CUET UG Biology Sample Paper - 7

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. The hard outer layer of pollen grains, called exine, is made up of:

(A) Cellulose and Pectin

(B) Sporopollenin

(C) Lignin

(D) Hemicellulose

Q2. Flowers which do not open at all are called:

(A) Chasmogamous

(B) Cleistogamous

(C) Dichogamous

(D) Polygamous

Q3. Production of seeds without fertilization is known as:

(A) Parthenocarpy

(B) Apomixis

(C) Polyembryony

(D) Somatic embryogenesis

Q4. What is the function of the filiform apparatus in the embryo sac?

(A) To guide the entry of the pollen tube

(B) To protect the egg cell

(C) To provide nourishment to the antipodals

(D) To help in the formation of endosperm

Q5. If the endosperm of an angiosperm has 36 chromosomes, what would be the chromosome number in its root cells?

(A) 12

(B) 24

(C) 48

(D) 36

Q6. The correct sequence of the male accessory ducts starting from the testis is:

(A) Rete testis → Vas efferentia → Epididymis → Vas deferens

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

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

(D) Epididymis → Rete testis → Vas efferentia → Vas deferens

Q7. Which of the following hormones is produced in women only during pregnancy?

(A) Estrogen

(B) Progesterone

(C) hCG (Human Chorionic Gonadotropin)

(D) Relaxin (from the ovary)

Q8. Capacitation occurs in:

(A) Epididymis

(B) Vas deferens

(C) Female reproductive tract

(D) Rete testis

Q9. The process of formation of a mature female gamete is called:

(A) Spermatogenesis

(B) Oogenesis

(C) Ovulation

(D) Menarche

Q10. The signals for parturition originate from:

(A) Fully developed fetus only

(B) Placenta only

(C) Both fully developed fetus and placenta

(D) Oxytocin released from maternal pituitary

Q11. Which of the following is a hormone-releasing IUD?

(A) Multiload 375

(B) Progestasert

(C) Lippes Loop

(D) CuT

Q12. Surgical methods of contraception are also called:

(A) Barrier methods

(B) Natural methods

(C) Sterilization

(D) IUDs

Q13. According to the MTP (Amendment) Act 2017, pregnancy may be terminated on certain grounds within:

(A) 12 weeks

(B) 20 weeks

(C) 24 weeks

(D) 30 weeks

Q14. ABO blood grouping in humans is an example of:

(A) Incomplete Dominance

(B) Co-dominance and Multiple Allelism

(C) Pleiotropy

(D) Polygenic inheritance

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

(A) 45, XO

(B) 47, XXY

(C) 47, XYY

(D) 44, XX

Q16. What is the probability of a homozygous recessive offspring in a cross between two heterozygous parents (Aa x Aa)?

(A) 25%

(B) 50%

(C) 75%

(D) 100%

Q17. In which of the following organisms is the female heterogametic (ZW)?

(A) Humans

(B) Drosophila

(C) Birds

(D) Grasshopper

Q18. Thalassemia is a/an _____ linked recessive blood disease.

(A) X-linked

(B) Y-linked

(C) Autosome

(D) Mitochondrial

Q19. The phenomenon of a single gene expressing more than one phenotypic trait is:

(A) Epistasis

(B) Pleiotropy

(C) Polygenic inheritance

(D) Co-dominance

Q20. DNA is negatively charged due to the presence of:

(A) Nitrogenous base

(B) Pentose sugar

(C) Phosphate group

(D) Hydroxyl group

Q21. The repeating units of a nucleosome in chromatin look like:

(A) Beads-on-string

(B) Double helix

(C) Clover leaf

(D) Hairpin loop

Q22. During DNA replication, the strand that is synthesized continuously is the:

(A) Lagging strand

(B) Leading strand

(C) Template strand

(D) Coding strand

Q23. The "Adapter molecule" that brings amino acids to the ribosome is:

(A) mRNA

(B) rRNA

(C) tRNA

(D) hnRNA

Q24. The human genome contains approximately how many base pairs?

(A) 3×10^9 bp

(B) 6×10^9 bp

(C) 3×10^6 bp

(D) 2×10^9 bp

Q25. In transcription, the DNA strand with the polarity $3' \rightarrow 5'$ acts as the:

(A) Coding strand

(B) Template strand

(C) Sense strand

(D) Leading strand

Q26. Satellite DNA is important because it:

(A) Codes for enzymes

(B) Codes for proteins needed for cell cycle

(C) Shows high degree of polymorphism

(D) Forms the primary structure of RNA

Q27. The first genetic material was:

(A) DNA

(B) RNA

(C) Protein

(D) Carbohydrate

Q28. The Miller-Urey experiment proved that _____ could be formed in a primitive atmosphere.

(A) DNA

(B) Amino acids

(C) Polysaccharides

(D) Vitamins

Q29. Forelimbs of whale, bat, cheetah, and human are examples of:

(A) Analogous organs

(B) Homologous organs

(C) Vestigial organs

(D) Atavism

Q30. Genetic drift operates only in:

(A) Large populations

(B) Small isolated populations

(C) Fast-growing populations

(D) Island populations

Q31. Industrial melanism is an example of:

(A) Mutation

(B) Natural Selection

(C) Genetic drift

(D) Anthropogenic evolution

Q32. Which of the following is a "Physical barrier" in innate immunity?

(A) Mucus coating of epithelium

(B) Skin

(C) HCl in stomach

(D) Both A and B

Q33. Malignant tumors show a property where cells slough off and reach distant sites to start new tumors. This is:

(A) Metastasis

(B) Apoptosis

(C) Necrosis

(D) Transformation

Q34. Ringworm is caused by:

(A) Bacteria

(B) Virus

(C) Fungi

(D) Protozoa

Q35. The yellow fluid "Colostrum" secreted by a mother during the initial days of lactation provides:

(A) Passive Immunity

(B) Active Immunity

(C) Autoimmunity

(D) Cell-mediated immunity

Q36. Which microbe is used for the production of Swiss Cheese?

(A) Propionibacterium sharmanii

(B) Lactobacillus

(C) Saccharomyces cerevisiae

(D) Penicillium roqueforti

Q37. Methanogens are found in:

(A) Anaerobic sludge in STP

(B) Rumen of cattle

(C) Gobar gas plant

(D) All of the above

Q38. Mycorrhiza is a symbiotic association between fungi and:

(A) Roots of higher plants

(B) Algae

(C) Bacteria

(D) Lichens

Q39. The DNA fragments separated on an agarose gel can be visualized after staining with:

(A) Acetocarmine

(B) Ethidium bromide

(C) Methylene blue

(D) Bromophenol blue

Q40. Which of the following is a cloning vector?

