

ICSE Board Class 12 Biology Question Paper with Solution

Time Allowed :3 Hours	Maximum Marks :70	Total Questions :18
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General Instructions

1. You are allowed an additional fifteen minutes for only reading the question paper.
2. You must NOT start writing during reading time.
3. This question paper has 11 printed pages and one blank page.
4. It has eighteen questions in all. Answer all questions.
5. There are four sections in the paper: A, B, C and D. Internal choices have been provided in one question each in Sections B, C and D.
6. Section A consists of one question. Each subpart carries one mark.
7. While answering Multiple Choice Questions in Section A, you are required to write only one option as the answer.
8. Section B consists of seven questions each carrying two marks.
9. Section C consists of seven questions each carrying three marks.
10. Section D consists of three questions each carrying five marks.
11. Diagrams should be drawn wherever necessary using a pencil only.
12. The intended marks for questions are given in brackets [].

Section A

1(i). Zara is suffering from cough and has bluish lips. Her mucus is mixed with blood. What is the biological name of the causative organism responsible for Zara's condition?

Correct Answer: *Streptococcus pneumoniae* (or *Haemophilus influenzae*)

Solution:

Step 1: Understanding the Concept:

The clinical symptoms described—cough, bloody mucus, and cyanosis (bluish lips)—are severe indicators of Bacterial Pneumonia.

Step 2: Detailed Explanation:

In pneumonia, the alveoli (air sacs) of the lungs get filled with fluid, leading to severe problems in respiration.

The bluish color of the lips and finger nails is due to the lack of oxygen in the blood, a condition occurring in severe cases.

The most common pathogens causing this in humans are *Streptococcus pneumoniae* and *Haemophilus*

influenzae.

Step 3: Final Answer:

The causative organism is *Streptococcus pneumoniae*.

 Quick Tip

Always associate "bluish lips/finger nails" with Pneumonia rather than common cold in your exams.

1(ii). Observe the relation between the first two words and complete the analogy.
Dengue: Aedes :: Plague: -----

Correct Answer: *Xenopsylla cheopis* (or Rat flea)

Solution:

Step 1: Understanding the Concept:

This is a vector-disease relationship analogy.

Dengue is a disease transmitted by the *Aedes* mosquito.

Step 2: Detailed Explanation:

Plague is caused by the bacterium *Yersinia pestis*.

It is transmitted to humans via the bite of an infected flea that typically lives on rats.

The scientific name for this rat flea is *Xenopsylla cheopis*.

Step 3: Final Answer:

The correct term is *Xenopsylla cheopis*.

 Quick Tip

Biological analogies usually require the vector or the causative agent; read the first pair carefully to identify the relationship.

1(iii). If the number of chromosomes in the cells of the calyx is 16, how many chromosomes will be formed in the endosperm after double fertilisation?

Correct Answer: 24

Solution:

Step 1: Understanding the Concept:

Calyx cells are somatic/vegetative cells and are diploid ($2n$).

In angiosperms, the endosperm is formed by the fusion of one male gamete (n) and two polar nuclei ($n + n$), resulting in a triploid ($3n$) tissue.

Step 2: Key Formula or Approach:

Given: Somatic number ($2n$) = 16.

Therefore, haploid number (n) = $16/2 = 8$.

Step 3: Detailed Explanation:

The endosperm is triploid ($3n$).

Calculating $3n$:

$$3 \times 8 = 24$$

Step 4: Final Answer:

The endosperm will have 24 chromosomes.

💡 Quick Tip

Endosperm is $3n$ in Angiosperms but n (haploid) in Gymnosperms. Always check the plant group!

1(iv). A scientist isolates a second restriction endonuclease from the strain DC3 of *Helicobacter pyogenes*. What would the scientist name it using the standard naming technique of restriction enzyme?

Correct Answer: *Hpy* DCII

Solution:

Step 1: Understanding the Concept:

Restriction enzymes are named based on the genus, species, strain of the organism, and the order of discovery.

Step 2: Detailed Explanation:

1. First letter: Genus *Helicobacter* → H
 2. Next two letters: Species *pyogenes* → py
 3. Next part: Strain name → DC
 4. Roman numeral: Order of isolation (2nd) → II
- Combining these: *Hpy* DCII.

Step 3: Final Answer:

The name of the enzyme is *Hpy* DCII.

 Quick Tip

The first letter is always capitalized, and the species name letters are lowercase. The Roman numeral indicates discovery order in that specific strain.

1(v). Meenu is suffering from a genetic disorder in which phenylpyruvic acid and its metabolites accumulate in blood. It causes impairment of nervous tissues. Which enzyme deficiency has caused this disorder in Meenu?

Correct Answer: Phenylalanine hydroxylase

Solution:

Step 1: Understanding the Concept:

The symptoms point to Phenylketonuria (PKU), an autosomal recessive metabolic disorder.

Step 2: Detailed Explanation:

In an individual with PKU, the body lacks the enzyme **phenylalanine hydroxylase**.

This enzyme is responsible for converting the amino acid phenylalanine into tyrosine.

Without it, phenylalanine builds up and is converted into phenylpyruvic acid, which causes mental retardation and nervous system damage.

Step 3: Final Answer:

The deficiency is of the enzyme Phenylalanine hydroxylase.

 Quick Tip

PKU is a classic example of pleiotropy, where a single gene mutation affects multiple phenotypic traits.

1(vi). There were 770 frogs in a pond. 70 of them died within a month. Calculate the death rate of the population of frogs in the pond.

Correct Answer: 0.0909 individuals per frog per month

Solution:

Step 1: Understanding the Concept:

Death rate (Mortality) is calculated as the number of deaths divided by the initial population size.

Step 2: Key Formula or Approach:

$$\text{Death Rate} = \frac{\text{Number of deaths}}{\text{Initial population size}}$$

Step 3: Detailed Explanation:

Number of deaths = 70.

