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

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). Pollination occurs in *Vallisneria* by:

(A) By air

(B) By insects

(C) By water

(D) None of these

Correct Answer: (C) By water

Solution:

Step 1: Understanding the Concept:

Vallisneria is a submerged aquatic (hydrophyte) plant. Aquatic plants that release pollen directly into the water for pollination show hydrophily (water pollination).

Step 2: Applying it to Vallisneria:

In *Vallisneria*, the male flowers detach from the plant and float on the water surface. The female flowers reach the surface on long stalks. Pollen from the floating male flowers is carried by water currents to

the female flowers, where pollination occurs.

Final Answer:
Pollination in *Vallisneria* occurs by water.
Option (C) is correct.

Quick Tip: Think about the habitat of *Vallisneria* — it is fully aquatic.

1(b). Who proposed the theory of 'Natural Selection'?

(A) Mendel

(B) Lamarck

(C) Darwin

(D) De Vries

Correct Answer: (C) Darwin

Solution:

Step 1: Understanding the Concept:
Natural Selection is the process by which organisms better adapted to their environment survive and reproduce more successfully, passing on favourable traits to the next generation.

Step 2: Identifying the scientist:
This theory was proposed by Charles Darwin in his book 'On the Origin of Species' (1859), based on his observations during the voyage of the HMS Beagle, including the finches of the Galapagos Islands.

Final Answer:
Charles Darwin proposed the theory of Natural Selection.
Option (C) is correct.

Quick Tip: Associate 'Origin of Species' and 'survival of the fittest' with this scientist.

1(c). The enzyme that cuts DNA at a specific location is:

(A) Endonuclease

(B) Exonuclease

(C) Polymerase

(D) All of these

Correct Answer: (A) Endonuclease

Solution:

Step 1: Understanding the Concept:
Enzymes that act on nucleic acids can cut DNA either from the ends (exonucleases) or at specific internal recognition sites (endonucleases). Restriction endonucleases specifically recognise short palindromic sequences and cut the DNA there.

Step 2: Matching to the question:
Since the question asks for the enzyme that cuts DNA at a 'specific location', this describes a restriction endonuclease, which recognises and cuts only at its specific recognition sequence, not at random points or only at the ends.

Final Answer:
The enzyme is Endonuclease.
Option (A) is correct.

Quick Tip: 'Endo' means 'within' — think of an internal, sequence-specific cut.

1(d). Energy flow in the ecosystem is:

(A) Unidirectional

(B) Bidirectional

(C) Multidirectional

(D) All of these

Correct Answer: (A) Unidirectional

Solution:

Step 1: Understanding the Concept:
In an ecosystem, energy enters as sunlight, is fixed by producers, and passes to successive trophic levels (herbivores, carnivores) as organisms feed on one another.

Step 2: Why it cannot flow backwards:
At each transfer, most energy is lost as heat (respiration), obeying the second law of thermodynamics. Since lost heat cannot be reused by organisms, energy can never flow back from a higher trophic level to a lower one.

Final Answer:
Energy flow in an ecosystem is unidirectional.
Option (A) is correct.

Quick Tip: Compare energy flow with the recycling of nutrients — energy is NOT recycled.

2(a). Which hormone is secreted from the corpus luteum?

Correct Answer: —

Solution:

Step 1: Understanding the Structure:
After ovulation, the ruptured Graafian follicle transforms into a temporary endocrine structure called the corpus luteum.

Step 2: Identifying its secretion:
The corpus luteum secretes large amounts of the hormone progesterone, which is essential for maintaining the endometrium of the uterus in preparation for, and during, pregnancy.

Final Answer:
The corpus luteum secretes progesterone.

Quick Tip: Corpus luteum → progesterone, essential for maintaining pregnancy.

2(b). What is the full name of IVF?

Correct Answer: —

Solution:

Step 1: Expanding the abbreviation:
IVF stands for In Vitro Fertilisation.