(A) EcoRI

(B) pBR322

(C) BamHI

(D) HindIII

Q41. To force bacteria to take up the plasmid, they are treated with a specific concentration of a divalent cation, such as:

(A) Sodium

(B) Calcium

(C) Potassium

(D) Iron

Q42. In gel electrophoresis, DNA fragments move towards:

(A) Anode (Positive electrode)

(B) Cathode (Negative electrode)

(C) Neutral point

(D) Bottom of the tank

Q43. The first gene therapy was given in 1990 to a 4-year-old girl with which deficiency?

(A) Insulin deficiency

(B) Adenosine deaminase (ADA) deficiency

(C) Tyrosine deficiency

(D) Growth hormone deficiency

Q44. Transgenic "Rosie" cow produced milk enriched with:

(A) Vitamin A

(B) Human α-lactalbumin

(C) Insulin

(D) Beta-carotene

Q45. Which organization in India monitors GM research and safety of introducing GM organisms?

(A) ICMR

(B) GEAC

(C) CSIR

(D) DBT

Q46. Barnacles growing on the back of a whale is an example of:

(A) Mutualism

(B) Parasitism

(C) Commensalism

(D) Competition

Q47. The maximum number of individuals that an environment can sustain is called:

(A) Biotic potential

(B) Carrying capacity

(C) Environmental resistance

(D) Natality

Q48. In an ecosystem, the energy flow is always:

(A) Unidirectional

(B) Bidirectional

(C) Multidirectional

(D) Cyclic

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

(A) National Park

(B) Wildlife Sanctuary

(C) Cryopreservation (Seed Bank)

(D) Sacred Grove

Q50. The "Species-Area Relationship" was proposed by:

(A) Edward Wilson

(B) Alexander von Humboldt

(C) Paul Ehrlich

(D) Robert May

Detailed Solutions

Q1.

Solution

Concept: Structure and Composition of the Pollen Wall (Sporoderm).

Solution: The pollen grain represents the male gametophyte and is protected by a two-layered wall called the sporoderm. The inner layer is the intine (made of cellulose and pectin), while the hard outer layer is known as the exine. The exine is primarily composed of Sporopollenin, which is considered one of the most resistant organic materials found in the biological world.

Sporopollenin is a highly cross-linked polymer composed of fatty acids and phenolics. It is exceptionally resistant to high temperatures, strong acids, and powerful alkalis. To date, no enzyme has been discovered that can degrade sporopollenin. This characteristic property allows pollen grains to be exceptionally well-preserved as fossils for millions of years. The exine also features prominent apertures called germ pores where sporopollenin is absent, allowing for the emergence of the pollen tube during germination.

Final Answer : "Sporopollenin"

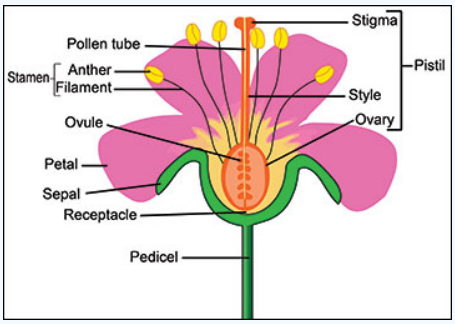
Answer: (B)

Q2.

Solution

Concept: Floral Biology and Mechanisms of Pollination.

Solution:



In some plants, such as *Viola* (common pansy), *Oxalis*, and *Commelina*, two types of flowers are produced: chasmogamous and cleistogamous. Chasmogamous flowers are similar to flowers of other species with exposed anthers and stigma. In contrast, cleistogamous flowers are those which do not open at all.

In cleistogamous flowers, the anthers and stigma lie very close to each other within the closed bud. When anthers dehisce in the flower buds, pollen grains immediately come into contact with the stigma to effect pollination. Therefore, cleistogamous flowers are invariably autogamous (self-pollinating) as there is no possibility of cross-pollen landing on the stigma from external sources. These flowers ensure a guaranteed seed-set even in the absence of pollinators or adverse weather conditions, though they result in a lack of genetic variation.

Final Answer : "Cleistogamous"

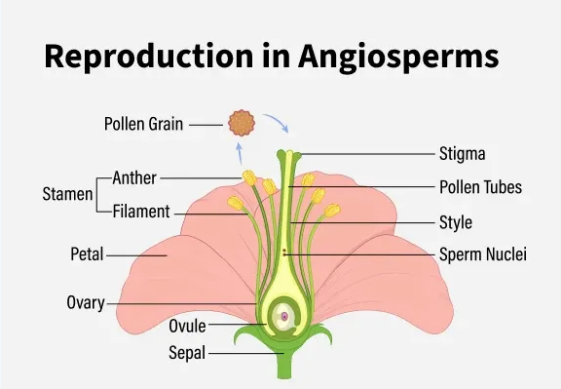
Answer: (B)

Q3.

Solution

Concept: Special Modes of Reproduction in Angiosperms.

Solution:



Although seeds, in general, are the products of fertilization (amphimixis), a few flowering plants such as some species of Asteraceae and grasses have evolved a special mechanism called Apomixis. Apomixis is the production of seeds without fertilization. It is essentially a form of asexual reproduction that mimics sexual reproduction because it produces a seed.

There are several ways apomictic seeds can develop. In some species, the diploid egg cell is formed without reduction division (meiosis) and develops into the embryo without fertilization. In other cases, such as in many Citrus and Mango varieties, some of the maternal nucellar cells surrounding the embryo sac start dividing, protrude into the embryo sac, and develop into the embryos (adventive embryony). This process is highly significant in agriculture as it allows the preservation of hybrid characters over many generations without segregation of traits.

Final Answer : "Apomixis"

Answer: (B)

Q4.

Solution

Concept: Functional Anatomy of the Female Gametophyte (Embryo Sac).

Solution: The mature embryo sac of an angiosperm typically consists of seven cells and eight nuclei. At the micropylar end, the egg apparatus is situated, consisting of two synergids and one egg cell. The synergids possess special, highly dense cellular thickenings at the micropylar tip called the filiform apparatus.

