NIOS Class 12 Biology Sample Paper-7

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. The oxygen gas released during photosynthesis comes from the splitting of which molecule? **(1)**

(A) Carbon dioxide (CO_2)

(B) Glucose ($C_6H_{12}O_6$)

(C) Water (H_2O)

(D) Ribulose bisphosphate (RuBP)

Q2. The physical, observable characteristics of an organism (such as flower colour or seed shape) that result from the expression of its genes are collectively called its: **(1)**

(A) Genotype

(B) Phenotype

(C) Karyotype

(D) Genome

Q3. Which of the following is the most widely used criterion to distinguish fungi from green plants? **(1)**

(A) Fungi are always unicellular

(B) Fungi reproduce only asexually

(C) Fungi lack chlorophyll and are heterotrophic

(D) Fungi have a cellulose-based cell wall

Q4. In an ecological pyramid of energy, the base is always occupied by the: **(1)**

(A) Producers (autotrophs)

(B) Primary consumers (herbivores)

(C) Secondary consumers (carnivores)

(D) Decomposers

Q5. In the absence of oxygen, yeast cells break down glucose to produce ethanol and carbon dioxide. This process is known as: **(1)**

(A) Anaerobic fermentation (alcoholic fermentation)

(B) Aerobic respiration

(C) Photosynthesis

(D) Chemosynthesis

Q6. The outermost whorl of a typical flower, which consists of small green leaf-like structures that protect the flower bud, is called the: **(1)**

(A) Corolla

(B) Androecium

(C) Gynoecium

(D) Calyx

Q7. The technique used to make millions of copies of a specific DNA segment in vitro using a heat-stable DNA polymerase (Taq polymerase) is called: **(1)**

(A) Gel electrophoresis

(B) Polymerase chain reaction (PCR)

(C) Recombinant DNA technology

(D) Southern blotting

Q8. Bryophytes (e.g., mosses) are often called the "amphibians of the plant kingdom" because they: **(1)**

(A) Live exclusively in water

(B) Can survive only in deserts

(C) Live on land but require water for sexual reproduction

(D) Are fully adapted to a terrestrial life without water

Q9. The liquid, straw-coloured matrix of human blood in which the blood cells are suspended is called: **(1)**

(A) Serum

(B) Lymph

(C) Interstitial fluid

(D) Plasma

Q10. Severe deficiency of Vitamin D in growing children leads to improper calcification of bones, causing them to become soft and deformed. This condition is called: **(1)**

(A) Rickets

(B) Pellagra

(C) Scurvy

(D) Kwashiorkor

Q11. During DNA replication, if the template strand reads 3′-ATGCCA-5′, the newly synthesised complementary strand will read: **(1)**

(A) 5′-ATGCCA-3′

(B) 5′-TACGGT-3′

(C) 5′-UACGGU-3′

(D) 5′-GCATGC-3′

Q12. The hormone adrenaline (epinephrine), which prepares the body for a "fight or flight" response during stress, is secreted by the: **(1)**

(A) Thyroid gland

(B) Pituitary gland

(C) Pancreas

(D) Adrenal medulla

Q13. In animals, the tissue that lines the inner surface of blood vessels and the alveoli of the lungs, forming a thin, smooth, single-layered barrier, is called: **(1)**

(A) Squamous epithelium

(B) Striated muscle tissue

(C) Areolar connective tissue

(D) Nervous tissue

Q14. A person who has recovered from chickenpox rarely gets the disease again. This long-lasting protection is an example of: **(1)**

(A) Passive immunity

(B) Innate immunity

(C) Naturally acquired active immunity

(D) Artificially acquired passive immunity

Q15. In the human female reproductive cycle, the hormone that is primarily responsible for the development and maintenance of the uterine lining (endometrium) after ovulation is: **(1)**

(A) Follicle-stimulating hormone (FSH)

(B) Progesterone

(C) Luteinising hormone (LH)

(D) Testosterone

Q16. The process by which water is lost from the aerial parts (mainly leaves) of a plant in the form of water vapour through stomata is called: **(1)**

(A) Guttation

(B) Transpiration

(C) Translocation

(D) Absorption

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:

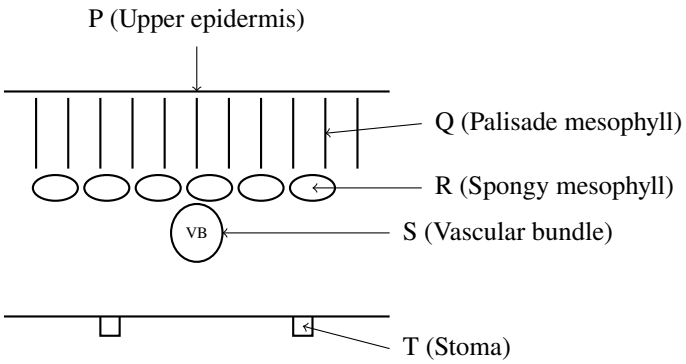
Cellular respiration in plants begins with glycolysis in the cytoplasm, where one molecule of glucose (a six-carbon sugar) is split into two molecules of pyruvic acid (a three-carbon compound), producing a net gain of 2 ATP and 2 NADH. Under aerobic conditions, pyruvic acid then enters the mitochondria, where it is completely oxidised through the Krebs cycle and the electron transport chain, yielding a total of about 36 ATP molecules per glucose molecule. **(2)**

1. Name the three-carbon compound formed at the end of glycolysis.
2. In which cellular organelle does the complete aerobic oxidation of pyruvic acid occur?

Q18. Complete the following sentences using the words given below:
(vascular, thallus, rhizoids, sporophyte, gametophyte) **(2)**

1. Bryophytes lack true roots and instead possess hair-like structures called . that anchor the plant body to the substratum.
2. The main plant body of a bryophyte (e.g., moss) is the haploid generation, which produces gametes for sexual reproduction.

Q19. Study the diagram of a transverse section of a dicot leaf given below and answer the questions that follow. **(2)**



1. Name the tissue labelled Q that contains the maximum number of chloroplasts and is the main site of photosynthesis in the leaf.

2. Name the tiny pore labelled T on the lower epidermis through which gaseous exchange and transpiration occur.

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

1. A cross between a homozygous dominant organism and a homozygous recessive organism for a single trait is called a ..... cross.
2. The ratio of different genotypes among the offspring of a genetic cross is called the ..... ratio.

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

Column I	**Column II**
(a) Red blood cells (RBCs)	(i) Defence against pathogens; produce antibodies
(b) White blood cells (WBCs)	(ii) Carry oxygen from lungs to tissues using haemoglobin
(c) Platelets	(iii) Transport dissolved nutrients, hormones, and waste products
(d) Plasma	(iv) Aid in blood clotting at the site of an injury

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

1. A species of plant or animal that is found naturally in a particular geographic area and nowhere else on Earth is called an ..... species.
2. The variety of life forms found in a particular ecosystem, including diversity of species, genes, and ecosystems, is called .....

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

1. In flowering plants, pollination is the transfer of pollen grains from the anther to the stigma of a flower.
2. The human egg (ovum) is released from the pituitary gland every month during the menstrual cycle.

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

Column I	**Column II**
(a) Bryophyta	(i) Seeds enclosed in fruits; flowers present
(b) Pteridophyta	(ii) Non-vascular; requires water for fertilisation; e.g., moss
(c) Gymnospermae	(iii) Vascular; spore-bearing; e.g., fern
(d) Angiospermae	(iv) Seeds naked (not enclosed in fruits); e.g., pine

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

1. The outermost layer of cells in a young root, some of whose cells extend outward to form root hairs, is called the .....
2. The central core of the root containing xylem and phloem arranged in a specific pattern is called the ..... (or stele).

