NEET-UG Biology Sample Paper - 20

Duration: 1 Hour **Maximum Marks: 360**

Instructions

- This paper contains a total of 90 Multiple Choice Questions.
- Each correct answer carries **+4 marks**.
- Each incorrect answer carries **-1 mark**.
- No negative marking for unattempted questions.

Q1. Which of the following statements is incorrect regarding the taxonomical aids?

(A) Separate taxonomic keys are required for each taxonomic category.

(B) Keys are based on the contrasting characters generally in a pair called lead.

(C) Herbarium sheets carry a label providing information about date and place of collection.

(D) Monographs contain information on any one taxon.

Q2. Match the following regarding Floral Formulae and families:

List-I	Family	List-II	Floral Formula
(a)	Brassicaceae	(i)	$\oplus\, K_{(5)}\, C_{(5)}\, A_5\, G_{(2)}$
(b)	Fabaceae	(ii)	$\%\, K_{(5)}\, C_{1+2+(2)}\, A_{(9)+1}\, G_1$
(c)	Solanaceae	(iii)	$\oplus\, P_{3+3}\, A_{3+3}\, G_{(3)}$
(d)	Liliaceae	(iv)	$\oplus\, K_{2+2}\, C_4\, A_{2+4}\, G_{(2)}$

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

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

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

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

Q3. Given below are two statements: Statement I: Mycoplasma can pass through less than 1 micron filter size. Statement II: Mycoplasma are bacteria with cell wall. In light of the above statements, choose the most appropriate answer:

(A) Both Statement I and Statement II are correct.

(B) Both Statement I and Statement II are incorrect.

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

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

Q4. In the process of 'Photorespiration', the RuBP combines with O_2 to form:

(A) One molecule of 3-carbon compound and one molecule of 2-carbon compound.

(B) Two molecules of 3-carbon compound.

(C) Two molecules of 2-carbon compound.

(D) One molecule of 6-carbon compound.

Q5. During the G_1 phase of the cell cycle, if the initial amount of DNA is $2C$, then the amount of DNA at the end of the S-phase and G_2 phase will be:

(A) $2C$ and $4C$

(B) $4C$ and $4C$

(C) $4C$ and $8C$

(D) $2C$ and $2C$

Q6. Which of the following is the correct sequence of events in the human female reproductive cycle?

(A) Secretion of FSH → Growth of follicle → Secretion of Estrogen → LH Surge → Ovulation.

(B) LH Surge → Secretion of FSH → Growth of follicle → Ovulation.

(C) Secretion of Estrogen → LH Surge → Secretion of FSH → Ovulation.

(D) Secretion of FSH → LH Surge → Secretion of Estrogen → Ovulation.

Q7. If a female having blood group A (heterozygous) marries a male having blood group B (heterozygous), what is the probability of their offspring having blood group O?

(A) 0%

(B) 25%

(C) 50%

(D) 75%

Q8. What will be the direction of net water movement between two cells? Cell A with $\Psi_w = -10$ bars and Cell B with $\Psi_w = -4$ bars.

(A) From Cell A to Cell B

(B) From Cell B to Cell A

(C) No net movement

(D) Equilibrium is already reached

Q9. Identify the correct set of statements regarding the properties of DNA: (i) The two chains have anti-parallel polarity. (ii) The bases in two strands are paired through Hydrogen bonds. (iii) The pitch of the helix is 3.4 nm. (iv) Adenine forms three hydrogen bonds with Thymine.

(A) (i), (ii), (iii)

(B) (i), (ii), (iv)

(C) (ii), (iii), (iv)

(D) (i), (iii), (iv)

Q10. The process of translation of mRNA to proteins begins as soon as:

(A) The larger subunit of ribosome encounters mRNA.

(B) The small subunit of ribosome encounters mRNA.

(C) tRNA is activated and the larger subunit of ribosome encounters mRNA.

(D) The tRNA is charged.

Q11. Which of the following is correct regarding the chitinous exoskeleton of arthropods?

(A) It is a heteropolysaccharide formed by N-acetyl glucosamine.

(B) It is a homopolysaccharide formed by N-acetyl glucosamine.

(C) It is a nitrogen-containing protein.

(D) It is a lipid derivative found in the cuticle.

Q12. Identify the correct statement regarding the S-phase of the cell cycle:

(A) Amount of DNA doubles, but the chromosome number remains the same.

(B) Amount of DNA remains the same, but the chromosome number doubles.

(C) Both DNA and chromosome number double.

(D) Centriole duplication occurs in the nucleus.

Q13. In a plant, the red fruit color (R) is dominant over yellow (r) and tallness (T) is dominant over short (t). If a plant with RRTt genotype is crossed with a plant of rrtt genotype, the percentage of tall plants with red fruits in the next generation is:

(A) 25%

(B) 50%

(C) 75%

(D) 100%

Q14. Which of the following statements is incorrect about the properties of the Genetic Code?

(A) The codon is triplet and read in a contiguous fashion.

(B) It is nearly universal from bacteria to humans.

(C) One amino acid is coded by only one codon.

(D) Some amino acids are coded by more than one codon.

Q15. Match List-I (Phases of Prophase I) with List-II (Events):

List-I	Phase	List-II	Event
(a)	Zygotene	(i)	Crossing over occurs
(b)	Pachytene	(ii)	Synapsis begins
(c)	Diplotene	(iii)	Terminalization starts
(d)	Diakinesis	(iv)	Chiasmata become visible

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

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

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

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

Q16. Regarding the human heart, if the stroke volume is 70 mL and the heart rate is 80 beats per minute, what will be the cardiac output?

(A) 5000 mL

(B) 5600 mL

(C) 4600 mL

(D) 6500 mL

Q17. Which of the following factors favor the formation of oxyhaemoglobin in the alveoli?

(A) High pO_2, low pCO_2, less H^+ concentration, lower temperature.

(B) Low pO_2, high pCO_2, high H^+ concentration, higher temperature.

(C) High pO_2, high pCO_2, less H^+ concentration, higher temperature.

(D) Low pO_2, low pCO_2, high H^+ concentration, lower temperature.

Q18. In E. coli cloning vector pBR322, the presence of restriction sites for Pvu I and Pst I are located within:

(A) amp^R gene

(B) tet^R gene

(C) rop gene

(D) ori region

Q19. In a terrestrial ecosystem, what happens to the energy that is not used for growth and reproduction at a trophic level?

(A) It is recycled back to the producers.

(B) It is lost as heat to the environment.

(C) It is stored as fat in the soil.

(D) It is consumed by primary consumers only.

Q20. The functional unit of the human kidney, the nephron, performs ultrafiltration in:

(A) Bowman's capsule and Glomerulus

(B) Proximal Convoluted Tubule

(C) Loop of Henle

(D) Collecting Duct

Q21. Which of the following is a symptom of Addison's disease?

(A) Low blood sugar and low sodium concentration.

(B) High blood sugar and high blood pressure.

(C) Accumulation of fat in the face and neck.

(D) Excessive growth of body hair.

Q22. Experimental proof for the semi-conservative replication of DNA was first shown in:

(A) Escherichia coli

(B) Salmonella typhimurium

(C) Drosophila melanogaster

(D) Vicia faba

Q23. During Double Fertilization in angiosperms, the triple fusion results in the formation of:

(A) Zygote

(B) Primary Endosperm Nucleus

(C) Scutellum

(D) Perisperm

Q24. Recombinant DNA technology involves several steps. Which of the following is the correct sequence?

(A) Isolation → Fragmentation → Ligation → Transformation → Culturing → Extraction.

(B) Fragmentation → Isolation → Ligation → Extraction.

(C) Ligation → Isolation → Fragmentation → Transformation.

(D) Isolation → Ligation → Fragmentation → Culturing.

Q25. Which hormone is responsible for the 'Milk Ejection Reflex' during breastfeeding?

(A) Prolactin

(B) Oxytocin

(C) Estrogen

(D) Progesterone

Q26. In human lungs, the volume of air that remains even after a forcible expiration is known as:

(A) Tidal Volume

(B) Residual Volume

(C) Expiratory Reserve Volume

(D) Vital Capacity

Q27. In Lac Operon, the i gene codes for:

(A) Inducer

(B) Repressor

(C) β-galactosidase

(D) Permease

Q28. The Greenhouse Effect is mainly caused by the accumulation of:

(A) CO_2 and CH_4

(B) O_3 and SO_2

(C) N_2 and O_2

(D) CO and NO_2

Q29. Which of the following is an example of Ex-situ conservation?

(A) National Parks

(B) Biosphere Reserves

(C) Seed Banks

(D) Sacred Groves

Q30. The primary lymphoid organ in humans is:

(A) Spleen

(B) Thymus and Bone Marrow

(C) Lymph nodes

(D) Peyer's patches

Q31. Identify the correct statement about the structure of an antibody molecule:

(A) It consists of four polypeptide chains: two long and two short.

(B) It consists of two polypeptide chains: one heavy and one light.

(C) Antigen-binding sites are located on the constant regions.

(D) Disulfide bonds are absent between the chains.

Q32. The first human-like hominid was:

(A) Homo habilis

(B) Homo erectus

(C) Australopithecus

(D) Neanderthal man

Q33. In a typical Mendelian dihybrid cross, the ratio of round yellow to wrinkled green seeds in F_2 generation is:

(A) 9 : 1

(B) 3 : 1

(C) 1 : 1

(D) 9 : 3 : 3 : 1

Q34. Which of the following is not a functional unit of an ecosystem?

(A) Productivity
(B) Stratification
(C) Energy flow
(D) Decomposition

Q35. The enzyme recombinase is required at which stage of meiosis?

(A) Pachytene
(B) Zygotene
(C) Diplotene
(D) Diakinesis

Q36. Which of the following is used as a cellular factory for the synthesis of proteins?

(A) Ribosome
(B) Golgi apparatus
(C) Lysosome
(D) Mitochondria

Q37. The process by which organisms with different evolutionary history evolve similar phenotypic adaptations is called:

(A) Convergent evolution
(B) Divergent evolution
(C) Non-adaptive radiation
(D) Saltation

Q38. In recombinant DNA technology, the term 'Vectors' refers to:

(A) DNA molecules that can carry a foreign DNA fragment into a host cell.

(B) Enzymes that cut DNA at specific sites.

(C) Host cells that receive the foreign DNA.

(D) Proteins produced by the transformed cells.

Q39. Which part of the brain is responsible for thermoregulation?

(A) Hypothalamus

(B) Cerebellum

(C) Medulla oblongata

(D) Corpus callosum

Q40. The primary producer in a deep-sea hydrothermal vent ecosystem is:

(A) Chemosynthetic bacteria

(B) Green algae

(C) Phytoplankton

(D) Zooplankton

Q41. In which of the following groups are all the animals triploblastic and coelomate?

(A) Annelida, Arthropoda, Mollusca

(B) Platyhelminthes, Aschelminthes, Annelida

(C) Porifera, Coelenterata, Ctenophora

(D) Echinodermata, Hemichordata, Chordata (but not Arthropoda)

Q42. The first stable product of fixation of atmospheric nitrogen in leguminous plants is:

(A) Ammonia

(B) Nitrate

(C) Glutamate

(D) Nitrogenase

Q43. Which hormone stimulates the secretion of gastric juice?

(A) Gastrin

(B) Secretin

(C) Cholecystokinin

(D) Enterogastrone

Q44. A person with blood group AB can receive blood from:

(A) Only AB

(B) Only A and B

(C) Any blood group

(D) Only O

Q45. The site of perception of light in plants for photoperiodism is:

(A) Leaf

(B) Shoot apex

(C) Stem

(D) Lateral buds

Q46. The most abundant protein in the whole of the biosphere is:

(A) RuBisCO

(B) Collagen

(C) Keratin

(D) Insulin

Q47. In Mendel's experiments, the character which was not observed in the F_1 generation but reappeared in the F_2 generation is:

(A) Recessive

(B) Dominant

(C) Codominant

(D) Incomplete dominant

Q48. The method of DNA fingerprinting was first developed by:

(A) Alec Jeffreys

(B) Watson and Crick

(C) Frederick Griffith

(D) Hargobind Khorana

Q49. The structural and functional unit between developing embryo and maternal body is called:

(A) Placenta

(B) Umbilical cord

(C) Amnion

(D) Yolk sac

Q50. Which of the following is a non-reducing sugar?

(A) Sucrose

(B) Glucose

(C) Fructose

(D) Lactose

Q51. The process of formation of RNA from DNA is called:

(A) Transcription

(B) Translation

(C) Replication

(D) Transformation

Q52. In human males, the hormone that stimulates spermatogenesis is:

(A) Testosterone

(B) Progesterone

(C) Estrogen

(D) Relaxin

Q53. The largest reservoir of carbon on earth is:

(A) Oceans

(B) Atmosphere

(C) Fossil fuels

(D) Living organisms

(E)

Q54. A population that exhibits a J-shaped growth curve is undergoing:

(A) Exponential growth

(B) Logistic growth

(C) Zero growth

(D) Negative growth

Q55. The part of the flower that develops into a seed after fertilization is:

(A) Ovule

(B) Ovary

(C) Stigma

(D) Anther

Q56. In the context of the immune system, the term 'Interferons' refers to:

(A) Proteins secreted by virus-infected cells to protect non-infected cells.

(B) Antibodies produced by B-cells.

(C) Enzymes that digest bacteria.

(D) Toxins produced by pathogens.

Q57. Which of the following is a direct consequence of global warming?

(A) Melting of polar ice caps and rise in sea level.

(B) Increase in volcanic activity.

(C) Decrease in atmospheric CO_2.

(D) Increase in the thickness of the ozone layer.

Q58. The technique of micropropagation is used for:

(A) Producing a large number of plants in a short duration.

(B) Developing pest-resistant varieties.

(C) Studying plant diseases.

(D) Conserving endangered animal species.

Q59. Which of the following is not an autoimmune disease?

(A) Alzheimer's disease

(B) Rheumatoid arthritis

(C) Myasthenia gravis

(D) Psoriasis

Q60. In the human eye, the point of maximum visual acuity is:

(A) Fovea centralis

(B) Blind spot

(C) Optic disc

(D) Iris

Q61. The role of DNA ligase in the process of DNA replication is to:

(A) Join the Okazaki fragments.

