CBSE EXAMINATION PAPER-2023

BIOLOGY

(Solved)

Time allowed : 3 hours | Maximum Marks : 75

General Instructions :

Read the following instructions carefully and follow them :

i. This question paper contains **31 questions.** All questions are **compulsory.**

ii. This question paper is divided into **5 sections.**

iii. **Section A** – questions number **1 to 2** are case based questions

iv. **Section B** – questions number **3 to 11** are multiple choice questions

v. **Section C** – questions number **12 to 17** are very short answer

vi. **Section D** – questions number **18 to 25** are short answer

vii. **Section E** – questions number **26 to 31** are long answer

viii. There is no overall choice given in the question paper. However, an internal choice has been provided in few questions.

ix. Use of calculator is NOT allowed.

Section A

Question 1.

Question 2.

When a microorganism invades a host, a definite sequence of events usually occur leading to infection and disease, causing suffering to the host. This process is called pathogenesis. Once a microorganism overcomes the defense system of the host, development of the disease follows a certain sequence of events as shown in the graph.

Study the graph given below for the sequence of events leading to appearance of a disease and answer the questions that follow:

(1)

In which period, the number of immune cells forming antibodies will be the highest in a person suffering from pneumonia? Name the immune cells that produce antibodies

[1 Marks]

Answer: The number of immune cells forming antibodies will be highest during the secondary response period after the initial exposure to pneumonia pathogens. The immune cells responsible for producing antibodies are called B cells.

Key Points: Secondary response; B cells

(2)

In which period, according to the graph there are maximum chances of a person transmitting a disease/infection and why

[1 Marks]

Answer: According to the graph, the maximum chances of a person transmitting a disease occur during the period when symptoms are most apparent and viral load is at its peak. This is because, in this phase, the infected individual exhibits noticeable symptoms and is likely to engage in activities that facilitate the spread of the pathogen, such as coughing, sneezing, or direct contact with others.

Key Points: maximum transmission during peak symptoms-viral load highest-symptoms increase contact with others

(3)

Study the graph and write what is an incubation period. Name a sexually transmitted disease that can be easily transmitted during this period. Name the specific type of lymphocytes that are attacked by the pathogen of this disease.

[1 Marks]

Answer: The incubation period is the time interval between the entry of the pathogen into the host and the onset of symptoms. An example of a sexually transmitted disease that can be easily transmitted during this period is HIV. The specific type of lymphocytes attacked by the HIV pathogen are CD4+ T cells.

Key Points: incubation period- HIV- CD4+ T lymphocytes

(4)

Draw a schematic labelled diagram of an antibody.

[2 Marks]

Answer: The schematic diagram of an antibody consists of four polypeptide chains, two heavy chains and two light chains. The structure has a Y shape with a variable region at the tips of the Y, which is responsible for binding to specific antigens. The stem of the Y is known as the constant region, which determines the class of the antibody and interacts with immune cells. Label the diagram with 'Heavy Chain', 'Light Chain', 'Variable Region', and 'Constant Region'.

Key Points: Y-shaped structure-heavy and light chains-variable region-constant region

Section B

Question 3.

At which stage during evolution did human use hides to protect their bodies and buried their dead?

[1 Marks]

(A) Homo habilis

(B) Neanderthal man

(C) Java man

(D) Homo erectus

Explanation: The correct answer is Neanderthal man, as they are known to have used animal hides for clothing and practiced burial rituals for their dead, indicating a level of social and cultural development.

Question 4.

The decrease in the T-lymphocytes count in human blood will result in:

[1 Marks]

(A) Decrease in antigens

(B) Decrease in antibodies

(C) Increase in antibodies

(D) Increase in antigens

Explanation: The correct answer is 'Decrease in antibodies.' T-lymphocytes, or T-cells, play a crucial role in the immune response by helping to produce antibodies that fight off infections. If the count of T-lymphocytes decreases, the body's ability to produce antibodies is compromised, leading to a decrease in their levels.

Question 5.

Given below is a sequence of bases in mRNA of a bacterial cell. Identify the amino acid that would be incorporated at codon position 3 and codon position 5 during the process of its translation.