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

Column I	**Column II**
(a) Parasitism	(i) Both species benefit from the interaction
(b) Commensalism	(ii) One organism benefits while the other is harmed
(c) Mutualism	(iii) Both species are negatively affected
(d) Competition	(iv) One organism benefits; the other is neither helped nor harmed

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

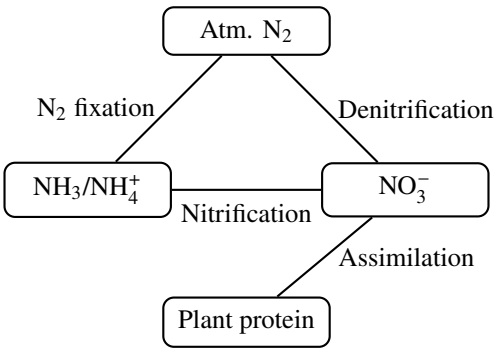
1. Bt cotton is a transgenic crop that contains a gene from the bacterium *Bacillus thuringiensis*, which produces a protein toxic to certain insect pests.
2. The human immunodeficiency virus (HIV) primarily attacks and destroys red blood cells (RBCs), leading to AIDS.

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

Column I	Column II
(a) Stamen	(i) Contains the ovules (egg cells)
(b) Pistil (Carpel)	(ii) Brightly coloured whorl that attracts pollinators
(c) Petal (Corolla)	(iii) Male reproductive organ that produces pollen
(d) Sepal (Calyx)	(iv) Green outermost whorl that protects the flower bud

Section: B

Q29. With the help of a simple flow diagram, outline the nitrogen cycle showing the four key steps: nitrogen fixation, nitrification, assimilation, and denitrification. **(2)**



Q30. Differentiate between self-pollination and cross-pollination, and state one advantage of cross-pollination over self-pollination. **(2)**

Q31. (i) What is meant by an 'endangered species'? Name any two endangered animal species found in India and state one reason why they are threatened.

OR

(ii) Define 'ecosystem'. Name the two major components of an ecosystem and give one example of each. **(2)**

Q32. (i) State two characteristic features of Kingdom Fungi, giving one example of a saprophytic fungus.

OR

(ii) State two differences between bacteria and viruses. **(2)**

Q33. During anaerobic fermentation by yeast, 1 mole of glucose produces 2 moles of ethanol and 2 moles of CO_2. If a baker uses yeast to ferment 3 moles of glucose in bread dough, calculate the total moles of CO_2 gas released (which causes the dough to rise) and the total moles of ethanol produced. **(2)**

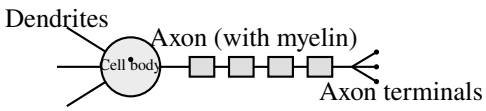
Q34. In humans, the ability to roll the tongue (R) is dominant over the inability to roll the tongue (r). A man who is heterozygous for tongue rolling (Rr) marries a woman who cannot roll her tongue (rr). Using a Punnett square, work out the probability that their child will be a tongue roller. **(2)**

	R	r
r	Rr	rr
r	Rr	rr

Q35. (i) Draw a simple labelled diagram of a neuron (nerve cell) showing the cell body, dendrites, axon, and axon terminals.

OR

(ii) Define 'reflex action' and draw a simple labelled diagram of a reflex arc. **(2)**



Q36. What are 'vitamins'? Classify them into fat-soluble and water-soluble groups, giving one example of each. **(2)**

Q37. Define 'blood pressure'. What is meant by systolic and diastolic pressure, and what is the normal blood pressure reading in a healthy young adult? **(2)**

Q38. Describe the basic steps involved in the production of a recombinant DNA molecule, mentioning:

A. The role of restriction endonuclease

B. The role of DNA ligase

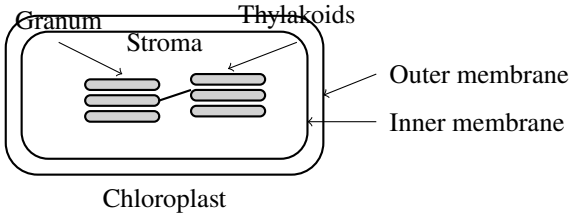
C. The role of the vector (plasmid) **(3)**

Q39. (i) Explain the chromosomal basis of sex determination in humans (XX–XY system), stating how the sex of a child is determined at the time of fertilisation.

OR

(ii) Define the term 'mutation'. State two types of gene mutations and give one example of a human genetic disorder caused by a gene mutation. **(3)**

Q40. With the help of a labelled diagram, describe the structure of a chloroplast, identifying the outer membrane, inner membrane, thylakoid, granum, and stroma. State where the light-dependent and light-independent reactions occur. **(3)**



Q41. (i) Describe the harmful effects of smoking tobacco on the respiratory system and overall health of a person. List two measures for prevention.

OR

(ii) What are communicable (infectious) diseases? Name one disease each caused by a bacterium, a virus, and a protozoan, and state one preventive measure for each. **(3)**

Q42. (i) (a) Describe the structure of a mature embryo sac (female gametophyte) in angiosperms, mentioning the seven cells and eight nuclei.

(b) Explain the process of double fertilisation and state its significance.

OR

(ii) (a) Explain the structure of DNA as proposed by Watson and Crick, mentioning the double helix, base pairing, and antiparallel strands.

(b) Describe the process of transcription in a eukaryotic cell, mentioning the role of RNA polymerase and the formation of mRNA. **(5)**

Q43. (i) Describe the structure and functions of the four types of animal tissues: epithelial, connective, muscular, and nervous. Give one example of where each is found in the human body.

OR

(ii) (a) Draw a well-labelled diagram of the human heart showing all four chambers, major blood vessels, and valves.

(b) Describe the flow of blood through the heart during one complete cardiac cycle (pulmonary and systemic circulation). **(5)**

Detailed Solutions

Q1.

Solution

Concept: During the light-dependent reactions of photosynthesis, water molecules are split (photolysis) at Photosystem II on the thylakoid membrane. The oxygen released as a by-product comes entirely from the splitting of water, not from carbon dioxide.

Step 1: The overall equation of photosynthesis ($6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$) shows O_2 is produced, but does not immediately reveal its molecular source.
Step 2: Experiments using heavy oxygen isotope (^{18}O) demonstrated that when water is labelled with ^{18}O, the released oxygen gas contains ^{18}O, confirming that O_2 comes from H_2O, not from CO_2.
Step 3: In the light reactions, the reaction $2H_2O \rightarrow 4H^+ + 4e^- + O_2$ (photolysis of water) releases oxygen, protons, and electrons.

Why other options are wrong:

- **Option A:** The oxygen atoms in CO_2 are incorporated into glucose and water during the Calvin cycle, not released as O_2.
- **Option B:** Glucose is a product of photosynthesis, not a source of released oxygen.
- **Option D:** RuBP is the CO_2 acceptor in the Calvin cycle; it does not release O_2.

Final Answer: $\boxed{\text{Water } (H_2O)}$ (Option C)

Answer: (C)

Go Back to Question 1

Q2.

Solution

Concept: In genetics, the genotype is the genetic makeup (set of alleles) of an organism, while the phenotype is the set of observable physical, biochemical, and physiological characteristics expressed by an organism as a result of the interaction between its genotype and the environment.

Step 1: The phenotype includes all visible traits – height, colour, shape, biochemical properties – that can be observed or measured in an organism.
Step 2: Two organisms may have the same genotype but different phenotypes if raised in different environments, showing that phenotype depends on both genotype and environment.

Why other options are wrong:

- **Option A:** The genotype refers to the allelic composition, not the physical appearance.
- **Option C:** A karyotype is the number and visual appearance of chromosomes, not trait expression.
- **Option D:** A genome is the complete set of genetic material (all DNA) in an organism.

Final Answer: Phenotype (Option B)

Answer: (B)

Go Back to Question 2

Q3.

Solution

Concept: Fungi are eukaryotic, heterotrophic organisms that lack chlorophyll and therefore cannot carry out photosynthesis. This is the most fundamental distinction from green plants, which are autotrophic and possess chlorophyll.