The primary function of the filiform apparatus is to guide the entry of the pollen tube into the synergid. As the pollen tube reaches the ovary and approaches the ovule, the filiform apparatus is believed to secrete chemical attractants (chemotropism) that direct the pollen tube's growth. Once the pollen tube enters one of the synergids through the filiform apparatus, the synergid degenerates, and the tube ruptures to release the two male gametes for the process of double fertilization.

Final Answer : "To guide the entry of the pollen tube"

Answer: (A)

Q5.

Solution

Concept: Ploidy levels and Chromosomal Calculations in Life Cycles.

Solution: To solve this, we must identify the ploidy (the number of sets of chromosomes) of the tissues mentioned in an angiosperm plant:

1. Endosperm ($3n$): In angiosperms, the endosperm is formed by "Triple Fusion," where one male gamete (n) fuses with the secondary nucleus ($2n$). Thus, it is a triploid tissue.
2. Root Cells ($2n$): Root cells are somatic vegetative cells belonging to the main plant body (sporophyte). In angiosperms, the sporophyte generation is diploid.

Calculation:

- Given that the endosperm ($3n$) = 36.
- Therefore, the haploid number (n) = $36/3 = 12$.
- The root cells are diploid ($2n$), so the number of chromosomes = $2 \times 12 = 24$.

Thus, if the endosperm has 36 chromosomes, the root cells of the same plant will have 24 chromosomes.

Final Answer : "24"

Answer: (B)

Q6.

Solution

Concept: Anatomy of the Male Reproductive System and Sperm Transport.

Solution: The male sex accessory ducts include the rete testis, vasa efferentia, epididymis, and vas deferens. The pathway of sperm from the site of production (seminiferous tubules) to the exterior is as follows:

1. Seminiferous Tubules: Located within the testicular lobules, these are the sites of sperm production.
2. Rete Testis: A network of tubules located at the hilum of the testis where all seminiferous tubules converge.
3. Vasa Efferentia: These are 10–12 fine ductules that leave the testis and carry sperm from the rete testis to the epididymis.
4. Epididymis: A long, highly coiled tube (divided into caput, corpus, and cauda) where sperm are stored and undergo physiological maturation.
5. Vas Deferens: A muscular tube that ascends into the abdominal cavity, loops over the urinary bladder, and eventually joins the duct of the seminal vesicle.

Therefore, the correct chronological sequence is: Rete testis → Vas efferentia → Epididymis → Vas deferens.

Final Answer : "Rete testis → Vas efferentia → Epididymis → Vas deferens"

Answer: (A)

Q7.

Solution

Concept: Endocrinology of Pregnancy and Placental Hormones.

Solution: During pregnancy, the female body undergoes significant hormonal changes to support fetal development and maintain the uterine environment. While hormones like Estrogen and Progesterone are present throughout the reproductive life of a woman (secreted by the corpus luteum and ovaries during the menstrual cycle), certain hormones are secreted exclusively when a woman is pregnant.

These pregnancy-specific hormones include hCG (Human Chorionic Gonadotropin), hPL (Human Placental Lactogen), and Relaxin.

1. hCG: Secreted by the trophoblast cells of the placenta shortly after implantation. It maintains the corpus luteum so it can continue secreting progesterone. It is also the basis for most pregnancy tests.

2. hPL: Produced by the placenta to regulate maternal metabolism and provide energy to the fetus.

3. Relaxin: In the later phase of pregnancy, relaxin is also secreted by the ovary (and placenta) to help facilitate parturition by softening the connective tissue of the symphysis pubis.

Since Estrogen and Progesterone are produced even in non-pregnant states, hCG is the most definitive answer for a hormone produced only during pregnancy.

Final Answer : "hCG (Human Chorionic Gonadotropin)"

Answer: (C)

Q8.

Solution

Concept: Sperm Activation and the Fertilization Process.

Solution: Spermatozoa produced in the testes and stored in the epididymis are morphologically mature but are not yet capable of fertilizing an ovum. They must undergo a process called Capacitation. This process occurs while the sperm are residing within the female reproductive tract (specifically the uterus and the fallopian tubes).

During capacitation, several physiological and biochemical changes occur:

1. Removal of inhibitory proteins and cholesterol from the sperm's plasma membrane (acrosome).

2. Increase in calcium ion permeability, which leads to hyperactivation of the sperm flagellum (increasing motility).

3. Preparation of the acrosome for the acrosomal reaction upon contact with the zona pellucida of the egg.

This process typically takes about 5 to 7 hours in humans. Without undergoing capacitation in the female tract, the sperm cannot penetrate the protective layers of the ovum.

Final Answer : "Female reproductive tract"

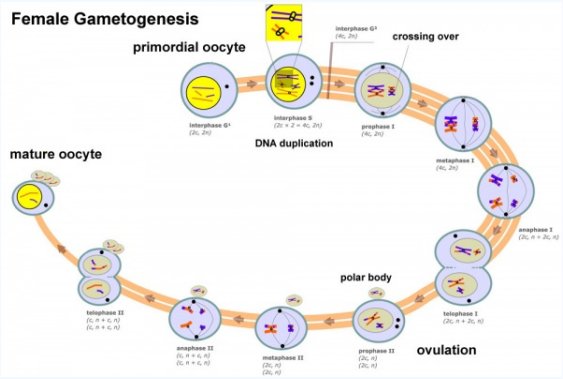
Answer: (C)

Q9.

Solution

Concept: Gametogenesis in Females.

Solution: The process of formation of a mature female gamete is called Oogenesis. Unlike spermatogenesis, which begins at puberty, oogenesis is initiated during the embryonic development stage when a couple of million gamete mother cells (oogonia) are formed within each fetal ovary. No more oogonia are formed or added after birth.



The steps of oogenesis are as follows:

1. Oogonia enter meiosis I and get temporarily arrested at the prophase-I stage (primary oocytes).

2. At puberty, primary oocytes complete the first meiotic division to form a large secondary oocyte and a tiny first polar body.

3. The secondary oocyte begins meiosis II but is arrested at metaphase-II. It only completes the second meiotic division if and when a sperm penetrates it, resulting in the formation of an Ootid (mature ovum) and a second polar body.

In contrast, "Ovulation" refers to the release of the secondary oocyte from the Graafian follicle, and "Menarche" is the beginning of the menstrual cycle at puberty.

Final Answer : "Oogenesis"

Answer: (B)

Q10.

Solution

Concept: Mechanism of Parturition (Childbirth).

Solution: Parturition is induced by a complex neuroendocrine mechanism. The process is initiated by the Fetal Ejection Reflex. The signals for parturition originate from both the fully developed fetus and the placenta.

