Maharashtra Board Class 12 Biology Solutions 2023

SECTION A

Question 1. Select and write the correct answer for the following multiple choice type of questions:
i. Histones are rich in _____.
(A) Lysine and Arginine
(B) Leucine and Methionine
(C) Serine and Leucine
(D) Phenyl alanine and Lysine

Answer. The correct answer is: (A) Lysine and Arginine

ii. How many mitotic divisions take place during the formation of a female gametophyte from a functional megaspore?
(A) One
(B) Two
(C) Three
(D) Four

Answer. The correct answer is (C) Three.

iii. Which of the following is the only gaseous plant growth regulator?
(A) ABA
(B) Cytokinin
(C) Ethylene
(D) Gibberellin

Answer. The correct answer is: (C) Ethylene

iv. The pH of nutrient medium for plant tissue culture is in the range of _____.
(A) 2 to 4.2
(B) 5 to 5.8
(C) 7 to 7.5
(D) 8 to 9.5

Answer. The correct answer is: (B) 5 to 5.8

v. Rivet Popper Hypothesis is an analogy to explain the significance of _____.
(A) Biodiversity
(B) natality
(C) sex-ratio
(D) age distribution ratio

Answer. The correct answer is: (A) Biodiversity

vi. Which of the following group shows ZW-ZZ type of sex determination?
(A) Pigeon, Parrot, Sparrow
(B) Parrot, Bat, Fowl
(C) Bat, Fowl, Crow
(D) Sparrow, Fowl, Cat

Answer. The correct answer is: (A) Pigeon, Parrot, Sparrow

vii. In Hamburger's phenomenon, _____.
(A) Cl – diffuse into WBCs
(B) Cl– diffuse into RBCs
(C) Na + diffuse into RBCs
(D) Na+ diffuse into WBCs

Answer. The correct answer is: (B) Cl– diffuse into RBCs

viii. Calcium and Phosphate ions are balanced between blood and other tissues by _____.
(A) Thymosin and Parathormone
(B) Calcitonin and Somatostatin
(C) Collip's hormone and Calcitonin
(D) Calcitonin and Thymosin

Answer. The correct answer is: (C) Collip's hormone and Calcitonin

ix. Identify the INCORRECT statement.
(A) In a flaccid cell, T.P. is zero
(B) In a turgid cell, DPD is zero
(C) In a fully turgid cell, TP = OP
(D) Water potential of pure water is negative

Answer. The correct answer is: (D) Water potential of pure water is negative

x. Which of the following is a hormone releasing contraceptive?
(A) Cu-T
(B) Cu-7
(C) Multiload-375
(D) LNG-20

Answer. The correct answer is: (D) LNG-20

Question 2. Answer the following questions:
i. Which disease is caused by HPV?

Answer. Human papillomavirus (HPV) is associated with various diseases, with one of the most notable being cervical cancer. HPV infection is a significant risk factor for the development of cervical cancer in women.

ii. Which device is used to clean both dust and gases from polluted air?

Answer. An air purifier is a device used to clean both dust and gases from polluted air. It employs various technologies such as filters, electrostatic precipitators, or UV light to remove particulate matter and pollutants from the air, improving its quality.

iii. Mention the name of sterile animal produced by intergeneric hybridisation.

Answer. The term "sterile animal produced by intergeneric hybridization" refers to a mule. Mules are hybrids resulting from the crossbreeding of a male donkey (Equus asinus) and a female horse (Equus ferus caballus). Mules are generally sterile because donkeys and horses have a different number of chromosomes, making it challenging for their hybrid offspring to produce viable gametes.

iv. Give the name of first transgenic plant.

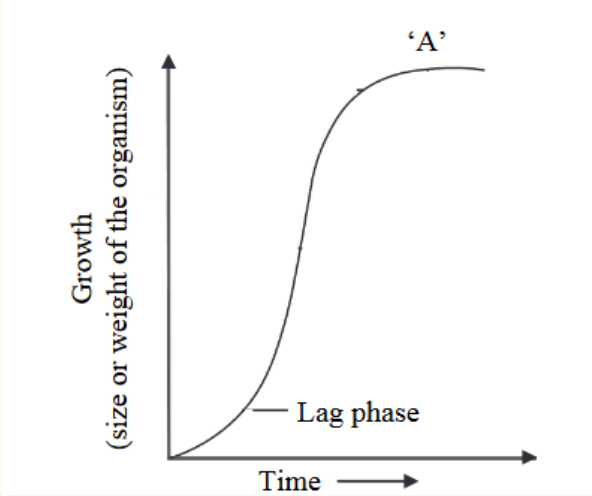
Answer. The first transgenic plant is commonly considered to be a tobacco plant (Nicotiana tabacum) that was genetically modified to be resistant to antibiotics. This landmark achievement occurred in 1983 by researchers Herbert Boyer and Robert Horsch. They used a gene from the bacterium Escherichia coli (E. coli) that conferred resistance to the antibiotic kanamycin. This marked the beginning of genetic engineering in plants.

v. A child has low BMR, delayed puberty and mental retardation. Identify the disease.

Answer. The symptoms described, including low basal metabolic rate (BMR), delayed puberty, and mental retardation, are characteristic of congenital hypothyroidism. This condition occurs when the thyroid gland fails to produce sufficient thyroid hormones, leading to a variety of

developmental issues. It can result in cretinism, a severe form of mental and physical retardation if left untreated. Early detection and treatment with thyroid hormone replacement therapy are crucial for managing congenital hypothyroidism and preventing long-term complications.

vi. Identify 'A' in the given graph of population growth:



vii. Complete the following box with reference to symptoms of mineral deficiency:

Abscission	**Pre-mature fall of flowers, fruits and leaves**
	Appearance of green and non-green patches on leaves

Answer.

Abscission	Pre-mature fall of flowers, fruits and leaves
Chlorosis (Loss of chlorophyll)	Appearance of green and non-green patches on leaves

viii. Give an example of plant having both kidney and dumb-bell shaped guard cells in stomata.

Answer. The plant that is commonly known to have both kidney-shaped and dumbbell-shaped guard cells in stomata is the Oat plant (genus *Avena*). The stomatal complex in oats exhibits this variation in the shapes of guard cells.

SECTION B

Attempt any EIGHT of the following questions:
Question 3. Define the terms:
a. Gross Primary Productivity

Answer. Gross Primary Productivity (GPP): Gross Primary Productivity refers to the total amount of organic material (usually expressed in terms of biomass or energy) that the primary producers (usually plants) produce through photosynthesis in a given area and time period. It represents the total energy captured by autotrophs from sunlight and converted into organic compounds.

b. Net Primary Productivity

Answer. Net Primary Productivity (NPP): Net Primary Productivity is the energy or biomass that remains after subtracting the energy used by the primary producers for their respiration from the total energy fixed during photosynthesis. In simpler terms, NPP is the amount of energy or biomass available for consumption by herbivores in an ecosystem. It is a key indicator of the ecosystem's productivity and its potential to support higher trophic levels.

Question 4. Draw a neat diagram of thyroid gland and label thyroid follicle, follicular cells and blood capillaries.

Question 5.
i. Give reason – ABA is also known as antitranspirant.

Answer. Abscisic Acid (ABA) is known as an antitranspirant for the following reason:

ABA regulates stomatal closure in plants. Stomata are small openings on the surface of leaves that allow for gas exchange, including water vapor during transpiration. In conditions of water stress or drought, ABA levels increase in plant cells. Elevated ABA levels prompt the closure of stomata, reducing transpiration and water loss from the plant.

By inducing stomatal closure, ABA helps to conserve water and prevent excessive transpiration, making it an antitranspirant. This is crucial for plants facing water scarcity or challenging environmental conditions, as it helps them adapt and survive in conditions where water availability is limited.

ii. Explain the role of chlorophyllase enzyme in banana.

Answer. Chlorophyllase enzyme in banana:

Chlorophyllase is an enzyme that plays a role in the degradation of chlorophyll, the green pigment in plants. In bananas, the activity of chlorophyllase is significant during the ripening process. As bananas ripen, there is a breakdown of chlorophyll, leading to changes in color from green to yellow.

The chlorophyllase enzyme catalyzes the hydrolysis of chlorophyll into various products, including non-green pigments. This enzymatic action is part of the biochemical processes associated with fruit ripening. The

degradation of chlorophyll allows the expression of other pigments, such as carotenoids, which contribute to the yellow coloration of ripened bananas.