Step 1: Green plants contain chlorophyll and manufacture their own food through photosynthesis (autotrophic nutrition).
Step 2: Fungi completely lack chlorophyll and cannot photosynthesise. They are heterotrophic – they obtain nutrition by absorbing organic matter from their surroundings (saprophytic or parasitic nutrition).
Step 3: Their cell wall is made of chitin (not cellulose), they can be unicellular or multicellular, and they can reproduce both sexually and asexually.

Why other options are wrong:

- **Option A:** Many fungi are multicellular (e.g., mushrooms, moulds).
- **Option B:** Fungi can reproduce both sexually and asexually.
- **Option D:** The fungal cell wall is made of chitin, not cellulose.

Final Answer: Fungi lack chlorophyll and are heterotrophic (Option C)

Answer: (C)

Go Back to Question 3

Q4.

Solution

Concept: An ecological pyramid of energy always has a broad base and a narrow apex, reflecting the progressive decrease in available energy at each successive trophic level. The base is always occupied by producers because they trap the maximum solar energy through photosynthesis.

Step 1: Producers (autotrophs such as green plants and algae) fix solar energy into chemical energy, forming the foundation of every food chain and energy pyramid.
Step 2: At each subsequent trophic level, approximately 90% of the energy is lost as heat through respiration, so the available energy decreases progressively from producers to primary consumers to secondary consumers.
Step 3: Unlike pyramids of numbers or biomass (which may occasionally be inverted), the pyramid of energy is never inverted – producers always occupy the widest base.

Why other options are wrong:

- **Option B:** Primary consumers occupy the second level, above producers.
- **Option C:** Secondary consumers occupy the third level.
- **Option D:** Decomposers are not typically shown as a trophic level in the energy pyramid.

Final Answer: Producers (autotrophs) (Option A)

Answer: (A)

Go Back to Question 4

Q5.

Solution

Concept: In the absence of oxygen, many organisms (including yeast) carry out anaerobic respiration (fermentation), in which glucose is incompletely broken down without using the electron transport chain. In yeast, this produces ethanol (ethyl alcohol) and CO_2.

Step 1: Under anaerobic conditions, yeast first performs glycolysis (splitting glucose into two molecules of pyruvic acid in the cytoplasm, producing 2 ATP).
Step 2: The pyruvic acid is then converted to ethanol and CO_2 by the enzyme pyruvate decarboxylase and alcohol dehydrogenase. This process is called alcoholic fermentation.
Step 3: This is different from aerobic respiration (which requires oxygen and produces 36 ATP), photosynthesis (which synthesises glucose), and chemosynthesis (which uses chemical energy instead of light).

Why other options are wrong:

- **Option B:** Aerobic respiration requires oxygen and completely oxidises glucose.
- **Option C:** Photosynthesis builds glucose using light energy, not breaks it down.
- **Option D:** Chemosynthesis uses inorganic chemical reactions to produce energy (in certain bacteria).

Final Answer: Anaerobic fermentation (Option A)

Answer: (A)

Go Back to Question 5

Q6.

Solution

Concept: A typical flower has four whorls arranged from outside to inside: calyx (sepals), corolla (petals), androecium (stamens), and gynoecium (carpels/pistils). The calyx is the outermost whorl of small, green, leaf-like structures called sepals.

Step 1: Sepals are typically green and photosynthetic. They enclose and protect the developing flower bud before it opens.
Step 2: The calyx (collective term for all sepals) is always the outermost whorl, located below the petals.
Step 3: The corolla consists of petals (usually colourful), the androecium consists of stamens (male), and the gynoecium consists of pistils (female) – none of these is the outermost protective whorl.

Why other options are wrong:

- **Option A:** The corolla (petals) is the second whorl, inside the calyx.
- **Option B:** The androecium (stamens) is the third whorl, the male reproductive part.
- **Option C:** The gynoecium (pistil) is the innermost whorl, the female reproductive part.

Final Answer: Calyx (Option D)

Answer: (D)

Go Back to Question 6

Q7.

Solution

Concept: The Polymerase Chain Reaction (PCR) is an in vitro technique that amplifies (makes millions of copies of) a specific target DNA segment. It uses repeated cycles of denaturation, annealing, and extension with a thermostable DNA polymerase (Taq polymerase).

Step 1: PCR involves three repeating steps: (a) denaturation (heating to ~95°C to separate the two DNA strands), (b) annealing (cooling to ~55°C to allow primers to bind to target sequences), and (c) extension (~72°C, where Taq polymerase synthesises new complementary strands).
Step 2: Each cycle doubles the number of copies of the target DNA, so after 30 cycles, approximately one billion copies are produced from a single starting molecule.

Why other options are wrong:

- **Option A:** Gel electrophoresis separates DNA fragments by size, it does not amplify them.
- **Option C:** Recombinant DNA technology is the broader field of combining DNA from different sources; PCR is a specific technique within it.
- **Option D:** Southern blotting is a method for detecting specific DNA sequences using hybridisation probes.

Final Answer: Polymerase chain reaction (PCR) (Option B)

Answer: (B)

Go Back to Question 7

Q8.

Solution

Concept: Bryophytes (mosses, liverworts, hornworts) are the simplest land plants. They are called "amphibians of the plant kingdom" because, although they live on moist land, they depend on water for the transfer of male gametes (sperms) to the female gamete, since their sperm are flagellated and must swim through water.

Step 1: Bryophytes grow on land (typically in moist, shady habitats) but lack true vascular tissues and true roots, relying on diffusion and capillarity for water transport.
Step 2: Their male gametes (antherozoids) are flagellated and require an external film of water to swim from the male reproductive organ (antheridium) to the female reproductive organ (archegonium), just as amphibian animals need water for reproduction.

Why other options are wrong:

- **Option A:** Bryophytes live on land (moist habitats), not exclusively in water.
- **Option B:** Bryophytes cannot survive in deserts; they need moist conditions.
- **Option D:** They are not fully adapted to land life – they still depend on water for reproduction.

Final Answer: Live on land but require water for sexual reproduction (Option C)

Answer: (C)

Go Back to Question 8

Q9.

Solution

Concept: Blood consists of a liquid matrix called plasma (about 55% of blood volume) in which the formed elements (RBCs, WBCs, and platelets) are suspended. Plasma is a straw-coloured, slightly alkaline fluid composed mainly of water (~90%), proteins, salts, nutrients, hormones, and waste products.

Step 1: Plasma is the liquid component of blood that remains when all formed elements are removed. It is pale yellow (straw-coloured) due to dissolved bilirubin and other pigments.
Step 2: Serum is plasma minus clotting factors (fibrinogen); lymph is the filtered fluid within lymphatic vessels; interstitial fluid bathes the cells outside blood vessels. None of these is the liquid matrix of blood itself.

Why other options are wrong:

- **Option A:** Serum is plasma without clotting factors – obtained after blood clots.
- **Option B:** Lymph is a clear fluid in the lymphatic system, not the matrix of blood.
- **Option C:** Interstitial fluid is the extracellular fluid between cells in tissues.

Final Answer: Plasma (Option D)

Answer: (D)

Go Back to Question 9

Q10.

Solution

Concept: Vitamin D (calciferol) is essential for the absorption of calcium and phosphorus from the intestine and their proper deposition in bones and teeth. In growing children, prolonged deficiency of Vitamin D leads to rickets, characterised by soft, weak, and deformed bones.

Step 1: Without adequate Vitamin D, the intestine cannot absorb sufficient calcium and phosphorus, resulting in defective mineralisation of growing bones.
Step 2: The under-mineralised bones become soft, bend under the weight of the body, and develop characteristic deformities such as bow legs, knock knees, and a pigeon chest. This condition is called rickets.
Step 3: Vitamin D can be obtained from sunlight exposure (UV light triggers its synthesis in the skin), fish liver oil, egg yolk, and fortified milk.

Why other options are wrong:

- **Option B:** Pellagra is caused by niacin (Vitamin B_3) deficiency (dermatitis, diarrhoea, dementia).
- **Option C:** Scurvy is caused by Vitamin C deficiency (bleeding gums, poor healing).
- **Option D:** Kwashiorkor is caused by severe protein deficiency (oedema, distended abdomen).