When the fetus is fully developed, it and the placenta secrete substances that trigger mild uterine contractions. These mild contractions (the fetal ejection reflex) act on the maternal posterior pituitary gland to release Oxytocin.

1. Oxytocin acts on the uterine muscles, causing stronger contractions.

2. These stronger contractions, in turn, stimulate the further secretion of oxytocin.

3. This stimulatory reflex between the uterine contraction and oxytocin secretion continues, resulting in increasingly stronger contractions, eventually leading to the expulsion of the baby out of the uterus through the birth canal.

Final Answer : "Both fully developed fetus and placenta"

Answer: (C)

Q11.

Solution

Concept: Types of Intrauterine Devices (IUDs).

Solution: Intrauterine Devices (IUDs) are effective contraceptive methods inserted by doctors into the uterus through the vagina. They are categorized into three main types based on their mechanism of action:

1. Non-medicated IUDs: These increase the phagocytosis of sperm within the uterus. Example: Lippes Loop.

2. Copper-releasing IUDs: These release Cu ions which suppress sperm motility and the fertilizing capacity of sperm. Examples: CuT, Cu7, Multiload 375.

3. Hormone-releasing IUDs: These release hormones (like synthetic progesterone) that make the cervix hostile to sperm and the endometrium unsuitable for implantation. Examples: Progestasert and LNG-20.

Progestasert specifically releases small amounts of progesterone, making it a "hormone-releasing" device.

Final Answer : "Progestasert"

Answer: (B)

Q12.

Solution

Concept: Permanent Methods of Contraception.

Solution: Surgical methods of contraception are also known as Sterilization. These are terminal and permanent methods intended for couples who do not want any more pregnancies. These methods block gamete transport and thereby prevent conception.

There are two main types of sterilization procedures:

1. Vasectomy: In males, a small part of the vas deferens is removed or tied up through a small incision on the scrotum. This prevents sperm from entering the semen.

2. Tubectomy: In females, a small part of the fallopian tubes is removed or tied up through a small incision in the abdomen or through the vagina. This prevents the egg from meeting the sperm.

While these methods are highly effective with a nearly 100% success rate, their reversibility is very poor.

Final Answer : "Sterilization"

Answer: (C)

Q13.

Solution

Concept: Legal Provisions for Medical Termination of Pregnancy (MTP).

Solution: Medical Termination of Pregnancy (MTP) or induced abortion was legalized in India in 1971 with strict conditions to avoid misuse. To further ensure the safety and reproductive rights of women, the MTP (Amendment) Act 2017 (and subsequent updates in 2021) revised the legal timeframe.

According to the legal framework:

1. Termination of pregnancy can be done up to 12 weeks on the opinion of one registered medical practitioner.

2. If the pregnancy has lasted between 12 and 24 weeks (extended from the earlier 20-week limit for certain categories such as rape survivors, minors, or women with disabilities), the opinion of two registered medical practitioners is required.

3. The grounds for termination include a risk to the life of the pregnant woman, grave injury to her physical or mental health, or a substantial risk that the child would suffer from serious physical or mental abnormalities.

In the context of the amendment specifically expanding the upper limit for vulnerable categories, 24 weeks is the significant milestone.

Final Answer : "24 weeks"

Answer: (C)

Q14.

Solution

Concept: Multiple Allelism and Co-dominance in ABO Blood Groups.

Solution: ABO blood grouping is a classic example of both multiple allelism and co-dominance. It is controlled by the gene I, which has three alleles: I^A, I^B, and i.

1. Multiple Allelism: Unlike Mendelian traits with two alleles, this gene has three, which combine to produce six possible genotypes.

2. Co-dominance: When I^A and I^B are present together (I^AI^B), both express their respective antigens (A and B) on the surface of red blood cells, rather than one being dominant over the other.

3. Complete Dominance: Both I^A and I^B are completely dominant over the recessive allele i.

Final Answer : "Answer"

Answer: (B)

Q15.

Solution

Concept: Chromosomal Disorders (Aneuploidy).

Solution: Klinefelter's Syndrome is a genetic disorder caused by the presence of an additional copy of the X-chromosome in males.

- Karyotype: The individual has 47 chromosomes instead of the normal 46, specifically 44 + XXY (or 47, XXY).
- Characteristics: Affected individuals are phenotypically male but possess feminine traits such as development of breast tissue (Gynaecomastia) and are typically sterile.
- Contrast: 45, XO refers to Turner's Syndrome, while 47, XYY is known as Jacob's Syndrome.

Final Answer : "Answer"

Answer: (B)

Q16.

Solution

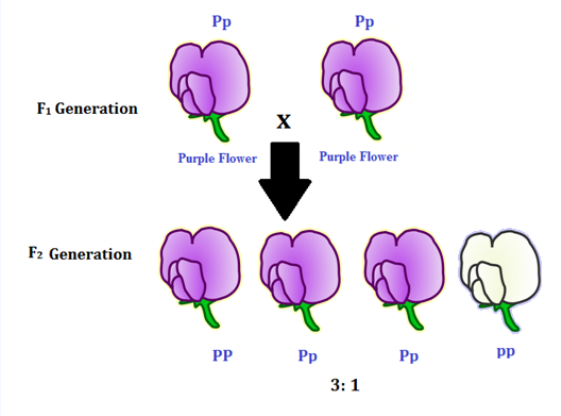
Concept: Mendelian Genetics - Monohybrid Cross.

Solution: When two heterozygous parents ($Aa \times Aa$) are crossed, the possible genotypes of the offspring can be determined using a Punnett square:

- Genotypic Ratio: $1(AA) : 2(Aa) : 1(aa)$.

- Homozygous Recessive (aa): This genotype occurs in 1 out of 4 possible combinations. - Calculation: Probability = $\frac{1}{4} \times 100 = 25\%$.

The other 75% of offspring will show the dominant phenotype (25%AA and 50%Aa).



Final Answer : "Answer"

Answer: (A)

Q17.

Solution

Concept: Sex Determination Mechanisms.

Solution: In different organisms, sex is determined by different chromosomal combinations:

1. Female Heterogamety (ZW): Found in birds (like chickens) and some reptiles. Here, the female produces two types of gametes (Z and W), while the male is homogametic (ZZ).

2. Male Heterogamety (XY/XO): Found in humans and Drosophila (XY) and Grasshoppers (XO), where the male produces two types of gametes and the female is homogametic (XX).

Final Answer : "Answer"

Answer: (C)

Q18.

