UP Board Class 12 Biology 2026 (Set 348 EG) Question Paper with Solutions

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General Instructions

(i) This booklet contains 9 questions, each provided with a complete, step-by-step solution.

(ii) It comprises 4 single-correct multiple-choice questions.

(iii) Attempt each question on your own before reviewing the given solution.

1(a). Which organ in flower represents the female reproductive organ?

(A) Gynoecium

(B) Androecium

(C) Anther

(D) Tapetum

Correct Answer: (A) Gynoecium

Solution:

Step 1: Recall floral whorls:

A flower has four whorls: calyx (sepals), corolla (petals), androecium (male, stamens) and gynoecium (female, carpels/pistil).

Step 2: Identify the female whorl:

The gynoecium, made of one or more carpels, is the female reproductive whorl - each carpel has an ovary (with ovules), style and stigma.

Final Answer:
Gynoecium is the female reproductive organ of a flower.

Quick Tip: The innermost floral whorl is female.

1(b). Which of the following characteristics of a flower is suitable for insect pollination?

(A) Light weighted pollen grains

(B) Coloured attractive corolla

(C) Multiple ovule

(D) Small pollen grains

Correct Answer: (B) Coloured attractive corolla

Solution:

Step 1: Recall entomophily traits:
Flowers pollinated by insects (entomophily) are typically large, colourful, fragrant, and produce nectar to attract the pollinator.

Step 2: Contrast with anemophily:
Light, small, non-sticky pollen in huge numbers are wind-pollination (anemophily) traits, not insect-pollination traits.

Final Answer:
A coloured, attractive corolla is the insect-pollination adaptation.

Quick Tip: Think about what attracts an insect visually.

1(c). How many years did Gregor Mendel conduct experiments on garden pea plants?

(A) Five years

(B) Two years

(C) Seven years

(D) Eleven years

Correct Answer: (C) Seven years

Solution:

Step 1: Recall the historical fact:
Gregor Mendel carried out his hybridization experiments on the garden pea (Pisum sativum) at the monastery in Brno between 1856 and 1863.

Final Answer:
Mendel's pea experiments spanned seven years (1856-1863).

Quick Tip: 1856 to 1863.

1(d). Sickle cell anaemia disease is an example of which type of mutation?

(A) Point mutation

(B) Euploidy

(C) Deletion

(D) Translocation

Correct Answer: (A) Point mutation

Solution:

Step 1: Recall the molecular basis:
Sickle cell anaemia is caused by a single base substitution (GAG to GTG) in the sixth codon of the beta-globin gene, changing glutamic acid to valine in the beta chain of haemoglobin.

Step 2: Classify the change:
A change confined to a single base pair, without loss or rearrangement of DNA, is called a point mutation.

Final Answer:
Point mutation is correct.

Quick Tip: Only one base pair changes.

2(a). Malaria disease is transmitted by which organism?

Correct Answer: —

Solution:

Step 1: State the vector:
Malaria is transmitted to humans by the bite of an infected female Anopheles mosquito, which carries the Plasmodium parasite in its salivary glands.

Final Answer:
The female Anopheles mosquito transmits malaria.

Quick Tip: The vector is a specific mosquito genus, and only the female bites.

2(b). Write the complete form of the BOD abbreviation.

Correct Answer: —

Solution:

Step 1: Expand the abbreviation:
BOD stands for Biochemical Oxygen Demand (also called Biological Oxygen Demand) - the amount of dissolved oxygen microorganisms need to decompose organic matter in a water sample.

Final Answer:
BOD = Biochemical (Biological) Oxygen Demand.

Quick Tip: It measures oxygen used by microbes decomposing waste.

2(c). Give one example of commensalism.

Correct Answer: —

Solution:

Step 1: Define commensalism:
Commensalism is an interaction between two species where one species benefits and the other is neither helped nor harmed.

Step 2: Give a concrete example:

An orchid growing as an epiphyte on a mango branch benefits (gains support and better light) while the mango tree is unaffected.

Final Answer:
Orchid growing epiphytically on a mango tree is an example of commensalism.

Quick Tip: One species benefits, the other is unaffected.

2(d). Who proposed the chromosomal theory of inheritance?