Final Answer: Rickets (Option A)

Answer: (A)

Go Back to Question 10

Q11.

Solution

Concept: During DNA replication, the new strand is synthesised by the enzyme DNA polymerase according to the base-pairing rules: A pairs with T, and G pairs with C. The new strand is antiparallel to the template strand (5′ to 3′ direction).

Step 1: The template strand given is 3′-ATGCCA-5′. DNA polymerase reads this template in the 3′ to 5′ direction and synthesises the new strand in the 5′ to 3′ direction.
Step 2: Applying the DNA base-pairing rules: A→T, T→A, G→C, C→G, C→G, A→T. So the new strand reads 5′-TACGGT-3′.

Why other options are wrong:

- **Option A:** This is identical to the template, not complementary.
- **Option C:** This contains uracil (U), which is found in RNA, not DNA.
- **Option D:** This sequence does not follow correct base-pairing with the template.

Final Answer: 5′-TACGGT-3′ (Option B)

Answer: (B)

Go Back to Question 11

Q12.

Solution

Concept: The adrenal glands sit on top of each kidney. The inner part (adrenal medulla) secretes the catecholamine hormones adrenaline (epinephrine) and noradrenaline (norepinephrine). Adrenaline rapidly prepares the body for emergency situations – the "fight or flight" response.

Step 1: When a stressful or threatening situation is detected, nerve signals from the hypothalamus stimulate the adrenal medulla to release adrenaline into the bloodstream.
Step 2: Adrenaline increases heart rate, dilates air passages, raises blood pressure, redirects blood to muscles, and mobilises glucose – all adaptations for rapid physical action.

Why other options are wrong:

- **Option A:** The thyroid gland secretes thyroxine, which regulates metabolic rate.
- **Option B:** The pituitary gland secretes growth hormone and regulatory hormones.
- **Option C:** The pancreas secretes insulin and glucagon for blood glucose regulation.

Final Answer: Adrenal medulla (Option D)

Answer: (D)

Go Back to Question 12

Q13.

Solution

Concept: Epithelial tissue covers body surfaces and lines internal cavities and organs. Squamous epithelium consists of thin, flat cells forming a smooth, single-layered lining. It is found where diffusion or filtration occurs rapidly – lining blood vessels (endothelium) and alveoli of the lungs.

Step 1: The inner lining of blood vessels requires an extremely thin, smooth surface to minimise friction and allow rapid exchange of substances. This is provided by simple squamous epithelium.
Step 2: Similarly, the walls of lung alveoli are lined by squamous epithelium to allow efficient diffusion of O_2 and CO_2 between the alveolar air and the blood capillaries.

Why other options are wrong:

- **Option B:** Striated muscle tissue is responsible for voluntary movement, not lining surfaces.
- **Option C:** Areolar connective tissue fills spaces between organs; it does not form thin linings.
- **Option D:** Nervous tissue transmits impulses; it does not line blood vessels or alveoli.

Final Answer: Squamous epithelium (Option A)

Answer: (A)

Go Back to Question 13

Q14.

Solution

Concept: Active immunity is produced when the body's own immune system encounters an antigen (naturally or artificially) and mounts an immune response, producing antibodies and long-lasting memory cells. Naturally acquired active immunity develops after recovering from a natural infection.

Step 1: When a person is infected with the chickenpox virus for the first time, their immune system produces specific antibodies and, critically, memory B-cells and T-cells that "remember" the virus.
Step 2: If the same virus enters the body again, these memory cells mount a rapid, strong secondary immune response that eliminates the pathogen before symptoms develop, providing long-lasting protection.
Step 3: This immunity was acquired naturally (through infection, not vaccination) and actively (the person's own immune system produced the antibodies, not received them from an external source).

Why other options are wrong:

- **Option A:** Passive immunity involves receiving pre-formed antibodies, not making your own.
- **Option B:** Innate immunity is non-specific and present from birth; it does not explain pathogen-specific memory.
- **Option D:** Artificially acquired passive immunity involves injection of antibodies (e.g., anti-venom), not natural infection.

Final Answer: Naturally acquired active immunity (Option C)

Answer: (C)

Go Back to Question 14

Q15.

Solution

Concept: After ovulation in the human female, the ruptured Graafian follicle transforms into the corpus luteum, which secretes the hormone progesterone. Progesterone maintains and thickens the uterine lining (endometrium), preparing it for possible implantation of a fertilised egg.

Step 1: After ovulation, LH from the pituitary stimulates the remaining follicular cells to form the corpus luteum, a temporary endocrine structure.
Step 2: The corpus luteum secretes progesterone, which acts on the endometrium to make it thick, highly vascularised, and rich in glandular secretions – essential for the nourishment and implantation of the embryo.
Step 3: If pregnancy does not occur, the corpus luteum degenerates, progesterone levels drop, and the endometrium breaks down (menstruation).

Why other options are wrong:

- **Option A:** FSH stimulates follicle development in the ovary before ovulation.
- **Option C:** LH triggers ovulation and stimulates corpus luteum formation but does not directly maintain the endometrium.
- **Option D:** Testosterone is the principal male sex hormone; it does not maintain the female endometrium.

Final Answer: Progesterone (Option B)

Answer: (B)

Go Back to Question 15

Q16.

Solution

Concept: Plants lose water from their aerial surfaces primarily through small pores called stomata on leaves. This evaporative loss of water vapour from the aerial parts of the plant is called transpiration.

Step 1: Transpiration occurs mainly through stomata (stomatal transpiration), with minor amounts lost through the cuticle (cuticular transpiration) and lenticels on the bark.
Step 2: Transpiration generates a negative pressure (suction) in the xylem, called transpiration pull, which helps draw water upward from the roots to the leaves.

Why other options are wrong:

- **Option A:** Guttation is the loss of liquid water from leaf tips/margins through hydathodes, usually at night.
- **Option C:** Translocation is the transport of food (sucrose) through phloem from leaves to other plant parts.
- **Option D:** Absorption is the uptake of water and minerals by root hairs from the soil.

Final Answer: Transpiration (Option B)

Answer: (B)

Go Back to Question 16

Q17.

Solution

Concept: Glycolysis is the first step of cellular respiration. It occurs in the cytoplasm and splits one six-carbon glucose molecule into two three-carbon pyruvic acid (pyruvate) molecules. The subsequent aerobic oxidation of pyruvate occurs entirely within the mitochondria.

Step 1: The passage states that glucose "is split into two molecules of pyruvic acid (a three-carbon compound)." Therefore, the three-carbon compound formed at the end of glycolysis is **pyruvic acid (pyruvate)**.
Step 2: The passage states that "pyruvic acid then enters the mitochondria, where it is completely oxidised through the Krebs cycle and the electron transport chain." Therefore, the organelle in which complete aerobic oxidation occurs is the **mitochondrion (mitochondria)**.

Final Answer:
1. Pyruvic acid (pyruvate)
2. Mitochondria (mitochondrion)

Answer: (See above)

Go Back to Question 17

Q18.

Solution

Concept: Bryophytes are the simplest land plants. They lack true roots, stems, and leaves. Instead, they possess hair-like structures called rhizoids for anchorage and absorption. The main plant body is the haploid gametophyte generation, which produces gametes.

Step 1: **Rhizoids** are simple, filamentous, hair-like structures found on the underside of bryophytes. They anchor the plant body to the substratum (soil, rock, or bark) and help absorb water and minerals by capillarity.
Step 2: In bryophytes, the dominant, conspicuous plant body is the haploid **gametophyte** generation (n), which bears the sex organs (archegonia and antheridia) and produces gametes. The sporophyte generation (2n) is small and dependent on the gametophyte.

Final Answer:
1. rhizoids
2. gametophyte

Answer: (See above)
Go Back to Question 18

Q19.

