NIOS Class 12 Biology Sample Paper-9

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 atmospheric carbon dioxide required for photosynthesis enters the leaf mainly through: **(1)**

(A) Root hairs

(B) Lenticels on the stem

(C) Stomata on the leaf epidermis

(D) Xylem vessels

Q2. A cross between an organism showing a dominant phenotype of unknown genotype and a homozygous recessive organism, used to determine the unknown genotype, is called a: **(1)**

(A) Back cross

(B) Test cross

(C) Reciprocal cross

(D) Dihybrid cross

Q3. Paramecium, a unicellular organism of Kingdom Protista, moves through its aquatic environment by beating numerous short, hair-like projections called: **(1)**

(A) Cilia

(B) Flagella

(C) Pseudopodia

(D) Pili

Q4. Organisms such as bacteria and fungi that break down the dead remains and waste products of other organisms, releasing nutrients back into the soil, are called: **(1)**

(A) Producers

(B) Primary consumers

(C) Tertiary consumers

(D) Decomposers (saprotrophs)

Q5. The net gain of ATP molecules produced during glycolysis from one molecule of glucose (before the pyruvate enters the mitochondria) is: **(1)**

(A) 2

(B) 4

(C) 36

(D) 38

Q6. In angiosperms, the female gametophyte is contained within the ovule and is also known as the: **(1)**

(A) Pollen sac

(B) Anther

(C) Testa

(D) Embryo sac

Q7. A new-born baby receives antibodies from the mother through breast milk (colostrum). This type of immunity is classified as: **(1)**

(A) Naturally acquired active immunity

(B) Artificially acquired active immunity

(C) Naturally acquired passive immunity

(D) Innate (non-specific) immunity

Q8. Animals of phylum Mollusca typically have a soft, unsegmented body often protected by a hard calcareous shell. Which of the following is an example of a mollusc? **(1)**

(A) Snail

(B) Starfish

(C) Earthworm

(D) Cockroach

Q9. White blood cells (leukocytes) are primarily responsible for: **(1)**

(A) Transporting oxygen to body tissues

(B) Defending the body against infections and foreign substances

(C) Carrying carbon dioxide from tissues to the lungs

(D) Initiating the blood clotting cascade

Q10. Deficiency of Vitamin B_{12} (cobalamin) in the diet leads to a type of anaemia called: **(1)**

(A) Iron-deficiency anaemia

(B) Sickle-cell anaemia

(C) Pernicious anaemia

(D) Thalassaemia

Q11. According to Chargaff's rule of base pairing in DNA, the amount of adenine (A) is always equal to the amount of: **(1)**

(A) Thymine (T)

(B) Cytosine (C)

(C) Guanine (G)

(D) Uracil (U)

Q12. The hormone that promotes the overall growth of the body, especially the growth of bones and muscles during childhood and adolescence, is: **(1)**

(A) Thyroxine

(B) Growth hormone (somatotropin)

(C) Insulin

(D) Adrenaline

Q13. Cardiac muscle tissue, found exclusively in the wall of the heart, is unique because its cells are: **(1)**

(A) Voluntary, multinucleated, and non-striated

(B) Involuntary, uninucleate, striated, and branched with intercalated discs

(C) Voluntary, cylindrical, and attached to bones

(D) Involuntary, spindle-shaped, and non-striated

Q14. Golden rice, a genetically modified crop enriched with β-carotene (a precursor of Vitamin A), is an example of a: **(1)**

(A) Hybrid variety

(B) Transgenic organism

(C) Naturally mutant variety

(D) Polyploid variety

Q15. The assisted reproductive technique in which the ovum is fertilised by the sperm outside the body (in a laboratory dish) and the resulting embryo is then transferred into the mother's uterus is called: **(1)**

(A) Artificial insemination

(B) In vitro fertilisation (IVF)

(C) Surrogacy

(D) Amniocentesis

Q16. The vascular tissue in plants that is primarily responsible for the transport of prepared food (sucrose) from the leaves to other parts of the plant is: **(1)**

(A) Xylem

(B) Parenchyma

(C) Collenchyma

(D) Phloem

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:

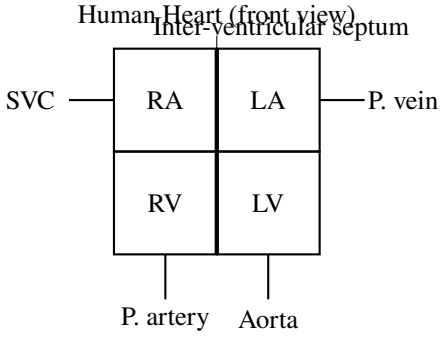
The nitrogen cycle is a biogeochemical cycle that converts atmospheric nitrogen (N_2) into forms usable by organisms. Nitrogen-fixing bacteria such as *Rhizobium*, found in root nodules of leguminous plants, convert N_2 into ammonia (NH_3). Ammonia is then converted to nitrite and nitrate by nitrifying bacteria (*Nitrosomonas* and *Nitrobacter*). Plants absorb nitrate from the soil and use it to synthesise amino acids and proteins. When plants and animals die, decomposers release the nitrogen as ammonia, a process called ammonification. **(2)**

1. Name the bacterium mentioned in the passage that lives in root nodules of leguminous plants and fixes atmospheric nitrogen.
2. What is the term used for the process by which decomposers release nitrogen from dead organisms as ammonia?

Q18. Complete the following sentences using the words given below:
(nucleus, cell membrane, cell wall, vacuole, chloroplast) **(2)**

1. The membrane-bound organelle that contains the genetic material (DNA) and controls all the activities of a eukaryotic cell is called the .....
2. The rigid, non-living outer covering made of cellulose that provides shape and protection to a plant cell but is absent in animal cells is called the ....

Q19. Study the simplified diagram of the human heart given below and answer the questions that follow. **(2)**



1. Which chamber of the heart pumps deoxygenated blood to the lungs through the pulmonary artery?
2. What is the function of the thick muscular wall (septum) that separates the left and right sides of the heart?

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

1. Pollination carried out by wind is called .... pollination (or anemophily).
2. Pollination carried out by insects (such as bees and butterflies) is called . pollination (or entomophily).

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

Column I	**Column II**
(a) Kidney	(i) Exchange of gases between air and blood
(b) Lung	(ii) Filtration of blood; formation of urine
(c) Liver	(iii) Absorption of digested food into the blood
(d) Small intestine	(iv) Secretion of bile; detoxification of blood

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

1. The trapping of heat by gases such as CO_2, methane, and water vapour in the Earth's atmosphere, which keeps the planet warm enough to sustain life, is called the ..... effect.
2. The progressive thinning of the ozone layer in the stratosphere, caused mainly by the release of chlorofluorocarbons (CFCs), results in increased radiation reaching the Earth's surface.

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

1. Mitosis produces two daughter cells that are genetically identical to each other and to the parent cell.

2. Crossing over (exchange of genetic material between homologous chromosomes) occurs during mitosis.

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

Column I	**Column II**
(a) Tapeworm	(i) Phylum Annelida – segmented body, true coelom
(b) Earthworm	(ii) Phylum Platyhelminthes – flat body, parasitic
(c) Roundworm (*Ascaris*)	(iii) Phylum Echinodermata – spiny skin, water vascular system
(d) Starfish	(iv) Phylum Nematoda – cylindrical body, pseudocoelom

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

1. A root system in which one main root grows vertically downward with smaller lateral roots branching off it is called a . . root system (e.g., carrot, mustard).
2. A root system in which numerous thin roots of similar size arise from the base of the stem, without any single dominant root, is called a root system (e.g., wheat, rice).