Correct Answer: —

Solution:

Step 1: Recall the proposers:
Walter Sutton and Theodor Boveri independently proposed the chromosomal theory of inheritance around 1902, noting that chromosomes behave the same way Mendel's factors (genes) do during meiosis.

Final Answer:
Walter Sutton and Theodor Boveri proposed the chromosomal theory of inheritance.

Quick Tip: Two scientists, working independently, around 1902.

2(e). Write the name of any one transgenic animal.

Correct Answer: —

Solution:

Step 1: Define transgenic animal:

A transgenic animal has had its DNA manipulated to contain and express a foreign gene.

Step 2: Give an example:

Rosie, a transgenic cow, was engineered to produce milk enriched with the human protein alpha-lactalbumin.

Final Answer:

Rosie, the transgenic cow, is an example of a transgenic animal.

Quick Tip: Think of an animal engineered to produce a useful human protein.

3(a). What is a pest resistant plant? Give one example.

Correct Answer: —

Solution:

Step 1: Define pest-resistant plant:

A pest-resistant plant is one that has been genetically modified or bred to express a trait (often a toxin gene) that protects it from insect pest damage, reducing the need for chemical pesticides.

Step 2: Give an example:

Bt cotton is a pest-resistant plant, engineered with a cry gene from the

bacterium Bacillus thuringiensis that produces a protein toxic to bollworm larvae.

Final Answer:
A pest-resistant plant resists insect attack; example - Bt cotton.

Quick Tip: Think of the famous Bt crops.

3(b). What is an external parasite? Explain with one example.

Correct Answer: —

Solution:

Step 1: Define ectoparasite:
An external parasite (ectoparasite) is an organism that lives and feeds on the outer surface (skin/body surface) of its host, rather than inside the host's body.

Step 2: Give an example:
Lice living on the human scalp, feeding on blood, are a common example of an external parasite (ectoparasite).

Final Answer:
An ectoparasite lives on the host's body surface; example - lice.

Quick Tip: "External" means attached to the outside of the body.

3(c). Write the names of any two atmospheric nitrogen-fixing microorganisms.

Correct Answer: —

Solution:

Step 1: Recall free-living nitrogen fixers:
Free-living bacteria like Azotobacter and Clostridium can fix atmospheric nitrogen (N_2) into ammonia directly in the soil.

Final Answer:
Azotobacter and Clostridium (or Rhizobium as a symbiotic fixer) are nitrogen-fixing microorganisms.

Quick Tip: Think of both free-living and symbiotic examples.

3(d). Write the names of any two projects to save rivers from pollution.

Correct Answer: —

Solution:

Step 1: Recall the major river-cleaning projects in India:
The Ganga Action Plan (GAP), launched in 1985, was India's first major river-cleaning project, aimed at reducing pollution load in the Ganga.

Final Answer:
Ganga Action Plan and Yamuna Action Plan are two such projects.

Quick Tip: Think of government action plans named after specific rivers.

3(e). What is gel electrophoresis? Explain.

Correct Answer: —

Solution:

Step 1: Define gel electrophoresis:
Gel electrophoresis is a technique used to separate DNA, RNA or protein fragments based on their size, by making them move through a porous agarose or polyacrylamide gel under an electric field.

Step 2: Explain the principle:
Since DNA/RNA fragments are negatively charged (due to the phosphate backbone), they move towards the positive electrode (anode) when current is applied; smaller fragments move faster and farther through the gel's pores than larger ones, so fragments separate by size into distinct bands, which can then be visualized by staining (e.g. ethidium bromide) under UV light.

Final Answer:
Gel electrophoresis separates nucleic acid/protein fragments by size using an electric field through a gel matrix.

Quick Tip: Smaller fragments move faster through the gel's pores.

4(a). Describe the ecological pyramid in brief.

Correct Answer: —

Solution:

Step 1: Define ecological pyramid:

An ecological pyramid is a graphical representation of the trophic structure of an ecosystem, with producers forming the base and successive trophic levels (herbivores, carnivores) stacked above.

Step 2: List the three types:

There are three kinds: pyramid of number (number of individuals at each trophic level), pyramid of biomass (total mass of organisms at each level), and pyramid of energy (energy flow at each level).