Initial population = 770.

$$\text{Death Rate} = \frac{70}{770} = \frac{1}{11} \approx 0.0909$$

Step 4: Final Answer:

The death rate is 0.0909 per frog per month.

💡 Quick Tip

Always include the per capita unit in rate calculation questions in ecology.

1(vii). A farmer notices that the leaves of his cabbage plants are curling up because of heavy infestation of aphids. Suggest one ecofriendly method to control their spread in the cabbage plants.

Correct Answer: Biological control using Ladybirds (beetles)

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

Ecofriendly methods focus on biological control instead of chemical pesticides.

Step 2: Detailed Explanation:

Aphids are pests that feed on plant sap.

Ladybirds (ladybugs) are natural predators of aphids.

Introducing ladybirds into the field will naturally control the aphid population without introducing toxic chemicals into the ecosystem.

Step 3: Final Answer:

The use of ladybirds as a biological control agent.

💡 Quick Tip

Dragonflies are used to control mosquitoes, while Ladybirds are used for Aphids.

1(viii). In a particular plant with bilobed dithecous anther, there were 50 Pollen Mother Cells. Only 25% could develop their pollen tubes. Calculate the number of pollen grains that would proceed for fertilisation.

Correct Answer: 50

Solution:

Step 1: Understanding the Concept:

Each Pollen Mother Cell (PMC) undergoes meiosis to produce 4 pollen grains.

Step 2: Detailed Explanation:

1. Total pollen grains produced = $50 \times 4 = 200$.
2. Only 25% of these pollen grains successfully germinate and develop pollen tubes.
3. Calculation: $200 \times 0.25 = 50$.

Step 3: Final Answer:

50 pollen grains will proceed for fertilisation.

 Quick Tip

Remember: 1 Microspore Mother Cell (MMC) $\rightarrow$ 4 Pollen grains, but 1 Megaspore Mother Cell $\rightarrow$ only 1 functional Egg.

1(ix). Choose the components that are required for the proper functioning of DNA polymerase enzyme.

(P) DNA template

(Q) A DNA primer

(R) An RNA primer

(S) Four different dNTPs

- (a) Only (P), (Q) and (R)
(b) Only (P), (R) and (S)
(c) Only (Q), (R) and (S)
(d) Only (P), (Q) and (S)

Correct Answer: (b) Only (P), (R) and (S)

Solution:

Step 1: Understanding the Concept:

DNA polymerase is the enzyme that synthesizes a new DNA strand. It has specific requirements for initiation and elongation.

Step 2: Detailed Explanation:

1. **DNA Template (P):** Required to guide the sequence of the new strand.
2. **Primer:** DNA polymerase cannot start a new strand from scratch. In natural replication (in-vivo), it uses an **RNA primer (R)**.
3. **dNTPs (S):** These are the building blocks (dATP, dTTP, dGTP, dCTP) and also provide energy.

Step 3: Final Answer:

Components (P), (R), and (S) are required. Option (b) is correct.

💡 Quick Tip

In PCR (in-vitro), we use DNA primers, but in the biological context of the enzyme's proper functioning in a cell, RNA primers are the standard requirement.

1(x). The left hind limb of a person was swollen like elephant's limb. Which one of the following was MOST likely the cause of swelling?

- (a) Accumulation of uric acid
- (b) Blockage of blood vessels
- (c) Blockage of lymph vessels
- (d) Hypertrophy of skeletal muscles

Correct Answer: (c) Blockage of lymph vessels

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

The described condition is Elephantiasis (Filariasis).

Step 2: Detailed Explanation:

Elephantiasis is caused by filarial worms like *Wuchereria bancrofti*.

These worms reside in the lymphatic vessels of the lower limbs.

They cause chronic inflammation and blockage of these **lymph vessels**, which leads to massive swelling and accumulation of lymph fluid in the tissues.

Step 3: Final Answer:

The most likely cause is the blockage of lymph vessels. Option (c).

💡 Quick Tip

Associate "swelling of limbs" and "elephant-like" symptoms directly with the Lymphatic System.

1(xi). Given below are two statements marked Assertion and Reason.

Assertion: RNAi technique is applied to plants and animals to protect them from pest infestation.

Reason: This technique inhibits the expression of certain genes in pests.

- (a) Both Assertion and Reason are true and Reason is the correct explanation for Assertion.
- (b) Both Assertion and Reason are true but Reason is not the correct explanation for Assertion.
- (c) Assertion is true and Reason is false.
- (d) Both Assertion and Reason are false.

Correct Answer: (a) Both Assertion and Reason are true and Reason is the correct explanation for Assertion.

Solution:

Step 1: Understanding the Concept:

RNA interference (RNAi) is a gene silencing mechanism.

Step 2: Detailed Explanation:

Assertion: RNAi is used in biotechnology to develop pest-resistant plants (e.g., against *Meloidogyne incognita*). It is a cellular defense mechanism.

Reason: The mechanism works by binding a complementary dsRNA to a specific mRNA, preventing its translation (silencing it). In pests, this inhibits genes vital for their survival. Since the Reason explains "how" the protection in the Assertion works, it is the correct explanation.

Step 3: Final Answer:

Both are true and Reason explains Assertion. Option (a).

💡 Quick Tip

RNAi = Gene Silencing. Always look for this link in Biotech questions.

1(xii). Given below are two statements marked Assertion and Reason.

Assertion: Individuals with Klinefelter syndrome lose their secondary sexual characters and develop gynaecomastia.

Reason: The presence of the XYY chromosomal pattern leads to underdeveloped testes and reduced testosterone levels in affected males.

- (a) Both Assertion and Reason are true and Reason is the correct explanation for Assertion.
- (b) Both Assertion and Reason are true but Reason is not the correct explanation for Assertion.
- (c) Assertion is true and Reason is false.
- (d) Both Assertion and Reason are false.

