

CUET UG (Biology)

29 May 2024 Shift 1

Question 1

Who performed experiments on *Vicia faba* to prove that the DNA replicates semi-conservatively ?

Options:

- A. Taylor and colleagues
- B. Matthew Meselson
- C. Stahl
- D. Hershey and Chase

Answer: A

Solution:

The correct answer is **Taylor and colleagues**

Concept:

- DNA replication is the process by which a cell duplicates its DNA, making an exact copy. This process is essential for cell division and is fundamental to biological inheritance.
- The semi-conservative model of DNA replication suggests that each of the two strands of the DNA molecule serves as a template for the production of a complementary strand. This results in two DNA molecules, each with one original strand and one new strand.

Explanation:

- **Taylor and colleagues:** They performed experiments on *Vicia faba* (fababean) in 1958 using radioactive thymidine to prove the semi-conservative replication of DNA. Their work involved tracking the incorporation of the radioactive marker into new DNA strands during replication. The experiments proved that the DNA in chromosomes also replicate semiconservatively.
- **Matthew Meselson and Stahl:** Meselson, along with Franklin Stahl, conducted the famous experiment using *E. coli* and isotopes of nitrogen (N-14 and N-15) to demonstrate the semi-conservative replication of DNA. cells. Matthew Meselson and Franklin Stahl performed the experiment in 1958. This experiment provided strong evidence for the semi-conservative model but did not involve *Vicia faba*.

- **Hershey and Chase:** The unequivocal proof that DNA is the genetic material came from the experiments of Alfred Hershey and Martha Chase (1952). They worked with viruses that infect bacteria called bacteriophages.
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Question 2

A thermostable DNA polymerase is isolated from :

Options:

- A. *Thermus aquaticus*
- B. *Agrobacterium tumefaciens*
- C. *E. coli*
- D. *Salmonella typhimurium*

Answer: A

Solution:

The correct answer is *Thermus aquaticus*

Concept:

- Thermostable DNA polymerases are enzymes that can withstand high temperatures without denaturing, which is crucial for applications such as the Polymerase Chain Reaction (PCR).
- PCR is a widely used technique in molecular biology to amplify DNA sequences, and it requires repeated heating and cooling cycles. Hence, a thermostable DNA polymerase is essential for this process.
- The most well-known thermostable DNA polymerase is Taq polymerase, isolated from the bacterium *Thermus aquaticus*.

Explanation:

Thermus aquaticus:

- This bacterium was discovered in hot springs and can survive at high temperatures.
- Taq polymerase, derived from *Thermus aquaticus*, is highly thermostable and remains active at the high temperatures required for PCR.
- A thermostable DNA polymerase is used for repeated amplification.
- Taq polymerase enzyme remains active even in high temperatures because the bacteria from which it is extracted survive in extreme heat conditions like hot springs.

Agrobacterium tumefaciens:

- This is a bacterium that contains the Ti-plasmid.
- This plasmid can be genetically modified to be used as cloning vectors.

- It can efficiently deliver the gene of our interest into the host plant.

E. coli: Escherichia coli is a commonly used bacterium in molecular biology for cloning and protein production.

Salmonella typhimurium: This bacterium is a pathogen known for causing foodborne illness.

Question 3

ELISA is based on the principle of :

Options:

- A. Antigen – Antigen interaction
- B. B-cells and T-cells interaction
- C. Antigen – Antibody interaction
- D. T-cell – Antibody interaction

Answer: C

Solution:

The correct answer is **Antigen – Antibody interaction**

Explanation:

- ELISA stands for Enzyme-Linked Immunosorbent Assay.
 - It is a widely used analytical biochemistry assay to detect the presence of an antibody or an antigen in a sample.
 - The test relies on the specific interaction between antigens and antibodies, which is then visualized using an enzyme-substrate reaction that produces a measurable signal.
 - ELISA works on the principle of **antigen-antibody binding**, where an antibody specifically binds to its corresponding antigen, and this interaction is detected and quantified using enzyme-linked indicators.
 - ELISA is used for detecting and quantifying substances such as peptides, proteins, antibodies, and hormones.
 - It is commonly used for diagnosing infections such as HIV, hepatitis, and certain other bacterial and viral infections,
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Question 4

Which of the following represents a test cross in which half the offspring is heterozygous and half would be homozygous recessive ?

Options:

A. $TT \times tt$

B. $Tt \times tt$

C. $Tt \times T$

D. $tt \times tt$

Answer: B

Solution:

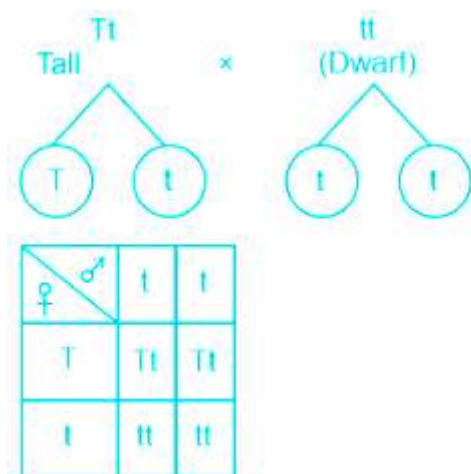
The correct answer is $Tt \times tt$

Explanation:

- A test cross is used to determine the genotype of an individual with a dominant phenotype.
- This is done by crossing the individual with a homozygous recessive parent.
- If any offspring show the recessive phenotype, the unknown genotype must be heterozygous.
- If the individual is heterozygous, the offspring will show a 1:1 ratio of heterozygous to homozygous recessive.
- If the individual is homozygous dominant, all offspring will display the dominant phenotype.

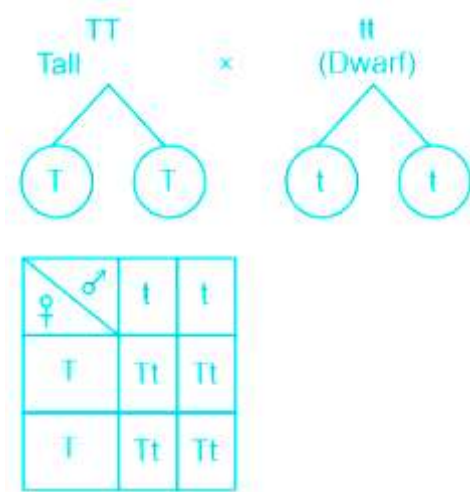
Explanation:

$Tt \times tt$: This cross involves a heterozygous individual (Tt) and a homozygous recessive individual (tt). The offspring will be 50% heterozygous (Tt) and 50% homozygous recessive (tt). This matches the given condition and is the correct answer.



$TT \times tt$: This involves a homozygous dominant individual (TT) and a homozygous recessive individual (tt). All offspring will be heterozygous (Tt) and display the dominant phenotype. This does not match the given

condition.



- **Tt × T:** This is not a valid cross as it does not involve a recessive individual. The genotype "T" is incomplete and not standard nomenclature in genetics.
- **tt × tt:** This involves two homozygous recessive individuals (tt). All offspring will be homozygous recessive (tt). This does not match the given condition as it does not produce heterozygous offspring.

Question 5

In which phase of cell cycle does replication of DNA take place ?

Options:

- A. G₁ phase
- B. M phase
- C. S phase
- D. G₂ phase

Answer: C

Solution:

The correct answer is **S phase**

Explanation:

- The cell cycle is a series of phases that cells go through as they grow and divide.
- It consists of interphase (G₁, S, and G₂ phases) and the mitotic phase (M phase).
- During interphase, the cell prepares for division by growing and replicating its DNA.

- The interphase is subdivided into three phases: G1 (Gap 1), S (Synthesis), and G2 (Gap 2).
- **S phase** is the synthesis phase where the replication of DNA takes place. Each chromosome is duplicated to ensure that each daughter cell will receive a complete set of chromosomes.
- During this time the amount of DNA per cell doubles. If the initial amount of DNA is denoted as 2C then it increases to 4C.