3' AUCAGGUUUGUGAUGGUACGA 5'

[1 Marks]

(A) Serine, Valine

(B) Alanine, Proline

(C) Cysteine, Glycine

(D) Phenylalanine, Methionine

Explanation:

To determine the amino acids at codon positions 3 and 5, we first need to convert the mRNA sequence to codons. The given sequence is interpreted from the 5' to 3' direction: 5' UACGUUUGUCA 3'. The third codon (UUG) corresponds to Leucine, and the fifth codon (UGU) corresponds to Cysteine. The correct combination is therefore Cysteine, Glycine.

Question 6.

A Tight one-to-one relationship between many species of fig tree and certain wasps is an example of -

[1 Marks]

(A) Commensalism

(B) Parasitism

(C) Mutualism

(D) Amensalism

Explanation: The correct answer is Mutualism. In this relationship, both the fig trees and the wasps benefit from each other. The fig trees provide a habitat and food for the wasps, while the wasps help in the pollination of the fig trees, which is crucial for their reproduction.

Question 7.

Select the pathogen mismatched with the symptoms of disease caused by it from the list given below:

[1 Marks]

(A) Wuchererids bancrofti: Chronic inflammation of lymphatic vessels of lower limb.

(B) Haemophilus influenzae : Blockage of the intestinal passage.

(C) Epidermophyton: Dry scaly lesions on nail.

(D) Entamoeba histolytica: Constipation, abdominal pain.

Explanation: Haemophilus influenzae is a bacterial pathogen known to cause respiratory tract infections, meningitis, and ear infections, but it is not associated with blockage of the intestinal passage. Blocking of the intestinal passage is not a known symptom caused by Haemophilus influenzae. Other options correctly match the pathogens with their disease symptoms: Entamoeba histolytica causes amoebiasis with constipation and abdominal pain, Epidermophyton causes dry scaly lesions on nails (a fungal infection), and Wuchereria bancrofti causes chronic inflammation of lymphatic vessels leading to elephantiasis.

Question 8.

Given below are the list of the commercially important products and their source organisms. Select the option that gives the correct matches.

[1 Marks]

(A) (A)-(i), (B)-(ii), (C)-(iii), (D)-(iv)

(B) (A)-(iii), (B)-(iv), (C)-(ii), (D)-(i)

(C) (A)-(iv), (B)-(iii), (C)-(ii), (D)-(i)

(D) (A)-(ii), (B)-(iv), (C)-(i), (D)-(iii)

Explanation: The correct matches refer to correctly identifying the commercially important products alongside their source organisms. Options should be evaluated accordingly based on accurate knowledge of common products and their origins.

Question 9.

Important attributes belonging to a population but not to an individual are:

(i) Birth rate and death rate

(ii)Male and female

(iii)Birth and death

(iv)Sex-ratio

Select the correct option from the given options:

[1 Marks]

(A) (i) only

(B) (ii) only

(C) (ii) and (iii)

(D) (i) and (iv)

Explanation: The correct option is (i) and (iv). Birth rate and death rate (i) are demographic measures that apply to populations, not individuals, while sex-ratio (iv) is also a population attribute that reflects the proportion of males to females in a population. Male and female (ii) and birth and death (iii) are characteristics of individuals.

Question 10.

Assertion (A): Synthetic oligonucleotide polymers are used during Annealing in a PCR.

Reason (R): The primers bind to the double stranded DNA at their complementary regions.

[1 Marks]

(A) Both (A) and (R) are true and (R) is the correct explanation of (A).

(B) (A) is true, but (R) is false.

(C) (A) is false, but (R) is true.

(D) Both (A) and (R) are true, but (R) is not the correct explanation of (A).

Explanation: Both (A) and (R) are true and (R) is the correct explanation of (A). Synthetic oligonucleotide polymers, which are the primers, are essential during the annealing step of PCR as they bind to the complementary regions of the double-stranded DNA, helping to initiate the replication process.

Question 11.

Assertion (A): In Thalassemia an abnormal myoglobin chain is synthesized due to a gene defect.

Reason (R): a-Thalassemia is controlled by genes HBA1 and HBA2 on chromosome 16.

[1 Marks]

(A) (A) is false, but (R) is true.

(B) Both (A) and (R) are true, but (R) is not the correct explanation of (A).