Step 3: Note the general shape:

The pyramid of energy is always upright (energy decreases at each successive level, per the 10% law), while pyramids of number and biomass can sometimes be inverted, e.g. in a tree ecosystem or a pond ecosystem respectively.

Final Answer:

An ecological pyramid graphically shows the decrease in number, biomass or energy across successive trophic levels of an ecosystem.

Quick Tip: Three types: number, biomass, energy.

4(b). Describe the process of decomposition with a diagram.

Correct Answer: —

Solution:

Step 1: Define decomposition:

Decomposition is the process by which decomposers (bacteria and fungi) break down complex organic matter in dead plant and animal remains (detritus) into simpler inorganic substances.

Step 2: List the steps in order:

The main steps are: (1) Fragmentation - detritivores like earthworms break detritus into smaller particles; (2) Leaching - water-soluble inorganic nutrients seep into the soil; (3) Catabolism - bacterial/fungal enzymes degrade detritus into simpler compounds; (4) Humification - leads to accumulation of a dark, amorphous substance called humus that is resistant to microbial action; (5) Mineralization - humus is further degraded, releasing inorganic nutrients back to the soil.

Step 3: Note the controlling factors:

Decomposition is faster when detritus is rich in nitrogen and sugars, and is favoured by warm, moist conditions; it slows down when detritus is rich in lignin and chitin.

Final Answer:

Decomposition converts detritus into simpler inorganic substances via fragmentation, leaching, catabolism, humification and mineralization, and releases nutrients back into the soil for reuse by producers (a diagram would show detritus arrows flowing through each of these five stages back to the soil nutrient pool).

Quick Tip: Five steps: fragmentation, leaching, catabolism, humification,

mineralization.

4(c). State the importance of the artificial insemination technique.

Correct Answer: —

Solution:

Step 1: Define artificial insemination:
Artificial insemination (AI) is a technique in which semen collected from a genetically superior/desired male is introduced into the reproductive tract of the female by artificial (non-mating) means.

Step 2: State the breeding benefits:
It allows the semen of a single genetically superior bull to be used to inseminate a very large number of cows, rapidly improving the overall quality and productivity of a herd without needing to physically transport or maintain the male.

Step 3: State the practical/health benefits:
It avoids the transmission of venereal diseases that can occur through natural mating, allows semen to be preserved (frozen/cryopreserved) and transported over long distances, and can also be used to overcome certain physical mating difficulties.

Final Answer:
Artificial insemination lets breeders rapidly improve livestock quality using superior male genetics, while avoiding disease transmission and physical/logistical mating constraints.

Quick Tip: Think in terms of livestock (animal husbandry) improvement.

4(d). Describe the Hardy-Weinberg principle.

Correct Answer: —

Solution:

Step 1: State the principle:
The Hardy-Weinberg principle states that allele frequencies and genotype frequencies in a population remain constant from generation to generation in the absence of evolutionary influences, i.e. the population is said to be in genetic equilibrium.

Step 2: Give the mathematical form:
If p and q are the frequencies of two alleles of a gene ($p + q = 1$), then the genotype frequencies in the population follow $p^2 + 2pq + q^2 = 1$, where p^2 is the frequency of the homozygous dominant genotype, $2pq$ the heterozygous, and q^2 the homozygous recessive.

Step 3: List the required conditions:
This equilibrium holds only if there is no mutation, no gene migration (no gene flow), random mating, no genetic drift (large population size), and no natural selection acting on the population.

Final Answer:
The Hardy-Weinberg principle describes a state of genetic equilibrium ($p^2+2pq+q^2=1$) maintained only when no evolutionary force is acting on the population; any deviation from the expected genotype ratios signals that evolution is occurring.

Quick Tip: p^2 + 2pq + q^2 = 1, and five conditions must hold.

5(a). Write a short note on transfer RNA (tRNA).

Correct Answer: —

Solution:

Step 1: Define tRNA:

Transfer RNA (tRNA) is a small, single-stranded adaptor RNA molecule that reads the genetic code on mRNA and carries the corresponding specific amino acid to the ribosome during protein synthesis (translation).

