NIOS Class 12 Biology Sample Paper-1

Duration: 180 Minutes **Maximum Marks: 80**

Instructions

- This paper contains **43** Questions. The paper is divided into two sections: **Section A – 40** marks, **Section B – 40** marks.
- **Section A** consists of
  - **Q.No. 1 to 16** – Multiple Choice type questions (MCQs) carrying 1 mark each. Select and write the most appropriate option out of the four options given in each of these questions. An internal choice has been provided in some of these questions. You have to attempt only one of the given choices in such questions.
  - **Q. No. 17 to 28**– Objective-type questions. Q. No. 17 to 28 carry 02 marks each (with 2 sub- parts of 1 mark each). Attempt these questions as per the instructions given for each of the questions 17 –28.
- **Section B** consists of
  - **Q.No. 29 to 37** – Very Short questions carrying 02 marks each to be answered in the range of 30 to 50 words.
  - **Q.No. 38 to 41** – Short Answer type questions carrying 03 marks each to be answered in the range of 50 to 80 words.
  - **Q.No. 42 and 43** – Long Answer type questions carrying 05 marks each to be answered in the range of 80 to 120 words.
- There is **No Negative marking**.
- Use of mobile phones, smartwatches, calculators, or any electronic gadgets is strictly prohibited.

Section: A

Q1. In a green plant cell, the light-dependent reactions of photosynthesis, including the splitting of water and generation of ATP and NADPH, occur specifically in which part of the chloroplast? **(1)**

(A) Stroma

(B) Thylakoid membrane

(C) Outer chloroplast membrane

(D) Cytoplasm surrounding the chloroplast

Q2. In a monohybrid cross between a pure tall pea plant (TT) and a pure dwarf pea plant (tt), all F1 offspring are tall. This observation is best explained by Mendel's law of: **(1)**

(A) Independent assortment

(B) Dominance

(C) Segregation

(D) Multiple alleles

Q3. The rigid cell wall of most bacteria (Kingdom Monera) provides mechanical strength and shape mainly due to the presence of a polymer called: **(1)**

(A) Cellulose

(B) Chitin

(C) Peptidoglycan (murein)

(D) Pectin

Q4. In a grassland food chain, Grass → Grasshopper → Frog → Snake → Eagle, the frog occupies which trophic level? **(1)**

(A) Producer

(B) Primary consumer

(C) Secondary consumer

(D) Tertiary consumer

Q5. The first stage of cellular respiration in a plant cell, glycolysis, in which glucose is broken down into pyruvate, occurs in the: **(1)**

(A) Mitochondrial matrix

(B) Cytoplasm (cytosol)

(C) Inner mitochondrial membrane

(D) Nucleus

Q6. Transfer of pollen grains from the anther of a flower to the stigma of a genetically different plant of the same species is called: **(1)**

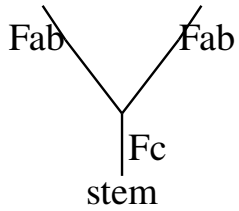
(A) Autogamy

(B) Geitonogamy

(C) Xenogamy

(D) Cleistogamy

Q7. The diagram below shows the basic structure of an antibody molecule. The two upper arms of the Y-shaped structure, which bind specifically to an antigen, are called the: **(1)**



(A) Fc regions

(B) Fab regions

(C) Light chains only

(D) Heavy chains only

Q8. Which of the following is the most fundamental criterion used to place an organism in Kingdom Plantae rather than Kingdom Animalia in the five-kingdom classification? **(1)**

(A) Presence of a well-defined nucleus

(B) Presence of a cellulose cell wall and autotrophic mode of nutrition

(C) Ability to reproduce sexually

(D) Presence of a multicellular body

Q9. Which bacterium, living symbiotically in the root nodules of leguminous plants, converts atmospheric nitrogen gas into a usable form (ammonia)? **(1)**

(A) Nitrosomonas

(B) Nitrobacter

(C) Rhizobium

(D) Pseudomonas denitrificans

Q10. Prolonged deficiency of Vitamin C in the diet leads to a disease characterised by bleeding gums and poor wound healing, known as: **(1)**

(A) Rickets

(B) Scurvy

(C) Night blindness

(D) Beri-beri

Q11. In a double-stranded DNA molecule, adenine on one strand always pairs with which base on the complementary strand? **(1)**

(A) Guanine

(B) Cytosine

(C) Thymine

(D) Uracil

Q12. Which formed element of human blood is primarily responsible for clot formation at the site of an injury? **(1)**

(A) Erythrocytes (RBCs)

(B) Platelets (thrombocytes)

(C) Lymphocytes

(D) Plasma proteins alone

Q13. The tissue found at the root and shoot tips of a plant, consisting of small, thin-walled, actively dividing cells, is called: **(1)**

(A) Permanent tissue

(B) Meristematic tissue

(C) Parenchyma only

(D) Sclerenchyma

Q14. In recombinant DNA technology, the molecular "scissors" used to cut DNA at specific recognition sequences are called: **(1)**

(A) DNA ligases

(B) DNA polymerases

(C) Restriction endonucleases

(D) Reverse transcriptases

Q15. Which of the following is a barrier method of contraception rather than a hormonal method? **(1)**

(A) Oral contraceptive pills

(B) Condom

(C) Hormonal implants

(D) Injectable contraceptives

Q16. The small gap between the axon terminal of one neuron and the dendrite of the next neuron, across which a nerve impulse is transmitted chemically, is called the: **(1)**

(A) Node of Ranvier

(B) Synapse

(C) Axon hillock

(D) Myelin sheath

Note: Q. No. 17 to 28 are the objective type questions of 2 marks each.

Q17. Read the passage given below and answer the following questions:

Photosynthesis occurs in two broad stages. In the light-dependent reactions, chlorophyll and other pigments absorb light energy, split water molecules (photolysis), and generate ATP and NADPH along with the release of oxygen. In the light-independent reactions (Calvin cycle), the ATP and NADPH produced are used to fix atmospheric carbon dioxide into carbohydrates, without directly requiring light. **(2)**

1. Name the two energy-rich molecules produced during the light-dependent reactions.
2. Which gas is released as a by-product of the splitting of water during the light reactions?

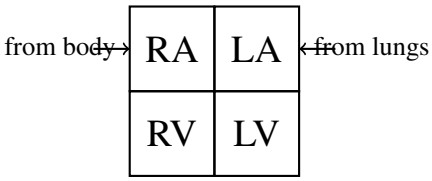
Q18. Complete the following sentences using the words given below:
(mycelium, hyphae, saprophytic, chitin, spores) **(2)**

1. The body of a fungus is made up of thread-like filaments called . , and the network formed by these filaments is called the .....
2. Most fungi obtain nutrition by absorbing organic matter from dead material, a mode of nutrition called ... ; their cell wall is composed mainly of ....

Q19. Read the passage and answer the questions that follow it.

The human heart is a four-chambered muscular organ that pumps deoxygenated blood to the lungs and oxygenated blood to the rest of the body, a process called double circulation. The diagram below shows a simplified structure of the heart with its four chambers. **(2)**

Heart (simplified front view)



1. Name the chamber that receives oxygenated blood coming from the lungs.
2. Name the valve that prevents the backflow of blood from the left ventricle into the left atrium.

Q20. Fill in the blanks: **(2)**

1. The observable physical and biochemical characteristics of an organism, resulting from the interaction of its genotype with the environment, are together called its .....
2. The complete set of alleles present in an organism for a particular trait is called its .....

Q21. Match the items in Column I with the most appropriate items in Column II: **(2)**

Column I	**Column II**
(a) Pancreas	(i) Secretes growth hormone; regulates other endocrine glands
(b) Thyroid gland	(ii) Secretes insulin and glucagon
(c) Adrenal gland	(iii) Secretes thyroxine; regulates metabolic rate
(d) Pituitary gland	(iv) Secretes adrenaline; "fight or flight" response

Q22. Fill in the blanks: **(2)**

1. The sequential transfer of food energy from producers through a series of organisms with repeated eating and being eaten is called a .....
2. The graphical representation of the number, biomass, or energy at each trophic level of an ecosystem is called an ecological .....

