CBSE EXAMINATION PAPER-2024

BIOLOGY

(Solved)

Time allowed : 3 hours | Maximum Marks : 82

General Instructions :

Read the following instructions carefully and follow them :

i. This question paper contains **38 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 18** are multiple choice questions

v. **Section C** – questions number **19 to 24** are very short answer

vi. **Section D** – questions number **25 to 32** are short answer

vii. **Section E** – questions number **33 to 38** are long answer

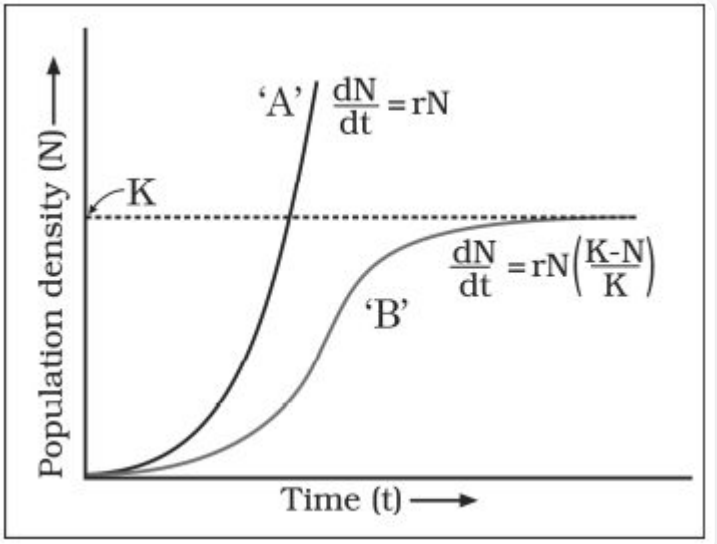
viii. There is no overall choice given in the question paper. However, an internal choice has been provided in few questions.

ix. Use of calculator is NOT allowed.

Section A

Question 1.

Populations evolve to maximise their reproductive fitness in the habitat in which they live. Ecologists suggest, the life history of organisms have evolved in relations to the constraints imposed by the biotic and abiotic components of the habitat in which they live. This gets reflected in the population growth pattern of all organisms including humans. Study the population growth curves shown in the given graph and answer the questions that follow :



(1)

Identify the growth curves 'A' and 'B'

[1 Marks]

Answer: Curve 'A' represents exponential growth, while curve 'B' represents logistic growth.

Key Points: Exponential growth; Logistic growth; Curve characteristics

(2)

Mention what does the dotted line in the graph indicate and state its importance also.

[1 Marks]

Answer: The dotted line in the graph indicates the carrying capacity (K) of the environment, which represents the maximum population size that the habitat can sustain indefinitely without degrading the environment. This line is important because it highlights the limits of resources and the potential for competition among individuals, serving as a critical point in understanding population dynamics and the transitioning from exponential to logistic growth.

Key Points: dotted line indicates carrying capacity-K is maximum sustainable population importance in understanding resource limits-competition among individuals

(3)

(i) Which one of the two curves is more “realistic” and why ?

(ii) Which one of the two curves is relevant in present days with respect to human population in our country and why ?

[1 Marks]

Answer: The logistic growth curve is more realistic because it accounts for the limitations of resources available in an environment, representing the competition that occurs naturally for these resources. In the context of the current human population in India, the logistic growth model is more relevant today, as it reflects the constraints imposed by limited resources such as food, space, and healthcare, which are essential for sustainable population growth.

Key Points: Logistic growth reflects resource limitations-Realistic representation of population dynamics-Sustainable growth considerations for humans

(4)

Growth curve ‘B’ shows a different pattern from that of growth curve ‘A’.Justify giving one reason.

[2 Marks]

Answer: Growth curve 'B' represents logistic growth, which differs from the exponential growth shown in curve 'A'. The primary reason for this difference is that growth curve 'B' reaches a carrying capacity (K) due to limited resources available in the environment. Unlike curve 'A', where resources are unlimited allowing for continuous exponential growth, curve 'B' accounts for competition and the environmental constraints that lead to a stabilization of the population size after a certain point, reflecting the reality of most natural populations.

Key Points: Logistic growth; carrying capacity; limited resources

Question 2.

Read the following passage :

Generally, in eukaryotic cells the average length of a transcription unit along a DNA molecule is about 8,000 nucleotides, so the RNA product of the transcription is also that long. But it only takes about

1200 nucleotides from the above RNA product to translate average sized polypeptide of 400 Amino acids.

(1)

Name this RNA product transcribed from the DNA that subsequently translates into a polypeptide of 400 amino acids. Mention the enzyme responsible for transcribing this type of RNA from the DNA

[1 Marks]

Answer: The RNA product is messenger RNA (mRNA), and the enzyme responsible for its transcription from DNA is RNA polymerase.

Key Points: mRNA-RNA polymerase

(2)

Name and explain the process the RNA molecule transcribed from 8000 nucleotide long DNA undergoes to be able to translate a polypeptide of 400 amino acids.

[2 Marks]

Answer: The process that the RNA molecule undergoes is called 'translation'. During translation, the mRNA is decoded by ribosomes to synthesize a polypeptide chain. The sequence of nucleotides in the mRNA is read in sets of three bases, called codons, each specifying a particular amino acid. This is how the RNA's information is converted into a polypeptide.

Key Points: Translation; mRNA decoding by ribosomes; codons specify amino acids; polypeptide synthesis

(3)

Mention the difference in the site of transcription in a prokaryote and eukaryote cell.

[1 Marks]

Answer: In prokaryotic cells, transcription occurs in the cytoplasm, as there is no nucleus present. In contrast, in eukaryotic cells, transcription takes place in the nucleus, where the DNA is enclosed. This separation allows for additional processing of RNA transcripts in eukaryotes before they are translated into proteins.

Key Points: Prokaryotes: Transcription in cytoplasm; Eukaryotes: Transcription in nucleus

(4)

Write the number of RNA polymerases involved in the transcription of DNA in a prokaryote and eukaryotes.

[1 Marks]

Answer: Prokaryotes have a single RNA polymerase that transcribes all types of RNA, while eukaryotes have at least three distinct RNA polymerases (RNA polymerase I, II, and III) for different types of RNA.