Correct Answer: (c) Assertion is true and Reason is false.

Solution:

Step 1: Understanding the Concept:

Klinefelter's Syndrome is a chromosomal disorder.

Step 2: Detailed Explanation:

Assertion: Klinefelter's syndrome results in sterile males with feminized characters like gynaecomastia (breast development). This is true.

Reason: The chromosomal pattern for Klinefelter's is actually **XXY** (47 chromosomes), not XYY. XYY is a different condition (Supermale syndrome).

Step 3: Final Answer:

Assertion is true, but Reason is false due to incorrect chromosomal pattern. Option (c).

💡 Quick Tip

Klinefelter = XXY; Turner = XO. These are the most commonly tested syndromes.

1(xiii). In a garden pea plant, the flowers are in axial (A) position. Find out the proportion of flowers in terminal position (a), if a cross is made between two heterozygous plants.

Correct Answer: 1/4 (or 25%)

Solution:

Step 1: Understanding the Concept:

Axial (A) is dominant over terminal (a). Heterozygous plants have the genotype *Aa*.

Step 2: Detailed Explanation:

Cross: *Aa* × *Aa*

Punnett Square:

- *AA* (Axial)
- *Aa* (Axial)
- *Aa* (Axial)
- *aa* (Terminal)

The ratio is 3:1. The terminal position (*aa*) appears in 1 out of 4 cases.

Step 3: Final Answer:

The proportion is 1/4 or 25%.

 Quick Tip

A heterozygous monohybrid cross always yields a 3:1 phenotypic ratio and 1:2:1 genotypic ratio.

1(xiv). Name the autoimmune disorder that affects the skeletal muscles in humans.

Correct Answer: Myasthenia gravis

Solution:

Step 1: Understanding the Concept:

An autoimmune disorder is a condition where the immune system attacks the body's own tissues.

Step 2: Detailed Explanation:

In Myasthenia gravis, the body produces antibodies that block or destroy the acetylcholine receptors at the neuromuscular junction.

This prevents skeletal muscles from receiving nerve signals, leading to muscle weakness and fatigue.

Step 3: Final Answer:

The disorder is Myasthenia gravis.

 Quick Tip

Do not confuse this with Muscular Dystrophy, which is a genetic disorder, not autoimmune.

1(xv)(a). Expand the abbreviation IUI.

Correct Answer: Intrauterine Insemination

Solution:

Step 1: Understanding the Concept:

IUI is an Assisted Reproductive Technology (ART).

Step 2: Detailed Explanation:

In this procedure, semen is collected from the husband or a donor and is artificially introduced into the uterus of the female to facilitate fertilization.

Step 3: Final Answer:

IUI stands for Intrauterine Insemination.

💡 Quick Tip

Common ART terms: IVF, ZIFT, GIFT, IUI, ICSI. Learn them all!

1(xv)(b). The enzyme polynucleotide phosphorylase helps the in-vitro synthesis of RNA. Name the scientist who discovered this enzyme.

Correct Answer: Severo Ochoa

Solution:

Step 1: Understanding the Concept:

Polynucleotide phosphorylase (Severo Ochoa enzyme) was crucial in deciphering the genetic code.

Step 2: Detailed Explanation:

This enzyme was used to synthesize RNA with defined sequences without the need for a DNA template, helping scientists determine which codons code for which amino acids.

Step 3: Final Answer:

The scientist is Severo Ochoa.

💡 Quick Tip

He shared the Nobel Prize in 1959 for this discovery.

1(xvi). Shama complained of severe itching in certain parts of her body where patches as shown below appeared on her skin. Write the biological name of the causative agent responsible for her condition.



Correct Answer: *Microsporum* / *Trichophyton* / *Epidermophyton*

Solution:

Step 1: Understanding the Concept:

The symptoms of dry, scaly lesions and intense itching indicate a fungal infection known as Ringworm.

Step 2: Detailed Explanation:

Ringworm is not caused by a worm but by various genera of fungi.

Common causative agents include *Microsporum*, *Trichophyton*, and *Epidermophyton*.

These fungi thrive in heat and moisture, often affecting skin folds.

Step 3: Final Answer:

The causative agent belongs to the genus *Microsporum* (or the others listed).

💡 Quick Tip

Ringworm is highly infectious; sharing towels or combs can spread it easily.

1(xvii). Name the chemical messenger that activates Natural Killer T-cells and macrophages.

Correct Answer: Cytokines (Interferons)

Solution:

Step 1: Understanding the Concept:

Cells of the immune system communicate through chemical signals.

Step 2: Detailed Explanation:

Interferons are a class of cytokines released by virus-infected cells.

They act as chemical messengers that activate other immune cells like Natural Killer (NK) cells and Macrophages to destroy infected cells and pathogens.

Step 3: Final Answer:

The messengers are Cytokines, specifically Interferons.

 Quick Tip

Interferons represent a "cytokine barrier" in innate immunity.

1(xviii)(a). Give a reason for the following: Kanika was suffering from SCID and needed periodic infusion of transformed lymphocytes.

Correct Answer: Lymphocytes are not immortal cells

Solution:

Step 1: Understanding the Concept:

SCID (Severe Combined Immunodeficiency) can be treated with gene therapy using the patient's own lymphocytes.

Step 2: Detailed Explanation:

In gene therapy, a functional ADA gene is inserted into the patient's lymphocytes.

However, these lymphocytes have a limited lifespan; they naturally die after some time.

Therefore, the patient requires regular infusions of new genetically modified lymphocytes to maintain an active immune system.

Step 3: Final Answer:

Periodic infusion is necessary because lymphocytes are not immortal and have a finite life span.

 Quick Tip

A permanent cure for ADA deficiency is only possible if the corrective gene is introduced into bone marrow cells at an early embryonic stage.