Solution

Concept: A transverse section of a typical dicot leaf shows an upper and lower epidermis, two types of mesophyll tissue (palisade and spongy), vascular bundles (veins), and stomata on the lower surface. The palisade mesophyll is the chief photosynthetic tissue, and stomata regulate gas exchange.

Step 1: Tissue Q (**palisade mesophyll**) is located just below the upper epidermis. Its cells are columnar, tightly packed, and contain the largest number of chloroplasts per cell in the leaf. This tissue is the principal site of photosynthesis because it receives the maximum amount of light.
Step 2: Structure T is a **stoma** (plural: stomata). Stomata are microscopic pores on the leaf epidermis (mainly the lower surface in dorsiventral leaves). Each stoma is surrounded by two bean-shaped guard cells that regulate the size of the pore opening. Stomata allow the entry of CO_2 for photosynthesis, the exit of O_2, and the evaporation of water vapour (transpiration).

Final Answer:
1. Palisade mesophyll
2. Stoma (stomata)

Answer: (See above)
Go Back to Question 19

Q20.

Solution

Concept: A monohybrid cross is a genetic cross that involves only one pair of contrasting characters. The genotypic ratio describes the proportion of different genotypes (allele combinations) among the offspring.

Step 1: A **monohybrid** cross is defined as a cross between two organisms that differ in only a single trait (one gene pair). For example, TT $\times$ tt (tall $\times$ dwarf) in pea plants is a monohybrid cross.
Step 2: The **genotypic** ratio describes the proportions of each genotype (e.g., TT : Tt : tt = 1 : 2 : 1) among the offspring, as opposed to the phenotypic ratio which describes the proportions of each observable phenotype.

Final Answer:
1. monohybrid
2. genotypic

Answer: (See above)
Go Back to Question 20

Q21.

Solution

Concept: Blood consists of formed elements suspended in plasma. Each type of blood cell has a specialised function: RBCs transport oxygen, WBCs defend against infection, platelets aid clotting, and plasma transports dissolved substances.

Step 1: Red blood cells (RBCs/erythrocytes) contain the protein haemoglobin, which binds oxygen in the lungs and releases it in body tissues, matching pair (a)–(ii).
Step 2: White blood cells (WBCs/leukocytes) are the immune cells that defend the body against pathogens by phagocytosis and antibody production, matching pair (b)–(i).
Step 3: Platelets (thrombocytes) are cell fragments that aggregate at wound sites and release clotting factors, initiating the coagulation cascade, matching pair (c)–(iv).
Step 4: Plasma is the liquid matrix that transports dissolved nutrients, hormones, waste products, antibodies, and clotting factors throughout the body, matching pair (d)–(iii).

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

Answer: (See above)
Go Back to Question 21

Q22.

Solution

Concept: An endemic species is one that is native to and found only in a particular geographic region – it does not occur naturally anywhere else. Biodiversity refers to the totality of variation in life forms at all levels – species, genetic, and ecosystem diversity.

Step 1: An **endemic** species is one whose natural distribution is restricted to a specific geographic area (a country, a mountain range, an island) and is not found naturally anywhere else in the world. Examples include the lion-tailed macaque (endemic to the Western Ghats of India) and the kangaroo (endemic to Australia).
Step 2: **Biodiversity** (biological diversity) is the variety of life forms found in a particular region or on Earth as a whole. It includes three levels: (a) species diversity (variety of species), (b) genetic diversity (variation of genes within a species), and (c) ecosystem diversity (variety of habitats and ecosystems).

Final Answer:
1. endemic
2. biodiversity

Answer: (See above)
Go Back to Question 22

Q23.

Solution

Concept: Pollination is the transfer of pollen from the anther (male part) to the stigma (female part) of a flower. The human egg (ovum) is released from the ovary (not the pituitary gland) during ovulation.

Step 1: Pollination is accurately defined as the transfer of pollen grains from the anther of a stamen to the stigma of a pistil (either of the same flower or a different flower). This is a pre-fertilisation event. Statement 1 is **True (T)**.
Step 2: The human egg (ovum) is released from the ovary (specifically from a mature Graafian follicle) during ovulation, approximately on day 14 of a 28-day menstrual cycle. The pituitary gland secretes LH and FSH that regulate the cycle, but it does not release the egg itself. Therefore, statement 2 is **False (F)**.

Final Answer:
1. True (T)
2. False (F)

Answer: (See above)
Go Back to Question 23

Q24.

Solution

Concept: The plant kingdom is classified into four major divisions based on the presence or absence of vascular tissue, seeds, flowers, and fruits.

Step 1: Bryophyta (mosses, liverworts) – non-vascular plants that lack true roots, stems, and leaves; they require water for sexual reproduction. Example: moss, matching pair (a)–(ii).
Step 2: Pteridophyta (ferns, horsetails) – the first vascular plants with true roots, stems, and leaves. They reproduce by spores (no seeds). Example: fern, matching pair (b)–(iii).
Step 3: Gymnospermae (gymnosperms) – vascular, seed-bearing plants whose seeds are "naked" (not enclosed in fruits). They bear cones, not flowers. Example: pine, matching pair (c)–(iv).
Step 4: Angiospermae (angiosperms) – vascular, seed-bearing plants whose seeds are enclosed within fruits that develop from the ovary of a flower. Example: mango, wheat, 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: In a young root, the outermost cell layer is the epiblema (epidermis/piliferous layer), from which root hairs develop for absorption. The central region of the root containing the xylem and phloem is called the vascular cylinder (stele).

Step 1: The **epiblema** (also called the piliferous layer or root epidermis) is the outermost layer of cells in a young root. Some of its cells extend outward to form long, tubular, unicellular root hairs that enormously increase the absorptive surface area for water and mineral uptake.
Step 2: The **vascular cylinder** (stele) is the central core of the root, enclosed within the endodermis. It contains the pericycle, xylem (for water transport), and phloem (for food transport), arranged in a specific radial pattern in dicot roots.

Final Answer:
1. epiblema (piliferous layer / root epidermis)
2. vascular cylinder (stele)

Answer: (See above)

Go Back to Question 25

Q26.

Solution

Concept: Species interactions in an ecosystem can be beneficial, harmful, or neutral to the organisms involved. The four main types are parasitism, commensalism, mutualism, and competition.

Step 1: Parasitism – one organism (parasite) benefits at the expense of the other (host), which is harmed. Example: tapeworm in human intestine, matching pair (a)–(ii).
Step 2: Commensalism – one organism benefits while the other is neither helped nor harmed. Example: barnacles on a whale (barnacles get transport; whale is unaffected), matching pair (b)–(iv).
Step 3: Mutualism – both species benefit from the association. Example: Rhizobium in legume root nodules, matching pair (c)–(i).
Step 4: Competition – both species are negatively affected as they compete for the same limited resources (food, space, light). Example: two plant species competing for sunlight, matching pair (d)–(iii).

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

Answer: (See above)
Go Back to Question 26

Q27.

Solution

Concept: Bt cotton is a genetically modified crop containing the *cry* gene from *Bacillus thuringiensis*. HIV primarily attacks helper T-lymphocytes (CD4+ T-cells), not red blood cells.

Step 1: Bt cotton contains a gene from the soil bacterium *Bacillus thuringiensis* that produces a crystal protein (Cry protein/Bt toxin). When specific insect larvae (e.g., bollworm) ingest the plant tissue, the toxin destroys their gut lining, killing the pest. Statement 1 is **True (T)**.
Step 2: HIV does not attack red blood cells. It specifically targets and destroys CD4+ helper T-lymphocytes (a type of white blood cell) using its gp120 surface glycoprotein. The progressive destruction of T-helper cells cripples the immune system, eventually leading to AIDS. Therefore, statement 2 is **False (F)**.

Final Answer:
1. True (T)
2. False (F)

Answer: (See above)
Go Back to Question 27

Q28.

Solution

Concept: A typical flower has four whorls: calyx (sepals), corolla (petals), androecium (stamens), and gynoecium (pistil/carpel), each serving a distinct reproductive or protective function.

