

UP Board Class 12 Biology 2026 (Set 348 EK) 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). Which of the following is a water pollinated plant?

- (A) Vallisneria
- (B) Zostera
- (C) Hydrilla
- (D) All of these

Correct Answer: (C) Hydrilla

Solution:

Step 1: Understanding the Concept:

Pollination carried out by water is called hydrophily. It is rare and found only in a small number of aquatic plants that release their pollen directly into the water, or onto its surface.

Step 2: Check each option.

Vallisneria is a submerged freshwater plant. Its male flowers break off and float up to the surface, where they release pollen that drifts to reach the female flowers. This is a genuine case of hydrophily.

Hydrilla is also a submerged freshwater plant that uses the same

surface pollination strategy as Vallisneria, so it is hydrophilous too. Zostera (sea grass) is a marine plant. Unlike Vallisneria and Hydrilla, its pollen is released and travels while fully underwater, not on the surface, but it still counts as water pollination.

Step 3: Combine the findings.

Since Vallisneria, Zostera, and Hydrilla are all examples of plants pollinated by water, no single one of them can be picked over the other two.

Final Answer:

All three named plants are pollinated by water, so the complete answer is "All of these."

All of these

Quick Tip: Think about how each of these three plants gets its pollen across water, on the surface or below it.

1(b). Which of the following is an initiation codon?

- (A) AUG
- (B) AUU
- (C) UAG
- (D) GAU

Correct Answer: (A) AUG

Solution:

Step 1: Understanding the Concept:

Protein synthesis (translation) on a ribosome always begins at a fixed triplet of mRNA bases called the initiation or start codon. This codon does two jobs: it marks where the ribosome should start reading, and it codes for the first amino acid of the chain.

Step 2: Recall the actual codon.

In almost all organisms, the start codon is AUG. It codes for the amino acid methionine (or a modified form, formyl methionine, in bacteria), which becomes the first amino acid of every newly made polypeptide before any later processing removes it.

Step 3: Why the other options are wrong.

AUU codes for isoleucine, an ordinary amino acid used inside a chain, not a signal to start reading.

UAG is one of the three stop codons (along with UAA and UGA); it tells the ribosome to stop, the opposite job of a start codon.

GAU codes for aspartic acid and has no start or stop role at all.

Final Answer:

AUG is the only codon among these that signals the ribosome to begin translation.

AUG

Quick Tip: Only one of these four codons both starts translation and sets the reading frame.

1(c). Which of the following is needed in recombinant DNA technology?

- (A) Restriction enzyme
- (B) Ligase
- (C) Vector
- (D) All of these

Correct Answer: (D) All of these

Solution:

Step 1: Understanding the Concept:

Recombinant DNA technology means cutting a gene of interest out of one organism's DNA and joining it into another piece of DNA (a vector) so it can be carried into and expressed inside a host cell. Each stage of that process needs its own tool.

Step 2: Match each tool to its job.

A restriction enzyme is a molecular scissor that cuts DNA at a specific recognition sequence, which is how the gene of interest is first removed from its source DNA.

Ligase is the molecular glue: it joins the cut ends of the gene to the cut ends of the vector DNA, sealing them into one continuous recombinant molecule.

A vector (such as a plasmid) is the vehicle that carries the joined gene into the host cell and allows it to replicate there along with the host's own DNA.

Step 3: Combine the three roles.

Skipping any one of these three steps breaks the process: without the enzyme there is no fragment to insert, without ligase the fragment cannot be sealed into the vector, and without a vector there is no way to deliver the gene into a cell.

Final Answer:

All three, restriction enzyme, ligase, and vector, are required together.

All of these

Quick Tip: Recombinant DNA technology has three stages: cutting, joining, and delivering. Match a tool to each.

1(d). Lichen is an example of which of the following type of population interactions?

- (A) Predation
- (B) Commensalism
- (C) Mutualism
- (D) Parasitism

Correct Answer: (C) Mutualism

Solution:**Step 1: Understanding the Concept:**

A lichen is not a single organism. It is a close, permanent partnership between a fungus and a photosynthetic partner (a green alga or a cyanobacterium) living together as one body.

Step 2: Check what each partner gets.

The fungus builds the outer structure of the lichen, which shields the delicate alga from drying out and from strong light, and it also absorbs water and minerals from the surface the lichen grows on.

The alga or cyanobacterium photosynthesises and shares the sugars it makes with the fungus, since the fungus itself cannot photosynthesise.

Step 3: Why the other options are wrong.

Predation means one organism kills and eats another, which does not happen here since both partners stay alive and intact.

Commensalism means one species benefits while the other is unaffected, but here the fungus clearly benefits from the sugars, so the alga is not "unaffected."

Parasitism means one organism harms the other for its own benefit, but the fungus does not damage the alga, it protects it.

Step 4: Name the correct interaction.

Since both the fungus and the alga gain something essential from living together, and neither is harmed, this is a two-way, mutually beneficial relationship.

Final Answer:

A lichen is the textbook example of mutualism between a fungus and an alga.

Mutualism

Quick Tip: Ask what each partner in a lichen, the fungus and the alga, would lose if it lived alone.

2(a). Name any two plants in which multicarpellary syncarpous gynoecium is found.