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

Column I	**Column II**
(a) Malaria	(i) Caused by *Mycobacterium tuberculosis* (bacterium)
(b) Tuberculosis	(ii) Caused by *Plasmodium* (protozoan); spread by *Anopheles* mosquito
(c) Dengue fever	(iii) Caused by a virus; spread by *Aedes* mosquito
(d) Cholera	(iv) Caused by *Vibrio cholerae* (bacterium); spreads through contaminated water

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

1. An antigen is any substance (usually a protein) that is recognised as foreign by the immune system and triggers an immune response.
2. All bacteria are harmful (pathogenic) to humans and no bacterium has any beneficial role.

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

Column I	**Column II**
(a) mRNA	(i) Structural component of the ribosome
(b) tRNA	(ii) Carries the genetic code from DNA to the ribosome
(c) rRNA	(iii) Removes introns from pre-mRNA (in eukaryotes)
(d) snRNA	(iv) Carries specific amino acids to the ribosome during translation

Section: B

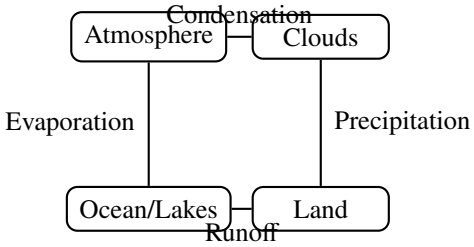
Q29. With the help of suitable examples, describe any two types of leaf modifications found in plants and state the function served by each modification. **(2)**

Q30. Define 'asexual reproduction'. Name any two methods of asexual reproduction found in organisms other than flowering plants and give one example of each. **(2)**

Q31. (i) With the help of a simple flow diagram, outline the water cycle (hydrological cycle), mentioning evaporation, condensation, precipitation, and surface runoff.

OR

(ii) With the help of a simple flow diagram, outline the carbon cycle, mentioning photosynthesis, respiration, combustion, and decomposition. **(2)**



Q32. (i) Name the four main components of human blood and state one function of each.

OR

(ii) Differentiate between striated (skeletal) muscle and smooth (unstriated) muscle with respect to (a) location and (b) voluntary or involuntary control. **(2)**

Q33. The overall balanced equation of photosynthesis shows that 6 molecules of CO_2 and 6 molecules of H_2O produce 1 molecule of glucose and 6 molecules of O_2. If a plant releases 42 molecules of O_2 during photosynthesis, calculate the number of glucose molecules produced and the number of CO_2 molecules fixed. **(2)**

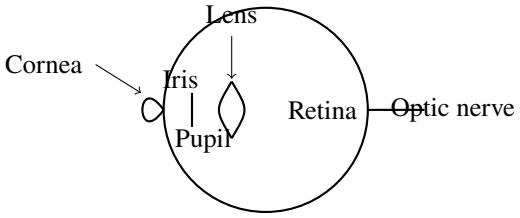
Q34. In the ABO blood group system, a man with blood group A (genotype I^Ai) marries a woman with blood group B (genotype I^Bi). Using a Punnett square, work out the possible blood groups of their children. **(2)**

	I^A	i
I^B	I^AI^B	I^Bi
i	I^Ai	ii

Q35. (i) Draw a simple labelled diagram of the human eye showing the cornea, iris, pupil, lens, retina, and optic nerve. State the function of the retina.

OR

(ii) Name the three main parts of the human ear (outer, middle, inner) and state one function of each. **(2)**



Q36. What are 'water-borne diseases'? Name two water-borne diseases and state one preventive measure applicable to both. **(2)**

Q37. Differentiate between aerobic respiration and anaerobic respiration with respect to (a) requirement of oxygen, (b) end products, and (c) amount of ATP produced per glucose molecule. **(2)**

Q38. Explain briefly:

A. What is 'biogas'? Name the main gas present in biogas.

B. What is 'bioremediation'?

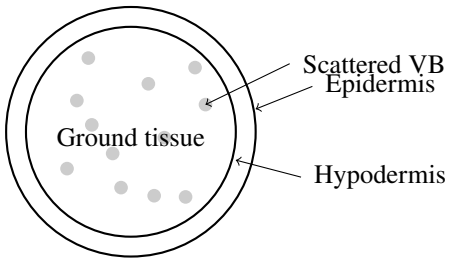
C. Name one application of recombinant DNA technology in medicine. **(3)**

Q39. (i) What are 'chromosomal disorders'? Describe the cause and symptoms of Down syndrome (Trisomy 21).

OR

(ii) Explain the difference between 'dominant' and 'recessive' alleles. Give one example of a trait controlled by a dominant allele and one controlled by a recessive allele in humans. **(3)**

Q40. Differentiate between the internal structure (transverse section) of a dicot stem and a monocot stem with respect to (a) arrangement of vascular bundles, (b) presence or absence of cambium, and (c) differentiation of ground tissue into cortex and pith. Draw a simple labelled diagram of a monocot stem T.S. **(3)**



Monocot stem T.S.

Q41. (i) What is 'obesity'? State two health risks associated with obesity and two measures to prevent or manage it.

OR

(ii) Explain the importance of personal hygiene in preventing infectious diseases. List any three specific hygiene practices that help prevent the spread of diseases. **(3)**

Q42. (i) (a) What is 'organic evolution'? State two evidences that support the theory of organic evolution.

(b) Distinguish between 'homologous organs' and 'analogous organs' with one example of each.

OR

(ii) (a) Describe the structure of a chromosome, mentioning the centromere, chromatids, and telomeres. Draw a labelled diagram.

(b) What is the significance of meiosis in sexually reproducing organisms? **(5)**

Q43. (i) Describe the process of digestion in humans, covering the role of the mouth (salivary amylase), stomach (pepsin, HCl), small intestine (bile, pancreatic enzymes, intestinal enzymes), and large intestine (water absorption). Name one enzyme and its function at each site.

OR

(ii) Describe the life cycle of a typical moss plant (*Funaria*), explaining the alternation of generations between the gametophyte and sporophyte stages. Draw a simple labelled diagram showing both stages. **(5)**

Detailed Solutions

Q1.

Solution

Concept: Stomata are tiny pores on the leaf surface, primarily on the lower epidermis in most dicots. They are the main entry points for atmospheric CO_2 needed for photosynthesis and the exit points for O_2 and water vapour.

Step 1: During the day, stomata open under the control of guard cells. Atmospheric CO_2 diffuses through the stomatal pores into the intercellular air spaces of the spongy mesophyll, dissolves in the cell-surface moisture, and reaches the chloroplasts for the Calvin cycle.
Step 2: Root hairs absorb water and minerals from the soil, not CO_2. Lenticels allow gaseous exchange in woody stems but are not the primary CO_2 entry route for photosynthesis. Xylem transports water upward, not gases.

Why other options are wrong:

- **Option A:** Root hairs absorb water and dissolved minerals, not atmospheric CO_2.
- **Option B:** Lenticels on woody stems allow limited gas exchange but are not the main CO_2 entry for photosynthesis.
- **Option D:** Xylem vessels transport water and minerals upward; they do not admit CO_2.

Final Answer: Stomata on the leaf epidermis (Option C)

Answer: (C)

Go Back to Question 1

Q2.

Solution

Concept: A test cross is a specific type of genetic cross in which an organism displaying the dominant phenotype but of unknown genotype is crossed with a homozygous recessive individual. The offspring ratios reveal whether the unknown parent is homozygous dominant (all dominant offspring) or heterozygous (1:1 ratio).

Step 1: If the unknown parent is homozygous dominant (AA), all offspring of the test cross (AA $\times$ aa) will be Aa (dominant phenotype). If the unknown parent is heterozygous (Aa), the test cross (Aa $\times$ aa) will produce a 1:1 ratio of dominant to recessive offspring.
Step 2: A back cross is a cross of a hybrid with one of its parents. A reciprocal cross reverses the sexes of the parents. A dihybrid cross involves two traits simultaneously.