(C) (A) is true, but (R) is false.

(D) Both (A) and (R) are true and (R) is the correct explanation of (A).

Explanation: (A) is false because Thalassemia refers to an abnormal production of hemoglobin chains rather than myoglobin. (R) is true as it correctly states that a-Thalassemia is controlled by genes HBA1 and HBA2 on chromosome 16.

Section C

Question 12.

The graph given below shows the number of primordial follicles per ovary in women at different ages. Study the graph and answer the questions that follow.

(a) What is the average age of the women at the onset of menopause?

(b) At what age are maximum primordial follicles present in the ovary, according to the given graph?

[2 Marks]

Answer: The average age of women at the onset of menopause is approximately 51 years. This is the age when hormonal changes lead to the cessation of menstruation. According to the graph, the maximum number of primordial follicles per ovary is typically present around the age of 20 years. At this age, women's ovaries contain the highest reserve of these follicles, which gradually decline as they age.

Question 13.

"Cattle and goats do not browse the Calotropis plant." Justify the statement giving reasons.

[2 Marks]

Answer: Cattle and goats generally avoid browsing Calotropis plants due to their high toxicity. The plant contains toxic compounds called cardenolides, which can be harmful to these animals if ingested. Additionally, the bitter taste of Calotropis makes it unappealing to livestock. This is an evolutionary adaptation since consuming such toxic plants can cause significant health problems or even death in these animals.

Question 14.

By using Punnert square depict the genotypes and phenotypes of test crosses (where green pod colour (G) is dominant over yellow pod colour (g)) in Garden pea with unknown genotype.

[2 Marks]

Answer: To perform a test cross for pod color in garden peas, we assume an unknown genotype, which could be homozygous dominant (GG) or heterozygous (Gg). Using a Punnett square with a known homozygous recessive genotype (gg), we have: For GG x gg: all offspring will be green (100% Gg). For Gg x gg: offspring will be 50% green (Gg) and 50% yellow (gg). This illustrates potential outcomes.

Question 15.

(i) Give an example of a genus of virus used as narrow spectrum insecticidal biocontrol agent.

(ii) How does its use serve as an aid in overall integrated pest management programme?

[2 Marks]

Answer: One example of a genus of virus used as a narrow spectrum insecticidal biocontrol agent is the 'Baculovirus'. Baculoviruses specifically target certain insect hosts, making them effective in controlling pest populations without harming non-target organisms. Their use in pest management supports integrated pest management (IPM) by reducing reliance on chemical pesticides, thus minimizing environmental impact and preserving beneficial insect populations. Moreover, they can be incorporated into a wider pest control strategy along with biological and cultural practices.

Question 16.

Why a malignant tumour considered to be more damaging than a benign tumour? Explain.

[2 Marks]

Answer: A malignant tumour is considered more damaging than a benign tumour because it can invade and destroy surrounding tissues, leading to serious health complications. Unlike benign tumours, which grow slowly and do not spread, malignant tumours can metastasize to other parts of the body, forming secondary tumours. This aggressive nature of malignant tumours poses significant risks to overall health and can adversely affect vital organs, making treatment more complex and necessary.

Question 17.

(a) Write the scientific name of the source organism of the themostable DNA polymerase used in PCR.

(b) State the advantage of using Thermostable DNA polymerase.

[2 Marks]

Answer: The scientific name of the source organism of the thermostable DNA polymerase used in PCR is Thermus aquaticus. The advantage of using thermostable DNA polymerase is that it remains active at high temperatures, which is essential for the denaturation step in PCR. This stability allows for repeated cycles of heating and cooling without degrading the enzyme, ensuring efficient DNA amplification.

Section D

Question 18.

Name and explain a surgical contraceptive method that can be adopted by the male partner of a couple.

[3 Marks]

Answer: One effective surgical contraceptive method for males is a vasectomy. This procedure involves cutting and sealing the vas deferens, the tubes that carry sperm from the testicles to the urethra. During a vasectomy, local anesthesia is usually employed, and the operation can be performed in a clinic. After the procedure, sperm can't mix with semen during ejaculation, which effectively prevents pregnancy. Vasectomy is considered a permanent method of contraception, although reversals are sometimes possible. Men are advised to consider this option seriously, as it can lead to lifelong infertility if not reversed. Post-operative care includes avoiding heavy lifting and sexual activity for a short period to allow proper healing. Overall, a vasectomy is a safe, effective, and relatively simple procedure for permanent contraception.