(B) Unwind the DNA double helix.

(C) Synthesize a short RNA primer.

(D) Add nucleotides to the 3′ end of the growing strand.

Q62. Which of the following is an example of a vestigial organ in humans?

(A) Vermiform appendix

(B) Heart

(C) Lungs

(D) Kidney

Q63. The process of 'Guttation' in plants occurs through:

(A) Hydathodes

(B) Stomata

(C) Lenticels

(D) Cuticle

Q64. The hormone that is known as the 'Emergency hormone' or 'Fight or Flight' hormone is:

(A) Adrenaline

(B) Insulin

(C) Thyroxine

(D) Cortisol

Q65. In the F_2 generation of a Mendelian monohybrid cross, the genotypic ratio is:

(A) 1 : 2 : 1

(B) 3 : 1

(C) 9 : 3 : 3 : 1

(D) 1 : 1

Q66. The functional unit of contraction in a skeletal muscle is:

(A) Sarcomere

(B) Myofibril

(C) Fascicle

(D) Sarcolemma

Q67. Which of the following is a characteristic of a wind-pollinated flower?

(A) Small, inconspicuous flowers with well-exposed stamens.

(B) Large, brightly colored flowers with nectar.

(C) Sticky pollen grains and feathery stigma.

(D) Heavy, nutrient-rich pollen grains.

Q68. The first clinical gene therapy was given for the treatment of:

(A) Adenosine Deaminase (ADA) deficiency.

(B) Cystic fibrosis.

(C) Hemophilia.

(D) Sickle cell anemia.

Q69. Which of the following is a greenhouse gas?

(A) Methane (CH_4)

(B) Oxygen (O_2)

(C) Nitrogen (N_2)

(D) Argon (Ar)

Q70. The sequence of base pairs in DNA that reads the same on both strands when read in the $5' \rightarrow 3'$ direction is called:

(A) Palindromic sequence

(B) Non-coding sequence

(C) Satellite DNA

(D) Promoter sequence

Q71. Which of the following is used in the treatment of cancer?

(A) Chemotherapy and Radiation

(B) Antibiotics

(C) Vaccinations

(D) Vitamins

Q72. The enzyme that catalyzes the process of transcription in eukaryotes is:

(A) RNA Polymerase

(B) DNA Polymerase

(C) Reverse Transcriptase

(D) RNA Ligase

Q73. In a food chain, the position of an organism is determined by its:

(A) Trophic level

(B) Size

(C) Population density

(D) Habitat

Q74. Which of the following is an example of an infectious disease?

(A) Tuberculosis

(B) Diabetes

(C) Hypertension

(D) Cancer

Q75. The component of the human blood that is responsible for clotting is:

(A) Platelets

(B) Erythrocytes

(C) Leucocytes

(D) Plasma proteins

Q76. Which of the following is a function of the liver?

(A) Bile production and detoxification.

(B) Production of digestive enzymes like pepsin.

(C) Absorption of water.

(D) Storage of urine.

Q77. The process of 'Parturition' refers to:

(A) Childbirth

(B) Fertilization

(C) Implantation

(D) Ovulation

Q78. In an ecosystem, the rate of production of organic matter during photosynthesis is called:

(A) Gross Primary Productivity

(B) Net Primary Productivity

(C) Secondary Productivity

(D) Standing Crop

Q79. Which of the following is not a part of the human female reproductive system?

(A) Vas deferens

(B) Uterus

(C) Fallopian tubes

(D) Ovaries

Q80. The process by which DNA fragments are separated based on their size is:

(A) Gel Electrophoresis

(B) PCR

(C) Southern Blotting

(D) Centrifugation

Q81. Which of the following is a characteristic of 'r-selected' species?

(A) High reproductive rate and small body size.

(B) Low reproductive rate and large body size.

(C) Extensive parental care.

(D) Long lifespan.

Q82. The hormone that promotes apical dominance in plants is:

(A) Auxin
(B) Gibberellin
(C) Cytokinin
(D) Abscisic acid

Q83. Which of the following is a water-soluble vitamin?

(A) Vitamin C
(B) Vitamin A
(C) Vitamin D
(D) Vitamin K

Q84. The study of the relationship between organisms and their environment is:

(A) Ecology
(B) Genetics
(C) Evolution
(D) Physiology

Q85. In the human digestive system, the absorption of most nutrients occurs in the:

(A) Small intestine
(B) Stomach
(C) Large intestine
(D) Esophagus

Q86. Which structure in the human ear is responsible for converting sound waves into nerve impulses?

(A) Organ of Corti

(B) Malleus

(C) Eustachian tube

(D) Semicircular canals

Q87. In the context of evolution, Analogous structures are a result of:

(A) Convergent evolution

(B) Divergent evolution

(C) Genetic drift

(D) Adaptive radiation

Q88. Which enzyme is used to join DNA fragments?

(A) DNA Ligase

(B) DNA Polymerase

(C) Restriction Endonuclease

(D) Helicase

Q89. The pyramid of biomass in a sea is generally:

(A) Inverted

(B) Upright

(C) Spindle-shaped

(D) Bell-shaped

Q90. In a population, if the frequency of a recessive allele (q) is 0.4, what is the frequency of the homozygous dominant genotype (p^2) according to Hardy-Weinberg equilibrium?

(A) 0.36

(B) 0.16

(C) 0.48

(D) 0.60

Detailed Solutions

Q1.

Solution

Concept:

Taxonomical aids are collection of samples or preserved organisms which help in research and identification of various species. Key aids include:

1. Herbarium: A storehouse of collected plant specimens that are dried, pressed and preserved on sheets.
2. Key: A tool used for identification of plants and animals based on the similarities and dissimilarities.
3. Monograph: A comprehensive study that provides information on any one taxon (like a single genus or family).

Solution:

The analytical nature of taxonomic keys requires that separate taxonomic keys be used for each taxonomic category such as family, genus, and species for identification purposes. This confirms that statement (A) is correct.

In a taxonomic key, the pair of contrasting characters is technically referred to as a "couplet." Each individual statement within the couplet is called a "lead." Statement (B) incorrectly identifies the pair of characters as a lead, which is technically inaccurate.

Herbarium sheets serve as a quick referral system in taxonomical studies. They must carry a label providing information about the date and place of collection, English, local and botanical names, family, and the collector's name, confirming statement (C) is correct.

Monographs contain exhaustive information on any one specific taxon at a time, making statement (D) correct. Since the prompt asks for the incorrect description regarding taxonomical aids, the error in the definition of a "lead" makes (B) the required answer.

Final Answer: The pair of contrasting characters is called a couplet, while each statement is a lead.

Answer: (B)

Q2.

Solution

Concept:

The floral formula represents the morphological features of a flower using symbols. It indicates symmetry, sexuality, and the number, fusion, and arrangement of floral whorls (calyx, corolla, androecium, and gynoecium). Each plant family has a characteristic floral formula used for identification.

Solution:

The family Brassicaceae is characterized by actinomorphic symmetry ($\oplus$), four sepals and four petals, and a tetradynamous androecium (A_{2+4}). This corresponds to formula (iv).

The family Fabaceae shows zygomorphic symmetry (%), papilionaceous corolla ($C_{1+2+(2)}$), and diadelphous stamens ($A_{(9)+1}$). This corresponds to formula (ii).

The family Solanaceae has actinomorphic flowers with gamosepalous and gamopetalous condition ($K_{(5)}, C_{(5)}$) and five epipetalous stamens (A_5). This corresponds to formula (i).

The family Liliaceae is a monocot family with perianth (P_{3+3}), six stamens (A_{3+3}), and tricarpellary gynoecium. This corresponds to formula (iii).

Thus, the correct matching is: a-iv, b-ii, c-i, d-iii.

Final Answer: The correct matching sequence is a-iv, b-ii, c-i, d-iii.

Answer: (C)

Q3.

Solution

Concept:

Mycoplasma are a genus of bacteria that are unique among prokaryotes because they lack a cell wall around their cell membranes. This lack of a cell wall makes them naturally resistant to many common antibiotics, such as penicillin, which target cell wall synthesis. They are the smallest living cells known and can survive without oxygen.

Solution:

Statement I claims that Mycoplasma can pass through filters with a pore size of less than 1 μm. This is factually correct because the size of Mycoplasma typically ranges from 0.1 to 0.3 μm, which is significantly smaller than 1 μm. Their lack of a rigid cell wall also allows them to be pleomorphic and squeeze through small spaces.

Statement II claims that Mycoplasma are bacteria with a cell wall. This is scientifically incorrect. The defining biological characteristic of Mycoplasma is the total absence of a cell wall. This absence is what allows them to change shape and makes them insensitive to cell-wall-inhibiting antibiotics.

Evaluating both statements, we find that Statement I is correct whereas Statement II is incorrect.

Final Answer: Statement I is correct but Statement II is incorrect.

Answer: (C)

Q4.

Solution

Concept:

Photorespiration (also known as the C_2 cycle) occurs in C_3 plants when the enzyme RuBisCO (Ribulose-1,5-bisphosphate carboxylase-oxygenase) acts as an oxygenase rather than a carboxylase. This happens when the CO_2 levels are low and O_2 levels are high, usually due to the closure of stomata at high temperatures.

Solution:

In the photorespiratory pathway, O_2 binds to RuBisCO, causing the 5-carbon compound Ribulose-1, 5-bisphosphate (RuBP) to undergo oxygenation.

This reaction results in the breakdown of the 5-carbon RuBP into two different molecules rather than two molecules of 3-PGA (as seen in the Calvin Cycle).

One molecule of 3-phosphoglycerate (3-PGA) is produced, which is a 3-carbon compound.

The other molecule produced is phosphoglycolate, which is a 2-carbon compound.

Because this process leads to the formation of a 2-carbon compound and involves the loss of fixed carbon as CO_2 without the production of ATP or NADPH, it is considered a wasteful process in plants.

Final Answer: The process yields one molecule of a 3-carbon compound and one molecule of a 2-carbon compound.

Answer: (A)

Q5.

Solution

Concept:

The cell cycle is divided into Interphase and the M-phase. Interphase consists of the G_1 phase, S phase (Synthesis phase), and G_2 phase. During the S phase, DNA replication takes place, which doubles the amount of DNA per cell. However, the chromosome number remains unchanged during this process.

Solution:

If the initial amount of DNA during the G_1 phase is designated as $2C$, the cell is preparing for replication.

During the S phase (Synthesis phase), the DNA undergoes replication, effectively doubling the genetic material. Therefore, by the end of the S phase, the amount of DNA becomes $2 \times 2C = 4C$.

Following the S phase, the cell enters the G_2 phase (second gap phase). During this phase, the cell continues to grow and synthesizes proteins required for mitosis, but no further DNA replication occurs.

Consequently, the amount of DNA that was doubled in the S phase remains at $4C$ throughout the G_2 phase until the cell undergoes division during the M-phase.

Thus, at the end of both the S phase and the G_2 phase, the DNA content is consistently $4C$.

Final Answer: The amount of DNA at the end of the S-phase and G2 phase will be 4C and 4C.

Answer: (B)

Q6.

Solution

Concept:

The human female reproductive cycle, or menstrual cycle, is a series of natural changes in the production of hormones and the structures of the uterus and ovaries. It is divided into several phases: the menstrual phase, the follicular (proliferative) phase, ovulation, and the luteal (secretory) phase. The process is governed by the hypothalamus-pituitary-ovarian axis.

Solution:

The cycle begins with the secretion of Follicle Stimulating Hormone (FSH) from the anterior pituitary. FSH stimulates the primary follicles in the ovary to grow and become fully mature Graafian follicles.

As the follicles develop, they start secreting Estrogen. Estrogen is responsible for the proliferation of the endometrium (the inner lining of the uterus) which was shed during the previous menstruation.

Increasing levels of Estrogen eventually trigger a sharp rise in Luteinizing Hormone (LH) from the pituitary, known as the "LH Surge."

This LH Surge is the critical trigger that causes the mature Graafian follicle to rupture and release the secondary oocyte (egg) into the fallopian tube, a process called Ovulation.

Therefore, the correct physiological sequence follows the path of hormonal stimulation leading to follicular growth, followed by further hormonal triggers for release.

Final Answer: The sequence is Secretion of FSH → Growth of follicle → Secretion of Estrogen → LH Surge → Ovulation.

Answer: (A)

Q7.

Solution

Concept:

ABO blood groups in humans are determined by three alleles of the gene I: I^A, I^B, and i. The alleles I^A and I^B are co-dominant, while the allele i is recessive. A person's blood group phenotype depends on the combination of these alleles inherited from their parents.

Solution:

A female with blood group A who is heterozygous has the genotype I^Ai. A male with blood group B who is heterozygous has the genotype I^Bi.

When these two individuals reproduce, the possible combinations of alleles in the offspring can be determined using a Punnett square: - The female produces gametes with I^A or i. - The male produces gametes with I^B or i.

The resulting genotypes in the F_1 generation are: 1. I^AI^B (Phenotype: AB) 2. I^Ai (Phenotype: A) 3. I^Bi (Phenotype: B) 4. ii (Phenotype: O)

Since there are four equally likely outcomes, each genotype has a probability of 1/4 or 25%. The question asks specifically for the probability of blood group O, which corresponds to the ii genotype.

Final Answer: The probability of their offspring having blood group O is 25%.

Answer: (B)

Q8.

Solution

Concept:

Water potential (Ψ_w) is a measure of the free energy of water in a system. It determines the direction in which water will move via osmosis. Water always moves spontaneously from a region of higher water potential (closer to zero or less negative) to a region of lower water potential (more negative).

Solution:

We are comparing two adjacent cells: Cell A has a water potential (Ψ_w) of -10 bars. Cell B has a water potential (Ψ_w) of -4 bars.

In terms of numerical value, -4 is greater than -10. This means that Cell B has a higher water potential than Cell A.

Because osmosis is the movement of water molecules from an area of higher potential to an area of lower potential across a semi-permeable membrane, the water will flow from the "less negative" environment to the "more negative" environment.

Therefore, the net movement of water will occur from Cell B into Cell A until the water potentials of both cells become equal (equilibrium).

Final Answer: The net movement of water will be from Cell B to Cell A.