In summary, chlorophyllase in bananas is involved in the breakdown of chlorophyll, facilitating the color changes associated with ripening, and contributing to the characteristic yellow color of ripe bananas.

Question 6. Complete the chart showing human proteins produced by rDNA technology to treat human diseases and re-write.

Disorders/diseases	Recombinant Proteins
?	**Erythropoietin**
Asthma	**?**
?	**Tissue plasminogen activator**
Emphysema	**?**

Answer.

Disorders/diseases	Recombinant Proteins
Anemia	Erythropoietin
Asthma	Monoclonal antibodies (e.g., Omalizumab)
Thrombosis (blood clot-related conditions)	Tissue plasminogen activator
Emphysema	Alpha-1 antitrypsin

Explanation:

- Erythropoietin: Used to treat anemia by stimulating red blood cell production.

- Asthma: Monoclonal antibodies (e.g., Omalizumab) are used to control allergic asthma.
- Tissue plasminogen activator: Used to treat conditions related to thrombosis, such as stroke or heart attack.
- Alpha-1 antitrypsin: Used in the treatment of genetic disorders like alpha-1 antitrypsin deficiency, which can lead to emphysema.

Question 7.
i. Define – Imbibition

Answer. Imbibition is the process in which a substance, typically a solid, absorbs moisture or water and swells. In the context of plants, imbibition commonly refers to the absorption of water by dry seeds, causing them to swell and become hydrated. This initial uptake of water by seeds is a crucial step in the germination process.

During imbibition, water is absorbed by the colloidal substances present in the seed, leading to the enlargement and softening of the seed. This process is important for breaking dormancy and initiating the metabolic activities necessary for germination. Imbibition is influenced by factors such as temperature, humidity, and the nature of the imbibing material.

ii. Explain how imbibition helps root hairs in adsorption of water.

Answer. Imbibition plays a significant role in the absorption of water by root hairs in plants. Root hairs are microscopic outgrowths of root epidermal cells, and their primary function is to absorb water and minerals from the soil. The process of imbibition aids root hairs in the adsorption of water through the following mechanisms:

1. Hydration of Cell Walls: The cell walls of root hairs are composed of cellulose and other hydrophilic substances. During imbibition, these

cell walls absorb water, causing them to swell. This hydration of cell walls creates a favorable environment for water adsorption.

2. Increase in Volume: Imbibition leads to an increase in the volume of the root hair cells. As water is absorbed, the cells swell, and this swelling creates a pressure gradient between the cell interior and the external soil solution.
3. Osmotic Pressure: The increase in cell volume and the hydration of cell walls result in an increase in osmotic pressure within the root hairs. This osmotic pressure gradient facilitates the movement of water from the soil into the root hairs, as water tends to move from regions of lower solute concentration (soil) to higher solute concentration (root hairs).
4. Facilitation of Nutrient Uptake: The imbibed water not only provides hydration to the root hairs but also helps in the dissolution and uptake of essential minerals and nutrients present in the soil. This is crucial for the plant's growth and development.

In summary, imbibition helps root hairs by creating a favorable environment for water adsorption, increasing osmotic pressure, and facilitating the absorption of water along with essential nutrients from the soil.

Question 8. Draw a neat diagram of the conducting system of human heart and label AV node, Bundle of His and Purkinje fibres.

Question 9. Distinguish between heterochromatin and euchromatin with reference to staining property and activity.

Answer. Heterochromatin and euchromatin are two distinct forms of chromatin, which is the complex of DNA and proteins that makes up chromosomes. They differ in terms of staining properties and activity levels:

1. Staining Property:
    - Heterochromatin:
        - Heterochromatin stains densely and appears as dark, condensed regions under a microscope.

        - It stains more intensely with dyes like hematoxylin, indicating a higher DNA density and tight packaging.
    - Euchromatin:
        - Euchromatin stains less densely and appears as light, less condensed regions.
        - It stains less intensely with dyes like hematoxylin, indicating a lower DNA density and a more open, accessible structure.
2. Activity:
    - Heterochromatin:
        - Heterochromatin is generally transcriptionally inactive or less active.
        - It contains highly condensed and tightly packed DNA, making it less accessible to the transcriptional machinery.
        - It often consists of repetitive sequences and plays a role in maintaining the structural integrity of chromosomes.
    - Euchromatin:
        - Euchromatin is transcriptionally active.
        - It has a less condensed and more open structure, allowing for easier access to the transcriptional machinery.
        - Euchromatin is involved in active gene expression, and it contains the genes that are actively transcribed to fulfill cellular functions.

In summary, heterochromatin is densely stained, transcriptionally inactive or less active, and associated with structural functions, while euchromatin is lightly stained, transcriptionally active, and involved in active gene expression. The distinction between these two forms is crucial for understanding the functional organization of the genome.

Question 10. Complete the following chart regarding energy flow in an Ecosystem and re-write:

?	**Herbivores**
Primary Producer	**?**
?	**Man, Lion**
Secondary consumer	**?**

Question 11.
i. What is biofortification?

Answer. Biofortification is a process that involves enhancing the nutritional content of food crops through conventional breeding, genetic engineering, or agronomic practices. The goal of biofortification is to improve the nutritional quality of crops, making them richer in essential nutrients, such as vitamins and minerals, to address specific nutritional deficiencies in human diets.

Key points about biofortification:

1. Nutrient Enhancement: Biofortification aims to increase the levels of essential nutrients in crops, focusing on improving the nutritional value of staple foods commonly consumed by populations facing micronutrient deficiencies.
2. Methods: Biofortification can be achieved through conventional plant breeding methods, where plants with desired nutritional traits are selected and crossbred to produce varieties with higher nutrient content. Alternatively, genetic engineering techniques may be employed to introduce or enhance specific genes responsible for nutrient accumulation.
3. Targeted Nutrients: Different biofortified crops may focus on addressing specific nutrient deficiencies. For example, biofortified crops might be developed to contain higher levels of vitamin A, iron, zinc, or other micronutrients.

4. Impact on Public Health: Biofortification is seen as a sustainable and cost-effective approach to combat malnutrition, particularly in regions where people heavily depend on a limited variety of staple crops. Consuming biofortified foods can contribute to improved health and well-being by addressing nutrient deficiencies.

Common examples of biofortified crops include vitamin A-enriched golden rice, iron-fortified beans, and zinc-enriched wheat. These crops are designed to have a positive impact on the nutritional status of populations, especially in areas where access to diverse diets or nutritional supplements may be limited.

ii. Mention one example each of fortification with reference to –
a. Amino acid content

Answer. An example of fortification related to amino acids is the enrichment of certain food products with lysine. Lysine is an essential amino acid that plays a crucial role in protein synthesis. It is often added to food items like cereals or grains to improve their overall protein quality, especially in regions where lysine deficiency is a concern.

b. Vitamin-C content

Answer. An example of fortification related to Vitamin C is the addition of ascorbic acid (Vitamin C) to various food and beverage products. This fortification is commonly seen in fruit juices, breakfast cereals, and other processed foods to enhance their Vitamin C content. Ascorbic acid is an important antioxidant and contributes to the nutritional value of these products.

Question 12. Differentiate between X-chromosome and Y-chromosome with reference to –

i. length of non-homologous regions

Answer. X-Chromosome:

- The X-chromosome is generally larger than the Y-chromosome.
- It contains a more extensive region of non-homologous (non-matching) genes.
- The X-chromosome carries a variety of genes unrelated to sex determination and is involved in the inheritance of a wide range of traits.

- Y-Chromosome:
  - The Y-chromosome is typically smaller than the X-chromosome.
  - It has a shorter region of non-homologous genes.
  - The Y-chromosome is primarily associated with the determination of male sex and related traits.

ii. type as per position of centromere.

Answer. X-Chromosome:

- The centromere of the X-chromosome is typically located in a more central or median position.
- It divides the chromosome into two relatively equal arms.

- Y-Chromosome:
  - The centromere of the Y-chromosome is usually located closer to one end.
  - This results in the Y-chromosome having a shorter "p" arm (short arm) and a longer "q" arm (long arm).

In summary, the X-chromosome is larger, with an extended non-homologous region and a centromere in a more central position. In contrast, the Y-chromosome is smaller, has a shorter non-homologous region, and its centromere is often located towards one end of the chromosome. The differences between these sex chromosomes contribute to their distinct roles in sex determination and inheritance.