1(xviii)(b). Give a reason for the following: In HIV infected persons, the immune system is compromised.

Correct Answer: HIV destroys Helper T-lymphocytes (T_H)

Solution:

Step 1: Understanding the Concept:

HIV targets the core cells that coordinate the immune response.

Step 2: Detailed Explanation:

The HIV virus enters and replicates within Helper T-lymphocytes.

The replication process eventually leads to the destruction and massive decline in the count of these T_H cells.

Since T_H cells are required to activate both B-cells and Killer T-cells, their depletion renders the person unable to fight even minor opportunistic infections.

Step 3: Final Answer:

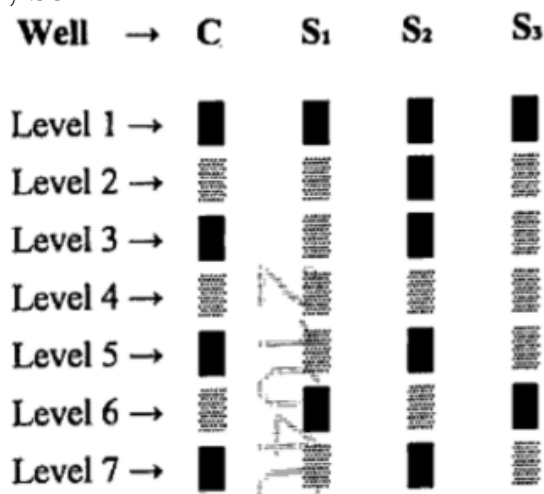
The immune system is compromised because HIV specifically destroys Helper T-lymphocytes, leading to severe immunodeficiency.

💡 Quick Tip

Remember the "Central Dogma" of HIV: It uses Reverse Transcriptase to turn its RNA into DNA within the host cell.

Section B

Question 2 The diagram below shows DNA banding patterns obtained after DNA samples collected from a crime scene were subjected to gel electrophoresis. Samples from crime scene are denoted by C and three suspects are represented by S₁, S₂, S₃.



2(i). Which suspect's DNA sample matches the sample collected from the crime scene (C) based on the provided banding patterns?

Correct Answer: Suspect 2 (S_2)

Solution:

Step 1: Understanding the Concept:

DNA profiling involves matching VNTR (Variable Number of Tandem Repeats) bands across multiple levels in electrophoresis.

Step 2: Detailed Explanation:

By carefully comparing the bands in lane 'C' with those in S_1 , S_2 , and S_3 :

1. Level 1: C matches S_2, S_3 .
2. Level 2: C matches S_1, S_2 .
3. Level 3: C matches only S_2 .
4. Level 4: C matches only S_2 .

Comparing all 7 levels, the complete sequence of bands in C is identical only to Suspect 2 (S_2).

Step 3: Final Answer:

Suspect 2 is the match.

 Quick Tip

In DNA fingerprinting, every single band in the evidence sample must have a corresponding band in the suspect's sample for it to be a match.

2(ii). Mention the principle on which DNA profiling is based.

Correct Answer: DNA Polymorphism (VNTRs)

Solution:

Step 1: Understanding the Concept:

DNA profiling identifies unique regions in a person's genome.

Step 2: Detailed Explanation:

The principle is based on **DNA polymorphism**, specifically in the non-coding repetitive DNA sequences called satellite DNA.

The most commonly used markers are **VNTRs** (Variable Number of Tandem Repeats). The size and number of these repeats vary from individual to individual, creating a unique "fingerprint."

Step 3: Final Answer:

The principle is DNA polymorphism using VNTRs.

 Quick Tip

Polymorphism at the DNA level is the basis of both genetic mapping and DNA fingerprinting.

3. In a group discussion on pollination, Shubham argued that Cleistogamy was a type of Xenogamy whereas Ameena was of the opinion that it was a kind of Autogamy. Whose argument is correct? Justify.

Correct Answer: Ameena is correct

Solution:

Step 1: Understanding the Concept:

Autogamy is self-pollination. Xenogamy is cross-pollination. Cleistogamy is the state of flowers that never open.

Step 2: Detailed Explanation:

Cleistogamous flowers are closed flowers. Since the flowers do not open, the pollen from the anther can only fall on the stigma of the same flower.

This ensures **obligatory autogamy** (self-pollination). There is no chance of cross-pollination (Xenogamy) occurring.

Step 3: Final Answer:

Ameena's argument is correct because cleistogamy prevents the entry of foreign pollen, ensuring internal self-pollination.

 Quick Tip

Cleistogamous flowers ensure seed-set even in the absence of pollinators.

4(i). The amount of energy at the fourth trophic level in the food chain: Grass → Zebra → Crocodile → Vulture is 4 J. What will be the amount of energy available at the sunlight and transducer level?

Correct Answer: Sunlight: 4,00,000 J; Transducer: 4,000 J

Solution:

Step 1: Understanding the Concept:

1. Lindeman's 10% law: Only 10% energy is transferred to the next level.
2. Transducers (plants) capture only about 1% of sunlight.

Step 2: Key Formula or Approach:

Work backward from Vulture (T4):

- T4 (Vulture) = 4 J.
- T3 (Crocodile) = $4 \times 10 = 40$ J.
- T2 (Zebra) = $40 \times 10 = 400$ J.
- T1 (Grass/Transducer) = $400 \times 10 = 4,000$ J.

Step 3: Detailed Explanation:

The transducer (Grass) energy is 4,000 J.

Since plants capture only 1% of incident solar energy:

Sunlight = $4,000 \times 100 = 4,00,000$ J.

Step 4: Final Answer:

Energy at Transducer level = 4,000 J; Sunlight energy = 4,00,000 J.

💡 Quick Tip

Always use the 1% rule for Sun to Producer and 10% rule for one trophic level to the next.