Answer: (B)

Q9.

Solution

Concept:

The Double Helix model of DNA, proposed by Watson and Crick, describes the physical structure of DNA. It is composed of two polynucleotide chains that are twisted around each other. The structure is held together by specific chemical bonds and follows strict geometric rules.

Solution:

The two polynucleotide chains of DNA run in opposite directions; one is in the $5' \rightarrow 3'$ direction and the other is in the $3' \rightarrow 5'$ direction. This is known as anti-parallel polarity, making statement (i) correct.

The nitrogenous bases of the two strands are paired via hydrogen bonds. According to Chargaff's rules, a purine always pairs with a pyrimidine. Specifically, Adenine pairs with Thymine, and Guanine pairs with Cytosine. This makes statement (ii) correct.

The pitch (one complete turn) of the DNA helix is 3.4 nm (or 34 Å), and there are roughly 10 base pairs in each turn. This makes statement (iii) correct.

Adenine and Thymine are joined by two hydrogen bonds ($A = T$), while Guanine and Cytosine are joined by three hydrogen bonds ($G \equiv C$). Statement (iv) claims Adenine forms three bonds, which is incorrect.

Final Answer: Statements (i), (ii), and (iii) are correct, while (iv) is incorrect.

Answer: (A)

Q10.

Solution

Concept:

Translation is the process of protein synthesis where the genetic information encoded in mRNA is translated into a sequence of amino acids. This process occurs in the cytoplasm and involves ribosomes, tRNA, and various enzymes. It consists of three main stages: initiation, elongation, and termination.

Solution:

The ribosome is the cellular machinery where translation occurs. It consists of two subunits: a large subunit and a small subunit. In their inactive state, these subunits exist separately.

The process of translation begins (Initiation) when the mRNA molecule binds to the small subunit of the ribosome. Specifically, the small subunit recognizes and binds to the $5'$ end of the mRNA and moves along it until it reaches the start codon (AUG).

Once the small subunit is bound to the mRNA and the initiator tRNA has paired with the start codon, the larger subunit then attaches to form a complete functional ribosome.

Therefore, the very first physical interaction that marks the beginning of the translation process is the encounter between the mRNA and the small ribosomal subunit.

Final Answer: Translation begins as soon as the small subunit of the ribosome encounters mRNA.

Answer: (B)

Q11.

Solution

Concept:

Arthropods are characterized by a jointed appendages and a tough external covering known as an exoskeleton. This exoskeleton provides structural support, protection from predators, and prevents desiccation. The primary chemical component of this exoskeleton is chitin, which is a complex carbohydrate.

Solution:

Chitin is a long-chain polymer of N-acetyl glucosamine, which is a derivative of glucose. Because it is composed of a single type of monomeric unit (N-acetyl glucosamine) repeated throughout the chain, it is classified as a homopolysaccharide.

While many biological structures are made of heteropolysaccharides (like hyaluronic acid), chitin's repetitive nature makes it a homopolymer. It is the second most abundant natural polymer on Earth after cellulose.

In arthropods, this chitinous layer is often hardened by the deposition of calcium salts or through a process called sclerotization (cross-linking of proteins), but the base matrix remains the homopolysaccharide chitin.

Final Answer: The chitinous exoskeleton is a homopolysaccharide formed by N-acetyl glucosamine.

Answer: (B)

Q12.

Solution

Concept:

The cell cycle is a regulated process that ensures the faithful duplication and distribution of genetic material. The S-phase, or Synthesis phase, is the most critical period for DNA metabolism within Interphase, occurring between the G_1 and G_2 phases.

Solution:

During the S-phase, DNA replication occurs. If the initial amount of DNA is denoted as $2C$, it becomes $4C$ by the end of this phase. However, it is essential to understand that this doubling of DNA does not involve a change in the number of chromosomes.

Instead of creating new independent chromosomes, each existing chromosome replicates to form two identical sister chromatids which remain attached at the centromere. Therefore, if the cell started with a diploid number ($2n$), it remains $2n$ after the S-phase.

Additionally, in animal cells, the duplication of the centriole begins in the cytoplasm during the S-phase, not in the nucleus.

Final Answer: During S-phase, the amount of DNA doubles, but the chromosome number remains the same.

Answer: (A)

Q13.

Solution

Concept:

This problem involves a dihybrid cross where two traits are considered simultaneously: fruit color and plant height. To find the probability of a specific phenotype in the offspring, we use the principles of Mendelian inheritance and the product rule of probability.

Solution:

We are crossing a parent with genotype $RRTt$ (Red, Tall) and a parent with genotype $rrtt$ (Yellow, Short).

1. For Fruit Color: The cross is $RR \times rr$. All offspring will be Rr. Since Red (R) is dominant over yellow (r), 100% of the offspring will have Red fruits.

2. For Height: The cross is $Tt \times tt$. This is a test cross ratio. The offspring will be 50% Tt (Tall) and 50% tt (Short).

3. Combined Phenotype: We want "Tall plants with red fruits." The probability is: (Probability of Red) $\times$ (Probability of Tall) = 1.0 (Red) $\times$ 0.5 (Tall) = 0.5 or 50%.

Final Answer: The percentage of tall plants with red fruits in the next generation is 50%.

Answer: (B)

Q14.

Solution

Concept:

The genetic code is the set of rules by which information encoded in genetic material is translated into proteins by living cells. It consists of 64 codons, where 61 code for amino acids and 3 serve as stop signals.

Solution:

The genetic code has several key properties: 1. Triplet Nature: Three bases form one codon. 2. Contiguous fashion: The code is read without punctuation. 3. Universal: The same codons generally code for the same amino acids in all organisms. 4. Degeneracy: Some amino acids are coded by more than one codon (e.g., Leucine has six codons).

However, the code is "unambiguous" and "specific," meaning that one particular codon will code for only one specific amino acid. Statement (C) claims "One amino acid is coded by only one codon," which is the definition of a non-degenerate code. Since most amino acids have multiple codons, statement (C) is incorrect.

Final Answer: Statement (C) is incorrect because many amino acids are coded by multiple codons (Degeneracy).

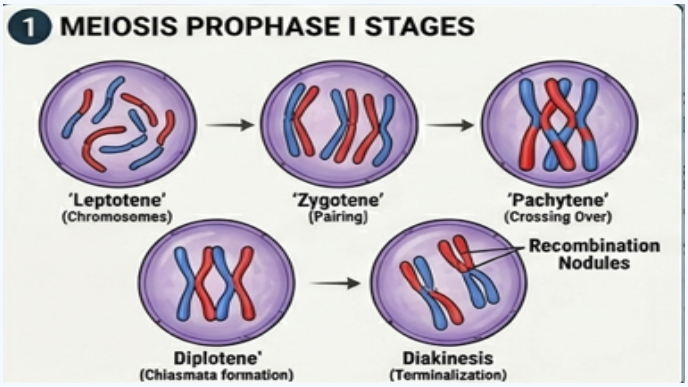
Answer: (C)

Q15.

Solution

Concept:

Meiosis I, specifically Prophase I, is a prolonged and complex phase divided into five substages: Leptotene, Zygotene, Pachytene, Diplotene, and Diakinesis. Each stage is characterized by specific chromosomal behaviors.



Solution:

1. Zygotene: Chromosomes start pairing together, a process called Synapsis, accompanied by the formation of the synaptonemal complex. (a matches ii)

2. Pachytene: This is the stage where "Crossing Over" occurs between non-sister chromatids of homologous chromosomes, mediated by the enzyme recombinase. (b matches i)

3. Diplotene: The synaptonemal complex dissolves, and the homologous chromosomes begin to separate except at the sites of crossovers, making the X-shaped structures called Chiasmata visible. (c matches iv)

4. Diakinesis: This final stage is marked by the terminalisation of chiasmata and the disappearance of the nucleolus. (d matches iii)

Final Answer: The correct match is a-ii, b-i, c-iv, d-iii.

Answer: (A)

Q16.

Solution

Concept:

The cardiac output is the volume of blood pumped by each ventricle of the heart per minute. It is a vital indicator of cardiovascular health and is determined by two primary factors: the Stroke Volume (the amount of blood pumped per beat) and the Heart Rate (the number of beats per minute). The mathematical relationship is expressed as:

$$\text{Cardiac Output} = \text{Stroke Volume} \times \text{Heart Rate}$$

Solution:

Given data: 1. Stroke Volume (SV) = 70 mL per beat. 2. Heart Rate (HR) = 80 beats per minute. Calculation:

$$\text{Cardiac Output} = 70 \text{ mL/beat} \times 80 \text{ beats/min}$$

$$\text{Cardiac Output} = 5600 \text{ mL/min}$$

In a healthy adult, the average cardiac output is approximately 5 Litres per minute. In this specific case, based on the provided parameters, the output is 5.6 Litres or 5600 mL.

Final Answer: The cardiac output is 5600 mL.

Answer: (B)

Q17.

Solution

Concept:

The transport of oxygen in the blood occurs primarily through the formation of oxyhaemoglobin. This is a reversible process that depends on several physico-chemical factors. The binding of oxygen to haemoglobin occurs in the lungs (alveoli), while its dissociation occurs in the tissues.

Solution:

In the alveoli, where oxygen is taken up by the blood, the conditions are highly favorable for the formation of oxyhaemoglobin. These specific conditions include: 1. High partial pressure of oxygen (pO_2): This drives the loading of oxygen onto haemoglobin. 2. Low partial pressure of carbon dioxide (pCO_2): Reduced CO_2 levels decrease the competition for binding sites. 3. Lower H^+ concentration (Higher pH): Alkaline conditions stabilize the oxyhaemoglobin complex. 4. Lower temperature: High temperatures favor dissociation, while lower temperatures favor binding. Conversely, in the tissues, low pO_2, high pCO_2, high H^+, and higher temperature favor the dissociation of oxygen from haemoglobin.

Final Answer: High pO_2, low pCO_2, less H^+ concentration, and lower temperature favor oxyhaemoglobin formation.

Answer: (A)

Q18.

Solution

Concept:

The pBR322 vector is a widely used plasmid in recombinant DNA technology. It contains several important features including an origin of replication (*ori*), antibiotic resistance genes (amp^R and tet^R), and specific restriction sites for various enzymes. Selective markers like amp^R allow researchers to identify transformed cells.

Solution:

In the pBR322 plasmid: 1. The amp^R gene (ampicillin resistance) contains the restriction sites for the enzymes *PvuI* and *PstI*. 2. The tet^R gene (tetracycline resistance) contains the restriction sites for *BamHI* and *SalI*. 3. If a foreign gene is inserted at the *PstI* site, the ampicillin resistance is lost (insertional inactivation), allowing for the selection of recombinants. 4. The *rop* gene codes for the proteins involved in the replication of the plasmid and contains the *PvuII* site.

Therefore, the restriction sites for *PvuI* and *PstI* are specifically located within the ampicillin resistance gene region.

Final Answer: The restriction sites for Pvu I and Pst I are located within the amp^R gene.

Answer: (A)

Q19.

Solution

Concept:

Energy flow in an ecosystem follows the Laws of Thermodynamics. According to Lindeman's 10% Law, only about 10% of the energy available at a particular trophic level is transferred to the next higher trophic level. The remaining 90% of energy must be accounted for according to the law of conservation of energy.

Solution:

Energy enters an ecosystem through photosynthesis and is passed along the food chain. However, at each step, a significant portion of energy is utilized by the organisms for their own metabolic processes (respiration).

The energy that is not used for growth, reproduction, or passed to the next level is primarily lost as heat to the environment. This heat energy is "low-grade" energy that cannot be reused by the biological system for work or recycled back to the producers. Unlike nutrients, which cycle through an ecosystem, energy flows in a unidirectional manner and eventually dissipates into space as heat.

Final Answer: The energy not used for growth or passed on is lost as heat to the environment.

Answer: (B)

Q20.

Solution

Concept:

The nephron is the functional unit of the kidney, responsible for the removal of waste from the blood. The process of urine formation involves three main steps: ultrafiltration, selective reabsorption, and tubular secretion. Ultrafiltration is a non-selective process that filters the blood under high pressure.

Solution:

Ultrafiltration occurs in the renal corpuscle (also known as the Malpighian body). This structure consists of two parts: 1. The Glomerulus: A tuft of capillaries through which blood flows under high pressure. 2. Bowman's Capsule: A cup-like structure that surrounds the glomerulus and collects the filtrate.

The pressure difference between the afferent and efferent arterioles forces water and small solutes out of the blood and through the three-layered filtration membrane into the lumen of Bowman's capsule. Larger particles like proteins and blood cells remain in the capillaries. Other parts of the nephron, like the PCT and Loop of Henle, are primarily involved in reabsorption and secretion rather than the initial filtration.

Final Answer: Ultrafiltration is performed in the Bowman's capsule and Glomerulus.

Answer: (A)

Q21.

Solution

Concept:

Adrenal insufficiency, or Addison's disease, is a hormonal disorder that occurs when the adrenal glands (located on top of the kidneys) do not produce enough of certain hormones, primarily cortisol and aldosterone. Cortisol helps the body respond to stress and maintain blood glucose, while aldosterone regulates sodium and potassium balance.

Solution:

The deficiency of aldosterone leads to excessive loss of sodium in the urine (hyponatremia) and a corresponding decrease in water retention, which can lead to low blood pressure.

Simultaneously, the lack of cortisol results in impaired gluconeogenesis, leading to low blood sugar levels (hypoglycemia).

Common symptoms also include extreme fatigue, weight loss, and hyperpigmentation (darkening) of the skin.

Options involving high blood sugar or fat accumulation in the face are characteristic of the opposite condition, Cushing's syndrome (excess cortisol). Excessive hair growth (hirsutism) is typically associated with adrenal virilism or PCOS.

Final Answer: The symptoms include low blood sugar and low sodium concentration.

Answer: (A)

Q22.

Solution

Concept:

DNA replication is the biological process of producing two identical replicas of DNA from one original DNA molecule. In 1958, Matthew Meselson and Franklin Stahl performed a landmark experiment to determine whether DNA replication was conservative, semi-conservative, or dispersive.

Solution:

Meselson and Stahl used the bacterium Escherichia coli (E. coli) for their experiments. They grew the bacteria in a medium containing a heavy isotope of nitrogen (^{15}N) so that all the DNA became labeled with heavy nitrogen.