Question 19.

Human Genome Project (HGP) was a mega project launched in the year 1990 with some important goals.

(a) Enlist any four prime goals of HGP.

(b) Name any one common non-human animal model organism which has also been sequenced thereafter.

[3 Marks]

Answer: The Human Genome Project (HGP) aimed to achieve several important goals. Firstly, it sought to identify and map all the genes in the human genome. Secondly, it aimed to determine the sequences of the three billion chemical base pairs that make up human DNA. Thirdly, it endeavored to create databases for storing and analyzing genomic information. Lastly, it aimed to address ethical, legal, and social issues related to genetic research. A common non-human model organism that has been sequenced is the fruit fly (Drosophila melanogaster).

Question 20.

Industrial melanism in England after 1850 is an excellent example of Natural selection. Explain how?

[3 Marks]

Answer: Industrial melanism refers to the phenomenon where darker-colored individuals of a species become more common due to environmental changes and selective pressures. In England, during the Industrial Revolution, soot and pollution from factories

darkened tree bark in urban areas. The peppered moth, which was typically light-colored, became more visible to predators on these darkened backgrounds. Consequently, darker variants of the moths, known as melanistic forms, had a survival advantage as they were less likely to be eaten by birds. This shift in survival rates led to an increase in the population of the dark moths, demonstrating natural selection in action. The reverse occurred after pollution control measures were implemented, leading to a rise in light-colored moths as they became better camouflaged, showing how environmental changes can drive evolutionary adaptations.

Question 21.

One of the major approaches of crop improvement programme is Artificial Hybridisation. Explain the steps involved in making sure that only the desired pollen grain pollinate the stigma of a bisexual flower by a plant

[3 Marks]

Answer: Artificial hybridization in plants involves several steps to ensure that only the desired pollen grains fertilize the stigma. Firstly, the plant breeder selects the parent plants with desirable traits. Next, the bisexual flower from the female parent is emasculated, which involves removing the anthers to prevent self-pollination. The next step is the collection of pollen grains from the male parent. Once collected, the desired pollen is carefully introduced to the stigma of the emasculated flower using a fine brush or tool. Finally, the flower is often covered or bagged to prevent contamination from unwanted pollen, ensuring that only the intended cross-pollination occurs. These steps emphasize precision in controlled pollination to achieve the desired genetic traits in crop improvement.

Question 22.

"Plasmodium protozoan needs both a mosquito and a human host for its continuity." Explain.

[3 Marks]

Answer: Plasmodium is a genus of protozoan parasites that cause malaria in humans. It has a complex life cycle that requires two hosts: the female Anopheles mosquito and humans. In the mosquito, Plasmodium undergoes sexual reproduction, producing sporozoites that are transferred to humans during a blood meal. Once inside the human host, the sporozoites travel to the liver, where they reproduce asexually, leading to the release of merozoites into the bloodstream. These merozoites infect red blood cells, further multiplying and causing the symptoms of malaria. The cycle continues when a mosquito bites an infected human, ingesting the parasites, thus allowing for the transmission and continuation of the Plasmodium life cycle. This dependence on both hosts ensures the persistence of the malaria pathogen in the environment.

Question 23.

We all must work towards maintaining good health because 'health is wealth'. Enlist any six ways of achieving good health.

[3 Marks]

Answer: Maintaining good health is essential for leading a fulfilling life. Here are six effective ways to achieve good health: First, a balanced diet rich in fruits, vegetables, whole grains, and proteins provides essential nutrients and energy. Second, regular physical activity, such as at least 30 minutes of exercise most days, helps maintain a healthy weight and strengthens the heart. Third, staying hydrated by drinking adequate water is vital for bodily functions. Fourth, ensuring enough sleep enhances overall health and cognitive function. Fifth, managing stress through techniques like meditation or yoga promotes mental well-being. Finally, avoiding harmful habits like smoking and excessive alcohol consumption significantly reduces health risks. By incorporating these practices into daily life, individuals can work towards achieving and maintaining good health.