Question 13. Define the terms:
i. Genetic drift

Answer. Genetic drift is a mechanism of evolution that involves random changes in the frequency of alleles in a population over successive generations. Unlike natural selection, genetic drift is driven by chance events rather than by the adaptation of individuals to their environment. It is more pronounced in small populations where random fluctuations can have a more significant impact. Genetic drift can lead to the fixation of certain alleles (allele becomes present in all members of the population) or the loss of alleles in a population over time.

ii. Homologous organs

Answer. Homologous organs are structures in different species that share a common evolutionary origin, indicating that they are derived from the same ancestral structure in a common ancestor. Despite potentially having different functions in the modern organisms, homologous organs share similarities in their basic structure and are evidence of common ancestry. For example, the forelimbs of vertebrates, such as the wings of bats, the arms of humans, and the flippers of whales, are considered homologous organs because they have a common origin in the limbs of a common ancestor. Homologous organs provide important evidence for evolutionary relationships between species.

Question 14.
i. What is ex-situ conservation?

Answer. Ex-situ conservation refers to the conservation of biological diversity outside of the natural habitats. In ex-situ conservation, organisms are taken out of their natural habitat and placed in controlled environments such as botanical gardens, zoos, seed banks, or captive breeding programs. The goal is to protect and preserve species that are endangered, rare, or at risk of extinction.

Key components of ex-situ conservation include:

1. Botanical Gardens and Arboreta: These are places where plants are grown and conserved outside their natural habitat. They serve as living repositories for a diverse range of plant species.
2. Zoos and Aquariums: These institutions house and care for animals in captivity, especially those facing threats in the wild. Zoos may participate in breeding programs to enhance genetic diversity and reintroduce species into their natural habitats.
3. Seed Banks: Seed banks store seeds of various plant species, preserving genetic diversity and ensuring the availability of plant material for future restoration or research purposes. The Svalbard Global Seed Vault is an example of a global seed bank.
4. Captive Breeding Programs: These programs involve breeding and raising endangered or threatened species in controlled environments to ensure their survival. Once the population is strengthened, individuals may be reintroduced into their natural habitats.

Ex-situ conservation plays a crucial role in complementing in-situ conservation efforts (conservation within natural habitats). It provides a safety net for species that face immediate threats and helps prevent the loss of genetic diversity. However, it is essential to integrate ex-situ and in-situ approaches for comprehensive biodiversity conservation.

ii. Mention any two places where the ex-situ conservation is undertaken.

Answer. San Diego Zoo (United States): San Diego Zoo is a well-known institution that actively participates in ex-situ conservation efforts. The zoo is involved in breeding programs for various endangered species and conducts research to contribute to the understanding and conservation of wildlife.

1. Royal Botanic Gardens, Kew (United Kingdom): Kew Gardens is a renowned botanical garden that plays a significant role in ex-situ

conservation of plants. It houses extensive plant collections, conducts research on plant species, and maintains seed banks to preserve genetic diversity and contribute to global plant conservation efforts.

SECTION C

Attempt any EIGHT of the following questions:

Question 15.
i. Define – Incomplete dominance.

Answer. Incomplete dominance is a genetic phenomenon where neither of two alleles in a heterozygous individual completely masks the expression of the other. Instead of one allele being dominant over the other, a unique phenotype is produced in the heterozygote that is a blending or intermediate of the two homozygous phenotypes.

In incomplete dominance:

1. Heterozygous Phenotype: The heterozygous individual expresses a phenotype that is intermediate between the phenotypes of the two homozygous parents.
2. Allelic Interaction: Both alleles contribute to the phenotype, and there is a blending or mixing of their effects.
3. Genotypic and Phenotypic Ratios: In the offspring of a cross between two heterozygous individuals, the genotypic ratio is 1:2:1, and the phenotypic ratio is also 1:2:1.

A classic example of incomplete dominance is seen in flower color in snapdragons. When a red-flowered plant (RR) is crossed with a white-flowered plant (WW), the heterozygous offspring (RW) display a pink flower color, which is an intermediate phenotype between red and white.

ii. If a red flowered Mirabilis jalapa plant is crossed with a white flowered plant, what will be the phenotypic ratio in F2 generation? Show it by a chart.

Answer. Certainly! Let's represent the cross between a red-flowered Mirabilis jalapa plant (RR) and a white-flowered plant (WW). The F1 generation will be heterozygous (RW), and if two F1 individuals are crossed, the F2 generation can be represented as follows:

1. Cross between RR (red) and WW (white):
    - Gametes: R and W
    - F1 generation: RW (heterozygous, pink)
2. Cross between two RW individuals (F1 generation):
    - Gametes: R and W
    - F2 generation phenotypic ratio: 1 (red) : 2 (pink) : 1 (white)

Here's the chart representing the phenotypic ratio in the F2 generation:

	R	W
R	RR	RW
W	RW	WW

Phenotypic ratio in the F2 generation:

- Red flowers: 1 (RR)
- Pink flowers: 2 (RW)
- White flowers: 1 (WW)

This represents the phenotypic outcome of the cross between a red-flowered Mirabilis jalapa plant and a white-flowered plant in the F2 generation.

Question 16.
i. Differentiate between sympathetic and parasympathetic nervous system with reference to the following:
a. Pre and post ganglionic nerve fibres.

Answer. Sympathetic Nervous System vs. Parasympathetic Nervous System:

a. Pre and Post Ganglionic Nerve Fibres:

- Sympathetic Nervous System:
  - *Pre-ganglionic Fibres:* The cell bodies of pre-ganglionic fibers are located in the lateral horns of the spinal cord (thoracic and lumbar regions).
  - *Length of Fibres:* The pre-ganglionic fibers are relatively short.
  - *Ganglia Location:* The pre-ganglionic fibers synapse with post-ganglionic neurons in the sympathetic chain ganglia, which are located near the spinal cord.
  - *Neurotransmitter:* The neurotransmitter released at the pre-to-post ganglionic synapse is mostly acetylcholine (ACh).
- Parasympathetic Nervous System:
  - *Pre-ganglionic Fibres:* The cell bodies of pre-ganglionic fibers are located in the nuclei of cranial nerves (e.g., in the brainstem) and the sacral region of the spinal cord.
  - *Length of Fibres:* The pre-ganglionic fibers are relatively long.
  - *Ganglia Location:* The pre-ganglionic fibers synapse with post-ganglionic neurons in ganglia located near or within the target organ.
  - *Neurotransmitter:* The neurotransmitter released at the pre-to-post ganglionic synapse is acetylcholine (ACh).

In summary, the sympathetic nervous system has short pre-ganglionic fibers originating from the thoracic and lumbar regions of the spinal cord, synapsing in the sympathetic chain ganglia. The parasympathetic nervous system has long pre-ganglionic fibers originating from the brainstem and sacral region of the spinal cord, synapsing in ganglia near or within the

target organ. The neurotransmitter at the pre-to-post ganglionic synapse is acetylcholine in both systems.

b. Effect on heart beat.

Answer. Effect on Heartbeat:

- Sympathetic Nervous System:
  - *Stimulation Effect:* Sympathetic stimulation increases the heart rate.
  - *Neurotransmitter Released:* The post-ganglionic fibers release norepinephrine (noradrenaline) at the synapse with the heart's pacemaker cells (sinoatrial node).
  - *Action:* Norepinephrine binds to beta-adrenergic receptors on the pacemaker cells, leading to an increase in the rate and force of heart contractions.
- Parasympathetic Nervous System:
  - *Stimulation Effect:* Parasympathetic stimulation decreases the heart rate.
  - *Neurotransmitter Released:* The post-ganglionic fibers release acetylcholine at the synapse with the pacemaker cells.
  - *Action:* Acetylcholine binds to muscarinic receptors on the pacemaker cells, leading to a decrease in the rate of depolarization and a decrease in heart rate.

In summary, the sympathetic nervous system increases heart rate and contractility, preparing the body for "fight or flight" responses. In contrast, the parasympathetic nervous system decreases heart rate, promoting a "rest and digest" state. The dynamic interplay between these two systems helps regulate heart function to suit the body's needs in different situations.

ii. Give reason – All spinal nerves are of mixed type.