Other Options:

- **G1 phase:** This is the first gap phase where the cell grows and synthesizes proteins necessary for DNA replication. However, DNA replication does not occur in this phase.
 - **M phase:** This is the mitotic phase where the cell undergoes mitosis and cytokinesis, leading to the division of the cell into two daughter cells.
 - **G2 phase:** This is the second gap phase where the cell continues to grow and prepares for mitosis. During this phase, the cell checks for DNA replication errors and begins to form the structures necessary for cell division.
-

Question 6

In Hershey and Chase experiment, some viruses grew on medium that contained :

Options:

A. $^{35}\text{S}, ^{32}\text{P}$

B. $^{36}\text{S}, ^{34}\text{P}$

C. $^{32}\text{S}, ^{36}\text{P}$

D. $^{34}\text{S}, ^{36}\text{P}$

Answer: A

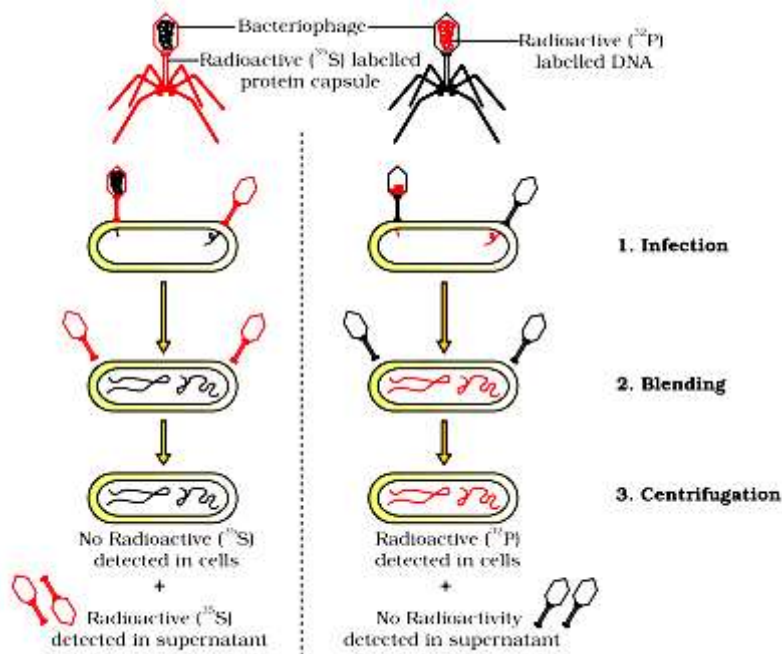
Solution:

The correct answer is $^{35}\text{S}, ^{32}\text{P}$

Explanation:

- The unequivocal proof that DNA is the genetic material came from the experiments of Alfred Hershey and Martha Chase (1952). They worked with viruses that infect bacteria called **bacteriophages**.
- The experiment used the T2 bacteriophage, a type of virus that infects bacteria. The bacteriophage consists of a protein coat and DNA.
- **Hershey and Chase** worked to discover whether it was protein or DNA from the viruses that entered the bacteria.

- They grew some viruses on a medium that contained radioactive phosphorus and some others on medium that contained radioactive sulfur.
- Viruses grown in the presence of radioactive phosphorus contained radioactive DNA but not radioactive protein because DNA contains phosphorus but protein does not.
- Similarly, viruses grown on radioactive sulfur contained radioactive protein but not radioactive DNA because DNA does not contain sulfur.



Explanation:

- ^{32}P : Phosphorus-32 is a radioactive isotope used to label DNA. Phosphorus is a key component of the phosphate backbone of DNA but not found in significant quantities in proteins.
- ^{35}S : Sulfur is present in the amino acids methionine and cysteine, and therefore, in proteins but not in DNA. The bacteriophages were grown in a medium containing radioactive sulfur (^{35}S), which labeled the protein coats of the phages.

Question 7

Which one of the following is not a process of DNA recombinant technology ?

Options:

- A. Isolation of DNA
- B. RNA interference (RNAi)
- C. Introduction of Restriction endonucleases

D. Culturing the host cells in a medium at a large scale

Answer: B

Solution:

The correct answer is **RNA interference (RNAi)**

Concept:

- DNA recombinant technology, also known as genetic engineering, involves combining DNA from different sources to create new genetic combinations that are of value to science, medicine, agriculture, and industry.
- This technology relies on several key processes to achieve the recombination and expression of new genes.
- RNA interference (RNAi) is a biological process in which RNA molecules inhibit gene expression or translation, by neutralizing targeted mRNA molecules.
- This technology is used to silence specific genes in order to prevent the production of certain proteins that may be harmful or unwanted, such as those involved in pest infestation.
- In the case of tobacco plants, RNAi is used to silence the mRNA of *Meloidogyne incognita*, a parasitic nematode that causes significant damage to the plants.

Explanation:

- **Isolation of DNA:** This is the first step in recombinant DNA technology, where the DNA of interest is extracted from the source organism. This step is crucial as it provides the genetic material needed for manipulation.
 - **Introduction of Restriction Endonucleases:** These are enzymes that cut DNA at specific sequences, generating fragments that can be easily manipulated. This step is essential for creating recombinant DNA molecules.
 - **Culturing the Host Cells in a Medium at a Large Scale:** After the recombinant DNA is introduced into host cells, these cells are cultured in a medium to proliferate and produce the desired product, such as a protein or enzyme, on a large scale.
 - **RNA Interference (RNAi):** This is a biological process where RNA molecules inhibit gene expression or translation by neutralizing targeted mRNA molecules. While RNAi is an important tool in genetic research and therapy, it is not a process used in the creation of recombinant DNA. Therefore, it is not considered a part of recombinant DNA technology.
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Question 8

Which of the following gas is found in the Stratosphere ?

Options:

A. Ozone

B. Carbon dioxide

C. Methane

D. Hydrogen

Answer: A

Solution:

The correct answer is **Ozone**

Explanation:

- Ozone (O_3) is a gas composed of three oxygen atoms. It is found in high concentrations in the stratosphere and forms the ozone layer, which protects life on Earth by absorbing most of the Sun's harmful ultraviolet radiation.
- This layer is crucial because it absorbs the majority of the sun's harmful ultraviolet (UV) radiation, specifically UV-B and UV-C rays, which can cause skin cancer and cataracts in humans, as well as having detrimental effects on plants and animals.
- The stratosphere is located above the troposphere and below the mesosphere, typically extending from about 10 km to 50 km above Earth's surface.

Other Options:

- **Carbon dioxide:** Carbon dioxide (CO_2) is a greenhouse gas found in the Earth's atmosphere. It is more abundant in the troposphere and is a key factor in the greenhouse effect and global warming.
 - **Methane:** Methane (CH_4) is another greenhouse gas present in the Earth's atmosphere. It is more prevalent in the troposphere and contributes to the greenhouse effect.
 - **Hydrogen:** Hydrogen (H_2) is the lightest and most abundant element in the universe, but it is not a major component of the Earth's atmosphere and is not significant in the stratosphere.
-

Question 9

In which of the following units is thickness of ozone layer measured ?

Options:

A. Dobson

B. Joule

C. Newton

D. Decibel

Answer: A

Solution:

The correct answer is **Dobson**

Explanation:

- The ozone layer is a region of Earth's stratosphere that contains a high concentration of ozone (O₃) and protects life on Earth by absorbing most of the sun's harmful ultraviolet (UV) radiation.
- The thickness of the ozone layer is measured in **Dobson Units (DU)**, which is a unit of measurement that describes the amount of ozone in a column of the atmosphere.
- The thickness of the ozone in a column of air from the ground to the top of the atmosphere is measured in terms of **Dobson units (DU)**.
- One Dobson unit represents a layer of ozone that would be 0.01 millimeters thick under standard temperature and pressure.
- This unit is named after G. M. B. Dobson, who was a pioneer in the study of atmospheric ozone.

Other Options:

- **Joule:** This is a unit of energy in the International System of Units (SI). One Joule is the amount of energy transferred or work done when applying a force of one newton over a distance of one meter.
 - **Newton:** This is the SI unit of force. One Newton is the force required to accelerate a mass of one kilogram at a rate of one meter per second squared.
 - **Decibels:** This is a unit used to measure the intensity of sound.
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Question 10

Ex-situ conservation includes :

Options:

- A. biosphere reserves
- B. national parks
- C. wildlife sanctuaries
- D. seed banks

Answer: D

Solution:

The correct answer is **Seed banks**

Concept:

- Conservation methods are strategies used to preserve endangered or threatened species of plants and animals.
- These methods are classified into two main types: in-situ conservation and ex-situ conservation.
- **Ex-situ conservation** involves the preservation of components of biological diversity outside their natural habitats. Examples include zoos, botanical gardens, wildlife safari and seed banks.
- **In Situ conservation** involves the conservation of biodiversity within its natural habitat. It includes protected areas such as Biosphere reserves, national parks, wildlife sanctuaries where ecosystems and species are conserved in their natural environment.

