Roll No. ☐☐☐☐☐☐☐☐

Q.P. Code 57/2/1

BIOLOGY (THEORY) – TERM II

CBSE Class XII Board Examination 2022 (Term 2) — with answers

Time allowed: 2 hours **Maximum Marks: 35**

General Instructions:

1. The paper has 13 questions and all of them must be answered.
2. It is divided into three sections: Section A (6 questions of 2 marks), Section B (6 questions of 3 marks) and Section C (one case-based question of 5 marks).
3. There is no overall choice, but some questions offer an internal choice; answer only one alternative in those.
4. Draw neat, properly labelled diagrams wherever needed.

SECTION A

Q1–6 carry 2 marks each.

1. Filariasis rarely kills, yet it causes a lot of suffering, deformity and disability in people. Name (scientifically) any two helminths that cause filariasis and give two long-term (chronic) effects of the disease. **2**

ANSWER

Wuchereria bancrofti and Wuchereria malayi; chronic inflammation of lymphatic vessels of the lower limbs (elephantiasis) and deformities of the genital organs.

Causative worms (½ + ½): Wuchereria bancrofti and Wuchereria malayi – filarial worms transmitted by the bite of the female Culex mosquito.
Chronic manifestations (½ + ½), any two:
• Slowly developing chronic inflammation of the organs in which the worms live for many years.
• Inflammation and blockage of lymphatic vessels of the lower limbs, causing gross swelling – elephantiasis.
• Deformities (swelling) of the genital organs.
Tip: write the genus with a capital letter and species in small letters, and underline both when handwritten.

2. Justify with two reasons the statement that humans digest curd more easily than milk. **2**

ANSWER

LAB in curd make acid that coagulates milk and they partly digest the milk proteins, so curd is pre-digested.

Curd is made when Lactobacillus and other lactic acid bacteria (LAB) grow in milk.
1. LAB convert lactose to lactic acid; the acid coagulates the milk proteins (casein), giving a soft curd that is easier to break down. (1)
2. LAB partially digest the milk proteins, so part of the digestion has already happened before we eat it. (1)
Extra point: LAB also add vitamin B_{12} and check harmful microbes in the stomach, but the two reasons above are the ones that earn marks.

3. An AIDS patient usually dies of opportunistic infections – infections a healthy person would easily have overcome. **2**

(i) Give one reason why an HIV patient falls prey to such infections.

(ii) Name (scientifically) one bacterium and one parasite that commonly attack AIDS patients.

(iii) Expand the name of the most widely used diagnostic test for AIDS.

ANSWER

(i) HIV destroys helper T-lymphocytes, so immunity collapses; (ii) Mycobacterium (bacterium), Toxoplasma (parasite); (iii) ELISA – Enzyme Linked Immuno-Sorbent Assay.

(i) HIV multiplies inside helper T-lymphocytes (TH cells) and destroys them. As their number falls steadily, the person's immunity becomes very weak, so even ordinary microbes cause disease. (½)
(ii) Bacterium: Mycobacterium (e.g. M. tuberculosis) (½); parasite: Toxoplasma (½). Other opportunistic pathogens include fungi and viruses.
(iii) ELISA = Enzyme Linked Immuno-Sorbent Assay. (½)
Common mistake: writing 'Immuno-Absorbent'; the correct word is Immuno-Sorbent.

OR

Cigarette packets carry a statutory health warning, yet smoking is still common. List four major health hazards faced by a smoker.

ANSWER

Any four: more CO in blood and less oxygen carried by haem, cancers (lung, throat, urinary bladder), bronchitis, emphysema, coronary heart disease, gastric ulcer, high blood pressure, raised heart rate.

Tobacco smoke contains nicotine, carbon monoxide and many carcinogens. Hazards (½ each, any four):
1. CO binds haemoglobin, raising blood CO and lowering haem-bound oxygen – oxygen deficiency in the body.
2. Higher incidence of cancers of the lung, throat, oral cavity and urinary bladder.
3. Bronchitis and emphysema (damage to alveoli, reduced gas exchange).
4. Coronary heart disease.
5. Nicotine stimulates adrenaline release – raised blood pressure and increased heart rate.
6. Gastric ulcer.

4. Two biogas plants are shown. Both have a slurry inlet tank, a digester, a gas holder with a gas pipe and a sludge outlet. Plant A is fed with a slurry of (cattle) dung, while plant B is fed with a slurry of human excreta. Which plant would be used for producing gas fuel and electricity, and why? Give reasons. **2**

ANSWER

Plant A (dung) – cow dung contains methanogens that produce large amounts of methane.