Question 24.

On spraying Bacillus thuringiensis on an infected cotton crop field the pests are killed by the toxin, however the toxin although produced by the bacteria does not affect it. Explain giving reason.

[3 Marks]

Answer: Bacillus thuringiensis (Bt) produces a crystal protein toxin, known as Bt toxin, which is lethal to certain insects. When these bacteria are sprayed on infected cotton crops, the toxin is ingested by the target pests, such as caterpillars. In the insects' digestive systems, the toxin is activated and binds to specific receptors in their gut cells, leading to their death. However, Bt has evolved specific receptors in its own cells that do not bind to the toxin, thus rendering it immune. This specificity allows Bt to effectively control pest populations without harming itself or beneficial organisms, making it an eco-friendly option for pest management.

Question 25.

"Biodiversity plays a major role in many ecosystem services that nature provides."

(a) Describe any two broadly utilatarian arguments to justify the given statement.

(b) State one ethical reason of conserving biodiversity.

[3 Marks]

Answer: Biodiversity contributes significantly to ecosystem services, providing numerous utilitarian benefits. Firstly, it supports food security; diverse species improve crop yields and resilience to pests and diseases, ensuring sustainable food production. Secondly,

biodiversity promotes ecological balance and stability; a variety of organisms contributes to nutrient cycling, soil fertility, and pest control, which are vital for ecosystem health. Additionally, conserving biodiversity is morally justified; all species have intrinsic value and the right to exist, which supports ethical stewardship of our planet's resources.

Section E

Question 26.

(i)Explain the monosporic development of embryo sac in the ovule of an angiosperm.

(ii) Draw a diagram of the mature embryo sac of an angiospermic ovule and label any four parts in it.

[5 Marks]

Answer: The monosporic development of the embryo sac in angiosperms typically involves the formation of a single megaspore from the megasporangium (nucellus) following meiosis. This haploid megaspore undergoes three mitotic divisions to produce an eight-nucleate stage, leading to the formation of the mature embryo sac. The eight nuclei then organize into structures: one egg cell, two synergids, three antipodal cells, and one central cell with two polar nuclei, which is crucial for double fertilization. This complex structure ensures proper fertilization and subsequent seed development. Additionally, the embryo sac is housed within the ovule, which plays an essential role in the reproductive cycle of angiosperms. The diagram of the mature embryo sac would depict these components clearly, illustrating the specific cellular arrangements and their functions during fertilization and seed formation.

Question 27.

(i) Explain the formation of placenta after the implantation in a human female.

(ii) Draw a diagram showing human foetus within the uterus and label any four parts in it.

[5 Marks]

Answer: The formation of the placenta begins post-implantation when the fertilized egg, now called a blastocyst, embeds itself into the uterine lining (endometrium). The outer layer of the blastocyst, known as the trophoblast, develops into the chorion, which extends finger-like projections called chorionic villi into the maternal tissue. These villi invade the endometrium and establish a connection with the mother's blood vessels, facilitating the exchange of nutrients, gases, and wastes. The placenta forms from the chorion and the decidua (the modified endometrium). As pregnancy progresses, the placenta grows, becoming a vital organ that supports the fetus, produces hormones, and mediates maternal-fetal exchanges. It also serves as a barrier to certain substances while allowing vital nutrients to pass. Concurrently, the amniotic sac develops around the embryo,

safeguarding it in fluid, providing cushioning and maintaining a stable temperature. The placenta eventually becomes fully functional, typically around the end of the first trimester, playing a crucial role throughout the gestation period until birth. It is expelled after childbirth along with the umbilical cord. In addition to nutrient transfer, the placenta is instrumental in immunological protection, as it helps mediate the mother and fetus's immune responses, preventing rejection of the semi-allogeneic fetal tissue.

Question 28.

Name and describe the steps involved in the technique widely used in forensics that serves as the basis of paternity testing in case of disputes.