Why other options are wrong:

- **Option A:** A back cross is any cross of the hybrid with either parent, not necessarily with the homozygous recessive.
- **Option C:** A reciprocal cross reverses male and female parents to study sex-linked effects.
- **Option D:** A dihybrid cross involves two pairs of contrasting traits, not a test for genotype.

Final Answer: Test cross (Option B)

Answer: (B)

Go Back to Question 2

Q3.

Solution

Concept: Paramecium is a ciliated protozoan. Its entire body surface is covered with thousands of short, hair-like structures called cilia that beat in coordinated waves, propelling the organism rapidly through water and also creating currents to sweep food particles into the oral groove.

Step 1: Cilia are short, numerous, and arranged in rows over the cell surface. Their coordinated beating creates a wave-like motion that moves the cell forward, backward, or in a spiral path.
Step 2: Pseudopodia are used by Amoeba (cytoplasmic extensions), flagella are used by Euglena (long whip-like appendages), and pili are thin protein filaments on bacteria for attachment.

Why other options are wrong:

- **Option A:** Pseudopodia are used by Amoeba, not Paramecium.
- **Option B:** Flagella are long, whip-like structures used by Euglena and many bacteria.
- **Option D:** Pili are thin protein appendages on bacteria used for attachment and conjugation.

Final Answer: Cilia (Option A)

Answer: (A)

Go Back to Question 3

Q4.

Solution

Concept: Decomposers (saprotrophs) are organisms, primarily bacteria and fungi, that feed on dead and decaying organic matter. They break down complex organic molecules into simpler inorganic substances (CO_2, water, mineral salts), returning essential nutrients to the soil and completing nutrient cycles.

Step 1: Without decomposers, dead organisms and waste would accumulate indefinitely, locking up nutrients and making them unavailable for new growth. Decomposers recycle these nutrients, maintaining soil fertility.

Step 2: Producers (autotrophs) synthesise food, primary consumers eat plants, and tertiary consumers are top carnivores – none of these break down dead matter.

Why other options are wrong:

- **Option A:** Producers synthesise organic matter through photosynthesis.
- **Option B:** Primary consumers are herbivores that eat living plants.
- **Option D:** Tertiary consumers are top predators that eat other carnivores.

Final Answer: Decomposers (saprotrophs) (Option D)

Answer: (D)

Go Back to Question 4

Q5.

Solution

Concept: Glycolysis is the first stage of cellular respiration, occurring in the cytoplasm. One glucose molecule is converted to two pyruvate molecules. Although 4 ATP are produced, 2 ATP are consumed in the initial phosphorylation steps, giving a **net gain of 2 ATP**.

Step 1: In the energy-investment phase, 2 ATP are used to phosphorylate glucose (at steps 1 and 3), converting it to fructose-1,6-bisphosphate.
Step 2: In the energy-payoff phase, 4 ATP are generated by substrate-level phosphorylation (2 per pyruvate, $\times 2$ pyruvates = 4 ATP total). Net ATP = 4 produced $-$ 2 consumed = **2 ATP**.

Why other options are wrong:

- **Option B:** 4 is the gross ATP produced, not the net gain after subtracting the 2 ATP invested.
- **Option C:** 36 ATP is the total yield of the entire aerobic respiration process, not glycolysis alone.
- **Option D:** 38 ATP is an alternative estimate of total aerobic yield in some references, not from glycolysis.

Final Answer: $\boxed{2}$ (Option A)

Answer: (A)

Go Back to Question 5

Q6.

Solution

Concept: In angiosperms, the female gametophyte develops inside the ovule and is called the embryo sac. It is a seven-celled, eight-nucleate structure containing the egg apparatus, antipodal cells, and a central cell with two polar nuclei.

Step 1: A megaspore mother cell inside the ovule undergoes meiosis to produce four megaspores, of which only one survives and develops into the embryo sac (female gametophyte) through three rounds of mitosis.
Step 2: The mature embryo sac contains the egg cell (female gamete), two synergids, three antipodal cells, and two polar nuclei – all essential for double fertilisation.

Why other options are wrong:

- **Option A:** The pollen sac is where pollen grains (male gametophytes) are produced inside the anther.
- **Option B:** The anther is the male reproductive structure producing pollen.
- **Option D:** The testa is the outer seed coat, a protective layer.

Final Answer: Embryo sac (Option D)

Answer: (D)

Go Back to Question 6

Q7.

Solution

Concept: Passive immunity is acquired when pre-formed antibodies are transferred from one individual to another, rather than being produced by the recipient's own immune system. When a mother's antibodies pass to her baby through breast milk (colostrum) or the placenta, it is called naturally acquired passive immunity.

Step 1: Colostrum (the first milk produced after birth) is rich in IgA antibodies. These maternal antibodies provide the newborn with immediate, short-term protection against many pathogens that the baby's immature immune system cannot yet fight.
Step 2: This immunity is "passive" because the baby did not produce the antibodies itself, and "naturally acquired" because it was obtained through a natural biological process (breastfeeding), not through medical intervention.

Why other options are wrong:

- **Option A:** Active immunity requires the individual's own immune system to produce antibodies (e.g., after infection).
- **Option B:** Artificially acquired active immunity involves vaccination, not maternal transfer.
- **Option D:** Innate immunity is non-specific defence present from birth (e.g., skin, mucous membranes), not antibody transfer.

Final Answer: Naturally acquired passive immunity (Option C)

Answer: (C)

Go Back to Question 7

Q8.

Solution

Concept: Phylum Mollusca is the second-largest animal phylum. Molluscs have a soft, unsegmented body typically divided into a head, muscular foot, and visceral mass. Most secrete a calcareous shell for protection. Examples include snails, mussels, octopuses, and slugs.

Step 1: A snail has a soft body enclosed within a spirally coiled calcareous shell, a muscular foot for locomotion, and a head bearing tentacles and eyes – all characteristic features of molluscs.
Step 2: The other options belong to different phyla: earthworm (Annelida), starfish (Echinodermata), cockroach (Arthropoda).

Why other options are wrong:

- **Option B:** Starfish belongs to phylum Echinodermata (spiny-skinned, water vascular system).
- **Option C:** Earthworm belongs to phylum Annelida (segmented worms).
- **Option D:** Cockroach belongs to phylum Arthropoda (jointed legs, chitinous exoskeleton).

Final Answer: Snail (Option A)

Answer: (A)

Go Back to Question 8

Q9.

Solution

Concept: White blood cells (WBCs / leukocytes) are the cellular components of the immune system. They identify, engulf, and destroy foreign pathogens (bacteria, viruses, fungi) and abnormal cells through phagocytosis and by producing antibodies.

Step 1: WBCs include neutrophils (phagocytosis of bacteria), monocytes/macrophages (engulf pathogens), lymphocytes (B-cells produce antibodies; T-cells kill infected cells), eosinophils (combat parasites), and basophils (release histamine in allergies).
Step 2: Collectively, WBCs defend the body against infections and foreign substances, making immunity their primary role.

Why other options are wrong:

- **Option A:** Transporting oxygen is the function of RBCs (haemoglobin), not WBCs.
- **Option C:** CO_2 transport is mainly via plasma (as bicarbonate) and partly by haemoglobin, not WBCs.
- **Option D:** Blood clotting is initiated by platelets (thrombocytes), not WBCs.

Final Answer: Defending the body against infections (Option B)

Answer: (B)

Go Back to Question 9

Q10.

Solution

Concept: Vitamin B_{12} (cobalamin) is essential for the production of healthy red blood cells and the proper functioning of the nervous system. Its deficiency impairs RBC maturation, producing abnormally large, immature cells, leading to pernicious anaemia.