Correct Answer: —

Solution:

Step 1: Understanding the Concept:

A gynoecium is called multicarpellary when a flower has more than one carpel, and syncarpous when those carpels are fused together into a single unit rather than staying separate.

Step 2: Name real examples.

Hibiscus (China rose) has a gynoecium made of five carpels fused into one, so it is multicarpellary and syncarpous.

Tomato (*Solanum lycopersicum*) also has several carpels fused into a single compound ovary, making it another clear example.

Final Answer:

Hibiscus and tomato are two common plants with a multicarpellary syncarpous gynoecium.

Quick Tip: You need two conditions at once: more than one carpel, and those carpels fused together.

2(b). Write the full form of ZIFT.

Correct Answer: —

Solution:

Step 1: Understanding the Concept:

ZIFT is one of the assisted reproductive technology (ART) procedures used to help couples who cannot conceive naturally.

Step 2: Expand the abbreviation.

ZIFT stands for Zygote Intra Fallopian Transfer.

Step 3: What the procedure means.

In this method, an egg is fertilised outside the body (in vitro), and the resulting zygote is then transferred into the fallopian tube of the female, so it can continue development in a natural location.

Final Answer:

ZIFT means Zygote Intra Fallopian Transfer.

Quick Tip: Expand each letter: Z for the fertilised cell, then where it gets placed.



2(c). Name the gene which can exhibit multiple phenotypic expressions.

Correct Answer: —

Solution:

Step 1: Understanding the Concept:

Usually one gene is thought of as controlling one trait, but some single genes influence several apparently unrelated traits at once. This phenomenon has a specific name.

Step 2: Name the gene type.

A gene that has multiple phenotypic expressions is called a pleiotropic gene, and the phenomenon itself is called pleiotropy.

Step 3: Give a supporting example.

In the garden pea studied by Mendel, a single gene that controls seed colour also affects flower colour and the colour of the seed coat, showing several visible effects from one gene.

Final Answer:

Such a gene is called a pleiotropic gene.

Quick Tip: Think of a gene whose protein is used in more than one biochemical pathway at once.



2(d). What is the length of DNA in a typical nucleosome?

Correct Answer: —

Solution:

Step 1: Understanding the Concept:

A nucleosome is the basic packaging unit of chromatin. It consists of a core of eight histone protein molecules (a histone octamer) with DNA wound around it.

Step 2: State the length.

About 200 base pairs (bp) of DNA is associated with one nucleosome, made up of roughly 146 bp wrapped around the histone octamer and a short linker stretch of DNA that connects to the next nucleosome.

Final Answer:

A typical nucleosome is associated with about 200 bp of DNA.

Quick Tip: Add the DNA wrapped around the histone core to the short linker piece that follows it.

2(e). Name the type of food chain which begins with dead organic matter.

Correct Answer: —

Solution:

Step 1: Understanding the Concept:

Ecosystems have more than one kind of food chain, depending on what the first organism in the chain eats.

Step 2: Identify the starting point given.

A chain that begins with dead organic matter (detritus, such as fallen leaves, dead animal remains, and faecal matter) rather than with a living green plant is called a detritus food chain.

Step 3: Contrast with the other type.

This is different from a grazing food chain, which begins with living producers (green plants) being eaten by herbivores.

Final Answer:

The food chain that begins with dead organic matter is the detritus food chain.

Quick Tip: This food chain does not begin with a living green plant.

3(a). What do you mean by Mendelian disorders? Give two examples of sex-linked Mendelian disorder.

Correct Answer: —

Solution:

Step 1: Understanding the Concept:

Mendelian disorders are disorders caused by an alteration (mutation) in a single gene, and they are passed from parents to offspring following the same inheritance patterns that Mendel described for pea plants: dominant, recessive, autosomal, or sex-linked.

Step 2: State the general idea.

Because only one gene is involved, the pattern of inheritance of a Mendelian disorder in a family can usually be traced using a pedigree analysis, and the disorder can be dominant or recessive, and located on an autosome or a sex chromosome.

Step 3: Give sex-linked examples.

Haemophilia is a sex-linked recessive disorder in which blood fails to clot normally, caused by a gene carried on the X chromosome.

Colour blindness is another sex-linked recessive disorder, in which a person cannot distinguish between red and green colours, also caused by a gene on the X chromosome.

Final Answer:

Mendelian disorders are single-gene disorders inherited in Mendelian fashion; haemophilia and colour blindness are two sex-linked examples.

Quick Tip: Mendelian disorders trace back to a single gene; think of two X-linked recessive conditions.



3(b). Explain Frame shift mutation with an example.

Correct Answer: —

Solution:

Step 1: Understanding the Concept:

A gene is read by the ribosome in groups of three bases at a time, called codons, starting from a fixed point. If bases are added or removed from the DNA in a number that is not a multiple of three, every codon downstream of that point shifts out of its normal grouping.

Step 2: Explain the mechanism.

This kind of mutation, caused by insertion or deletion of one or two nucleotides (or any number not divisible by three), is called a frame shift mutation, because it literally shifts the reading frame used to group bases into codons.

Step 3: Give an example.