Explanation:

- **Seed banks:** This method of conservation is an example of ex-situ conservation because it involves taking biological material out of its natural habitat for preservation. These are facilities used to store seeds of various plants as a genetic reservoir for future use. They serve as a backup to protect against the loss of genetic diversity due to habitat destruction, climate change, or other factors. The seeds can be used for research, breeding programs, and restoration projects.
- **Biosphere reserves:** These are large areas of terrestrial or marine ecosystems or a combination thereof, which are internationally recognized within the framework of UNESCO's Man and the Biosphere (MAB) Program. They promote the conservation of biodiversity, research, and sustainable development. India now has 14 biosphere reserves.
- **National parks:** These are protected areas established to conserve the natural environment and biodiversity while allowing for public enjoyment and education. National parks protect ecosystems and wildlife within their natural habitats, making this an in-situ conservation strategy. India has 90 national parks.
- **Wildlife sanctuaries:** These are designated areas for the protection of wildlife where animals are protected from hunting, poaching, and habitat destruction. India has 448 wildlife sanctuaries.

Question 11

In a velvet grass seed, the cotyledon is called :

Options:

- A. Scutellum
- B. Coleorrhiza
- C. Coleoptile
- D. Testa

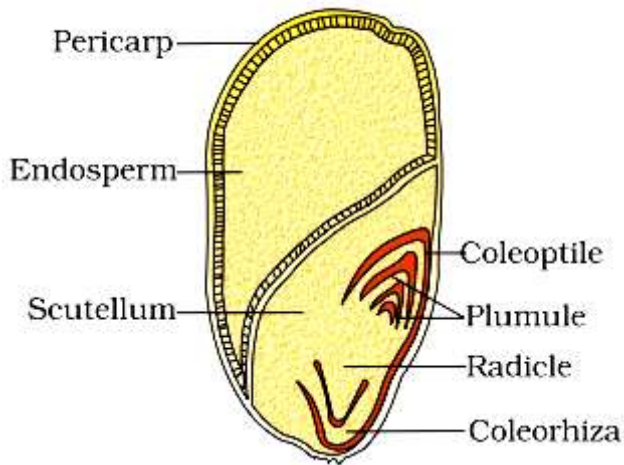
Answer: A

Solution:

The correct answer is **Scutellum**

Explanation:

- The scutellum is a specialized cotyledon found in monocot seeds, especially in grasses like velvet grass. It is responsible for nutrient absorption during germination. Its shield-like structure is adapted to efficiently transfer nutrients from the endosperm to the developing embryo.
- Embryos of monocotyledons possess only one cotyledon. In the grass family the cotyledon is called **scutellum** that is situated towards one side (lateral) of the embryonal axis.
- At its lower end, the embryonal axis has the **radical and root cap** enclosed in an undifferentiated sheath called **coleorrhiza**.
- The portion of the embryonal axis above the level of attachment of scutellum is the epicotyl.
- Epicotyl has a **shoot apex** and a few leaf primordia enclosed in a hollow foliar structure, the **coleoptile**.



Other Options:

- **Coleorrhiza:** This is incorrect. The coleorrhiza is a protective sheath that covers the radicle (embryonic root) in monocot seeds.
 - **Coleoptile:** This is incorrect. The coleoptile is a protective sheath covering the emerging shoot (plumule) in monocot seeds.
 - **Testa:** This is incorrect. The testa is the seed coat, which is the outer protective layer of a seed. It protects the seed from physical damage and desiccation.
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Question 12

Which of the following is a recessive trait for garden pea plant ?

Options:

- A. Round seed
- B. Constricted pod
- C. Tall plant
- D. Violet flower















Answer: B

Solution:

The correct answer is **Constricted pod**

Concept:

- Gregor Mendel conducted experiments on pea plants (*Pisum sativum*) to understand how traits are inherited.
- Mendel chose pea plants due to their unique characteristics.
- It is bisexual, self-pollinated, easy to grow, has less generation time, and is disease-resistant as well.
- Mendel had chosen 14 true-breeding pea plant varieties. Mendel selected pairs, which were similar except for one character with contrasting traits.
- These 7 pairs of contrasting characters are easily observable and studied by Mendel.
- Traits in pea plants, such as seed shape, pod shape, plant height, and flower color, follow predictable inheritance patterns.

Pea trait	Dominant trait	Recessive trait
Seeds		
Seed shape	Round 	Wrinkled 
Seed colour	Yellow 	Green 
Flower colour	Purple 	White 
Flower position	Axial 	Terminal 
Plant height	Tall 	Short 
Pod shape	Inflated 	Constricted 
Pod colour	Green 	Yellow 

Explanation:

- **Constricted pod:** This is a recessive trait in garden pea plants. For a plant to exhibit this trait, it must inherit two recessive alleles (one from each parent).
- **Round seed:** This is a dominant trait.
- **Tall plant:** Tallness is a dominant trait in pea plants.
- **Violet flower:** Violet flower color is a dominant trait.

Question 13

Nucleosome is :

Options:

- A. Positively charged DNA wrapped around negatively charged histone octamer
- B. Negatively charged DNA wrapped around positively charged histone octamer
- C. Positively charged DNA wrapped around positively charged histone octamer
- D. Negatively charged DNA wrapped around negatively charged histone octamer

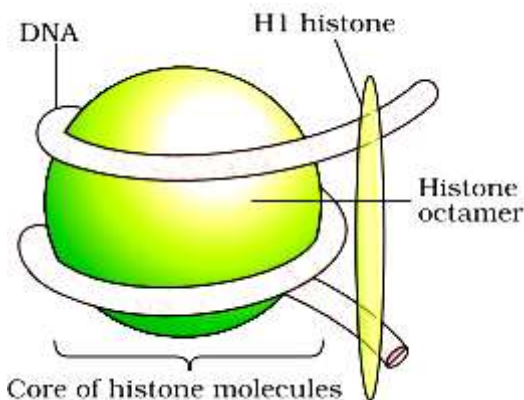
Answer: B

Solution:

The correct answer is **Negatively charged DNA wrapped around positively charged histone octamer**

Explanation:

- A nucleosome is the basic unit of DNA packaging in eukaryotes.
- It consists of a segment of DNA wound around a core of histone proteins.
- A nucleosome consists of a segment of DNA wound around a core of histone proteins.
- **DNA is negatively charged** primarily because of its phosphate backbone. Each nucleotide in DNA consists of a sugar, a phosphate group, and a nitrogenous base.
- **Histones are rich in the basic amino acid** residues lysine and arginine. Both the amino acid residues carry positive charges in their side chains.
- Histones are organised to form a unit of eight molecules called histone octamer. The histone core around which DNA is wrapped is composed of eight histone molecules: two each of histone proteins H2A, H2B, H3, and H4.
- The **negatively charged DNA is wrapped around the positively charged histone octamer** to form a structure called **nucleosome**
- A typical nucleosome contains 200 bp of DNA helix.
- Nucleosomes constitute the repeating unit of a structure in nucleus called chromatin, thread-like stained (coloured) bodies seen in nucleus.
- The nucleosomes in chromatin are seen as 'beads-on-string' structure when viewed under electron microscope



Question 14

“Transforming Principle” was given by :

Options:

- A. Maclyn McCarty
- B. Frederick Griffith
- C. Alfred Hershey
- D. Watson and Crick

Answer: B

Solution:

The correct answer is **Frederick Griffith**

Concept:

- The "Transforming Principle" is a term used to describe the substance responsible for transformation in bacteria, which was first identified by **Frederick Griffith in 1928**.
- Griffith's experiments involved two strains of the bacterium *Streptococcus pneumoniae*, a virulent smooth strain (S) and a non-virulent rough strain (R).
- He discovered that when he killed the virulent S strain and mixed it with the non-virulent R strain, the R strain became virulent. This was due to the transfer of some "transforming principle" from the S strain to the R strain.