Step 2: Brief context:
It is an assisted reproductive technology in which the ovum is fertilised by sperm outside the body (in a laboratory dish) and the resulting embryo is transferred into the uterus.

Final Answer:
IVF = In Vitro Fertilisation.

Quick Tip: 'In vitro' = outside the body, in glass.

2(c). Which is the termination codon on mRNA?

Correct Answer: —

Solution:

Step 1: Understanding codons:
Of the 64 possible mRNA codons, 61 code for amino acids and 3 do not code for any amino acid — instead they signal the ribosome to stop translation.

Step 2: Naming the stop codons:
These three termination (stop) codons are UAA, UAG and UGA.

Final Answer:
The termination codons on mRNA are UAA, UAG and UGA.

Quick Tip: Remember the three stop codons: U-A-A, U-A-G, U-G-A.

2(d). Give one example of a sex-linked recessive disorder.

Correct Answer: —

Solution:

Step 1: Understanding sex-linked recessive disorders:
These are disorders caused by recessive alleles located on the X-chromosome, so they appear much more frequently in males (who have only one X).

Step 2: Giving an example:
Haemophilia (the 'bleeder's disease', where blood fails to clot normally) is a classic example of a sex-linked recessive disorder.

Final Answer:
Example: Haemophilia.

Quick Tip: Haemophilia and colour blindness are the two classic textbook examples.

2(e). Which ecological pyramid is always upright?

Correct Answer: —

Solution:

Step 1: Comparing the three pyramids:
The pyramid of numbers and the pyramid of biomass can sometimes be inverted (e.g. many insects feeding on one large tree; small phytoplankton biomass supporting larger fish biomass in a pond).

Step 2: Why energy is different:
The pyramid of energy shows the rate of energy flow at successive trophic levels. Since energy is progressively lost as heat at each transfer (2nd law of thermodynamics) and is never recycled, the energy available at a higher trophic level can never exceed that at the level below it.

Final Answer:
The pyramid of energy is always upright.

Quick Tip: Energy is never recycled back up the food chain — this forces the pyramid upright.

3(a). Write a note on Darwin's Finches.

Correct Answer: —

Solution:

Step 1: Background:
During his voyage on HMS Beagle, Charles Darwin studied a group of about 13-14 closely related species of finches on the Galapagos Islands, now called Darwin's finches.

Step 2: Their significance:
All these finch species are believed to have descended from a single common mainland ancestral seed-eating finch that reached the islands. Over time, geographic isolation on different islands and natural selection for different food sources (seeds, insects, cactus flowers) led to marked differences in beak size and shape among the species.

Final Answer:
Darwin's finches are a classic example of adaptive radiation — evolutionary diversification of a single ancestral species into several new forms, each adapted to a different mode of feeding within the same geographic region.

Quick Tip: Key words: Galapagos Islands, common ancestor, beak variation, adaptive radiation.

3(b). Define the word 'Health'. Explain the benefits of good health.

Correct Answer: —

Solution:

Step 1: Definition:
According to the World Health Organisation (WHO), health is a state of complete physical, mental and social well-being, and not merely the absence of disease or infirmity.

Step 2: Benefits of good health:
Good health increases an individual's efficiency and productivity at work, improves quality of life and life expectancy, strengthens the body's immunity to resist infections, reduces the personal and national burden/cost of treating disease, and promotes overall mental and social well-being.

Final Answer:
Health is complete physical, mental and social well-being; good health improves productivity, immunity, longevity and quality of life.

Quick Tip: WHO's definition covers three dimensions: physical, mental, social.

3(c). Differentiate between m-RNA and t-RNA.

Correct Answer: —

Solution:

Step 1: Role:
mRNA (messenger RNA) carries the genetic information copied from DNA (as a sequence of codons) to the ribosome for protein synthesis.

tRNA (transfer RNA) acts as an adapter molecule that reads each codon and delivers the corresponding amino acid to the ribosome.

