CUET UG Biology Sample Paper - 16

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. Functional megaspore in an angiosperm develops into:

(A) Endosperm

(B) Embryo sac

(C) Embryo

(D) Ovule

Q2. Which of the following is the correct sequence of events in double fertilization?

(A) Syngamy followed by Triple fusion.

(B) Triple fusion followed by Syngamy.

(C) Both occur simultaneously in the pollen tube.

(D) Triple fusion occurs in the synergid.

Q3. In a typical angiosperm embryo sac, the 7-celled and 8-nucleate condition is achieved after:

(A) Three mitotic divisions of the megaspore nucleus.

(B) Two mitotic and one meiotic division of the megaspore.

(C) Three meiotic divisions of the megaspore nucleus.

(D) One meiotic and two mitotic divisions.

Q4. Cleistogamous flowers are strictly autogamous because:

(A) They remain closed and do not expose reproductive organs.

(B) They have large colorful petals to attract insects.

(C) Pollen grains are light and non-sticky.

(D) They exhibit geitonogamy.

Q5. Match the following

List I	Term	List II	Function
(i)	Taq Polymerase	(a)	Cutting DNA at specific sites
(ii)	Restriction Endonuclease	(b)	Separation of DNA fragments by size
(iii)	Gel Electrophoresis	(c)	Thermostable enzyme for PCR
(iv)	Bioreactor	(d)	Large scale production of proteins

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

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

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

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

Q6. Which hormone is responsible for the 'Surge' that triggers ovulation in the menstrual cycle?

(A) Progesterone

(B) FSH

(C) LH

(D) Estrogen

Q7. In the process of spermatogenesis, the first haploid cells formed are:

(A) Spermatogonia

(B) Primary spermatocytes

(C) Secondary spermatocytes

(D) Spermatids

Q8. The correct sequence of the transport of sperm cells in the male reproductive system is:

(A) Seminiferous tubules → Rete testis → Vasa efferentia → Epididymis → Vas deferens

(B) Rete testis → Epididymis → Vasa efferentia → Vas deferens

(C) Vas deferens → Epididymis → Rete testis → Vasa efferentia

(D) Seminiferous tubules → Vas deferens → Epididymis → Rete testis

Q9. In human females, meiosis-II is not completed until:

(A) Puberty

(B) Fertilization

(C) Birth

(D) Uterine implantation

Q10. Capacitation occurs in:

(A) Epididymis

(B) Vas deferens

(C) Female reproductive tract

(D) Rete testis

Q11. Which of the following is a non-medicated IUD?

(A) Lippes loop

(B) Multiload 375

(C) LNG-20

(D) Cu7

Q12. In the GIFT (Gamete Intra-Fallopian Transfer) technique:

(A) Embryo with 8 blastomeres is transferred to the uterus.

(B) Zygote is transferred to the Fallopian tube.

(C) Ovum collected from a donor is transferred to the Fallopian tube.

(D) Sperm is directly injected into the ovum.

Q13. Select the hormone-releasing IUD:

(A) Vaults

(B) Progestasert

(C) Multiload 375

(D) CuT

Q14. In a monohybrid cross between two heterozygous tall plants (Tt), what is the probability of obtaining a homozygous recessive dwarf plant?

(A) 25%

(B) 50%

(C) 75%

(D) 100%

Q15. A person with Klinefelter's Syndrome has the karyotype:

(A) 45, XO

(B) 47, XXY

(C) 47, XYY

(D) 47, +21

Q16. Which of the following is an example of pleiotropy?

(A) ABO Blood grouping

(B) Phenylketonuria

(C) Skin color in humans

(D) Flower color in Snapdragon

Q17. If the recombination frequency between gene A and B is 5%, B and C is 15%, and A and C is 10%, what is the sequence of genes on the chromosome?

(A) A-B-C

(B) B-A-C

(C) A-C-B

(D) C-B-A

Q18. Thalassemia and Sickle cell anemia are caused due to problems in globin molecule synthesis. Select the correct statement.

(A) Both are qualitative defects.

(B) Thalassemia is a quantitative defect; Sickle cell is a qualitative defect.

(C) Thalassemia is a qualitative defect; Sickle cell is a quantitative defect.

(D) Both are quantitative defects.

Q19. Down's syndrome is caused by:

(A) Monosomy of 21st chromosome.

(B) Trisomy of 21st chromosome.

(C) Nullisomy of sex chromosome.

(D) Trisomy of 18th chromosome.

Q20. In the Lac Operon, the 'repressor protein' binds to:

(A) Promoter gene

(B) Structural gene

(C) Operator gene

(D) Regulatory gene

Q21. 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.

Q22. Which enzyme is known as the 'Universal Polymerase' in DNA replication?

(A) DNA Ligase

(B) Helicase

(C) DNA Polymerase III

(D) Topoisomerase

Q23. The sequence of structural genes in the Lac Operon is:

(A) lac y, lac z, lac a

(B) lac z, lac y, lac a

(C) lac a, lac z, lac y

(D) lac z, lac a, lac y

Q24. The DNA Fingerprinting process involves identifying differences in specific regions of DNA sequence called:

(A) Satellite DNA

(B) Coding DNA

(C) Non-repetitive DNA

(D) Exons

Q25. Spliceosomes are not found in cells of:

(A) Fungi

(B) Animals

(C) Bacteria

(D) Plants

Q26. If the sequence of bases in the coding strand of DNA is 5' -GTGCAT- 3', then the sequence of bases in mRNA will be:

(A) 5’ -GUGCAU- 3’

(B) 3’ -GUGCAU- 5’

(C) 5’ -CACGUA- 3’

(D) 3’ -CACGUA- 5’

Q27. Taylor conducted experiments to prove semi-conservative replication of DNA on:

(A) Vicia faba

(B) Drosophila melanogaster

(C) E. coli

(D) Streptococcus pneumoniae

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 is:

(A) 0.4

(B) 0.5

(C) 0.6

(D) 0.7

Q29. Adaptive radiation refers to:

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

(B) Migration of members of a species to different geographical areas.