Key Points: Prokaryotes have one RNA polymerase - Eukaryotes have three RNA polymerases (I, II, III) - Division of labor in eukaryotic transcription

Section B

Question 3.

In a fertilized ovule of an angiosperm, the cells in which n, 2n and 3n conditions respectively occur are:

[1 Marks]

(A) endosperm, nucellus and zygote

(B) zygoate, nucellus and endosperm

(C) antipodals, synergids and integuments

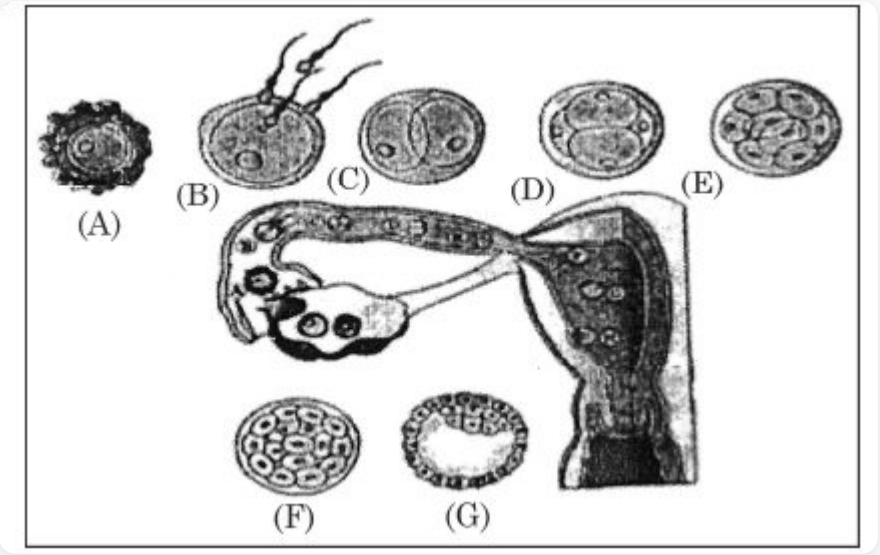
(D) antipodal, zygote and endosperm

Explanation: The correct option is 'antipodal, zygote and endosperm.' In a fertilized ovule, the zygote is diploid (2n), formed by the fusion of the sperm and ovule, the antipodal cells are haploid (n), and the endosperm, which provides nourishment, is triploid (3n) as it is formed by the fusion of one sperm cell with two polar nuclei.

Question 4.

Select the option that gives the correct identification of ovum, morula and blastocyst in a human female reproduction system as shown in the following diagram:

[1 Marks]



(A) Ovum – B, Morula – D, Blastocyst – F

(B) Ovum – A, Morula – E, Blastocyst – G

(C) Ovum – A, Morula – B, Blastocyst – G

(D) Ovum – B, Morula – D, Blastocyst – G

Explanation: According to the provided context, the fertilized egg moves through the fallopian tube passing points labeled from B to H. The morula, which is an embryo with 8 to 16 blastomeres, is shown at point E. The blastocyst, a hollow ball of cells with an outer trophoblast layer and an inner cell mass, is indicated at point G. Therefore, the ovum corresponds to point A (before fertilization and division), the morula to point E, and the blastocyst to point G.

Question 5.

Study the table given below: Contraceptive / Contraceptive Method Mode of Action A. The pill I. Prevent sperm reaching cervix B. Condom II. Prevent implantation C. Vasectomy III. Inhibits ovulation

D. Copper-T IV. Semen contains no sperm Select the option where contraceptive/contraceptive method are correctly matched with their mode of action.

[1 Marks]

Study the table given below :

Contraceptive / Contraceptive Method	Mode of Action
A. The pill	I. Prevent sperm reaching cervix
B. Condom	II. Prevent implantation
C. Vasectomy	III. Inhibits ovulation
D. Copper-T	IV. Semen contains no sperm

(A) A – II, B – III, C – I, D – IV

(B) A – III, B – II, C – I, D – IV

(C) A – III, B – I, C – IV, D – II

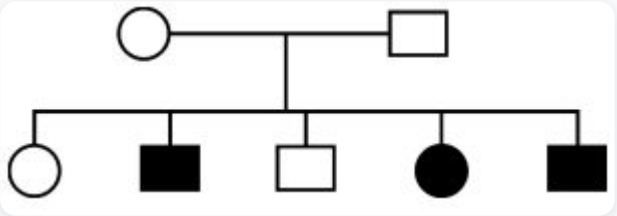
(D) A – IV, B – III, C – II, D – I

Explanation: The correct option is: A – III, B – I, C – IV, D – II. The pill (A) inhibits ovulation (III), the condom (B) prevents sperm from reaching the cervix (I), vasectomy (C) ensures that semen contains no sperm (IV), and Copper-T (D) prevents implantation (II).

Question 6.

Identify the category of genetic disorder depicted in the pedigree chart given below:

[1 Marks]



(A) X-Linked dominant

(B) Autosomal dominant

(C) X-Linked recessive

(D) Autosomal recessive

Explanation: The correct option is determined by analyzing the inheritance pattern shown in the pedigree chart. If the disorder appears in males more frequently than females and skips generations, it is likely X-Linked recessive. If both males and females are equally affected and it does not skip

generations, it's likely Autosomal dominant. If females are primarily affected and the trait is passed from father to daughter, it's X-Linked dominant. In cases where both genders are equally affected and the trait can skip generations, it is Autosomal recessive.

Question 7.

Which was the last of the 24 human chromosome to be completely sequenced?

[1 Marks]

(A) Chromosome – X

(B) Chromosome – 21

(C) Chromosome – 1

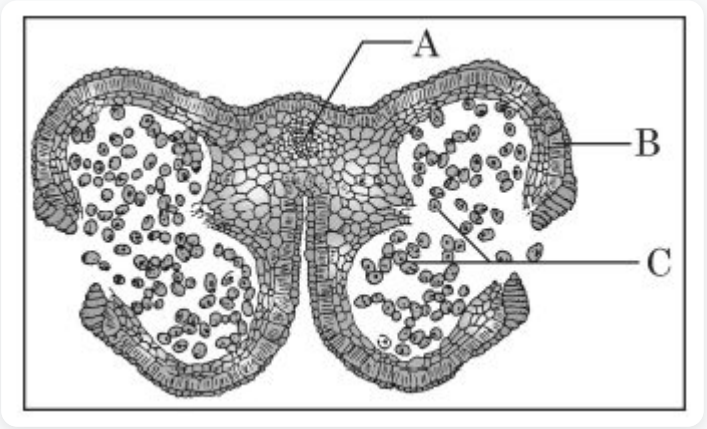
(D) Chromosome – 11

Explanation: According to the provided context, the sequence of chromosome 1 was completed only in May 2006, and it was the last among the 24 human chromosomes (22 autosomes plus X and Y) to be completely sequenced.