Solution

Concept: Autosomal Recessive Disorders.

Solution: Thalassemia is a group of inherited blood disorders characterized by decreased hemoglobin production.

- Inheritance: It is an autosome-linked recessive disease, meaning it is passed down through non-sex chromosomes and only manifests when an individual inherits two defective alleles (one from each parent).
- Mechanism: It involves the mutation or deletion of genes that control the synthesis of alpha or beta globin chains, leading to the formation of abnormal hemoglobin and subsequent anemia.

Final Answer : "Answer"

Answer: (C)

Q19.

Solution

Concept: Pleiotropy.

Solution: Pleiotropy is a genetic phenomenon where a single gene influences multiple, seemingly unrelated phenotypic traits.

- Example: In Phenylketonuria (PKU), a mutation in a single gene that codes for the enzyme phenylalanine hydroxylase leads to multiple effects such as mental retardation, reduced hair growth, and skin pigmentation.
- Contrast: Polygenic inheritance is the opposite, where many genes influence a single trait (like human skin color).

Final Answer : "Answer"

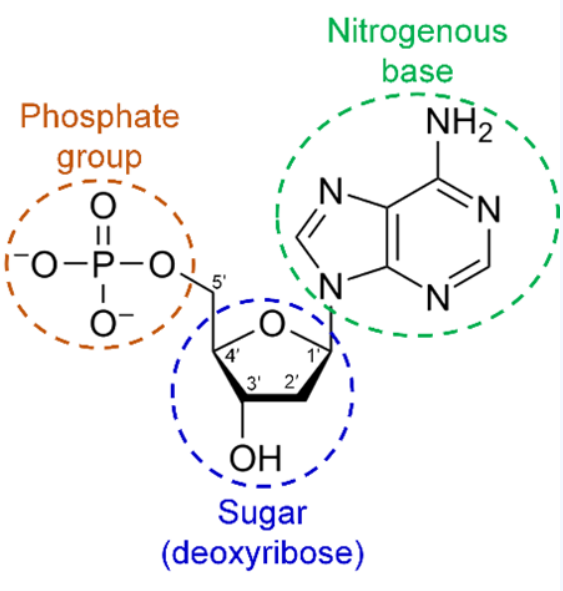
Answer: (B)

Q20.

Solution

Concept: Chemical Composition of DNA.

Solution: The DNA molecule is composed of three components: a nitrogenous base, a pentose sugar, and a phosphate group.



- Reason for Charge: The phosphate group (PO_4^{3-}) contains oxygen atoms with negative charges. Since these phosphate groups form the "backbone" of the DNA strand, they impart an overall negative charge to the entire molecule.
- Significance: This negative charge allows DNA to wrap around positively charged histone proteins to form nucleosomes.

Final Answer : "Answer"

Answer: (C)

Q21.

Solution

Concept: Packaging of DNA (Nucleosomes).

Solution: In eukaryotes, DNA is packaged into a compact structure called chromatin.

- Structure: The fundamental unit of chromatin is the nucleosome, which consists of DNA wrapped around an octamer of histone proteins.
- Appearance: When viewed under an electron microscope, the series of nucleosomes connected by "linker DNA" resembles beads-on-a-string.
- This structure further coils to form chromatin fibers and eventually chromosomes during cell division.

Final Answer : "Answer"

Answer: (A)

Q22.

Solution

Concept: DNA Replication Process.

Solution: DNA polymerase can only synthesize a new DNA strand in the $5' \rightarrow 3'$ direction.

1. Leading Strand: As the replication fork opens, the strand with the $3' \rightarrow 5'$ template orientation allows the enzyme to move continuously in the same direction as the fork. This strand is synthesized continuously.
2. Lagging Strand: The other template ($5' \rightarrow 3'$) requires synthesis in the opposite direction of the fork, resulting in discontinuous fragments known as Okazaki fragments.

Final Answer : "Answer"

Answer: (B)

Q23.

Solution

Concept: The Role of tRNA (Transfer RNA) in Translation.

Solution: Francis Crick postulated the presence of an "adapter molecule" that would on one hand read the genetic code and on the other hand would bind to specific amino acids.

- **Structure:** tRNA has a secondary structure that looks like a cloverleaf and a 3D structure that looks like an inverted 'L'.
- **Function:** It has an **anticodon loop** that has bases complementary to the code on the mRNA, and it also has an **amino acid acceptor end** (at the 3' end) to which it binds to specific amino acids.
- **Specificity:** There are specific tRNAs for every amino acid. For initiation, there is a specific tRNA referred to as initiator tRNA.

Since it facilitates the translation of nucleotide sequences into amino acid sequences, it is termed the adapter molecule.

Final Answer : "Answer"

Answer: (C)

Q24.

Solution

Concept: DNA Content in the Human Genome.

Solution: The size of a genome is typically measured in terms of the number of base pairs (bp) present in a haploid set of chromosomes.

- **Haploid Content:** The human haploid genome (contained in a gamete) consists of approximately 3.3×10^9 base pairs.
- **Diploid Content:** A normal human somatic cell is diploid ($2n$) and contains roughly 6.6×10^9 base pairs.

In most academic and competitive examinations, "the human genome" refers to the haploid content. Thus, 3×10^9 bp (or 3 billion base pairs) is the accepted approximation.

Final Answer : "Answer"

Answer: (A)

Q25.

Solution

Concept: Transcription Unit and DNA Strands.

Solution: Transcription is the process of copying genetic information from one strand of the DNA into RNA. A transcription unit in DNA is defined primarily by three regions: a Promoter, the Structural gene, and a Terminator.

- **Template Strand:** The DNA-dependent RNA polymerase catalyses the polymerisation in only one direction, which is $5' \rightarrow 3'$. Therefore, the strand that has the polarity $3' \rightarrow 5'$ acts as a template and is called the **Template Strand**.
- **Coding Strand:** The other strand, which has the polarity $5' \rightarrow 3'$ and the same sequence as the RNA (except thymine is replaced by uracil), is displaced during transcription and is referred to as the **Coding Strand** (or sense strand), even though it does not code for anything in this specific process.

Final Answer : "Answer"

Answer: (B)

Q26.

Solution

Concept: Satellite DNA and DNA Polymorphism.

Solution: During density gradient centrifugation of genomic DNA, the bulk DNA forms a major peak, while other small peaks are referred to as satellite DNA.