(C) Power of adaptation in an individual to a variety of environments.

(D) Adaptations due to Geographical isolation.

Q30. Which of the following hominid had a brain capacity of 900cc and probably ate meat?

(A) Homo habilis

(B) Homo erectus

(C) Neanderthal man

(D) Australopithecus

Q31. The "Industrial Melanism" in the peppered moth (Biston betularia) is an example of:

(A) Disruptive selection

(B) Stabilizing selection

(C) Directional selection

(D) Artificial selection

Q32. In the life cycle of Plasmodium, the fertilization and development take place in:

(A) Human Liver

(B) Human RBCs

(C) Gut of female Anopheles mosquito

(D) Salivary glands of mosquito

Q33. Transplantation of tissues/organs to save certain patients often fails due to rejection. Which type of immune response is responsible for such rejections?

(A) Humoral immune response

(B) Cell-mediated immune response

(C) Physiological immune response

(D) Auto-immune response

Q34. MALT (Mucosa-Associated Lymphoid Tissue) constitutes about 50 percent of the lymphoid tissue in human body.

(A) 20%

(B) 70%

(C) 10%

(D) 50%

Q35. Which of the following is an example of an "Innate Immunity" barrier?

(A) T-lymphocytes

(B) B-lymphocytes

(C) Saliva in mouth

(D) Antibodies

Q36. During sewage treatment, the "activated sludge" is:

(A) The sediment in the primary settling tank.

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

(C) The floating debris removed during filtration.

(D) The effluent sent to the aeration tank.

Q37. Baculoviruses (specifically Nucleopolyhedrovirus) are excellent candidates for:

(A) Broad spectrum herbicidal applications.

(B) Species-specific, narrow spectrum insecticidal applications.

(C) Increasing the nutritional value of crops.

(D) Bio-remediation of oil spills.

Q38. Which of the following is used as a biofertilizer in paddy fields?

(A) Rhizobium

(B) Azotobacter

(C) Cyanobacteria (Anabaena)

(D) Mycorrhiza

Q39. In the naming of the restriction enzyme EcoRI, the letter 'R' stands for:

(A) Name of the scientist

(B) The strain of the bacterium

(C) The genus

(D) The species

Q40. The correct order of steps in PCR is:

(A) Extension, Denaturation, Annealing

(B) Annealing, Extension, Denaturation

(C) Denaturation, Annealing, Extension

(D) Denaturation, Extension, Annealing

Q41. Stirred-tank bioreactors have been designed for:

(A) Purification of product.

(B) Addition of preservatives to the product.

(C) Availability of oxygen throughout the process.

(D) Ensuring anaerobic conditions.

Q42. Restriction endonucleases make cuts at specific positions within the DNA called:

(A) Palindromic nucleotide sequences

(B) Exons

(C) Introns

(D) Poly-A tail

Q43. The process of RNA interference (RNAi) has been used in the development of plants resistant to:

(A) Fungi

(B) Viruses

(C) Insects

(D) Nematodes

Q44. What was the main challenge in the production of insulin using rDNA technology?

(A) Production of C-peptide.

(B) Getting insulin assembled into a mature form.

(C) Removal of A-peptide.

(D) Production of B-peptide.

Q45. Bt toxin kills insects by:

(A) Blocking the nerve conduction.

(B) Damaging the reproductive system.

(C) Creating pores in the midgut epithelial cells.

(D) Inhibiting protein synthesis.

Q46. An association between a sea anemone and a hermit crab in which the anemone gets a free ride and the crab gets protection is:

(A) Mutualism

(B) Commensalism

(C) Parasitism

(D) Amensalism

Q47. In an age pyramid, if the pre-reproductive population is very large compared to the reproductive and post-reproductive population, the population is:

(A) Declining

(B) Stable

(C) Expanding

(D) Fluctuating

Q48. In an ecosystem, the rate of production of organic matter during photosynthesis is termed:

(A) Net Primary Productivity

(B) Gross Primary Productivity

(C) Secondary Productivity

(D) Net Community Productivity

Q49. Which of the following is an "Ex-situ" conservation method?

(A) National Park

(B) Biosphere Reserve

(C) Botanical Garden

(D) Wildlife Sanctuary

Q50. The "Evil Quartet" is a term used to describe:

(A) Four major causes of biodiversity loss.

(B) Four stages of ecological succession.

(C) Four types of population interactions.

(D) Four levels of energy transfer in a food chain.

Detailed Solutions

Q1.

Solution

Concept: In angiosperms, megasporogenesis results in the formation of four haploid megaspores. Usually, three of these degenerate, and only one remains functional. This functional megaspore undergoes mitosis to produce the female gametophyte.

Solution: The functional megaspore expands and undergoes three rounds of free nuclear mitotic divisions. These divisions lead to the formation of an 8-nucleate embryo sac. The nuclei then organize into specific cells: three antipodal cells, two synergids, one egg cell, and one large central cell containing two polar nuclei. Therefore, the functional megaspore develops directly into the embryo sac (female gametophyte).

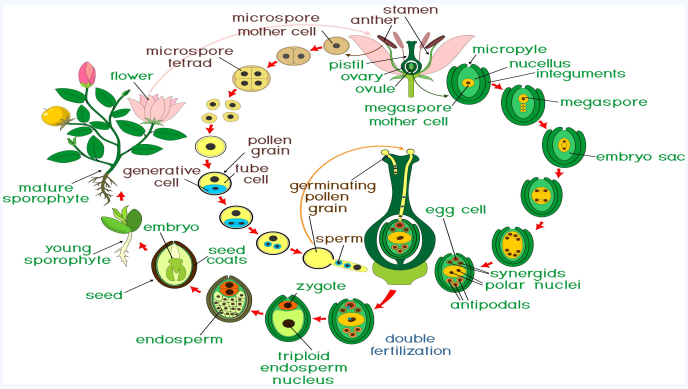
Final Answer: Embryo sac

Answer: (B)

Q2.