Answer: Biogas plant A. (1)
Reasons:
• Cattle dung (gobar) is rich in methanogenic bacteria such as Methanobacterium, which are present in the rumen of cattle. (½)
• Growing anaerobically on the cellulose-rich dung, these bacteria release large amounts of methane along with CO_2 and H_2; methane is the combustible gas used for cooking, lighting and generating electricity. (½)
Tip: always name the microbe (methanogen / Methanobacterium) and the gas (methane).

5. Describe the two physiological features that allow a kangaroo rat to live in desert conditions. **2**

ANSWER

It meets its water needs by internal oxidation of fat (metabolic water), and it saves water by producing very concentrated urine.

1. Metabolic water: the kangaroo rat of North American deserts can manage without drinking; it gets water from the internal oxidation of fats, since water is a by-product of this breakdown. (1 mark)
2. Water conservation: its kidneys concentrate the urine, so only a very small volume of water is used to remove excretory wastes. (1 mark)

6. Two graphs show how solar radiation on Earth changes over the year (January to December). In graph (X) the radiation rises steeply from a low value to a sharp peak in mid-year and falls steeply again, staying above a dashed reference level only for a few months. In graph (Y) the curve stays high and almost flat all year, always above the dashed level. **2**

(i) Which graph represents (I) a tropical region and (II) a temperate region?

(ii) Which region, X or Y, will have greater biological diversity? Give two reasons.

ANSWER

(i) (I) tropical = Y, (II) temperate = X; (ii) Y – less seasonal, constant/predictable environment and more solar energy available.

(i) Tropical regions receive high, nearly uniform sunlight all year → graph Y. Temperate regions have strong seasonal variation → graph X. (½)

(ii) Region Y (tropics) shows higher biodiversity (½), because:

• The tropics have remained relatively undisturbed for millions of years and their climate is less seasonal, relatively constant and predictable – this favours niche specialisation and more species. (½)

• More solar energy is available, giving higher productivity, which in turn supports greater diversity. (½)

This is the latitudinal gradient of diversity: species richness decreases from the equator towards the poles.

OR

(i) When prickly pear cactus was brought into Australia in the early 1920s, it spread over millions of hectares of rangeland, reaching very high densities and disturbing the ecosystem. Why did it spread so fast?

(ii) State the importance of the prey–predator relationship in a habitat.

ANSWER

(i) Its natural predators (herbivores) were absent in Australia; (ii) predators transfer energy across trophic levels, keep prey numbers in check and maintain species diversity by reducing competition among prey.

(i) In a new land an exotic species is free from the natural enemies that controlled it at home. Prickly pear had no natural predator (herbivore) in Australia, so its population grew unchecked. It was finally controlled only when a cactus-feeding moth from its native range was introduced. (1)

(ii) Importance (any two, ½ each):

• Predators act as conduits for energy transfer from one trophic level to the next.

• They keep prey populations under control, preventing over-population and ecosystem instability.

• By reducing competition among prey species, predators help maintain species diversity in a community.

• Predators are 'prudent' – over-exploiting prey would make the prey and then the predator itself extinct.

SECTION B

Q7–12 carry 3 marks each.

7. After several rounds of asexual multiplication in the human body (which cause malaria), Plasmodium enters its sexual phase. Describe the sexual stages of the parasite, starting from when a female Anopheles mosquito bites an infected person, up to the formation of the mature infective stage. **3**

ANSWER

Gametocytes form in RBCs → taken up by female Anopheles with blood → fertilisation and development in mosquito gut → sporozoites formed → migrate to salivary glands → injected into a new human during the bite.

Six points (½ each):

1. Inside the human RBCs, some parasites develop into sexual stages – gametocytes.
2. A female Anopheles mosquito sucks blood of the infected person and takes up these gametocytes.
3. In the mosquito's gut the gametocytes form gametes, and fertilisation takes place.
4. The zygote develops further in the gut wall, producing the mature infective stages – sporozoites.
5. Sporozoites escape from the gut and migrate to the mosquito's salivary glands.
6. When this mosquito bites another human, sporozoites are injected along with saliva, starting a new infection (first in the liver, then RBCs).

Note: the mosquito is the definitive host (sexual phase); humans are the intermediate host.

8. (a) Name the kind of immunity that protects the developing foetus in the womb against many infections like a 'biological shield', and say what it means. **3**

(b) Many infants stay free of serious infections for at least three months after birth, and longer if they are breast-fed. Explain why.

ANSWER

(a) Passive immunity – ready-made antibodies (IgG) pass from mother through the placenta; (b) colostrum/breast milk supplies abundant IgA antibodies.

(a) Passive immunity (½). In passive immunity, ready-made antibodies are given directly to the body instead of being produced by it (½); here maternal antibodies (IgG) cross the placenta into the foetus.

(b) • The yellowish fluid colostrum secreted by the mother in the first few days of lactation (and breast milk later) (1)

• contains abundant IgA antibodies that protect the infant's gut and body from infections (1).