Answer. Reason Why All Spinal Nerves Are of Mixed Type:

All spinal nerves are classified as mixed nerves because they contain both sensory (afferent) and motor (efferent) nerve fibers within the same nerve bundle. This mixed nature is a result of the way spinal nerves are formed and their diverse functions in the peripheral nervous system. Here's the reason:

1. Formation of Spinal Nerves:
    - Spinal nerves are formed by the fusion of dorsal (posterior) and ventral (anterior) roots that emerge from the spinal cord.
    - The dorsal roots contain sensory (afferent) nerve fibers that carry signals from sensory receptors (such as in the skin, muscles, and organs) to the spinal cord.
    - The ventral roots contain motor (efferent) nerve fibers that transmit signals from the spinal cord to muscles and glands, controlling voluntary and involuntary movements.
2. Combination of Sensory and Motor Fibers:
    - As the dorsal and ventral roots merge to form spinal nerves, they combine both sensory and motor fibers in the same nerve trunk.
    - This mixed composition allows for the integration of sensory input (information from the external environment and the body's internal conditions) and motor output (responses to that input) within a single nerve.
3. Functional Roles:
    - Spinal nerves play a crucial role in connecting the central nervous system (CNS) to different parts of the body.
    - The sensory fibers in spinal nerves transmit information about touch, temperature, pain, and other sensations from the periphery to the CNS.
    - The motor fibers in spinal nerves carry signals from the CNS to muscles and glands, enabling motor responses.

In summary, the mixed nature of spinal nerves is a functional adaptation that allows them to serve as conduits for both sensory and motor

information, facilitating communication between the central nervous system and the rest of the body.

Question 17.
i. Draw a suitable diagram of replication of eukaryotic DNA and label any three parts.

ii. How many amino acids will be there in the polypeptide chain formed on the following mRNA?
5GCCACAUGGAGAUGACGACAAAAUUUUACUAGAAAA3

Answer. To determine the number of amino acids in the polypeptide chain formed by the given mRNA sequence, we need to translate the mRNA sequence into its corresponding amino acid sequence using the genetic code. Each three-nucleotide sequence, called a codon, corresponds to one amino acid.

Given mRNA sequence:

5' GCC ACA UGG AGA UGA CGA CAA AAU UUA CUU AGA AAA 3'
Let's break it into codons:

GCC ACA UGG AGA UGA CGA CAA AAU UUA CUU AGA AAA

Now, let's translate each codon into its corresponding amino acid:

- GCC: Alanine (Ala)
- ACA: Threonine (Thr)
- UGG: Tryptophan (Trp)
- AGA: Arginine (Arg)
- UGA: Stop codon (End of translation)
- CGA: Arginine (Arg)
- CAA: Glutamine (Gln)
- AAU: Asparagine (Asn)
- UUA: Leucine (Leu)

- CUU: Leucine (Leu)
- AGA: Arginine (Arg)
- AAA: Lysine (Lys)

The translation stops at the UGA codon because it is a stop codon. Therefore, the polypeptide chain formed by this mRNA sequence consists of the amino acids:

- Alanine (Ala)
- Threonine (Thr)
- Tryptophan (Trp)
- Arginine (Arg)
- (Translation stops)

So, there are four amino acids in the polypeptide chain formed by the given mRNA sequence.

Question 18. Describe the steps in breathing.

Answer. Breathing Process:

Breathing, or respiration, is the process by which organisms exchange gases with their environment, typically involving the intake of oxygen (O2) and the release of carbon dioxide (CO2). In humans, breathing involves two main processes: inhalation (inspiration) and exhalation (expiration). The steps in breathing are as follows:

**1. Inhalation (Inspiration):

- Muscle Contraction: The primary muscle involved in inhalation is the diaphragm, a dome-shaped muscle below the lungs. The external intercostal muscles between the ribs also play a role.
- Diaphragm Contraction: When the diaphragm contracts, it moves downward, increasing the volume of the thoracic cavity.
- Intercostal Muscle Action: Simultaneously, the external intercostal muscles contract, lifting the ribcage and expanding the chest cavity.

- Volume Increase: The increase in thoracic cavity volume leads to a decrease in air pressure in the lungs.
- Air Rushes In: Due to the pressure difference, air rushes into the lungs from the higher atmospheric pressure outside.

2. Exhalation (Expiration):

- Muscle Relaxation: Exhalation is a passive process in normal breathing at rest. The muscles involved in inhalation relax.
- Diaphragm Relaxation: The diaphragm relaxes and moves upward, reducing the thoracic cavity volume.
- Intercostal Muscle Relaxation: The external intercostal muscles relax, allowing the ribcage to move downward.
- Volume Decrease: The decrease in thoracic cavity volume increases air pressure in the lungs.
- Air is Exhaled: Due to the pressure difference, air is pushed out of the lungs to the atmosphere.

3. Control of Breathing:

- Central Control: Breathing is controlled by the respiratory centers in the brainstem, particularly the medulla oblongata and the pons.
- Chemoreceptors: These receptors sense changes in the levels of oxygen, carbon dioxide, and pH in the blood and provide feedback to regulate breathing rate and depth.

4. Additional Factors:

- Surface Tension: Surfactant in the alveoli reduces surface tension, preventing the collapse of small air sacs during exhalation.
- Compliance: The elasticity of the lung tissue and chest wall influences the ease with which the lungs expand and contract.

Breathing is a continuous and rhythmic process that ensures a constant supply of oxygen to cells and the removal of carbon dioxide, supporting cellular respiration. The regulation of breathing is vital for maintaining homeostasis in the body.

Question 19.
i. What is spermatogenesis?

Answer. Spermatogenesis is the process by which male germ cells, known as spermatogonia, undergo a series of divisions and differentiations to produce mature sperm cells, or spermatozoa. This complex and highly regulated process takes place in the testes, specifically within the seminiferous tubules, and is essential for the continuous production of sperm throughout the reproductive life of a male.

The key stages of spermatogenesis include:

1. Spermatogonium (Spermatogonia):
    - Spermatogenesis begins with diploid stem cells called spermatogonia, located in the outer lining of the seminiferous tubules.
    - Spermatogonia undergo mitotic divisions to produce primary spermatocytes.
2. Primary Spermatocyte:
    - The primary spermatocyte, still diploid, undergoes the first meiotic division (meiosis I).
    - This division results in two haploid cells called secondary spermatocytes.
3. Secondary Spermatocytes:
    - Each secondary spermatocyte undergoes the second meiotic division (meiosis II).
    - This division results in four haploid cells called spermatids.
4. Spermatids:
    - Spermatids are immature cells with a reduced chromosome number.
    - They undergo further differentiation and maturation to develop into spermatozoa (sperm cells).
5. Spermatozoa (Sperm Cells):

- Spermatozoa undergo a process called spermiogenesis, involving structural changes to develop into mature and motile sperm.
- The mature sperm cells are released into the lumen of the seminiferous tubules.

6. Release of Sperm:
    - Spermatozoa move into the epididymis, where they undergo maturation and become capable of fertilizing an egg.
    - During ejaculation, mature sperm are propelled through the vas deferens and mixed with seminal fluid to form semen.

Spermatogenesis is a continuous and regulated process that ensures the production of millions of sperm per day in a healthy adult male. The entire process takes approximately 64 to 72 days, and the sperm produced during spermatogenesis carry half of the genetic information needed for fertilization.

ii. Draw a neat and labelled diagram of spermatogenesis.

Question 20.
i. What is a connecting link?

Answer. In biological classification, a "connecting link" refers to an organism or a taxonomic group that exhibits characteristics of two distinct groups, providing a link between them. Connecting links are often considered transitional forms that share features of ancestral and descendant groups, offering insights into the evolutionary relationships between different taxa. These organisms are crucial in understanding the evolutionary pathways and the development of various traits over time.

Connecting links are particularly relevant in the context of evolutionary biology and paleontology. Fossils, comparative anatomy, molecular biology, and other scientific approaches help identify these transitional forms. By studying connecting links, scientists can gain a better understanding of how

certain traits and characteristics have evolved and diversified throughout the history of life on Earth.

One classic example of a connecting link is the Archaeopteryx, which is considered a transitional form between dinosaurs and birds. Archaeopteryx exhibits features of both reptiles (such as teeth, a long bony tail, and clawed fingers) and birds (such as feathers and a wishbone), providing evidence for the evolutionary transition from dinosaurs to modern birds.

Connecting links play a crucial role in the study of phylogenetics and the construction of evolutionary trees, helping scientists map out the relationships between different groups of organisms and trace the evolutionary history of life.

ii. Which fossil animal is considered as the connecting link between reptiles and birds? Give any one character of each class found in it.