OR

4(ii). Roselin had an aquarium at her home with 10 fish in it. In a year, a fish gave birth to 7 fish. During this period, 3 adult fish had died. Roselin's father purchased 2 more pairs of fish from market for the aquarium. Later, Roselin gifted 4 fish from the aquarium to her friend. Find out the growth rate of fish in Roselin's aquarium.

Correct Answer: 0.4 per fish per year

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

Growth rate (r) = Net increase in population / Initial population.

Step 2: Detailed Explanation:

Initial population (N) = 10.

Births = 7. Deaths = 3.

Immigration (purchased) = 2 pairs = 4 fish.

Emigration (gifted) = 4 fish.

Net Change (ΔN) = $(7 + 4) - (3 + 4) = 11 - 7 = 4$.

Step 3: Final Answer:

Growth Rate = $4/10 = 0.4$ per fish per year.

💡 Quick Tip

Growth rate calculation must include both internal (birth/death) and external (immigration/emigration) factors if provided.

5. Anthony needs to obtain biological products in large quantities. He has a vessel with a sparger and one with a stirrer. Which is more advantageous? Why?

Correct Answer: Stirred-tank bioreactor (Vessel with stirrer)

Solution:

Step 1: Understanding the Concept:

Bioreactors provide optimal growth conditions.

Step 2: Detailed Explanation:

The stirred-tank bioreactor with a stirrer is more advantageous.

The stirrer ensures uniform mixing of the culture medium and ensures that oxygen is available equally to all the cells throughout the reactor.

A sparger only bubbles air, but without a stirrer, the mixing and nutrient distribution would be uneven.

Step 3: Final Answer:

The stirrer vessel is better as it facilitates constant mixing and better oxygen transfer efficiency.

💡 Quick Tip

Standard bioreactors are usually "stirred-tank" types for a reason: mixing is the key to scalability.

6. Based on data (Birds decline, Plants % decline, Area decline), interpret two reasons for change in the population of migratory birds.

Population decline over the last three years.

Year	Population of Birds	Aquatic Plants (%)	Aquatic Area (ha)
2023	10,000	85	350
2024	8000	60	280
2025	5000	45	220

Correct Answer: Habitat loss and Food shortage

Solution:

Step 1: Understanding the Concept:

Analysis of the provided table shows a correlation between bird population and environmental

factors.

Step 2: Detailed Explanation:

1. **Habitat Loss:** The total aquatic area decreased from 350 to 220 hectares. Smaller area means less space for nesting and foraging.
2. **Food Shortage:** Aquatic plant cover dropped from 85% to 45%. Since many migratory birds depend on these plants for food, the decline in vegetation leads to starvation or migration to other areas.

Step 3: Final Answer:

Reasons: Habitat destruction (area reduction) and lack of primary productivity/food (plant decline).

 Quick Tip

In data-based questions, always link your biological reasoning directly to the variables shown in the table columns.

7. Identify and explain the type of ecological interaction where *Paramecium caudatum* got eliminated when grown with *Paramecium aurelia* based on Gause's principle.

Correct Answer: Competitive Exclusion (Interspecific Competition)

Solution:

Step 1: Understanding the Concept:

Gause's Principle describes the outcome of competition for finite resources.

Step 2: Detailed Explanation:

The interaction is **Competition**.

According to **Gause's Competitive Exclusion Principle**, two closely related species competing for the same limiting resources cannot co-exist indefinitely.

The competitively superior species (*P. aurelia*) will eventually eliminate the inferior one (*P. caudatum*).

Step 3: Final Answer:

Competitive exclusion due to niche overlap.

 Quick Tip

If two species can coexist while using the same resource, it's called "Resource Partitioning." Gause's principle only applies when resources are limited.

8(i). Predict the outcome of an experiment where a plasmid without a selectable marker was used as a vector.

Correct Answer: Non-transformants cannot be distinguished from transformants

Solution:

Step 1: Understanding the Concept:

Selectable markers (like antibiotic resistance genes) are essential to identify transformed cells.

Step 2: Detailed Explanation:

Without a selectable marker, there is no way to selectively kill the cells that did not take up the plasmid.

Both recombinant and non-recombinant cells will grow on the medium, making it impossible for the scientist to isolate the desired recombinant cells.

Step 3: Final Answer:

The experiment fails because selection of transformants is not possible.

💡 Quick Tip
Common selectable markers in pBR322 are amp^R and tet^R .

8(ii). Name an artificial chromosome used as a vector for *Penicillium notatum*.

Correct Answer: YAC (Yeast Artificial Chromosome)

Solution:

Step 1: Understanding the Concept:

Penicillium is a fungus (eukaryote).

Step 2: Detailed Explanation:

To clone large fragments of DNA in eukaryotic systems, artificial chromosomes like **YAC** are used as they mimic natural chromosomes and can accommodate huge DNA inserts.

Step 3: Final Answer:

YAC is the appropriate vector.

💡 Quick Tip

BAC (Bacterial) and YAC (Yeast) were both extensively used in the Human Genome Project.

Section C

9(i). How is mature insulin different from pro-insulin secreted by pancreas in humans?

Correct Answer: Mature insulin lacks the C-peptide

Solution:

Step 1: Understanding the Concept:

Insulin is synthesized as a pro-hormone that requires processing.

Step 2: Detailed Explanation:

Pro-insulin contains three chains: A, B, and an extra C-peptide.

During maturation, the **C-peptide** is removed. Mature insulin consists only of A and B chains linked by disulfide bridges.

Step 3: Final Answer:

Absence of C-peptide makes it mature.

💡 Quick Tip

Think of the C-peptide as a "clip" that is removed to make the hormone active.

9(ii). Name the company that produced genetically engineered insulin for the first time.

Correct Answer: Eli Lilly

Solution:

Step 1: Understanding the Concept:

Biotechnology milestone in 1983.