Step 1: Vitamin B_{12} is required as a coenzyme for DNA synthesis in rapidly dividing cells, including the precursors of red blood cells in the bone marrow. Without sufficient B_{12}, these cells cannot divide properly and produce enlarged, immature RBCs called megaloblasts.
Step 2: Pernicious anaemia is characterised by fatigue, weakness, numbness and tingling in the hands and feet (neurological symptoms), glossitis (inflamed tongue), and pallor.

Why other options are wrong:

- **Option A:** Iron-deficiency anaemia is caused by insufficient dietary iron, not B_{12}.
- **Option B:** Sickle-cell anaemia is a genetic disorder caused by a point mutation in the haemoglobin gene.
- **Option D:** Thalassaemia is a genetic disorder affecting haemoglobin chain synthesis.

Final Answer: Pernicious anaemia (Option C)

Answer: (C)

Go Back to Question 10

Q11.

Solution

Concept: Chargaff's rule states that in any double-stranded DNA molecule, the amount of adenine (A) always equals the amount of thymine (T), and the amount of guanine (G) always equals the amount of cytosine (C), because of the specific base-pairing: A pairs with T via two hydrogen bonds, and G pairs with C via three hydrogen bonds.

Step 1: Since adenine always pairs with thymine in double-stranded DNA, the molar amount of A = T and the molar amount of G = C in any given DNA sample.
Step 2: This rule was discovered by Erwin Chargaff before the Watson-Crick model and provided critical evidence for the base-pairing rules in the double helix structure.

Why other options are wrong:

- **Option B:** Cytosine pairs with guanine, not with adenine.
- **Option C:** Guanine pairs with cytosine, not with adenine.
- **Option D:** Uracil is found in RNA (replacing thymine) and is not present in DNA.

Final Answer: Thymine (T) (Option A)

Answer: (A)
Go Back to Question 11

Q12.

Solution

Concept: Growth hormone (GH / somatotropin) is secreted by the anterior lobe of the pituitary gland. It promotes overall body growth by stimulating protein synthesis, cell division, and the lengthening of long bones during childhood and adolescence.

Step 1: GH acts on almost all tissues. In bones, it stimulates the growth plates (epiphyseal plates) to produce new cartilage, which is later replaced by bone, increasing height. In muscles, it promotes protein synthesis and cell growth.
Step 2: Excess GH in childhood causes gigantism; deficiency causes dwarfism. Excess in adulthood causes acromegaly (enlargement of hands, feet, and face).

Why other options are wrong:

- **Option A:** Thyroxine regulates basal metabolic rate, not primarily bone/muscle growth.
- **Option C:** Insulin regulates blood glucose levels.
- **Option D:** Adrenaline mediates the "fight or flight" response, not long-term growth.

Final Answer: Growth hormone (somatotropin) (Option B)

Answer: (B)
Go Back to Question 12

Q13.

Solution

Concept: Cardiac muscle is a specialised type of muscle found only in the heart wall (myocardium). It combines features of both skeletal and smooth muscle: it is striated (like skeletal) but involuntary (like smooth). Its cells are uninucleate, branched, and connected by intercalated discs that allow rapid, coordinated contraction.

Step 1: Cardiac muscle cells are cylindrical, branched, and uninucleate. They show cross-striations (alternating light and dark bands) due to the organised arrangement of actin and myosin filaments.
Step 2: Intercalated discs are specialised cell junctions between adjacent cardiac muscle cells. They contain gap junctions that allow electrical impulses to pass rapidly from cell to cell, enabling the heart to contract as a coordinated unit.

Why other options are wrong:

- **Option A:** This describes skeletal muscle incorrectly – skeletal muscle is voluntary and multinucleated, but is striated, not non-striated.
- **Option C:** This describes skeletal muscle – voluntary, cylindrical, attached to bones.
- **Option D:** This describes smooth (visceral) muscle – involuntary, spindle-shaped, non-striated (no intercalated discs).

Final Answer: Involuntary, uninucleate, striated, branched with intercalated discs (Option B)

Answer: (B)

Go Back to Question 13

Q14.

Solution

Concept: A transgenic organism (genetically modified organism / GMO) is one whose genetic material has been altered by inserting a gene from another species using recombinant DNA technology. Golden rice has been engineered to produce β-carotene (provitamin A) in the edible parts of the grain to combat Vitamin A deficiency.

Step 1: Golden rice was created by introducing genes from daffodil and the bacterium *Erwinia uredovora* into rice, enabling the rice endosperm to synthesise β-carotene, giving it a golden colour.
Step 2: This is a transgenic modification because foreign genes from different species were introduced into the rice genome using genetic engineering.

Why other options are wrong:

- **Option A:** A hybrid is produced by crossing two different varieties of the same species, not by inserting foreign genes.
- **Option C:** A natural mutant arises from spontaneous DNA changes, not deliberate gene insertion.
- **Option D:** Polyploidy involves multiplication of the entire chromosome set, not insertion of specific genes.

Final Answer: Transgenic organism (Option B)

Answer: (B)

Go Back to Question 14

Q15.

Solution

Concept: In vitro fertilisation (IVF) is an assisted reproductive technology (ART) in which the egg and sperm are combined outside the body in a laboratory dish ("in vitro" means "in glass"). The resulting embryo is then transferred to the mother's uterus for implantation and development.

Step 1: In IVF, the woman's ovaries are hormonally stimulated to produce multiple eggs, which are surgically retrieved. These eggs are fertilised with sperm in a culture dish. The resulting embryos are monitored for development.
Step 2: One or more healthy embryos are transferred into the uterus. If implantation is successful, a normal pregnancy follows. IVF is commonly used for couples with infertility issues.

Why other options are wrong:

- **Option A:** Artificial insemination involves introducing sperm directly into the female reproductive tract, but fertilisation occurs inside the body.
- **Option C:** Surrogacy involves another woman carrying the pregnancy, but it does not define the fertilisation method.
- **Option D:** Amniocentesis is a diagnostic test on amniotic fluid, not a reproductive technique.

Final Answer: In vitro fertilisation (IVF) (Option B)

Answer: (B)

Go Back to Question 15

Q16.

Solution

Concept: Plants have two types of vascular (conducting) tissue: xylem for water/mineral transport and phloem for food transport. Phloem consists of sieve tube elements and companion cells and translocates prepared food (mainly sucrose) from the site of synthesis (leaves) to all other parts of the plant.

Step 1: Phloem is a complex tissue composed of sieve tube elements (conducting cells with sieve plates), companion cells (provide metabolic support), phloem parenchyma (storage), and phloem fibres (support).
Step 2: Food is transported by the pressure-flow (mass-flow) mechanism: sucrose is actively loaded into sieve tubes at the source (leaves), creating high osmotic pressure. Water follows by osmosis, generating a pressure gradient that pushes the solution toward the sink (roots, fruits, growing tips).

Why other options are wrong:

- **Option A:** Xylem transports water and minerals upward, not food.
- **Option B:** Parenchyma is a simple tissue for storage and photosynthesis, not long-distance food transport.
- **Option C:** Collenchyma is a simple tissue providing flexible support, not transport.

Final Answer: Phloem (Option D)

Answer: (D)

Go Back to Question 16

Q17.

Solution

Concept: The nitrogen cycle involves several bacterial processes. *Rhizobium* is a symbiotic nitrogen-fixing bacterium living in root nodules of legumes. Ammonification is the process by which decomposers break down organic nitrogen in dead matter, releasing ammonia.

Step 1: The passage states: "Nitrogen-fixing bacteria such as *Rhizobium*, found in root nodules of leguminous plants, convert N_2 into ammonia." Therefore, the answer to sub-part 1 is ***Rhizobium***.
Step 2: The passage states: "When plants and animals die, decomposers release the nitrogen as ammonia, a process called ammonification." Therefore, the answer to sub-part 2 is **ammonification**.

Final Answer:
1. *Rhizobium*
2. Ammonification

Answer: (See above)

Go Back to Question 17

Q18.