Q23. Write TRUE (T) for the correct statement and FALSE (F) for the incorrect statement: **(2)**

1. Fertilisation in humans normally occurs in the ampulla of the fallopian tube (oviduct).

2. The corpus luteum degenerates immediately after ovulation and secretes no hormones.

Q24. Match the items in Column I with the most appropriate items in Column II: **(2)**

Column I	**Column II**
(a) Epithelial tissue	(i) Conducts nerve impulses
(b) Connective tissue	(ii) Covers body surfaces and lines cavities
(c) Muscular tissue	(iii) Binds and supports other tissues/organs
(d) Nervous tissue	(iv) Brings about movement by contraction

Q25. Fill in the blanks: **(2)**

1. The conversion of ammonia into nitrite and then nitrate by soil bacteria is called .....
2. The conversion of nitrate back into atmospheric nitrogen gas by denitrifying bacteria is called .....

Q26. Match the items in Column I with the most appropriate items in Column II: **(2)**

Column I	**Column II**
(a) Restriction enzyme	(i) Amplifies a specific DNA segment
(b) DNA ligase	(ii) Joins DNA fragments together
(c) Plasmid	(iii) Cuts DNA at specific recognition sites
(d) PCR	(iv) Acts as a vector to carry foreign DNA

Q27. Write TRUE (T) for the correct statement and FALSE (F) for the incorrect statement: **(2)**

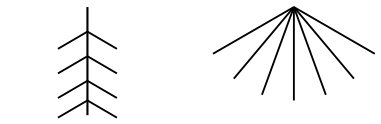
1. A balanced diet must supply carbohydrates, proteins, fats, vitamins, minerals, and water in proportions adequate for growth and maintenance of the body.
2. Kwashiorkor is caused by excessive intake of dietary fats.

Q28. Match the items in Column I with the most appropriate items in Column II: **(2)**

Column I	Column II
(a) Replication	(i) Synthesis of protein from a codon sequence
(b) Transcription	(ii) Copying of DNA into a complementary RNA strand
(c) Translation	(iii) Carries the genetic code from nucleus to ribosome
(d) mRNA	(iv) Synthesis of a new DNA strand from a parent DNA template

Section: B

Q29. With the help of a labelled diagram, differentiate between a tap root system and a fibrous root system, and give one plant example of each. **(2)**



Tap root system Fibrous root system

Q30. Name any two methods of vegetative propagation in plants and give one example of a plant propagated by each method. **(2)**

Q31. (i) Describe briefly the sigmoid (S-shaped) pattern of population growth shown by most natural populations, mentioning the carrying capacity.

OR

(ii) What is ecological succession? Distinguish briefly between primary and secondary succession. **(2)**

Q32. (i) State two characteristic features of Protozoa (Kingdom Protoctista), giving one example.

OR

(ii) State two characteristic features of algae (Kingdom Protoctista), giving one example. **(2)**

Q33. During aerobic respiration in a plant cell, if 1 mole of glucose yields a net of 36 ATP molecules, calculate the number of ATP molecules produced from the complete aerobic breakdown of 0.5 mole of glucose. **(2)**

Q34. In garden pea, tallness (T) is dominant over dwarfness (t). Two heterozygous tall plants (Tt) are crossed. Using a Punnett square, work out the genotypic and phenotypic ratio of the F1 offspring. **(2)**

	T	t
T	TT	Tt
t	Tt	tt

Q35. (i) State two functions of the nervous system in coordinating the activities of the human body.

OR

(ii) Describe briefly the events occurring at a reflex arc when a person accidentally touches a hot object. **(2)**

Q36. What is meant by a 'balanced diet'? Name one disease each caused by protein deficiency and Vitamin D deficiency. **(2)**

Q37. Explain briefly what is meant by 'double circulation' in humans, and state one advantage of double circulation over single circulation. **(2)**

Q38. Define the following terms with one example each:

A. Antigen

B. Antibody

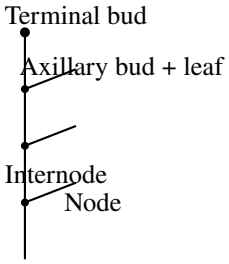
C. Active immunity **(3)**

Q39. (i) Describe briefly the process of transcription in a eukaryotic cell.

OR

(ii) Describe briefly the process of translation, mentioning the role of ribosomes and tRNA. **(3)**

Q40. With the help of a labelled diagram of a typical dicot shoot/twig, identify and describe the functions of the node, internode, and terminal bud. **(3)**



Q41. (i) Explain the causes, symptoms, and prevention of Vitamin A deficiency (night blindness) in humans.

OR

(ii) Explain the causes, symptoms, and prevention of iron-deficiency anaemia in humans. **(3)**

Q42. (i) (a) State Mendel's law of independent assortment.
(b) In a dihybrid cross between a pea plant with round, yellow seeds (RrYy) and another with round, yellow seeds (RrYy), work out the phenotypic ratio of the F1 generation.

OR

(ii) (a) Explain the mechanism of sex determination in humans (XX–XY type).
(b) A cross is made between a normal woman (XX) and a colour-blind man (X^cY). Work out the possible genotypes of their children with respect to colour blindness (colour blindness is an X-linked recessive trait). **(5)**

Q43. (i) Describe the five-kingdom system of classification proposed by Whittaker, giving one distinguishing feature and one example organism for each kingdom.

OR

(ii) With the help of labelled diagrams, describe the structure and function of meristematic tissue and any one type of permanent tissue in plants. **(5)**

Detailed Solutions

Q1.

Solution

Concept: Photosynthesis has two stages localised in different parts of the chloroplast. The light-dependent reactions require chlorophyll and directly use light energy, whereas the light-independent (Calvin cycle) reactions use the chemical products of the light reactions and do not directly need light. The chloroplast has an outer envelope, a fluid stroma, and stacks of membranous sacs called thylakoids (grana) which house the photosynthetic pigments.

Step 1: The light-dependent reactions require chlorophyll molecules to be arranged in an organised, membrane-bound system so that light energy can be efficiently absorbed and converted into chemical energy.

Step 2: The thylakoid membrane houses the photosystems (PS I and PS II), the electron transport chain, and ATP synthase, all of which are essential for capturing light energy and splitting water.

Step 3: As light strikes the pigments embedded in the thylakoid membrane, water molecules are split (photolysis), releasing oxygen, electrons, and protons; the electron transport chain uses this energy to generate ATP and NADPH.

Step 4: The stroma, by contrast, is the site of the Calvin cycle (dark reactions), where CO_2 fixation occurs using the ATP and NADPH diffusing in from the thylakoid membrane; it is not the site of the light reactions.

Step 5: Since the question specifically asks about the site of water splitting and ATP/NADPH generation, the correct location must be the membrane system, not the stroma or the outer envelope.

Final Answer: Thylakoid membrane

Answer: (B)

Go Back to Question 1

Q2.

Solution

Concept: Mendel's law of dominance states that when two contrasting pure-breeding traits are crossed, only one form of the trait (the dominant allele) is expressed in the F1 hybrid, while the other (recessive) allele remains hidden, though present in the genotype.

Step 1: A pure tall pea plant carries the genotype TT (dominant allele for tallness), while a pure dwarf pea plant carries the genotype tt (recessive allele for dwarfness).
Step 2: When these two pure-breeding plants are crossed, every F1 offspring inherits one T allele from the tall parent and one t allele from the dwarf parent, producing a heterozygous genotype Tt in all offspring.
Step 3: Because T (tallness) is dominant over t (dwarfness), the heterozygous Tt plants show only the tall phenotype; the recessive dwarf trait is masked but not lost, since it can reappear in the F2 generation.
Step 4: This masking of the recessive allele by the dominant allele in a heterozygote is precisely what Mendel's law of dominance describes, distinguishing it from the law of segregation (which concerns gamete formation) and independent assortment (which concerns two or more gene pairs).
Final Answer: Law of Dominance

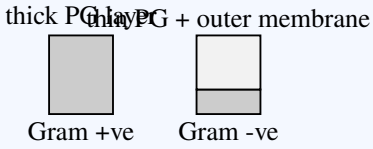
Answer: (B)

Go Back to Question 2

Q3.