Answer. The fossil animal considered as a connecting link between reptiles and birds is Archaeopteryx.

Characteristics of Archaeopteryx:

1. Reptilian Characteristics:
    - *Teeth:* Archaeopteryx possesses teeth, a reptilian characteristic. This is in contrast to modern birds, which lack teeth.
2. Avian (Bird) Characteristics:
    - *Feathers:* Archaeopteryx has well-developed feathers, a defining avian characteristic. The presence of feathers in Archaeopteryx provides evidence of the link between reptiles and birds.

Archaeopteryx is often considered a transitional fossil, exhibiting features of both reptiles and birds. Its combination of reptilian and avian traits supports the hypothesis that birds evolved from reptilian ancestors. The fossil record

of Archaeopteryx helps scientists understand the gradual acquisition of avian characteristics during the course of evolution.

Question 21. Complete the following chart regarding population interaction and re-write:

Sr. No.	**Name of interaction**	**Interaction between**
1	**?**	**Plasmodium and Man**
2	**?**	**Leopard and Lion**
3	**?**	**Clown fish and Sea-anemone**

Answer.

Sr. No.	**Name of interaction**	**Interaction between**
1	Parasitism	Plasmodium and Man
2	Predation	Leopard and Lion
3	Mutualism	Clown fish and Sea-anemone

Re-written:

1. Parasitism (Interaction between Plasmodium and Man):
    - Plasmodium, the causative agent of malaria, exhibits parasitism by infecting humans. The parasite benefits by utilizing the human host for nourishment and reproduction, causing harm to the host in the process.
2. Predation (Interaction between Leopard and Lion):

- Predation is observed between leopards and lions in the context of carnivores. Lions, as predators, may prey on leopards or compete for similar prey in their ecosystem.

3. Mutualism (Interaction between Clown fish and Sea-anemone):
   - Clown fish and sea-anemone engage in mutualism, a symbiotic relationship where both species benefit. The clown fish find protection within the stinging tentacles of the sea-anemone, while the sea-anemone benefits from the nutrients provided by the clown fish and protection from potential predators.

Question 22.
i. What is composition of bio-gas?

Answer. Biogas Composition:

Biogas is a renewable energy source produced through the anaerobic digestion of organic materials, such as agricultural residues, manure, municipal waste, and sewage. The primary components of biogas are methane (CH_4) and carbon dioxide (CO_2), along with small amounts of other gases. The composition of biogas can vary depending on the feedstock and the anaerobic digestion process, but the typical composition is as follows:

1. Methane (CH_4): Methane is the main component of biogas and is a valuable energy source. It typically makes up around 50% to 70% of the total volume of biogas.
2. Carbon Dioxide (CO_2): Carbon dioxide is the second most abundant component in biogas. It usually constitutes around 30% to 50% of the total volume. While methane is the desired energy component, the presence of carbon dioxide is unavoidable in the anaerobic digestion process.
3. Trace Gases:
   - Hydrogen Sulfide (H_2S): In some cases, biogas may contain traces of hydrogen sulfide, which is a corrosive and odorous

gas. Hydrogen sulfide levels need to be reduced for safety and environmental reasons.
- Nitrogen (N_2), Oxygen (O_2), and Other Trace Gases: These gases may be present in small amounts, depending on the feedstock and the anaerobic digestion conditions.

It's important to note that the composition of biogas can be influenced by factors such as the type of organic material used, the efficiency of the anaerobic digestion process, and the presence of contaminants. Biogas can be used as a renewable energy source for heating, electricity generation, and as a vehicle fuel. Additionally, the byproduct of anaerobic digestion, known as digestate, can be used as a nutrient-rich fertilizer.

ii. Mention any four benefits of bio-gas.

Answer. Four Benefits of Biogas:

1. Renewable Energy Source:
   - Reduced Dependency on Fossil Fuels: Biogas is a renewable energy source produced from organic materials, such as agricultural waste, animal manure, and sewage. Using biogas helps reduce dependency on non-renewable fossil fuels, contributing to sustainable energy practices.
2. Greenhouse Gas Reduction:
   - Methane Capture and Utilization: The anaerobic digestion process used to produce biogas captures methane, a potent greenhouse gas that would otherwise be released into the atmosphere during the decomposition of organic waste. By converting methane into biogas and utilizing it for energy, biogas systems contribute to greenhouse gas reduction and mitigate climate change.
3. Waste Management and Pollution Control:
   - Organic Waste Utilization: Biogas production involves the anaerobic digestion of organic waste, providing an effective means of waste management. It helps to treat and utilize

agricultural residues, animal manure, and sewage, reducing the environmental impact of untreated organic waste. This process also helps control odors and prevents water pollution associated with the disposal of untreated waste.

4. Energy Independence for Rural Communities:
    - Local Energy Generation: Biogas systems can be implemented on a small scale in rural areas, allowing communities to generate their own energy locally. This promotes energy independence, especially in areas where access to traditional energy sources may be limited. Biogas provides a reliable and sustainable energy solution for cooking, lighting, and other domestic needs in rural settings.
5. Nutrient-Rich Fertilizer Production:
    - Digestate Utilization: The byproduct of the anaerobic digestion process, known as digestate, is a nutrient-rich fertilizer. It contains valuable nutrients such as nitrogen, phosphorus, and potassium. By using digestate as fertilizer, biogas systems contribute to soil fertility and enhance agricultural practices in a sustainable manner.

These benefits highlight the multifaceted advantages of biogas, encompassing environmental, social, and economic aspects.

Question 23.
i. Give reason – Water acts as thermal buffer.

Answer. Reason Why Water Acts as a Thermal Buffer:

Water exhibits a property known as high specific heat capacity, and this characteristic allows it to act as a thermal buffer. The specific heat capacity of a substance is the amount of heat energy required to raise the temperature of a unit mass of that substance by a certain amount. Water has a relatively high specific heat capacity compared to many other substances. The main reason for water acting as a thermal buffer is its

ability to absorb and store a significant amount of heat without experiencing a large change in temperature. Here's why:

1. Hydrogen Bonding: Water molecules are polar, meaning they have a partial positive charge on the hydrogen side and a partial negative charge on the oxygen side. This polarity results in hydrogen bonding between water molecules. Hydrogen bonds are relatively strong forces that require energy to break.
2. Heat Absorption: When heat is applied to water, the energy is used to break the hydrogen bonds between water molecules before the temperature of the water increases. This means that water can absorb a considerable amount of heat energy without a significant rise in temperature.
3. Heat Release: Conversely, when water releases heat, such as during cooling or phase changes (e.g., from liquid to solid during freezing), the hydrogen bonds reform. This process releases stored energy, helping to maintain a stable temperature.
4. Thermal Inertia: The high specific heat capacity of water contributes to its thermal inertia, which means that it resists rapid temperature changes. This property is particularly important in natural systems like oceans, lakes, and living organisms.
5. Stabilizing Effect: In natural environments, bodies of water, such as oceans or large lakes, can act as thermal buffers. They absorb heat during the day and release it at night, moderating temperature extremes and creating a more stable environment for aquatic life and surrounding ecosystems.

In summary, water's high specific heat capacity, coupled with its ability to form hydrogen bonds, allows it to absorb and release heat efficiently, making it an effective thermal buffer in various natural systems.

ii. Draw a neat and proportionate diagram of root hair and label mitochondria, nucleus and vacuole.

Question 24. Explain three main functions of free antibodies produced by B-lymphocytes.