- **Non-coding Nature:** Satellite DNA usually does not code for any proteins.
- **Polymorphism:** These sequences show a high degree of **polymorphism** (variation at the genetic level). This occurs because mutations in these non-coding sequences do not affect the individual's reproductive fitness immediately and thus accumulate over generations.
- **Application:** This polymorphism forms the basis of DNA fingerprinting and is used in paternity testing and forensic science to identify individuals.

Final Answer : "Answer"

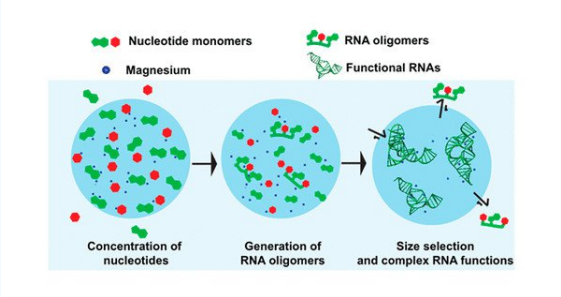
Answer: (C)

Q27.

Solution

Concept: The RNA World Hypothesis.

Solution:



There is substantial evidence to suggest that RNA was the first genetic material in living systems.

- **Dual Role:** RNA used to act as a genetic material as well as a catalyst (ribozymes). Essential life processes like metabolism, splicing, and translation evolved around RNA.
- **Instability:** However, RNA being a catalyst was reactive and hence unstable.
- **Evolution of DNA:** Therefore, DNA evolved from RNA with chemical modifications (like the loss of the 2'-OH group to become deoxyribose and the substitution of Uracil with Thymine) that make it more stable and resistant to degradation.

Final Answer : "Answer"

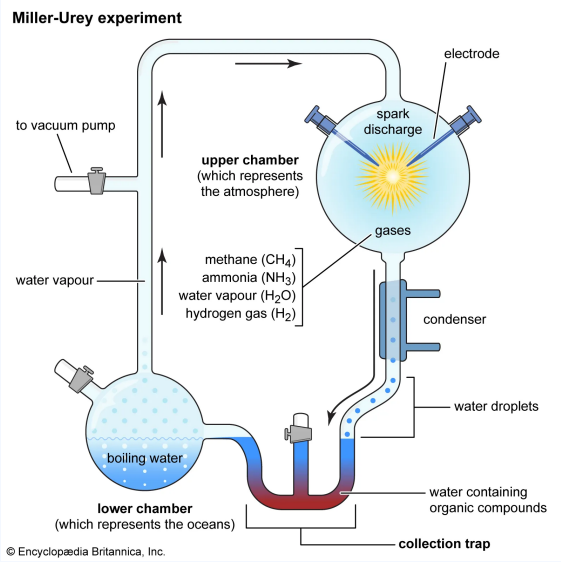
Answer: (B)

Q28.

Solution

Concept: Experimental Proof of Chemical Evolution (Miller-Urey Experiment).

Solution:



In 1953, S.L. Miller and H.C. Urey provided experimental evidence for the theory of chemical evolution.

- **Setup:** They created conditions in a laboratory similar to those thought to exist on primitive Earth: high temperature, volcanic storms, and a reducing atmosphere.
- **Procedure:** In a closed flask, they used electric discharges (to simulate lightning) in a mixture of CH_4, NH_3, H_2 and water vapor at $800^\circ C$.
- **Observation:** After several days, they observed the formation of various organic compounds, specifically **amino acids** (such as glycine, alanine, and aspartic acid).

This proved that the first non-cellular forms of life could have originated from non-living organic molecules.

Final Answer : "Answer"

Answer: (B)

Q29.

Solution

Concept: Homology and Divergent Evolution.

Solution: Homology is the relationship between structures derived from a common ancestor.

- **Structural Similarity:** The forelimbs of whales (flippers), bats (wings), cheetahs (legs), and humans (hands) all exhibit the same basic anatomical plan. They all possess bones like the humerus, radius, ulna, carpals, metacarpals, and phalanges.
- **Functional Difference:** Although they share the same origin, these organs have been modified to perform different functions (swimming, flying, running, and grasping) in response to different environmental needs.
- **Evolutionary Path:** This is known as **divergent evolution**. In contrast, analogous organs (Option A) show similar functions but different origins (convergent evolution).

Final Answer : "Answer"

Answer: (B)

Q30.

Solution

Concept: Genetic Drift (Sewall Wright Effect).

Solution: Genetic drift is the change in the frequency of an existing gene variant (allele) in a population due to random sampling of organisms.

- **Population Size:** In large populations, the laws of probability ensure that the allele frequencies remain relatively stable. However, in **small isolated populations**, random chance can cause certain alleles to disappear or become fixed regardless of their adaptive value.
- **Consequences:** Genetic drift can lead to a loss of genetic variation. Significant examples include the "Founder Effect" (where a small group starts a new population) and the "Bottleneck Effect" (where a population size is drastically reduced).

Final Answer : "Answer"

Answer: (B)

Q31.

Solution

Concept: Natural Selection (Example of Industrial Melanism).

Solution: Industrial melanism is a classic observation of Natural Selection in the peppered moth (*Biston betularia*) in England.

- **Pre-industrialization:** White-winged moths were more abundant because they could camouflage against white lichens on tree trunks, while dark (melanic) moths were easily predated.
- **Post-industrialization:** Soot from factories killed lichens and darkened tree trunks. Now, the dark moths were camouflaged and survived better, while the white moths were predated.
- **Conclusion:** This change in the population frequency of moths demonstrated that the individuals with the most favorable variations for a given environment survive and reproduce (Natural Selection).

Final Answer : "Answer"

Answer: (B)

Q32.

Solution

Concept: Innate Immunity Barriers (Physical vs. Physiological).

Solution: Innate immunity is a non-specific type of defense that is present at the time of birth. It consists of four types of barriers:

1. Physical Barriers: These are the first line of defense that physically block the entry of pathogens. The skin is the primary physical barrier. Additionally, the mucus coating of the epithelium lining the respiratory, gastrointestinal, and urogenital tracts traps microbes trying to enter the body.
2. Physiological Barriers: These include chemical secretions such as HCl in the stomach, saliva in the mouth, and tears from the eyes, which prevent microbial growth.
3. Cellular Barriers: Certain white blood cells like PMNL-neutrophils and monocytes.
4. Cytokine Barriers: Proteins like interferons.

Since both the skin and the mucus coating act as primary physical obstacles, the correct answer includes both A and B.

Final Answer : "Both A and B"

Answer: (D)

Q33.

Solution

Concept: Characteristics of Malignant Tumors.