Antibodies received earlier through the placenta also persist for some months.

This is natural passive immunity; it is short-lived because no memory cells are formed.

9. Modern genetic engineering lets us purify and isolate DNA easily. Name and explain the technique and steps used to separate and isolate the DNA fragments produced after cutting with restriction endonucleases. **3**

ANSWER

Agarose gel electrophoresis: fragments move to the anode and separate by size → stained with ethidium bromide → seen as orange bands under UV → bands cut out and DNA eluted.

Technique: Gel electrophoresis (½).

Steps (½ each):

1. DNA fragments are negatively charged, so in an electric field they move towards the anode (+).
2. They are made to move through a matrix of agarose gel (from seaweed), which acts like a sieve.
3. Fragments separate by size – smaller fragments move farther than larger ones.
4. The separated fragments are stained with ethidium bromide.
5. On exposure to UV light they appear as bright orange bands.
6. The required bands are cut out of the gel and the DNA is extracted from the gel piece – elution; it is then used for constructing recombinant DNA.

Common mistake: saying DNA moves to the cathode – it moves to the anode because of its phosphate groups.

10. "Some species in an ecosystem have a much greater influence on its major services than others." How did Paul Ehrlich explain this idea through his 'rivet popper hypothesis'? **3**

ANSWER

Ecosystem = aeroplane, species = rivets; losing a few rivets is not noticed at first, but losing many weakens the plane, and losing rivets on the wings (key species) is far more dangerous.

Points of the analogy:

1. Ehrlich compared an ecosystem to an aeroplane and the species in it to the thousands of rivets that hold its parts together.
2. If passengers each pull out a rivet and take it home (a species goes extinct), flight safety (ecosystem function) may not be affected at first.
3. As more and more rivets are removed, the plane gradually becomes dangerously weak.
4. The position of the rivet matters: losing rivets from the wings is a much greater threat than losing a few seats or windows.
5. Wing rivets stand for key species that drive major ecosystem functions.
6. Conclusion: loss of species weakens ecosystems over time, and loss of key species can lead to collapse – so all species, especially key ones, must be conserved.

OR

(i) What damage did the introduction of the Nile perch into Lake Victoria (East Africa) cause to the native species of the lake?

(ii) Name two invasive weeds that threaten the native species of India.

ANSWER

(i) More than 200 species of native cichlid fish became extinct; (ii) any two of Parthenium (carrot grass), Lantana, Eichhornia (water hyacinth).

(i) The Nile perch, a large predatory fish, was introduced into Lake Victoria. It preyed on the native fish and wiped out an ecologically unique assemblage of more than 200 species of cichlid fish. (1)
(ii) Alien weeds (1 + 1): Parthenium hysterophorus (carrot grass), Lantana camara, and Eichhornia crassipes (water hyacinth). They spread rapidly, out-compete native plants and harm the environment. This is an example of alien species invasion, one of the 'Evil Quartet' causes of biodiversity loss.

11. A picture shows a large, dense natural habitat that, over time and because of human activities, is being broken up by gaps into smaller and smaller isolated patches – a process that keeps increasing and is said to put the species living there at great risk. **3**

(a) Do you agree? Give two reasons.

(b) What is the ecological term for such patches formed within an original habitat?

ANSWER

(a) Yes – habitat fragmentation degrades habitat; animals needing large territories (mammals, birds, migratory birds) are badly affected and their populations decline; (b) fragments (habitat fragmentation).

(a) Yes, I agree. (1)

Reasons (½ + ½):

• Breaking a large habitat into small fragments degrades it and reduces the area and resources available to each population.

• Mammals and birds that need large territories, and animals with migratory habits, are badly affected; their populations decline and may become extinct.

(Other valid points: isolated small populations lose genetic diversity; more edge effects.)

(b) The patches are called fragments; the process is habitat fragmentation. (1)

Habitat loss and fragmentation is the most important cause of biodiversity loss.

12. Biotechnology is used in agriculture to make pest-resistant plants with 'cry' genes taken from a bacterium. Name this bacterium and explain why the cry gene product kills the insect pest but does not harm the bacterium itself. **3**

ANSWER

Bacillus thuringiensis; the Bt toxin is stored as an inactive protoxin crystal in the bacterium and becomes active only in the alkaline pH of the insect gut.

Bacterium: Bacillus thuringiensis (Bt). (1)

Why the bacterium is safe: the cry genes code for Bt toxin, which the bacterium makes as protein crystals in an inactive form – protoxin – so it cannot harm the bacterium. (1)

Why the insect dies:

• When the insect eats the toxin, the alkaline pH of its gut solubilises the crystals and converts the protoxin into the active toxin. (½)

• The active toxin binds to the surface of midgut epithelial cells and creates pores, causing the cells to swell and burst (lysis), so the insect dies. (½)

Example: cryIAc and cryIIAb control cotton bollworms; cryIAb controls corn borer.