Explanation:

- **Frederick Griffith:** He concluded that R strain bacteria had been transformed by the heat-killed S strain bacteria. Some ‘transforming principle’, transferred from the heat-killed S strain, had enabled the R strain to synthesize a smooth polysaccharide coat and become virulent. This must be due to the transfer of the genetic material.
 - **Maclyn McCarty:** He, along with Oswald Avery and Colin MacLeod worked to determine the biochemical nature of the ‘transforming principle’ in Griffith's experiment.
 - **Alfred Hershey:** He was an American bacteriologist who, along with Martha Chase, confirmed that DNA is the genetic material through the Hershey-Chase experiments in 1952.
 - **Watson and Crick:** James Watson and Francis Crick are credited with discovering the double helix structure of DNA in 1953.
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Question 15

Which disorder is caused by the substitution of Glutamic acid (Glu) by Valine (Val) at the sixth position of the beta globin chain of the haemoglobin?

Options:

- A. Phenylketonuria
- B. Sickle-cell Anaemia
- C. Haemophilia
- D. Thalassemia

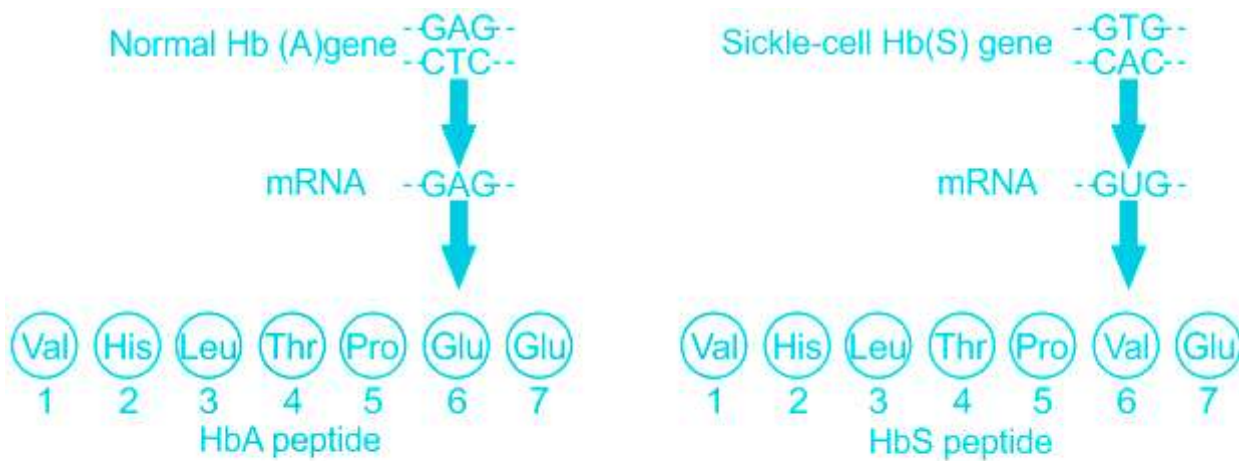
Answer: B

Solution:

The correct answer is **Sickle-cell Anaemia**

Explanation:

- Sickle-cell anaemia is an autosomal recessive disorder caused by a point mutation in the beta-globin chain of haemoglobin.
- This mutation results in the substitution of the amino acid glutamic acid (Glu) by valine (Val) at the sixth position of the beta-globin chain.
- The mutant haemoglobin molecule undergoes polymerisation under low oxygen tension causing the change in the shape of the RBC from biconcave disc to elongated sickle like structure
- Sickle-shaped cells are less flexible and can block blood flow, leading to pain, organ damage, and increased risk of infection.



Micrograph of the red blood cells and the amino acid composition of the relevant portion of b-chain of haemoglobin: (a) From a normal individual; (b) From an individual with sickle-cell anaemia

Other Options:

- **Phenylketonuria:** This is a metabolic disorder caused by a deficiency in the enzyme phenylalanine hydroxylase, which leads to the accumulation of phenylalanine in the body.
- **Haemophilia:** This is a genetic disorder that affects the blood's ability to clot properly due to the deficiency of clotting factors.
- **Thalassemia:** This is also an autosome-linked recessive blood disease. The defect could be due to either mutation or deletion which ultimately results in reduced rate of synthesis of one of the globin chains (α and β chains) that make up haemoglobin. Thalassemia differs from sickle-cell anaemia in that the former is a quantitative problem of synthesizing too few globin molecules while the latter is a qualitative problem of synthesizing an incorrectly functioning globin.

Question 16

Arrange the following steps of DNA fingerprinting in proper sequence :

- (A) Hybridisation using labelled VNTR probe
- (B) Separation of DNA fragments by electrophoresis
- (C) Digestion of DNA by restriction endonucleases
- (D) Blotting of separated DNA fragments to nylon
- (E) Isolation of DNA

Choose the correct answer from the options given below :

Options:

A. (C), (A), (B), (D), (E)

B. (E), (C), (B), (D), (A)

C. (B), (C), (D), (E), (A)

D. (C), (D), (B), (A), (E)

Answer: B

Solution:

The correct answer is **(E), (C), (B), (D), (A)**

Explanation:

DNA fingerprinting is a technique used to identify individuals based on the unique patterns in their DNA. The technique of DNA Fingerprinting was initially developed by Alec Jeffreys.

He used a satellite DNA as probe that shows very high degree of polymorphism.

This process involves several key steps including isolation, digestion, separation, blotting, and hybridization.

1. **Isolation of DNA (E):** To extract DNA from the cells of the sample. This can be from blood, hair, skin, or other tissues.
2. **Digestion of DNA by restriction endonucleases (C):** The isolated DNA is then cut into fragments using restriction enzymes, which recognize specific sequences in the DNA
3. **Separation of DNA fragments by electrophoresis (B):** The DNA fragments are then separated based on size using gel electrophoresis. The fragments migrate through the gel when an electric current is applied.
4. **Transferring (blotting) of separated DNA fragments to synthetic membranes, such as nitrocellulose or nylon (D):** The separated DNA fragments are transferred from the gel to a nylon membrane, a process known as Southern blotting.
5. **Hybridisation using labelled VNTR probe (A):** The nylon membrane is then exposed to labeled probes that are specific to variable number tandem repeats (VNTRs) in the DNA.
6. **Detection of hybridised DNA fragments by autoradiography.**

Question 17

Match List-I with List-II :

List – I	List - II

Disease		Pathogen/Genera	
A.	Amoebiasis	I.	<i>Wuchereria</i>
B.	Filariasis	II.	<i>Entamoeba histolytica</i>
C.	Ringworm	III.	<i>Hemophilus influenzae</i>
D.	Pneumonia	IV.	<i>Epidermophyton</i>

Choose the correct answer from the options given below :

Options:

- A. (A) - (III), (B) - (I), (C) - (IV), (D) - (II)
- B. (A) - (II), (B) - (I), (C) - (IV), (D) - (III)
- C. (A) - (II), (B) - (III), (C) - (IV), (D) - (I)
- D. (A) - (II), (B) - (IV), (C) - (III), (D) - (I)

Answer: B

Solution:

The correct answer is (A) - (II), (B) - (I), (C) - (IV), (D) - (III)

Explanation:

- **Amoebiasis:** This is caused by the protozoan parasite *Entamoeba histolytica*. Symptoms of this disease include constipation, abdominal pain and cramps, stools with excess mucous and blood clots.
- **Filariasis:** This is caused by the helminth *Wuchereria* species, which are transmitted through mosquito bites. It can lead to severe swelling and elephantiasis.
- **Ringworm:** This is a fungal infection caused by the genus *Epidermophyton*. Many fungi belonging to the genera *Microsporum*, *Trichophyton* and *Epidermophyton* are responsible for ringworms. Appearance of dry, scaly lesions on various parts of the body such as skin, nails and scalp are the main symptoms of the disease.
- **Pneumonia:** This is a bacterial infection often caused by *Haemophilus influenzae*. It affects the lungs and can cause symptoms like fever, cough, and difficulty breathing.