Question 8.

Study the following diagram of Transverse Section of a young anther of an angiosperm: Select the option where parts 'A', 'B' and 'C' are correctly identified.

[1 Marks]



(A) A – Endothecium, B – Pollen grain, C – Connective.

(B) A – Endothecium, B – Connective, C – Pollen grain.

(C) A – Connective, B – Endothecium, C – Pollen grain.

(D) A – Pollen grain, B – Connective, C – Endothecium.

Explanation: In a transverse section of a young anther, part 'A' corresponds to the endothecium, which is the layer just beneath the epidermis helping in anther dehiscence. Part 'B' is the connective, the tissue connecting the two lobes of the anther. Part 'C' refers to pollen grains, the male gametophytes produced inside pollen sacs. This identification aligns perfectly with the described anatomy of anther layers and tissues.

Question 9.

Turner's syndrome in humans occurs due to

[1 Marks]

(A) Autosomal abnormality

(B) Polyploidy

(C) Euploidy

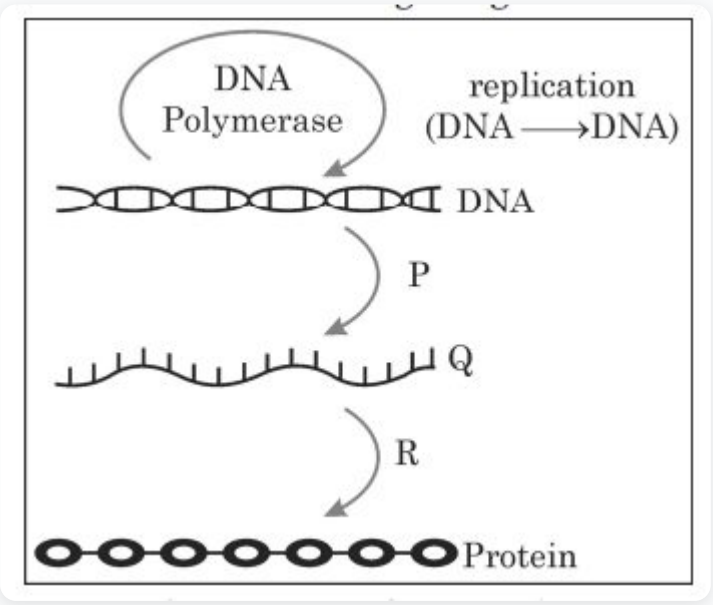
(D) Aneuploidy

Explanation: The correct answer is 'Aneuploidy' because Turner's syndrome is caused by the absence of one X chromosome in females, resulting in a total of 45 chromosomes instead of the typical 46. This type of chromosomal abnormality falls under aneuploidy, which refers to the presence of an abnormal number of chromosomes in a cell.

Question 10.

Which of the options has correct identification of 'P', 'Q' and 'R' in the illustration of 'Central Dogma' given below?

[1 Marks]



(A) P – Replication, Q – rRNA, R – Transcription

(B) P – Transcription, Q – mRNA, R – Translation

(C) P – Translation, Q – mRNA, R – Transcription

(D) P – Replication, Q – mRNA, R – Translation

Explanation: The correct answer is 'P – Transcription, Q – mRNA, R – Translation'. This is because the Central Dogma of molecular biology describes the flow of genetic information where transcription is the process of converting DNA into mRNA, and translation is the process of synthesizing proteins from mRNA.

Question 11.

Who proposed the mutation theory in favour of organic evolution?

[1 Marks]

(A) Hugo de Vries

(B) Louis Pasteur

(C) Darwin

(D) Weisman

Explanation: The correct answer is Hugo de Vries. He proposed the mutation theory, which suggests that new species arise through sudden and significant genetic changes or mutations, rather than gradual changes as suggested by Darwin's theory of natural selection.

Question 12.

Study the following list of bioactive substances and their action:

Select the option in which the bioactive substances are correctly matched with their action.

[1 Marks]

Bioactive Substance		Role	
A.	Statin	I.	Removal of oil stains
B.	Cyclosporin A	II.	Removal of clots from blood vessels
C.	Streptokinase	III.	Lowering of blood cholesterol
D.	Lipase	IV.	Immuno-suppressive agent

(A) A – III, B – IV, C – II, D – I

(B) A – II, B – III, C – I, D – IV

(C) A – IV, B – I, C – II, D – III

(D) A – IV, B – II, C – I, D – III

Explanation: The correct option is determined by analyzing the relationships between the bioactive substances and their respective actions. Therefore, upon matching each listed substance with their correct action, we can identify the accurate pairs, which can be found in the correct option among those provided.

Question 13.

The ‘molecular scissors’ fall in the category of:

[1 Marks]

(A) Restriction enzymes

(B) Exonuclease

(C) Cleaving enzyme

(D) Endonuclease

Explanation: The correct answer is 'Restriction enzymes'. Molecular scissors refer to enzymes that can cut DNA at specific sequences, which are known as restriction enzymes. These enzymes play a key role in molecular biology for gene cloning and DNA manipulation.

Question 14.

ELISA technique is based on the principle of:

[1 Marks]

(A) pathogen – antigen interaction

(B) antigen – protein interaction

(C) antigen-antibody interaction

(D) DNA replication

Explanation: The correct answer is 'antigen-antibody interaction' because the ELISA (Enzyme-Linked Immunosorbent Assay) technique relies on the specific binding of antibodies to their corresponding antigens to detect and quantify biological substances.

Question 15.

Assertion (A) : A given fig species can be pollinated only by its partner' wasp.