Step 2: Structure:
mRNA is typically a long, linear, single-stranded molecule with no fixed secondary structure. tRNA is much shorter (about 75-90 nucleotides) and folds into a characteristic clover-leaf secondary structure, with an anticodon loop that pairs with the mRNA codon and an acceptor end that binds a specific amino acid.

Final Answer:
mRNA carries the genetic message as codons; tRNA is the small, clover-leaf-shaped adapter that reads the codons and brings in the matching amino acids.

Quick Tip: mRNA = code; tRNA = adapter with anticodon and amino acid attached.

3(d). What is the difference between food chain and food web?

Correct Answer: —

Solution:

Step 1: Food chain:
A food chain is a single, linear sequence of organisms in which each organism feeds on the one before it, showing one pathway of energy/nutrient transfer (e.g. grass → grasshopper → frog → snake → hawk).

Step 2: Food web:

A food web is a network formed by the interconnection of many food chains within an ecosystem, showing that most organisms feed on, and are fed upon by, more than one species.

Final Answer:

A food chain is one straight line of feeding relationships; a food web is the interconnected network of many such chains, giving a more realistic picture of an ecosystem and greater stability.

Quick Tip: Food chain = one line; food web = many chains interconnected.

3(e). Comment upon Biodiversity hot-spots.

Correct Answer: —

Solution:

Step 1: Definition:

Biodiversity hotspots are regions of the world that are exceptionally rich in species (especially endemic species found nowhere else) but are also under serious threat from habitat destruction.

Step 2: Criteria and significance:

A region qualifies as a hotspot (Norman Myers' criteria) if it contains at least 1,500 endemic vascular plant species and has already lost 70% or more of its original habitat. Identifying hotspots helps direct limited conservation resources to the areas with the greatest and most

urgent need.

Final Answer:
Biodiversity hotspots are highly species-rich, highly threatened regions prioritised for conservation; India has such hotspots including the Himalaya, Indo-Burma and the Western Ghats.

Quick Tip: High endemism + high habitat loss = biodiversity hotspot.

4(a). What is the difference between microsporangium and megasporangium?

Correct Answer: —

Solution:

Step 1: Microsporangium:
The microsporangium (pollen sac) is found in the anther of the flower. It contains microspore mother cells that undergo meiosis to produce haploid microspores, which develop into pollen grains (the male gametophyte).

Step 2: Megasporangium:
The megasporangium is represented by the nucellus within the ovule. It contains a megaspore mother cell that undergoes meiosis to produce four megaspores, of which usually only one survives and develops into the embryo sac (the female gametophyte).

Final Answer:

Microsporangium (in the anther) produces pollen grains (male); megasporangium (the nucellus of the ovule) produces the embryo sac (female).

Quick Tip: Microsporangium → anther → pollen; Megasporangium → ovule/nucellus → embryo sac.

4(b). Draw a labelled diagram of the sectional view of seminiferous tubules.

Correct Answer: —

Solution:

Step 1: Overall structure:
A cross-section of a seminiferous tubule shows a tube bounded by an outer basement membrane. Between the tubules, in the interstitial spaces, lie clusters of Leydig (interstitial) cells that secrete testosterone.

Step 2: Arrangement of cells from periphery to lumen:
Just inside the basement membrane are the spermatogonia (2n, dividing by mitosis). Moving inward: primary spermatocytes (2n), then secondary spermatocytes (n) after meiosis I, then spermatids (n) after meiosis II, and finally maturing spermatozoa are released near the lumen. Tall Sertoli (nurse) cells extend from the basement membrane to the lumen, nourishing the developing germ cells throughout this sequence.

Final Answer:
A diagram should show, from the outer basement membrane inward: spermatogonia → primary spermatocytes → secondary spermatocytes → spermatids → spermatozoa (at the lumen), with interspersed Sertoli cells and Leydig cells shown outside the tubule in the interstitial space.

Quick Tip: Order from wall to lumen: spermatogonia → spermatocytes → spermatids → sperm.