Question 18

Streptokinase enzyme is used for :

Options:

- A. removing clot from blood vessels
- B. clarifying fruit juices
- C. synthesis of cholesterol
- D. removing oily stains

Answer: A

Solution:

The correct answer is **removing clot from blood vessels**

Explanation:

Streptokinase produced by the bacterium *Streptococcus* and modified by genetic engineering is used as a 'clot buster' for removing clots from the blood vessels of patients who have undergone myocardial infarction leading to heart attack.

- **Streptokinase** is used to **remove the blood clots** that are formed in the blood vessels i.e. acts like a **clot buster**.
- It is mainly used for people who have undergone myocardial infarction leading to heart attack.
- This helps in restoring the blood flow to the affected tissue.
- It is produced by bacterium *Streptococcus*.

Other Options:

- **Clarifying fruit juices:** This is incorrect. The process of clarifying fruit juices typically involves enzymes like pectinase, which break down pectin, a substance that causes cloudiness in juice.
 - **Synthesis of cholesterol:** This is incorrect. Cholesterol synthesis in the body involves a complex pathway of biochemical reactions, primarily in the liver.
 - **Removing oily stains:** This is incorrect. Enzymes used in detergents for removing oily stains are typically lipases, which break down fats and oils.
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Question 19

Select the incorrect statement :

Options:

- A. Chromosome 1 has the most genes and chromosome Y has the fewest.
- B. Chromosome 21 has the most genes and chromosome Y has the fewest
- C. Less than 2 percent of the genome codes for proteins.

D. The functions of over 50 percent of discovered genes are unknown

Answer: B

Solution:

The correct answer is **Chromosome 21 has the most genes and chromosome Y has the fewest**

Explanation:

The human genome consists of 23 pairs of chromosomes. Each chromosome is made up of DNA and contains many genes, which are the basic units of heredity. Chromosomes vary in the number of genes they contain, and their functions are crucial in determining the traits and characteristics of an organism.

- **Chromosome 1 has the most genes and chromosome Y has the fewest:** This statement is correct. Chromosome 1 has most genes (2968), and the Y has the fewest (231).
 - **Chromosome 21 has the most genes and chromosome Y has the fewest:** This statement is incorrect. Chromosome 21 does not have the most genes. It is one of the smallest human chromosomes and contains around 200-300 genes.
 - **Less than 2 percent of the genome codes for proteins:** This statement is correct. Less than 2 per cent of the genome codes for proteins. The rest of the genome is made up of non-coding DNA, which has various regulatory and structural roles.
 - **The functions of over 50 percent of discovered genes are unknown:** This statement is correct. The functions are unknown for over 50 percent of the discovered genes. Researchers are continually studying these genes to understand their roles in health and disease.
-

Question 20

Which of the following is not a step of Polymerase Chain Reaction ?

Options:

- A. Extension
- B. Downstream processing
- C. Annealing
- D. Denaturation

Answer: B

Solution:

The correct answer is **Downstream processing**

Explanation:

- Polymerase Chain Reaction (PCR) is a widely used method in molecular biology to rapidly make millions to billions of copies of a specific DNA sample.
- The PCR process consists of three main steps: Denaturation, Annealing, and Extension. Each of these steps is repeated multiple times to amplify the DNA.

Denaturation-

- It is the process by which 2 strands of ds-DNA separates to form 2 single strands.
- This is achieved by applying heat that helps in breaking the H-bonds between the 2 DNA strands.

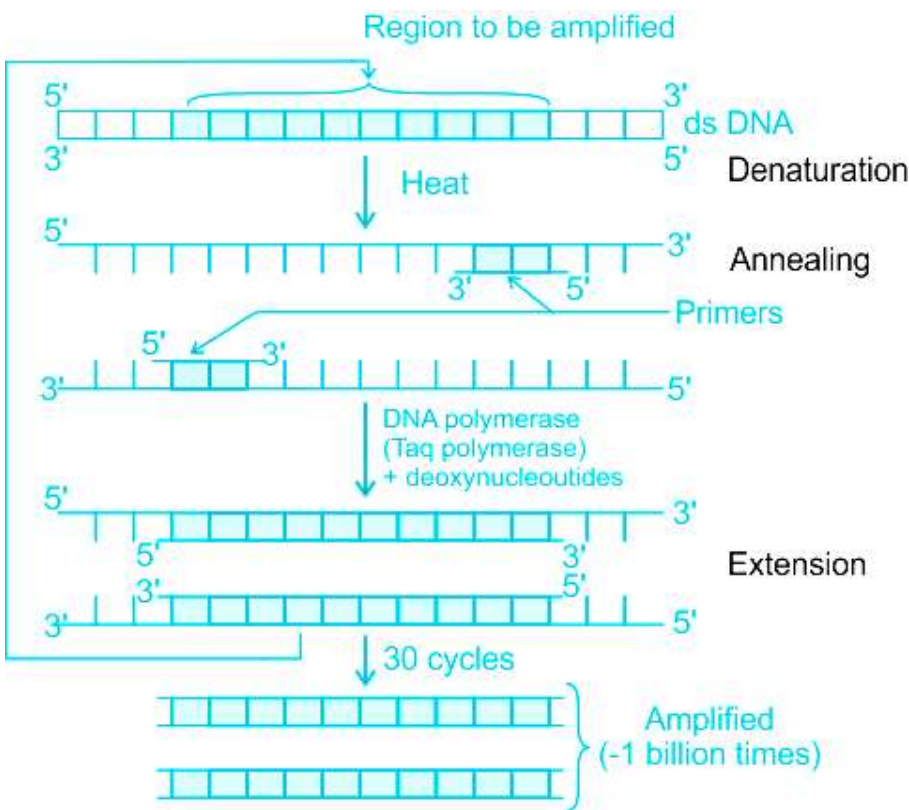
Annealing-

- In this process, 2 sets of primers bind to specific regions on the separated strands of DNA.
- **Primers** are small, chemically synthesized oligonucleotides that are complementary to specific regions of DNA.

Extension-

- This step involves **extension of the primers** using **Taq DNA polymerase** in the presence of deoxynucleotides.
- Taq polymerase is a **thermostable DNA polymerase** that is used for repeated amplification.
- This enzyme remains **active even in high temperatures** because it is obtained from the bacteria *Thermus aquaticus*, which survives in extreme heat conditions like hot springs.

These steps are repeated in cycles such that we get about a billion copies of the DNA in 30 cycles.



- **Downstream Processing:** This is not a step in the PCR process. Downstream processing refers to the recovery and purification of biosynthetic products, particularly pharmaceuticals, from natural sources such as animal or plant tissue or fermentation broth.

Question 21

Which of the following equation is correct about Verhulst-Pearl Logistic Growth?

Options:

A.

$$dN/dt = (h - d) \frac{(K-N)}{K}$$

B.

$$dN/dt = rN \frac{(N-K)}{K}$$

C.

$$dN/dt = rN \frac{(K-N)}{K}$$

D.

$$dN/dt = (h - d) \frac{(N-K)}{K}$$

Answer: C

Solution:

The correct answer is $dN/dt = rN \frac{(K-N)}{K}$ $dN/dt = rN \frac{(K-N)}{K}$

Explanation:

Verhulst-Pearl logistic growth, also simply known as logistic growth, is a model of population growth that describes how a population grows more slowly as it approaches its carrying capacity.

A population growing in a habitat with limited resources show initially a lag phase, followed by phases of acceleration and deceleration and finally an asymptote, when the population density reaches the carrying capacity.

A plot of N in relation to time (t) results in a sigmoid curve. This type of population growth is called **Verhulst-Pearl Logistic Growth**.

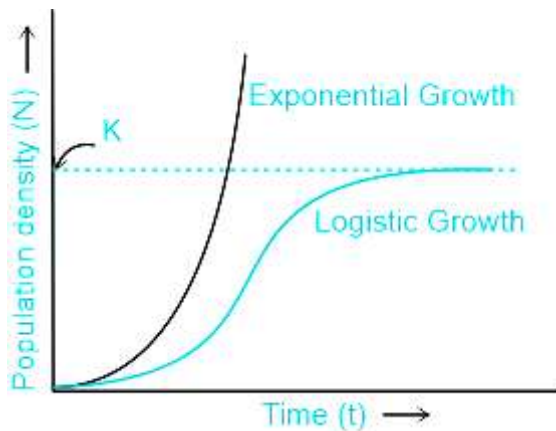
- Ideally if the resources in a habitat are unlimited, the population shows exponential growth pattern.
- But resources are not available to any species population in unlimited amount. Thus, the species compete for the available resources to survive.