They then transferred the bacteria to a medium with a lighter isotope (^{14}N) and allowed them to replicate. By using cesium chloride (CsCl) density gradient centrifugation, they observed that the DNA in the first generation was of intermediate density, and the second generation contained both intermediate and light DNA.

This provided definitive evidence that each strand of the original DNA molecule serves as a template for a new strand, a process known as semi-conservative replication. While similar experiments were later performed on higher plants (Vicia faba) by Taylor, the "first" proof was in E. coli.

Final Answer: Experimental proof for semi-conservative replication was first shown in Escherichia coli.

Answer: (A)

Q23.

Solution

Concept:

Double fertilization is a unique and defining characteristic of angiosperms (flowering plants). It involves two separate fusion events occurring within the embryo sac after the pollen tube enters the ovule. This process ensures that the plant allocates resources to the endosperm only when an egg is successfully fertilized.

Solution:

The pollen tube releases two male gametes into the cytoplasm of a synergid.

1. Syngamy: One male gamete moves toward the egg cell and fuses with its nucleus, forming a diploid zygote ($2n$), which eventually develops into the embryo.

2. Triple Fusion: The second male gamete moves toward the two polar nuclei located in the central cell and fuses with them. Since this involves the fusion of three haploid nuclei (one male gamete + two polar nuclei), it is called triple fusion.

The result of triple fusion is the formation of a triploid ($3n$) Primary Endosperm Nucleus (PEN). This nucleus subsequently develops into the primary endosperm cell and eventually the endosperm, which provides nourishment to the developing embryo.

Final Answer: Triple fusion results in the formation of the Primary Endosperm Nucleus.

Answer: (B)

Q24.

Solution

Concept:

Recombinant DNA (rDNA) technology, also known as genetic engineering, involves a series of controlled steps to isolate a specific gene of interest and insert it into a host organism to produce a desired protein or trait.

Solution:

The logical sequence of steps in rDNA technology is as follows:

1. Isolation of DNA: Obtaining the genomic DNA from the source organism. 2. Fragmentation: Using restriction endonucleases to cut the DNA into smaller pieces. 3. Selection and Ligation: Choosing the gene of interest and joining it with a vector (like a plasmid) using DNA ligase. 4. Transformation: Inserting the recombinant DNA into a host cell (like E. coli). 5. Culturing: Growing the host cells in a large-scale medium (bioreactor) to produce the product. 6. Extraction and Downstream Processing: Isolating and purifying the final protein or product.

Option (A) accurately reflects this logical flow from the initial source to the final product extraction.

Final Answer: The correct sequence is Isolation → Fragmentation → Ligation → Transformation → Culturing → Extraction.

Answer: (A)

Q25.

Solution

Concept:

Lactation and breastfeeding involve complex hormonal regulation. While several hormones (estrogen, progesterone, prolactin, and oxytocin) contribute to the development of mammary glands and the production of milk, specific hormones are responsible for distinct actions during the nursing process.

Solution:

1. Prolactin: Secreted by the anterior pituitary, it is primarily responsible for the "production" (synthesis) of milk within the mammary alveoli.

2. Oxytocin: Secreted by the posterior pituitary (specifically synthesized in the hypothalamus), it is responsible for the "ejection" or "let-down" of milk.

When the infant suckles at the breast, sensory impulses are sent to the hypothalamus, triggering the release of oxytocin. Oxytocin causes the contraction of the myoepithelial cells surrounding the mammary alveoli, forcing milk into the ducts from which it can be extracted. This is known as the Milk Ejection Reflex. Estrogen and progesterone are more involved in the structural development of the glands during pregnancy.

Final Answer: Oxytocin is the hormone responsible for the Milk Ejection Reflex.

Answer: (B)

Q26.

Solution

Concept:

The respiratory system involves several measurable volumes and capacities that help in assessing pulmonary function. These volumes represent the amount of air moved in or out of the lungs under different conditions. It is physically impossible to empty the lungs completely, as certain structures like the trachea and bronchi must remain inflated to prevent collapse.

Solution:

1. Tidal Volume (TV) is the volume of air inspired or expired during a normal breath. 2. Expiratory Reserve Volume (ERV) is the additional volume of air a person can expire by a forceful expiration. 3. Vital Capacity (VC) is the maximum volume of air a person can breathe in after a forced expiration. 4. Residual Volume (RV) is the volume of air remaining in the lungs even after a maximum forceful expiration.

This residual air stays in the alveoli and respiratory passages to allow for continuous gas exchange between breaths and to prevent the lungs from collapsing entirely. Because it never leaves the lungs, RV cannot be measured directly using simple spirometry.

Final Answer: The volume of air that remains after a forcible expiration is the Residual Volume.

Answer: (B)

Q27.

Solution

Concept:

The Lac Operon is a classic model of gene regulation in prokaryotes, specifically in 'E. coli'. It consists of structural genes ('z', 'y', 'a') and regulatory elements (promoter, operator, and the 'i' gene). The operon is designed to ensure that the enzymes required for lactose metabolism are only produced when lactose is present.

Solution:

The 'i' gene (where 'i' stands for 'inhibitor', not inducer) is a regulatory gene that is expressed constitutively (continuously).

1. Transcription and translation of the 'i' gene produce the Repressor protein. 2. In the absence of an inducer (lactose/allolactose), this Repressor protein binds to the operator region of the operon. 3. This binding physically prevents RNA polymerase from transcribing the structural genes, thus turning the operon "off." 4. When lactose is present, it acts as an inducer, binding to the repressor and changing its shape so it can no longer bind to the operator.

The structural genes 'z', 'y', and 'a' code for β-galactosidase, Permease, and Transacetylase, respectively.

Final Answer: The 'i' gene in the Lac Operon codes for the Repressor.

Answer: (B)

Q28.

Solution

Concept:

The Greenhouse Effect is a natural process that warms the Earth's surface. When the sun's energy reaches the Earth's atmosphere, some of it is reflected back to space and the rest is absorbed and re-radiated by greenhouse gases. Problems arise when human activities increase the concentration of these gases, leading to global warming.

Solution:

Various gases contribute to the greenhouse effect, but they vary in their concentration and impact: 1. Carbon dioxide (CO_2): Responsible for approximately 60% of the human-enhanced greenhouse effect. It is released through burning fossil fuels and deforestation. 2. Methane (CH_4): Responsible for about 20% of the effect, released from rice paddies, livestock, and landfills. 3. Chlorofluorocarbons (CFCs) and Nitrous Oxide (N_2O) contribute smaller percentages (14% and 6% respectively).

While gases like SO_2 cause acid rain and CO is a toxic pollutant, they are not primary "greenhouse gases" involved in global warming in the same way CO_2 and CH_4 are.

Final Answer: The greenhouse effect is mainly caused by CO_2 and CH_4.

Answer: (A)

Q29.

Solution

Concept:

Biodiversity conservation is generally classified into two categories: In-situ (on-site) and Ex-situ (off-site). 1. In-situ conservation protects species in their natural habitat. 2. Ex-situ conservation involves taking organisms out of their natural habitats and placing them in special settings where they can be protected and managed.

Solution:

1. National Parks, Biosphere Reserves, and Sacred Groves are all examples of In-situ conservation because the entire ecosystem is protected where the species naturally reside. 2. Seed Banks, Botanical Gardens, Zoological Parks (Zoos), and Cryopreservation are examples of Ex-situ conservation. 3. In a Seed Bank, seeds of different genetic strains of commercially important or endangered plants are stored in a viable and fertile condition for long periods under controlled temperature and humidity. This is an "off-site" strategy.

Final Answer: Seed Banks are an example of Ex-situ conservation.

Answer: (C)

Q30.

Solution

Concept:

The immune system consists of lymphoid organs where lymphocytes originate, mature, and proliferate. These are categorized into primary and secondary lymphoid organs based on their role in the development of immune cells.

Solution:

1. Primary Lymphoid Organs: These are the sites where immature lymphocytes differentiate into antigen-sensitive lymphocytes. In humans, the primary lymphoid organs are the Bone Marrow and the Thymus. - All blood cells, including B and T lymphocytes, are produced in the bone marrow. - T-lymphocytes then migrate to the thymus for maturation. 2. Secondary Lymphoid Organs: These include the Spleen, Lymph nodes, Tonsils, and Peyer's patches. These are the sites where lymphocytes interact with antigens and undergo proliferation to become effector cells.

Final Answer: The primary lymphoid organs are the Thymus and Bone Marrow.

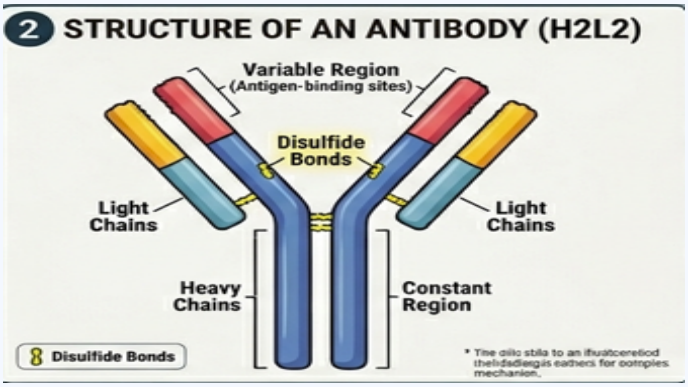
Answer: (B)

Q31.

Solution

Concept:

Antibodies, or immunoglobulins, are Y-shaped glycoprotein molecules produced by B-lymphocytes in response to pathogens. Their structure is highly specific to the antigens they neutralize. A standard antibody molecule (like IgG) is represented by the formula H_2L_2, referring to its polypeptide composition.



Solution:

Each antibody molecule is composed of four polypeptide chains: 1. Two identical heavy (H) chains, which are longer and have a higher molecular weight. 2. Two identical light (L) chains, which are shorter.

These chains are connected to each other by disulfide bonds, forming a stable Y-shaped configuration.

Each chain has a constant region and a variable region. The variable regions are located at the tips of the "Y" arms. It is in these variable regions that the "Antigen-binding sites" (paratopes) are found. Therefore, the binding sites are not in the constant regions as stated in some incorrect options. Statement (A) accurately describes the chain composition.

Final Answer: It consists of four polypeptide chains: two long (heavy) and two short (light).

Answer: (A)

Q32.

Solution

Concept:

The evolution of humans involved several intermediate stages characterized by changes in brain capacity, posture, and tool use. Understanding the chronological order of hominids helps identify the point where ape-like ancestors transitioned into human-like beings.

Solution:

1. 'Australopithecus' lived in East African grasslands and were essentially ape-like but walked upright. 2. 'Homo habilis' followed 'Australopithecus'. He was the first "human-like" being or hominid. His brain capacity was between 650–800 cc. He is often called the "handy man" because he was the first to use tools, and he probably did not eat meat. 3. 'Homo erectus' appeared later, around 1.5 million years ago, with a larger brain (900 cc) and definitely ate meat. 4. 'Neanderthal man' lived much later with a brain size of 1400 cc.

Since 'Homo habilis' is the first species classified under the genus 'Homo', he is recognized as the first human-like hominid.

Final Answer: The first human-like hominid was Homo habilis.

Answer: (A)

Q33.

Solution

Concept:

A dihybrid cross involves the study of the inheritance of two pairs of contrasting traits simultaneously. Mendel's Law of Independent Assortment states that the alleles for different traits are distributed to gametes independently of one another.

Solution:

In Mendel's classic dihybrid cross between a plant with Round Yellow seeds ($RRYY$) and a plant with Wrinkled Green seeds ($rryy$): 1. The F_1 generation is all Round Yellow ($RrYy$). 2. When F_1 plants are self-pollinated, the F_2 generation shows a phenotypic ratio of $9:3:3:1$.

The breakdown is: - $9/16$ are Round Yellow (Parental type) - $3/16$ are Round Green (Recombinant type) - $3/16$ are Wrinkled Yellow (Recombinant type) - $1/16$ are Wrinkled Green (Parental type)

The ratio of the most dominant phenotype (Round Yellow) to the most recessive phenotype (Wrinkled Green) is $9:1$ within the total population of 16 possibilities.

Final Answer: The ratio of round yellow to wrinkled green seeds in the F_2 generation is 9:1.

Answer: (A)

Q34.

Solution

Concept:

An ecosystem is a self-sustaining unit of nature where living organisms interact among themselves and with the surrounding physical environment. To be functional, an ecosystem must perform certain fundamental processes that facilitate the movement of energy and matter.

Solution:

The four main functional units (components) of an ecosystem are: 1. Productivity: The rate of biomass production. 2. Decomposition: The breakdown of complex organic matter into inorganic substances. 3. Energy flow: The unidirectional movement of energy through trophic levels. 4. Nutrient cycling: The movement of nutrient elements through the various components of an ecosystem.

Stratification, however, refers to the vertical distribution of different species occupying different levels in a biotic community (e.g., trees occupy top strata, shrubs the second, and grasses the bottom). While it is a structural feature of many ecosystems (like forests), it is not considered one of the four core "functional units."

Final Answer: Stratification is a structural feature, not a functional unit of an ecosystem.

Answer: (B)

Q35.

Solution

Concept:

Meiosis is a reductional division that occurs in germ cells to produce gametes. Prophase I of Meiosis I is a long phase where genetic recombination occurs, ensuring genetic diversity in offspring. This process is facilitated by specific enzymes.

Solution:

During Prophase I, the stage of Pachytene is particularly significant. At this stage: 1. Bivalent chromosomes clearly appear as tetrads. 2. Recombination nodules appear at the sites where crossing over occurs between non-sister chromatids of homologous chromosomes. 3. Crossing over is an enzyme-mediated process. The enzyme involved is called "recombinase."

Recombinase facilitates the physical exchange of genetic material. The other stages like Zygotene (synapsis), Diplotene (dissolution of synaptonemal complex), and Diakinesis (terminalization of chiasmata) do not involve the primary activity of the recombinase enzyme.

Final Answer: The enzyme recombinase is required at the Pachytene stage.

Answer: (A)

Q36.