Consider the sequence AUG-CAU-CAU-CAU, which normally codes methionine-histidine-histidine-histidine. If a single base A is inserted right after AUG, the sequence becomes AUG-ACA-UCA-UCA-U, so every codon after the insertion point reads differently, changing the entire amino acid sequence from that point onward.

Final Answer:

A frame shift mutation is an insertion or deletion not in multiples of three that shifts the reading frame and scrambles the protein sequence downstream of the mutation.

Quick Tip: Insert or delete one base in a triplet-read sequence and see how every codon after it changes.



3(c). What is trichoderma? Give one application of trichoderma as an effective biocontrol agent.

Correct Answer: —

Solution:

Step 1: Understanding the Concept:

Trichoderma is a genus of free-living fungi that is very common in the root ecosystem of plants, meaning it naturally lives in and around plant roots and soil.

Step 2: State why it matters biologically.

Because it can attack and control other, harmful fungi that cause plant disease, Trichoderma is classed as a biocontrol agent, a living organism used to fight pests or pathogens instead of a chemical pesticide.

Step 3: Give a specific application.

Trichoderma species are used to control several plant pathogens, including species that cause root rot disease in various crop plants (such as those caused by Pythium and Fusarium), protecting the crop without needing chemical fungicides.

Final Answer:

Trichoderma is a soil-dwelling fungus used as a biocontrol agent, commonly applied to protect crops from root rot caused by other pathogenic fungi.

Quick Tip: Trichoderma is a soil fungus that fights other, disease-causing fungi around plant roots.



3(d). Write a note on photosynthetically active radiation.

Correct Answer: —

Solution:**Step 1: Understanding the Concept:**

Sunlight reaching the earth contains a broad range of wavelengths, but plants can only use a specific part of that range for photosynthesis.

Step 2: Define the term.

Photosynthetically Active Radiation (PAR) is the portion of solar radiation, roughly in the wavelength range of 400 to 700 nanometres (the visible light range), that green plants and other photosynthetic organisms can actually absorb and use to drive photosynthesis.

Step 3: State how much of it is actually used.

Even though PAR itself is a big share of sunlight, plants only manage to capture about 2 to 10 percent of it, because of factors like leaf reflection, transmission of light through leaves, and losses during the

chemical reactions of photosynthesis.

Final Answer:

PAR is the 400-700 nm band of sunlight usable for photosynthesis, of which plants convert only a small fraction, about 2-10 percent, into chemical energy.

Quick Tip: PAR is the visible-light slice of the full solar spectrum, not all of sunlight.



3(e). Write a short note on over exploitation.

Correct Answer: —

Solution:

Step 1: Understanding the Concept:

Natural populations of plants and animals can renew themselves over time, but only up to a certain rate. Overexploitation is what happens when humans take from that population faster than it can recover.

Step 2: Define it.

Overexploitation means using or harvesting a species or natural resource at a rate greater than its natural capacity to regenerate, which steadily shrinks the population instead of letting it stay stable.

Step 3: Give the consequence and an example.

If overexploitation continues unchecked, the species population keeps falling until it can disappear altogether. Historically, Steller's sea cow and the passenger pigeon were both driven to extinction within a

short span of human overexploitation (excessive hunting).

Final Answer:

Overexploitation is excessive use of a natural resource beyond its ability to regenerate, and it is a major cause of species extinction, as seen with the passenger pigeon and Steller's sea cow.

Quick Tip: Compare how fast a population is harvested against how fast it can naturally replace its losses.



4(a). What is Placenta? Describe different functions of placenta in brief.

Correct Answer: —

Solution:

Step 1: Understanding the Concept:

During pregnancy, the developing embryo needs a permanent, direct connection to the mother's blood supply so it can get food and oxygen and get rid of waste, since it cannot feed or breathe on its own yet.

Step 2: Define the placenta.

The placenta is a special structure that forms this connection: it is made of chorionic villi (finger-like projections from the embryo side) that interdigitate with uterine tissue on the mother's side, in close contact with maternal blood.

Step 3: List its functions.

It acts as an exchange site, allowing oxygen and nutrients to pass from maternal blood into fetal blood, and carbon dioxide and excretory

(waste) products to pass in the opposite direction.

It behaves as a structural anchor, physically attaching the growing fetus to the uterine wall throughout pregnancy.

It functions as an endocrine gland, producing several hormones such as human chorionic gonadotropin (hCG), human placental lactogen (hPL), estrogens, and progestogens, which are needed to maintain the pregnancy.

Final Answer:

The placenta is the fetus-mother connecting structure; it exchanges nutrients, gases, and wastes, anchors the fetus, and secretes hormones that sustain pregnancy.

Quick Tip: Group the placenta's roles into exchange, structural support, and hormone production.

4(b). Describe various factors responsible for explosive population growth in India.

Correct Answer: —

Solution:

Step 1: Understanding the Concept:

A population grows rapidly when its birth rate stays much higher than its death rate for a long stretch of time. India's population growth in the last century is a clear case of this imbalance.

Step 2: List the main factors.

A steep fall in the death rate happened because of major advances in

medicine, better healthcare access, and control of epidemic diseases. The maternal mortality rate (MMR) dropped sharply due to improved healthcare during pregnancy and childbirth, so more mothers survive to have more children over their lifetime.