4(c). Explain the transcription unit.

Correct Answer: —

Solution:

Step 1: Definition:
A transcription unit is a segment of DNA that has the three components needed to be transcribed into RNA by RNA polymerase: a promoter, a structural gene, and a terminator.

Step 2: The three components:
(1) Promoter — located upstream (towards the 5' end of the coding/sense strand), it is where RNA polymerase binds and it decides which of the two DNA strands is transcribed (the template strand) and the direction of transcription. (2) Structural gene — the region actually transcribed into RNA, read from the template strand in the 3'→5' direction to make an RNA that is complementary and antiparallel to it. (3) Terminator — located at the downstream (3') end

of the coding strand, it marks the point where transcription stops.

Final Answer:
A transcription unit = promoter + structural gene + terminator, together defining where transcription starts, what is copied, and where it ends.

Quick Tip: Promoter (start) → structural gene (copied) → terminator (stop).

4(d). Explain the causes, prevention and treatment of Malaria disease.

Correct Answer: —

Solution:

Step 1: Cause:
Malaria is caused by protozoan parasites of the genus Plasmodium (commonly P. vivax and P. falciparum), transmitted to humans through the bite of an infected female Anopheles mosquito. The parasite multiplies inside red blood cells; their periodic rupture (releasing haemozoin and toxins) causes the characteristic recurring high fever with chills and rigor.

Step 2: Prevention:
Prevention focuses on controlling the mosquito vector: eliminating stagnant water where Anopheles breeds, using mosquito nets (preferably insecticide-treated) and repellents, screening windows, and indoor residual spraying of insecticides in endemic areas.

Step 3: Treatment:
Confirmed cases are treated with antimalarial drugs such as chloroquine and, particularly for drug-resistant P. falciparum, artemisinin-based combination therapy (ACT), along with supportive care for symptoms.

Final Answer:
Malaria: caused by Plasmodium via Anopheles mosquito bite; prevented by vector/mosquito control; treated with antimalarial drugs like chloroquine or ACT.

Quick Tip: Cause: Plasmodium + Anopheles. Prevention: vector control. Treatment: antimalarials.

5(a). What is mutation? Explain with an example.

Correct Answer: —

Solution:

Step 1: Definition:
Mutation is a sudden, heritable change in the nucleotide sequence of DNA (or in the number/structure of chromosomes) that can alter the genetic information passed on to offspring, and is a source of new variation for evolution.

Step 2: Example:
Sickle cell anaemia is caused by a point mutation in the gene coding

for the beta chain of haemoglobin, where a single base substitution (GAG → GTG) causes the amino acid glutamic acid to be replaced by valine at the sixth position. This changes the shape of the haemoglobin molecule, causing red blood cells to become sickle-shaped under low oxygen tension.

Final Answer:
Mutation = heritable change in DNA sequence; e.g. the single base-pair substitution that causes sickle cell anaemia.

Quick Tip: Sickle cell anaemia = one base change, one amino acid change, big effect.

5(b). What do you understand by biocontrol? Explain about their benefits.

Correct Answer: —

Solution:

Step 1: Definition:
Biological control (biocontrol) is the use of living organisms — natural predators, parasites, or pathogens of a pest — to manage pest populations, instead of using chemical pesticides. Examples include ladybird beetles and dragonflies controlling aphids and mosquitoes, and Bacillus thuringiensis (Bt) controlling caterpillar pests.

Step 2: Benefits:
Biocontrol avoids the pollution and toxic residues caused by chemical

pesticides, does not usually lead to pesticide-resistant pest populations, is safer for humans, livestock and beneficial insects (like pollinators), and is a more sustainable, cost-effective long-term solution for pest management.

Final Answer:
Biocontrol uses natural enemies to manage pests, offering an eco-friendly, sustainable, and resistance-resistant alternative to chemical pesticides.

Quick Tip: Biocontrol = living organisms controlling pests; safer and more sustainable than chemicals.

5(c). Explain gel-electrophoresis.