Solution

Concept: Bacterial cell walls provide mechanical strength, maintain cell shape, and protect against osmotic lysis. Unlike plant cell walls (cellulose) or fungal cell walls (chitin), most bacterial cell walls are built from a unique polymer of sugars and amino acids called peptidoglycan, whose thickness also differentiates Gram-positive from Gram-negative bacteria.



Step 1: Peptidoglycan (also called murein) is a polymer made up of long chains of two alternating sugar derivatives (N-acetylglucosamine and N-acetylmuramic acid) cross-linked by short peptide chains.

Step 2: This cross-linked mesh forms a strong, rigid layer just outside the plasma membrane, which resists osmotic swelling and gives the bacterial cell its characteristic shape (rod, coccus, spirillum, etc.).

Step 3: Cellulose is the structural polysaccharide of plant cell walls, chitin forms fungal cell walls and arthropod exoskeletons, and pectin is a component of the middle lamella in plants – none of these are found in bacterial cell walls.

Step 4: Gram-positive bacteria have a thick peptidoglycan layer that retains crystal violet stain, while Gram-negative bacteria have a thin peptidoglycan layer covered by an additional outer membrane, which is why they lose the stain and appear pink on counterstaining.

Final Answer: Peptidoglycan (murein)

Answer: (C)

Go Back to Question 3

Q4.

Solution

Concept: In a food chain, energy flows from producers to a series of consumers occupying successive trophic levels. Producers occupy the first trophic level; herbivores (primary consumers) occupy the second; carnivores that eat herbivores (secondary consumers) occupy the third; and carnivores that eat other carnivores (tertiary consumers) occupy the fourth.

Step 1: In the given chain, grass is the producer (first trophic level), since it manufactures its own food through photosynthesis.
Step 2: The grasshopper feeds directly on grass, making it a herbivore and hence the primary consumer, occupying the second trophic level.
Step 3: The frog feeds on the grasshopper (a primary consumer), which makes the frog a carnivore that consumes a herbivore – by definition, this places the frog at the secondary consumer level, the third trophic level overall.
Step 4: The snake, which eats the frog, is the tertiary consumer, and the eagle, which eats the snake, is the quaternary consumer, confirming that the frog's position is exactly the secondary consumer.
Final Answer: Secondary consumer

Answer: (C)
Go Back to Question 4

Q5.

Solution

Concept: Aerobic respiration in a plant cell occurs in distinct stages at different locations: glycolysis in the cytoplasm, the Krebs cycle in the mitochondrial matrix, and the electron transport chain on the inner mitochondrial membrane. Glycolysis does not require oxygen and is common to both aerobic and anaerobic respiration.

Step 1: Glycolysis is the enzymatic breakdown of one molecule of glucose (a 6-carbon sugar) into two molecules of pyruvate (a 3-carbon compound), along with a small net gain of ATP and NADH.
Step 2: This sequence of ten enzyme-catalysed reactions takes place entirely in the soluble cytoplasm (cytosol) of the cell, outside any organelle, because the enzymes required for glycolysis are free-floating in the cytosol.
Step 3: Only after pyruvate is transported into the mitochondrion does it enter the matrix for the Krebs cycle, and later the electron transport chain operates on the inner mitochondrial membrane – neither of these later stages is the site of glycolysis.
Final Answer: Cytoplasm (cytosol)

Answer: (B)
Go Back to Question 5

Q6.

Solution

Concept: Pollination is classified based on the source of pollen. Autogamy involves pollen transfer within the same flower, geitonogamy involves transfer between two flowers on the same plant, and xenogamy involves transfer of pollen from one plant to a genetically different plant of the same species, ensuring genetic variation.

Step 1: Autogamy occurs when pollen from the anther lands on the stigma of the very same flower, so no genetic material from another plant is involved.
Step 2: Geitonogamy occurs when pollen is transferred to a different flower, but on the same plant; genetically, this is still equivalent to self-pollination since both flowers belong to one individual.
Step 3: Xenogamy specifically refers to the transfer of pollen grains from the anther of one plant to the stigma of a flower on a different, genetically distinct plant of the same species, which introduces new genetic combinations in the offspring.
Step 4: Since the question explicitly states pollen moves to "a genetically different plant of the same species," this matches the definition of xenogamy and rules out autogamy, geitonogamy, and cleistogamy (self-pollination within an unopened flower).
Final Answer: Xenogamy

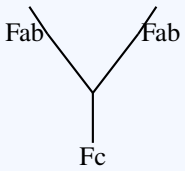
Answer: (C)

Go Back to Question 6

Q7.

Solution

Concept: An antibody (immunoglobulin) has a Y-shaped structure made of two heavy chains and two light chains. The two upper arms, called Fab (Fragment antigen-binding) regions, contain the variable regions that specifically recognise and bind an antigen. The stem, called the Fc (Fragment crystallisable) region, interacts with immune cells and complement proteins.



Step 1: The overall antibody molecule is shaped like the letter Y, with two identical arms at the top and a single stem at the bottom, all connected at a flexible hinge region.

Step 2: Each of the two upper arms possesses a variable region whose amino acid sequence differs between antibodies, allowing it to bind precisely to a specific antigen shape, much like a lock and key.

Step 3: Because these arms are directly responsible for antigen recognition and binding, they are named the Fab (Fragment antigen-binding) regions – distinct from the Fc stem, which does not bind antigen but instead mediates effector functions.

Final Answer: Fab regions

Answer: (B)

Go Back to Question 7

Q8.

Solution

Concept: The five-kingdom classification separates living organisms primarily on the basis of cell structure, mode of nutrition, and body organisation. Kingdom Plantae consists of multicellular, autotrophic organisms with cellulose cell walls and chlorophyll-based photosynthesis, which fundamentally distinguishes them from the heterotrophic, wall-less cells of Kingdom Animalia.

Step 1: Both plant and animal cells are eukaryotic and possess a well-defined nucleus, so nuclear organisation alone cannot be used to separate the two kingdoms.
Step 2: Many organisms in both kingdoms reproduce sexually and show multicellularity, so these criteria are also shared and cannot serve as the distinguishing feature.
Step 3: Plant cells uniquely possess a rigid cellulose cell wall external to the plasma membrane and contain chloroplasts that enable autotrophic (self-feeding) nutrition through photosynthesis.
Step 4: Animal cells lack a cell wall entirely and are heterotrophic, depending on ingestion of other organisms for nutrition; this combination of cellulose wall plus autotrophy is therefore the most fundamental criterion separating Plantae from Animalia.
Final Answer: Presence of a cellulose cell wall and autotrophic mode of nutrition

Answer: (B)
Go Back to Question 8

Q9.

Solution

Concept: Biological nitrogen fixation is the process by which certain bacteria convert inert atmospheric nitrogen gas (N_2) into ammonia, a form usable by plants. Some of these bacteria, such as Rhizobium, live symbiotically within the root nodules of leguminous plants, while others such as Nitrosomonas and Nitrobacter carry out nitrification rather than nitrogen fixation.

Step 1: Rhizobium bacteria infect the root hairs of leguminous plants (such as pea, gram, and bean), inducing the formation of specialised root nodules that house the bacteria.
Step 2: Inside these nodules, Rhizobium uses the enzyme nitrogenase to convert atmospheric nitrogen gas into ammonia, which the host plant then uses to synthesise amino acids and proteins, while the bacterium receives carbohydrates from the plant in return.
Step 3: Nitrosomonas oxidises ammonia to nitrite, and Nitrobacter oxidises nitrite to nitrate – these bacteria perform nitrification, not nitrogen fixation. Pseudomonas denitrificans is associated with denitrification, converting nitrate back into nitrogen gas.
Step 4: Since the question specifically asks about the symbiotic root-nodule bacterium that fixes atmospheric nitrogen, only Rhizobium fits this exact functional and symbiotic description.
Final Answer: Rhizobium

Answer: (C)
Go Back to Question 9

Q10.