The infant mortality rate (IMR) also fell, meaning more babies now survive to adulthood, adding directly to population numbers.

The number of people in the reproductive age group (15 to 44 years) has grown very large, so even a modest birth rate per person still produces a huge total number of births.

Illiteracy, lack of awareness about family planning methods, and early marriage practices keep the birth rate itself relatively high in many regions.

Final Answer:

India's explosive population growth comes mainly from a falling death rate, falling MMR and IMR, a very large reproductive-age population, and continued high birth rates linked to illiteracy and limited use of family planning.

Quick Tip: Separate the causes into what pushed the death rate down and what kept the birth rate up.

4(c). Explain test cross and back cross.

Correct Answer: —

Solution:

Step 1: Understanding the Concept:

When an organism shows a dominant trait, you cannot tell just by

looking at it whether it is homozygous dominant or heterozygous, since both genotypes look identical. A special cross is needed to find out which one it is.

Step 2: Define test cross.

A test cross is a cross between an individual with an unknown genotype (showing the dominant phenotype) and an individual that is homozygous recessive for that trait. If all offspring show the dominant trait, the unknown parent is homozygous dominant; if about half the offspring show the recessive trait, the unknown parent is heterozygous.

Step 3: Define back cross.

A back cross is a cross between an F1 hybrid and either one of its two parents (or an individual genetically similar to a parent).

Step 4: Connect the two terms.

When the F1 hybrid is crossed back to the homozygous recessive parent specifically, that particular back cross is also, by definition, a test cross, since it fits both descriptions at once.

Final Answer:

A test cross reveals an unknown genotype by crossing with a homozygous recessive individual, while a back cross is any cross of the F1 with either parent; the back cross to the recessive parent is itself a special case of a test cross.

Quick Tip: Test cross always uses a homozygous recessive partner; back cross can go to either parent.

4(d). What is adaptive radiation? Describe it with the help of a suitable example.

Correct Answer: —

Solution:

Step 1: Understanding the Concept:

When a single ancestral species reaches a new area with many different, unfilled habitats (or ecological niches), its descendants can spread out and adapt to those different niches over time.

Step 2: Define adaptive radiation.

Adaptive radiation is the process by which many new species evolve from a single common ancestor within a relatively short span of geological time, radiating outward from a central point of origin as they adapt to different available niches.

Step 3: Explain with the classic example.

Darwin's finches on the Galapagos Islands are the standard example: a single ancestral finch species reached the islands and, over time, gave rise to several different finch species, each with a beak shape suited to a different food source, such as seed-crushing beaks, insect-catching beaks, and cactus-feeding beaks.

Final Answer:

Adaptive radiation is the diversification of one ancestral species into many species adapted to different niches; Darwin's finches on the Galapagos Islands, each with a different beak shape, illustrate this clearly.

Quick Tip: Think of one ancestor species splitting into many, each fitted to a different food source or niche.



5(a)(i). Comment upon the following: Infectious disease.

Correct Answer: —

Solution:

Step 1: Understanding the Concept:

Not every disease is caused by an outside organism; some come from internal causes like nutrient deficiency or genetics. Infectious diseases are specifically the kind caused by outside agents.

Step 2: Define it.

An infectious disease is one caused by a pathogenic microorganism, such as a bacterium, virus, fungus, or protozoan parasite, that enters and multiplies inside the body.

Step 3: Note the key feature.

Because the causal agent is a living microorganism, such diseases can spread from an infected person to a healthy person, either directly (through contact, air, or body fluids) or indirectly (through contaminated food, water, or a carrier organism).

Final Answer:

Infectious diseases are caused by pathogens and, unlike non-infectious diseases, can be transmitted from one person to another.

Quick Tip: Infectious disease needs a living pathogen that can pass from one host to another.



5(a)(ii). Comment upon the following: Amoebiasis.

Correct Answer: —

Solution:

Step 1: Understanding the Concept:

Amoebiasis is a specific infectious disease of the gut, caused by a single-celled parasite rather than a bacterium or virus.

Step 2: Name the cause.

It is caused by the protozoan *Entamoeba histolytica*, which infects the large intestine of humans.

Step 3: Explain how it spreads.

The parasite spreads mainly through contaminated food and water, and houseflies acting as mechanical carriers can also transfer it from faecal matter onto exposed food.

Step 4: Note the symptoms.

An infected person typically suffers from constipation, abdominal pain, cramps, and stools containing excess mucus, sometimes progressing to painful ulceration in the intestinal wall.

Final Answer:

Amoebiasis is an intestinal infection caused by *Entamoeba histolytica*,

spread through contaminated food and water, causing abdominal pain, cramps and mucus-containing stools.

Quick Tip: Amoebiasis is caused by a single-celled parasite living in the large intestine.



5(b). Briefly describe the structure and function of antibody molecule.

Correct Answer: —

Solution:

Step 1: Understanding the Concept:

When a foreign substance (antigen) enters the body, the immune system responds by making special protein molecules designed to recognise and bind that specific antigen. These are antibodies.

Step 2: Describe the structure.