Solution

Concept:

Proteins are essential macromolecules synthesized within the cell based on genetic instructions. This synthesis, known as translation, requires a complex molecular machine capable of reading mRNA and linking amino acids in the correct order. In biological systems, the ribosome serves as the primary site for this process.

Solution:

1. Ribosomes are often referred to as the "protein factories" of the cell. They are composed of ribosomal RNA (rRNA) and various proteins. 2. In eukaryotic cells, they can be found floating freely in the cytoplasm or attached to the Rough Endoplasmic Reticulum (RER). 3. Other organelles listed have different primary functions: - The Golgi apparatus is involved in the modification, sorting, and packaging of proteins. - Lysosomes contain digestive enzymes to break down waste. - Mitochondria are the sites of ATP (energy) production. 4. While mitochondria and chloroplasts have their own ribosomes, the ribosome itself is the fundamental unit/factory where the actual chemical synthesis of proteins occurs.

Final Answer: The ribosome is the cellular factory used for the synthesis of proteins.

Answer: (A)

Q37.

Solution

Concept:

Evolutionary biology distinguishes between different patterns of development based on ancestry and environmental pressures. When organisms that are not closely related independently evolve similar traits to adapt to similar environmental needs, it is known as convergent evolution.

Solution:

1. Convergent evolution results in "analogous structures." These are organs that perform the same function and look similar but have different anatomical origins (e.g., the wings of a butterfly and the wings of a bird). 2. Divergent evolution, conversely, occurs when related species evolve different traits (leading to homologous structures like the forelimbs of humans and bats). 3. Adaptive radiation is a type of divergent evolution where a single ancestral species rapidly diversifies into many new forms (e.g., Darwin's finches). 4. Saltation refers to a sudden, large mutation that leads to speciation in a single step, as proposed by Hugo de Vries. 5. Since the question describes unrelated organisms evolving similar phenotypes, the correct term is convergent evolution.

Final Answer: The process is called convergent evolution.

Answer: (A)

Q38.

Solution

Concept:

In Biotechnology, specifically recombinant DNA technology, a "vector" acts as a vehicle. Just as a biological vector (like a mosquito) carries a pathogen to a host, a molecular vector carries a specific piece of DNA into a target cell.

Solution:

1. Vectors are DNA molecules used as a tool to artificially carry foreign genetic material into another cell, where it can be replicated and/or expressed. 2. Common examples of vectors include plasmids (circular DNA found in bacteria) and bacteriophages (viruses that infect bacteria). 3. A good vector must have: - An Origin of Replication (*ori*) so it can replicate within the host. - A Selectable Marker (like antibiotic resistance) to identify transformed cells. - Cloning sites (Recognition sites) for restriction enzymes to insert the DNA. 4. Enzymes that cut DNA are "Restriction Endonucleases," not vectors. The host is the organism receiving the DNA.

Final Answer: Vectors are DNA molecules that can carry a foreign DNA fragment into a host cell.

Answer: (A)

Q39.

Solution

Concept:

The brain is the central control unit of the body, with different regions specialized for specific physiological functions. The maintenance of a stable internal body temperature (homeostasis) is a vital function regulated by the autonomic nervous system.

Solution:

1. The Hypothalamus, located at the base of the brain, acts as the body's "thermostat." It receives input from temperature sensors in the skin and within the brain itself. 2. If the body is too hot, the hypothalamus triggers cooling mechanisms like sweating and vasodilation. If too cold, it triggers shivering and vasoconstriction. 3. Other functions of the hypothalamus include controlling hunger, thirst, and the release of hormones from the pituitary gland. 4. The Cerebellum is for balance and coordination; the Medulla oblongata controls heart rate and respiration; the Corpus callosum connects the two cerebral hemispheres.

Final Answer: The Hypothalamus is the part of the brain responsible for thermoregulation.

Answer: (A)

Q40.

Solution

Concept:

Ecosystems are supported by primary producers that convert inorganic energy into organic biomass. While most terrestrial and shallow-water ecosystems rely on photosynthesis (sunlight), deep-sea hydrothermal vents exist in total darkness where sunlight cannot reach.

Solution:

1. In deep-sea hydrothermal vents, producers utilize "chemosynthesis" instead of photosynthesis. 2. Chemosynthetic bacteria (lithotrophs) oxidize chemical inorganic substances like hydrogen sulfide (H_2S) released from the vents to produce energy. 3. This energy is used to fix carbon into organic matter, forming the base of the deep-sea food web. 4. Phytoplankton and green algae require sunlight, which is absent at these depths. Zooplankton are consumers, not producers.

Final Answer: Chemosynthetic bacteria are the primary producers in deep-sea hydrothermal vent ecosystems.

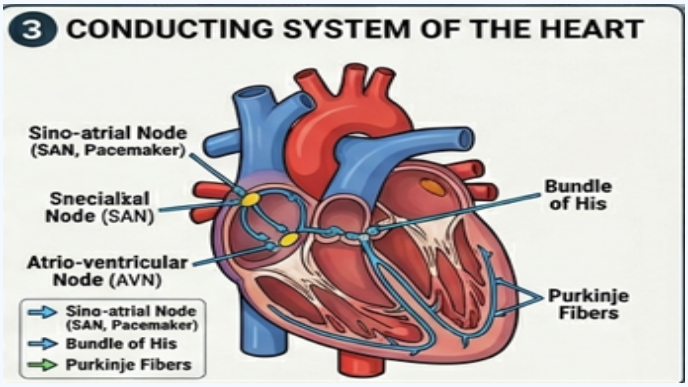
Answer: (A)

Q41.

Solution

Concept:

The human heart is a myogenic organ, meaning the impulse for contraction is generated within the heart muscle itself. This is handled by a specialized system called the nodal tissue. The sequence of electrical activity ensures that the atria and ventricles contract in a coordinated manner to pump blood efficiently.



Solution:

1. The Sino-atrial node (SAN) is located in the upper right corner of the right atrium. It is known as the "Pacemaker" because it generates the initial action potential at the highest rate (70–75 per minute). 2. The impulse travels from the SAN across the atria, causing them to contract, and reaches the Atrio-ventricular node (AVN) located in the lower-left corner of the right atrium. 3. From the AVN, the impulse passes to the AV bundle (Bundle of His), which then splits into right and left bundle branches. 4. These branches give rise to a network of fine fibers called Purkinje fibers throughout the ventricular musculature.

5. The correct path of the impulse is: SAN → AVN → Bundle of His → Purkinje fibers.

Final Answer: The correct pathway is SAN → AVN → Bundle of His → Purkinje fibers.

Answer: (A)

Q42.

Solution

Concept:

DNA fingerprinting is a forensic technique used to identify individuals based on their unique genetic makeup. It relies on the presence of repetitive DNA sequences that do not code for proteins but vary greatly in length and number between individuals.

Solution:

1. The technique of DNA fingerprinting was initially developed by Alec Jeffreys. 2. He used a satellite DNA as a probe that shows a very high degree of polymorphism (variation). 3. These specific sequences are called Variable Number of Tandem Repeats (VNTRs). 4. Because the pattern of VNTRs is unique to every person (except identical twins), they serve as an "identity card" at the molecular level. 5. While SNPs (Single Nucleotide Polymorphisms) and ESTs (Expressed Sequence Tags) are important genomic concepts, VNTRs are the specific basis for the classical DNA fingerprinting method.

Final Answer: The basis of DNA fingerprinting is VNTRs (Variable Number of Tandem Repeats).

Answer: (B)

Q43.

Solution

Concept:

In a population, different species interact in various ways that can be beneficial, harmful, or neutral. These interactions are categorized based on their effect on the fitness of the participating species.

Solution:

1. Mutualism: Both species benefit $(+, +)$. 2. Competition: Both species are harmed $(-, -)$. 3. Parasitism: One species benefits, the other is harmed $(+, -)$. 4. Commensalism: One species benefits, and the other is neither harmed nor benefited $(+, 0)$. 5. Example: An orchid growing as an epiphyte on a mango branch. The orchid gets a place to grow and access to light, while the mango tree is unaffected. 6. Similarly, barnacles on a whale or cattle egrets following grazing cattle are examples where one benefits and the other is neutral.

Final Answer: Commensalism is the interaction where one species benefits and the other is unaffected.

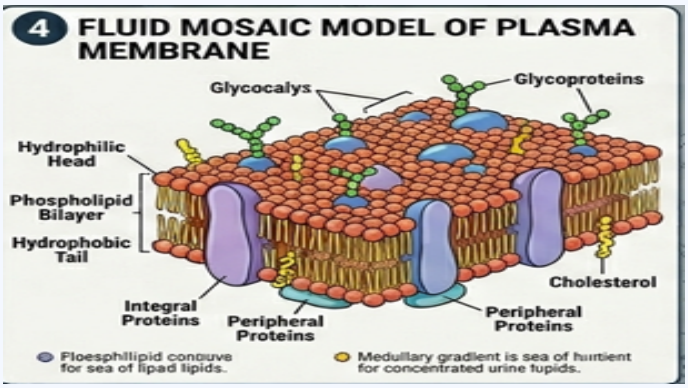
Answer: (A)

Q44.

Solution

Concept:

The structure of the plasma membrane is best explained by the Fluid Mosaic Model proposed by Singer and Nicolson in 1972. It describes the membrane as a dynamic, "sea-like" structure that allows for the lateral movement of molecules.



Solution:

1. The membrane consists of a phospholipid bilayer with embedded proteins. 2. The "fluid" part of the model refers to the quasi-fluid nature of lipids, which enables the lateral movement of proteins within the overall bilayer. 3. This ability to move within the membrane is measured as its "fluidity." 4. Membrane fluidity is crucial for various functions such as cell growth, formation of intercellular junctions, secretion, endocytosis, and cell division. 5. The mosaic part refers to the irregular distribution of proteins (integral and peripheral) within the lipid layer.

Final Answer: The Fluid Mosaic Model of the plasma membrane was proposed by Singer and Nicolson.

Answer: (B)

Q45.

Solution

Concept:

Mendel's Law of Segregation (The Law of Purity of Gametes) describes how alleles are separated during gamete formation. It is one of the most fundamental principles of genetics and explains why recessive traits can reappear in the F_2 generation.

Solution:

1. In a diploid organism, the two alleles for a trait exist together in the somatic cells. 2. When gametes (pollen or eggs) are formed through meiosis, the two alleles separate or "segregate" from each other. 3. Consequently, each gamete receives only one of the two alleles. 4. There is no blending or mixing of alleles; they stay distinct. This is proven by the fact that in a cross between a homozygous tall (TT) and short (tt) plant, the F_1 is tall (Tt), but the F_2 contains both tall and short plants in a 3 : 1 ratio. 5. The segregation ensures that a gamete is always "pure" for a specific trait.

Final Answer: Segregation occurs during the process of gamete formation.

Answer: (A)

Q46.

Solution

Concept:

The human respiratory system uses a pressure gradient to move air in and out of the lungs. Inspiration (breathing in) is an active process that occurs when the pressure within the lungs (intra-pulmonary pressure) is lower than the atmospheric pressure.

Solution:

1. To initiate inspiration, the diaphragm contracts, which increases the volume of the thoracic chamber in the antero-posterior axis. 2. Simultaneously, the external intercostal muscles contract, lifting up the ribs and the sternum, which increases the volume of the thoracic chamber in the dorso-ventral axis.

[Image of the mechanism of breathing showing inspiration and expiration]

3. The overall increase in thoracic volume causes a similar increase in pulmonary volume. 4. According to Boyle's Law, an increase in volume leads to a decrease in pressure. Thus, the intra-pulmonary pressure falls below atmospheric pressure. 5. This negative pressure gradient forces air from outside to rush into the lungs.

Final Answer: Inspiration occurs when there is a negative pressure in the lungs with respect to atmospheric pressure.

Answer: (A)

Q47.

Solution

Concept:

The female gametophyte of angiosperms, also known as the embryo sac, develops from a functional megaspore through a series of mitotic divisions. The most common type of embryo sac is the "Polygonum type," which follows a specific cellular organization.

Solution:

1. The functional megaspore undergoes three successive free-nuclear mitotic divisions. 2. This results in the formation of 8 nuclei. 3. These nuclei then become organized into cells: - Three nuclei move to the micropylar end to form the egg apparatus (one egg cell and two synergids). - Three nuclei move to the chalazal end to form three antipodal cells. - The remaining two nuclei (polar nuclei) move to the center and reside within a large central cell. 4. Consequently, the mature embryo sac contains 7 cells (3 antipodals + 1 central cell + 3 in egg apparatus) but has 8 nuclei because the central cell contains two polar nuclei.

Final Answer: A typical angiosperm embryo sac at maturity is 8-nucleate and 7-celled.

Answer: (C)

Q48.

Solution

Concept:

Secondary metabolites are organic compounds produced by plants, fungi, and microbes that are not directly involved in the normal growth, development, or reproduction of the organism. However, they often play significant roles in defense and ecological interactions.

Solution:

1. Secondary metabolites are classified into various groups such as alkaloids, flavonoids, terpenoids, and lectins. 2. Lectins are specific proteins that bind to carbohydrates. 3. A well-known example of a lectin derived from plants (specifically from the Jack bean) is Concanavalin A. 4. Other categories include: - Pigments: Carotenoids, Anthocyanins. - Alkaloids: Morphine, Codeine. - Terpenoids: Monoterpenes, Diterpenes. - Toxins: Abrin, Ricin. 5. Vinblastine and Curcumin are drugs, while Codeine is an alkaloid. Concanavalin A specifically fits the classification of a lectin.

Final Answer: Concanavalin A is an example of a lectin.

Answer: (C)

Q49.

Solution

Concept:

Active transport is a cellular process used to move molecules or ions across a cell membrane against a concentration gradient (from a region of lower concentration to a region of higher concentration).

Solution:

1. Because active transport moves substances "uphill" (against the gradient), it requires the expenditure of cellular energy, usually in the form of ATP. 2. This process is carried out by specific membrane proteins called "pumps." 3. Characteristics of active transport include: - Selectivity: Only specific molecules are transported. - Saturation: The transport rate reaches a maximum when all protein carriers are being used. - Sensitivity: It can be inhibited by substances that react with protein side chains. 4. Passive transport, such as simple diffusion or facilitated diffusion, does not require energy as it follows the concentration gradient.