Answer. Three Main Functions of Free Antibodies Produced by B-Lymphocytes:

1. Neutralization of Pathogens:
    - One primary function of free antibodies is to neutralize pathogens, such as bacteria and viruses, by binding to their surface antigens. Antibodies can neutralize pathogens by preventing them from entering or infecting host cells. When antibodies attach to the surface of a pathogen, they can block the pathogen's ability to interact with host cells or interfere with the pathogen's ability to release toxins. This neutralization process is crucial for preventing the spread of infections and limiting the severity of diseases.
2. Opsonization and Phagocytosis:
    - Antibodies enhance the process of phagocytosis, where specialized immune cells (phagocytes) engulf and destroy pathogens. This process is facilitated by a phenomenon known as opsonization. Antibodies coat the surface of pathogens, marking them for recognition by phagocytes. Phagocytes, such as macrophages and neutrophils, have receptors for the constant region (Fc region) of antibodies. When antibodies bind to pathogens, they act as opsonins, making it easier for phagocytes to recognize and engulf the marked pathogens. This enhances the efficiency of the immune system in clearing infections.
3. Activation of Complement System:
    - Antibodies can activate the complement system, which is a group of proteins that play a crucial role in the immune response. The complement system can be activated through

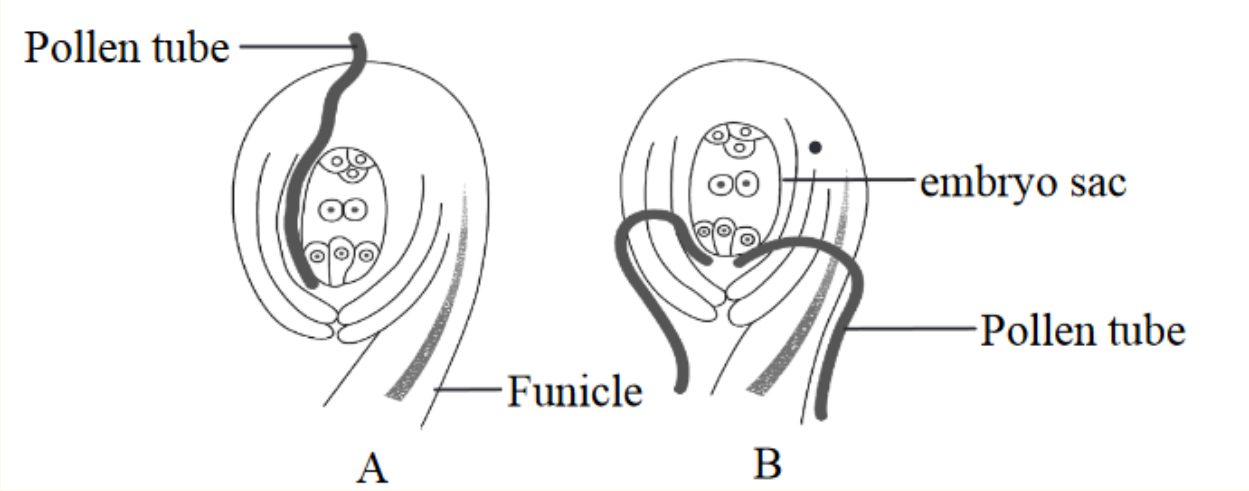
the classical pathway, which involves the binding of antibodies to antigens on the surface of pathogens. Once activated, the complement system can lead to several immune responses, including the formation of membrane attack complexes that can directly lyse pathogens, the recruitment of immune cells to the site of infection, and the enhancement of phagocytosis.

- Additionally, the complement system amplifies the immune response by promoting inflammation and facilitating the removal of immune complexes. The interaction between antibodies and the complement system is an important aspect of the humoral immune response.

In summary, free antibodies produced by B-lymphocytes play crucial roles in the immune response, including neutralizing pathogens, facilitating phagocytosis, and activating the complement system. These functions contribute to the body's ability to recognize, target, and eliminate harmful invaders.

Question 25.

i. Following are the diagrams of entry of pollen tube into ovule. Identify the type A and B.



ii. Give any four points of significance of double fertilization.

Answer. Four Points of Significance of Double Fertilization:

1. Formation of Zygote and Endosperm:
    - In double fertilization, two sperm cells are involved in fertilizing two different structures within the ovule. One sperm fertilizes the egg cell, forming the zygote, which develops into the embryo. The other sperm fuses with two polar nuclei, leading to the formation of a triploid cell called the primary endosperm nucleus. This triploid cell undergoes multiple divisions to give rise to the endosperm, a nutrient-rich tissue that nourishes the developing embryo in the seed. The simultaneous formation of the zygote and endosperm is a unique feature of double fertilization.
2. Nutrient Supply for Embryo Development:
    - The endosperm formed through double fertilization serves as a nutritive tissue that provides essential nutrients, such as carbohydrates, proteins, and lipids, for the developing embryo. As the embryo undergoes early stages of development, it relies on the stored nutrients in the endosperm until it can establish its own photosynthetic capabilities or absorb nutrients from the surrounding environment. This ensures the initial nourishment and support for the growing embryo.
3. Regulation of Seed Development:
    - Double fertilization plays a crucial role in regulating seed development and ensuring the proper balance of genetic material. The fusion of one sperm cell with the egg cell results in the diploid zygote, which gives rise to the embryo. Simultaneously, the fusion of the other sperm cell with the polar nuclei results in the triploid endosperm nucleus. The triploid nature of the endosperm contributes to its function as a nutrient storage tissue, and the coordinated development of the embryo and endosperm is essential for the successful formation of seeds.
4. Prevention of Polyembryony:
    - Double fertilization helps prevent polyembryony, which is the development of multiple embryos within a single seed. By ensuring that only one of the two sperm cells fuses with the egg

cell to form the zygote, double fertilization helps maintain the proper structure and function of seeds. This selective fertilization contributes to seed diversity and ensures the genetic integrity of individual plants.

Overall, double fertilization is a unique and essential reproductive mechanism in angiosperms that contributes to the successful development of seeds by forming both the zygote and the nutritive endosperm.

Question 26.
i. Name the hormone which is responsible for apical dominance.

Answer. The hormone responsible for apical dominance is auxin. Auxin is a class of plant hormones that plays a crucial role in regulating various aspects of plant growth and development, including the suppression of lateral bud growth in favor of apical (terminal) bud growth. In the context of apical dominance, auxin is produced in the apical bud (the terminal bud at the tip of a shoot) and inhibits the growth of lateral buds below it.

The apical bud releases auxin, which moves downward, inhibiting the growth of lateral buds by suppressing the development of branches. This phenomenon allows the apical bud to maintain dominance over the lateral buds, ensuring the vertical growth of the main stem. Pruning or removal of the apical bud can release lateral buds from auxin inhibition, promoting branching and lateral shoot development.

ii. A farmer wants to remove broad-leaved weeds from the jowar plantation in his field. Suggest any plant hormone to remove such weeds.

Answer. The plant hormone that can be used to selectively remove broad-leaved weeds from a jowar (sorghum) plantation is 2,4-Dichlorophenoxyacetic acid, commonly known as 2,4-D.

Mode of Action:

- 2,4-D is a synthetic auxin that disrupts the normal growth patterns in broad-leaved plants, leading to uncontrolled growth and eventually causing the death of the target weeds.
- While 2,4-D has a selective effect on broad-leaved plants, it is less harmful to grasses, such as jowar. This selectivity makes it a suitable herbicide for controlling broad-leaved weeds in grass crops like jowar.

Application:

- 2,4-D is often formulated as an herbicide and can be applied as a spray in the field. It is absorbed by the leaves and stems of the target weeds, disrupting their growth processes.

Caution:

- Care should be taken to follow recommended application rates and guidelines to prevent damage to the desired crop (jowar) and minimize environmental impact.

It's important for the farmer to consult with agricultural experts or follow recommended practices to ensure the safe and effective use of herbicides like 2,4-D in weed control within the jowar plantation.

iii. Mention any two applications of cytokinin.

Answer. Two Applications of Cytokinin:

1. Promotion of Cell Division and Shoot Growth:
    - Cytokinins are plant hormones that play a key role in promoting cell division and shoot growth. They stimulate the formation of new cells and influence the development of shoots and lateral buds. As a result, cytokinins are commonly used in horticulture and agriculture to enhance the growth and branching of plants.

Applications of cytokinins can lead to increased yields, improved crop architecture, and overall healthier plants.

2. Delaying Senescence and Promoting Longevity of Cut Flowers:
    - Cytokinins are used in the floral industry to extend the vase life of cut flowers. When applied to cut flower stems, cytokinins can delay senescence (aging) processes, such as wilting and petal loss. This allows cut flowers to remain fresh and attractive for a longer period, making them more appealing to consumers. Cytokinins help maintain the turgor pressure in plant cells and reduce the impact of aging-related processes, contributing to the longevity of cut flowers in floral arrangements.

These applications highlight the role of cytokinins in regulating plant growth and development, both in the context of crop production and in enhancing the ornamental value of cut flowers.

SECTION D

Attempt any THREE of the following questions:

Question 27.

i. What is blood pressure?