Step 2: Describe its structure:

tRNA folds into a characteristic clover-leaf secondary structure (and an L-shaped tertiary structure), with an anticodon loop that base-pairs with a complementary codon on mRNA, and an acceptor end (3' CCA end) where the specific amino acid attaches.

Step 3: State its role in translation:

Each of the twenty amino acids has at least one specific tRNA; the correct tRNA delivers its amino acid to the ribosome only when its anticodon correctly pairs with the mRNA codon being read, ensuring the amino acid sequence of the protein matches the genetic code.

Final Answer:

tRNA is the adaptor molecule of translation, with a clover-leaf structure carrying an anticodon (to pair with mRNA) at one end and a specific amino acid at the other.

Quick Tip: Adaptor molecule; clover-leaf shape; anticodon pairs with mRNA codon.

5(b). Describe palaeontological evidence with an example.

Correct Answer: —

Solution:

Step 1: Define palaeontological evidence:
Palaeontological evidence for evolution comes from fossils - preserved remains or impressions of organisms from earlier geological periods - which show that life forms have changed progressively over time and that present-day organisms descended from earlier, often simpler, ancestral forms.

Step 2: Explain the age-depth relationship:
Fossils found in deeper, older rock strata are generally simpler in form, while those in more recent (upper) strata more closely resemble modern organisms, showing gradual change over geological time.

Step 3: Give a classic example:
The fossil series showing horse evolution - from the small, multi-toed Eohippus (Hyracotherium) of about 55 million years ago, through several intermediate forms, to the large, single-toed modern Equus - is a classic, well-documented example of palaeontological evidence for evolution.

Final Answer:
Fossils in successive rock strata trace a gradual, connected sequence

of change; the horse evolutionary series (Eohippus to Equus) is a classic example of palaeontological evidence for evolution.

Quick Tip: Fossils in successive rock layers form a connected sequence; horse evolution is the standard example.

5(c). Describe polyembryony with an example.

Correct Answer: —

Solution:

Step 1: Define polyembryony:
Polyembryony is the occurrence of more than one embryo in a single seed.

Step 2: Explain how it arises:
It commonly arises when, in addition to the zygotic embryo formed by normal fertilization, some of the surrounding nucellus (or sometimes integument) cells also start dividing and develop into additional embryos, without undergoing fertilization themselves (a form of apomixis).

Step 3: Give an example:
Citrus species (like orange) commonly show polyembryony, where multiple nucellar embryos develop alongside the zygotic embryo within the same seed, producing several genetically identical seedlings from one seed.

Final Answer:

Polyembryony is the presence of multiple embryos in one seed, commonly seen in Citrus, where extra nucellar embryos form alongside the normal zygotic embryo.

Quick Tip: More than one embryo per seed, e.g. nucellar embryos in Citrus.

5(d). Draw a labelled diagrammatic sectional view of seminiferous tubules.

Correct Answer: —

Solution:

Step 1: Describe the overall structure:
Each testis contains about 250 lobules, each with one to three highly coiled seminiferous tubules, which are the sites of sperm production (spermatogenesis).

Step 2: Describe the two main cell types lining the tubule:
The seminiferous tubule wall is lined by two types of cells: spermatogenic cells (which, moving from the periphery towards the lumen, differentiate in sequence through spermatogonia, primary spermatocytes, secondary spermatocytes, spermatids, and finally mature sperm) and Sertoli cells (tall cells that nourish and support the developing germ cells).

Step 3: Describe the surrounding region:
Outside the seminiferous tubules, the interstitial spaces contain small clusters of Leydig cells (interstitial cells), which synthesize and

secrete testosterone (androgens).

Final Answer:
A correctly labelled cross-section would show, from the outer basement membrane inward: spermatogonia, primary spermatocytes, secondary spermatocytes, spermatids and sperm lining the lumen, interspersed with tall Sertoli cells, with Leydig cells labelled in the interstitial spaces outside the tubule.

Quick Tip: Label spermatogonia to sperm (inside-out order), Sertoli cells, and Leydig cells in the interstitium.

6(a). What is allergy? Explain with an example.

Correct Answer: —

Solution:

Step 1: Define allergy:
Allergy is an exaggerated (hypersensitive) response of the immune system to certain harmless environmental antigens, called allergens.