An antibody molecule is shaped like the letter Y and is built from four polypeptide chains: two identical long chains called heavy chains, and two identical short chains called light chains, all held together by disulfide bonds.

Each chain has a constant region (which stays the same across antibodies of the same class) and a variable region (which differs and forms the antigen-binding site at the tips of the Y).

Step 3: Describe the function.

The variable regions at the two arms of the Y bind specifically to a matching antigen, like a lock fitting a key, which either neutralises the antigen directly or tags it so other immune cells can destroy it.

Final Answer:

An antibody is a Y-shaped protein of two heavy and two light chains, whose variable tips bind specifically to an antigen to neutralise or mark it for destruction.

Quick Tip: Picture a Y shape built from two long and two short protein chains, with variable tips that grab the antigen.



5(c). Describe the causes, detection and diagnosis of cancer in brief.

Correct Answer: —

Solution:**Step 1: Understanding the Concept:**

Cancer develops when normal cells lose their usual growth controls and start dividing uncontrollably, invading and damaging surrounding tissue.

Step 2: State the causes.

Cancer can be triggered by carcinogens, which include physical agents (like ionising radiation), chemical agents (like tobacco smoke), and biological agents (like certain viruses, called oncogenic viruses). These agents convert normal genes called proto-oncogenes into cancer-causing oncogenes, and normal cells also lose contact inhibition, the usual signal that stops cell division once cells touch their neighbours.

Step 3: Describe detection and diagnosis.

A biopsy, taking a small piece of the suspected tissue and studying it

under a microscope (histopathological study), is a primary method to confirm cancer.

Blood and bone marrow tests can detect abnormal cell counts linked to cancers like leukaemia.

Imaging methods such as radiography (X-rays), CT scans, and MRI scans help locate tumours inside the body.

Monoclonal antibodies that specifically bind tumour-associated markers are also used for precise detection of cancer cells.

Final Answer:

Cancer is caused by physical, chemical, and biological carcinogens converting proto-oncogenes to oncogenes and disabling contact inhibition; it is detected and diagnosed through biopsy, blood/bone marrow tests, imaging (X-ray, CT, MRI), and monoclonal antibody techniques.

Quick Tip: Split the answer into what causes cancer at the cell level, and what tools find it in the body.

5(d). Discuss various measures for prevention and control of drug/alcohol abuse.

Correct Answer: —

Solution:

Step 1: Understanding the Concept:

Drug and alcohol abuse usually begins gradually, often through social or emotional pressures, so preventing it means addressing those root causes as well as offering support once a problem exists.

Step 2: List preventive measures.

Avoiding undue peer pressure is important, since curiosity and the wish to fit in with a group is one of the most common reasons young people first try drugs or alcohol.

Education and awareness programmes that explain the real physical and social harm caused by these substances help people make informed choices.

Learning to say no when friends or acquaintances offer drugs or alcohol, and recognising early warning signs in oneself or others, both help prevent escalation.

Step 3: List control/support measures.

Seeking help and guidance from parents and trusted peers gives an affected person a support system rather than facing the problem alone.

Seeking professional counselling or medical help from doctors and de-addiction specialists is essential once dependence has developed, since abuse can be very hard to overcome without expert support.

Final Answer:

Prevention relies on avoiding peer pressure and building awareness, while control relies on support from family, peers, and professional medical or counselling help.

Quick Tip: Separate what stops someone starting from what helps someone already affected.

6(a). Explain the nomenclature of restriction endonucleases. Add a note on its applications.

Correct Answer: —

Solution:

Step 1: Understanding the Concept:

Restriction endonucleases are enzymes that cut DNA at specific recognition sites, and since hundreds of them have been discovered from different bacteria, they need a systematic naming scheme to avoid confusion.

Step 2: Explain the naming rule.

The name is built from the source organism: the first letter of the genus name (capitalised), followed by the first two letters of the species name, giving a three-letter abbreviation.

If needed, a further letter or number identifies the bacterial strain, and a Roman numeral at the end shows the order in which that particular enzyme was discovered or isolated from that strain.

For example, EcoRI comes from *Escherichia* (E) *coli* (co), strain R, and was the first (I) such enzyme identified from that strain.

Step 3: Describe applications.

Restriction enzymes are essential tools for genetic engineering: they cut DNA at precise recognition sequences to produce fragments with matching sticky ends, which is how a gene of interest is removed from source DNA and later joined into a vector to build recombinant DNA. They are also used in gene cloning, DNA fingerprinting, and mapping restriction sites on a DNA molecule.

Final Answer:

A restriction endonuclease is named from its genus, species, strain, and order of discovery (like EcoRI); its main application is cutting DNA at specific sites for genetic engineering, cloning, and DNA fingerprinting.

Quick Tip: Break a name like EcoRI into genus, species, strain, and order-of-discovery parts.

6(b). Briefly describe the different methods used to transfer the recombinant DNA into the host cell.

Correct Answer: —

Solution:

Step 1: Understanding the Concept:

Once a recombinant DNA molecule has been built (gene plus vector), it still needs to physically get inside a living host cell before it can be copied or expressed. Different host types need different delivery methods.

Step 2: Describe transformation.