Solution

Concept: Double fertilization is a unique characteristic of flowering plants (angiosperms). It involves two separate fusion events within the embryo sac: Syngamy (fusion of a male gamete with the egg) and Triple Fusion (fusion of a male gamete with two polar nuclei).



Solution: Upon reaching the embryo sac through a synergid, the pollen tube releases two male gametes. One male gamete moves toward the egg cell and fuses with its nucleus to complete syngamy, resulting in a zygote. The other male gamete moves toward the central cell and fuses with the two polar nuclei to produce a triploid primary endosperm nucleus (PEN). Since syngamy involves the primary reproductive cells, it is considered the primary event, followed by triple fusion.

Final Answer: Syngamy followed by Triple fusion.

Answer: (A)

Q3.

Solution

Concept: The development of the female gametophyte (embryo sac) from a functional megaspore is called monosporic development. This process involves sequential mitotic nuclear divisions to reach the mature stage before cellularization occurs.

Solution: The nucleus of the functional megaspore undergoes the first mitotic division to produce two nuclei. These move to opposite poles. Each nucleus then undergoes a second mitotic division (4-nucleate stage) and a third mitotic division (8-nucleate stage). Following these three rounds of mitosis, cell walls are laid down among six of the eight nuclei, while the remaining two (polar nuclei) stay in the large central cell. This results in the mature 7-celled, 8-nucleate embryo sac.

Final Answer: Three mitotic divisions of the megaspore nucleus.

Answer: (A)

Q4.

Solution

Concept: Cleistogamy refers to a condition where flowers do not open at all. This structural adaptation ensures that only self-pollination (autogamy) can occur, as the reproductive organs are never exposed to foreign pollen or external pollinators.

Solution: In cleistogamous flowers, the anthers and stigma lie close to each other. When anthers dehisce within the closed flower buds, pollen grains come into contact with the stigma. Because the flower remains closed, there is no chance of cross-pollen landing on the stigma, making them strictly autogamous even in the absence of pollinators.

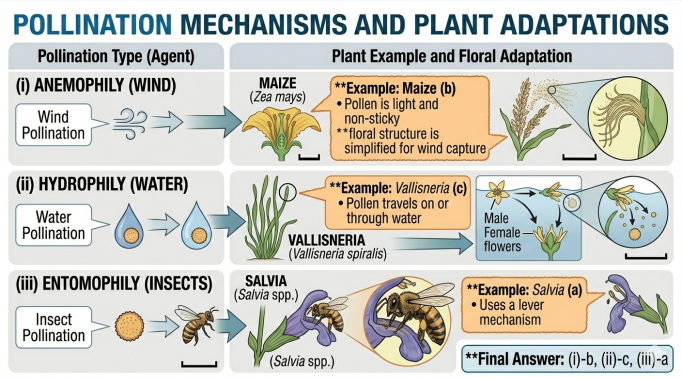
Final Answer: They remain closed and do not expose reproductive organs.

Answer: (A)

Q5.

Solution

Concept: Pollination types are classified based on the agent involved: Anemophily (wind), Hydrophily (water), and Entomophily (insects). Each plant species adapts its floral structure to suit its specific pollinating agent.



Solution: (i) **Anemophily** is wind pollination, common in grasses like **Maize** (b), where pollen is light and non-sticky. (ii) **Hydrophily** is water pollination, seen in aquatic plants like **Vallisneria** (c), where pollen travels on or through water. (iii) **Entomophily** is insect pollination, seen in **Salvia** (a), which uses a "lever mechanism" to dust insects with pollen.

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

Answer: (A)

Q6.

Solution

Concept: The menstrual cycle is regulated by the pituitary hormones (LH and FSH) and ovarian hormones (Estrogen and Progesterone). Ovulation is the pivotal event of the cycle, occurring at the end of the follicular phase.

Solution: Both LH and FSH attain a peak level in the middle of the cycle. The rapid secretion of LH leading to its maximum level during the mid-cycle is called the LH surge. This surge is essential as it triggers the final maturation and rupture of the Graafian follicle, thereby releasing the secondary oocyte into the fallopian tube.

Final Answer: LH

Answer: (C)

Q7.

Solution

Concept: Spermatogenesis is the process of formation of sperm in the testes. It involves a sequence of mitotic and meiotic divisions that transform diploid germ cells into haploid gametes.
Solution: Spermatogonia ($2n$) multiply by mitosis to form primary spermatocytes ($2n$). A primary spermatocyte completes the first meiotic division (reduction division), leading to the formation of two equal, haploid (n) cells called secondary spermatocytes. These secondary spermatocytes then undergo the second meiotic division to produce four haploid spermatids. Therefore, the secondary spermatocytes are the very first haploid cells in the lineage.
Final Answer: Secondary spermatocytes

Answer: (C)

Q8.

Solution

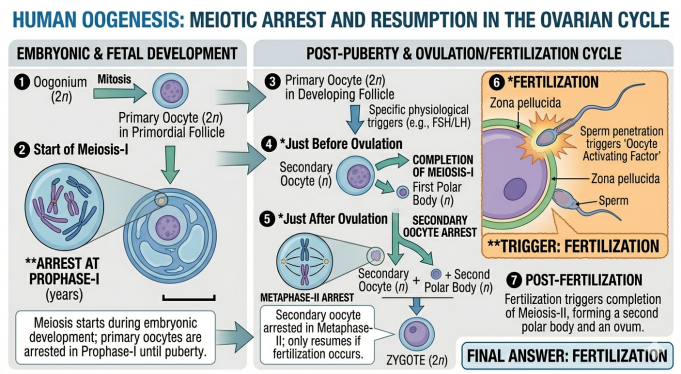
Concept: The male sex accessory ducts include the rete testis, vasa efferentia, epididymis, and vas deferens. These structures are responsible for the storage and transport of spermatozoa from the site of production to the outside.
Solution: Spermatozoa are produced in the **seminiferous tubules** of the testes. They leave the tubules and enter the **rete testis**, followed by the **vasa efferentia**. From there, they enter the **epididymis**, which is located along the posterior surface of each testis. The epididymis leads to the **vas deferens**, which ascends into the abdomen to join the ejaculatory duct.
Final Answer: Seminiferous tubules $\rightarrow$ Rete testis $\rightarrow$ Vasa efferentia $\rightarrow$ Epididymis $\rightarrow$ Vas deferens

Answer: (A)

Q9.

