minisatellite

Answer: (B)

Q25.

Solution

Concept: Transcription is the process of copying a segment of DNA into RNA. Like DNA polymerase, RNA polymerase is restricted by the chemical structure of the nucleotides it assembles.

Solution: All nucleic acid polymerases (DNA-dependent DNA polymerase or DNA-dependent RNA polymerase) can only add new nucleotides to the 3′ hydroxyl group of the growing chain. Consequently, they catalyze polymerization exclusively in the **5′ $\rightarrow$ 3′** direction, reading the template strand in the 3′ $\rightarrow$ 5′ direction.

Final Answer: 5’ $\rightarrow$ 3’

Answer: (B)

Q26.

Solution

Concept: Translation continues until the ribosome’s A-site reaches a specific codon that does not code for any amino acid. These are known as stop codons or nonsense codons.

Solution: There are three stop codons: **UAA** (Ochre), **UAG** (Amber), and **UGA** (Opal). When the ribosome encounters one of these, release factors bind to the stop codon, causing the newly synthesized polypeptide chain to be released and the translation machinery to dissociate. AUG is a start codon, while UGG codes for Tryptophan and GUG for Valine.

Final Answer: UAA

Answer: (B)

Q27.

Solution

Concept: The Lac Operon is a cluster of genes under the control of a single promoter. The structural genes are transcribed together into a single polycistronic mRNA and are required for the metabolism of lactose.

Solution: The structural genes are arranged in the order **z, y, and a**:

- **z**: Codes for β-galactosidase (breaks lactose into glucose and galactose).
- **y**: Codes for permease (increases cell permeability to β-galactosides).
- **a**: Codes for transacetylase.

Final Answer: z, y, a

Answer: (A)

Q28.

Solution

Concept: The Hardy-Weinberg principle uses the equation $p^2 + 2pq + q^2 = 1$, where p is the frequency of the dominant allele and q is the frequency of the recessive allele. The sum of allele frequencies is $p + q = 1$.

Solution: 1. Given the recessive allele frequency $q = 0.4$. 2. Calculate the dominant allele frequency p:

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

3. Calculate the frequency of heterozygotes ($2pq$):

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

$$2pq = 2 \times 0.24 = 0.48$$

Final Answer: 0.48

Answer: (C)

Q29.

Solution

Concept: Evolutionary processes can lead to the diversification of a single ancestral lineage into various forms that are specialized to exploit different ecological niches. This often occurs when a species enters a new environment with diverse habitats.

Solution: **Adaptive radiation** is the process where species evolve from a common ancestor and "radiate" out to occupy different habitats. A classic example is Darwin's finches in the Galápagos Islands, where a single species evolved into multiple species with different beak shapes suited for different food sources. Convergent evolution is the opposite, where unrelated species develop similar traits.

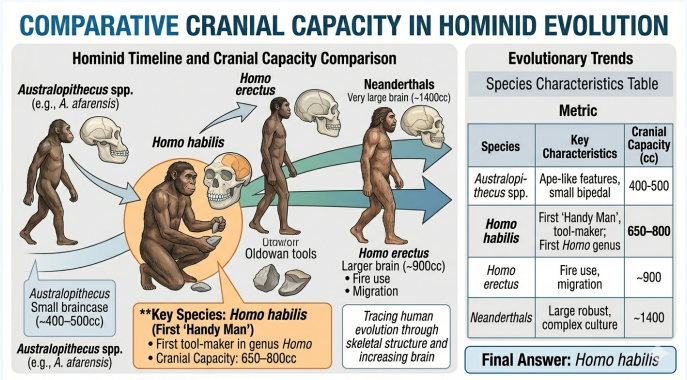
Final Answer: Adaptive radiation

Answer: (B)

Q30.

Solution

Concept: Human evolution is traced through various stages characterized by changes in skeletal structure and increasing cranial (brain) capacity.



Solution: **Homo habilis** is considered the first "handy man" or tool-maker and is the first hominid in the genus *Homo*. They had a brain capacity of approximately **650–800cc**. In comparison:

- *Australopithecus* had a smaller brain capacity (around 400–500cc).
- *Homo erectus* had a larger brain (around 900cc).
- *Neanderthals* had a brain capacity of about 1400cc.

Final Answer: Homo habilis

Answer: (B)

Q31.

Solution

Concept: Evolutionary structures are categorized based on their origin and function.