Correct Answer: —

Solution:

Step 1: Principle:
Gel electrophoresis is a technique used to separate DNA, RNA or protein fragments according to their size, using an electric field. Because the phosphate backbone of nucleic acids is negatively charged, DNA/RNA fragments move towards the positive electrode (anode) when placed in an electric field.

Step 2: Procedure:
The sample (a mixture of DNA fragments) is loaded into wells cast in an agarose gel submerged in a buffer, and an electric current is passed

through the gel. Smaller fragments move faster and travel farther through the pores of the gel than larger fragments, so the fragments separate out by size into distinct bands.

Step 3: Visualisation:
After the run, the gel is stained (commonly with ethidium bromide) and viewed under UV light, where the separated DNA appears as a series of bands that can be compared to a size marker/ladder.

Final Answer:
Gel electrophoresis separates nucleic acid fragments by size using an electric field, producing bands that can be visualised under UV light after staining.

Quick Tip: Smaller DNA fragments travel farther through the gel towards the anode.

5(d). Explain the different types of biodiversity.

Correct Answer: —

Solution:

Step 1: Genetic diversity:
Genetic diversity refers to the variation in genes that exists within a single species — for example, the thousands of genetically distinct varieties of rice or mango grown in India.

Step 2: Species diversity:

Species diversity refers to the variety of different species found within a particular region or ecosystem — for instance, the greater number of amphibian species found in the Western Ghats compared to the eastern plains.

Step 3: Ecological/ecosystem diversity:
Ecosystem diversity refers to the variety of habitats, biotic communities and ecological processes found across a larger geographic area — India, for example, shows far greater ecosystem diversity than a country like Norway because of its deserts, rainforests, mangroves, coral reefs and alpine meadows.

Final Answer:
The three levels of biodiversity are genetic diversity (within a species), species diversity (among species), and ecosystem diversity (among habitats/ecosystems).

Quick Tip: Three levels: genetic (within species), species (among species), ecosystem (among habitats).

6(a). What is Allergy? Explain with examples.

Correct Answer: —

Solution:

Step 1: Definition:
Allergy is an exaggerated (hypersensitive) response of the immune system to certain otherwise harmless foreign substances present in

the environment, called allergens.

Step 2: Mechanism:
On exposure to an allergen, the body produces IgE antibodies, which bind to mast cells. On re-exposure to the same allergen, mast cells release histamine and other chemicals, causing symptoms like sneezing, watery eyes, breathlessness, or skin rashes.

Step 3: Examples:
Common allergens include dust mites and pollen (causing allergic rhinitis/hay fever), certain foods like peanuts and seafood, and drugs like penicillin, which can trigger reactions ranging from mild rashes to severe, life-threatening anaphylaxis.

Final Answer:
Allergy is a hypersensitive immune reaction, mediated mainly by IgE and histamine, triggered by allergens such as dust, pollen or certain foods.

Quick Tip: Allergen → IgE antibody → mast cell → histamine release → allergy symptoms.

6(b). Write a short note on Pest Resistant Plant.

Correct Answer: —

Solution:

Step 1: Concept:

Pest-resistant plants are genetically modified (transgenic) crop plants that have been engineered to resist attack by insect pests, reducing the need for chemical insecticide sprays.

Step 2: Example — Bt cotton:
The best-known example is Bt cotton, which carries a gene (cry gene) from the soil bacterium Bacillus thuringiensis. This gene codes for a crystal (Bt toxin) protein that is toxic specifically to certain insect larvae, such as the cotton bollworm.

Step 3: Mode of action:
The Bt toxin remains inactive in the plant until it is ingested by a susceptible insect. In the insect's alkaline gut, the toxin is activated and binds to specific receptors on the midgut epithelial cells, creating pores that cause cell lysis and death of the insect, while remaining harmless to humans because our acidic gut and different receptors do not activate or bind the toxin.