Solution

Concept: The nucleus is the control centre of a eukaryotic cell, housing the DNA that directs all cellular activities. The cell wall is a rigid, non-living structure outside the cell membrane in plant cells, made of cellulose, absent in animal cells.

Step 1: The **nucleus** is a large, membrane-bound organelle containing the chromosomes (DNA). It directs protein synthesis and controls cell division, growth, and metabolism.
Step 2: The **cell wall** is a rigid outer layer made of cellulose microfibrils. It provides structural support, maintains cell shape, prevents over-expansion due to osmotic water uptake, and protects against mechanical damage. It is present in plant cells but absent in animal cells.

Final Answer:
1. nucleus
2. cell wall

Answer: (See above)
Go Back to Question 18

Q19.

Solution

Concept: The heart is a four-chambered pump. The right ventricle (RV) pumps deoxygenated blood to the lungs via the pulmonary artery. The interventricular septum is the thick muscular wall between the left and right ventricles that prevents mixing of oxygenated and deoxygenated blood.

Step 1: The **right ventricle (RV)** receives deoxygenated blood from the right atrium and contracts to pump it through the pulmonary artery to the lungs for oxygenation.
Step 2: The **septum** (inter-ventricular septum) is the thick muscular wall that completely separates the right side (carrying deoxygenated blood) from the left side (carrying oxygenated blood) of the heart. Its function is to **prevent the mixing of oxygenated and deoxygenated blood**, ensuring efficient oxygen delivery to the body tissues.

Final Answer:
1. Right ventricle (RV)
2. Septum prevents mixing of oxygenated and deoxygenated blood

Answer: (See above)
Go Back to Question 19

Q20.

Solution

Concept: Pollination can be mediated by different agents. When wind carries pollen, it is called anemophily (wind pollination). When insects carry pollen, it is called entomophily (insect pollination). Each type has specific floral adaptations.

Step 1: **Wind** pollination (anemophily) occurs in plants with small, inconspicuous, unscented flowers that produce large quantities of light, dry, smooth pollen grains easily carried by air currents (e.g., grasses, maize, wheat).
Step 2: **Insect** pollination (entomophily) occurs in plants with large, brightly coloured, fragrant flowers that produce nectar to attract insects. The pollen grains are often sticky or spiny to adhere to insect bodies (e.g., sunflower, rose, mustard).

Final Answer:
1. wind (anemophily)
2. insect (entomophily)

Answer: (See above)
Go Back to Question 20

Q21.

Solution

Concept: Each major organ in the human body has a specific, specialised function. The kidney filters blood and produces urine, the lung exchanges gases, the liver produces bile and detoxifies blood, and the small intestine absorbs digested nutrients.

Step 1: The kidney filters blood through its nephrons, removing urea, excess salts, and water to form urine, matching pair (a)–(ii).
Step 2: The lung provides a large surface area (alveoli) for the exchange of O_2 and CO_2 between inhaled air and blood, matching pair (b)–(i).
Step 3: The liver secretes bile (for fat emulsification), detoxifies harmful substances (drugs, alcohol, metabolic waste), and performs numerous metabolic functions, matching pair (c)–(iv).
Step 4: The small intestine (with its villi) is the principal site of absorption of digested nutrients (amino acids, glucose, fatty acids) into the bloodstream, 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: The greenhouse effect is the natural warming of Earth due to atmospheric gases trapping heat radiated from the surface. Ozone depletion in the stratosphere, primarily by CFCs, increases the amount of harmful ultraviolet (UV) radiation reaching the Earth.

Step 1: The **greenhouse** effect is the process by which greenhouse gases (CO_2, CH_4, N_2O, water vapour) in the atmosphere absorb and re-radiate infrared (heat) radiation emitted by the Earth's surface, keeping the planet's average temperature about 33°C warmer than it would otherwise be.
Step 2: CFCs released from refrigerants and aerosols rise to the stratosphere where they release chlorine atoms that catalytically destroy ozone (O_3) molecules. The resulting thinning of the ozone layer allows more **ultraviolet (UV)** radiation to pass through, increasing the risk of skin cancer, cataracts, and damage to ecosystems.

Final Answer:
1. greenhouse
2. ultraviolet (UV)

Answer: (See above)
Go Back to Question 22

Q23.

Solution

Concept: Mitosis is an equational cell division that produces two genetically identical daughter cells. Crossing over (recombination) is a feature of meiosis I (specifically prophase I), not mitosis.

Step 1: Mitosis accurately replicates the parent cell's DNA and distributes identical copies to each daughter cell. Both daughters have the same chromosome number and genetic composition as the parent. Statement 1 is **True (T)**.
Step 2: Crossing over (exchange of segments between non-sister chromatids of homologous chromosomes) occurs during prophase I of **meiosis**, not during mitosis. In mitosis, homologous chromosomes do not pair up or exchange material. Statement 2 is **False (F)**.

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

Answer: (See above)
Go Back to Question 23

Q24.

Solution

Concept: Different invertebrate phyla are distinguished by body plan features such as body symmetry, segmentation, coelom type, and unique structural features.

Step 1: Tapeworm has a flat, ribbon-like body and is an endoparasite. It belongs to **Phylum Platyhelminthes** (flatworms), matching pair (a)–(ii).
Step 2: Earthworm has a cylindrical body divided into ring-like segments (metameres) and has a true coelom. It belongs to **Phylum Annelida** (segmented worms), matching pair (b)–(i).
Step 3: Roundworm (*Ascaris*) has a cylindrical, unsegmented body with a pseudocoelom (body cavity not fully lined by mesoderm). It belongs to **Phylum Nematoda** (roundworms), matching pair (c)–(iv).
Step 4: Starfish has a radially symmetrical body with a spiny calcareous endoskeleton and a unique water vascular system for locomotion. It belongs to **Phylum Echinodermata**, matching pair (d)–(iii).

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

Answer: (See above)

Go Back to Question 24

Q25.

Solution

Concept: Root systems are broadly classified into two types based on their origin and morphology: the tap root system (found in most dicots) and the fibrous root system (found in most monocots).

Step 1: A **tap** root system develops from the radicle of the germinating seed. The primary root grows vertically downward and persists as the main root, with smaller secondary and tertiary lateral roots branching off it. Examples: carrot, mustard, mango.
Step 2: A **fibrous** root system develops when the primary root is short-lived and is replaced by numerous adventitious roots of roughly equal size growing from the base of the stem. These form a dense, shallow network. Examples: wheat, rice, grass.

Final Answer:
1. tap
2. fibrous

Answer: (See above)

Go Back to Question 25

Q26.

Solution

Concept: Infectious diseases are caused by specific pathogenic microorganisms and can be transmitted by different routes: vectors (mosquitoes), contaminated water/food, air droplets, or direct contact.

Step 1: Malaria is caused by the protozoan *Plasmodium* (species: *P. vivax*, *P. falciparum*, etc.) and is transmitted by the bite of the female *Anopheles* mosquito, matching pair (a)–(ii).
Step 2: Tuberculosis (TB) is caused by the bacterium *Mycobacterium tuberculosis* and spreads through airborne droplets, matching pair (b)–(i).
Step 3: Dengue fever is caused by the dengue virus (a flavivirus) and is spread by the bite of the infected *Aedes aegypti* mosquito, matching pair (c)–(iii).
Step 4: Cholera is caused by the bacterium *Vibrio cholerae* and spreads through consumption of water or food contaminated with the bacterium, matching pair (d)–(iv).

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

Answer: (See above)

Go Back to Question 26

Q27.

Solution

Concept: An antigen is any molecule (usually a protein or polysaccharide) that the immune system recognises as foreign and that triggers an immune response. Many bacteria are beneficial – e.g., gut flora aid digestion, *Rhizobium* fixes nitrogen, and *Lactobacillus* is used to make curd/yoghurt.