Final Answer: Active transport uses energy to pump molecules against a concentration gradient.

Answer: (B)

Q50.

Solution

Concept:

The breakdown of glucose to derive energy occurs through several stages. The first stage is glycolysis, which occurs in the cytoplasm. The subsequent stages, which require oxygen (aerobic respiration), occur within the mitochondria.

Solution:

1. Pyruvate, the end product of glycolysis, is transported from the cytoplasm into the mitochondrial matrix. 2. In the matrix, it undergoes oxidative decarboxylation to form Acetyl CoA. 3. Acetyl CoA then enters the Tricarboxylic Acid (TCA) cycle, also known as the Krebs Cycle. 4. The TCA cycle involves a series of enzymatic reactions that oxidize the acetyl group into CO_2, while reducing NAD^+ and FAD to $NADH$ and $FADH_2$. 5. The enzymes for the Krebs cycle are located in the mitochondrial matrix (except for succinate dehydrogenase, which is on the inner membrane). 6. The inner membrane is the site of the Electron Transport System (ETS) and oxidative phosphorylation.

Final Answer: The enzymes of the TCA cycle (Krebs cycle) are located in the mitochondrial matrix.

Answer: (A)

Q51.

Solution

Concept:

The human endocrine system consists of various glands that secrete hormones directly into the bloodstream to regulate physiological processes. Each hormone has a specific target organ and a unique biological function.

Solution:

1. Insulin: Secreted by the β-cells of the Islets of Langerhans in the pancreas. Its primary role is to lower blood glucose levels by enhancing cellular glucose uptake and stimulating glycogenesis. (a matches ii) 2. Thyroxine: Secreted by the thyroid gland. It is the primary regulator of the Basal Metabolic Rate (BMR) and is essential for physical and mental growth. (b matches iv) 3. Corticoids (Glucocorticoids): Secreted by the adrenal cortex. They are involved in carbohydrate metabolism, anti-inflammatory reactions, and the body's response to chronic stress. (c matches i) 4. Growth Hormone (GH): Secreted by the anterior pituitary gland. It stimulates the growth of bones, cartilage, and muscles. Over-secretion leads to gigantism, while under-secretion leads to dwarfism. (d matches iii)

[Image of the major endocrine glands in the human body]

Matching these results gives the sequence: a-ii, b-iv, c-i, d-iii.

Final Answer: The correct match is a-ii, b-iv, c-i, d-iii.

Answer: (A)

Q52.

Solution

Concept:

Plant hormones, or phytohormones, are small chemical messengers that coordinate various aspects of plant growth and development. They are broadly categorized into growth promoters and growth inhibitors.

Solution:

1. Auxins (e.g., IAA): These are primarily responsible for apical dominance, cell elongation, and root initiation. (a matches iv) 2. Gibberellins (e.g., GA_3): These are known for causing an increase in the length of the axis (bolting) and increasing the size of fruits like grapes. (b matches iii) 3. Cytokinins (e.g., Zeatin): These promote active cell division and are used to delay leaf senescence and overcome apical dominance. (c matches ii) 4. Ethylene: This is a gaseous hormone primarily involved in fruit ripening and promoting abscission of leaves and flowers. (d matches i)

The correct sequence of matching is: a-iv, b-iii, c-ii, d-i.

Final Answer: The correct match is a-iv, b-iii, c-ii, d-i.

Answer: (A)

Q53.

Solution

Concept:

In a food chain, organisms are grouped into trophic levels based on their source of nutrition. Because energy is lost as heat at each transfer, food chains usually have a limited number of levels.

Solution:

A typical grazing food chain in a terrestrial ecosystem follows this pattern: 1. Producers (First Trophic Level): Green plants that fix solar energy (e.g., Grass). 2. Primary Consumers (Second Trophic Level): Herbivores that eat plants (e.g., Grasshopper). 3. Secondary Consumers (Third Trophic Level): Primary carnivores that eat herbivores (e.g., Frog). 4. Tertiary Consumers (Fourth Trophic Level): Secondary carnivores that eat primary carnivores (e.g., Snake). 5. Quaternary Consumers (Fifth Trophic Level): Top carnivores (e.g., Hawk/Eagle).

In this chain, the snake occupies the fourth trophic level as it consumes the frog.

Final Answer: In the given food chain, the snake represents the fourth trophic level.

Answer: (C)

Q54.

Solution

Concept:

Restriction endonucleases are "molecular scissors" used in biotechnology to cut DNA at specific sequences. The naming of these enzymes follows a specific scientific convention derived from the organism of origin.

Solution:

Let's use the enzyme $EcoRI$ as an example: 1. The first letter ('E') represents the Genus of the organism ('Escherichia'). 2. The next two letters ('co') represent the species ('coli'). 3. The fourth letter ('R') represents the specific strain of the bacterium ('RY 13'). 4. The Roman numeral ('I') indicates the order in which the enzyme was isolated from that strain of bacteria.

Therefore, the Roman numerals are not indicative of the cutting site, the concentration, or the molecular weight; they simply denote the chronological order of discovery or isolation.

Final Answer: Roman numerals in restriction enzymes indicate the order in which the enzymes were isolated from the strain of bacteria.

Answer: (C)

Q55.

Solution

Concept:

Global warming is the gradual increase in the average temperature of the Earth's atmosphere and oceans. It is primarily driven by the enhanced greenhouse effect caused by the accumulation of certain gases.

Solution:

Human activities such as burning fossil fuels, industrial processes, and large-scale agriculture have significantly increased the concentrations of: 1. Carbon dioxide (CO_2): The most significant contributor (60%). 2. Methane (CH_4): A potent gas with a higher warming potential than CO_2 (20%). 3. Nitrous oxide (N_2O): Released from fertilizers and industrial activity (6%). 4. Chlorofluorocarbons (CFCs): Used in refrigeration and aerosols (14%).

[Image of the greenhouse effect and global warming]

These gases trap the long-wave (infrared) radiation reflected from the Earth's surface, preventing it from escaping into space, thereby warming the planet. Nitrogen (N_2) and Oxygen (O_2) are not greenhouse gases.

Final Answer: The gases primarily responsible for global warming are CO_2, CH_4, N_2O, and CFCs.

Answer: (B)

Q56.

Solution

Concept:

The human skeletal system is a complex framework of bones and joints that provide structure, protection, and mobility. Joints are classified based on the degree of movement they allow: fibrous (immovable), cartilaginous (limited movement), and synovial (freely movable).

Solution:

1. Ball and Socket Joint: This is a type of synovial joint where the rounded head of one bone fits into the cup-like cavity of another. It allows for the greatest range of motion in all directions. A primary example is the joint between the Humerus (upper arm bone) and the Pectoral Girdle (specifically the glenoid cavity of the scapula). (a matches ii)

2. Hinge Joint: A synovial joint that allows movement primarily in one plane, similar to the hinge of a door. The knee joint and the elbow joint are classic examples. (b matches iv)

3. Pivot Joint: This allows for rotational movement around a single axis. The joint between the first cervical vertebra (Atlas) and the second (Axis) allows the head to turn from side to side. (c matches i)

4. Gliding Joint: Occurs between flat or slightly curved surfaces of bones, allowing them to slide over each other. Examples include the joints between the Carpals in the wrist. (d matches iii)

Matching these gives: a-ii, b-iv, c-i, d-iii.

Final Answer: The correct match is a-ii, b-iv, c-i, d-iii.

Answer: (A)

Q57.

Solution

Concept:

The transport of carbon dioxide (CO_2) in the blood is more complex than oxygen transport because CO_2 is more soluble and can be carried in three distinct forms: dissolved in plasma, as carbamino-haemoglobin, and as bicarbonate ions.

Solution:

1. Dissolved state: About 7% of CO_2 is carried dissolved in the blood plasma. 2. Carbamino-haemoglobin: About 20–25% of CO_2 binds directly to the amine groups of the haemoglobin molecule. 3. Bicarbonate ions (HCO_3^-): The largest portion, approximately 70%, is transported as bicarbonate. - In the Red Blood Cells (RBCs), CO_2 reacts with water to form carbonic acid (H_2CO_3), a reaction catalyzed by the enzyme carbonic anhydrase. - Carbonic acid then dissociates into H^+ and HCO_3^-.

The bicarbonate then diffuses into the plasma. This is the most efficient way to transport the bulk of metabolic CO_2 from tissues to the lungs.

Final Answer: About 70% of CO_2 is transported as bicarbonate ions.

Answer: (C)

Q58.

Solution

Concept:

The endomembrane system of a eukaryotic cell is a group of membranes and organelles that work together to modify, package, and transport lipids and proteins. It includes the nuclear envelope, endoplasmic reticulum, Golgi apparatus, lysosomes, and vacuoles.

Solution:

1. Endoplasmic Reticulum (ER): Specifically, the Rough ER is the site of protein synthesis, while the Smooth ER is the site of lipid synthesis. 2. Golgi Apparatus: Acts as the "packaging and shipping center." It modifies proteins and lipids received from the ER and packages them into vesicles for delivery to their destinations. 3. Lysosomes: Membrane-bound sacs filled with hydrolytic enzymes used for intracellular digestion (breaking down waste). 4. Vacuoles: Primarily used for storage of water, sap, and waste products; in plant cells, they maintain turgor pressure.

Organelles like Mitochondria, Chloroplasts, and Peroxisomes are not part of the endomembrane system because their functions are not coordinated with the organelles mentioned above.

Final Answer: The endomembrane system includes the ER, Golgi complex, Lysosomes, and Vacuoles.

Answer: (B)

Q59.

Solution

Concept:

Transcription is the process by which the information in a strand of DNA is copied into a new molecule of messenger RNA (mRNA). This process is mediated by the enzyme RNA polymerase and occurs in three distinct stages: Initiation, Elongation, and Termination.

Solution:

1. Initiation: RNA polymerase binds to the promoter region of the DNA. This requires a specific initiation factor called the Sigma factor (σ). 2. Elongation: The RNA polymerase moves along the template strand, synthesizing the RNA chain. 3. Termination: When the enzyme reaches the terminator sequence, the process stops, and the nascent RNA is released. This stage requires a termination factor called the Rho factor (ρ).

The core enzyme (RNA polymerase) is capable of elongation on its own, but it requires the Sigma factor to specifically recognize the start site and the Rho factor to recognize the stop site.

Final Answer: The Sigma factor and Rho factor are required for initiation and termination of transcription, respectively.

Answer: (A)

Q60.

Solution

Concept:

Secondary growth in dicotyledonous plants results in an increase in the girth (thickness) of the stem and roots. This is made possible by the activity of lateral meristems: the vascular cambium and the cork cambium.

Solution:

1. Vascular Cambium: It produces secondary xylem (wood) toward the inside and secondary phloem toward the outside. 2. Cork Cambium (Phellogen): As the stem increases in thickness, the outer cortical and epidermis layers break. To replace them, the cork cambium develops in the cortex. - The Phellogen cuts off cells on both sides. - The outer cells differentiate into Cork (Phellem), which is suberized and waterproof. - The inner cells differentiate into Secondary Cortex (Phelloderm). 3. Collectively, these three layers—Phellem, Phellogen, and Phelloderm—are known as the Periderm.

Final Answer: Phellogen, Phellem, and Phelloderm are collectively known as the Periderm.

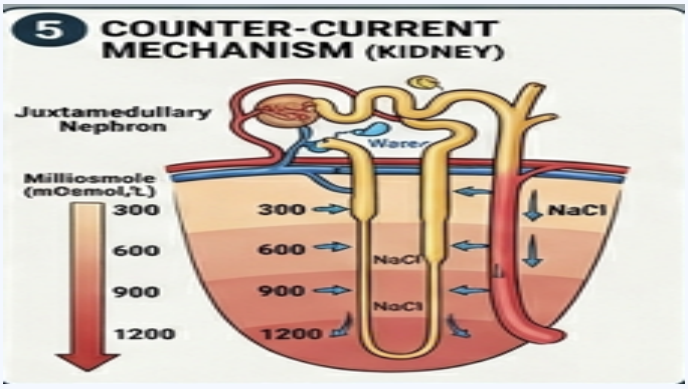
Answer: (B)

Q61.

Solution

Concept:

Human urine formation and its subsequent concentration are vital for maintaining water balance (homeostasis). This process relies on the specialized anatomy of the juxtamedullary nephrons, specifically the long loops of Henle and the vasa recta, which work together through a mechanism called the counter-current multiplier system.



Solution:

1. The gradient in the renal medulla is created by the transport of sodium chloride ($NaCl$) and urea. 2. The ascending limb of the loop of Henle transports $NaCl$ into the interstitial fluid, while the descending limb is permeable to water but not to electrolytes. 3. This creates an increasing osmolarity from the cortex (300 mOsmol/L) to the inner medulla (1200 mOsmol/L). 4. The proximity of the vasa recta (a capillary network) allows it to pick up the reabsorbed water and return it to the general circulation, maintaining the medullary gradient.

5. As the dilute filtrate passes through the collecting duct in the presence of Antidiuretic Hormone (ADH), water is drawn out into the highly concentrated medullary interstitium. 6. This allows humans to produce urine that is nearly four times more concentrated than the initial filtrate.

Final Answer: The counter-current mechanism between the loop of Henle and vasa recta helps in the concentration of urine.

Answer: (A)

Q62.

Solution

Concept:

Aleurone grains are specialized storage organelles found in the outermost layer of the endosperm in many cereal grains. This layer is crucial for the mobilization of nutrients during seed germination, as it responds to hormonal signals by producing enzymes like α-amylase.

Solution:

1. The endosperm is the primary food storage tissue in seeds, particularly in monocots like maize and wheat. 2. The aleurone layer is the protein-rich layer that surrounds the starchy endosperm. 3. Because the endosperm is formed through triple fusion (the fusion of one male gamete with two polar nuclei), the cells of the endosperm—and consequently the aleurone layer—are triploid ($3n$). 4. The primary function of aleurone grains is to store protein, which will be broken down into amino acids to support the growing embryo once the seed begins to sprout.

Final Answer: Aleurone grains are mainly involved in the storage of proteins.

Answer: (B)

Q63.