Bacterial cells can be made "competent" to take up foreign DNA by treating them with a specific concentration of calcium chloride, which increases the permeability of the cell wall/membrane, followed by a brief heat shock that helps the DNA enter.

Step 3: Describe micro-injection.

For animal cells, recombinant DNA can be injected directly into the nucleus of the cell using a very fine needle under a microscope, a

method called micro-injection.

Step 4: Describe biolistics and vector-mediated transfer.

For plant cells, the biolistic or gene gun method fires micro-particles (like gold or tungsten) coated with DNA into the cells at high velocity, letting the DNA enter directly.

Alternatively, disarmed pathogen vectors, most commonly the bacterium *Agrobacterium tumefaciens*, are used to naturally carry and insert the desired DNA into plant cells.

Final Answer:

Recombinant DNA is delivered into host cells by transformation (bacteria, using CaCl_2 and heat shock), micro-injection (animal cells), and the biolistic method or disarmed vectors like *Agrobacterium* (plant cells).

Quick Tip: Match the transfer method to the host: bacteria, animal cell, or plant cell.

6(c). What are transgenic plants? Describe benefits of transgenic plants in brief.

Correct Answer: —

Solution:

Step 1: Understanding the Concept:

Normally a plant only carries genes passed down from its own species through breeding. Genetic engineering makes it possible to add a gene from a completely different organism.

Step 2: Define transgenic plants.

Transgenic plants are plants whose DNA has been altered by inserting a foreign gene using genetic engineering techniques, giving them a new trait that they would not otherwise have.

Step 3: Describe the benefits.

Pest resistance: crops like Bt cotton carry a bacterial gene (from *Bacillus thuringiensis*) that makes the plant toxic to specific insect pests, cutting crop losses without needing as much chemical pesticide.

Herbicide tolerance: some transgenic crops can survive herbicide sprays that would otherwise kill them, making weed control easier for farmers.

Improved nutrition: Golden rice is engineered to produce vitamin A, helping fight vitamin A deficiency in populations that rely heavily on rice.

Reduced post-harvest losses and stress tolerance: certain transgenic plants are engineered to resist abiotic stresses like drought, cold, or high salinity, and to stay fresh longer after harvest.

Final Answer:

Transgenic plants carry a foreign gene inserted by genetic engineering; their benefits include pest and herbicide resistance, improved nutritional content, and better tolerance of environmental stress.

Quick Tip: A transgenic plant carries a gene taken from an unrelated organism, not from normal breeding.

6(d). What is trophic level? Comment upon the different types of trophic levels in an ecosystem.

Correct Answer: —

Solution:

Step 1: Understanding the Concept:

Energy in an ecosystem moves step by step, from the sun into plants and then into the animals that eat plants, and then into animals that eat those animals. Each of these feeding steps is a level.

Step 2: Define trophic level.

A trophic level is each successive step in a food chain at which food (and the energy in it) is transferred, defined by the source of nutrition of the organisms occupying that step.

Step 3: Describe each level.

The first trophic level is occupied by producers, the autotrophs (mainly green plants) that make their own food through photosynthesis.

The second trophic level is occupied by primary consumers or herbivores, organisms that eat the producers directly.

The third trophic level is occupied by secondary consumers, the primary carnivores that eat the herbivores.

The fourth trophic level, where it exists, is occupied by tertiary consumers, secondary carnivores that eat the secondary consumers.

Final Answer:

A trophic level is a feeding step in a food chain; from first to last these are producers, primary consumers (herbivores), secondary consumers (primary carnivores), and tertiary consumers (secondary carnivores).

Quick Tip: Picture a ladder: producers at the bottom, each higher rung eating the one below it.



7. Define spermatogenesis. Describe the process of spermatogenesis with the help of schematic diagram.

Correct Answer: —

Solution:

Step 1: Understanding the Concept:

Spermatogenesis is the process by which male germ cells inside the testis produce mature, haploid sperm cells (spermatozoa), starting from diploid cells and passing through cell division and a change in shape.

Step 2: State where it happens.

It occurs inside the seminiferous tubules of the testis, in a layer of cells called the germinal epithelium.

Step 3: Describe the stages in order.

Diploid germ cells called spermatogonia ($2n$) present in the tubule lining multiply repeatedly by mitosis to increase in number.

Some spermatogonia grow in size and become primary spermatocytes ($2n$), which then undergo the first meiotic division (meiosis I) to form two secondary spermatocytes (n , haploid).

Each secondary spermatocyte undergoes the second meiotic division (meiosis II) to produce two spermatids (n), so one primary spermatocyte ultimately yields four haploid spermatids.

These spermatids, though already haploid, do not look like functional

sperm yet, so they go through a transformation process called spermiogenesis, in which they develop a head, a midpiece with mitochondria, and a tail, becoming mature spermatozoa. Finally, the fully formed sperm heads are released from the Sertoli cells into the lumen of the seminiferous tubule, a step called spermiation.

Step 4: Note the schematic flow (diagram in words).

Spermatogonium ($2n$) $\rightarrow$ mitosis $\rightarrow$ Primary spermatocyte ($2n$) $\rightarrow$ meiosis I $\rightarrow$ two Secondary spermatocytes (n) $\rightarrow$ meiosis II $\rightarrow$ four Spermatids (n) $\rightarrow$ spermiogenesis $\rightarrow$ four Spermatozoa (n), released into the tubule lumen by spermiation.