Reason (R) : The wasp pollinates the fig inflorescence while searching for suitable egg laying sites.

[1 Marks]

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

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

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

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

Explanation:

Both (A) and (R) are true and (R) is the correct explanation of (A) because the fig relies on a specific wasp for pollination, and the wasp, in its search for a place to lay eggs, simultaneously pollinates the fig, establishing a mutual dependence.

Question 16.

Assertion (A) : Plasmids are autonomously replicating circular extrachromosomal DNA.

Reason (R) : Plasmids are usuall

[1 Marks]

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

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

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

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

Explanation: The assertion (A) is true because plasmids are indeed small, circular DNA molecules that replicate independently of the chromosomal DNA inside bacterial cells. However, the reason (R) is incomplete and not provided fully in the question, so it cannot be considered true or a correct explanation of (A). Therefore, (A) is true but (R) is false.

Question 17.

Assertion (A) : Patents are granted by government to an inventor.

Reason (R) : Patents prevents others from commercial use of an invention.

[1 Marks]

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

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

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

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

Explanation:

Both (A) and (R) are true and (R) is the correct explanation of (A) because patents are indeed granted by governments to protect the rights of inventors and prevent unauthorized commercial use of their inventions.

Question 18.

Assertion (A) : Some aquatic ecosystems have inverted biomass pyramids.

Reason (R) : More energy is required by the organisms occupying higher trophic levels.

[1 Marks]

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

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

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

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

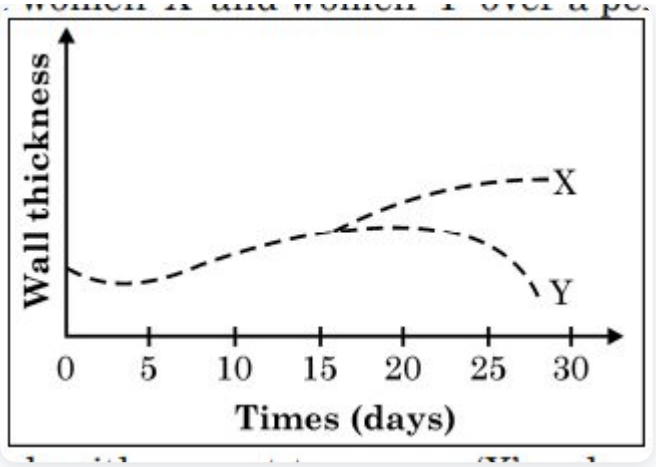
Explanation:

Both (A) and (R) are true and (R) is not the correct explanation of (A). Aquatic ecosystems can have inverted biomass pyramids where the biomass of primary producers (like phytoplankton) is less than that of higher trophic levels (like zooplankton and fish) due to the high turnover rate of primary producers. While it is true that higher trophic levels require more energy, it does not explain the occurrence of inverted pyramids.

Section C

Question 19. Study the graph given below that represents the changes in the thickening of the uterine wall in women ‘X’ and women ‘Y’ over a period of one month. What does the graph with respect to woman ‘X’ and woman ‘Y’ indicate? Give suitable reason.

[2 Marks]



Answer: The graph shows that woman 'X' experiences a consistent thickening of the uterine wall throughout the month, indicating the influence of hormonal regulation during her menstrual cycle. In contrast, woman 'Y' shows irregular changes, suggesting possible hormonal imbalances. The differences exemplify how endometrial changes respond to hormonal fluctuations, primarily driven by estrogen and progesterone. Thus, woman 'X' reflects normal cyclical changes, while woman 'Y' may need further investigation regarding menstrual irregularities.

Key Points: Thickening of uterine wall; Woman 'X' shows consistent thickening; Woman 'Y' shows irregular changes; Indicates hormonal regulation; Cyclical changes based on estrogen and progesterone; Suggests woman 'Y' may have hormonal imbalances.

Question 20.

(a) Intensely lactating mothers generally do not conceive. Why ?

(b) Our government has intentionally imposed strict conditions for MTP. Why ?

[2 Marks]

Answer: Intensely lactating mothers generally do not conceive due to a biological phenomenon known as lactational amenorrhea. During breastfeeding, particularly exclusive breastfeeding, the hormones prolactin and oxytocin are elevated, which suppress ovulation and menstrual cycles. This natural contraceptive effect leads to a delay in the return of fertility. Therefore, breastfeeding serves not only to nourish infants but also to space births naturally, resulting in a lower likelihood of conception during this period.

Key Points: lactational amenorrhea-hormonal suppression of ovulation-breastfeeding as natural contraceptive

Question 21.

(a) Name the source from which insulin was extracted in earlier times. Why is this insulin no more in use by the diabetic patients ?

(b) Why does the insulin synthesised in the human body undergo processing whereas the insulin produced by Eli Lilly company does not need to undergo any processing ? Explain.

[2 Marks]

Answer: Insulin was traditionally extracted from the pancreases of slaughtered cattle and pigs. This animal-derived insulin is no longer widely used because it may cause allergic reactions and is less effective than human insulin. Eli Lilly produces human insulin by using genetically modified bacteria, which synthesizes insulin that does not require processing. Human insulin is produced as a pro-hormone containing C-peptide, which is removed during maturation. This makes the Eli Lilly insulin ready for use without additional processing.

Key Points: insulin source historically cattle/pig pancreas – allergic reactions/effectiveness issues; Eli Lilly produces human insulin using bacteria – no processing needed; human insulin synthesized as pro-hormone; C-peptide removed during maturation

Question 22.

Differentiate between grazing food chain and detritus food chain.

[2 Marks]

Answer: The grazing food chain starts with primary producers like plants, which are eaten by herbivores. This chain is primarily driven by photosynthesis and energy from the sun. In contrast, the detritus food chain begins with dead organic matter, which is decomposed by detritivores, such as fungi and bacteria, and then consumed by larger organisms. While the grazing food chain is linked to living plants and herbivores, the detritus food chain focuses on decomposers and nutrient recycling.

Key Points: Grazing food chain starts with producers; Detritus food chain starts with dead matter; Grazing food chain involves herbivores; Detritus food chain focuses on decomposers; Energy source varies (sun vs decay).

Question 23.

Explain Brood parasitism with the help of a suitable example.