Solution

Concept: Oogenesis is a discontinuous process. Meiosis begins during embryonic development but is arrested at various stages, only resuming and completing under specific physiological triggers.



Solution: The primary oocyte completes Meiosis-I just before ovulation, forming a secondary oocyte. This secondary oocyte begins Meiosis-II but is arrested at the metaphase stage. It is only when a sperm penetrates the zona pellucida of the ovum during **fertilization** that the "Oocyte Activating Factor" triggers the completion of Meiosis-II, resulting in the formation of a second polar body and a haploid ovum (ootid).

Final Answer: Fertilization

Answer: (B)

Q10.

Solution

Concept: Spermatozoa released by the male are not immediately capable of fertilizing an ovum. They must undergo a series of physiological and biochemical changes known as capacitation to gain "fertility potential."

Solution: Capacitation occurs while the sperm are residing in the **female reproductive tract** (specifically the uterus and fallopian tubes). During this process, the glycoprotein coat and seminal plasma proteins are removed from the plasma membrane over the acrosome, and membrane permeability to calcium increases, enhancing sperm motility. This process typically takes about 5–7 hours in humans.

Final Answer: Female reproductive tract

Answer: (C)

Q11.

Solution

Concept: Intrauterine Devices (IUDs) are classified into three categories: non-medicated IUDs, copper-releasing IUDs, and hormone-releasing IUDs. Each type prevents pregnancy through different mechanisms.

Solution: The **Lippes loop** (A) is a **non-medicated IUD** made of plastic (polyethylene) impregnated with barium sulphate. It works by increasing the phagocytosis of sperm within the uterus. In contrast, Cu7 and Multiload 375 are copper-releasing IUDs, and LNG-20 is a hormone-releasing IUD.

Final Answer: Lippes loop

Answer: (A)

Q12.

Solution

Concept: GIFT stands for Gamete Intra-Fallopian Transfer. Unlike IVF, where fertilization occurs in a lab, GIFT is used for females who cannot produce ova but can provide a suitable environment for fertilization and further development.

Solution: In the GIFT technique, an **ovum collected from a donor** is transferred into the **fallopian tube** of another female who can provide the right environment for fertilization. Sperm are also transferred simultaneously so that in vivo fertilization (fertilization inside the body) can take place. This differs from ZIFT, where a zygote is transferred, or ICSI, where sperm is injected into the ovum.

Final Answer: Ovum collected from a donor is transferred to the Fallopian tube.

Answer: (C)

Q13.

Solution

Concept: Hormone-releasing IUDs make the uterus unsuitable for implantation and the cervix hostile to sperm. They release small amounts of hormones (like progesterone) consistently.

Solution: Among the given options, **Progestasert** (B) and LNG-20 are **hormone-releasing IUDs**. In contrast, Multiload 375 and CuT are copper-releasing IUDs, which increase sperm phagocytosis and suppress sperm motility. Vaults are barrier methods (contraceptives) rather than intrauterine devices.

Final Answer: Progestasert

Answer: (B)

Q14.

Solution

Concept: According to Mendel's Law of Segregation, alleles separate during gamete formation. A monohybrid cross between two heterozygous parents ($Tt \times Tt$) results in a specific predictable ratio of genotypes and phenotypes.

Solution: When two Tt plants are crossed, the possible gametes are T and t. The resulting offspring genotypes are TT (25%), Tt (50%), and tt (25%). The homozygous recessive condition (tt) results in the dwarf phenotype. Mathematically, this is $1/4$ of the total progeny, which corresponds to 25%.

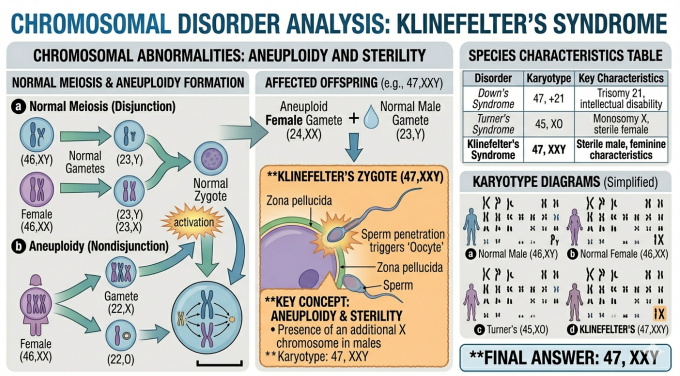
Final Answer: 25%

Answer: (A)

Q15.

Solution

Concept: Chromosomal disorders are caused by the absence, excess, or abnormal arrangement of one or more chromosomes. Aneuploidy, such as trisomy or monosomy, leads to specific clinical syndromes.



Solution: Klinefelter's Syndrome is a genetic condition caused by the presence of an additional copy of the X chromosome in males, resulting in a karyotype of **47, XXY**. Affected individuals are typically sterile males with feminine characteristics (such as gynaecomastia). In contrast, 45, XO is Turner's Syndrome, and 47, +21 is Down's Syndrome.

Final Answer: 47, XXY

Answer: (B)

Q16.

Solution

Concept: Pleiotropy is a genetic phenomenon where a single gene mutation or locus affects multiple phenotypic traits. This is the opposite of polygenic inheritance, where multiple genes affect a single trait.