Step 1: The stamen is the male reproductive organ, consisting of the anther (which produces pollen grains) and the filament (which supports the anther), matching pair (a)–(iii).
Step 2: The pistil (carpel) is the female reproductive organ, consisting of the stigma, style, and ovary. The ovary contains the ovules (which contain egg cells), matching pair (b)–(i).
Step 3: Petals (corolla) are the typically brightly coloured, scented parts of the flower that attract pollinators such as insects and birds, matching pair (c)–(ii).
Step 4: Sepals (calyx) are the green, leaf-like structures forming the outermost whorl. They enclose and protect the flower bud before it opens, matching pair (d)–(iv).

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

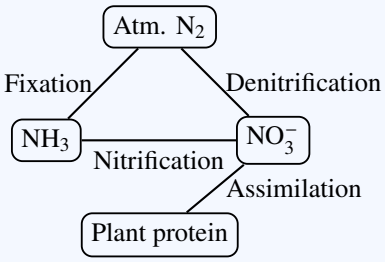
Answer: (See above)

Go Back to Question 28

Q29.

Solution

Concept: The nitrogen cycle describes how nitrogen is converted between its various chemical forms as it circulates through the atmosphere, soil, water, and living organisms. The four key steps are nitrogen fixation, nitrification, assimilation, and denitrification.



Step 1 – Nitrogen fixation: Atmospheric N_2 is converted to ammonia (NH_3) either biologically (by Rhizobium, Azotobacter, cyanobacteria using nitrogenase enzyme) or industrially (Haber process).

Step 2 – Nitrification: Ammonia in the soil is oxidised first to nitrite (NO_2^-) by Nitrosomonas and then to nitrate (NO_3^-) by Nitrobacter. Nitrate is the form most easily absorbed by plant roots.

Step 3 – Assimilation: Plants absorb nitrate (or ammonium) from the soil and incorporate it into organic molecules such as amino acids, proteins, and nucleic acids. Animals obtain nitrogen by consuming plants.

Step 4 – Denitrification: Denitrifying bacteria (e.g., Pseudomonas) in waterlogged, anaerobic soils convert nitrate back to gaseous nitrogen (N_2), returning it to the atmosphere and completing the cycle.

Final Answer: Nitrogen cycle: fixation ($N_2 \rightarrow NH_3$), nitrification ($NH_3 \rightarrow NO_3^-$), assimilation ($NO_3^- \rightarrow$ plant protein), denitrification ($NO_3^- \rightarrow N_2$).

Answer: (See above)

Go Back to Question 29

Q30.

Solution

Concept: Self-pollination involves transfer of pollen from the anther to the stigma of the same flower (or another flower on the same plant). Cross-pollination involves transfer of pollen to a flower on a genetically different plant of the same species.

Step 1: Self-pollination (autogamy): Pollen from the anther is transferred to the stigma of the same flower. It does not require external agents and always produces offspring genetically similar to the parent.

Step 2: Cross-pollination (allogamy/xenogamy): Pollen from the anther of one plant is transferred to the stigma of a flower on a genetically different plant of the same species. It requires external agents such as wind, insects, birds, or water.

Step 3: Advantage of cross-pollination: It introduces new genetic combinations (genetic variation) in the offspring by combining alleles from two different parents. This increased variability makes the population better adapted to changing environmental conditions and more resistant to diseases.

Final Answer: Self-pollination occurs within the same flower; cross-pollination occurs between different plants. Cross-pollination produces genetic variation, improving adaptability.

Answer: (See above)

Go Back to Question 30

Q31.

Solution

Concept: An endangered species is one whose population has declined to such low numbers that it faces a serious risk of extinction unless protective measures are taken. An ecosystem is a functional unit of nature consisting of living organisms interacting with their physical environment.

Alternative (i):

Step 1: An **endangered species** is a species whose total population has declined to a critically low level, placing it at high risk of extinction in the wild due to habitat loss, hunting, pollution, or other threats.

Step 2: Two endangered animal species in India: (a) **Bengal tiger** (*Panthera tigris tigris*) – threatened by poaching, habitat loss, and human-wildlife conflict; (b) **Indian one-horned rhinoceros** (*Rhinoceros unicornis*) – threatened by poaching for its horn and habitat destruction.

Step 3: A major reason these species are threatened is **habitat destruction** due to deforestation, urbanisation, and agricultural expansion, combined with illegal hunting/poaching.

Alternative (ii):

Step 1: An **ecosystem** is a self-sustaining, functional unit of nature in which living organisms (biotic community) interact with each other and with their non-living physical environment (abiotic factors) through energy flow and nutrient cycling.

Step 2: Two major components: (a) **Biotic component** – all living organisms (producers, consumers, decomposers). Example: trees, deer, bacteria in a forest ecosystem. (b) **Abiotic component** – all non-living physical and chemical factors. Example: sunlight, temperature, water, soil minerals.

Final Answer: (i) Endangered species face extinction risk; e.g., Bengal tiger (poaching/habitat loss), Indian rhinoceros; (ii) Ecosystem: biotic (living, e.g., plants) + abiotic (non-living, e.g., sunlight) components interacting.

Answer: (See above)

Go Back to Question 31

Q32.

Solution

Concept: Fungi are eukaryotic, heterotrophic organisms with chitinous cell walls that obtain nutrition by absorption. Bacteria are prokaryotic single-celled organisms, while viruses are non-cellular, obligate intracellular parasites consisting of nucleic acid enclosed in a protein coat.

Alternative (i) – Kingdom Fungi:

Step 1: Two characteristic features: (a) Fungi are eukaryotic organisms whose body is made up of thread-like filaments called hyphae, forming a mycelium; their cell wall is composed of chitin (not cellulose). (b) Fungi lack chlorophyll and are heterotrophic – they secrete enzymes onto organic material and absorb the digested nutrients (saprophytic, parasitic, or symbiotic nutrition).

Step 2: Example of a saprophytic fungus: *Rhizopus* (bread mould) – it grows on moist bread, secreting digestive enzymes and absorbing nutrients from the dead organic substrate.

Alternative (ii) – Bacteria vs Viruses:

Step 1: Bacteria are living, prokaryotic, unicellular organisms with their own cellular machinery (ribosomes, enzymes, cell membrane) and can reproduce independently by binary fission. Viruses are non-cellular entities that lack cellular machinery and can only replicate inside a living host cell (obligate intracellular parasites).

Step 2: Bacteria have both DNA and RNA, while viruses contain either DNA or RNA (never both). Bacteria are typically 1–10 μm in size, while viruses are much smaller (20–300 nm) and can only be seen with an electron microscope.

Final Answer: (i) Fungi: chitinous wall, heterotrophic, hyphae-based body; e.g., Rhizopus; (ii) Bacteria are cellular prokaryotes; viruses are non-cellular, obligate parasites with either DNA or RNA.

Answer: (See above)

Go Back to Question 32

Q33.

Solution

Concept: The balanced equation for alcoholic fermentation by yeast is: $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$. This means 1 mole of glucose produces 2 moles of ethanol and 2 moles of CO_2.

Step 1: From the equation, 1 mole of glucose yields 2 moles of CO_2 and 2 moles of ethanol.

Step 2: For 3 moles of glucose:

CO_2 produced = $3 \times 2 = 6$ moles of CO_2.

Step 3: Ethanol produced = $3 \times 2 = 6$ moles of ethanol.

Step 4: The CO_2 gas released creates bubbles in the bread dough, causing it to rise (leavening). The ethanol evaporates during baking.

Final Answer: 6 moles of CO_2 gas released; 6 moles of ethanol produced.

Answer: (See above)

Go Back to Question 33

Q34.

Solution

Concept: When a heterozygous individual (Rr) is crossed with a homozygous recessive individual (rr), this is called a test cross. It produces offspring in a 1:1 ratio of dominant to recessive phenotypes.

	R	r
r	Rr	rr
r	Rr	rr

Step 1: The father (Rr) produces two types of gametes: R and r. The mother (rr) produces only one type: r.