Step 1: An antigen can be a surface protein of a pathogen, a toxin, or even a pollen grain. When the immune system detects it, B-cells produce specific antibodies and T-cells are activated. Statement 1 is **True (T)**.
Step 2: The statement that "all bacteria are harmful" is factually incorrect. Many bacteria are essential for human health (gut microbiome, nitrogen-fixing soil bacteria, bacteria used in food production like cheese and yoghurt, and bacteria used in bioremediation). Statement 2 is **False (F)**.

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

Answer: (See above)

Go Back to Question 27

Q28.

Solution

Concept: There are several types of RNA, each with a specific role in gene expression. mRNA carries the genetic code, tRNA delivers amino acids, rRNA forms part of the ribosome structure, and snRNA (small nuclear RNA) is involved in RNA splicing in eukaryotes.

Step 1: mRNA (messenger RNA) carries the transcribed genetic information from DNA in the nucleus to the ribosome in the cytoplasm, serving as the template for protein synthesis, matching pair (a)–(ii).
Step 2: tRNA (transfer RNA) is a small adapter molecule that reads the mRNA codon via its anticodon and brings the corresponding amino acid to the growing polypeptide chain at the ribosome, matching pair (b)–(iv).
Step 3: rRNA (ribosomal RNA) is a structural and catalytic component of the ribosome, the molecular machine where translation occurs, matching pair (c)–(i).
Step 4: snRNA (small nuclear RNA) is found in the nucleus and, as part of the spliceosome complex, catalyses the removal of introns (non-coding sequences) from pre-mRNA during RNA processing, matching pair (d)–(iii).

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

Answer: (See above)

Go Back to Question 28

Q29.

Solution

Concept: Leaves can be modified into various structures to serve functions other than photosynthesis, such as defence, support, water/food storage, or reproduction, depending on the plant's habitat and survival needs.

Step 1: Tendrils (leaf tendrils): In some climbing plants, leaves or parts of leaves (e.g., leaflets, leaf tips) are modified into thin, coiling, thread-like structures called tendrils. These tendrils wrap around nearby supports to help the plant climb and gain access to sunlight. Example: Sweet pea (*Pisum sativum*) – the terminal leaflets are modified into tendrils.
Step 2: Spines: In plants growing in arid (dry) environments, leaves are modified into sharp, pointed spines to reduce the surface area for water loss (transpiration) and to protect the plant from grazing animals. Example: Cactus (*Opuntia*) – the entire leaf is reduced to a spine, and the green, fleshy stem takes over the function of photosynthesis.

Final Answer: Leaf tendrils for climbing (e.g., sweet pea); leaf spines for water conservation and defence (e.g., cactus).

Answer: (See above)

Go Back to Question 29

Q30.

Solution

Concept: Asexual reproduction is the production of new organisms from a single parent without the fusion of gametes (sex cells). The offspring are genetically identical to the parent (clones). Methods include binary fission, budding, fragmentation, spore formation, and vegetative propagation.

Step 1: **Asexual reproduction** is defined as a mode of reproduction in which a single organism produces offspring without the formation and fusion of gametes. The offspring are genetically identical to the parent.
Step 2: Two methods (other than vegetative propagation in flowering plants):
(a) **Binary fission:** The parent cell divides into two equal daughter cells, each growing into a new organism. Example: *Amoeba* divides by binary fission under favourable conditions.
(b) **Budding:** A small bud (outgrowth) forms on the parent organism, grows, and eventually detaches to become an independent individual. Example: *Hydra* reproduces by budding – a small bud develops on the body wall, grows tentacles, and detaches.

Final Answer: Asexual reproduction: offspring from one parent without gamete fusion. Binary fission (Amoeba) and budding (Hydra).

Answer: (See above)

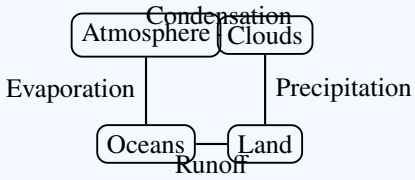
Go Back to Question 30

Q31.

Solution

Concept: Biogeochemical cycles describe the continuous movement of essential elements through the biotic and abiotic components of the Earth. The water (hydrological) cycle and carbon cycle are two fundamental cycles sustaining life.

Alternative (i) – Water cycle:



Step 1: Evaporation: Water from oceans, lakes, and rivers is heated by the sun and evaporates into water vapour, rising into the atmosphere.
Step 2: Condensation: As water vapour rises and cools, it condenses around dust particles to form tiny water droplets, forming clouds.
Step 3: Precipitation: When clouds become heavy with water droplets, the water falls back to the Earth's surface as rain, snow, sleet, or hail.
Step 4: Surface runoff: Precipitation that falls on land flows over the surface as streams and rivers, eventually returning to the oceans, completing the cycle.

Alternative (ii) – Carbon cycle:
Step 1: Plants absorb atmospheric CO_2 during **photosynthesis** and convert it into organic carbon (glucose).
Step 2: Both plants and animals release CO_2 back into the atmosphere through **respiration**.
Step 3: Combustion of fossil fuels (coal, oil, gas) and burning of wood releases stored carbon as CO_2.
Step 4: Decomposition of dead organisms by bacteria and fungi releases carbon as CO_2 (or methane under anaerobic conditions).

Final Answer: (i) Water cycle: evaporation → condensation → precipitation → runoff; (ii) Carbon cycle: photosynthesis fixes CO_2, respiration/combustion/decomposition release CO_2.

Answer: (See above)

Go Back to Question 31

Q32.

Solution

Concept: Blood is a fluid connective tissue with four main components: plasma, RBCs, WBCs, and platelets. Striated and smooth muscles differ in location, appearance, and voluntary/involuntary control.

Alternative (i) – Blood components:
Step 1: Plasma (~55%) – straw-coloured liquid; transports nutrients, hormones, waste, and proteins. **RBCs** (erythrocytes) – biconcave, enucleated discs; transport O_2 via haemoglobin.
Step 2: WBCs (leukocytes) – nucleated cells; defend against infections. **Platelets** (thrombocytes) – cell fragments; initiate blood clotting at wound sites.

Alternative (ii) – Striated vs Smooth muscle:
Step 1 (a): Striated muscle is attached to bones (hence "skeletal muscle"). **Smooth muscle** is found in the walls of hollow internal organs (stomach, intestine, blood vessels, uterus).
Step 2 (b): Striated muscle is under **voluntary** (conscious) control. Smooth muscle is under **involuntary** (unconscious, autonomic) control.

Final Answer: (i) Plasma (transport), RBCs (O_2), WBCs (immunity), Platelets (clotting); (ii) Striated: attached to bones, voluntary; Smooth: internal organ walls, involuntary.

Answer: (See above)

Go Back to Question 32

Q33.

Solution

Concept: From the balanced equation of photosynthesis, $6\ CO_2 + 6\ H_2O \rightarrow 1\ C_6H_{12}O_6 + 6\ O_2$. So 6 molecules of O_2 are produced per glucose molecule, meaning the ratio of O_2 : glucose = 6 : 1.

Step 1: From the equation, 6 O_2 are released per 1 glucose molecule produced.
Step 2: If 42 O_2 molecules are released:
Glucose molecules produced = $\frac{42}{6}$ = 7 molecules.
Step 3: From the equation, 6 CO_2 are fixed per glucose molecule.
CO_2 molecules fixed = $7 \times 6 = 42$ molecules.

Final Answer: 7 glucose molecules produced; 42 CO_2 molecules fixed.

Answer: (See above)

Go Back to Question 33

Q34.

Solution

Concept: The ABO blood group system is controlled by three alleles: I^A, I^B, and i. I^A and I^B are codominant to each other but both are dominant over i. A cross between $I^A i \times I^B i$ produces offspring with all four possible blood groups.