Step 2: Explain the underlying mechanism:
On first exposure, the allergen triggers the production of IgE antibodies, which bind to mast cells; on re-exposure, the allergen cross-links these bound IgE antibodies, causing mast cells to release chemicals like histamine and serotonin, which produce the visible allergic symptoms.

Step 3: Give an example:

Exposure to dust or pollen commonly triggers symptoms such as sneezing, watery eyes, and a runny nose (a condition often called hay fever) in susceptible individuals.

Final Answer:
Allergy is an IgE-mediated hypersensitive immune reaction to allergens like dust or pollen, producing symptoms such as sneezing and watery eyes.

Quick Tip: IgE antibodies + mast cells + histamine release.

6(b). Describe the false fruit with a diagram.

Correct Answer: —

Solution:

Step 1: Define false fruit:
A false fruit (pseudocarp) is a fruit that develops mainly from a floral part other than the ovary, such as the thalamus (receptacle), unlike a true fruit which develops solely from the fertilized ovary.

Step 2: Explain the structural difference from a true fruit:
In a false fruit, the swollen, edible part is largely the enlarged thalamus, with the actual ovary-derived tissue (the true fruit / core containing seeds) often forming a smaller, separate structure within or at one end.

Step 3: Give an example:
Apple is the classic example of a false fruit - the fleshy edible part we

eat is the swollen thalamus, while the true fruit (formed from the ovary) is the small, five-chambered core containing the seeds.

Final Answer:
A false fruit (like the apple) develops mainly from the thalamus rather than the ovary; a labelled diagram would show the thalamus forming the bulk of the flesh, with the true, ovary-derived fruit as the small central core enclosing the seeds.

Quick Tip: Thalamus forms the bulk; the ovary forms only the small core.

6(c). Describe the symptoms of Down syndrome.

Correct Answer: —

Solution:

Step 1: State the genetic cause:
Down syndrome is caused by the presence of an extra copy of chromosome 21 (trisomy 21), giving affected individuals 47 chromosomes instead of the usual 46.

Step 2: Describe the physical symptoms:
Characteristic features include short stature, a small round head, a furrowed tongue, a partially open mouth, and a single (simian) crease across the palm.

Step 3: Describe the developmental symptoms:
Affected individuals also typically show a flat facial profile with a broad short skull, slanting eyes, and varying degrees of mental

retardation/intellectual disability.

Final Answer:
Down syndrome (trisomy 21) causes short stature, a small round head, a furrowed tongue, a simian palm crease, a flat facial profile, and mental retardation.

Quick Tip: Extra chromosome 21; physical + developmental signs.

6(d). Explain convergent evolution with an example.

Correct Answer: —

Solution:

Step 1: Define convergent evolution:
Convergent evolution is the process by which unrelated species, living in similar environments and facing similar selection pressures, independently evolve similar (analogous) structures or traits, without inheriting them from a common ancestor.

Step 2: Contrast with divergent evolution:
This is the opposite of divergent evolution (adaptive radiation), where related species from a common ancestor evolve different structures suited to different environments/functions.

Step 3: Give an example:
The wings of butterflies (insects) and the wings of birds are a classic example: both serve the same flight function and look superficially similar, but they evolved completely independently from very

different ancestral structures - the two groups are not closely related.

Final Answer:
Convergent evolution produces superficially similar (analogous) structures in unrelated organisms facing similar environmental pressures - e.g. the wings of butterflies and birds, or the streamlined body shape of sharks (fish) and dolphins (mammals).

Quick Tip: Look for similar structures in UNRELATED organisms - that similarity is analogous, not homologous.

7. What is cancer? Describe its causes and diagnosis in detail.

Correct Answer: —

Solution:

Step 1: Define cancer:
Cancer is a disease characterized by uncontrolled and abnormal division of cells, which invade and damage surrounding normal tissue, and can spread (metastasize) to distant parts of the body via blood or lymph, forming secondary tumours.

Step 2: Describe the causes (2 marks):
Causes include: physical carcinogens (ionizing/UV radiation damaging DNA), chemical carcinogens (like tobacco-derived compounds, certain industrial chemicals), and biological carcinogens (oncogenic viruses, such as HPV or Hepatitis B virus, carrying viral oncogenes or activating cellular proto-oncogenes into cancer-causing oncogenes); loss of function of tumour suppressor genes (like p53)

also removes the normal brakes on cell division.