Solution

Concept: Vitamin C (ascorbic acid) is essential for the synthesis of collagen, a structural protein required for healthy connective tissue, blood vessel walls, and gums. Chronic dietary deficiency of Vitamin C impairs collagen formation, producing the deficiency disease scurvy.

Step 1: Collagen synthesis requires the hydroxylation of specific amino acid residues (proline and lysine), a reaction catalysed by enzymes that depend on Vitamin C as a cofactor.
Step 2: When Vitamin C is chronically deficient in the diet, collagen cannot be properly synthesised or stabilised, weakening connective tissue throughout the body, particularly in the gums and small blood vessels.
Step 3: This weakening manifests clinically as bleeding and swollen gums, loosening of teeth, poor wound healing, and easy bruising – the classic symptoms of scurvy.
Step 4: Rickets results from Vitamin D deficiency (affecting bone mineralisation), night blindness results from Vitamin A deficiency (affecting the retina), and beri-beri results from Vitamin B1 (thiamine) deficiency (affecting the nervous system) – none of these match the gum and wound-healing symptoms described.
Final Answer: Scurvy

Answer: (B)
Go Back to Question 10

Q11.

Solution

Concept: According to the base-pairing rules discovered by Watson and Crick, the two strands of a DNA double helix are held together by specific hydrogen-bonded pairs: adenine (A) always pairs with thymine (T) via two hydrogen bonds, and guanine (G) always pairs with cytosine (C) via three hydrogen bonds.

Step 1: DNA is composed of four nitrogenous bases: adenine and guanine (purines), and cytosine and thymine (pyrimidines).
Step 2: The complementary base-pairing rule restricts a purine to pair only with a specific pyrimidine of matching size and hydrogen-bonding pattern, so that the double helix maintains a uniform width throughout its length.
Step 3: Adenine, a purine, pairs specifically with thymine, a pyrimidine, through two hydrogen bonds – this pairing is fixed and does not vary along the DNA molecule.
Step 4: Uracil replaces thymine in RNA, not DNA, so it is not a valid answer here; guanine and cytosine form a separate complementary pair with three hydrogen bonds.
Final Answer: Thymine

Answer: (C)
Go Back to Question 11

Q12.

Solution

Concept: Human blood contains three main types of formed elements: erythrocytes (RBCs) for oxygen transport, leukocytes (WBCs) for immune defence, and platelets (thrombocytes) for haemostasis (clot formation), each performing a distinct physiological role.

Step 1: Erythrocytes are packed with haemoglobin and are specialised for carrying oxygen from the lungs to body tissues; they play no direct role in clotting.
Step 2: Lymphocytes are a type of white blood cell involved in specific immune responses, including antibody production and cell-mediated immunity, but they do not initiate clot formation.
Step 3: When a blood vessel is injured, platelets aggregate at the site of damage, release clotting factors, and form a temporary platelet plug, which is further stabilised by the fibrin mesh formed through the coagulation cascade.
Step 4: Plasma proteins (such as fibrinogen and prothrombin) are indeed involved in the clotting cascade, but they act as precursors that must be activated; the cellular trigger and plug formation is primarily carried out by platelets, making them the correct answer.
Final Answer: Platelets (thrombocytes)

Answer: (B)
Go Back to Question 12

Q13.

Solution

Concept: Plant tissues are broadly classified as meristematic (actively dividing) or permanent (differentiated, non-dividing). Meristematic tissue, located at root tips, shoot tips, and cambium, consists of small, thin-walled cells with dense cytoplasm and prominent nuclei that continuously divide to produce new cells for growth.

Step 1: Meristematic cells are characteristically small, closely packed, thin-walled, and lack large vacuoles, features that support their capacity for rapid and repeated cell division.
Step 2: Apical meristems located precisely at the tips of roots and shoots are responsible for the primary (longitudinal) growth of the plant, continuously adding new cells that later differentiate into specialised tissues.
Step 3: In contrast, permanent tissues such as parenchyma, collenchyma, and sclerenchyma consist of mature, differentiated cells that have generally lost the ability to divide, and are not located specifically at growing tips.
Step 4: Since the question specifies location (root and shoot tips) and the property of active division, this description matches meristematic tissue precisely, ruling out any permanent tissue type.
Final Answer: Meristematic tissue

Answer: (B)
Go Back to Question 13

Q14.

Solution

Concept: Recombinant DNA technology relies on a set of molecular tools: restriction endonucleases cut DNA at specific recognition sequences, DNA ligases join DNA fragments, and DNA polymerases synthesise new DNA strands, while reverse transcriptases convert RNA into complementary DNA.

Step 1: Restriction endonucleases are bacterial enzymes that recognise short, specific palindromic DNA sequences and cleave the DNA backbone at or near those sequences, producing predictable fragments with defined ends.
Step 2: This precise, sequence-specific cutting ability is exactly why these enzymes are described metaphorically as molecular "scissors," allowing scientists to excise a gene of interest or open up a vector at a known site.
Step 3: DNA ligase, by contrast, performs the opposite function of joining (sealing) DNA fragments together, and is therefore sometimes called molecular "glue," not scissors.
Step 4: DNA polymerases synthesise new DNA strands during replication or PCR, and reverse transcriptases synthesise DNA from an RNA template – neither of these enzymes cuts DNA at specific recognition sequences, confirming restriction endonucleases as the correct answer.
Final Answer: Restriction endonucleases

Answer: (C)
Go Back to Question 14

Q15.

Solution

Concept: Contraceptive methods are classified as barrier methods, which physically prevent sperm from reaching the egg, or hormonal methods, which alter the hormonal environment to prevent ovulation or implantation.

Step 1: Oral contraceptive pills work by supplying synthetic hormones (oestrogen and/or progesterone) that suppress ovulation, making them a hormonal method rather than a barrier method.
Step 2: Hormonal implants and injectable contraceptives similarly release synthetic hormones into the bloodstream over an extended period to prevent ovulation, again classifying them as hormonal methods.
Step 3: A condom, on the other hand, is a thin sheath that acts as a physical (mechanical) barrier, preventing sperm from entering the female reproductive tract during intercourse, without altering any hormone levels.
Step 4: Since the condom works purely through physical obstruction rather than hormonal action, it is correctly classified as a barrier method, distinguishing it from the other three hormonal options.
Final Answer: Condom

Answer: (B)
Go Back to Question 15

Q16.

Solution

Concept: Neurons communicate with one another at specialised junctions rather than through direct cytoplasmic continuity. At these junctions, called synapses, an electrical nerve impulse is converted into a chemical signal (neurotransmitter release) that crosses a narrow gap to trigger a new impulse in the next neuron.

Step 1: The Node of Ranvier is a gap in the myelin sheath along the axon of a single neuron, important for saltatory conduction, but it is not a junction between two different neurons.
Step 2: The axon hillock is the region where the axon originates from the neuron's cell body and where action potentials are typically initiated; it is also part of a single neuron, not a junction.
Step 3: The synapse is the specific narrow gap between the axon terminal (presynaptic neuron) and the dendrite or cell body of the next neuron (postsynaptic neuron), across which neurotransmitter molecules diffuse to transmit the signal chemically.
Step 4: The myelin sheath is an insulating fatty layer around the axon that speeds up conduction, but again belongs to a single neuron and is unrelated to inter-neuronal transmission.
Final Answer: Synapse

Answer: (B)

Go Back to Question 16

Q17.

Solution

Concept: The light-dependent reactions of photosynthesis convert light energy into chemical energy stored in ATP and NADPH, while simultaneously splitting water molecules, a process that releases oxygen gas as a by-product.

Step 1: As light energy is absorbed by chlorophyll in Photosystem II, it drives the photolysis (splitting) of water molecules into protons, electrons, and oxygen.
Step 2: The electrons released from water travel through the electron transport chain, and the energy released during this transport is used to pump protons and ultimately synthesise ATP through chemiosmosis.
Step 3: At Photosystem I, the electrons (after being re-energised by light) are used, along with protons, to reduce $NADP^+$ to NADPH, the second key energy carrier produced by the light reactions.
Step 4: The oxygen atoms released from the split water molecules combine to form O_2 gas, which diffuses out of the leaf through stomata as a by-product of this stage.
Final Answer: ATP and NADPH are produced during the light reactions; oxygen gas is released as a by-product of water splitting.