	I^A	i
I^B	$I^A I^B$	$I^B i$
i	$I^A i$	ii

Step 1: Father ($I^A i$) produces gametes: I^A and i. Mother ($I^B i$) produces gametes: I^B and i.
Step 2: Offspring genotypes and blood groups:

- $I^A I^B \rightarrow$ Blood group **AB**
- $I^B i \rightarrow$ Blood group **B**
- $I^A i \rightarrow$ Blood group **A**
- $ii \rightarrow$ Blood group **O**

Step 3: All four blood groups (A, B, AB, O) are possible, each with a 25% probability.

Final Answer: Possible blood groups: A, B, AB, and O (each 25% probability).

Answer: (See above)

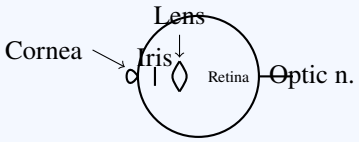
Go Back to Question 34

Q35.

Solution

Concept: The human eye is a complex sense organ for vision. The retina is the innermost light-sensitive layer containing photoreceptor cells (rods and cones). The ear has three parts: outer (collects sound), middle (amplifies vibrations), and inner (converts vibrations to nerve impulses and maintains balance).

Alternative (i) – Eye:



Step 1: The cornea refracts light; the iris controls the pupil size; the lens focuses light onto the retina.

Step 2: The **retina** contains photoreceptor cells: rods (dim light, black-and-white vision) and cones (bright light, colour vision). When light hits these cells, they generate nerve impulses that travel via the optic nerve to the brain's visual cortex, producing the perception of vision.

Alternative (ii) – Ear:

Step 1: Outer ear (pinna + ear canal): collects and channels sound waves to the eardrum (tympanic membrane).

Step 2: Middle ear (three ossicles: malleus, incus, stapes): amplifies sound vibrations from the eardrum and transmits them to the oval window of the inner ear.

Step 3: Inner ear (cochlea + semicircular canals): the cochlea converts sound vibrations into nerve impulses for hearing; the semicircular canals detect head position and movement for balance.

Final Answer: (i) Eye: cornea, iris, pupil, lens, retina (photoreceptors convert light to nerve impulses), optic nerve; (ii) Ear: outer (collects sound), middle (amplifies vibrations), inner (hearing + balance).

Answer: (See above)

Go Back to Question 35

Q36.

Solution

Concept: Water-borne diseases are infections caused by pathogenic microorganisms transmitted through contaminated drinking water or water used for food preparation.

Step 1: Water-borne diseases are diseases caused by ingesting water contaminated with pathogenic bacteria, viruses, or parasites from sewage, faecal matter, or industrial waste.
Step 2: Two examples: (a) **Cholera** – caused by *Vibrio cholerae*; symptoms include severe watery diarrhoea and dehydration. (b) **Typhoid** – caused by *Salmonella typhi*; symptoms include prolonged high fever, headache, and abdominal pain.
Step 3: Preventive measure applicable to both: **Drinking only clean, boiled, or chlorinated/filtered water** and ensuring proper sanitation and sewage disposal to prevent contamination of water sources.

Final Answer: Water-borne diseases spread through contaminated water (e.g., cholera, typhoid). Prevention: drink boiled/filtered water and maintain proper sanitation.

Answer: (See above)

Go Back to Question 36

Q37.

Solution

Concept: Aerobic respiration uses oxygen to completely oxidise glucose, producing CO_2, H_2O, and 36 ATP. Anaerobic respiration occurs without oxygen, incompletely breaking down glucose into ethanol + CO_2 (yeast) or lactic acid (muscles), producing only 2 ATP.

Step 1 (a) – Oxygen: Aerobic respiration **requires oxygen** as the final electron acceptor. Anaerobic respiration occurs **without oxygen**.
Step 2 (b) – End products: Aerobic: CO_2 + H_2O (complete oxidation). Anaerobic: ethanol + CO_2 (in yeast) or lactic acid (in muscle cells) – incomplete oxidation.
Step 3 (c) – ATP yield: Aerobic respiration produces **36 ATP** per glucose molecule (much more efficient). Anaerobic respiration produces only **2 ATP** per glucose molecule (much less efficient because glucose is only partially oxidised).

Final Answer: Aerobic: needs O_2, produces CO_2 + H_2O, yields 36 ATP. Anaerobic: no O_2, produces ethanol/lactic acid + CO_2, yields 2 ATP.

Answer: (See above)

Go Back to Question 37

Q38.

Solution

Concept: Biotechnology has diverse applications including biogas production, bioremediation, and the use of recombinant DNA technology in medicine to produce therapeutic proteins and vaccines.

Step 1 – Biogas: Biogas is a mixture of gases produced by the anaerobic digestion (fermentation) of organic waste (cow dung, agricultural waste, sewage) by methanogenic bacteria. The **main gas** present in biogas is **methane (CH_4)**, which constitutes about 60–70% of biogas and is a combustible fuel used for cooking and lighting.

Step 2 – Bioremediation: Bioremediation is the use of living organisms (mainly bacteria, fungi, and plants) to degrade, detoxify, or remove environmental pollutants (oil spills, heavy metals, pesticides, industrial waste) from contaminated soil, water, or air, restoring the environment to a cleaner state.

Step 3 – rDNA in medicine: One major application of recombinant DNA technology in medicine is the production of **human insulin (Humulin)** by genetically engineered bacteria (*E. coli*). The human insulin gene is inserted into bacterial plasmids, and the bacteria produce insulin on an industrial scale for treating diabetes.

Final Answer: A. Biogas: gas from anaerobic digestion of waste; main gas = methane. B. Bioremediation: using organisms to clean pollutants. C. rDNA application: production of human insulin by engineered bacteria.

Answer: (See above)

Go Back to Question 38

Q39.

Solution

Concept: Chromosomal disorders result from abnormalities in chromosome number or structure. Down syndrome is caused by trisomy of chromosome 21. Dominant alleles express their effect even in heterozygous condition, while recessive alleles express only in homozygous condition.

Alternative (i) – Down syndrome:

Step 1: **Chromosomal disorders** are genetic abnormalities caused by changes in the number or structure of chromosomes, rather than changes in individual genes. They may involve extra chromosomes (trisomy), missing chromosomes (monosomy), or structural rearrangements.

Step 2: **Down syndrome** (Trisomy 21) is caused by the presence of an extra copy of chromosome 21 (i.e., three copies instead of two), resulting in a total of 47 chromosomes instead of the normal 46. This usually occurs due to non-disjunction (failure of chromosome 21 to separate) during meiosis in egg or sperm formation.

Step 3: Symptoms include intellectual disability, characteristic facial features (flat face, small ears, epicanthic eye folds), short stature, broad hands with a single palmar crease, and an increased risk of heart defects.

Alternative (ii) – Dominant vs Recessive:

Step 1: A **dominant allele** is one that expresses its phenotypic effect even when present in a single copy (heterozygous condition, e.g., Aa). A **recessive allele** expresses its effect only when present in two copies (homozygous condition, e.g., aa).

Step 2: Example of a dominant trait in humans: **free (unattached) earlobes** – the allele for free earlobes is dominant over attached earlobes. Example of a recessive trait: **attached earlobes** – this phenotype appears only in homozygous recessive individuals.

Final Answer: (i) Chromosomal disorders: abnormal chromosome number/structure; Down syndrome: trisomy 21 (47 chromosomes), intellectual disability, characteristic facial features; (ii) Dominant allele expresses in heterozygote (free earlobes); recessive allele expresses only in homozygote (attached earlobes).

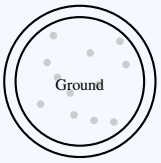
Answer: (See above)

Go Back to Question 39

Q40.