Step 3: Describe the diagnosis (2 marks):
Diagnosis methods include: biopsy and histopathological study of a suspected tissue sample under a microscope; blood and bone marrow tests (particularly for leukaemias); imaging techniques like radiography (X-rays), CT scans, and MRI to detect and localize tumours; and molecular biology techniques such as PCR to detect specific cancer-associated genetic mutations.

Final Answer:
Cancer is uncontrolled, invasive, metastasis-capable cell division, caused by physical/chemical/biological carcinogens and gene-level changes (oncogene activation, tumour suppressor loss), diagnosed via biopsy/histopathology, blood tests, imaging (X-ray/CT/MRI), and molecular techniques like PCR.

Quick Tip: Three cause categories (physical, chemical, biological); four diagnosis methods (biopsy, blood tests, imaging, molecular).

OR

Describe the life cycle of Plasmodium with a diagram.

Correct Answer: —

Solution:

Step 1: Identify the two hosts:
Plasmodium, the malaria-causing parasite, completes its life cycle in two hosts: the female Anopheles mosquito (the definitive host, where the sexual phase/sporogony occurs) and humans (the intermediate

host, where the asexual phase/schizogony occurs).

Step 2: Trace the cycle in the human host:
An infected mosquito injects sporozoites into the human bloodstream during a bite; sporozoites first infect liver cells (exo-erythrocytic schizogony, producing merozoites), which are then released and infect red blood cells (erythrocytic schizogony); the RBCs eventually rupture synchronously, releasing more merozoites plus a toxic substance called haemozoin, which causes the classic periodic chills and high fever of malaria.

Step 3: Trace the cycle in the mosquito host:
Some merozoites in the RBCs develop into gametocytes instead of dividing further; when a mosquito bites an infected person, it ingests these gametocytes, which mature into gametes in the mosquito's gut, fuse to form a zygote, develop into a motile ookinete, then an oocyst on the gut wall, which eventually releases sporozoites that migrate to the mosquito's salivary glands, ready to infect the next human host.

Final Answer:
Plasmodium alternates between human (asexual, liver then RBC schizogony causing periodic fever) and female Anopheles mosquito (sexual, gametocyte to zygote to oocyst to sporozoite) hosts, transmitted by the mosquito's bite each time (a diagram would show this cyclical transfer with an arrow from mosquito salivary gland into human blood, and an arrow from human blood gametocytes back into the mosquito gut).

Quick Tip: Two hosts: human (asexual schizogony) and Anopheles (sexual sporogony); periodic fever from RBC rupture.

8. What is DNA fingerprinting technique? Describe in detail with a diagram.

Correct Answer: —

Solution:

Step 1: Define DNA fingerprinting (2 marks):
DNA fingerprinting is a technique that identifies differences in specific regions of DNA sequences (called VNTRs - Variable Number of Tandem Repeats, which vary greatly between individuals) to create a unique identifying pattern for each person, used in forensics, paternity testing, and identification; it was developed by Alec Jeffreys.

Step 2: Describe the procedure step by step (3 marks):
The main steps are: (1) DNA isolation from a sample (blood, hair root, etc.); (2) digestion of the DNA using restriction endonuclease enzymes into fragments; (3) separation of fragments by size using gel electrophoresis; (4) transfer of the separated DNA onto a synthetic membrane (nylon/nitrocellulose) by Southern blotting; (5) hybridization of the membrane with a labelled (radioactive or fluorescent) VNTR probe; (6) detection of the hybridized fragments by autoradiography, producing a pattern of bands unique to that individual (like a barcode).

Final Answer:
DNA fingerprinting uses VNTR sequence variation, revealed through restriction digestion, gel electrophoresis, Southern blotting and probe hybridization, to generate a unique band pattern identifying an individual (a diagram would show this sequence: DNA to restriction

fragments to gel-separated bands to blotted membrane to hybridized/detected pattern).

Quick Tip: VNTR variation + restriction digestion + gel electrophoresis + Southern blotting + probe hybridization = unique band pattern.