Solution: Tumors are categorized into Benign (which remain confined to their original location) and Malignant (which are cancerous). Malignant tumors consist of a mass of proliferating cells called neoplastic cells. These cells grow very rapidly and compete with normal cells for vital nutrients.

The most dreaded property of malignant tumors is Metastasis. During this process, cancerous cells slough off from the primary tumor and are carried by the blood or lymph to distant sites in the body. Wherever these cells get lodged, they start a new tumor. This ability to spread to other organs makes malignant tumors much more dangerous than benign ones.

Final Answer : "Metastasis"

Answer: (A)

Q34.

Solution

Concept: Common Fungal Diseases in Humans.

Solution: Ringworm is one of the most common infectious diseases in humans. Despite the name, it is not caused by a worm, but by various genera of Fungi, primarily *Microsporum*, *Trichophyton*, and *Epidermophyton*.

The disease is characterized by the appearance of dry, scaly lesions on the skin, nails, and scalp, which are usually accompanied by intense itching. The fungus thrives in heat and moisture, which is why it commonly affects skin folds like the groin or the areas between the toes. It is generally acquired from soil or by using towels, clothes, or even the comb of infected individuals.

Final Answer : "Fungi"

Answer: (C)

Q35.

Solution

Concept: Passive Immunity via Colostrum.

Solution: Immunity is divided into two types:

1. Active Immunity: When a host is exposed to antigens and their own body produces antibodies.
2. Passive Immunity: When ready-made antibodies are directly given to the body to protect it against foreign agents.

The yellowish fluid Colostrum is secreted by the mother during the initial days of lactation. It is highly concentrated with antibodies, specifically of the IgA type. These antibodies are essential for providing the newborn with immediate protection against various pathogens while their own immune system is still developing. Because the infant is receiving pre-formed antibodies from the mother, this is a form of natural passive immunity.

Final Answer : "Passive Immunity"

Answer: (A)

Q36.

Solution

Concept: Microbes in Household Products.

Solution: Microorganisms are used in the production of a wide variety of food items, including cheese. Different varieties of cheese are known by their characteristic texture, flavor, and taste, which come from the specific microbes used.

Swiss Cheese is famous for having large holes. These holes are created during the fermentation process by the bacterium Propionibacterium sharmanii. As this bacterium grows, it produces a very large amount of carbon dioxide (CO_2) gas, which gets trapped in the cheese and forms the characteristic "eyes" or holes.

Final Answer : "Propionibacterium sharmanii"

Answer: (A)

Q37.

Solution

Concept: Methanogens and their Ecological Habitats.

Solution: Methanogens, such as *Methanobacterium*, are a group of obligate anaerobic bacteria that produce large quantities of methane (biogas). They are found in several environments rich in organic matter and lacking oxygen:

1. Anaerobic Sludge Digesters: In Sewage Treatment Plants (STP), they help break down organic solids.
2. Rumen of Cattle: They live in the rumen (the first stomach compartment) of ruminants to help digest cellulose, which is otherwise difficult for the animal to break down.
3. Gobar Gas Plants: These plants use methanogens to convert animal dung (rich in cellulose and these bacteria) into biogas for fuel.

Because they are found in all three of these locations, the correct option is "All of the above."

Final Answer : "All of the above"

Answer: (D)

Q38.

Solution

Concept: Symbiotic associations in Biofertilizers.

Solution: Mycorrhiza (plural: mycorrhizae) is a mutualistic, symbiotic association between certain fungi and the roots of higher plants.

Many members of the genus Glomus form these associations. The fungal hyphae extend into the soil to absorb phosphorus and other minerals and transport them to the plant. In exchange, the plant provides the fungus with sugars and other organic nutrients produced during photosynthesis. This association benefits the plant by providing resistance to root-borne pathogens, tolerance to salinity and drought, and overall improved growth.

Final Answer : "Roots of higher plants"

Answer: (A)

Q39.

Solution

Concept: Visualization techniques in Gel Electrophoresis.

Solution: DNA fragments separated by agarose gel electrophoresis cannot be seen directly because DNA is colorless. To visualize them:

1. The DNA must first be stained with a compound called Ethidium bromide (EtBr). This dye intercalates between the nitrogenous bases of the DNA.
2. The stained gel must then be exposed to Ultraviolet (UV) radiation.

Under UV light, the DNA fragments appear as bright, fluorescent orange-colored bands. It is important to note that DNA cannot be seen in visible light even after staining with EtBr; UV light is a requirement for the fluorescence to occur.

Final Answer : "Ethidium bromide"

Answer: (B)

Q40.

Solution

Concept: Tools of Recombinant DNA Technology.

Solution: In biotechnology, it is important to distinguish between enzymes and vectors:

- Cloning Vectors: These are DNA molecules that can carry a foreign DNA fragment into a host cell and replicate there. pBR322 is one of the most famous and early artificial cloning vectors used in *E. coli*. It contains an origin of replication (ori), antibiotic resistance genes, and several recognition sites for restriction enzymes.
- Restriction Endonucleases: EcoRI, BamHI, and HindIII are all examples of restriction enzymes. They act as "molecular scissors" to cut DNA at specific palindromic sequences, but they cannot act as vectors to carry DNA into a host.

Final Answer : "pBR322"

Answer: (B)

Q41.

Solution

Concept: Competent Host Preparation and Transformation.

Solution: DNA is a hydrophilic molecule; because of this, it cannot easily pass through the hydrophobic lipid bilayer of cell membranes. To facilitate the entry of recombinant DNA (plasmids) into bacterial cells, the cells must be made "competent."

This process involves treating the bacterial population (usually *E. coli*) with a specific concentration of a divalent cation, most commonly Calcium (Ca^{2+}) in the form of Calcium Chloride ($CaCl_2$). The divalent cations are believed to neutralize the repulsive negative charges of the DNA phosphate groups and the lipopolysaccharides on the bacterial cell wall, thereby increasing the efficiency with which the DNA enters the bacterium through pores.

Following this treatment, the cells are subjected to a Heat Shock (briefly placing them at 42°C and then back on ice), which creates transient pores in the membrane allowing the plasmid to enter.

Final Answer : "Calcium"

Answer: (B)

Q42.

Solution

Concept: Principles of Gel Electrophoresis and DNA Migration.

Solution: Agarose gel electrophoresis is a technique used to separate DNA fragments based on their size. The fundamental principle relies on the fact that DNA molecules are negatively charged due to the presence of phosphate groups in their sugar-phosphate backbone.