[2 Marks]

Answer: Brood parasitism is a reproductive strategy where one species lays its eggs in the nest of another species, relying on the host to raise its young. A well-known example is the cuckoo bird. Cuckoos lay their eggs in the nests of other birds, such as reed warblers. Once the cuckoo chick hatches, it usually pushes the host's eggs or chicks out of the nest, ensuring it gets all the food and care from the unsuspecting host parents.

Key Points: Brood parasitism - reproductive strategy - one species uses another's nest - cuckoo as an example - lays eggs in hosts' nests - cuckoo chick outcompetes host's young

Question 24.

(a) Biodiversity hotspots cover less than 2% of Earth's land area. Strict protection of these areas can reduce the rate of ongoing extinctions. Explain.

(b) Name any two hotspots in India.

[2 Marks]

Answer: Biodiversity hotspots, though cover less than 2% of Earth's land area, are crucial for sustaining the majority of Earth's biodiversity. By implementing strict protection measures in these areas, we can safeguard endangered species and their habitats, reducing the rate of extinctions significantly. Conservation efforts help maintain ecosystem functionality, protecting genetic diversity, and ensuring that species have the necessary resources for survival. Two biodiversity hotspots in India are the Himalayas and the Western Ghats.

Key Points: Biodiversity hotspots importance; Coverage of Earth; Strict protection reduces extinction rates; Conservation of habitats; Examples: Himalayas, Western Ghats

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Section D

Question 25.

Draw a well labelled diagram of sectional view of male gametophyte/microspore of an angiosperm and write the functions of any two parts labelled. (Any four labels).

[3 Marks]

Answer: The male gametophyte, or microspore, of an angiosperm represents a crucial stage in the plant's reproduction. The diagram should include labels such as the generative cell, tube cell, pollen wall, and nucleus. The generative cell develops into two sperm cells, which are essential for fertilization in the ovule. The tube cell, once the pollen grain lands on a stigma, develops a pollen tube that carries the sperm cells towards the ovule for successful fertilization. These structures work together to facilitate the reproductive process in flowering plants.

Key Points: Generative cell; functions in developing into sperm; Tube cell; forms pollen tube for fertilization; Pollen wall; provides protection and structure; Nucleus; contains genetic material for reproduction.

Question 26.

(a) A man with blood group ‘A’ marries a woman with blood group ‘AB’. The first child born to them has blood group ‘B’. Work out a cross to find the genotype of the father. Give the possible blood groups and their genotypes of the children that could be born to this couple. (Use a Punnet square).

(b) State the basis of ‘ABO’ blood grouping in humans.

[3 Marks]

Answer: To determine the genotype of the father, we represent his genotype as either IAIA or IAi (where IA represents gene for A). The mother’s genotype is IAIB. Setting up a Punnett square: For the father (IAi) and mother (IAIB), the possible combinations yield genotypes IAIB (Blood Group AB), IAi (Blood Group A), IBi (Blood Group B), and ii (Blood Group O). Thus, possible blood groups of their children are A, B, AB, and O. ABO blood grouping is based on presence/absence of antigens A and B on RBCs, governed by three alleles (IA, IB, i).

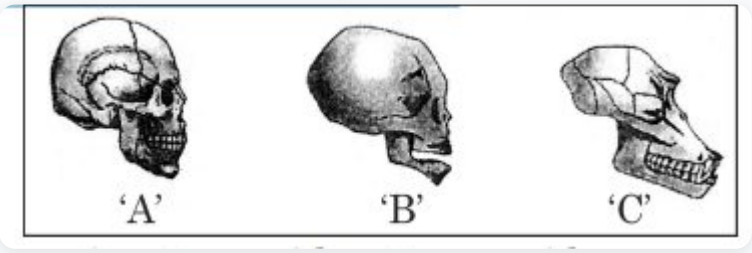
Key Points: Punnett square analysis; Possible genotypes of father (IAi); Blood groups of children (A, B, AB, O); Basis of ABO blood grouping (presence/absence of A and B antigens); Multiple alleles in ABO system.

Question 27.

(a) Whose skulls ‘A’, ‘B’, and ‘C’ are shown below ? Which of the two are more similar to each other ?

(b) Name the (i) ape like (ii) man like primates that existed 1.5 million years ago.

[3 Marks]



Answer: The skulls ‘A’, ‘B’, and ‘C’ likely belong to different species of early hominins and possibly represent stages in human evolution. Without visual aids, it is challenging to determine which two skulls are more similar. Typically, skulls from the genus Homo, such as Homo erectus, might be more similar to each other compared to those from earlier species like Australopithecus. Approximately 1.5 million years ago, ape-like primates such as Australopithecus and man-like primates like Homo habilis existed, marking significant milestones in evolution.

Key Points: 1. Identification of skulls A, B, C; 2. Similarity analysis between skulls; 3. Ape-like primates 1.5 million years ago; 4. Man-like primates 1.5 million years ago

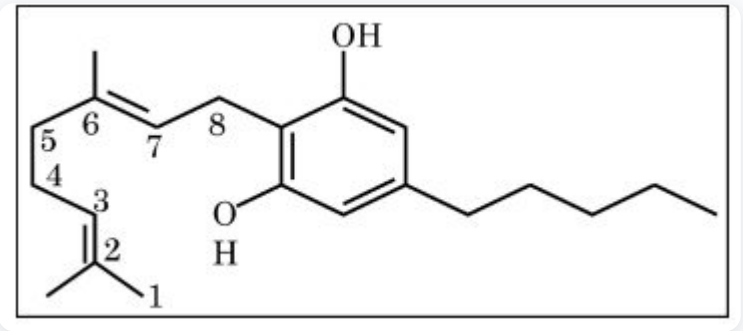
Question 28.

(a) Name the group of drugs whose skeletal molecule is shown below

(b) How are such drugs consumed ?

(c) Name the human body organ affected by the consumption of these drugs.

[3 Marks]



Answer: The group of drugs depicted is typically classified as 'steroid drugs'. These drugs can be consumed in various forms such as oral pills, injections, or topical applications. Oral consumption involves taking a tablet or capsule, while injections can be intramuscular or subcutaneous. Topical steroids are applied directly to the skin. The principal organ affected by the consumption of these drugs is the liver, as it plays a crucial role in metabolizing steroids, which can lead to various liver-related health issues, including potential liver damage and dysfunction.