Solution: **Phenylketonuria (PKU)** is caused by a mutation in the gene that codes for the enzyme phenylalanine hydroxylase. This single gene defect manifests as multiple phenotypic expressions, including mental retardation and a reduction in hair and skin pigmentation. In contrast, ABO blood grouping is an example of multiple alleles/co-dominance, and skin color is an example of polygenic inheritance.

Final Answer: Phenylketonuria

Answer: (B)

Q17.

Solution

Concept: Recombination frequency is used to map the relative distance and order of genes on a chromosome. The distance between two genes is additive if they are arranged linearly.

Solution: Given the distances: 1. Distance between A and B = 5 cM 2. Distance between A and C = 10 cM 3. Distance between B and C = 15 cM To satisfy the largest distance (B to C = 15 cM), B and C must be the flanking genes. Since the distance from B to A is 5 and A to C is 10 (5 + 10 = 15), gene A must lie between B and C. Therefore, the sequence is B-A-C (or C-A-B).

Final Answer: B-A-C

Answer: (B)

Q18.

Solution

Concept: Genetic disorders of hemoglobin can be classified based on whether the mutation affects the amount of hemoglobin produced (quantitative) or the structural integrity and function of the hemoglobin molecule (qualitative).

Solution: Thalassemia is a **quantitative** problem because it results from a reduced rate of synthesis of α or β globin chains, leading to fewer hemoglobin molecules. Sickle cell anemia is a **qualitative** problem because it results from a point mutation (glutamic acid to valine) that produces an abnormal globin molecule which changes shape under low oxygen tension.

Final Answer: Thalassemia is a quantitative defect; Sickle cell is a qualitative defect.

Answer: (B)

Q19.

Solution

Concept: Aneuploidy is a condition where there is an abnormal number of chromosomes in a cell. Trisomy refers to the gain of one extra chromosome ($2n + 1$).

Solution: Down's syndrome is a genetic disorder caused by the presence of an additional copy of chromosome number 21, known as **trisomy of the 21st chromosome**. It was first described by Langdon Down in 1866. Affected individuals show short stature, a furrowed tongue, and characteristic physical and mental development delays.

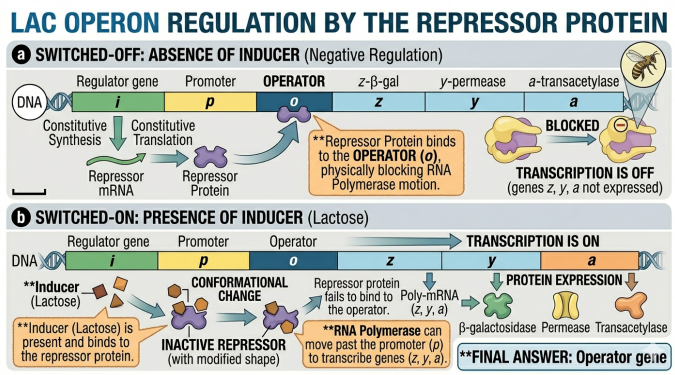
Final Answer: Trisomy of 21st chromosome.

Answer: (B)

Q20.

Solution

Concept: The Lac Operon is a polycistronic structural gene regulated by a common promoter and regulatory genes. The repressor protein is the product of the regulatory (i) gene and acts as a negative regulator of the system.



Solution: The repressor protein is synthesized constitutively by the i gene. In the absence of an inducer like lactose, this repressor protein binds specifically to the **operator gene** (o) of the operon. This binding physically blocks RNA polymerase from moving past the promoter to the structural genes (z, y, a), thereby switching off transcription.

Final Answer: Operator gene

Answer: (C)

Q21.

Solution

Concept: DNA replication is semi-discontinuous because DNA polymerase adds nucleotides only in the 5′ → 3′ direction. This creates a necessity for two different modes of synthesis on the antiparallel template strands.

Solution: On the template strand with polarity 3′ → 5′, replication is continuous (leading strand). However, on the template strand with 5′ → 3′ polarity, the new strand must be synthesized in short, discontinuous stretches called **Okazaki fragments**. Since the fork opens in one direction, these fragments are synthesized on the **lagging strand** in a direction **away from the replication fork**. These fragments are later joined by DNA ligase.

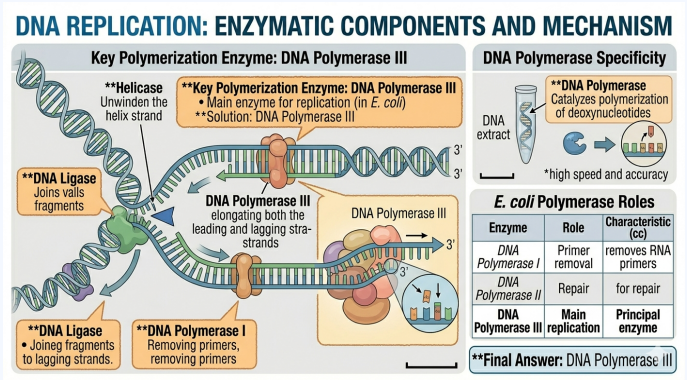
Final Answer: The lagging strand away from replication fork.

Answer: (D)

Q22.

Solution

Concept: DNA replication requires a highly coordinated set of enzymes. The main enzyme responsible for catalyzing the polymerization of deoxynucleotides with high speed and accuracy is DNA Polymerase.



Solution: In *E. coli*, **DNA Polymerase III** is the principal enzyme for replication. It adds nucleotides to the 3′ end of a growing DNA strand. While DNA Polymerase I is involved in removing RNA primers and DNA Polymerase II is for repair, Pol III does the "heavy lifting" of elongating both the leading and lagging strands. Enzymes like Helicase (unwinding) and Ligase (joining fragments) play supporting roles.

Final Answer: DNA Polymerase III

Answer: (C)

Q23.