Solution

Concept:

Ecological succession is the process of change in the species structure of an ecological community over time. It can be primary (starting on bare rock) or secondary (after a disturbance like a fire). The ultimate goal is the establishment of a stable, self-perpetuating community.

Solution:

1. Pioneer Species: These are the first organisms to colonize a bare area. On bare rock (lithosere), lichens and mosses are usually the pioneers as they can weather the rock and form soil. 2. Seral Stages (Seres): These are the intermediate developmental stages that follow the pioneers (e.g., grasses, shrubs, then small trees). 3. Climax Community: This is the final, stable stage of succession that is in near equilibrium with the environmental conditions of the area. It does not change significantly unless the environment itself changes.

4. The entire sequence of communities that successively change in a given area is called a "sere."

Final Answer: The final stable community in an ecological succession is the Climax Community.

Answer: (B)

Q64.

Solution

Concept:

Mendel's work on pea plants established several laws of inheritance. However, many exceptions to these laws have since been discovered. Pleiotropy and Polygenic Inheritance are two phenomena where the relationship between genes and phenotypes is more complex than "one gene, one trait."

Solution:

1. Pleiotropy: This occurs when a single gene mutation has multiple, seemingly unrelated phenotypic effects. A classic example is Phenylketonuria (PKU) or Sickle-cell anemia, where one genetic defect affects multiple organ systems. 2. Polygenic Inheritance: This occurs when a single trait is controlled by two or more genes. Examples include human skin color and height. 3. Co-dominance: Occurs when both alleles are expressed equally in the phenotype (e.g., AB blood group). 4. Epistasis: When one gene masks or interferes with the expression of another gene. 5. Given the question asks for a single gene influencing many traits, the answer is pleiotropy.

Final Answer: The phenomenon where a single gene can exhibit multiple phenotypic expressions is called pleiotropy.

Answer: (A)

Q65.

Solution

Concept:

The human skeletal system is divided into the axial skeleton (central axis) and the appendicular skeleton (limbs and girdles). The axial skeleton provides protection for the vital organs of the head, neck, and trunk.

Solution:

1. The axial skeleton consists of 80 bones distributed along the main axis of the body. 2. It includes: - The Skull (22 bones + 6 ear ossicles + 1 hyoid bone). - The Vertebral Column (26 serially arranged units called vertebrae). - The Ribs (12 pairs of bones forming the cage). - The Sternum (a flat bone on the ventral midline of the thorax). 3. The Pectoral girdle, Pelvic girdle, and the bones of the arms and legs are part of the appendicular skeleton.

Final Answer: The axial skeleton includes the Skull, Vertebral column, Ribs, and Sternum.

Answer: (A)

Q66.

Solution

Concept:

The human circulatory system is "closed," meaning blood is pumped by a muscular heart through a continuous network of vessels. The blood travels through the heart twice for every one complete circuit of the body, a process known as double circulation.

Solution:

Double circulation consists of two distinct loops: 1. Pulmonary Circulation: Deoxygenated blood from the right ventricle is pumped to the lungs via the pulmonary artery. After oxygenation, the blood returns to the left atrium via pulmonary veins. 2. Systemic Circulation: Oxygenated blood from the left ventricle is pumped through the aorta to all body tissues. Deoxygenated blood then returns to the right atrium via the vena cava.

This separation prevents the mixing of oxygenated and deoxygenated blood, allowing for a highly efficient supply of oxygen to the body, which is essential for maintaining the high metabolic rate of endothermic organisms like humans.

Final Answer: The process by which blood flows through the heart twice in one complete cycle is called double circulation.

Answer: (B)

Q67.

Solution

Concept:

The Five Kingdom classification, proposed by R.H. Whittaker in 1969, revolutionized biological taxonomy. It moved away from the simple two-kingdom system by using more sophisticated criteria to group life forms.

Solution:

The main criteria used by Whittaker for classification were: 1. Complexity of cell structure: Distinguishing between Prokaryotic and Eukaryotic organisms. 2. Complexity of organisms: Distinguishing between Unicellular and Multicellular forms. 3. Mode of nutrition: This was a major criterion, separating Autotrophic (plants), Absorptive Heterotrophic (fungi), and Ingestive Heterotrophic (animals). 4. Phylogenetic relationships: Evolutionary history of the organisms. 5. Reproduction: The method by which organisms produce offspring.

Whittaker did not use the "presence or absence of a well-defined nucleus" as a standalone primary criterion in the way cell complexity or nutrition were applied across all five kingdoms.

Final Answer: The main criteria included cell structure, body organization, mode of nutrition, and phylogenetic relationships.

Answer: (A)

Q68.

Solution

Concept:

The male reproductive system includes the testes, which are responsible for producing sperm and male sex hormones. Because sperm production (spermatogenesis) is highly sensitive to temperature, the testes are located in a specific position outside the main body cavity.

Solution:

1. The testes are situated outside the abdominal cavity within a pouch called the scrotum. 2. The primary biological reason for this is temperature regulation. 3. Spermatogenesis requires a temperature that is 2–2.5°C lower than the normal internal body temperature (37°C). 4. If the testes were located inside the abdomen, the higher temperature would inhibit the maturation of sperm, leading to infertility. 5. In some animals, the testes only descend into the scrotum during the breeding season, but in humans, this occurs during fetal development.

Final Answer: The scrotum helps in maintaining the low temperature of the testes necessary for spermatogenesis.

Answer: (A)

Q69.

Solution

Concept:

In addition to the primary respiratory and digestive organs, the human body utilizes several accessory organs for excretion. While the kidneys are the main excretory organs, the skin, lungs, and liver also play crucial roles in removing metabolic wastes.

Solution:

1. Lungs: Remove large amounts of CO_2 (approximately 18 L/day) and significant quantities of water vapor. 2. Liver: The largest gland in the body. It excretes bile-containing substances like bilirubin, biliverdin, cholesterol, degraded steroid hormones, vitamins, and drugs. These are eventually eliminated through the digestive tract. 3. Skin: Contains sweat glands and sebaceous glands. - Sweat helps in cooling the body and removes small amounts of urea, $NaCl$, and lactic acid. - Sebaceous glands eliminate certain substances like sterols, hydrocarbons, and waxes through sebum. 4. Pancreas: Primarily an endocrine and digestive gland; it does not have a major role in waste excretion.

Final Answer: The accessory excretory organs include the lungs, liver, and skin.

Answer: (B)

Q70.

Solution

Concept:

Meiosis II is essentially an equational division, similar to mitosis, where the sister chromatids of each chromosome are separated into different daughter cells. This process occurs in four stages: Prophase II, Metaphase II, Anaphase II, and Telophase II.

Solution:

1. Prophase II: The nuclear membrane disappears and chromosomes condense. 2. Metaphase II: Chromosomes align at the equator, and microtubules from opposite poles of the spindle attach to the kinetochores of sister chromatids. 3. Anaphase II: This is the critical step where the centromere of each chromosome splits simultaneously. The sister chromatids (now called chromosomes for the future daughter cells) are pulled toward opposite poles.

4. Telophase II: Nuclear envelopes reform around the four haploid sets of chromosomes. 5. In Meiosis I (Anaphase I), the homologous chromosomes separate, but the sister chromatids remain attached at their centromeres. The centromere splitting is unique to Anaphase II.

Final Answer: Splitting of centromeres and separation of sister chromatids occur during Anaphase II.

Answer: (C)

Q71.

Solution

Concept:

The human respiratory system involves specific volumes of air that can be measured to assess lung function. These are known as respiratory volumes and capacities. Two of these, Inspiratory Capacity (IC) and Expiratory Capacity (EC), describe the total volume of air a person can breathe in or out after a normal respiratory event.

Solution:

1. Tidal Volume (TV) is the volume of air inspired or expired during a normal, relaxed breath (approximately 500 mL). 2. Inspiratory Reserve Volume (IRV) is the additional volume of air that can be inspired forcefully after a normal inspiration. 3. Expiratory Reserve Volume (ERV) is the additional volume of air that can be expired forcefully after a normal expiration. 4. Inspiratory Capacity (IC) is defined as the total volume of air a person can inspire after a normal expiration. Mathematically, it is the sum of Tidal Volume and Inspiratory Reserve Volume ($IC = TV + IRV$).

5. Expiratory Capacity (EC) is the total volume of air a person can expire after a normal inspiration. It is the sum of Tidal Volume and Expiratory Reserve Volume ($EC = TV + ERV$).

Final Answer: Inspiratory Capacity (IC) is equal to $TV + IRV$.

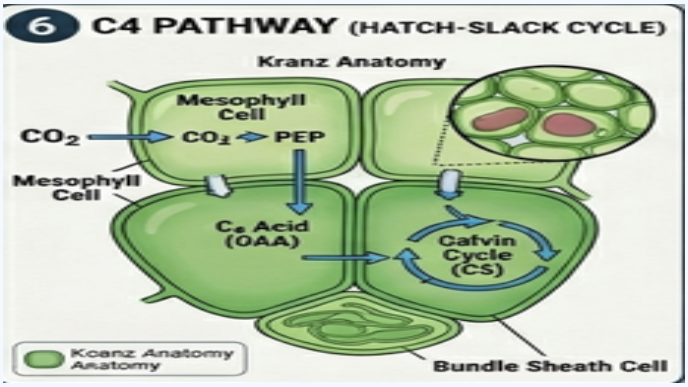
Answer: (A)

Q72.

Solution

Concept:

Aleurone cells form the outermost layer of the endosperm in cereal grains like maize and barley. This layer is biologically significant because it secretes enzymes during germination. Since the endosperm in angiosperms is a product of triple fusion, its ploidy differs from the rest of the plant body.



Solution:

1. In angiosperms, the plant body (roots, leaves, stems) is diploid ($2n$). 2. During double fertilization, one male gamete (n) fuses with the egg (n) to form a zygote ($2n$). 3. Simultaneously, the second male gamete (n) fuses with two polar nuclei ($n + n$) in the central cell to form the Primary Endosperm Nucleus (PEN). 4. Since three haploid nuclei fuse, the resulting endosperm tissue is triploid ($3n$). 5. Because the aleurone layer is the peripheral part of this endosperm, its cells are also triploid ($3n$). 6. If a plant has $2n = 20$ chromosomes, its aleurone cells would have 30 chromosomes.

Final Answer: The cells of the aleurone layer are triploid ($3n$).

Answer: (C)

Q73.

Solution

Concept:

The primary role of the large intestine in the human digestive system is not the digestion of food, as most chemical digestion is completed in the small intestine. Instead, the large intestine focuses on the final processing of undigested matter and the conservation of resources.

Solution:

The functions of the large intestine include: 1. Absorption: It absorbs water, some minerals, and certain drugs from the undigested food residue. 2. Secretion of Mucus: The lining secretes mucus which helps in adhering the waste (undigested) particles together and lubricating them for easy passage. 3. Storage: It temporarily stores fecal matter in the rectum before defecation. 4. Microbial Activity: It houses symbiotic bacteria that synthesize certain vitamins (like Vitamin K and some B vitamins). 5. It does not secrete digestive enzymes like amylase, lipase, or proteases; therefore, no significant digestive activity occurs here.

Final Answer: The large intestine is mainly involved in the absorption of water and minerals and the secretion of mucus.

Answer: (B)

Q74.

Solution

Concept:

In the C_4 pathway (Hatch-Slack pathway), plants have evolved a specialized leaf anatomy called "Kranz anatomy" to minimize photorespiration. This process involves a spatial separation of CO_2 fixation between two types of cells: mesophyll cells and bundle sheath cells.

Solution:

1. Primary CO_2 Fixation: Occurs in the mesophyll cells. 2. The atmospheric CO_2 is accepted by a 3-carbon molecule called Phosphoenolpyruvate (PEP). 3. This reaction is catalyzed by the enzyme PEP carboxylase (PEPcase). 4. The result is a 4-carbon compound, Oxaloacetic acid (OAA), which gives the C_4 pathway its name. 5. RuBisCO is absent in mesophyll cells of C_4 plants but present in the bundle sheath cells, where the actual Calvin cycle takes place after decarboxylation of the C_4 acids.

Final Answer: In C_4 plants, the primary CO_2 acceptor is PEP and it is found in mesophyll cells.

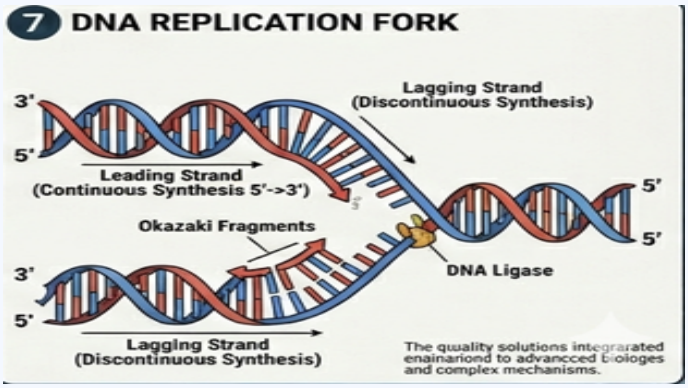
Answer: (B)

Q75.

Solution

Concept:

DNA replication is "semi-discontinuous" because the two strands of the DNA double helix are antiparallel ($5' \rightarrow 3'$ and $3' \rightarrow 5'$), but the enzyme DNA polymerase can only add nucleotides in one direction: $5'$ to $3'$.



Solution:

1. As the replication fork opens, one template strand (the $3' \rightarrow 5'$ strand) allows for continuous synthesis of a new strand in the $5' \rightarrow 3'$ direction. This is called the "leading strand." 2. The other template strand (the $5' \rightarrow 3'$ strand) requires the DNA polymerase to work away from the replication fork. 3. Synthesis on this strand occurs in small, disconnected fragments known as "Okazaki fragments." This is called the "lagging strand." 4. To create a continuous DNA molecule, these fragments must be joined together. This is performed by the enzyme DNA ligase, which facilitates the formation of a phosphodiester bond between the fragments.

Final Answer: DNA ligase is the enzyme used to join the discontinued fragments (Okazaki fragments) of DNA.

Answer: (A)

Q76.

Solution

Concept:

The human circulatory system is characterized by "double circulation," where blood passes through the heart twice to complete one full circuit of the body. To maintain this directional flow and prevent backflow, the heart is equipped with a set of specialized valves.