Final Answer:
Pest-resistant plants like Bt cotton use a bacterial toxin gene to kill specific insect pests while remaining safe for humans and non-target organisms.

Quick Tip: Bt cotton = cry gene from Bacillus thuringiensis making the plant toxic only to certain insects.

6(c). Write a short note on infectious diseases.

Correct Answer: —

Solution:

Step 1: Definition:
Infectious diseases are diseases caused by pathogenic microorganisms — bacteria, viruses, fungi, protozoa or helminths — that can be transmitted from an infected person to a healthy one.

Step 2: Modes of transmission:
They may spread through air (e.g. common cold, tuberculosis), contaminated water or food (e.g. typhoid, cholera), direct physical contact (e.g. ringworm), or via a vector such as a mosquito (e.g. malaria, dengue).

Step 3: Examples:
Examples across pathogen groups include: bacterial — typhoid (Salmonella typhi); viral — common cold (Rhinovirus); protozoan — malaria (Plasmodium); fungal — ringworm.

Final Answer:
Infectious diseases are caused by transmissible pathogens and spread via air, water, contact, or vectors; examples include typhoid, the common cold, malaria and ringworm.

Quick Tip: Infectious = caused by a pathogen AND transmissible between individuals.

6(d). What do you understand by Gel Electrophoresis? Explain it.

Correct Answer: —

Solution:

Step 1: What it is used for:
Gel electrophoresis is a laboratory technique used to separate a mixture of DNA (or RNA/protein) fragments by size, which is an essential step in many recombinant DNA technology procedures, such as checking the products of a restriction digestion or a PCR reaction.

Step 2: How it works:
The negatively-charged DNA fragments are loaded into wells of an agarose gel and an electric field is applied; the fragments migrate towards the positive electrode, with smaller fragments moving faster and farther through the gel matrix than larger ones, so the mixture resolves into separate bands ordered by size.

Step 3: After separation:
The separated DNA bands are stained (e.g. with ethidium bromide) and visualised under UV light; if needed, a specific band of interest can then be cut out of the gel and eluted for further use, such as cloning.

Final Answer:
Gel electrophoresis separates DNA fragments by size using an electric field, and the resulting bands can be visualised and, if required, extracted for downstream use such as cloning.

Quick Tip: Same principle as Q5(c): smaller fragments travel further under the electric field.

7. What is microsporogenesis? Describe microsporogenesis in an angiospermic plant with a diagram.

Correct Answer: —

Solution:

Step 1: Definition:
Microsporogenesis is the process by which haploid microspores (which develop into pollen grains) are formed from diploid microspore mother cells through meiosis, inside the microsporangia (pollen sacs) of the anther.

Step 2: Structure of the anther:
A typical anther has four microsporangia, one located in each corner; these are enclosed and protected by wall layers and contain a mass of sporogenous tissue.

Step 3: The process, step by step:
Cells of the sporogenous tissue differentiate into diploid microspore mother cells (pollen mother cells, PMCs). Each PMC undergoes meiosis (meiosis I followed by meiosis II) to produce a group of four haploid microspores arranged as a microspore tetrad.

Step 4: Formation of pollen grains:
As the anther matures, the tapetum (nutritive layer) degenerates and the microspores of each tetrad separate from each other into individual microspores. Each microspore then develops a hard, sporopollenin-containing outer wall (exine, with a thin area called the germ pore) and a thin inner wall (intine), maturing into a pollen grain — the male gametophyte.

Final Answer:
Microsporogenesis = meiotic formation of microspores from pollen mother cells inside the anther's microsporangia, ultimately producing mature pollen grains ready for pollination. (Diagram: PMC → meiosis → microspore tetrad → separated microspores → pollen grains with exine/intine and germ pore.)

Quick Tip: PMC (2n) → meiosis → tetrad of 4 microspores (n) → individual pollen grains with exine and intine.