Solution

Concept: The Lac Operon consists of a regulatory gene (i) and three structural genes that code for enzymes required for the metabolism of lactose. These genes are transcribed together as a single polycistronic mRNA.

Solution: The order of structural genes following the operator region is **lac z**, then **lac y**, and finally **lac a**. 1. **lac z** codes for β-galactosidase (breaks lactose into glucose and galactose). 2. **lac y** codes for permease (increases cell permeability to β-galactosides). 3. **lac a** codes for transacetylase.

Final Answer: lac z, lac y, lac a

Answer: (B)

Q24.

Solution

Concept: DNA fingerprinting relies on the fact that while 99.9% of the base sequence among humans is identical, specific regions of non-coding DNA vary significantly between individuals. These regions are used as genetic markers.

Solution: DNA fingerprinting involves identifying differences in **Satellite DNA**. These are regions where a small stretch of DNA is repeated many times (repetitive DNA). During density gradient centrifugation, these sequences separate as small peaks from the bulk DNA. These sequences, specifically Variable Number Tandem Repeats (VNTRs), show high levels of polymorphism, making them ideal for forensic and paternity analysis.

Final Answer: Satellite DNA

Answer: (A)

Q25.

Solution

Concept: Splicing is a post-transcriptional process in eukaryotes where non-coding sequences (introns) are removed and coding sequences (exons) are joined. This process is mediated by a large molecular complex called the spliceosome.

Solution: Spliceosomes are characteristic of eukaryotic cells, including **Fungi, Animals, and Plants**, where genes are "split." **Bacteria** (Prokaryotes) do not possess spliceosomes because their genes are typically continuous and lack introns. In bacteria, translation can even begin while the mRNA is still being transcribed, leaving no time or need for complex splicing machinery.

Final Answer: Bacteria

Answer: (C)

Q26.

Solution

Concept: During transcription, the DNA strand with $3' \rightarrow 5'$ polarity acts as the template. The other strand, with $5' \rightarrow 3'$ polarity, is called the coding strand. The mRNA sequence is complementary to the template strand and identical to the coding strand (replacing T with U).

Solution: If the coding strand is 5' -GTGCAT- 3', the mRNA will have the exact same sequence and direction, as both are complementary to the same template strand. The only chemical difference is that RNA contains Uracil (U) instead of Thymine (T). Therefore, the sequence becomes 5' -GUGCAU- 3'.

Final Answer: 5' -GUGCAU- 3'

Answer: (A)

Q27.

Solution

Concept: The semi-conservative nature of DNA replication states that each daughter DNA molecule retains one parental strand and one newly synthesized strand. This was proven in prokaryotes by Meselson and Stahl and in eukaryotes by Taylor.

Solution: In 1958, J. Herbert Taylor and his colleagues performed experiments on **Vicia faba** (faba beans). They used radioactive thymidine to label the DNA and followed its distribution in the chromosomes using autoradiography. Their results proved that the DNA in chromosomes also replicates semi-conservatively. Note that *E. coli* was used by Meselson and Stahl, and *Drosophila* is a common model for linkage studies.

Final Answer: Vicia faba

Answer: (A)

Q28.

Solution

Concept: According to the Hardy-Weinberg principle, the gene frequency of alleles in a population can be calculated using the formula $p + q = 1$, where p is the frequency of the dominant allele (A) and q is the frequency of the recessive allele (a).

Solution: Total individuals = 1000. Frequency of AA (p^2) = $360/1000 = 0.36$. Frequency of Aa ($2pq$) = $480/1000 = 0.48$. Frequency of aa (q^2) = $160/1000 = 0.16$. The frequency of allele A (p) can be calculated as the square root of p^2: $p = \sqrt{0.36} = 0.6$. Alternatively, p = (Total A alleles)/(Total alleles) = $[2(360) + 480]/2000 = 1200/2000 = 0.6$.

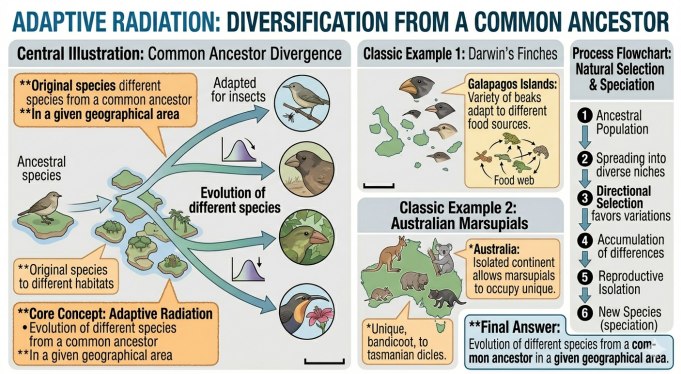
Final Answer: 0.6

Answer: (C)

Q29.

Solution

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



Solution: Adaptive radiation describes the **evolution of different species from a common ancestor** within a specific geographical area. As the original species spreads into different habitats, natural selection favors different traits, leading to speciation. Classic examples include the variety of beaks in Darwin's Finches on the Galapagos Islands and the diversity of Australian marsupials.

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

Answer: (A)

Q30.

Solution

Concept: Hominid evolution is characterized by a gradual increase in cranial capacity and changes in dietary habits. Different stages of human ancestors are identified by these specific physical and behavioral markers.

Solution: **Homo erectus** appeared about 1.5 million years ago and had a large brain capacity of approximately **900cc**. Unlike its predecessor *Homo habilis* (650–800cc), which probably did not eat meat, evidence suggests that *Homo erectus* was a meat-eater. Neanderthals had much larger brains (1400cc), and Australopithecus had a much smaller capacity (around 450–600cc).

Final Answer: Homo erectus

Answer: (B)

Q31.

Solution

Concept: Natural selection can follow different patterns: Stabilizing (favors average), Disruptive (favors both extremes), or Directional (favors one extreme). Industrial melanism is a classic observation of natural selection in response to anthropogenic environmental change.