Key Points: steroid drugs-forms of consumption: oral, injection, topical-afflicted organ: liver

Question 29.

Draw a schematic diagram of an antibody molecule and label any 4 parts. Mention their chemical nature. Name the cells which produce them.

[3 Marks]

Answer: An antibody molecule, also known as an immunoglobulin, typically has a Y-shaped structure. Four key components of an antibody are: 1) Heavy Chain - a long polypeptide chain that gives the antibody its structure; it is composed of amino acids, making it a protein. 2) Light Chain - a shorter polypeptide chain that pairs with the heavy chain; like the heavy chain, it is also a protein. 3) Antigen-binding site - located at the tips of the Y, it interacts with specific antigens, determined by its unique amino acid sequence. 4) Fc region - the stem of the Y, important for binding to cell receptors, also a protein. Antibodies are produced by B lymphocytes (B cells) which undergo differentiation into plasma cells that secrete antibodies.

Key Points: 1) Heavy Chain - protein structure 2) Light Chain - protein structure 3) Antigen-binding site - binds to antigens 4) Fc region - interacts with immune cells 5) Produced by B lymphocytes/ plasma cells

Question 30.

Explain the role of the following during the sewage treatment :

(a) flocs

(b) anaerobic sludge digester

[3 Marks]

Answer: During sewage treatment, flocs play a crucial role in the secondary treatment phase. They are aggregates of microorganisms, including bacteria, that form during the biological treatment process. These flocs help in the removal of organic matter by clumping together and settling down, thereby facilitating sedimentation. On the other hand, anaerobic sludge digesters are essential for breaking down the excess biomass produced in the treatment process. They use anaerobic bacteria to decompose the organic material in the sludge, resulting in the production of biogas and reducing the volume of waste. This process not only helps in waste stabilization but also allows for the recovery of energy in the form of methane, which can be utilized as a renewable energy source.

Key Points: Role of flocs in sewage treatment; Formation of microorganisms; Clumping and sedimentation; Function of anaerobic sludge digesters; Use of anaerobic bacteria; Breakdown of excess biomass; Production of biogas; Energy recovery.

Question 31.

Study the steps shown below, that are carried during a specific technique :

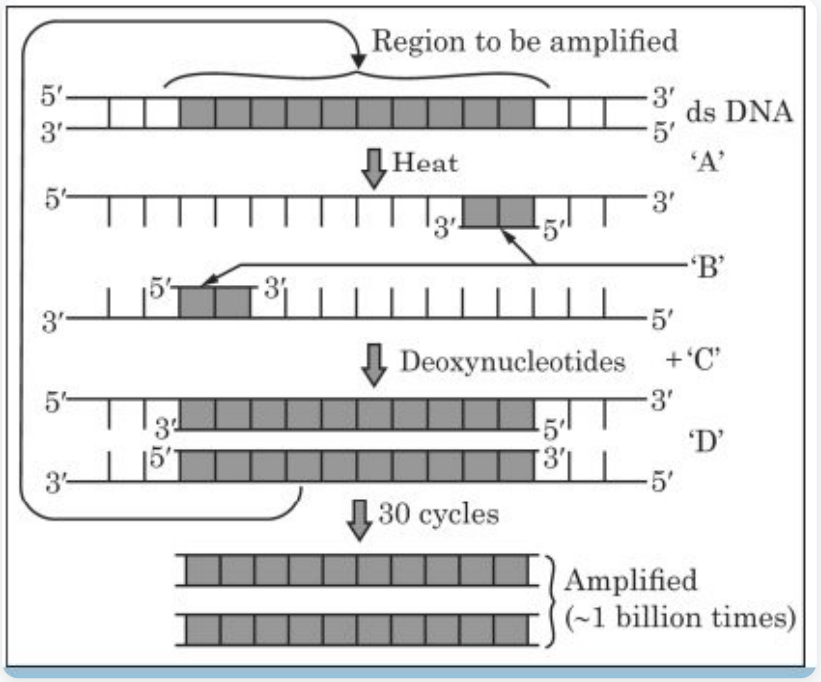
(a) Identify the steps ‘A’ and ‘D’ in the diagram.

(b) What does ‘B’ represent ?

(c) Write what is ‘C’ ? Name its source organism.

(d) Mention the use of this technique in molecular diagnostics.

[3 Marks]



Answer: In this specific technique, step 'A' typically represents the extraction of nucleic acids, while step 'D' refers to the amplification of the target nucleic acid sequences. Step 'B' usually represents the addition of primers, essential for initiating the PCR process. Step 'C' is the polymerase enzyme, specifically Taq polymerase, sourced from the thermophilic bacterium Thermus aquaticus. This PCR technique is widely used in molecular diagnostics to detect genetic material, identify pathogens, and perform genetic testing.

Key Points: Step A: Nucleic acid extraction; Step D: Amplification of nucleic acids; Step B: Addition of primers; Step C: Taq polymerase; Source organism: Thermus aquaticus; Uses: Genetic material detection, pathogen identification, genetic testing.

Question 32.

Explain the role of transgenic animals in :

(a) Production of Biological products

(b) Studying diseases

(c) Chemical safety testing

[3 Marks]

Answer: Transgenic animals play a pivotal role in various fields of biomedical research. (a) In the production of biological products, transgenic animals can be engineered to produce therapeutic proteins, hormones, and antibodies in their milk or blood, making these substances more accessible and cost-effective. (b) For studying diseases, transgenic models mimic human diseases, providing insights into disease mechanisms and allowing researchers to test new treatments. (c) In chemical safety testing, transgenic animals are used to evaluate the toxic effects of chemicals, helping to determine safety levels for human exposure, thereby assisting regulatory agencies.

Key Points: Production of therapeutic proteins-Transgenic models for disease study-Assessment of chemical toxicity

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Section E

Question 33. Describe the life cycle of HIV from the time of its entry into the human body till full blown AIDS sets in.