OR

Write an essay on the applications of biotechnology in agriculture.

Correct Answer: —

Solution:

Step 1: Introduce agricultural biotechnology:
Biotechnology has enabled genetic modification of crop plants to improve yield, nutritional value, and resistance to pests, diseases and environmental stress, addressing major agricultural challenges.

Step 2: Describe pest and herbicide resistance applications:
Bt crops, such as Bt cotton and Bt brinjal, carry a cry gene from the bacterium Bacillus thuringiensis, whose toxin protein kills specific insect pest larvae feeding on the plant, reducing dependence on chemical pesticides; RNA interference (RNAi) technology has similarly been used, for example, to make tobacco plants resistant to the nematode Meloidogyne incognitia by silencing a gene essential to the nematode's survival.

Step 3: Describe nutritional and other improvements:
Golden Rice has been genetically engineered to produce beta-carotene (a precursor of vitamin A) in the rice grain, aiming to address vitamin A deficiency in populations dependent on rice as a staple food; other

applications include developing herbicide-tolerant crops, improving drought/salinity tolerance, and producing biofertilizers and biopesticides as eco-friendly alternatives to chemical inputs.

Final Answer:
Biotechnology applications in agriculture include Bt pest-resistant crops, RNAi-based nematode resistance, nutritionally enhanced crops like Golden Rice, herbicide-tolerant and stress-tolerant crop varieties, and biofertilizers/biopesticides.

Quick Tip: Cover: Bt crops, RNAi resistance, Golden Rice, and biofertilizers/biopesticides.

9. What is an ecosystem? Describe the components of an ecosystem.

Correct Answer: —

Solution:

Step 1: Define ecosystem (1 mark):
An ecosystem is a functional unit of nature in which living organisms (biotic components) interact among themselves and with their non-living physical environment (abiotic components), forming a self-sustaining system with continuous exchange of energy and matter.

Step 2: Describe the abiotic components (2 marks):
Abiotic components include physical factors like temperature, light, rainfall, soil, and inorganic and organic substances present in the environment (e.g. water, carbon dioxide, oxygen, minerals, humus) that support and constrain the living organisms.

Step 3: Describe the biotic components (2 marks):
Biotic components are classified by their functional role: producers (autotrophic green plants and some bacteria/algae that fix solar energy through photosynthesis), consumers (heterotrophic organisms that depend on producers directly or indirectly for food, further divided into primary, secondary and tertiary consumers), and decomposers (bacteria and fungi that break down dead organic matter, releasing nutrients back into the abiotic pool).

Final Answer:
An ecosystem is the functional unit combining a physical (abiotic) environment with the living (biotic) community of producers, consumers and decomposers, linked through continuous energy flow and nutrient cycling.

Quick Tip: Abiotic (physical/chemical factors) + biotic (producers, consumers, decomposers).

OR

Write explanatory notes on: (i) Productivity (ii) Consumers.

Correct Answer: —

Solution:

Step 1: Explain Productivity (2.5 marks):
Productivity in an ecosystem refers to the rate of production/generation of biomass (organic matter) per unit area per unit time. Gross Primary Productivity (GPP) is the total rate of production of organic matter by producers through photosynthesis;

Net Primary Productivity (NPP) is what remains after subtracting the producers' own respiratory losses (NPP = GPP - Respiration), and it represents the biomass actually available to consumers. Secondary productivity refers to the rate of formation of new organic matter by consumers using the food they eat.

Step 2: Explain Consumers (2.5 marks):
Consumers are heterotrophic organisms that cannot produce their own food and depend directly or indirectly on producers. They are classified as primary consumers (herbivores, feeding directly on producers, e.g. deer, grasshoppers), secondary consumers (carnivores that eat primary consumers, e.g. a fox eating a rabbit), and tertiary consumers (carnivores that eat secondary consumers, often the top predators in a food chain).

Final Answer:
Productivity measures the rate of organic matter formation (GPP, NPP, secondary productivity), while consumers are the heterotrophic primary/secondary/tertiary levels of a food chain that rely on that productivity.

Quick Tip: Productivity: GPP, NPP = GPP - respiration. Consumers: primary/secondary/tertiary.