Solution: In pre-industrial England, light-colored moths were favored. Following the industrial revolution, soot covered the trees, favoring the dark-colored (melanic) moths as they were better camouflaged from predators. Because the population shifted from one extreme (light) to the other extreme (dark) due to environmental pressure, it is a perfect example of **Directional selection**.

Final Answer: Directional selection

Answer: (C)

Q32.

Solution

Concept: The life cycle of *Plasmodium* (the malaria parasite) requires two hosts: humans (asexual cycle) and female *Anopheles* mosquitoes (sexual cycle). Specific stages of development are restricted to certain tissues in each host.

Solution: When a female *Anopheles* mosquito takes a blood meal from an infected human, it ingests gametocytes. The **fertilization and further development** of these gametes occur in the **gut of the mosquito**. The resulting zygotes develop into sporozoites, which then migrate to the salivary glands to infect the next human host.

Final Answer: Gut of female Anopheles mosquito

Answer: (C)

Q33.

Solution

Concept: The human immune system has the ability to differentiate between self-cells and non-self (foreign) cells. This recognition is the primary barrier in organ transplantation.

Solution: The **cell-mediated immune response (CMI)**, primarily mediated by T-lymphocytes, is responsible for graft rejection. When a foreign organ is transplanted, T-cells recognize the foreign MHC (Major Histocompatibility Complex) molecules on the donor tissue and initiate an immune attack. This is why tissue matching and immunosuppressants are critical for transplant success.

Final Answer: Cell-mediated immune response

Answer: (B)

Q34.

Solution

Concept: Lymphoid organs are those where the origin, maturation, and proliferation of lymphocytes occur. These are categorized into primary and secondary lymphoid organs.

Solution: Mucosa-Associated Lymphoid Tissue (**MALT**) is located within the lining of the major tracts (respiratory, digestive, and urogenital tracts). It is a strategic collection of lymphoid tissue that protects the body's mucosal surfaces. It constitutes approximately **50%** of the total lymphoid tissue in the human body.

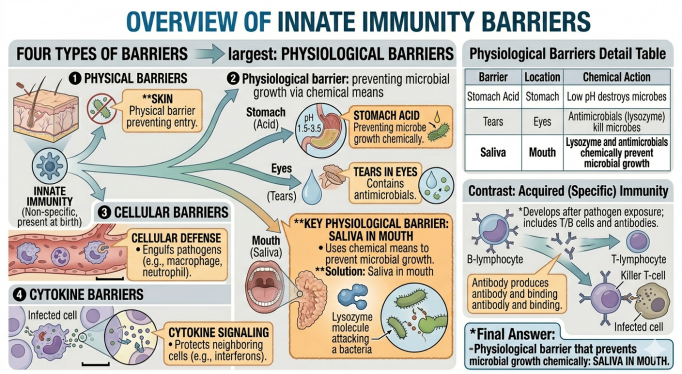
Final Answer: 50%

Answer: (D)

Q35.

Solution

Concept: Innate immunity is a non-specific type of defense that is present at the time of birth. It consists of four types of barriers: Physical, Physiological, Cellular, and Cytokine barriers.



Solution: **Saliva in the mouth**, along with tears in the eyes and acid in the stomach, belongs to the **Physiological barriers** of innate immunity. They prevent microbial growth through chemical means. In contrast, T-lymphocytes, B-lymphocytes, and antibodies are part of the Acquired (Specific) Immunity system, which develops after exposure to pathogens.

Final Answer: Saliva in mouth

Answer: (C)

Q36.

Solution

Concept: Secondary treatment of sewage is a biological process. It involves the use of aerobic microbes to reduce the Biochemical Oxygen Demand (BOD) of the effluent.

Solution: Once the BOD of sewage is significantly reduced, the effluent is passed into a settling tank where the bacterial "flocs" (masses of bacteria associated with fungal filaments) 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, while the rest is pumped into anaerobic sludge digesters.

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

Answer: (B)

Q37.

Solution

Concept: Biocontrol refers to the use of biological methods for controlling plant diseases and pests. Baculoviruses are pathogens that attack insects and other arthropods.

Solution: Baculoviruses, particularly those in the genus *Nucleopolyhedrovirus*, are used as biological control agents because they are **species-specific and have a narrow spectrum** of insecticidal activity. They have no negative impacts on plants, mammals, birds, or non-target insects, making them ideal for Integrated Pest Management (IPM) programs.

Final Answer: Species-specific, narrow spectrum insecticidal applications.

Answer: (B)

Q38.

Solution

Concept: Biofertilizers are organisms that enrich the nutrient quality of the soil. The main sources of biofertilizers are bacteria, fungi, and cyanobacteria.

Solution: **Cyanobacteria** (such as *Anabaena*, *Nostoc*, and *Oscillatoria*) are autotrophic microbes widely distributed in aquatic and terrestrial environments. In **paddy fields** (rice fields), cyanobacteria serve as an important biofertilizer by fixing atmospheric nitrogen, thereby increasing soil fertility and crop yield. While *Rhizobium* also fixes nitrogen, it is specific to leguminous plants.

Final Answer: Cyanobacteria (Anabaena)

Answer: (C)

Q39.

Solution

Concept: Restriction enzymes are named using a standard convention: the first letter is the Genus, the next two are the Species, the fourth is the Strain, and the Roman numeral indicates the order of discovery.

Solution: In *EcoRI*: 1. **E** stands for the genus *Escherichia*. 2. **co** stands for the species *coli*. 3. **R** stands for the name of the **strain** (RY 13). 4. **I** indicates it was the first enzyme isolated from that strain.

Final Answer: The strain of the bacterium

Answer: (B)

Q40.

Solution

Concept: Polymerase Chain Reaction (PCR) is a technique used to amplify a specific DNA segment. It involves repeated cycles of temperature changes to facilitate enzymatic replication.