[5 Marks]

Answer: The life cycle of HIV (Human Immunodeficiency Virus) starts when the virus enters the human body, typically through bodily fluids during unprotected sexual contact, sharing needles, or from mother to child. Upon entering, HIV targets CD4+ T cells, which are crucial for the immune response. The virus attaches to the CD4 receptor and fuses with the host cell's membrane, releasing its RNA and enzymes into the cell. Using reverse transcriptase, the viral RNA is transcribed into DNA, which then integrates into the host's genome. This integrated viral DNA can remain dormant for years, allowing the virus to evade detection. When the T cell is activated, the integrated viral DNA is transcribed into new viral RNA, leading to the production of new viral particles. These particles bud off from the host cell, allowing the cycle to continue. Over time, as more CD4+ T cells are destroyed, the immune system becomes weakened, and the individual may start to exhibit symptoms of HIV infection like fatigue, fever, or swollen lymph nodes. Without treatment, the progression leads to AIDS (Acquired Immunodeficiency Syndrome), characterized by a severely compromised immune system, making it difficult to fight off opportunistic infections and certain cancers. The transition from HIV to AIDS can take many years, often 10 or more, depending on various factors such as the individual's overall health and access to antiretroviral therapies.

Key Points: HIV entry via bodily fluids; targets CD4+ T cells; attaches and fuses to cell; releases RNA and enzymes; reverse transcription into DNA; integrates into host genome; remains dormant; activation leads to new virion production; immune system weakening; transition to AIDS; opportunistic infections.

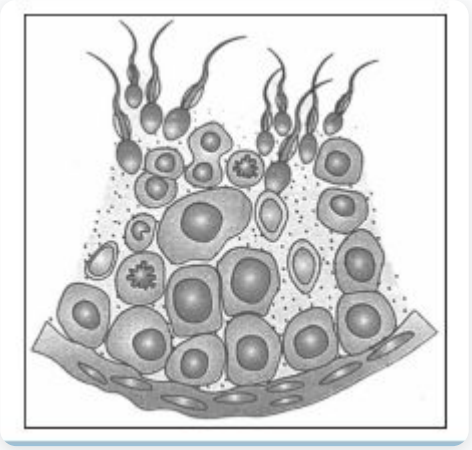
Question 34.

The given diagram shows the sectional view of a seminiferous tubule of Human testis :

(i) Name and describe the process depicted in the diagram which results in the development of spermatozoa.

(ii) dentify the cell where you are seeing a cluster of spermatozoa attached in the diagram. Write the function of the cell.

[5 Marks]



Answer: The process depicted in the diagram is called spermatogenesis, which is the formation of spermatozoa from spermatogonia. Spermatogenesis occurs in the seminiferous tubules of the testes and involves several stages, including mitosis and meiosis. Spermatogonia undergo mitotic division to produce primary spermatocytes, which then undergo meiosis to form secondary spermatocytes and finally haploid spermatids. These spermatids undergo differentiation to mature into spermatozoa. The clustered spermatozoa seen in the diagram are attached to Sertoli cells. Sertoli cells provide structural and nutritional support to developing sperm cells, facilitate transport of nutrients, remove waste, and secrete hormones like inhibin, which regulates spermatogenesis.

Key Points: Spermatogenesis is the process of sperm formation; Occurs in seminiferous tubules; Involves mitosis and meiosis; Primary spermatocytes form secondary spermatocytes; Spermatids mature into spermatozoa; Sertoli cells support and nourish sperm; Sertoli cells secrete inhibin to regulate sperm production.

Question 35.

Observe the picture of Commelina plant bearing two types of flowers given above.

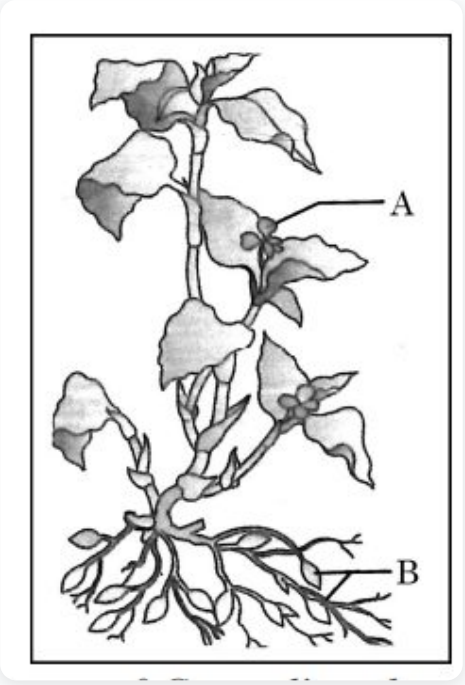
(i) Identify the two types of flowers labelled ‘A’ and ‘B’ in the picture.

(ii) Compare the two types of flowers with reference to :

- Characteristic feature
- modes of pollination

(ii) List any two ‘out breeding devices’ in flowering plants. Explain why do plants develop such devices.

[5 Marks]



Answer: In the Commelina plant, the two types of flowers labeled 'A' and 'B' are typically male (staminate) and female (pistillate) flowers. Characteristically, flower 'A' is smaller, has a prominent style, and contains only stamens, while flower 'B' is larger, possesses a well-formed ovary, and contains pistils. Regarding modes of pollination, flower 'A' may primarily use wind or insect pollination, while flower 'B' tends to rely on self-pollination to ensure fertilization. Outbreeding devices in flowering plants include dioecy, where male and female flowers are on separate plants, and self-incompatibility mechanisms that prevent self-fertilization. These devices are essential as they enhance genetic diversity, promote cross-pollination, and increase resilience to diseases and environmental changes, leading to healthier progeny.

Key Points: Identification of flowers 'A' and 'B' as male and female; comparison of characteristics between male and female flowers; discussion of pollination modes for each flower; identification of outbreeding devices such as dioecy and self-incompatibility; explanation of why outbreeding devices are important for genetic diversity and plant health.

Question 36.