Answer: (See above)

Go Back to Question 17

Q18.

Solution

Concept: The vegetative body of a fungus is composed of thread-like filaments, and fungi typically obtain nutrition by absorbing organic matter from dead or decaying material, features linked to the chemical composition of their cell wall.

Step 1: Each individual thread-like filament making up the fungal body is called a hypha, and the entire branched, interwoven network of hyphae is collectively termed the mycelium.
Step 2: Most fungi lack chlorophyll and cannot photosynthesise; instead, they secrete digestive enzymes onto dead organic material and absorb the resulting simple nutrients, a mode of nutrition called saprophytic (saprotrophic) nutrition.
Step 3: The fungal cell wall, unlike that of plants (cellulose), is composed mainly of chitin, a tough nitrogen-containing polysaccharide that also forms the exoskeleton of arthropods.
Final Answer: 1. hyphae; mycelium 2. saprophytic; chitin

Answer: (See above)
Go Back to Question 18

Q19.

Solution

Concept: The human heart's left side handles oxygenated blood while the right side handles deoxygenated blood. One-way valves between the atria and ventricles ensure that blood flows only from atrium to ventricle and not backward, maintaining the efficiency of double circulation.

RA	LA
RV	LV

Step 1: Pulmonary veins carry freshly oxygenated blood from the lungs back to the heart, emptying directly into the left atrium (LA), the upper-left chamber shown in the diagram.
Step 2: From the left atrium, oxygenated blood passes through the bicuspid (mitral) valve into the left ventricle (LV), which then pumps it out through the aorta to the entire body.
Step 3: The bicuspid (mitral) valve, located precisely between the left atrium and left ventricle, is a one-way valve that permits blood flow only from the left atrium into the left ventricle and snaps shut during ventricular contraction to prevent any backflow.
Step 4: If this valve were absent or leaking, oxygenated blood would regurgitate back into the left atrium during each heartbeat, drastically reducing the efficiency of systemic circulation.
Final Answer: 1. Left atrium 2. Bicuspid (mitral) valve

Answer: (See above)
Go Back to Question 19

Q20.

Solution

Concept: Genotype refers to the genetic constitution of an organism (its actual combination of alleles), whereas phenotype refers to the observable expression of that genotype, shaped further by environmental influences.

Step 1: An organism's phenotype includes all its visible or measurable traits, such as height, colour, or biochemical characteristics, which arise from the combined effect of its genes and the surrounding environment.

Step 2: Two organisms can share the exact same genotype yet display different phenotypes if raised in different environmental conditions, showing that phenotype is not determined by genotype alone.

Step 3: Genotype, in contrast, is a purely genetic description – the specific set of alleles (e.g., TT, Tt, or tt) an organism carries for a particular gene – and remains fixed regardless of the environment.

Final Answer: 1. phenotype 2. genotype

Answer: (See above) Go Back to Question 20

Q21.

Solution

Concept: Endocrine glands secrete specific hormones directly into the bloodstream, each hormone regulating a distinct physiological process. Correctly matching a gland to its secretion requires knowing both the hormone produced and its principal physiological effect.

Step 1: The pancreas contains islets of Langerhans that secrete insulin and glucagon, hormones that regulate blood glucose levels, matching pair (a)–(ii).

Step 2: The thyroid gland secretes thyroxine, a hormone that governs the body's basal metabolic rate, matching pair (b)–(iii).

Step 3: The adrenal gland (adrenal medulla) secretes adrenaline (epinephrine), which prepares the body for a rapid "fight or flight" response during stress, matching pair (c)–(iv).

Step 4: The pituitary gland, often called the master gland, secretes growth hormone and also regulates the secretions of several other endocrine glands, matching pair (d)–(i).

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

Answer: (See above)

Go Back to Question 21

Q22.

Solution

Concept: Energy in an ecosystem flows in a single direction from producers to successive consumers through a food chain, and this flow of energy, numbers, or biomass across trophic levels can be represented visually using an ecological pyramid.

Step 1: A food chain describes the specific, linear sequence in which food energy (and the organic matter it represents) is transferred from one organism to the next through repeated acts of eating and being eaten.
Step 2: Because energy is progressively lost as heat at each transfer, the amount of usable energy, number of organisms, or total biomass generally decreases from one trophic level to the next.
Step 3: This progressive decrease is conventionally illustrated using an ecological pyramid, in which each trophic level is represented as a horizontal bar, with producers forming the wide base and top carnivores forming the narrow apex.
Final Answer: 1. food chain 2. pyramid

Answer: (See above)
Go Back to Question 22

Q23.

Solution

Concept: Fertilisation and the subsequent hormonal support of pregnancy in the human female reproductive system depend on precise anatomical locations and glandular structures, namely the ampulla of the oviduct and the corpus luteum.

Step 1: After ovulation, the egg is released into the fallopian tube (oviduct), and fertilisation by a sperm cell normally takes place in its wider upper part known as the ampulla, making the first statement correct.
Step 2: After ovulation, the ruptured Graafian follicle in the ovary transforms into a temporary endocrine structure called the corpus luteum, rather than degenerating immediately.
Step 3: The corpus luteum actively secretes the hormone progesterone (along with some oestrogen), which maintains the uterine lining and supports early pregnancy if fertilisation occurs; therefore, the claim that it "degenerates immediately" and "secretes no hormones" is factually incorrect.
Final Answer: 1. True 2. False

Answer: (See above)
Go Back to Question 23

Q24.

Solution

Concept: Animal tissues are grouped into four fundamental types – epithelial, connective, muscular, and nervous – each specialised for a distinct structural or functional role in the body.

Step 1: Epithelial tissue forms continuous sheets of tightly packed cells that cover external body surfaces and line internal cavities and organs, matching pair (a)–(ii).
Step 2: Connective tissue, which includes bone, cartilage, blood, and areolar tissue, functions mainly to bind, support, and connect different tissues and organs together, matching pair (b)–(iii).
Step 3: Muscular tissue is composed of elongated, contractile cells that shorten to produce movement of body parts, matching pair (c)–(iv).
Step 4: Nervous tissue is specialised for the generation and rapid conduction of electrical nerve impulses throughout the body, matching pair (d)–(i).
Final Answer: (a)-(ii), (b)-(iii), (c)-(iv), (d)-(i)

Answer: (See above)
Go Back to Question 24

Q25.

Solution

Concept: The nitrogen cycle involves the interconversion of nitrogen compounds by different groups of soil bacteria. Nitrification oxidises ammonia stepwise into nitrite and then nitrate, whereas denitrification reduces nitrate back into gaseous nitrogen, completing the cycle.

Step 1: Ammonia present in the soil (from decomposition or nitrogen fixation) is first oxidised to nitrite by bacteria such as Nitrosomonas, and the nitrite is further oxidised to nitrate by bacteria such as Nitrobacter.
Step 2: This two-step oxidation of ammonia into nitrite and then nitrate is collectively termed nitrification, and the nitrate produced is the form of nitrogen most readily absorbed by plant roots.
Step 3: Denitrifying bacteria, such as Pseudomonas denitrificans, living in anaerobic (oxygen-poor) soil conditions, reduce nitrate back into nitrogen gas, which then escapes into the atmosphere, completing the cycle and replenishing atmospheric nitrogen.
Final Answer: 1. nitrification 2. denitrification

Answer: (See above)
Go Back to Question 25

Q26.

Solution

Concept: Recombinant DNA technology combines several molecular tools – restriction enzymes, DNA ligase, vectors such as plasmids, and PCR – each performing a specific and complementary function in isolating, joining, carrying, or amplifying DNA fragments.