Solution: The correct sequence is: 1. **Denaturation:** Heating (approx. 94°C) to separate double-stranded DNA. 2. **Annealing:** Cooling (approx. 50-65°C) to allow primers to join to the template strands. 3. **Extension:** The *Taq* polymerase adds nucleotides at approx. 72°C.

Final Answer: Denaturation, Annealing, Extension

Answer: (C)

Q41.

Solution

Concept: Bioreactors are large vessels used for the biological conversion of raw materials into specific products. Stirred-tank reactors are the most commonly used type in biotechnology.

Solution: A stirred-tank bioreactor is usually cylindrical or has a curved base to facilitate the mixing of the reactor contents. The stirrer facilitates even mixing and, more importantly, ensures **availability of oxygen throughout the process**. It also helps in maintaining uniform temperature and pH.

Final Answer: Availability of oxygen throughout the process.

Answer: (C)

Q42.

Solution

Concept: Restriction endonucleases (molecular scissors) do not cut DNA randomly. They identify a specific recognition sequence to bind and cleave the DNA phosphodiester backbone.

Solution: Each restriction endonuclease recognizes a specific **palindromic nucleotide sequence** in the DNA. A palindrome in DNA is a sequence of base pairs that reads the same on the two strands when orientation of reading (e.g., 5' → 3') is kept the same (e.g., 5'-GAATTC-3' and 3'-CTTAAG-5').

Final Answer: Palindromic nucleotide sequences

Answer: (A)

Q43.

Solution

Concept: RNA interference (RNAi) is a biological process in which RNA molecules inhibit gene expression or translation. In agriculture, this cellular defense mechanism is leveraged to create resistance against specific parasites.

Solution: RNAi has been successfully used to develop plants resistant to **nematodes**. A specific nematode, *Meloidogyne incognita*, infects the roots of tobacco plants. By introducing nematode-specific genes into the host plant using *Agrobacterium* vectors, both sense and anti-sense RNA are produced. These form double-stranded RNA (dsRNA) that initiates RNAi, silencing the specific mRNA of the nematode and preventing its survival in the transgenic host.

Final Answer: Nematodes

Answer: (D)

Q44.

Solution

Concept: Human insulin is synthesized as a pro-hormone containing three peptide chains: A, B, and C. In the mature functional insulin, the C-peptide is removed, and chains A and B are linked by disulfide bonds.

Solution: The main challenge in producing insulin via rDNA technology was **getting insulin assembled into a mature form**. Unlike human cells, *E. coli* does not have the machinery to excise the C-peptide from the pro-insulin chain. This was solved by the company Eli Lilly, which prepared two DNA sequences corresponding to the A and B chains separately, introduced them into *E. coli* plasmids, and later combined the extracted chains by creating disulfide bonds.

Final Answer: Getting insulin assembled into a mature form.

Answer: (B)

Q45.

Solution

Concept: *Bacillus thuringiensis* (Bt) produces protein crystals that contain a toxic insecticidal protein. This protein exists as an inactive protoxin and only becomes lethal under specific conditions.

Solution: The Bt toxin protein exists as inactive protoxins in the bacterium. Once an insect ingests it, the alkaline pH of its gut solubilizes the crystals, converting the protoxin into an active form. The activated toxin binds to the surface of **midgut epithelial cells** and **creates pores**. These pores cause cell swelling and lysis, eventually leading to the death of the insect.

Final Answer: Creating pores in the midgut epithelial cells.

Answer: (C)

Q46.

Solution

Concept: Population interactions describe how different species live together. Commensalism is an interaction where one species benefits and the other is neither harmed nor benefited.

Solution: The association between a **sea anemone and a hermit crab** is a classic example of **Commensalism**. The sea anemone hitches a ride on the shell of the hermit crab, allowing it to reach new feeding grounds (benefit), while the crab is generally unaffected (though it may gain some incidental protection from the anemone's stinging cells).

Final Answer: Commensalism

Answer: (B)

Q47.

Solution

Concept: An age pyramid is a graphical representation of the distribution of various age groups in a population. It typically consists of pre-reproductive, reproductive, and post-reproductive stages.

Solution: If the **pre-reproductive** population is significantly larger than the reproductive and post-reproductive groups, the pyramid has a broad base. This indicates that a large number of individuals will soon enter the reproductive phase, leading to a high birth rate and an **expanding** (growing) population.

Final Answer: Expanding

Answer: (C)

Q48.

Solution

Concept: Primary productivity is the rate at which solar energy is captured by the producers for the synthesis of organic compounds.

Solution: The total rate of production of organic matter during photosynthesis is known as **Gross Primary Productivity (GPP)**. When we subtract the energy lost during plant respiration (R) from GPP, we get the Net Primary Productivity (NPP). In formula terms: $NPP = GPP - R$.

Final Answer: Gross Primary Productivity

Answer: (B)

Q49.

Solution

Concept: Biodiversity conservation is categorized into two types: In-situ (on-site, in the natural habitat) and Ex-situ (off-site, in a controlled environment).

Solution: National Parks, Biosphere Reserves, and Wildlife Sanctuaries are examples of In-situ conservation. A **Botanical Garden** is an **Ex-situ** conservation method because endangered plant species are taken out of their natural habitats and cared for in a specialized man-made facility. Other examples include zoos and seed banks.

Final Answer: Botanical Garden

Answer: (C)

Q50.

Solution

Concept: The "Evil Quartet" is a conceptual framework used to categorize the primary anthropogenic drivers of species extinction and biodiversity decline.

Solution: The term **"Evil Quartet"** describes the **four major causes of biodiversity loss**: 1. Habitat loss and fragmentation. 2. Over-exploitation (hunting/poaching). 3. Alien species invasions. 4. Co-extinctions (loss of a host leading to the loss of its symbiont).

Final Answer: Four major causes of biodiversity loss.

Answer: (A)

Answer Key

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