When an electric current is applied to the gel matrix, the DNA fragments migrate through the agarose pores. Because they carry a net negative charge, they are repelled by the negative electrode (Cathode) and attracted towards the positive electrode (Anode). The agarose gel acts as a sieve; smaller DNA fragments move through the pores more easily and travel further toward the anode, while larger fragments are hindered and remain closer to the starting wells.

Final Answer : "Anode (Positive electrode)"

Answer: (A)

Q43.

Solution

Concept: Clinical Applications of Gene Therapy.

Solution: Gene therapy is a technique used to treat genetic disorders by inserting a functional gene into a patient's cells to replace a defective or missing one. The first clinical gene therapy trial took place in 1990 on a four-year-old girl suffering from Adenosine Deaminase (ADA) deficiency. ADA deficiency is a form of Severe Combined Immunodeficiency (SCID), where the absence of the ADA enzyme leads to the accumulation of toxic metabolic products that destroy T-lymphocytes, effectively crippling the immune system. In this specific case, lymphocytes were extracted from the girl's blood, a functional ADA-cDNA was introduced into these cells using a retroviral vector, and the modified cells were infused back into her body. Since these cells are not immortal, the patient required periodic infusions of such genetically engineered lymphocytes.

Final Answer : "Adenosine deaminase (ADA) deficiency"

Answer: (B)

Q44.

Solution

Concept: Transgenic Animals for Biological Products.

Solution: Transgenic animals are created to produce useful biological products that are otherwise difficult or expensive to manufacture. In 1997, the first transgenic cow, named Rosie, was produced.

The milk produced by Rosie was unique because it was enriched with Human α-lactalbumin. It contained 2.4 grams of this human protein per liter of milk. This protein makes the milk nutritionally superior and more balanced for human infants than natural cow milk, as α-lactalbumin is a key protein found in human breast milk that aids in development and is easier for human infants to digest. This serves as a primary example of using "animals as bioreactors."

Final Answer : "Human α-lactalbumin"

Answer: (B)

Q45.

Solution

Concept: Biotechnology Regulations and Ethical Committees.

Solution: Genetic modification of organisms can have unpredictable results when such organisms are introduced into the ecosystem. Therefore, the Indian Government established the GEAC (Genetic Engineering Appraisal Committee) under the Ministry of Environment, Forest and Climate Change. The GEAC is responsible for:

1. Evaluating the safety of Genetically Modified (GM) organisms for public use.
2. Monitoring and approving large-scale field trials and commercial release of GM crops (like Bt Cotton).
3. Ensuring that GM research adheres to ethical and biosafety standards to prevent harm to human health and the environment.

Other bodies like ICMR focus on medical research, and CSIR on general scientific industrial research, but GEAC specifically handles the appraisal of genetic engineering.

Final Answer : "GEAC"

Answer: (B)

Q46.

Solution

Concept: Types of Interspecific Population Interactions.

Solution: Population interactions are classified based on whether the participating species benefit (+), are harmed (-), or remain unaffected (0). Commensalism is an interaction where one species benefits while the other is neither helped nor harmed (+/0).

The example of barnacles growing on the back of a whale is a classic case of commensalism. The barnacles are sessile (fixed) organisms; by attaching to the whale, they gain a "free ride" to nutrient-rich waters and are protected from predators due to the whale's size. The whale, on the other hand, is large enough that the presence of the small barnacles does not cause it any significant drag, pain, or health issues, thus remaining unaffected.

Final Answer : "Commensalism"

Answer: (C)

Q47.

Solution

Concept: Logistic Growth and Environmental Limits.

Solution: In any natural habitat, resources (such as food, space, and water) are limited. Therefore, a population cannot grow infinitely. The maximum number of individuals of a particular species that a given environment can support and sustain indefinitely, given the available resources, is called the Carrying Capacity (K).

When population growth is plotted over time in such an environment, it follows the Verhulst-Pearl Logistic Growth model. Initially, the population shows a lag phase, followed by acceleration and deceleration, finally reaching an asymptote when the population density reaches the carrying capacity ($N = K$). At this point, the birth rate and death rate equilibrate, and the population size stabilizes.

Final Answer : "Carrying capacity"

Answer: (B)

Q48.

Solution

Concept: Thermodynamics and Energy Transfer in Ecosystems.

Solution: The flow of energy through various trophic levels in an ecosystem is always unidirectional (one-way). This process starts with the capture of solar energy by primary producers (autotrophs) via photosynthesis.

When energy is transferred from producers to primary consumers (herbivores) and then to secondary consumers (carnivores), it follows the 10% Law, where only about 10% of the energy is stored in the biomass of the next level. The remaining 90% is lost as heat during respiration and other metabolic processes. Because this heat energy is dissipated into the atmosphere and cannot be reclaimed by the organisms or returned to the sun, the energy never "cycles" back to the previous level, making the flow strictly unidirectional.

Final Answer : "Unidirectional"

Answer: (A)

Q49.

Solution

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

Solution: Conservation of biodiversity is divided into two main approaches:

1. In-situ (On-site): Protecting species in their natural habitats. Examples include National Parks, Wildlife Sanctuaries, Biosphere Reserves, and Sacred Groves.

2. Ex-situ (Off-site): Protecting threatened or endangered species by removing them from their natural habitat and placing them under human care.

Cryopreservation is an advanced ex-situ technique where biological materials (such as seeds, pollen, oocytes, or embryos) are stored at extremely low temperatures (usually $-196°C$ in liquid nitrogen). This allows genetic material to remain viable for decades in Seed Banks or Gene Banks, ensuring that the species can be "revived" or used in breeding programs even if it goes extinct in the wild.

Final Answer : "Cryopreservation (Seed Bank)"

Answer: (C)

Q50.

Solution

Concept: Ecological Theories of Species Richness.

Solution: The Species-Area Relationship was pioneered by the German naturalist and geographer Alexander von Humboldt. During his extensive explorations in the jungles of South America, he observed that within a specific region, the number of species (species richness) increases with the increasing area explored, but only up to a certain limit.

On a logarithmic scale, this relationship is expressed as a straight line with the equation:

$$\log S = \log C + Z \log A$$

Where:

- S = Species richness
- A = Area
- Z = Slope of the line (regression coefficient)
- C = Y-intercept

His work was fundamental in understanding how habitat size influences biodiversity and is a cornerstone of island biogeography and conservation biology.

Final Answer : "Alexander von Humboldt"

Answer: (B)

Answer Key

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