- This competition for the limited resources restricts the exponential or unlimited growth of any population.
- Any given habitat can only provide resources to support a maximum possible number, beyond which it further growth of population is not possible. This is known as the **carrying capacity (K)** for a particular species in a habitat.

Logistic growth is represented as: $\frac{dN}{dt} = rN \left(\frac{K-N}{K} \right)$

where,

- N = Population Density at time t
- K = Carrying Capacity,
- r = Intrinsic rate of natural increase
- $\frac{dN}{dt}$ = Rate of change of population density.
- 'r' value denotes the difference between the per capita birth and death (b-d).
- The environmental resistance is represented in the equation as $\left(\frac{K-N}{K} \right)$.



Question 22

Match List-I with List-II :

List – I		List - II	
Genes		Proteins – codes for lac operon	
A.	'i'	I.	permease
B.	'a'	II.	β -galactosidase
C.	'y'	III.	transacetylase
D.	'z'	IV.	repressor

Choose the correct answer from the options given below :

Options:

A. (A) - (III), (B) - (IV), (C) - (I), (D) - (II)

B. (A) - (IV), (B) - (III), (C) - (I), (D) - (II)

C. (A) - (II), (B) - (III), (C) - (IV), (D) - (I)

D. (A) - (IV), (B) - (II), (C) - (III), (D) - (I)

Answer: B

Solution:

The correct answer is **2)(A) - (IV), (B) - (III), (C) - (I), (D) - (II)**

Explanation:

The lac operon is a set of genes involved in the metabolism of lactose in bacteria, specifically E. coli. It includes structural genes that code for proteins, and regulatory genes that control the expression of these structural genes.

The genes and their corresponding proteins are as follows:

- The **i** gene codes for the repressor of the lac operon.
- The **z** gene codes for beta-galactosidase (β -gal), which is primarily responsible for the hydrolysis of the disaccharide, lactose into its monomeric units, galactose and glucose.
- The **y** gene codes for permease, which increases permeability of the cell to β -galactosides.
- The **a** gene encodes a transacetylase.

Therefore, the correct match is

- A. Gene 'i' - IV. Repressor protein
- B. Gene 'a' - III. Transacetylase
- C. Gene 'y' - I. Permease
- D. Gene 'z' - ii. β -galactosidase

Question 23

Analogous structures are a result of :

Options:

A. Divergent evolution

B. Convergent evolution

C. Genetic drift

D. Point mutations

Answer: B

Solution:

The correct answer is **Convergent evolution**

Explanation:

- Analogous structures are a result of **convergent evolution** - different structures evolving for the same function and hence having similarity.
- The flippers of penguins and dolphins are an example of convergent evolution. This is because both species, though not closely related, have developed similar body structures – flippers – to adapt to similar environmental pressures (i.e., moving efficiently through water).
- Other examples include (i) the eye of the octopus and of mammals and (ii) Sweet potato (root modification) and Potato(stem modification)

Other Options:

- **Divergent evolution:** This process occurs when two species that share a common ancestor evolve different traits, leading to increased differences over time. It results in homologous structures, which are similar due to shared ancestry but may differ in function. For example, the limbs of humans and the wings of bats are homologous structures.
 - **Genetic drift:** This is a mechanism of evolution that refers to random changes in the frequency of alleles (variants of a gene) in a population.
 - **Point mutations:** These are changes that occur at a single point in the DNA sequence.
-

Question 24

Amino acid is attached to which site of tRNA?

Options:

- A. Anticodon loop
- B. 3' end
- C. 5' end
- D. D-loop

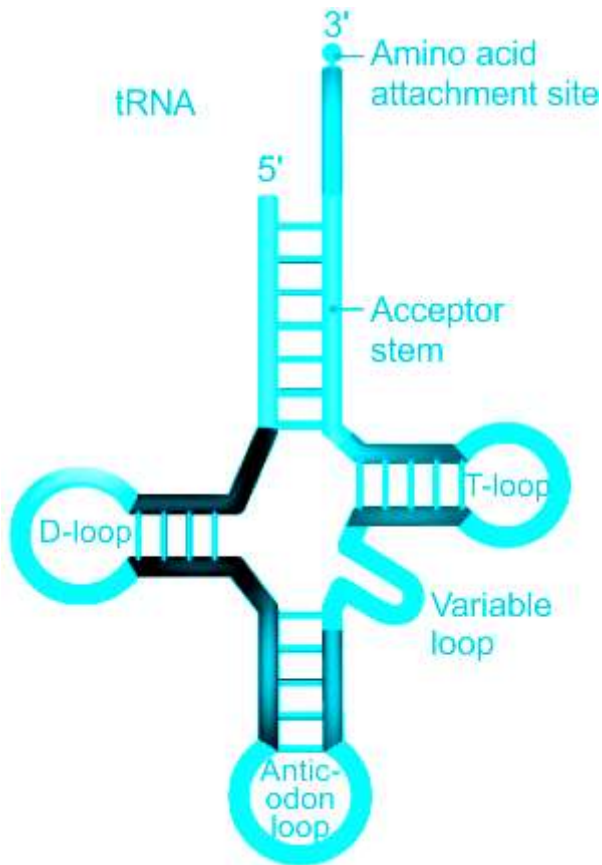
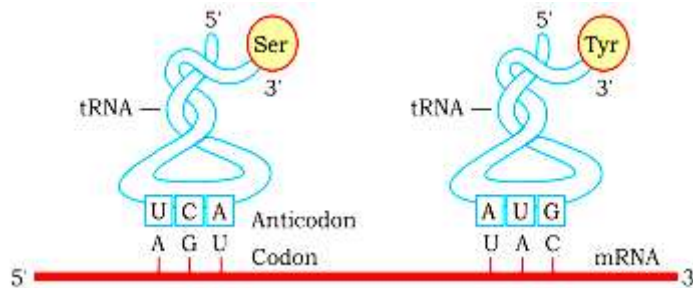
Answer: B

Solution:

The correct answer is **3' end**

Explanation:

- tRNA (transfer RNA) is a type of RNA molecule that helps decode a messenger RNA (mRNA) sequence into a protein during the process of translation.
- Each tRNA has a specific structure with an anticodon region that pairs with the corresponding codon on the mRNA strand.
- The 3' end of the tRNA is where the amino acid is covalently attached. This end has a CCA sequence that is essential for the attachment of the amino acid, forming an aminoacyl-tRNA complex ready for protein synthesis.



Other Options:

- **Anticodon Loop:** This region contains a sequence of three bases (anticodon) that is complementary to a codon on the mRNA. It is crucial for the recognition of the mRNA codon.
 - **5' end:** This end of the tRNA contains the phosphate group and is not involved in amino acid attachment.
 - **D-loop:** This loop contains dihydrouridine and helps in the proper folding and stability of the tRNA molecule.
-

Question 25

Which one of the following lymphoid organ is large at birth but reduces with age?

Options:

- A. Bone marrow
- B. Thymus
- C. Spleen
- D. Peyer's patches

Answer: B

Solution:

The correct answer is **Thymus**

Concept:

- Lymphoid organs are the organs where origin and/or maturation and proliferation of lymphocytes occur.
- The primary lymphoid organs include the bone marrow and thymus, where immature lymphocytes differentiate into antigen-sensitive lymphocytes.
- The secondary lymphoid organs include the spleen, lymph nodes, and Peyer's patches, which are involved in the immune response.

Explanation:

- **Thymus:** The thymus is a lobed organ located near the heart and beneath the breastbone. The thymus is quite large at the time of birth but keeps reducing in size with age and by the time puberty is attained it reduces to a very small size.
 - **Bone marrow:** The bone marrow is the main lymphoid organ where all blood cells including lymphocytes are produced. Unlike the thymus, the bone marrow does not reduce in size with age.
 - **Spleen:** The spleen is a secondary lymphoid organ that acts as a blood filter. It plays various roles in the immune system, including the removal of old red blood cells and the storage of white blood cells and platelets.
 - **Peyer's patches:** These are small masses of lymphoid tissue found in the small intestine. They play a role in monitoring intestinal bacteria and generating an immune response to pathogens.
-

Question 26

Which of the following plays a significant role in our stomach in checking disease causing microbes?