Solution:

1. Tricuspid Valve: Located between the right atrium and the right ventricle. It consists of three muscular flaps or cusps. (a matches iii) 2. Bicuspid (Mitral) Valve: Located between the left atrium and the left ventricle. It ensures that oxygenated blood flows into the ventricle and not back into the atrium during contraction. (b matches i) 3. Semilunar Valves: Located at the base of the pulmonary artery (right side) and the aorta (left side). They prevent blood from flowing back into the ventricles once it has been pumped out into the great vessels. (c matches ii)

Matching these specific locations results in the sequence: a-iii, b-i, c-ii.

Final Answer: The correct match is a-iii, b-i, c-ii.

Answer: (A)

Q77.

Solution

Concept:

Transcription is the process of copying a segment of DNA into RNA. A transcription unit in DNA is defined primarily by three regions: a promoter, the structural gene, and a terminator. The convention for naming the strands of DNA is based on their polarity and their relationship to the synthesized RNA.

Solution:

1. Template Strand: The DNA strand that has $3' \rightarrow 5'$ polarity. It acts as a template for RNA synthesis. 2. Coding Strand: The DNA strand that has $5' \rightarrow 3'$ polarity. Surprisingly, this strand does not code for anything; however, its sequence is identical to the synthesized RNA (except for Thymine being replaced by Uracil). 3. All reference points for defining the regions of a transcription unit are made with respect to the coding strand. 4. The "Promoter" is a DNA sequence that provides a binding site for RNA polymerase. It is located toward the $5'$-end (upstream) of the structural gene (with reference to the coding strand).

Final Answer: The promoter is located toward the 5'-end of the structural gene.

Answer: (A)

Q78.

Solution

Concept:

The human skeletal system is made of bones and cartilage. While bones are hard due to calcium salts, cartilage has a slightly pliable matrix due to chondroitin salts. Specialized structures called "ribs" form a protective cage around the thoracic organs.

Solution:

Humans have 12 pairs of ribs, categorized into three types based on their ventral attachment: 1. True Ribs (1st to 7th pairs): These are attached dorsally to the thoracic vertebrae and ventrally to the sternum via hyaline cartilage. 2. Vertebrochondral (False) Ribs (8th, 9th, and 10th pairs): These do not attach directly to the sternum. Instead, they join the seventh rib with the help of hyaline cartilage. 3. Floating Ribs (11th and 12th pairs): These are not attached ventrally at all, hence the name "floating."

Therefore, the 8th, 9th, and 10th pairs of ribs are specifically known as false ribs or vertebrochondral ribs.

Final Answer: The 8th, 9th, and 10th pairs of ribs are known as vertebrochondral ribs.

Answer: (B)

Q79.

Solution

Concept:

Oogenesis is the process of formation of a mature female gamete. Unlike spermatogenesis, which begins at puberty, oogenesis is initiated during the embryonic development stage.

Solution:

1. During fetal development, a couple of million gamete mother cells (oogonia) are formed within each fetal ovary. No more oogonia are formed or added after birth. 2. These cells start division and enter prophase-I of meiotic division and get temporarily arrested at that stage. These are called primary oocytes. 3. Each primary oocyte then gets surrounded by a layer of granulosa cells and is called a primary follicle. 4. A large number of these follicles degenerate during the phase from birth to puberty. 5. At puberty, only $60,000$–$80,000$ primary follicles are left in each ovary.

Final Answer: At puberty, only 60,000 to 80,000 primary follicles are left in each ovary.

Answer: (B)

Q80.

Solution

Concept:

The nitrogen cycle is a critical biogeochemical cycle that converts atmospheric nitrogen into forms usable by living organisms. Nitrogen fixation is the first step, where atmospheric N_2 is converted into ammonia (NH_3).

Solution:

1. Biological nitrogen fixation is carried out by specific prokaryotes (bacteria and cyanobacteria) that contain the enzyme "nitrogenase." 2. Free-living nitrogen fixers: These live independently in the soil. Examples include 'Azotobacter' and 'Beijerinckia' (aerobic), and 'Rhodospirillum' (anaerobic). 3. Symbiotic nitrogen fixers: These live in association with plants. - 'Rhizobium' has a symbiotic relationship with the roots of leguminous plants (like alfalfa, sweet pea, lentils). - 'Frankia' also produces nitrogen-fixing nodules, but it does so on the roots of non-leguminous plants, such as 'Alnus' (Alder).

Final Answer: Frankia is a nitrogen-fixer that forms symbiotic nodules on the roots of Alnus.

Answer: (A)

Q81.

Solution

Concept:

Taxonomy is the branch of science dealing with the classification of organisms. A "Taxon" (plural: taxa) represents a unit of classification at any level of the hierarchy (e.g., species, genus, family, order, class, phylum, or kingdom).

Solution:

1. To classify an organism, it is assigned to a specific rank in the taxonomic hierarchy. 2. For example, 'Mammalia' is a taxon at the Class level, while 'Chordata' is a taxon at the Phylum level. 3. 'Species' is the basic unit of classification and refers to a group of individual organisms with fundamental similarities. 4. 'Genus' comprises a group of related species which has more characters in common in comparison to species of other genera. 5. In the binomial nomenclature system, the first word represents the Genus and the second word represents the Specific Epithet.

Final Answer: A taxon is a taxonomic group of any ranking.

Answer: (C)

Q82.

Solution

Concept:

Human digestion involves the mechanical and chemical breakdown of food. Chemical digestion is carried out by enzymes secreted by various glands along the alimentary canal. Proteins are complex molecules that require specific proteolytic enzymes for their breakdown.

Solution:

1. Protein digestion begins in the stomach, where the proenzyme pepsinogen is converted into the active enzyme pepsin by hydrochloric acid (HCl). 2. As the partially digested food (chyme) enters the small intestine, it meets pancreatic juice, which contains three major inactive proteolytic enzymes: trypsinogen, chymotrypsinogen, and procarboxypeptidases. 3. Trypsinogen is activated into "trypsin" by an enzyme called enterokinase, which is secreted by the intestinal mucosa. 4. Once formed, trypsin activates the other two enzymes (chymotrypsin and carboxypeptidase). 5. These enzymes work together to break down proteins, peptones, and proteoses into dipeptides.

Final Answer: The inactive enzymes in pancreatic juice are trypsinogen, chymotrypsinogen, and procarboxypeptidases.

Answer: (B)

Q83.

Solution

Concept:

Plant tissues are categorized into meristematic and permanent tissues. Permanent tissues consist of cells that have lost the ability to divide and have attained a definite shape and function. These are further divided into simple (one type of cell) and complex (multiple types of cells).

Solution:

The three main types of simple permanent tissues are: 1. Parenchyma: Living cells with thin walls, involved in storage, photosynthesis, and secretion. 2. Collenchyma: Living cells with walls thickened at the corners (due to cellulose, hemicellulose, and pectin); they provide mechanical support to growing parts of the plant. 3. Sclerenchyma: Dead cells with highly thickened, lignified walls; they provide structural strength.

Xylem and Phloem are "Complex Permanent Tissues" because they consist of several types of cells (e.g., xylem contains tracheids, vessels, xylem parenchyma, and xylem fibers) that work together as a unit to conduct water and food.

Final Answer: Xylem and Phloem are examples of complex permanent tissues.

Answer: (B)

Q84.

Solution

Concept:

The human ear is a sophisticated organ responsible for both hearing and the maintenance of body balance (equilibrium). It is divided into the outer, middle, and inner ear.

Solution:

The inner ear contains the "Vestibular Apparatus," which is the organ of balance. It consists of: 1. Three Semicircular Canals: These are oriented in three different planes to detect rotational movement of the head. 2. Otolith Organs (Saccule and Utricle): These contain specialized sensory receptors called "maculae" that detect linear acceleration and the position of the head relative to gravity (static equilibrium). 3. The Cochlea, another part of the inner ear, is responsible for hearing (auditory function) but not for balance. 4. The Eustachian tube in the middle ear equalizes pressure on either side of the eardrum.

Final Answer: The vestibular apparatus is responsible for the maintenance of body balance and posture.

Answer: (A)

Q85.

Solution

Concept:

In an ecosystem, the number, biomass, and energy of organisms at different trophic levels can be represented graphically as "Ecological Pyramids." While many pyramids are upright (narrowing toward the top), there are specific exceptions depending on the ecosystem type.

Solution:

1. Pyramid of Number: Usually upright, but can be inverted in a parasitic food chain (e.g., many birds on a single tree). 2. Pyramid of Biomass: Usually upright in terrestrial ecosystems. However, in an aquatic (marine) ecosystem, the pyramid of biomass is often "inverted." This is because the biomass of the consumers (fishes) far exceeds the biomass of the producers (phytoplankton) at any given time, due to the high turnover rate of the small producers. 3. Pyramid of Energy: This pyramid is "always upright." According to the laws of thermodynamics, energy is lost as heat at every trophic transfer, so the energy available at a higher level can never exceed that of a lower level.

Final Answer: In a marine ecosystem, the pyramid of biomass is generally inverted.

Answer: (B)

Q86.

Solution

Concept:

Human blood is classified into different groups based on the presence or absence of specific surface antigens on the Red Blood Cells (RBCs). The most widely used system is the ABO blood grouping system, which was discovered by Karl Landsteiner.

Solution:

The ABO system is determined by two antigens (A and B) on the RBCs and two corresponding antibodies (anti-A and anti-B) in the plasma: 1. Blood Group A: Has antigen A and anti-B antibodies. 2. Blood Group B: Has antigen B and anti-A antibodies. 3. Blood Group AB: Has both antigens A and B, but no antibodies in the plasma. This makes them "Universal Recipients." 4. Blood Group O: Has no antigens on the RBCs, but contains both anti-A and anti-B antibodies in the plasma. Because it lacks antigens that could be attacked by a recipient's antibodies, Group O (specifically O negative) is the "Universal Donor."

Final Answer: Individuals with blood group O are called universal donors because their RBCs lack A and B antigens.

Answer: (B)

Q87.

Solution

Concept:

Respiration in plants and animals involves the oxidation of organic molecules to release energy. The "Respiratory Quotient" (RQ) is a dimensionless number used to determine which type of substrate (carbohydrate, fat, or protein) is being metabolized.

Solution:

The RQ is defined by the following ratio:

$$RQ = \frac{\text{Volume of } CO_2 \text{ evolved}}{\text{Volume of } O_2 \text{ consumed}}$$

The value of RQ depends on the chemical composition of the substrate: 1. Carbohydrates: The RQ is 1.0 because the volume of CO_2 produced equals the O_2 consumed ($C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$). 2. Fats: The RQ is less than 1.0 (typically around 0.7) because fats are oxygen-poor and require more external O_2 for oxidation. 3. Proteins: The RQ is approximately 0.9. 4. Organic Acids: The RQ is greater than 1.0.

Final Answer: The Respiratory Quotient (RQ) for carbohydrates is 1.0.

Answer: (A)

Q88.

Solution

Concept:

The cell membrane is a semi-permeable barrier that regulates the entry and exit of substances. One of the most important active transport mechanisms in animal cells is the Sodium-Potassium (Na^+/K^+) Pump, which maintains the electrochemical gradient across the plasma membrane.

Solution:

1. The Na^+/K^+ Pump is an electrogenic transmembrane ATPase. 2. For every cycle of the pump, it uses the energy from one molecule of ATP to: - Pump three Na^+ ions "out" of the cell. - Pump two K^+ ions "into" the cell. 3. Both ions are moved against their respective concentration gradients. 4. This process is crucial for maintaining the resting membrane potential in neurons and for regulating cell volume. 5. Since it uses ATP directly, it is an example of primary active transport.

Final Answer: The Na^+/K^+ pump transports three Na^+ out and two K^+ into the cell using ATP.

Answer: (B)

Q89.

Solution

Concept:

Amniocentesis is a medical procedure used primarily for prenatal diagnosis of chromosomal abnormalities and fetal infections. While it is a valuable diagnostic tool, its misuse for fetal sex determination has led to legal restrictions in several countries.

Solution:

1. The procedure involves taking a small sample of amniotic fluid, which contains fetal cells. 2. These cells are cultured and their chromosomes are analyzed (Karyotyping). 3. It can detect genetic disorders such as: - Down Syndrome (Trisomy 21). - Hemophilia. - Sickle-cell anemia. 4. It can also determine the sex of the fetus by looking for the presence of X or Y chromosomes. 5. It cannot, however, detect "Jaundice" or other non-genetic physiological conditions that may develop later or are caused by maternal-fetal incompatibility at birth.

[Image of the amniocentesis procedure]

Final Answer: Amniocentesis is used to detect genetic disorders but cannot be used to detect Jaundice.

Answer: (C)

Q90.

Solution

Concept:

The human brain is divided into the forebrain, midbrain, and hindbrain. The hindbrain is the posterior part of the brain and serves as a bridge between the spinal cord and the higher brain centers, controlling many essential involuntary functions.

Solution:

The hindbrain consists of three main parts: 1. Pons: Consists of fiber tracts that interconnect different regions of the brain; it also contains the pneumotaxic center which regulates breathing. 2. Cerebellum: Has a very convoluted surface to provide additional space for many more neurons; it is primarily responsible for coordinating voluntary muscular movements, posture, and balance. 3. Medulla Oblongata: Connects to the spinal cord and contains centers which control respiration, cardiovascular reflexes, and gastric secretions. 4. The "Corpus callosum" is a tract of nerve fibers that connects the two cerebral hemispheres of the forebrain; it is not part of the hindbrain.

Final Answer: The hindbrain comprises the Pons, Cerebellum, and Medulla oblongata.

Answer: (B)

Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	B	2	C	3	C	4	A	5	B
6	A	7	B	8	B	9	A	10	B
11	B	12	A	13	B	14	C	15	A
16	B	17	A	18	A	19	B	20	A
21	A	22	A	23	B	24	A	25	B
26	B	27	B	28	A	29	C	30	B
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36	A	37	A	38	A	39	A	40	A
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66	B	67	A	68	A	69	B	70	C
71	A	72	C	73	B	74	B	75	A
76	A	77	A	78	B	79	B	80	A
81	C	82	B	83	B	84	A	85	B
86	B	87	A	88	B	89	C	90	B