Step 1: Restriction enzymes recognise specific palindromic DNA sequences and cleave the DNA backbone precisely at or near those sites, matching pair (a)–(iii).
Step 2: DNA ligase catalyses the formation of phosphodiester bonds, sealing together DNA fragments that have been cut by restriction enzymes, matching pair (b)–(ii).
Step 3: A plasmid is a small, circular, extrachromosomal DNA molecule commonly used as a vector to carry and introduce foreign genes into a host cell, matching pair (c)–(iv).
Step 4: PCR (Polymerase Chain Reaction) uses a heat-stable DNA polymerase to make millions of copies of a specific target DNA segment within a few hours, matching pair (d)–(i).
Final Answer: (a)-(iii), (b)-(ii), (c)-(iv), (d)-(i)

Answer: (See above)
Go Back to Question 26

Q27.

Solution

Concept: A balanced diet must supply all major nutrient classes in appropriate proportions, while specific deficiency diseases arise from the lack of a particular nutrient rather than from its excess.

Step 1: A truly balanced diet must supply adequate amounts of carbohydrates, proteins, fats, vitamins, minerals, and water, in proportions suited to an individual's age, activity level, and physiological state, confirming the first statement as correct.
Step 2: Kwashiorkor is a well-documented protein-energy malnutrition disorder that specifically results from a severe deficiency of dietary protein, typically in children, and is characterised by oedema, a swollen abdomen, and stunted growth.
Step 3: The claim that Kwashiorkor is caused by "excessive intake of dietary fats" is factually incorrect; excessive fat intake is instead linked to conditions such as obesity and cardiovascular disease, not Kwashiorkor.
Final Answer: 1. True 2. False

Answer: (See above)
Go Back to Question 27

Q28.

Solution

Concept: The central dogma of molecular biology describes the directional flow of genetic information: DNA is replicated to produce more DNA, transcribed into messenger RNA, and the mRNA is translated into protein at the ribosome.

Step 1: Replication is the process by which a DNA molecule is copied to produce two identical daughter DNA molecules, each strand of the original acting as a template, matching pair (a)–(iv).
Step 2: Transcription is the process by which the genetic information in a DNA template strand is copied into a complementary, single-stranded messenger RNA (mRNA) molecule, matching pair (b)–(ii).
Step 3: Translation is the process occurring at the ribosome in which the codon sequence of mRNA directs the sequential assembly of amino acids into a specific polypeptide chain, matching pair (c)–(i).
Step 4: mRNA itself serves as the intermediate messenger molecule that physically carries the genetic code from the nucleus (site of transcription) to the ribosome in the cytoplasm (site of translation), matching pair (d)–(iii).
Final Answer: (a)-(iv), (b)-(ii), (c)-(i), (d)-(iii)

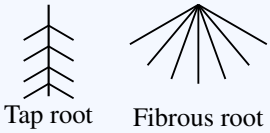
Answer: (See above)

Go Back to Question 28

Q29.

Solution

Concept: Roots may develop in two principal patterns. In a tap root system, one main root grows vertically downward with smaller lateral roots branching off it. In a fibrous root system, numerous thin roots of roughly equal size arise directly from the base of the stem, without any single dominant root.



Step 1: In a tap root system, the radicle of the germinating seed persists and continues to grow directly downward as a single, thick primary root, from which thinner secondary and tertiary lateral roots branch out.

Step 2: This pattern is typically seen in dicotyledonous plants; for example, the mustard plant and the mango tree both develop a prominent tap root system that anchors the plant deeply and firmly in the soil.

Step 3: In a fibrous root system, the original radicle is short-lived, and instead a cluster of thin, roughly equal-sized roots emerges directly from the base of the stem, spreading out just below the soil surface.

Step 4: This pattern is characteristic of monocotyledonous plants; for example, wheat and grass both possess a fibrous root system that provides a wide surface area for absorbing water and nutrients close to the topsoil.

Final Answer: Tap root system (single main root with laterals; e.g., mustard) versus fibrous root system (cluster of thin equal roots; e.g., wheat).

Answer: (See above) Go Back to Question 29

Q30.

Solution

Concept: Vegetative propagation is a form of asexual reproduction in plants in which a new individual develops from a vegetative part (root, stem, or leaf) of the parent plant, without the fusion of gametes, producing genetically identical offspring.

Step 1: Cutting is a common method in which a segment of a stem (containing at least one node) is cut from the parent plant and placed in soil or water, where it develops adventitious roots and grows into a new independent plant; for example, rose and sugarcane are commonly propagated by stem cuttings.

Step 2: Grafting is another method in which a shoot piece (scion) from a desirable variety is joined to the rooted stem (stock) of a different but related plant, so that the two grow together as a single plant combining the good qualities of both; for example, mango and rose varieties are commonly propagated by grafting.

Step 3: Both methods bypass seed formation entirely, allowing the new plant to retain the exact genetic characteristics of the parent, which is especially valuable for preserving desirable traits that might otherwise be lost through sexual reproduction and genetic recombination.

Final Answer: Cutting (e.g., rose) and grafting (e.g., mango) are two common methods of vegetative propagation.

Answer: (See above) Go Back to Question 30

Q31.

Solution

Concept: Population growth in a limited environment does not continue indefinitely at an exponential rate; instead, it follows a sigmoid (S-shaped) curve as resource availability increasingly restricts growth. Ecological succession, by contrast, describes the gradual, directional change in the species composition of a community over time in a given area.

Alternative (i): Step 1: When a small population is introduced into a new habitat with abundant resources, it initially grows slowly (lag phase), then rapidly accelerates as individuals reproduce with few restrictions (exponential phase).
Step 2: As the population size increases, resources such as food, space, and water become limiting, and competition, predation, and disease slow the growth rate progressively.
Step 3: Eventually, the population size stabilises around the maximum number of individuals that the environment can sustainably support, a value called the carrying capacity (K), producing the characteristic flattened top of the S-shaped curve.
Alternative (ii): Step 1: Ecological succession is the natural, gradual, and directional replacement of one biological community by another in a given area over time, ultimately tending toward a stable climax community.
Step 2: Primary succession begins on a completely bare, lifeless substrate that has never previously supported life, such as bare rock or newly cooled volcanic lava, and therefore proceeds very slowly, starting with pioneer species like lichens.
Step 3: Secondary succession, in contrast, begins in an area where a pre-existing community has been disturbed or destroyed (such as after a fire or flood) but the soil and some organisms remain, so it proceeds much faster than primary succession.
Final Answer: (i) Population growth follows an S-shaped curve levelling off at the carrying capacity; (ii) Succession is the directional change of communities over time – primary succession starts on bare substrate, secondary succession starts on a previously disturbed but soil-containing area.

Answer: (See above)

Go Back to Question 31

Q32.

Solution

Concept: Kingdom Protoctista is a diverse group of eukaryotic organisms that do not fit clearly into the plant, animal, or fungal kingdoms, and broadly includes unicellular protozoa and simple photosynthetic algae, each group possessing distinct characteristic features.

Alternative (i): Step 1: Protozoa are unicellular, eukaryotic, heterotrophic organisms that generally lack a rigid cell wall, allowing many of them to change shape or move using specialised structures.

Step 2: They typically show locomotion by means of pseudopodia, cilia, or flagella (for example, Amoeba moves using pseudopodia, while Paramecium moves using cilia), and they obtain nutrition by engulfing or absorbing organic food particles rather than photosynthesising.

Alternative (ii): Step 1: Algae are simple, chlorophyll-containing eukaryotic organisms (unicellular to multicellular) that are photosynthetic and autotrophic, most commonly found in aquatic or moist habitats.

Step 2: They lack the complex tissue differentiation (true roots, stems, and leaves) found in higher plants, though they may show a simple body organisation called a thallus; for example, Chlamydomonas is a common unicellular green alga, and Spirogyra is a common filamentous green alga.

Final Answer: (i) Protozoa: unicellular, heterotrophic, move by pseudopodia/cilia/flagella (e.g., Amoeba); (ii) Algae: photosynthetic, autotrophic, lack true tissue differentiation (e.g., Chlamydomonas).

Answer: (See above)

Go Back to Question 32

Q33.

Solution

Concept: The net ATP yield of aerobic respiration is directly proportional to the amount of glucose completely oxidised, since each mole of glucose passing through glycolysis, the Krebs cycle, and the electron transport chain yields a fixed number of ATP molecules under standard conditions.