Step 2: Detailed Explanation:

An American company named **Eli Lilly** prepared two DNA sequences for the A and B chains and introduced them into *E. coli* plasmids to produce human insulin (Humulin).

Step 3: Final Answer:

Eli Lilly.

💡 Quick Tip

This was the first-ever genetically engineered drug approved for human use.

9(iii). Why is functional insulin produced by rDNA technology better than the ones produced earlier?

Correct Answer: It does not cause allergic/immunological reactions

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

Comparison between animal-derived and recombinant-human insulin.

Step 2: Detailed Explanation:

Earlier, insulin was extracted from slaughtered pigs or cattle. Because it was a foreign protein, it often caused allergies in patients.

rDNA insulin is identical to human insulin and is recognized as "self" by the body.

Step 3: Final Answer:

Safety from immunological responses.

💡 Quick Tip

"Foreign" proteins trigger the immune system; "Identical" ones do not.

10 A biologist surveyed islands of different sizes and consolidated the results in the form of the data given below. Study the data carefully and answer the questions that follow.

Name of Islands	Island Area (sq. km)	No. of mammalian species
P	1	5
Q	10	18
R	100	60
S	1000	150

10(i). What pattern do you observe in the data of islands (Area vs Mammalian species)?

Correct Answer: Species richness increases with increasing area

Solution:

Step 1: Understanding the Concept:

Species-Area relationship.

Step 2: Detailed Explanation:

As the area increases from 1 to 1000 km^2 , the number of species increases from 5 to 150. The pattern shows that as we explore a larger area, we find more species.

Step 3: Final Answer:

Direct correlation between Area and Species count.

💡 Quick Tip

This holds true up to a certain limit; after that, the curve levels off.

10(ii). Name the scientist who proposed the concept of relationship between area and species.

Correct Answer: Alexander von Humboldt

Solution:

Step 1: Understanding the Concept:

Pioneer of Biogeography.

Step 2: Detailed Explanation:

Alexander von Humboldt explored South American jungles and proposed this mathematical relationship.

Step 3: Final Answer:

Alexander von Humboldt.

💡 Quick Tip

He is also famous for Humboldt's Current in oceanography.

10(iii). Write the mathematical expression for this relationship.

Correct Answer: $S = CA^z$ (or $\log S = \log C + z \log A$)

Solution:

Step 1: Understanding the Concept:

The species-area relationship follows a power function.

Step 2: Detailed Explanation:

$$S = CA^z$$

Where S = Species richness, A = Area, Z = Slope of the line, C = Y-intercept.

Step 3: Final Answer:

$$S = CA^z.$$

 Quick Tip

On a log-log scale, this relationship is a straight line.

11(i). Draw a flowchart for sex determination in honeybees.

Correct Answer: Haplo-diploid system flowchart

Solution:

Step 1: Understanding the Concept:

Sex is determined by the number of sets of chromosomes.

Step 2: Detailed Explanation:

1. Female (Queen/Worker) = Diploid ($2n = 32$).
2. Male (Drone) = Haploid ($n = 16$).
3. Fertilized egg (32) → Female.
4. Unfertilized egg (16) → Male (Parthenogenesis).

Step 3: Final Answer:

Queen ($2n=32$) → Meiosis → Egg ($n=16$).

Egg + Sperm ($n=16$) → Female ($2n=32$).

Egg → Parthenogenesis → Male ($n=16$).

 Quick Tip

Males have no father and cannot have sons, but they have a grandfather.

11(ii). If there are 16 chromosomes in somatic cells of a male honeybee, how many in spermatozoa?

Correct Answer: 16

Solution:

Step 1: Understanding the Concept:

Males are haploid (n).

Step 2: Detailed Explanation:

Since they are already haploid, they produce gametes by **mitosis**, not meiosis. Mitosis maintains the chromosome count.

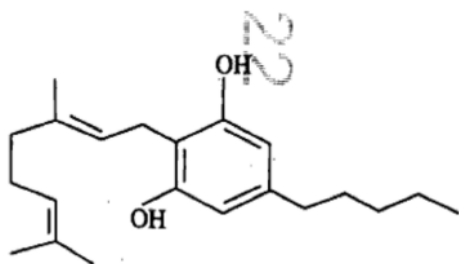
Step 3: Final Answer:

16 chromosomes.

💡 Quick Tip

Usually gametes are formed by meiosis, but in haploid organisms, mitosis is the tool.

12. Study the chemical structure of an addictive drug shown below and answer the questions that follow.



12(i). Mention the scientific name of the source plant of the addictive drug shown (Cannabinoid structure).

Correct Answer: *Cannabis sativa*

Solution:

Step 1: Understanding the Concept:

Identification of Cannabinoids.

Step 2: Detailed Explanation:

The structure shows a cannabinoid molecule, typically derived from the inflorescences of hemp.

Step 3: Final Answer:

Cannabis sativa.

 Quick Tip

Marijuana, Hashish, Charas, and Ganja are all obtained from different parts of this plant.

12(ii). State any one effect of this drug on human body.

Correct Answer: Effects on cardiovascular system

Solution:

Step 1: Understanding the Concept:

Cannabinoids interact with receptors in the brain.

Step 2: Detailed Explanation:

They primarily affect the heart rate and blood pressure.

Step 3: Final Answer:

Cardiovascular system impact.

 Quick Tip

Sportsmen are often checked for this drug because it can affect performance.

12(iii). What is meant by withdrawal symptom?

Correct Answer: Physical/psychological distress after stopping a substance

Solution:

Step 1: Understanding the Concept:

Dependency mechanism.

Step 2: Detailed Explanation:

If a regular dose of drugs is abruptly stopped, the body shows characteristic unpleasant symptoms like anxiety, sweating, and nausea.

Step 3: Final Answer:

Withdrawal syndrome.

 Quick Tip

This is why rehabilitation must be gradual and supervised.