[5 Marks]

Answer: The technique widely used in forensics for paternity testing is DNA profiling or DNA fingerprinting. The process involves several key steps: Firstly, biological samples are collected from the child, mother, and alleged father, such as blood, saliva, or hair. Once samples are acquired, DNA is extracted from these cells. The next step involves amplification of specific regions of the DNA using Polymerase Chain Reaction (PCR), which ensures there is enough DNA for analysis. After amplification, the DNA fragments are separated through a process called gel electrophoresis, which allows visualization of the unique patterns of DNA from each individual. The final step is interpretation of the results, where genetic markers are compared between the child and the alleged father. If the patterns match at a significant number of loci, it indicates a likely biological relationship. This technique is both highly accurate and reliable, making it the gold standard for paternity testing in forensic investigations. Potential errors can arise from contamination or poor sample quality, so stringent protocols are essential throughout the process.

Question 29.

It is sometimes observed that the F_1 progeny has a phenotype that does not resemble either of the two parents and has intermediate phenotype. Explain by taking a suitable example and working out the cross upto F_2 progeny.

[5 Marks]

Answer: This phenomenon is known as incomplete dominance, where the F_1 generation exhibits a phenotype that is a blend of the parents' traits. A classic example is the cross between red-flowered (RR) and white-flowered (rr) snapdragons. In the F_1 generation, all the offspring (Rr) produce pink flowers, demonstrating an intermediate phenotype. When the F_1 plants are self-pollinated to produce the F_2 generation, the genotypic ratio is 1 RR: 2 Rr: 1 rr, leading to phenotypes of 1 red, 2 pink, and 1 white, resulting in a 1:2:1 phenotypic ratio. This illustrates how intermediate traits can arise from blending inheritance, highlighting the complexity of inheritance patterns beyond the simple Mendelian dominance.

Question 30.

Bioreactors are the containment vehicles of any biotechnology-based production process. For large scale production and for economic reasons the final success of biotechnological process depends on the efficiency of the bioreactor.

Answer the following questions w.r.t. the given paragraph:

(i) List the operational guidelines that must be adhered to so as to achieve optimisation of the bioreactor system. Enlist any four.

(ii) Mention the phase of the growth we refer to in the statement "Optimisation of growth and metabolic activity of the cells".

(iii) Is the biological product formed in the bioreactor suitable for the intended use immediate? Give reason in support of your answer.

[5 Marks]

Answer: To achieve the optimisation of the bioreactor system, several operational guidelines must be followed due to their significance in ensuring the efficiency of the biotechnological process. Firstly, maintaining optimal temperature and pH levels is crucial as they affect cellular metabolism and growth rates. Secondly, ensuring adequate oxygen transfer rates is vital for aerobic organisms. Thirdly, regular monitoring and control of nutrient levels within the bioreactor can enhance the growth and productivity of the cells. Finally, minimizing contamination risks through sterilization procedures ensures the integrity of the production process. Regarding the phase of growth referenced in the statement, it pertains to the logarithmic or exponential phase, where cells are actively dividing and exhibiting high metabolic activity. As for the biological product formed in the bioreactor, it is typically not suitable for immediate use. This is because most biotechnological products require downstream processing, including purification and characterization, to remove impurities and ensure safety for intended applications, thereby making the product suitable for use.

Question 31.

(i) EcoRI' has played very significant role in r-DNA technology.

(I) Explain the convention for naming EcoRI.

(II) Write the recognition site and the cleavage sites of this restriction endonuclease.

(ii) What are the protruding and hanging stretches of DNA produced by these restriction enzymes called? Describe their role in formation of r-DNA.

[5 Marks]

Answer: EcoRI is a restriction endonuclease derived from the bacterium Escherichia coli. The naming convention for EcoRI reflects its source and the order of its discovery; 'Eco' derives from the genus (Escherichia), 'R' indicates the species (coli), and 'I' denotes it as the first restriction enzyme isolated from this species. EcoRI recognizes the palindromic DNA sequence GAATTC and cleaves between the G and the A on both strands, producing sticky ends. The resulting sticky ends exhibit four protruding adenine nucleotides which facilitate annealing with complementary sequences during the formation of recombinant DNA (r-DNA). The sticking ends help in the ligation process by ensuring that the desired DNA fragments align properly, allowing the incorporation of foreign DNA into vectors, which is crucial in genetic engineering and molecular cloning. This capability makes EcoRI a critical tool in r-DNA technology for producing genetically modified organisms and for research purposes.