Step 1: The problem states that the complete aerobic breakdown of 1 mole of glucose produces a net yield of 36 ATP molecules.
Step 2: Since ATP yield scales directly and proportionally with the amount of glucose respired, the ATP produced from any given quantity of glucose can be found by multiplying the yield per mole by the number of moles present.
Step 3: Substituting the given quantity of glucose, 0.5 mole, into this proportional relationship: ATP produced = $0.5 \times 36 = 18$ ATP molecules.
Step 4: This result is consistent with the underlying biochemistry, since respiring exactly half the amount of glucose logically yields exactly half the total ATP, with no additional gain or loss due to the amount of substrate alone.
Final Answer: 18 ATP molecules

Answer: (See above)

Go Back to Question 33

Q34.

Solution

Concept: A Punnett square is a diagrammatic tool used to predict the possible genotypes and their expected ratios among offspring of a genetic cross, by systematically combining the possible gametes produced by each parent.

	T	t
T	TT	Tt
t	Tt	tt

Step 1: Each heterozygous tall parent (Tt) produces two types of gametes in equal proportion: one carrying the dominant allele T, and one carrying the recessive allele t.

Step 2: Arranging the gametes of one parent along the top of the Punnett square (T, t) and the gametes of the other parent along the side (T, t), each of the four inner cells is filled by combining the corresponding row and column gametes.

Step 3: This combination produces four genotype boxes: TT (top-left), Tt (top-right), Tt (bottom-left), and tt (bottom-right), giving a total genotypic ratio of 1 TT : 2 Tt : 1 tt.

Step 4: Since T (tallness) is dominant over t (dwarfness), both TT and Tt genotypes produce a tall phenotype, while only tt produces a dwarf phenotype, giving a phenotypic ratio of 3 tall : 1 dwarf.

Final Answer: Genotypic ratio 1 TT : 2 Tt : 1 tt; phenotypic ratio 3 tall : 1 dwarf.

Answer: (See above)

Go Back to Question 34

Q35.

Solution

Concept: The nervous system coordinates the body's response to internal and external stimuli through rapid electrical signalling, and its simplest functional unit of quick, involuntary response is the reflex arc, which allows an immediate protective reaction without waiting for conscious brain processing.

Alternative (i): Step 1: The nervous system detects changes in the internal and external environment through sensory receptors and rapidly transmits this information as electrical impulses to the brain and spinal cord for processing.
Step 2: Based on this processed information, the nervous system coordinates an appropriate and rapid motor response, such as muscle contraction or gland secretion, allowing the body to react quickly and precisely to stimuli.
Alternative (ii): Step 1: When a person accidentally touches a hot object, heat-sensitive receptors in the skin generate a nerve impulse that travels along a sensory neuron toward the spinal cord.
Step 2: Within the spinal cord, the sensory neuron directly relays the impulse to an interneuron (relay neuron), which quickly passes it on to a motor neuron, bypassing the need to first involve the brain.
Step 3: The motor neuron carries the impulse to the muscles of the arm, causing them to contract and rapidly withdraw the hand from the hot object, protecting the body from further injury before the sensation of pain is even consciously perceived.
Final Answer: (i) The nervous system detects stimuli via receptors and coordinates rapid motor responses; (ii) A reflex arc withdraws the hand from a hot object via sensory neuron, spinal interneuron, and motor neuron, without requiring conscious brain processing.

Answer: (See above)

Go Back to Question 35

Q36.

Solution

Concept: A balanced diet supplies all the essential nutrients – carbohydrates, proteins, fats, vitamins, minerals, and water – in the correct proportions needed for growth, energy, and maintenance of body functions. Deficiency of any single nutrient over a prolonged period leads to a specific, identifiable deficiency disease.

Step 1: A balanced diet is defined as a diet that provides all the required nutrients in adequate amounts and correct proportions, matched to an individual's age, sex, activity level, and physiological condition, while avoiding both deficiency and excess.

Step 2: A chronic deficiency of dietary protein, especially in growing children, leads to Kwashiorkor, characterised by oedema, muscle wasting, and a swollen abdomen due to insufficient protein for tissue repair and fluid balance.

Step 3: A chronic deficiency of Vitamin D impairs the absorption and utilisation of calcium and phosphorus, leading to Rickets in children, characterised by soft, weak, and deformed bones due to inadequate bone mineralisation.

Final Answer: Balanced diet supplies all nutrients in correct proportions; protein deficiency causes Kwashiorkor; Vitamin D deficiency causes Rickets.

Answer: (See above)

Go Back to Question 36

Q37.

Solution

Concept: In organisms with double circulation, blood passes through the heart twice in one complete circuit of the body: once as deoxygenated blood pumped to the lungs (pulmonary circulation), and again as oxygenated blood pumped to the rest of the body (systemic circulation), which keeps oxygenated and deoxygenated blood almost entirely separate.

Step 1: Deoxygenated blood returning from body tissues enters the right side of the heart, which pumps it to the lungs for oxygenation; this first pass through the heart-lung route is called pulmonary circulation.

Step 2: The now-oxygenated blood returns from the lungs to the left side of the heart, which pumps it out through the aorta to supply oxygen and nutrients to all body tissues; this second pass is called systemic circulation.

Step 3: Since blood passes through the heart twice (once for each circuit) before completing one full round of the body, this overall pattern is termed double circulation.

Step 4: The key advantage of double circulation is that oxygenated and deoxygenated blood remain almost completely separated within the four-chambered heart, allowing blood to be pumped to the body at a higher pressure and with greater oxygen content, thereby supporting a higher metabolic rate than single circulation would allow.

Final Answer: Double circulation means blood passes through the heart twice per complete circuit (pulmonary and systemic); its advantage is efficient separation of oxygenated and deoxygenated blood, supporting a higher metabolic rate.

Answer: (See above)

Go Back to Question 37

Q38.

Solution

Concept: The immune system recognises and responds to foreign molecules through the interaction of antigens, antibodies, and different modes of immunity. Understanding these three terms is fundamental to describing how the body defends itself against pathogens.

Step 1: An antigen is any foreign molecule (usually a protein or polysaccharide present on the surface of a pathogen) that is capable of triggering a specific immune response in the body; for example, the surface protein of a virus acts as an antigen.

Step 2: An antibody (immunoglobulin) is a Y-shaped protein produced by plasma cells (derived from B-lymphocytes) that specifically recognises and binds to a particular antigen, neutralising or marking it for destruction; for example, the antibodies produced in response to the tetanus toxin specifically bind and neutralise that toxin.

Step 3: Active immunity is the type of immunity in which an individual's own immune system is stimulated to produce antibodies in response to exposure to an antigen, either through natural infection or through vaccination; for example, immunity developed after recovering from chickenpox or after receiving the measles vaccine is active immunity.

Final Answer: Antigen: foreign molecule triggering immune response (e.g., viral surface protein); Antibody: specific protein binding an antigen (e.g., anti-tetanus antibody); Active immunity: immunity from the individual's own antibody production (e.g., after vaccination).

Answer: (See above)

Go Back to Question 38

Q39.

Solution

Concept: Gene expression proceeds through transcription, in which a DNA template is copied into mRNA within the nucleus, followed by translation, in which the mRNA codon sequence is decoded at the ribosome to build a specific polypeptide chain with the help of transfer RNA (tRNA).

Alternative (i): Step 1: Transcription begins when the enzyme RNA polymerase binds to a specific promoter region on the DNA and unwinds a short section of the double helix, exposing the template strand.

Step 2: RNA polymerase then moves along the template strand, synthesising a complementary, single-stranded pre-mRNA molecule by adding ribonucleotides according to the base-pairing rules (with uracil replacing thymine).

Step 3: In eukaryotic cells, this pre-mRNA undergoes processing (capping, addition of a poly-A tail, and splicing out of non-coding introns) before the mature mRNA exits the nucleus through nuclear pores into the cytoplasm.

Alternative (ii): Step 1: Translation begins when the mature mRNA molecule attaches to a ribosome in the cytoplasm, with the ribosome reading the mRNA sequence in sets of three nucleotides called codons.