- **Homologous structures** share a common ancestry but perform different functions (Divergent evolution).
- **Analogous structures** have different origins but perform similar functions because they evolved in similar environments.

Solution: **Convergent evolution** occurs when unrelated species independently evolve similar traits to adapt to similar ecological niches. This results in analogous structures, such as the wings of a butterfly and the wings of a bird. They look and function similarly but do not share a common anatomical ancestor.

Final Answer: Convergent evolution

Answer: (B)

Q32.

Solution

Concept: *Plasmodium* (the malarial parasite) has a complex life cycle involving two hosts: the female *Anopheles* mosquito and humans. Different stages of the parasite are specialized for transfer or reproduction.

Solution: The **Sporozoite** is the infectious stage. When an infected female *Anopheles* mosquito bites a human, these sporozoites are injected into the bloodstream along with saliva. They then travel to the liver to initiate the infection. Gametocytes are the stage that infects the mosquito, while trophozoites and merozoites are stages found within human red blood cells.

Final Answer: Sporozoite

Answer: (B)

Q33.

Solution

Concept: The immune system distinguishes between "self" and "non-self." Acquired immunity is divided into two main branches:

- **Humoral immunity:** Mediated by B-cells and antibodies in body fluids.
- **Cell-mediated immunity (CMI):** Mediated by T-lymphocytes.

Solution: **Cell-mediated immunity (CMI)** is primarily responsible for the rejection of organ transplants. T-lymphocytes recognize the foreign HLA (Human Leukocyte Antigen) markers on the surface of the transplanted organ's cells and initiate a cytotoxic response to destroy the "invader." This is why tissue matching and immunosuppressants are critical in surgeries.
Final Answer: Cell-mediated immunity

Answer: (B)

Q34.

Solution

Concept: HIV (Human Immunodeficiency Virus) is a retrovirus that attacks the immune system, specifically targeting cells that possess the CD4 receptor on their surface.
Solution: HIV primarily infects and destroys **Helper T-lymphocytes** (T_H cells). These cells are crucial for orchestrating the immune response; their depletion leads to a weakened immune system, making the body susceptible to opportunistic infections—the condition known as AIDS.
Final Answer: Helper T-lymphocytes

Answer: (C)

Q35.

Solution

Concept: Contact inhibition is a regulatory mechanism where normal cells stop growing and dividing when they come into contact with neighboring cells, ensuring orderly tissue growth.
Solution: In **Malignant tumors** (cancerous cells), this regulatory property of contact inhibition is lost. As a result, the cells continue to divide uncontrollably even after touching each other, leading to the formation of a mass of cells called a tumor that can invade distant tissues (metastasis).
[Image comparing normal cells with contact inhibition vs cancer cells without contact inhibition]
Final Answer: Malignant tumors

Answer: (C)

Q36.

Solution

Concept: Biocontrol agents are living organisms used to manage pest populations in agriculture, reducing the need for chemical pesticides.

Solution: ***Bacillus thuringiensis* (Bt)** is a bacterium used to control butterfly caterpillars. It produces a toxic protein crystal (Bt toxin). When caterpillars ingest the bacteria (often applied as spores on leaves), the toxin is activated in their alkaline gut, creating pores that lead to the insect's death. *Trichoderma* is a fungicide, and *Baculoviruses* target insects and arthropods more broadly.

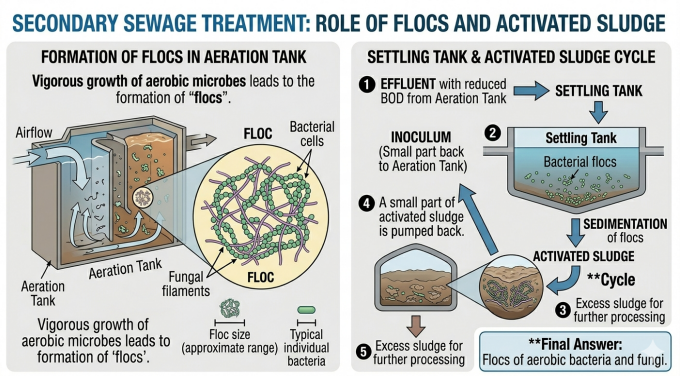
Final Answer: Bacillus thuringiensis

Answer: (C)

Q37.

Solution

Concept: Secondary treatment of sewage involves biological processes. In the aeration tank, vigorous growth of aerobic microbes leads to the formation of "flocs"—masses of bacteria associated with fungal filaments to form mesh-like structures.