Answer. Blood pressure is the force exerted by the blood against the walls of the arteries as it is pumped by the heart. It is expressed as two values: the systolic pressure over the diastolic pressure. The measurement is typically given in millimeters of mercury (mmHg). The two values represent different phases of the cardiac cycle:

1. Systolic Pressure:
    - The higher of the two values.
    - It represents the pressure in the arteries when the heart contracts (during systole) and pumps blood into the circulatory system.
    - This is the maximum pressure exerted on the arterial walls.

2. Diastolic Pressure:
    - The lower of the two values.
    - It represents the pressure in the arteries when the heart is at rest and is not actively contracting (during diastole).
    - This is the minimum pressure exerted on the arterial walls.

Blood pressure is a critical physiological parameter that reflects the cardiovascular health of an individual. It is influenced by factors such as the force of the heart's contractions, the volume of blood pumped, the elasticity of the arteries, and the resistance of the blood vessels. Blood pressure is measured using a sphygmomanometer and is expressed as the ratio of systolic pressure to diastolic pressure (e.g., 120/80 mmHg).

Normal blood pressure is generally considered to be around 120/80 mmHg. Persistent high blood pressure (hypertension) or low blood pressure (hypotension) can be indicative of underlying health issues and may require medical attention and management. Regular monitoring of blood pressure is crucial for maintaining cardiovascular health and preventing related complications.

ii. Give the name of the instrument which is used to measure the blood pressure.

Answer. The instrument used to measure blood pressure is called a sphygmomanometer. There are different types of sphygmomanometers, but the most common ones include:

1. Mercury Sphygmomanometer:
    - This traditional type of sphygmomanometer uses a column of mercury to measure blood pressure. It consists of an inflatable cuff to wrap around the upper arm, a mercury-filled manometer, and a bulb to inflate the cuff.
2. Aneroid Sphygmomanometer:
    - This type of sphygmomanometer uses a mechanical aneroid (a small, flexible metal box) instead of mercury to measure blood

pressure. It typically has a dial that displays the pressure readings.

3. Digital (Electronic) Sphygmomanometer:
    - Modern digital sphygmomanometers use electronic sensors and a digital display to provide blood pressure readings. They are often automated, making them user-friendly and suitable for home use.

The process of measuring blood pressure using a sphygmomanometer involves wrapping the inflatable cuff around the upper arm, inflating it to temporarily stop the blood flow, and then slowly releasing the pressure while listening to or monitoring the Korotkoff sounds. The first sound heard corresponds to the systolic pressure, and the point at which the sounds disappear corresponds to the diastolic pressure. The blood pressure reading is expressed as systolic/diastolic mmHg.

iii. Differentiate between an artery and a vein with reference to lumen and thickness of wall.

Answer. Difference Between Artery and Vein:

1. Lumen:
    - Artery: Arteries typically have a smaller lumen (the central, open space through which blood flows) compared to veins. The smaller lumen helps maintain the high pressure required to propel blood away from the heart to various parts of the body.
    - Vein: Veins generally have a larger lumen to accommodate the lower-pressure blood returning from different parts of the body back to the heart. The larger lumen facilitates the smooth flow of blood and reduces resistance.
2. Thickness of Wall:
    - Artery: Arteries have thicker walls compared to veins. The walls of arteries are composed of three main layers: the inner endothelium, a middle layer of smooth muscle and elastic fibers (media), and an outer layer of connective tissue (adventitia).

The thick, muscular walls of arteries contribute to their ability to withstand and regulate the high pressure generated by the pumping action of the heart.

- Vein: Veins have thinner walls compared to arteries. The walls of veins consist of three layers as well: the inner endothelium, a thinner layer of smooth muscle and elastic fibers, and an outer layer of connective tissue. The thinner walls of veins reflect the lower pressure of blood returning to the heart.

In summary, arteries have a smaller lumen and thicker walls to withstand high pressure and efficiently transport oxygenated blood away from the heart, while veins have a larger lumen and thinner walls to accommodate the return of deoxygenated blood at lower pressure back to the heart.

Question 28.
i. Describe any three adaptations in anemophilous flowers. Mention any one example of the anemophilous flower.

Answer. Adaptations in Anemophilous Flowers:

1. Reduced Petals and Sepals:
   - Anemophilous flowers often have reduced or inconspicuous petals and sepals. This reduction in floral structures minimizes the surface area exposed to the wind, reducing wind resistance. The primary goal is efficient wind pollination, and elaborate floral structures are not necessary to attract pollinators.
2. Large Amounts of Pollen:
   - Anemophilous flowers produce a large quantity of lightweight, dry pollen grains. These pollen grains are small, non-sticky, and easily carried by the wind over long distances. The abundance of pollen increases the chances of successful pollination, compensating for the lack of precision in wind dispersal.
3. Feathery Stigmas:
   - The stigmas of anemophilous flowers often have feathery or branched structures. These feathery structures increase the

surface area available for capturing airborne pollen. As the wind blows, the feathery stigmas can trap and collect pollen efficiently, enhancing the likelihood of successful pollination.

Example of Anemophilous Flower:

- Common Ragweed (*Ambrosia artemisiifolia*):
    - Common ragweed is an example of an anemophilous flower. It produces inconspicuous flowers with reduced petals and sepals. The plant releases large amounts of lightweight pollen into the air, relying on the wind to carry the pollen to neighboring flowers for pollination. The feathery stigmas of common ragweed facilitate the capture of airborne pollen for successful pollination.

These adaptations in anemophilous flowers are geared toward maximizing the efficiency of wind pollination, allowing plants to reproduce successfully in environments where reliance on wind dispersal is advantageous.

ii. Describe any three adaptations in hydrophilous flowers. Mention any one example of the hydrophilous flower.

Answer. Adaptations in Hydrophilous Flowers:

1. Reduced or Absent Petals and Sepals:
    - Hydrophilous flowers often have reduced or absent petals and sepals. Unlike anemophilous flowers that rely on wind for pollination, hydrophilous flowers are adapted for pollination in aquatic environments where water currents assist in the transfer of pollen. Reducing floral structures minimizes resistance to water flow.
2. Production of Viable, Buoyant Pollen:
    - Hydrophilous flowers produce pollen grains that are adapted to be buoyant and remain viable in water. These pollen grains typically have a mucilaginous coating or a gel-like structure that

helps them float on the water's surface. This adaptation ensures that the pollen can travel over water to reach the stigmas of other flowers for pollination.

3. Stigmas Above Water Surface:
    - The stigmas of hydrophilous flowers are positioned above the water surface to facilitate pollen capture. This positioning helps prevent pollen from becoming waterlogged and sinking. By keeping the stigmas above the water, the flowers increase the chances of successful pollen transfer in aquatic environments.

Example of Hydrophilous Flower:

- Water Lily (*Nymphaea spp.*):
    - Water lilies are classic examples of hydrophilous flowers. They have large, showy flowers with reduced sepals and petals. The pollen grains of water lilies are gel-coated, allowing them to float on the water's surface. The stigmas are positioned above the water to capture pollen efficiently. Water lilies are adapted to aquatic habitats, and their pollination is facilitated by water currents.

These adaptations in hydrophilous flowers are specialized for effective pollination in aquatic environments where water movement is a key factor in the reproductive process.

Question 29.
i. What is polymerase chain reaction (PCR)?

Answer. Polymerase Chain Reaction (PCR) is a widely used molecular biology technique that amplifies a specific segment of DNA. Developed by Kary Mullis in the 1980s, PCR has become a fundamental tool in various scientific and diagnostic applications. The process allows the rapid and selective amplification of DNA, making it possible to generate millions or billions of copies of a target DNA sequence within a short period.

Key Components and Steps of PCR:

1. Denaturation:
    - The PCR reaction begins with the denaturation of the DNA template. This involves heating the reaction mixture to a high temperature (usually around 94–98°C). The high temperature causes the double-stranded DNA to separate into two single strands.
2. Annealing:
    - After denaturation, the reaction temperature is lowered to allow the primers to anneal to the complementary sequences on each of the single-stranded DNA templates. Primers are short synthetic DNA sequences that flank the target region and serve as starting points for DNA synthesis.
3. Extension (Elongation):
    - DNA polymerase, a heat-stable enzyme, extends the primers by adding nucleotides to the 3' end of each primer, synthesizing a new DNA strand complementary to the template. The extension step typically occurs at a temperature optimal for the DNA polymerase used (usually around 72°C).
4. Cycling:
    - The entire process of denaturation, annealing, and extension is repeated in a cyclic manner, typically 20 to 40 cycles. Each cycle doubles the amount of DNA in the reaction, resulting in exponential amplification of the target DNA sequence.