Step 2: Specific transfer RNA (tRNA) molecules, each carrying a particular amino acid and possessing an anticodon complementary to a specific mRNA codon, bring the correct amino acids to the ribosome in the sequence dictated by the mRNA.

Step 3: The ribosome catalyses the formation of peptide bonds between successive amino acids, elongating the polypeptide chain until a stop codon is reached, at which point the completed protein is released.

Final Answer: (i) Transcription copies the DNA template into mRNA via RNA polymerase, followed by processing in eukaryotes; (ii) Translation uses ribosomes to read mRNA codons and tRNA to bring matching amino acids, building the polypeptide chain.

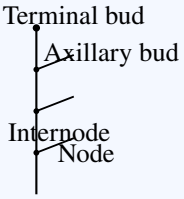
Answer: (See above)

Go Back to Question 39

Q40.

Solution

Concept: The shoot system of a dicot plant shows a regular external morphology consisting of nodes (points where leaves and buds arise), internodes (the stem segments between two nodes), and buds (undeveloped shoots), each performing a distinct role in the plant's growth and branching pattern.



Step 1: A node is the specific point on the stem from which a leaf, and often an axillary (lateral) bud, arises; nodes mark the fixed positions along the stem where lateral growth potential exists.
Step 2: An internode is the length of stem tissue lying between two successive nodes; internodes elongate to physically separate the leaves along the stem, allowing better exposure to sunlight and air.
Step 3: The terminal bud is located at the very tip (apex) of the shoot and contains the apical meristem responsible for the primary, longitudinal growth of the stem, continually adding new nodes and internodes as the plant grows taller.
Step 4: Axillary (lateral) buds, found at the nodes in the angle between the leaf and stem, remain dormant under the influence of the terminal bud (apical dominance) but can develop into new branches if the terminal bud is removed or damaged.
Final Answer: Node bears leaf/bud, internode separates nodes, terminal bud drives primary growth, and axillary buds can form branches.

Answer: (See above)

Go Back to Question 40

Q41.

Solution

Concept: Micronutrient deficiency diseases result from the prolonged inadequate intake of a specific vitamin or mineral, each producing a characteristic set of symptoms that can generally be prevented through dietary correction or supplementation.

Alternative (i): Step 1: Vitamin A is essential for the synthesis of rhodopsin, the light-sensitive pigment in the rod cells of the retina that enables vision in dim light.

Step 2: A chronic dietary deficiency of Vitamin A impairs rhodopsin regeneration, causing difficulty in seeing in low-light conditions, a symptom known as night blindness; severe, prolonged deficiency can further damage the cornea.

Step 3: This deficiency can be prevented by regularly including Vitamin A-rich foods in the diet, such as carrots, leafy green vegetables, liver, milk, and egg yolk, or through periodic Vitamin A supplementation programmes.

Alternative (ii): Step 1: Iron is a key structural component of haemoglobin, the oxygen-carrying protein pigment present inside red blood cells.

Step 2: A chronic dietary deficiency of iron reduces haemoglobin synthesis, leading to iron-deficiency anaemia, characterised by fatigue, pale skin, breathlessness, and reduced work capacity due to lowered oxygen-carrying ability of the blood.

Step 3: This condition can be prevented by including iron-rich foods such as green leafy vegetables, jaggery, pulses, and meat in the diet, along with foods rich in Vitamin C, which enhances iron absorption.

Final Answer: (i) Vitamin A deficiency impairs rhodopsin formation causing night blindness, prevented by Vitamin A-rich foods; (ii) Iron deficiency reduces haemoglobin causing anaemia, prevented by iron-rich foods and Vitamin C intake.

Answer: (See above)

Go Back to Question 41

Q42.

Solution

Concept: Mendel's law of independent assortment states that the alleles of two different genes segregate independently of one another during gamete formation, provided the genes lie on different chromosomes; this principle underlies the predictable phenotypic ratios seen in dihybrid crosses. Human sex determination, by contrast, depends on the specific combination of sex chromosomes (XX in females, XY in males) inherited from each parent.

Alternative (i): Step 1: Mendel's law of independent assortment states that when two pairs of contrasting traits are considered together, the alleles of one gene pair separate independently of the alleles of the other gene pair during gamete formation, provided the two genes are located on different chromosomes.

Step 2: A pea plant with genotype RrYy (round, yellow seeds) produces four types of gametes in equal proportion: RY, Ry, rY, and ry, because the R/r alleles assort independently of the Y/y alleles.

Step 3: Crossing two RrYy plants (a standard dihybrid cross) and combining all sixteen possible gamete combinations in a 4×4 Punnett square yields the classic dihybrid phenotypic ratio of 9 : 3 : 3 : 1 – that is, 9 round yellow : 3 round green : 3 wrinkled yellow : 1 wrinkled green.

Alternative (ii): Step 1: In humans, sex is determined by the combination of sex chromosomes: females carry two X chromosomes (XX), while males carry one X and one Y chromosome (XY).

Step 2: Since the mother can only contribute an X chromosome (being XX), while the father can contribute either an X or a Y chromosome (being XY) with equal probability, the sex chromosome donated by the father determines the sex of the child.

Step 3: For the cross between a normal woman (XX) and a colour-blind man (X^cY): the mother contributes either X to each child, and the father contributes either X^c or Y. This gives daughters with genotype XX^c (phenotypically normal but carriers) and sons with genotype XY (phenotypically normal, non-colour-blind), since the father's Y chromosome carries no colour-blindness allele.

Final Answer: (i) Dihybrid F1 phenotypic ratio is 9 round yellow : 3 round green : 3 wrinkled yellow : 1 wrinkled green; (ii) All daughters are carriers (XX^c, phenotypically normal) and all sons are normal (XY, non-colour-blind).

Answer: (See above)

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Q43.

Solution

Concept: Whittaker's five-kingdom classification groups all living organisms into Monera, Protista, Fungi, Plantae, and Animalia based on cell structure, mode of nutrition, and body organisation. Plant tissues, in turn, are divided into meristematic tissue (actively dividing) and permanent tissue (differentiated), each with characteristic cell features suited to its function.

Alternative (i): Step 1: Kingdom Monera comprises prokaryotic, unicellular organisms lacking a membrane-bound nucleus, such as bacteria (e.g., *Escherichia coli*).
Step 2: Kingdom Protista (Protoctista) comprises simple eukaryotic organisms, mostly unicellular, such as *Amoeba*, which do not fit clearly into the plant, animal, or fungal groups.
Step 3: Kingdom Fungi comprises eukaryotic, non-green, heterotrophic organisms with a chitinous cell wall that generally show saprophytic nutrition, such as *Rhizopus* (bread mould).
Step 4: Kingdom Plantae comprises multicellular, eukaryotic, autotrophic organisms with a cellulose cell wall and chlorophyll, such as the mango tree, while Kingdom Animalia comprises multicellular, eukaryotic, heterotrophic organisms lacking a cell wall, such as the housefly.
Alternative (ii): Step 1: Meristematic tissue is composed of small, thin-walled, densely cytoplasmic cells with prominent nuclei and no large vacuoles, located at the root tip, shoot tip, and cambium, where the cells actively and repeatedly divide to bring about growth.

Step 2: Parenchyma, a common type of permanent (simple) tissue, consists of relatively large, thin-walled, loosely arranged, living cells with prominent vacuoles, found in the cortex and pith of stems and roots, mainly performing storage and, where chloroplasts are present, photosynthesis.
Step 3: Unlike meristematic cells, mature parenchyma cells have generally lost the ability to divide and instead are specialised for specific supportive or storage functions, illustrating the fundamental structural and functional distinction between meristematic and permanent plant tissues.
Final Answer: (i) Monera (e.g., bacteria), Protista (e.g., Amoeba), Fungi (e.g., Rhizopus), Plantae (e.g., mango), Animalia (e.g., housefly); (ii) Meristematic tissue: small dividing cells at growing tips; Parenchyma (permanent tissue): large thin-walled cells for storage/photosynthesis.

Answer: (See above)

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Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	B	2	B	3	C	4	C	5	B
6	C	7	B	8	B	9	C	10	B
11	C	12	B	13	B	14	C	15	B
16	B								