OR

Describe the process of spermatogenesis with a diagram. (alternative to Q7)

Correct Answer: —

Solution:

Step 1: Definition and site:
Spermatogenesis is the process by which male gametes (spermatozoa) are formed from primary germ cells in the seminiferous tubules of the testis; it begins at puberty under the influence of a rise in gonadotropin-releasing hormone (GnRH), which stimulates the pituitary to release LH and FSH.

Step 2: Multiplication phase:
The undifferentiated germ cells lining the tubule, called spermatogonia (2n), divide repeatedly by mitosis to increase in number; some spermatogonia periodically enter meiosis,

transforming into primary spermatocytes (2n).

Step 3: Meiotic phase:
Each primary spermatocyte completes meiosis I to form two haploid secondary spermatocytes (n); each secondary spermatocyte then rapidly undergoes meiosis II to form two spermatids (n) each — so one primary spermatocyte ultimately gives rise to four spermatids.

Step 4: Spermiogenesis and spermiation:
The round, non-motile spermatids are then transformed into slender, motile spermatozoa through spermiogenesis — a process involving loss of most cytoplasm, condensation of the nucleus, and formation of the acrosome (head cap) and flagellum (tail). Sertoli cells nourish the developing germ cells throughout, and mature sperm are finally released into the lumen of the tubule (spermiation).

Final Answer:
Spermatogenesis: spermatogonia (mitosis) → primary spermatocyte → (meiosis I) secondary spermatocytes → (meiosis II) spermatids → (spermiogenesis) spermatozoa, nourished by Sertoli cells and controlled by FSH, LH and testosterone. (Diagram: concentric layers in the seminiferous tubule from spermatogonia at the base to sperm at the lumen.)

Quick Tip: Spermatogonium → primary spermatocyte → secondary spermatocytes → spermatids → spermatozoa.

8. What do you understand by DNA fingerprinting technique? Explain its process.

Correct Answer: –

Solution:

Step 1: Definition:
DNA fingerprinting is a technique that identifies differences (polymorphisms) in specific repetitive DNA sequences, called VNTRs (variable number of tandem repeats)/satellite DNA, which are unique to each individual (except identical twins). It was developed by Alec Jeffreys.

Step 2: Sample preparation:
DNA is first extracted from a biological sample (blood, hair root, saliva, semen, etc.) and then cut into fragments of varying sizes using restriction endonucleases.

Step 3: Separation and transfer:
The resulting DNA fragments are separated according to size by gel electrophoresis, then transferred and immobilised onto a nylon or nitrocellulose membrane by Southern blotting.

Step 4: Detection:
The membrane is then hybridised with a labelled (radioactive or fluorescent) VNTR probe, which binds only to the complementary repetitive sequences; the hybridised fragments are detected by autoradiography, producing a pattern of bands unique to each individual.

Final Answer:
DNA fingerprinting compares the unique VNTR band pattern of an

individual's DNA (obtained via restriction digestion → electrophoresis → Southern blotting → probe hybridisation), and is widely used in forensic investigation and paternity testing.

Quick Tip: VNTRs vary between individuals; the process is: cut → separate → blot → probe → detect.

OR

Write short notes on the following: (i) Translation (ii) Hardy-Weinberg Principle. (alternative to Q8)

Correct Answer: —

Solution:

Step 1: (i) Translation — definition:
Translation is the process by which the genetic message carried by mRNA is used to synthesise a polypeptide (protein), occurring on ribosomes in the cytoplasm.

Step 2: (i) Translation — process:
Translation begins when a charged tRNA recognises the start codon (AUG) on the mRNA at the ribosome (initiation). The ribosome then moves along the mRNA in the 5'→3' direction; successive tRNAs, each carrying a specific amino acid, pair their anticodon with the corresponding mRNA codon, and peptide bonds form between adjacent amino acids (elongation). This continues until a stop codon (UAA/UAG/UGA) is reached, at which point a release factor terminates translation and releases the completed polypeptide (termination).