Options:

A. *Penicillium notatum*

B. *Monascus purpureus*

C. *Trichoderma polysporum*

D. *Lactobacillus*

Answer: D

Solution:

The correct answer is **Lactobacillus**

Explanation:

- **Lactobacillus:** This is a type of beneficial bacteria that resides in the stomach and intestines. It helps in digestion and also plays a key role in preventing the growth of harmful microbes by producing lactic acid, which maintains the acidic environment of the stomach. Various species of this genus are used in the production of curd. These bacteria ferment lactose to produce lactic acid, which curdles the milk, forming curd.
 - ***Penicillium notatum*:** This fungus is used in the production of penicillin. It is the source of the antibiotic penicillin, discovered by Alexander Fleming.
 - ***Monascus purpureus*:** *Monascus purpureus* is a type of yeast that is used to produce blood cholesterol-lowering statins. Statins inhibit the enzyme responsible for synthesis of cholesterol
 - ***Trichoderma polysporum*:** *Trichoderma polysporum* is a fungus used in the production of Cyclosporin-A, an immunosuppressant drug.
-

Question 27

Given below are two statements :

Statement I : Whisky, brandy and rum are produced without distillation of the fermented broth.

Statement II : *Saccharomyces cerevisiae* is called doctor's yeast.

In the light of the above statements, choose the correct answer from the options given below :

Options:

- A. Both Statement I and Statement II are true
- B. Both Statement I and Statement II are false
- C. Statement I is true, but Statement II is false
- D. Statement I is false, but Statement II is true

Answer: B

Solution:

The correct answer is **Both Statement I and Statement II are false**

Concept:

- Distillation is a crucial process in the production of certain types of alcoholic beverages such as whisky, brandy, and rum. Distillation helps to separate alcohol from the fermented broth, increasing its concentration.
- *Saccharomyces cerevisiae* is a species of yeast commonly used in baking and brewing. It is also known as brewer's yeast or baker's yeast.

Explanation:

- **Statement I:** This statement is false because Wine and beer are produced without distillation whereas whisky, brandy and rum are produced by distillation of the fermented broth.
 - **Statement II:** This statement is also false because *Saccharomyces cerevisiae* is commonly referred to as brewer's yeast or baker's yeast, not as doctor's yeast.
-

Question 28

Given below is the DNA coding sequence. Its complementary strand would read as :

5'– GTATTACG – 3'

Options:

- A. 5' – CUTUUTGC – 3'

B. 3' – CATAATGC – 5'

C. 3' – CUTUUTGC – 5'

D. 5' – CTUTTUGC – 3'

Answer: B

Solution:

The correct answer is 3' – CATAATGC – 5'

Explanation:

- DNA is composed of two strands that coil around each other to form a double helix. These strands are made up of simpler molecules called nucleotides.
- Each nucleotide consists of a sugar molecule, a phosphate group, and a nitrogenous base. The four types of nitrogenous bases in DNA are adenine (A), thymine (T), cytosine (C), and guanine (G).
- The strands are complementary to each other, meaning that the base A on one strand pairs with T on the other strand, and C pairs with G.
- Complementary base pairing (A-T, G-C) ensures that the sequence of nitrogenous bases on one strand automatically determines the sequence on the complementary strand, which is essential for DNA replication and accurate transmission of genetic information.

Given the DNA coding sequence is 5' – GTATTACG – 3'. The complementary sequence is 3' - CATAATGC - 5'

Question 29

Which of the following statements is not correct for Restriction enzymes ?

Options:

- A. Exonucleases remove nucleotide from ends of the DNA
- B. Endonucleases make cuts at specific positions within the DNA.
- C. Ligases join sticky ends of DNA together.
- D. The first restriction endonuclease was Hind II.

Answer: C

Solution:

The correct answer is **Ligases join sticky ends of DNA together.**

Concept:

- Restriction enzymes are proteins that cut DNA at specific sequences, which are crucial tools in molecular biology.
- There are two main types of restriction enzymes: exonucleases and endonucleases.
- Exonucleases remove nucleotides from the ends of DNA molecules, whereas endonucleases cut DNA at specific sites within the molecule.
- Ligases are enzymes that join two strands of DNA together by forming a covalent bond between the phosphate backbone.
- The first restriction endonuclease discovered was Hind II, which was isolated from the bacterium *Haemophilus influenzae*.

Explanation:

- **Exonucleases remove nucleotides from ends of the DNA:** This statement is correct. Exonucleases are enzymes that cleave nucleotides one at a time from the end of a polynucleotide chain (DNA or RNA).
 - **Endonucleases make cuts at specific positions within the DNA:** This statement is also correct. Endonucleases are enzymes that cut at specific positions within the DNA, making them essential for gene cloning and DNA manipulation.
 - **Ligases join sticky ends of DNA together:** This statement is incorrect. Ligases are not restriction enzymes; they are enzymes that facilitate the joining of DNA strands by catalyzing the formation of a phosphodiester bond.
 - **The first restriction endonuclease was Hind II:** This statement is correct. Hind II was the first restriction endonuclease to be discovered and characterized.
-

Question 30

Match List-I with List-II :

List – I		List - II	
Recent Extinction		Place	
A.	Dodo	I.	Africa
B.	Quagga	II.	Russia
C.	Thylacine	III.	Mauritius
D.	Stellar's Sea Cow	IV.	Australia

Choose the correct answer from the options given below :

Options:

- A. (A) - (I), (B) - (III), (C) - (II), (D) - (IV)
- B. (A) - (II), (B) - (III), (C) - (IV), (D) - (I)

C. (A) - (III), (B) - (I), (C) - (IV), (D) - (II)

D. (A) - (III), (B) - (IV), (C) - (I), (D) - (II)

Answer: C

Solution:

The correct answer is **A - iii, B - i, C - iv, D - ii**

Explanation:

Some examples of recent extinctions include the dodo (Mauritius), quagga (Africa), thylacine (Australia), Steller's Sea Cow (Russia) and three subspecies (Bali, Javan, Caspian) of tiger.

- **Dodo:** The dodo was a flightless bird that lived on the island of Mauritius in the Indian Ocean.
 - **Quagga:** The quagga was a subspecies of the plains zebra, which was native to South Africa. It is now extinct.
 - **Thylacine:** The thylacine, also known as the Tasmanian tiger, was a carnivorous marsupial native to Australia, particularly Tasmania.
 - **Stellar's sea cow:** The Stellar's sea cow was a large marine mammal that lived in the Bering Sea, particularly around the Commander Islands, near Russia.
-

Question 31

Which one of the following is not associated with megasporangium ?

Options:

- A. Funicle
- B. Integument
- C. Generative cell
- D. Micropyle

Answer: C

Solution:

The correct answer is **Generative cell**

Concept:

- The megasporangium, also known as the ovule in seed plants, is an integral part of the female reproductive structure in plants.
- It contains the megaspore mother cell, which undergoes meiosis to produce megaspores that develop into female gametophytes.
- The megasporangium is protected by one or more layers called integuments and is attached to the ovary wall by a stalk known as the funicle.
- The micropyle is a small opening through which the pollen tube enters to fertilize the ovule.

Explanation:

- **Funicle:** This is a stalk that attaches the ovule (megasporangium) to the ovary wall. It provides support and nourishment to the developing ovule, making it an essential part of the megasporangium.
- **Integument:** These are protective layers surrounding the megasporangium. They provide protection and eventually form the seed coat after fertilization.
- **Generative cell:** This cell is **part of the male gametophyte (pollen grain)** and is responsible for forming sperm cells. It is not associated with the megasporangium, which is part of the female reproductive system. The generative cell of the pollen grain undergoes division to form two male gametes. This process typically occurs within the pollen tube, which grows from the pollen grain after it lands on the stigma of a flower.
- **Micropyle:** This is a small opening in the integuments of the ovule. It allows the pollen tube to enter and deliver sperm cells for fertilization.

Question 32

Which of the following does not constitute accessory duct of female reproductive system ?