Step 2: Offspring genotypes: 2 Rr (tongue rollers) and 2 rr (non-rollers). Genotypic ratio = 1 Rr : 1 rr.

Step 3: Since R is dominant, Rr individuals can roll their tongue. Phenotypic ratio = 1 roller : 1 non-roller.

Step 4: Probability that a child will be a tongue roller = $\frac{2}{4} = \frac{1}{2} = 50\%$.

Final Answer: Probability = 50% (1 in 2 chance). Genotypic ratio: 1 Rr : 1 rr. Phenotypic ratio: 1 roller : 1 non-roller.

Answer: (See above)

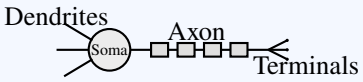
Go Back to Question 34

Q35.

Solution

Concept: A neuron (nerve cell) is the structural and functional unit of the nervous system. It consists of a cell body (with nucleus), branching dendrites (receive impulses), a long axon (transmits impulses away from the cell body), and axon terminals (pass impulses to the next neuron or effector). A reflex action is an automatic, rapid, involuntary response to a stimulus, mediated by a reflex arc.

Alternative (i) – Neuron structure:



Step 1: The **cell body (soma)** contains the nucleus and most cytoplasmic organelles. **Dendrites** are short, branching extensions that receive nerve impulses from other neurons or receptors and conduct them toward the cell body.
Step 2: The **axon** is a long, slender fibre that transmits impulses away from the cell body to the **axon terminals**, which form synapses with the next neuron or effector (muscle/gland).

Alternative (ii) – Reflex action:
Step 1: A **reflex action** is an involuntary, rapid, automatic response to a stimulus that does not involve conscious thought. It is mediated by a neural pathway called the reflex arc.
Step 2: The reflex arc consists of: receptor (detects stimulus) → sensory neuron (carries impulse to spinal cord) → relay neuron/interneuron (in spinal cord) → motor neuron (carries impulse to effector) → effector (muscle/gland that responds).

Final Answer: (i) Neuron: cell body + dendrites + axon + axon terminals; (ii) Reflex action: involuntary response via reflex arc (receptor → sensory → relay → motor → effector).

Answer: (See above)

Go Back to Question 35

Q36.

Solution

Concept: Vitamins are organic compounds required in very small amounts in the diet for normal growth, development, and maintenance of body functions. They cannot be synthesised by the body in sufficient quantities and must be obtained from food. Vitamins are classified as fat-soluble or water-soluble based on their solubility.

Step 1: Vitamins are defined as organic micronutrients required in trace amounts for specific metabolic functions. Their deficiency causes characteristic deficiency diseases.
Step 2: Fat-soluble vitamins dissolve in fats and oils and can be stored in the body (mainly in the liver and adipose tissue). Examples: Vitamin A (retinol), Vitamin D (calciferol), Vitamin E (tocopherol), Vitamin K (phylloquinone).
Step 3: Water-soluble vitamins dissolve in water and are not stored in the body in significant amounts; excess is excreted in urine. Examples: Vitamin C (ascorbic acid), B-complex vitamins (B_1, B_2, B_3, B_6, B_{12}, etc.).

Final Answer: Vitamins are essential organic micronutrients. Fat-soluble: e.g., Vitamin A; Water-soluble: e.g., Vitamin C.

Answer: (See above)
Go Back to Question 36

Q37.

Solution

Concept: Blood pressure is the force exerted by circulating blood on the walls of the arteries. It is measured using a sphygmomanometer and expressed as two values: systolic (maximum) and diastolic (minimum) pressure.

Step 1: Blood pressure is the lateral pressure exerted by the flowing blood on the inner walls of the blood vessels (arteries). It is generated by the pumping action of the heart.
Step 2: Systolic pressure is the maximum pressure in the arteries during ventricular contraction (systole), when the heart pumps blood out. **Diastolic pressure** is the minimum pressure in the arteries during ventricular relaxation (diastole), when the heart is filling with blood.
Step 3: The normal blood pressure reading for a healthy young adult is approximately **120/80 mm Hg** (120 mm Hg systolic over 80 mm Hg diastolic).

Final Answer: Blood pressure is the force of blood on arterial walls. Systolic = pressure during contraction; Diastolic = pressure during relaxation. Normal = 120/80 mm Hg.

Answer: (See above)
Go Back to Question 37

Q38.

Solution

Concept: Recombinant DNA technology involves cutting DNA from one organism, inserting it into a vector, and introducing the vector into a host cell. The key molecular tools are restriction endonucleases (molecular scissors), DNA ligase (molecular glue), and plasmid vectors (molecular vehicles).

Step 1 – Restriction endonuclease: The desired gene (gene of interest) is cut out from the donor organism's DNA using a specific restriction endonuclease, which recognises and cleaves the DNA at a specific palindromic recognition sequence. The same enzyme is also used to cut open the plasmid vector at a complementary site, creating compatible "sticky ends" on both the gene fragment and the plasmid.

Step 2 – DNA ligase: The gene fragment and the cut plasmid are mixed together. DNA ligase catalyses the formation of phosphodiester bonds between the sticky ends of the gene fragment and the plasmid, permanently sealing the foreign gene into the plasmid to create a **recombinant DNA molecule** (recombinant plasmid).

Step 3 – Vector (plasmid): The recombinant plasmid acts as a vector – a carrier molecule that transports the foreign gene into a host cell (usually a bacterium such as *E. coli*) through the process of transformation. Inside the host, the gene is replicated along with the plasmid and can be expressed to produce the desired protein.

Final Answer: Restriction endonuclease cuts DNA at specific sites; DNA ligase joins the gene to the plasmid; the recombinant plasmid (vector) carries the gene into the host cell.

Answer: (See above)

Go Back to Question 38

Q39.

Solution

Concept: In humans, sex is determined by the XX-XY chromosomal system: females have two X chromosomes (XX) and males have one X and one Y (XY). The father's sperm determines the sex of the child. A mutation is a sudden, heritable change in the DNA sequence.

Alternative (i) – Sex determination:

Step 1: Humans have 23 pairs of chromosomes: 22 pairs of autosomes and 1 pair of sex chromosomes. Females are XX and males are XY.

Step 2: During gamete formation, the mother always contributes an X chromosome (since she is XX). The father can contribute either an X or a Y chromosome (since he is XY).

Step 3: If the sperm carrying X fertilises the egg, the child is XX (female). If the sperm carrying Y fertilises the egg, the child is XY (male). Therefore, **the father's sperm determines the sex of the child**, with a 50:50 probability.

Alternative (ii) – Mutation:

Step 1: A **mutation** is a sudden, permanent, heritable change in the nucleotide sequence of DNA. Mutations can be spontaneous or induced by mutagens (chemicals, radiation, UV light).

Step 2: Two types of gene mutations: (a) **Point mutation (substitution)** – a single nucleotide is replaced by another. (b) **Frameshift mutation** – insertion or deletion of one or more nucleotides shifts the reading frame.

Step 3: Example: **Sickle cell anaemia** is caused by a point mutation in the gene for the β-chain of haemoglobin, where glutamic acid is replaced by valine at position 6.

Final Answer: (i) XX = female, XY = male; father's sperm determines sex; (ii) Mutation: heritable DNA change; types: point, frameshift; e.g., sickle cell anaemia.

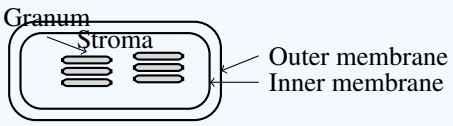
Answer: (See above)

Go Back to Question 39

Q40.

Solution

Concept: The chloroplast is a double-membrane-bound organelle in plant cells and algae where photosynthesis occurs. It contains an outer membrane, inner membrane, thylakoid membranes (organized into grana), and a fluid-filled stroma. Light reactions occur on thylakoids; the Calvin cycle occurs in the stroma.