13(i). Which embryo (X or Y) is likely to develop into a normal dicot embryo?

Correct Answer: Embryo Y

Solution:

Step 1: Understanding the Concept:

Normal dicot embryogeny starts with an unequal division.

Step 2: Detailed Explanation:

In dicots, the zygote divides into a large basal cell and a small apical cell. Equal division (X) is not standard.

Step 3: Final Answer:

Embryo Y.

 Quick Tip

Asymmetry is crucial for establishing the polarity of the plant body.

13(ii). What is the fate of: (a) Apical cell? (b) Basal cell?

Correct Answer: (a) Embryo proper; (b) Suspensor

Solution:

Step 1: Understanding the Concept:

Specific roles of the two initial cells.

Step 2: Detailed Explanation:

(a) The apical cell divides to form the embryo.

(b) The basal cell forms the suspensor to push the embryo into endosperm.

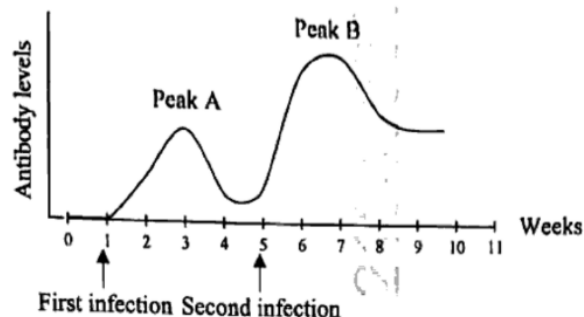
Step 3: Final Answer:

Embryo and Suspensor respectively.

💡 Quick Tip

The suspensor also helps in nutrient absorption.

14(i)(a). Identify response types for peaks A and B in antibody graph.



Correct Answer: A: Primary; B: Secondary (Anamnestic)

Solution:

Step 1: Understanding the Concept:

Primary vs Secondary response.

Step 2: Detailed Explanation:

Peak A is slow and weak (first encounter). Peak B is fast and strong (memory-based).

Step 3: Final Answer:

Primary and Secondary responses.

💡 Quick Tip

Vaccination relies on creating "memory" for a secondary response.

14(i)(b). Antibody type at highest level in 7th week?

Correct Answer: IgG

Solution:

Step 1: Understanding the Concept:

IgM is first; IgG is the main secondary response antibody.

Step 2: Detailed Explanation:

During a secondary response (Peak B), IgG levels skyrocket.

Step 3: Final Answer:
IgG.

💡 Quick Tip

IgG is the most abundant immunoglobulin in human serum.

OR

14(ii). Plasmodium is a digenetic parasite, completing its life cycle in humans and mosquitoes. In humans, it completes different parts of its life cycle in the liver and RBCs.

Draw a flow chart to outline its erythrocytic cycle in, humans.

Correct Answer: RBC cycle flowchart

Solution:

Step 1: Understanding the Concept:

Lifecycle in the blood.

Step 2: Detailed Explanation:

1. Merozoites infect RBC.
2. Multiplication in RBC.
3. RBC bursts (releasing Hemozoin).
4. Gametocytes form.

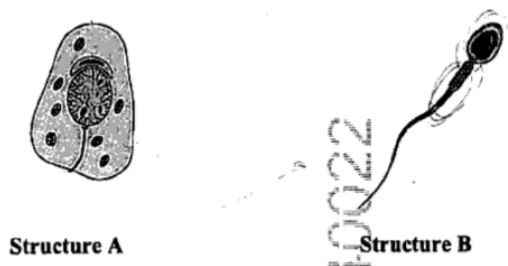
Step 3: Final Answer:

Merozoite → RBC infection → Trophozoite → RBC Rupture → Chills/Fever.

💡 Quick Tip

Hemozoin is the chemical responsible for the fever and chills.

15. The two structures shown below are formed in the process of spermatogenesis. Study them carefully and answer the questions that follow.



15(i). Identify process converting Structure A (Spermatid) to B (Spermatozoon).

Correct Answer: Spermiogenesis

Solution:

Step 1: Understanding the Concept:

Final maturation of sperm cells.

Step 2: Detailed Explanation:

Non-motile spermatids are transformed into motile, mature sperm.

Step 3: Final Answer:

Spermiogenesis.

💡 Quick Tip

Do not confuse with "Spermiation" which is the release of sperm from Sertoli cells.

15(ii). State two modifications in Structure B.

Correct Answer: Formation of tail and acrosome

Solution:

Step 1: Understanding the Concept:

Morphological changes.

Step 2: Detailed Explanation:

1. Development of a flagellar tail for motility.
2. Formation of a cap-like acrosome containing enzymes for fertilization.

Step 3: Final Answer:

Tail and Acrosome formation.

💡 Quick Tip

The middle piece contains mitochondria to power the tail!

Section D

16. As a part of his research, Arun conducted a study on the number of locusts in a forest. He compiled his findings in the form of the following data.

Day	Number of locusts
1	5
2	10
5	25
10	50
15	105
20	170
25	280
30	360
35	200

16(i). What type of growth curve is obtained for locusts based on the data?

Correct Answer: Sigmoid / Logistic Growth Curve

Solution:

Step 1: Understanding the Concept:

Populations grow rapidly and then stabilize.

Step 2: Detailed Explanation:

The population increases from 5 to 360 and then drops/stabilizes around 200, fitting the S-shaped model.

Step 3: Final Answer:

Logistic growth.

💡 Quick Tip

Carrying capacity (K) is the ceiling of the population size.

16(ii). Mathematical expression for Logistic Growth.

Correct Answer: $dN/dt = rN((K - N)/K)$

Solution:

Step 1: Understanding the Concept:

Verhulst-Pearl Equation.

Step 2: Detailed Explanation:

Rate depends on intrinsic growth rate and carrying capacity.