Solution: Once the BOD (Biochemical Oxygen Demand) of sewage is reduced, the effluent is passed into a settling tank where the bacterial "flocs" are allowed to sediment. This sediment is called **activated sludge**. A small part of this is pumped back into the aeration tank to serve as the inoculum.

Final Answer: Flocs of aerobic bacteria and fungi

Answer: (B)

Q38.

Solution

Concept: Several microorganisms are utilized for the commercial production of bioactive molecules. Statins act by competitively inhibiting the enzyme responsible for the synthesis of cholesterol.

Solution: Statins are produced by the yeast ***Monascus purpureus****. In contrast, *Trichoderma polysporum* produces Cyclosporin A (an immunosuppressant), and *Aspergillus niger* is used for the production of Citric acid.

Final Answer: Monascus purpureus

Answer: (A)

Q39.

Solution

Concept: Restriction endonucleases recognize specific palindromic nucleotide sequences in DNA and cut the strands at specific points. A palindromic sequence reads the same on both strands when the orientation of reading ($5' \rightarrow 3'$) is kept the same.

Solution: The restriction enzyme ***EcoRI** (isolated from *Escherichia coli* RY 13) recognizes the sequence ***GAATTC**. It cuts the DNA between the bases G and A on both strands, leaving overhanging "sticky ends."

Final Answer: GAATTC

Answer: (B)

Q40.

Solution

Concept: The Polymerase Chain Reaction (PCR) is a technique used to amplify a specific segment of DNA in vitro. It involves repeated cycles of heating and cooling to facilitate DNA synthesis by a thermostable DNA polymerase (Taq polymerase).

Solution: The correct order of steps in a PCR cycle is:

(a) **Denaturation:** The DNA is heated to high temperatures (approx. 94°C) to separate the double strands into single strands.

(b) **Annealing:** The temperature is lowered (approx. 50-65°C) to allow primers to bind to their complementary sequences on the single-stranded DNA.

(c) **Extension:** The temperature is raised slightly (approx. 72°C) for Taq polymerase to add nucleotides and extend the primers.

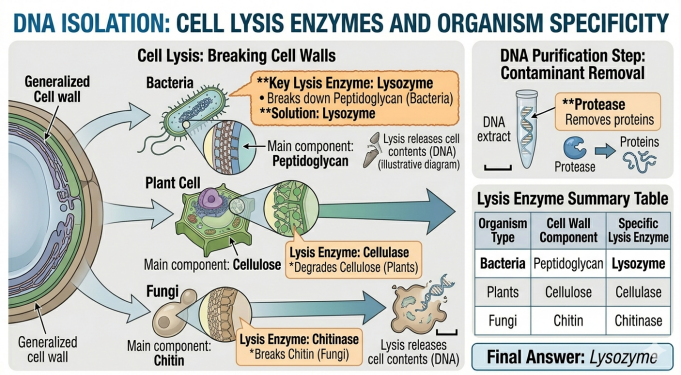
Final Answer: Denaturation $\rightarrow$ Annealing $\rightarrow$ Extension

Answer: (C)

Q41.

Solution

Concept: To isolate DNA, the cell must be lysed (broken open) to release its contents. Different organisms require specific enzymes to degrade their unique cell wall compositions.



Solution:

- **Lysozyme** is used for **bacteria** to break down peptidoglycan.
- **Cellulase** is used for plant cells (cellulose).
- **Chitinase** is used for fungi (chitin).

Protease is used to remove protein contaminants from the extract, not to break the cell wall.
Final Answer: Lysozyme

Answer: (B)

Q42.

Solution

Concept: A bioreactor is a large vessel (often 100–1000 liters) used for the large-scale production of biological products using microbial, plant, or animal cells. To maximize yield, the environment must be precisely regulated.
Solution: Bioreactors are equipped with control systems to maintain **optimal growth conditions**. This includes maintaining the correct **temperature**, regulating the **pH**, ensuring adequate **oxygen** delivery (via agitation or aeration), and managing substrate concentration and salts. Therefore, all the listed factors are controlled.
Final Answer: All of these

Answer: (D)

Q43.

Solution

Concept: RNA interference (RNAi) is a biological process in which RNA molecules inhibit gene expression or translation. It serves as a method of cellular defense against mobile genetic elements and viruses.