Final Answer:

Spermatogenesis is the formation of haploid sperm from diploid spermatogonia through mitosis, meiosis I, meiosis II, and spermiogenesis, ending with spermiation into the seminiferous tubule.

Quick Tip: Track how the chromosome number changes from spermatogonium to spermatid to mature sperm.

OR

Write an explanatory note on: Medical termination of pregnancy.

Correct Answer: —

Solution:

Step 1: Understanding the Concept:

Medical Termination of Pregnancy, usually abbreviated MTP, refers

to the intentional or induced ending of a pregnancy before it reaches full term.

Step 2: State the legal background.

In India, MTP was legalised through the MTP Act, 1971, mainly to check illegal and medically unsafe abortions that were putting women's lives at risk, and to give women a safe, legal option under expert supervision.

Step 3: Note when and how it is done.

MTP is considered relatively safe when carried out during the first trimester (first 12 weeks) of pregnancy; performing it during the second trimester carries a higher risk of complications. It must be carried out by, or under the guidance of, a qualified medical professional.

Step 4: Note its wider significance.

Besides its role in reproductive healthcare, safe and legal MTP services also help in controlling unwanted population growth and in cases involving risk to the mother's health or fetal abnormality.

Final Answer:

MTP is the legally permitted, medically supervised ending of a pregnancy, safest within the first trimester, introduced in India through the MTP Act of 1971 to prevent unsafe illegal abortions.

Quick Tip: MTP is legal, medically supervised, and safest earliest in pregnancy.

Write an explanatory note on: Biotic and abiotic agents of pollination.

Correct Answer: —

Solution:

Step 1: Understanding the Concept:

Pollen has to travel from the anther to the stigma for pollination to happen, and different plants rely on different carriers, called pollinating agents, to move it.

Step 2: Describe biotic agents.

Biotic agents are living carriers of pollen, including insects (bees, butterflies, moths, beetles), birds (like sunbirds and hummingbirds), bats, and even some snails; flowers pollinated this way are usually brightly coloured, scented, and produce nectar to attract these visitors.

Step 3: Describe abiotic agents.

Abiotic agents are non-living forces that move pollen, mainly wind (anemophily) and water (hydrophily). Wind is the most common abiotic pollinating agent, and wind-pollinated flowers usually produce very large amounts of light, dry pollen and often lack showy petals since they do not need to attract a visitor.

Final Answer:

Biotic agents of pollination are living carriers like insects, birds, and bats, while abiotic agents are non-living forces, mainly wind and water, with wind being the most common abiotic agent.

Quick Tip: Check whether the carrier of pollen is alive (biotic) or a physical force (abiotic).

8. Describe the mechanism of sex determination in honey bees and birds.

Correct Answer: —

Solution:

Step 1: Understanding the Concept:

Different groups of animals use different chromosome-based systems to decide whether an individual develops as male or female. Honey bees and birds each use a system different from the human XY system.

Step 2: Describe sex determination in honey bees.

Honey bees use a system called haplodiploidy. A fertilised egg, which is diploid ($2n$), develops into a female (this includes both the queen and the worker bees, the difference between them being diet, not genetics). An unfertilised egg, which is haploid (n), develops into a male (the drone) through a natural process called parthenogenesis, meaning it develops without ever being fertilised.

Step 3: Describe sex determination in birds.

Birds use the ZW system. Unlike mammals, where the female is the homogametic sex (XX), in birds the female is the heterogametic sex, carrying one Z and one W chromosome (ZW), while the male is homogametic, carrying two Z chromosomes (ZZ). So in birds, it is the egg (from the female) that determines the sex of the offspring, opposite to the situation in mammals.

Final Answer:

Honey bees determine sex by haplodiploidy (fertilised = diploid female, unfertilised = haploid male by parthenogenesis), while birds

use the ZW system, where the female (ZW) is heterogametic and the male (ZZ) is homogametic.

Quick Tip: Bees decide sex by fertilisation status; birds decide sex with a reversed Z/W chromosome system.

OR

Write an explanatory note on: Hardy-Weinberg principle.

Correct Answer: —

Solution:

Step 1: Understanding the Concept:

The Hardy-Weinberg principle describes what happens to the genetic makeup of a population when no evolutionary forces are acting on it, a useful reference point for detecting when evolution is actually happening.

Step 2: State the principle.

It states that the allele frequencies and genotype frequencies in a population remain constant, generation after generation, as long as the population is in a state of genetic equilibrium, meaning no mutation, no migration, random mating, an infinitely large population size, and no natural selection are occurring.

Step 3: Give the mathematical form.

For a gene with two alleles of frequency p and q (where $p + q = 1$), the genotype frequencies in the population are described by the equation $p^2 + 2pq + q^2 = 1$, where p^2 is the frequency of the homozygous dominant genotype, $2pq$ is the frequency of the heterozygous

genotype, and q^2 is the frequency of the homozygous recessive genotype.

Step 4: State its practical use.

If the actual genotype frequencies observed in a real population differ from those predicted by this equation, it signals that one of the assumed conditions is being violated, and evolutionary change is likely taking place.