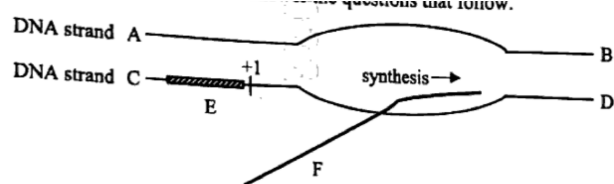
Step 3: Final Answer:

$dN/dt = rN(K - N/K)$.

💡 Quick Tip

If $N \neq K$, growth is positive; if $N = K$, growth is zero.

17 Study the diagram given below and answer the questions that follow.



17(i). Identify parts E and F in transcription diagram.

Correct Answer: E: Promoter; F: Primary transcript (hnRNA)

Solution:

Step 1: Understanding the Concept:

Transcription machinery.

Step 2: Detailed Explanation:

E is where RNA polymerase binds (+1 site). F is the newly made RNA strand.

Step 3: Final Answer:

Promoter and hnRNA.

💡 Quick Tip

Transcription always moves 5' to 3' on the RNA strand.

17(ii). Explain post-transcriptional modifications in part F.

Correct Answer: Splicing, Capping, Tailing

Solution:

Step 1: Understanding the Concept:

Processing of raw RNA.

Step 2: Detailed Explanation:

1. **Splicing:** Removing introns.
2. **Capping:** Adding Methyl-GTP at 5' end.
3. **Tailing:** Adding Poly-A tail at 3' end.

Step 3: Final Answer:

Splicing, Capping, and Tailing.

 Quick Tip

These modifications occur ONLY in eukaryotes.

18(i). Outline three major steps in artificial hybridisation.

Correct Answer: Emasculation, Bagging, and Re-bagging

Solution:

Step 1: Understanding the Concept:

Controlled plant breeding.

Step 2: Detailed Explanation:

1. Emasculation (removing anthers).
2. Bagging (preventing stray pollen).
3. Dusting desired pollen and re-bagging.

Step 3: Final Answer:

Emasculation, Bagging, and Pollination.

 Quick Tip

If flowers are unisexual, emasculation is not needed.

18(ii). Role of pollen-pistil interaction in hybrid formation.

Correct Answer: Recognition and promotion of compatible pollen

Solution:

Step 1: Understanding the Concept:

Pistil acts as a biological filter.

Step 2: Detailed Explanation:

The pistil recognizes right (compatible) vs wrong (incompatible) pollen through chemical signals. Only right pollen germinates.

Step 3: Final Answer:

Ensuring fertilization by compatible gametes.

💡 Quick Tip
This is a dynamic process of chemical "dialogue".

OR

18(iii). Draw a flowchart to represent the process of oogenesis.

Correct Answer: Flowchart of Oogenesis (see solution below)

Solution:

Step 1: Understanding the Concept:

Oogenesis is the process of formation of a mature female gamete (ovum). Unlike spermatogenesis, it begins during the embryonic development stage.

Step 2: Detailed Explanation:

1. **Fetal Life:** Oogonia ($2n$) multiply by mitosis. They enter Meiosis I and get arrested at the Prophase I stage, becoming **Primary Oocytes**.
2. **Puberty:** A primary oocyte completes its first meiotic division, which is unequal. This results in a large haploid **Secondary Oocyte** (n) and a tiny **First Polar Body** (n).
3. **Ovulation:** The secondary oocyte is released from the ovary. It starts Meiosis II but gets arrested at the Metaphase II stage.
4. **Fertilisation:** The entry of a sperm triggers the completion of Meiosis II. This is again an unequal division, resulting in a mature **Ovum** (n) and a **Second Polar Body** (n).

Step 3: Final Answer (Flowchart):

Oogonia ($2n$) $\xrightarrow{\text{Mitosis / Differentiation}}$ Primary Oocyte ($2n$)

↓ (Meiosis I starts in fetal life, arrested in Prophase I)

Primary Oocyte ($2n$) $\xrightarrow{\text{Meiosis I completed at Puberty}}$ Secondary Oocyte (n) + 1st Polar Body (n)

↓ (Meiosis II starts, arrested in Metaphase II)

Secondary Oocyte (n) $\xrightarrow{\text{Entry of Sperm / Fertilisation}}$ Ovum (n) + 2nd Polar Body (n)

💡 Quick Tip

Remember that the "arrest" points are crucial: Prophase I (from birth to puberty) and Metaphase II (until fertilization).

18(iv). Differentiate between oogenesis and spermatogenesis on the following basis:

- (a) Number of products
- (b) Gonadal hormones

Correct Answer: Comparison table (see solution below)

Solution:

Step 1: Understanding the Concept:

Spermatogenesis and Oogenesis are the two types of gametogenesis in humans, producing male and female gametes respectively. They differ significantly in their timing, output, and hormonal control.

Step 2: Detailed Explanation:

(a) Number of products:

- **Spermatogenesis:** One primary spermatocyte undergoes two meiotic divisions to produce **four** equal-sized functional haploid spermatozoa.
- **Oogenesis:** One primary oocyte undergoes two unequal meiotic divisions to produce only **one** functional haploid ovum and two or three non-functional polar bodies that eventually degenerate.

(b) Gonadal hormones:

- **Spermatogenesis:** It is primarily regulated by **androgens**, specifically **testosterone**, secreted by Leydig cells under the influence of LH (Luteinizing Hormone).
- **Oogenesis:** It is primarily regulated by **estrogens** and **progesterone** secreted by the follicles and the corpus luteum in the ovary.

Step 3: Final Answer:

The processes differ in output (4 vs 1) and primary regulatory hormones (Testosterone vs Estrogen/Progesterone).

 Quick Tip

Spermatogenesis is a continuous process starting at puberty, whereas oogenesis is a discontinuous process that starts before birth and ends at menopause.