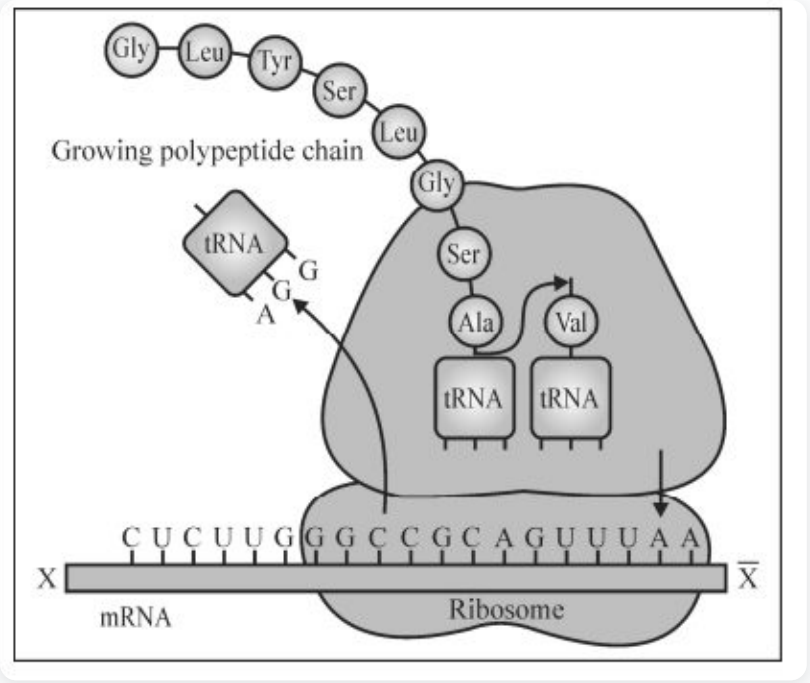
Study the schematic diagram given below and answer the questions that follow :

(i) Identify the polarity from ‘X’ to ‘ X ’ in the mRNA segment shown. Mention how many more amino acids can be added to the polypeptide that is being translated and why.

(ii) Write the initiating codon for translation, its anticodon and the amino acid it codes for.

(iii) Explain the charging of an adaptor molecule. Why this molecule needs to be charged ?

[5 Marks]



Answer:

(i) The polarity in the mRNA segment is from the 5' end to the 3' end. The number of amino acids that can be added to the polypeptide being translated can be determined by the number of codons remaining after the initial codon. Each codon corresponds to one amino acid. If there are 10 codons remaining, then 10 more amino acids can be added to the polypeptide chain due to the continuous reading of mRNA by the ribosome.

(ii) The initiating codon for translation is AUG. The corresponding anticodon on the tRNA is UAC, and this codon codes for the amino acid Methionine, which is the first amino acid incorporated during protein synthesis.

(iii) The charging of an adaptor molecule, such as tRNA, involves the attachment of an amino acid to its corresponding tRNA molecule. This process is facilitated by the enzyme aminoacyl-tRNA synthetase, which ensures that the correct amino acid is attached to the correct tRNA. This charging is critical because it enables the tRNA to deliver the appropriate amino acid during the process of translation, ensuring that the polypeptide chain is synthesized correctly according to the sequence specified by the mRNA.

Key Points: Polarity is from 5' to 3'-More amino acids depend on remaining codons-Starting codon is AUG, anticodon is UAC, Methionine coded-Charging involves tRNA and amino acids-Ensured by aminoacyl-tRNA synthetase-Important for correct translation.

Question 37.

1. Why is sickle-cell anaemia, a human blood disorder so named ?

2. Explain the genetic basis that results in the expression of this disorder.

3. Work out a cross to explain how normal parents may have a sicklecell anaemic child.

[5 Marks]

Answer: Sickle-cell anaemia is named for the characteristic sickle or crescent shape of the red blood cells that occur in this disorder. These misshapen cells can lead to blockages in blood flow and various health complications. The disorder is caused by a mutation in the HBB gene on chromosome 11, leading to the production of an abnormal form of hemoglobin called hemoglobin S (HbS). This mutation is inherited in an autosomal recessive pattern. An individual must inherit two copies of the HbS gene (one from each parent) to exhibit symptoms of sickle-cell anaemia. Parents who are carriers of the sickle cell trait (HbAS) typically exhibit no symptoms of the disease; however, there is a 25% chance with each pregnancy that their child will inherit two sickle genes and thus suffer from the disorder. This is illustrated in a Punnett square where the combinations of alleles from two carriers yield the genotypes: AA (normal), AS (carrier), and SS (sickle-cell), demonstrating that an individual can inherit sickle-cell anaemia even if both parents are asymptomatic.

> **Key Points: Sickle-cell anaemia name from sickle-shaped cells - Mutation in HBB gene - Autosomal recessive inheritance - Carriers (HbAS) are asymptomatic - Punnett square analysis shows 25% chance of child with sickle-cell (SS) if both parents are carriers.**

Question 38.

1. Write the symptoms of malaria in human and explain what causes these symptoms.
2. Describe the different steps in the sexual mode of reproduction in the life cycle of a malarial parasite from the time of its initiation till where it is completed and ready to start a fresh cycle.

[5 Marks]

Answer: Malaria is characterized by a range of symptoms that typically include high fever, chills, sweating, headaches, nausea, vomiting, fatigue, and muscle pain. These symptoms are caused by the malaria parasite, primarily Plasmodium falciparum, which enters the bloodstream via mosquito bites. As the parasites reproduce in the liver and invade red blood cells, they cause cell rupture and release toxic substances such as hemozoin, resulting in the clinical manifestations of the disease. The rapid destruction of red blood cells leads to anemia, worsening the symptoms. Treatment often involves antimalarial drugs to eliminate the parasites and alleviate symptoms, though prevention through mosquito control is crucial to curbing the spread of malaria. In the sexual reproduction phase of the malarial parasite, the process begins when a female Anopheles mosquito bites an infected human, ingesting the male and female gametocytes from the blood. Inside the mosquito's gut, the gametocytes mature into gametes. Fertilization occurs, forming a zygote that transforms into an ookinete, which then penetrates the gut wall and forms an oocyst. This oocyst undergoes division, producing sporozoites, the infectious form of the parasite. After maturation, the oocyst bursts, releasing sporozoites into the mosquito's salivary glands. When the mosquito bites another human, it transmits the sporozoites, initiating a new cycle of infection.

Key Points: Symptoms of malaria: high fever, chills, sweating, headaches; causes: Plasmodium falciparum, toxic release, anemia, red blood cell destruction. Sexual reproduction process: mosquito ingestion of gametocytes, formation of gametes, fertilization into zygote, oocyst development, sporozoite release in salivary glands, transmission in new bite.