Final Answer:

The Hardy-Weinberg principle says allele and genotype frequencies stay constant across generations without evolutionary influences, summarised by $p^2 + 2pq + q^2 = 1$; a deviation from this is used to detect evolution in a population.

Quick Tip: Hardy-Weinberg describes a population with no evolutionary change; the equation is $p^2 + 2pq + q^2 = 1$.

Write an explanatory note on: Linkage.

Correct Answer: —

Solution:

Step 1: Understanding the Concept:

Mendel's law of independent assortment assumes different genes sort into gametes independently of each other, but this only holds cleanly for genes on different chromosomes. Genes sitting on the same chromosome behave differently.

Step 2: Define linkage.

Linkage is the tendency of two or more genes located on the same

chromosome to be inherited together, as a group, rather than assorting independently into gametes.

Step 3: Explain what decides how strong the linkage is.

The strength of linkage depends on the physical distance between the genes on the chromosome: genes positioned close together are inherited together more often (strong linkage, since crossing over rarely separates them), while genes positioned far apart on the same chromosome show weaker linkage (since crossing over between them happens more often).

Final Answer:

Linkage is the joint inheritance of genes carried on the same chromosome, and its strength depends on how close together those genes lie, with closer genes showing stronger linkage.

Quick Tip: Linked genes ride the same chromosome; distance between them decides how often crossing over splits them apart.

9. Describe the decomposition cycle in a terrestrial ecosystem with the help of a diagram.

Correct Answer: —

Solution:

Step 1: Understanding the Concept:

Dead plant and animal material does not just disappear, it is broken down step by step by decomposers and physical processes, and its nutrients are returned to the soil so producers can use them again.

Step 2: Describe the stages in order.

Fragmentation is the first step, in which detritivores (such as earthworms) physically break detritus (dead remains) into smaller pieces, increasing the surface area available for further breakdown. Leaching happens alongside this, where water-soluble inorganic nutrients from the detritus dissolve and move down into the soil, becoming part of the soil layer.

Catabolism is carried out by bacterial and fungal enzymes, which degrade the fragmented detritus into simpler inorganic substances through biochemical breakdown.

Humification runs alongside catabolism, producing a dark-coloured, amorphous substance called humus, which resists further rapid microbial breakdown and is highly colloidal, acting as a nutrient reservoir in the soil.

Mineralisation is the final stage, in which the humus is degraded further, by certain microbes, releasing simple inorganic nutrients back into the soil, ready to be absorbed by plant roots again.

Step 3: Give the diagram flow in words.

Detritus → (fragmentation by detritivores) → smaller particles → (leaching) → soil nutrients, alongside → (catabolism by microbial enzymes) → simple organics → (humification) → humus → (mineralisation) → inorganic nutrients released back to soil → taken up by producers.

Final Answer:

The decomposition cycle moves detritus through fragmentation, leaching, catabolism, humification, and mineralisation, ultimately returning inorganic nutrients to the soil for producers to reuse.

Quick Tip: Follow detritus through five steps: fragmentation, leaching, catabolism, humification, mineralisation.

OR

Write an explanatory note on: Productivity.

Correct Answer: —

Solution:

Step 1: Understanding the Concept:

An ecosystem's productivity is a measure of how fast new organic matter (biomass) is being created, and this happens mainly through the photosynthesis of green plants.

Step 2: Define primary productivity.

Primary productivity is defined as the rate of biomass or organic matter production per unit area over a period of time, by plants during photosynthesis.

Step 3: Split it into gross and net.

Gross Primary Productivity (GPP) is the total rate of production of organic matter, before any of it is used up by the plant's own respiration.

Net Primary Productivity (NPP) is what remains after subtracting the plant's own respiratory losses from GPP, and it is this NPP that is actually available to herbivores and the rest of the food chain.

Final Answer:

Productivity, specifically primary productivity, is the rate at which

plants produce biomass; GPP is the total amount produced, and NPP is GPP minus what the plant itself uses up in respiration.

Quick Tip: Productivity is a rate; separate the total made (GPP) from what is left after the plant's own respiration (NPP).

Write an explanatory note on: Consumers.

Correct Answer: —

Solution:

Step 1: Understanding the Concept:

Not every organism in an ecosystem can make its own food; those that cannot rely on eating other organisms, directly or indirectly, for their nutrition.

Step 2: Define consumers.

Consumers are heterotrophic organisms that depend, directly or indirectly, on producers (autotrophs) for their food, since they cannot photosynthesise or otherwise manufacture their own organic matter.

Step 3: Classify them by feeding position.

Primary consumers, or herbivores, feed directly on producers, such as a deer eating grass.

Secondary consumers, or primary carnivores, feed on the primary consumers, such as a fox eating the deer.

Tertiary consumers, or secondary carnivores, feed on the secondary consumers, occupying an even higher position in the food chain.

Final Answer:

Consumers are heterotrophs dependent on producers for food,

classified in order as primary consumers (herbivores), secondary consumers (primary carnivores), and tertiary consumers (secondary carnivores).

Quick Tip: Consumers cannot make their own food; rank them by how many feeding steps separate them from a plant.