Step 1: The **outer membrane** is smooth and permeable to many small molecules. The **inner membrane** is less permeable and encloses the stroma.

Step 2: The **thylakoids** are flattened, membrane-bound sacs. Stacks of thylakoids form **grana** (singular: granum). The thylakoid membranes contain chlorophyll, photosystems, and ATP synthase – this is where the **light-dependent reactions** occur.

Step 3: The **stroma** is the fluid-filled matrix surrounding the grana. It contains the enzymes (including RuBisCO) for the Calvin cycle. The **light-independent reactions** (Calvin cycle) occur here, using ATP and NADPH from the light reactions to fix CO_2 into glucose.

Final Answer: Chloroplast: outer and inner membranes, thylakoids (grana), and stroma. Light reactions occur on thylakoid membranes; Calvin cycle occurs in stroma.

Answer: (See above)

Go Back to Question 40

Q41.

Solution

Concept: Smoking tobacco causes severe damage to the respiratory system and has wide-ranging harmful effects on overall health. Communicable diseases are caused by pathogenic microorganisms (bacteria, viruses, protozoa, fungi) and can spread from person to person through various modes.

Alternative (i) – Effects of smoking:

Step 1: Tobacco smoke contains nicotine (addictive), tar (carcinogenic), carbon monoxide (reduces blood oxygen), and many toxic chemicals. These substances damage the delicate lining of the respiratory tract, cilia, and alveoli.

Step 2: Harmful effects on the respiratory system: (a) Chronic bronchitis – inflammation and excessive mucus production in the bronchi; (b) Emphysema – destruction of alveolar walls, reducing surface area for gas exchange; (c) Lung cancer – uncontrolled cell growth due to carcinogens in tar.

Step 3: Preventive measures: (a) Awareness campaigns and education about health risks; (b) Legal restrictions on tobacco advertising and public smoking, along with support for cessation programmes.

Alternative (ii) – Communicable diseases:

Step 1: **Communicable diseases** are diseases caused by pathogenic microorganisms that can be transmitted from an infected person to a healthy person through direct contact, air, water, food, or vectors.

Step 2: (a) Disease caused by a bacterium: **Tuberculosis** (TB), caused by *Mycobacterium tuberculosis*; prevention: BCG vaccination. (b) Disease caused by a virus: **Dengue fever**, caused by the dengue virus; prevention: eliminating mosquito breeding sites. (c) Disease caused by a protozoan: **Malaria**, caused by *Plasmodium*; prevention: using mosquito nets and anti-malarial drugs.

Final Answer: (i) Smoking causes bronchitis, emphysema, lung cancer; prevented by education and legal restrictions; (ii) Communicable: TB (bacterium; BCG vaccine), Dengue (virus; mosquito control), Malaria (protozoan; mosquito nets).

Answer: (See above)

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Q42.

Solution

Concept: The mature embryo sac in angiosperms is a 7-celled, 8-nucleate structure that constitutes the female gametophyte. Double fertilisation, unique to angiosperms, involves two fusion events producing the embryo and endosperm. DNA has a double-helical structure with antiparallel strands and complementary base pairing; transcription copies DNA into mRNA.

Alternative (i):

Step 1 (a): The mature **embryo sac** contains 7 cells and 8 nuclei: (i) one egg cell and two synergids at the micropylar end (3 cells), (ii) three antipodal cells at the chalazal end (3 cells), and (iii) one large central cell containing two polar nuclei (1 cell with 2 nuclei). Total: 7 cells, 8 nuclei.

Step 2 (b): Double fertilisation: One sperm fuses with the egg cell (syngamy) to form the diploid (2n) zygote, which develops into the embryo. The other sperm fuses with the two polar nuclei (triple fusion) to form the triploid (3n) primary endosperm nucleus, which develops into the endosperm (nourishes the embryo).

Step 3 (b): Significance: Double fertilisation ensures that the endosperm (nutritive tissue) develops only when the egg is fertilised, conserving the plant's resources.

Solution

Alternative (ii):

Step 1 (a): Watson and Crick (1953) proposed that **DNA is a double helix** consisting of two polynucleotide strands wound around a common axis. The strands are **antiparallel** (one runs 5′ to 3′, the other 3′ to 5′). Each strand has a sugar-phosphate backbone with nitrogenous bases projecting inward. The bases pair specifically: Adenine with Thymine (2 H-bonds) and Guanine with Cytosine (3 H-bonds).

Step 2 (b): **Transcription** is the process by which the genetic information in one strand of DNA (the template strand) is copied into a complementary mRNA molecule. The enzyme **RNA polymerase** binds to the promoter region of the gene, unwinds the DNA, reads the template strand in the 3′ to 5′ direction, and synthesises mRNA in the 5′ to 3′ direction using RNA nucleotides (with uracil instead of thymine).

Step 3 (b): In eukaryotes, the primary mRNA transcript (pre-mRNA) undergoes processing – 5′ capping, 3′ polyadenylation, and splicing (removal of introns) – to form mature mRNA, which exits through nuclear pores into the cytoplasm for translation.

Final Answer: (i)(a) Embryo sac: 7 cells, 8 nuclei; (b) Double fertilisation: syngamy + triple fusion; significance: endosperm develops only after fertilisation; (ii)(a) DNA: double helix, antiparallel, A-T/G-C base pairs; (b) Transcription: RNA polymerase synthesises mRNA from DNA template; eukaryotic mRNA is processed.

Answer: (See above)

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Q43.

Solution

Concept: Animal tissues are classified into four types: epithelial (covering/lining), connective (binding/support), muscular (movement), and nervous (impulse transmission). The human heart is a four-chambered organ with a double circulatory system.

Alternative (i) – Four types of animal tissues:

Step 1: Epithelial tissue consists of tightly packed cells covering body surfaces and lining internal cavities. Functions: protection, absorption, secretion, filtration. Found: skin surface, lining of intestine, kidney tubules.

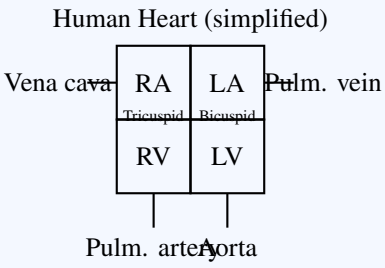
Step 2: Connective tissue consists of cells scattered in an extracellular matrix (fibres + ground substance). Functions: binding, support, protection, transport. Found: bone (skeleton), blood (circulatory system), cartilage (nose, ear), adipose tissue.

Step 3: Muscular tissue consists of elongated, contractile cells that produce movement. Three types: skeletal/striated (voluntary; attached to bones), smooth/unstriated (involuntary; walls of intestine, blood vessels), and cardiac (involuntary, striated; heart wall).

Step 4: Nervous tissue consists of neurons and glial cells. Functions: generation, transmission, and processing of electrical nerve impulses. Found: brain, spinal cord, peripheral nerves.

Solution

Alternative (ii) – Human heart structure and cardiac cycle:



Step 1: The heart has four chambers: right atrium (RA), right ventricle (RV), left atrium (LA), and left ventricle (LV). The tricuspid valve separates RA from RV; the bicuspid (mitral) valve separates LA from LV.

Step 2 – Pulmonary circulation: Deoxygenated blood from the body enters the RA via the vena cava → passes through the tricuspid valve to RV → RV pumps it to the lungs via pulmonary arteries → CO_2 is released and O_2 is absorbed → oxygenated blood returns to LA via pulmonary veins.

Step 3 – Systemic circulation: Oxygenated blood from LA → passes through the bicuspid valve to LV → LV pumps it out through the aorta to all body tissues → O_2 is delivered, CO_2 is collected → deoxygenated blood returns to RA via vena cava.

Final Answer: (i) Four tissues: epithelial (lining), connective (support), muscular (movement), nervous (impulses); (ii) Heart: 4 chambers, pulmonary circuit (heart → lungs → heart), systemic circuit (heart → body → heart) = double circulation.

Answer: (See above)

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Answer Key

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