SECTION C

Q13 is a case-based question of 5 marks.

13. rDNA technology lets scientists isolate, sequence and manipulate single genes, bringing breakthroughs in medicine and agriculture. A flow diagram shows the basic steps of genetically modifying an organism: (1) a restriction enzyme cuts out the gene of interest; (2) a restriction enzyme cuts a plasmid vector; step (X) joins the two to give (3) rDNA (recombinant vector); (4) the rDNA is put into E. coli; step (Y) shows many E. coli cells, each carrying many copies of the plasmid. **5**

(i) Are two different restriction endonucleases used – one for the vector and another for the DNA to be cloned? Give a reason.

(ii) Which enzyme is used at step (X) to join the foreign DNA to the vector?

(iii) What is step (Y), in which many copies of the foreign DNA are made in transformed E. coli, called?

(iv) Draw a diagram of the E. coli cloning vector pBR322 showing: (I) one restriction site in the tetracycline-resistance gene, (II) one restriction site in the ampicillin-resistance gene, (III) the ori.

(v) What does 'rop' code for in pBR322?

ANSWER

(i) No – the same enzyme is used so both get matching sticky ends; (ii) DNA ligase; (iii) cloning (gene cloning); (iv) pBR322 ring with BamH I/Sal I in tet^R, Pst I/Pvu I in amp^R, and ori; (v) proteins involved in replication of the plasmid.

(i) No (½). The vector and the source DNA are cut with the same restriction endonuclease so that both carry complementary (identical) sticky ends, which can pair and be joined end to end (½).

(ii) DNA ligase – seals the sugar–phosphate backbone between the insert and the vector. (1)

(iii) Cloning (gene cloning) – the recombinant plasmid replicates in the host so many identical copies of the foreign DNA are made. (1)

(iv) Diagram – a circular double-stranded plasmid labelled pBR322 showing:

- tet^R gene with a restriction site in it – BamH I (or Sal I);
- amp^R gene with a restriction site in it – Pst I (or Pvu I);
- ori (origin of replication).

Other labels that may be added: rop, EcoR I, Hind III, Cla I, Pvu II. (any two correct labels ½ + ½)

(v) rop codes for the proteins that take part in replication of the plasmid (it controls copy number). (1)

OR

RNA interference (RNAi) is promising both as a medicine and for pest control. In a 2006 experiment, Tracy Zimmerman and co-workers used RNAi to lower the 'ApoB' level in Cynomolgus monkeys; some people have mutations giving high ApoB, which raises lipoproteins and blood cholesterol and predisposes them to coronary artery disease. One group got siRNA at 1 mg/kg (Y), a second at 2.5 mg/kg (Z) and a third was injected with saline as control (X). A bar graph of relative serum cholesterol (% per dose) at 24, 48, 144 and 264 hours shows: saline X ≈ 90, 96, 109, 112; 1 mg/kg Y ≈ 80, 74, 90, 94; 2.5 mg/kg Z ≈ 65, 55, 46, 37.

(i) What do you conclude from bars X and Z at 264 hours?

(ii) In which category of organisms does RNAi occur naturally, and why?
(iii) What is the basic principle by which RNAi silences a chosen gene?

ANSWER

(i) X (saline): cholesterol rose (~112%); Z (2.5 mg/kg siRNA): cholesterol fell (~37%) – RNAi against ApoB lowers cholesterol, more at the higher dose; (ii) all eukaryotes, as a cellular defence; (iii) a complementary dsRNA binds the specific mRNA and stops its translation (silencing).

(i) Interpretation (1 + 1):
• Bar X (saline control): cholesterol keeps rising and is highest (~112%) at 264 h – no treatment effect.
• Bar Z (2.5 mg/kg siRNA): cholesterol falls steadily to the lowest value (~37%) at 264 h. So siRNA against ApoB silences the gene, lowers ApoB and therefore blood cholesterol, and the effect is dose-dependent and long-lasting.
(ii) RNAi takes place in all eukaryotic organisms (1) as a method of cellular defence (1) – e.g. against viruses with RNA genomes and mobile genetic elements (transposons) that pass through an RNA stage.
(iii) Principle (1): a double-stranded RNA complementary to the target mRNA binds to that mRNA and prevents its translation (the mRNA is degraded), so the gene is 'silenced'.
Same principle is used to make nematode-resistant tobacco (against Meloidogyne incognita).

— END —

Questions restated from the CBSE Class XII Board Examination 2022 (set 57/2/1) for practice. Reading passages and map items are described, not reproduced.