Solution: RNAi involves the silencing of a specific mRNA due to a complementary **double-stranded RNA (dsRNA)** molecule. The dsRNA binds to and prevents translation of the mRNA (silencing it). The source of this dsRNA could be from an infection by viruses that have RNA genomes or mobile genetic elements (transposons).

Final Answer: dsRNA

Answer: (B)

Q44.

Solution

Concept: Human insulin is synthesized as a pro-hormone (pro-insulin) which contains an extra stretch called the C-peptide.

Solution: The **C-peptide** is a connecting peptide that is present in pro-insulin but is **removed during maturation** into functional insulin. Mature insulin consists of two short polypeptide chains (A and B) linked together by disulfide bridges. One of the major challenges in producing insulin via rDNA technology was getting it to mature without this C-peptide.

Final Answer: Removed during maturation of pro-insulin

Answer: (B)

Q45.

Solution

Concept: *Bacillus thuringiensis* produces protein crystals that contain a toxic insecticidal protein. However, the bacterium itself remains unharmed by the toxin it produces.

Solution: The Bt toxin protein exists as **inactive protoxins** within the *Bacillus*. It does not kill the bacterium because the toxin only becomes active in the alkaline pH of the insect's gut. Once an insect ingests the protoxin, the alkaline environment triggers its conversion into an active toxin that creates pores in the gut wall.

Final Answer: The toxin exists as an inactive protoxin

Answer: (B)

Q46.

Solution

Concept: Population interactions are classified based on how the participating species affect each other.

- **Mutualism:** $(+, +)$ Both species benefit.
- **Parasitism:** $(+, -)$ One benefits, the other is harmed.
- **Commensalism:** $(+, 0)$ One benefits, the other is unaffected.
- **Amensalism:** $(-, 0)$ One is harmed, the other is unaffected.

Solution: The interaction $(+, 0)$ represents **Commensalism**. An orchid growing as an epiphyte on a mango branch; the orchid gets support (benefit), while the mango tree is neither helped nor harmed.
Final Answer: Commensalism

Answer: (C)

Q47.

Solution

Concept: Age pyramids display the distribution of various age groups in a population. The shape of the pyramid reflects the growth status of the population.

- **Triangular:** Expanding (high birth rate).
- **Bell-shaped:** Stable (birth and death rates nearly equal).
- **Urn-shaped:** Declining (low number of pre-reproductive individuals).

Solution: An **Urn-shaped** pyramid has a smaller base (fewer young individuals) compared to the middle, indicating that the birth rate is very low and the population is likely to decrease over time.
Final Answer: Urn-shaped

Answer: (C)

Q48.

Solution

Concept: Ecological pyramids usually have a broad base of producers. However, the pyramid of biomass represents the total living organic matter at each trophic level.
Solution: An inverted pyramid of biomass is typically found in **Sea/Marine** ecosystems. This occurs because the biomass of the primary producers (phytoplankton) is much less than that of the consumers (zooplankton and fish) at any given time. The phytoplankton have a very high turnover rate and short life span, allowing them to support a larger biomass of consumers.
Final Answer: Sea/Marine

Answer: (C)

Q49.

Solution

Concept: The "Evil Quartet" is a term used to describe the four major causes of biodiversity losses: Habitat loss and fragmentation, Over-exploitation, Alien species invasions, and Co-extinctions.
Solution: Among the four factors, **Habitat loss and fragmentation** is considered the most important cause driving animals and plants to extinction. The most dramatic examples come from tropical rain forests; for instance, the Amazon rain forest (the 'lungs of the planet') is being cut and cleared for cultivating soya beans or for conversion to grasslands for raising beef cattle.
Final Answer: Habitat loss and fragmentation

Answer: (C)

Q50.

Solution

Concept: Biodiversity conservation strategies are broadly categorized into two types:

- **In-situ (On-site):** Conservation of species within their natural habitats (e.g., National Parks, Sanctuaries, Biosphere Reserves).
- **Ex-situ (Off-site):** Conservation of species outside their natural habitats in specialized settings.

Solution: **Zoological Parks** (zoos) are an example of Ex-situ conservation because threatened animals are taken out of their natural habitat and placed in special settings where they can be protected and given special care. Other examples include Botanical Gardens, Wildlife Safari Parks, and Seed Banks. National Parks, Sanctuaries, and Biosphere Reserves are all In-situ methods.
[Image comparing In-situ and Ex-situ conservation methods]
Final Answer: Zoological Park

Answer: (C)

Answer Key

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