By the end of the PCR process, the targeted DNA sequence is amplified to a detectable level, and the resulting DNA products can be analyzed using various techniques, such as gel electrophoresis or real-time PCR.

Applications of PCR:

- Molecular Biology Research: PCR is widely used in molecular biology research for cloning, sequencing, and studying gene expression.
- Diagnostic Applications: PCR is used in diagnostic laboratories for the detection of pathogens, genetic diseases, and forensic analysis.

- DNA Profiling: PCR is employed in DNA fingerprinting and profiling for personal identification and criminal investigations.
- Genetic Engineering: PCR is a crucial tool in genetic engineering and the production of genetically modified organisms (GMOs).

PCR's versatility and efficiency make it an indispensable technique in various fields, revolutionizing the way DNA is studied and analyzed.

ii. Describe three steps involved in mechanism of PCR.

Answer. The polymerase chain reaction (PCR) involves a series of temperature-dependent steps that collectively amplify a specific DNA sequence. The key steps in the mechanism of PCR are denaturation, annealing, and extension (elongation).

1. Denaturation:
    - Temperature: The PCR reaction begins with a denaturation step, typically at a high temperature (around 94–98°C). This high temperature causes the double-stranded DNA template to separate into two single strands.
    - Purpose: Denaturation is a crucial step because it allows the DNA helix to unwind, breaking the hydrogen bonds between the complementary bases. This results in the formation of two single-stranded DNA molecules, serving as templates for the synthesis of new strands.
2. Annealing:
    - Temperature: Following denaturation, the reaction temperature is lowered to allow the primers to anneal to the single-stranded DNA templates. The annealing temperature is typically between 50–65°C.
    - Purpose: Annealing involves the binding of short synthetic DNA primers to the complementary sequences on each of the single-stranded DNA templates. Primers serve as starting points for DNA synthesis by DNA polymerase. The specificity of

PCR relies on the ability of the primers to selectively anneal to the target DNA sequence.

3. Extension (Elongation):
    - Temperature: After annealing, the reaction temperature is increased to a temperature optimal for DNA polymerase activity, usually around 72°C.
    - Purpose: DNA polymerase, a heat-stable enzyme, extends the primers by adding nucleotides to the 3' end of each primer. This results in the synthesis of a new DNA strand complementary to the template. The extension step completes the synthesis of the target DNA sequence. The duration of the extension step depends on the length of the target DNA segment and the DNA polymerase used.

These three steps—denaturation, annealing, and extension—are repeated in a cyclic manner through multiple rounds of PCR. Each cycle doubles the amount of DNA in the reaction, leading to exponential amplification of the target DNA sequence. The entire PCR process is typically carried out in a thermal cycler, which precisely controls the temperature at each step of the reaction.

Question 30.
i. Give any four significances of fertilization in human.

Answer. Significances of Fertilization in Humans:

1. Formation of a Diploid Zygote:
    - Fertilization involves the fusion of a sperm cell (haploid) with an egg cell (haploid) to form a diploid zygote. The zygote contains a complete set of chromosomes with genetic material from both parents. This diploid cell serves as the starting point for the development of a new individual.
2. Initiation of Embryonic Development:
    - Fertilization marks the beginning of embryonic development. The zygote undergoes multiple rounds of cell division through mitosis, forming a blastocyst. The blastocyst then undergoes

implantation into the lining of the uterus, leading to the establishment of pregnancy.

3. Genetic Diversity in Offspring:
    - Fertilization introduces genetic diversity into the offspring. The combination of genetic material from the mother and father results in unique combinations of traits, ensuring variability in the population. This genetic diversity is essential for adaptation to changing environments and contributes to the overall biodiversity of the human population.
4. Activation of Meiotic Arrest in Oocytes:
    - Fertilization leads to the activation of meiotic arrest in the secondary oocyte. The secondary oocyte is arrested at the metaphase II stage of meiosis. Upon fertilization, this arrest is lifted, and meiosis II is completed. This ensures the proper reduction in chromosome number and the formation of a haploid egg, facilitating the fusion with a haploid sperm.

These significances highlight the crucial role of fertilization in initiating the development of a new individual, establishing genetic diversity, and ensuring the proper progression of meiosis in oocytes. Fertilization is a complex biological process that sets the stage for the formation of a viable and genetically unique organism.

ii. Mention the names of any two organs each derived from ectoderm and mesoderm.

Answer. Organs Derived from Ectoderm:

1. Skin and Its Appendages: The epidermis of the skin, hair, nails, and sweat glands are derived from the ectoderm during embryonic development.
2. Nervous System: The central nervous system (including the brain and spinal cord), peripheral nerves, and sensory organs (such as the eyes and ears) originate from the ectodermal layer.

Organs Derived from Mesoderm:

1. Musculoskeletal System: The bones, muscles, and connective tissues of the musculoskeletal system develop from the mesoderm. This includes the axial and appendicular skeleton, as well as voluntary muscles.
2. Cardiovascular System: The heart, blood vessels, and blood cells are derived from the mesoderm. The mesoderm gives rise to the structures necessary for the circulatory system to function.

These examples illustrate the diverse range of organs and systems that originate from the ectodermal and mesodermal germ layers during embryonic development. The ectoderm contributes to structures involved in protection, sensation, and coordination, while the mesoderm gives rise to supportive and transport systems within the body.

Question 31.
i. Give any two functions of cerebellum.

Answer. Functions of the Cerebellum:

1. Coordination of Movement:
    - One of the primary functions of the cerebellum is the coordination of voluntary movements. It plays a crucial role in fine-tuning and coordinating the actions of muscles to ensure smooth and precise movements. The cerebellum receives input from sensory systems, such as the proprioceptive feedback from muscles and joints, and integrates this information to adjust and modulate motor commands sent from the brain's motor cortex.
2. Maintenance of Balance and Posture:
    - The cerebellum is essential for maintaining balance and posture. It receives input from the vestibular system, which is responsible for sensing the position and movement of the head in space. The cerebellum processes this information and

contributes to the regulation of muscle tone and coordination required for maintaining an upright posture and balance during both static and dynamic activities.

These functions highlight the crucial role of the cerebellum in motor control and the execution of coordinated movements. Damage or dysfunction of the cerebellum can result in movement disorders, impaired coordination, and difficulties with balance and posture.

ii. Write the names of any four motor cranial nerves with their appropriate serial number.

Answer. Here are four motor cranial nerves along with their appropriate serial numbers:

1. Oculomotor Nerve (CN III):
    - Serial Number: III
    - Function: Controls the movement of the eye muscles, including the levator palpebrae superioris (lifting the eyelid) and extraocular muscles responsible for eye movement.
2. Trochlear Nerve (CN IV):
    - Serial Number: IV
    - Function: Innervates the superior oblique muscle of the eye, contributing to the downward and outward movement of the eye.
3. Abducens Nerve (CN VI):
    - Serial Number: VI
    - Function: Controls the lateral rectus muscle, which is responsible for abducting (moving away) the eye.
4. Hypoglossal Nerve (CN XII):
    - Serial Number: XII
    - Function: Innervates the muscles of the tongue, contributing to tongue movement and speech articulation.

These motor cranial nerves are involved in the control of various muscles, including those responsible for eye movement, tongue movement, and facial expression.

iii. Which hormones stimulate liver for glycogenesis and glucogenolysis?

Answer. The hormones that regulate liver functions, specifically glycogenesis (formation of glycogen) and glycogenolysis (breakdown of glycogen into glucose), are insulin and glucagon.

1. Insulin:
    - Action on Liver: Insulin is released by the pancreas in response to high blood glucose levels. It stimulates the liver to take up glucose from the blood and convert it into glycogen through the process of glycogenesis. This helps lower blood glucose levels by storing excess glucose in the form of glycogen.
2. Glucagon:
    - Action on Liver: Glucagon is released by the pancreas in response to low blood glucose levels. It signals the liver to break down glycogen into glucose through the process of glycogenolysis. This results in the release of glucose into the bloodstream, raising blood glucose levels to meet the energy needs of the body.

The balance between insulin and glucagon levels helps maintain glucose homeostasis in the body by regulating the storage and release of glucose from the liver. These hormones play a crucial role in glucose metabolism and energy regulation.