Solution

Concept: Dicot and monocot stems differ in the arrangement of vascular bundles, presence of cambium, and differentiation of ground tissue. Dicot stems have a ring of open vascular bundles with cambium (allowing secondary growth), while monocot stems have scattered closed bundles without cambium.



Monocot stem

Step 1 (a): In a **dicot stem**, vascular bundles are arranged in a **ring** (one or two rings). In a **monocot stem**, vascular bundles are **scattered** throughout the ground tissue without any definite ring pattern.

Step 2 (b): Dicot vascular bundles are **open** – they contain a strip of cambium between the xylem and phloem, allowing secondary growth (increase in thickness). Monocot vascular bundles are **closed** – they lack cambium and cannot undergo secondary growth.

Step 3 (c): In a dicot stem, the ground tissue is clearly differentiated into an outer **cortex** (between epidermis and vascular bundles) and a central **pith** (inside the ring of bundles). In a monocot stem, there is **no differentiation** into cortex and pith – the ground tissue is uniform and the vascular bundles are scattered throughout it.

Final Answer: Dicot: ring of open VBs (with cambium), cortex + pith distinct. Monocot: scattered closed VBs (no cambium), undifferentiated ground tissue.

Answer: (See above)

Go Back to Question 40

Q41.

Solution

Concept: Obesity is a condition of excessive body fat accumulation that poses serious health risks. Personal hygiene is a set of practices that maintain cleanliness and health, preventing the transmission of infectious diseases.

Alternative (i) – Obesity:

Step 1: **Obesity** is a medical condition in which excess body fat has accumulated to the extent that it adversely affects health. It is usually measured by Body Mass Index (BMI > 30 kg/m^2).

Step 2: Health risks: (a) Increased risk of cardiovascular diseases (heart attack, stroke, hypertension); (b) Increased risk of Type 2 diabetes mellitus due to insulin resistance.

Step 3: Prevention/management: (a) Regular physical exercise (at least 30–60 minutes daily); (b) Eating a balanced diet with controlled calorie intake, rich in fruits, vegetables, and whole grains, and low in saturated fats and sugars.

Alternative (ii) – Personal hygiene:

Step 1: **Personal hygiene** refers to the practices that individuals follow to maintain cleanliness of their body and surroundings, thereby reducing the risk of contracting and spreading infectious diseases.

Step 2: Three hygiene practices: (a) Washing hands thoroughly with soap and water before eating and after using the toilet; (b) Bathing daily and wearing clean clothes; (c) Covering the mouth and nose while coughing or sneezing to prevent airborne transmission.

Final Answer: (i) Obesity: excess body fat; risks: heart disease, diabetes; prevention: exercise, balanced diet; (ii) Personal hygiene prevents infections: handwashing, daily bathing, covering coughs/sneezes.

Answer: (See above)

Go Back to Question 41

Q42.

Solution

Concept: Organic evolution is the gradual change in living organisms over generations. Homologous organs share a common origin (but may differ in function), while analogous organs share a common function (but differ in origin). A chromosome consists of DNA wrapped around histone proteins, with a centromere, two chromatids, and telomeres. Meiosis reduces chromosome number and generates genetic variation.

Alternative (i):

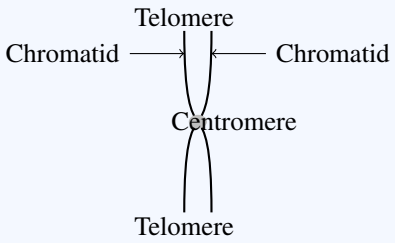
Step 1 (a): Organic evolution is the gradual, continuous change in the inherited characteristics of biological populations over successive generations, leading to the diversity of life. Two evidences: (a) **Fossil records** – fossils show progressive changes in life forms from simpler to more complex over geological time. (b) **Comparative anatomy** – similarities in body structures (homologous organs) across different species suggest descent from a common ancestor.

Step 2 (b): Homologous organs have the same embryonic origin and structural plan but may perform different functions in different organisms. Example: the forelimb of a human (for grasping) and the wing of a bat (for flying) share the same bone structure (humerus, radius, ulna). **Analogous organs** perform the same function but have different structural origins. Example: the wing of an insect (chitinous) and the wing of a bird (bony) both serve for flight but differ in internal structure.

Solution

Alternative (ii):

Step 1 (a): A **chromosome** is a thread-like structure of DNA and histone proteins found in the nucleus. During cell division, each chromosome consists of two identical halves called **chromatids**, joined at a constricted region called the **centromere**. The ends of the chromosome are capped by protective repetitive sequences called **telomeres**.



Step 2 (b): Significance of meiosis: (a) It reduces the diploid (2n) chromosome number to haploid (n), ensuring that when gametes fuse during fertilisation, the species' chromosome number is maintained constant across generations. (b) Crossing over and independent assortment during meiosis generate **genetic variation** among offspring, which is essential for adaptation and evolution.

Final Answer: (i)(a) Evolution: gradual change; evidences: fossils, comparative anatomy; (b) Homologous: same origin, different function (human arm/bat wing); Analogous: different origin, same function (insect wing/bird wing); (ii)(a) Chromosome: centromere + 2 chromatids + telomeres; (b) Meiosis: halves chromosome number, generates genetic variation.

Answer: (See above)

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Q43.

Solution

Concept: Digestion in humans is a stepwise process beginning in the mouth and continuing through the stomach, small intestine, and large intestine. The alternation of generations in mosses involves a dominant haploid gametophyte and a dependent diploid sporophyte.

Alternative (i) – Digestion:

Step 1 – Mouth: Salivary amylase (ptyalin) in saliva begins the digestion of starch, breaking it into maltose (a disaccharide). Teeth mechanically break food into smaller pieces.

Step 2 – Stomach: Pepsin (a protease) in the acidic environment created by HCl (pH ~2) breaks proteins into shorter peptide fragments. HCl also kills ingested bacteria and activates pepsinogen to pepsin.

Step 3 – Small intestine: This is the main site of digestion and absorption. **Bile** (from liver) emulsifies fats. **Pancreatic enzymes**: trypsin (digests proteins), pancreatic amylase (digests starch), lipase (digests fats). **Intestinal enzymes**: maltase, sucrase, lactase (digest disaccharides into monosaccharides), peptidases (complete protein digestion into amino acids).

Step 4 – Large intestine: Primarily absorbs **water**, electrolytes, and some vitamins (produced by gut bacteria). The remaining undigested residue is compacted into faeces and eliminated.

Solution

Alternative (ii) – Life cycle of moss (*Funaria*):

Step 1: The moss life cycle shows **alternation of generations** between a dominant, free-living, haploid gametophyte and a smaller, dependent, diploid sporophyte.

Step 2 – Gametophyte stage (n): The main plant body is the leafy gametophyte. It produces male (antheridia – produce sperms) and female (archegonia – produce eggs) sex organs. The flagellated sperm swims through water to reach and fertilise the egg in the archegonium.

Step 3 – Sporophyte stage (2n): The fertilised egg (zygote, 2n) develops into the sporophyte, which remains attached to and nutritionally dependent on the gametophyte. It consists of a foot (anchorage), seta (stalk), and capsule (sporangium). Inside the capsule, spore mother cells undergo meiosis to produce haploid spores (n).

Step 4: When the capsule matures, spores are released. Each spore germinates on moist soil to form a filamentous protonema, which eventually develops into a new leafy gametophyte, completing the life cycle.

Final Answer: (i) Digestion: mouth (amylase – starch), stomach (pepsin – protein), small intestine (bile + pancreatic/intestinal enzymes – fats/proteins/carbs), large intestine (water absorption); (ii) Moss: gametophyte (n, leafy, dominant) → fertilisation → sporophyte (2n, capsule on seta, dependent) → meiosis → spores → gametophyte.

Answer: (See above)

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Answer Key

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