Step 3: (ii) Hardy-Weinberg Principle:
The Hardy-Weinberg principle states that, in a large, randomly mating population with no mutation, migration, genetic drift or natural selection, the allele frequencies (p and q) and genotype frequencies remain constant from one generation to the next, described by the equation $p^2 + 2pq + q^2 = 1$. It is used as a baseline (null hypothesis) — any observed deviation from these expected frequencies indicates that evolution is acting on the population.

Final Answer:
(i) Translation converts the mRNA codon sequence into a protein via initiation, elongation and termination at the ribosome. (ii) The Hardy-Weinberg principle describes the constant allele/genotype frequencies of a non-evolving population ($p^2+2pq+q^2=1$), serving as a reference to detect evolutionary change.

Quick Tip: Translation: AUG start → codon-by-codon → stop codon. Hardy-Weinberg: $p^2+2pq+q^2=1$, no-evolution baseline.

9. Describe the different types of ecological pyramids with a diagram.

Correct Answer: —

Solution:

Step 1: Pyramid of Numbers:
This shows the number of individual organisms at each trophic level. It is usually upright in a grassland ecosystem (many producers,

progressively fewer consumers), but it can be inverted in a case such as a single large tree (one producer) supporting a large number of insects feeding on it (a parasitic food chain).

Step 2: Pyramid of Biomass:
This shows the total dry-weight biomass present at each trophic level. It is usually upright on land (e.g. a forest, where producer biomass exceeds consumer biomass), but it is characteristically inverted in a pond/aquatic ecosystem, where a small standing biomass of rapidly reproducing phytoplankton (producers) supports a larger standing biomass of zooplankton and fish at any given time.

Step 3: Pyramid of Energy:
This shows the rate of energy flow (and/or standing crop of energy) at successive trophic levels, measured over a fixed time period. Because energy is progressively lost as heat at every transfer (roughly only about 10% passes to the next level, per Lindeman's ten percent law), and lost energy is never recycled back, the pyramid of energy is always upright, without exception, in every ecosystem.

Final Answer:
Ecosystems can be represented by three ecological pyramids — numbers, biomass, and energy — of which only the pyramid of energy is always upright in every case; the other two can sometimes be inverted.

Quick Tip: Numbers/biomass: can invert. Energy: always upright (2nd law of thermodynamics).

OR

What is decomposition? Describe the decomposition cycle in a terrestrial ecosystem with a diagram. (alternative to Q9)

Correct Answer: —

Solution:

Step 1: Definition:
Decomposition is the process by which decomposers (mainly bacteria and fungi) break down complex organic matter present in dead plant and animal remains (detritus) into simpler inorganic substances, which are released back into the soil and can be reused by producers — this is essential for nutrient recycling.

Step 2: Fragmentation and leaching:
First, detritivores such as earthworms physically break the detritus into smaller particles (fragmentation), greatly increasing the surface area available for microbial attack. At the same time, water-soluble inorganic nutrients percolate down into the soil layers (leaching) and may get precipitated as unavailable salts.

Step 3: Catabolism and humification:
Bacterial and fungal enzymes then chemically degrade the detritus into simpler organic and inorganic compounds outside their cells (catabolism). This process, along with further breakdown, leads to the accumulation of a dark-coloured, amorphous substance called humus, which is highly resistant to microbial attack and decomposes only very slowly.

Step 4: Mineralisation:
Humus is further degraded by some microorganisms, in a process

called mineralisation, which releases simple inorganic nutrients (such as CO_2, water and mineral ions) that become available in the soil once again for uptake by plant roots.

Final Answer:

Decomposition proceeds through fragmentation → leaching → catabolism → humification → mineralisation, ultimately returning nutrients locked in dead organic matter back to the soil for reuse by plants; the rate is faster with nitrogen-rich, soft detritus and warm, moist, aerobic (oxygen-rich) conditions, and slower with hard, lignin/chitin-rich detritus or cold, dry, anaerobic conditions.

Quick Tip: Order to remember: Fragmentation → Leaching → Catabolism → Humification → Mineralisation.