Which of the following does not constitute accessory duct of female reproductive system ?

Options:

- A. Fallopian tubes
- B. Uterus
- C. Cervix
- D. Vagina

Answer: C

Solution:

The correct answer is **Cervix**

Concept:

- The female reproductive system consists of primary reproductive organs (ovaries) and accessory ducts. The accessory ducts include structures that assist in the transport and development of the egg and fetus.
- The accessory ducts include the Fallopian tubes (also called oviducts), uterus, and vagina, which play crucial roles in reproduction.
- The cervix is the lower part of the uterus and serves as a passage between the uterus and vagina but is not considered a separate accessory duct.

Explanation:

- **Fallopian tubes:** These tubes connect the ovaries to the uterus. They are the site where fertilization typically occurs. Once the egg is released from the ovary, it travels through the Fallopian tube towards the uterus.
 - **Uterus:** This is a hollow muscular organ where the fertilized egg implants and develops into a fetus. The uterus supports fetal development during pregnancy.
 - **Cervix:** This is the narrow lower part of the uterus that opens into the vagina. It acts as a gateway between the uterus and vagina but is not considered an accessory duct. It plays a role in childbirth and menstruation.
 - **Vagina:** This is a muscular canal that connects the cervix to the exterior of the body. It serves as the birth canal during delivery and is also involved in sexual intercourse and menstruation.
-

Question 33

The female external genitalia include :

- (A) Mons pubis
- (B) Hymen
- (C) Mammary ducts
- (D) Clitoris
- (E) Cervix

Choose the correct answer from the options given below :

The female external genitalia include :

- (A) Mons pubis**
- (B) Hymen**
- (C) Mammary ducts**

(D) Clitoris

(E) Cervix

Choose the correct answer from the options given below :

Options:

A. (A), (C) and (D) only

B. (B), (D) and (E) only

C. (A), (B) and (D) only

D. (C), (D) and (E) only

Answer: C

Solution:

The correct answer is **(A), (B) and (D) only**

Explanation:

- The external genitalia of the human female are collectively known as the vulva. These structures play key roles in protection, sensory reception, and sexual function.
- The main components of the vulva include the labia minora, labia majora, clitoris, and vestibular structures.
- The female external genitalia include mons pubis, labia majora, labia minora, hymen and clitoris.
- Mons pubis is a cushion of fatty tissue covered by skin and pubic hair.
- The labia majora are fleshy folds of tissue, which extend down from the mons pubis and surround the vaginal opening.
- The labia minora are paired folds of tissue under the labia majora.
- The opening of the vagina is often covered partially by a membrane called hymen.

Incorrect Options:

- **Mammary ducts:** These are part of the internal breast structure and are involved in the production and transport of milk. They are not considered part of the external genitalia.
- **Cervix:** This is the lower part of the uterus that opens into the vagina. It is an internal structure and not part of the external genitalia.

Question 34

Select the organ of female reproductive system where the sperm is not transported at the time of coitus :

Select the organ of female reproductive system where the sperm is not transported at the time of coitus :

Options:

- A. Cervix
- B. Ovary
- C. Uterus
- D. Fallopian tube

Answer: B

Solution:

The correct answer is **Ovary**

Explanation:

- The female reproductive system is composed of several organs, including the ovaries, fallopian tubes, uterus, cervix, and vagina.
 - During coitus (sexual intercourse), sperm is deposited in the female reproductive tract, but it does not reach all organs.
 - **Cervix:** The cervix is the lower part of the uterus that opens into the vagina. During coitus, sperm is deposited near the cervix in the vagina, and it can pass through the cervix to enter the uterus.
 - **Ovary:** The ovaries are the female reproductive organs that produce eggs (ova) and hormones. Sperm does not reach the ovaries during coitus. Instead, fertilization typically occurs in the fallopian tubes after the sperm has traveled through the cervix and uterus.
 - **Uterus:** The uterus is a muscular organ where a fertilized egg can implant and develop into a fetus. After passing through the cervix, sperm can travel into the uterus.
 - **Fallopian Tube:** The fallopian tubes connect the ovaries to the uterus. Sperm travels through the uterus to reach the fallopian tubes, where fertilization of the egg usually occurs.
-

Question 35

Which of the following does not take place before ovulation in human female ?

Which of the following does not take place before ovulation in human female ?

Options:

A.

The secretion of LH and FSH increases during follicular phase.

B.

The corpus luteum secretes large amounts of progesterone.

C.

LH and FSH attains a peak level in the middle of the cycle

D.

Maximum secretion of LH induces rupture of Graafian follicle.

Answer: B

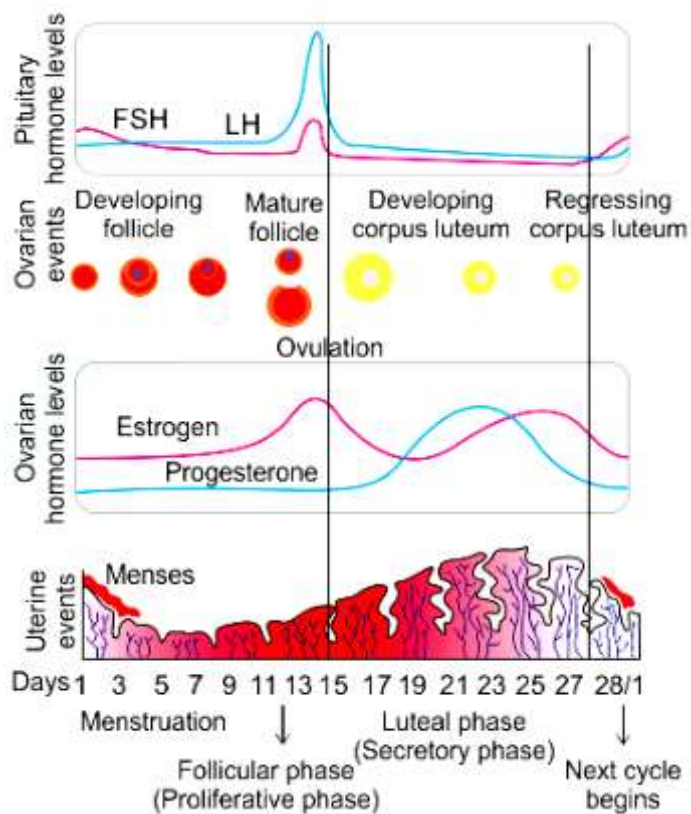
Solution:

The correct answer is **The corpus luteum secretes large amounts of progesterone.**

Explanation:

The menstrual cycle is divided into several phases: the follicular phase, ovulation, the luteal phase, and menstruation. Ovulation is the release of an egg from one of the ovaries and typically occurs around the middle of the menstrual cycle.

- **The secretion of LH and FSH increases during the follicular phase:** This statement is true. During the follicular phase, the levels of LH (Luteinizing Hormone) and FSH (Follicle Stimulating Hormone) increase, leading to the growth and maturation of ovarian follicles.
- **The corpus luteum secretes large amounts of progesterone:** The corpus luteum is formed from the ruptured Graafian follicle **after ovulation** and secretes large amounts of progesterone during the luteal phase.
- **LH and FSH attain a peak level in the middle of the cycle:** This statement is true. LH and FSH levels reach their peak during the middle of the cycle, which triggers ovulation.
- **Maximum secretion of LH induces the rupture of the Graafian follicle:** This statement is true. The surge in LH levels leads to the rupture of the Graafian follicle and the release of the ovum, which is the process of ovulation.



Question 36

Match List-I with List-II :

List – I		List - II	
Phase of menstrual cycle		Days of menstrual cycle	
A.	Proliferative phase	I.	14th day
B.	Menstrual phase	II.	15th – 28th/29th days
C.	Secretory phase	III.	1st – 5th days
D.	Ovulatory phase	IV.	5th – 13th days

Choose the correct answer from the options given below :

Match List-I with List-II :

List – I		List - II	
Phase of menstrual cycle		Days of menstrual cycle	
A.	Proliferative phase	I.	14th day

B.	Menstrual phase	II.	15th – 28th/29th days
C.	Secretory phase	III.	1st – 5th days
D.	Ovulatory phase	IV.	5th – 13th days

Choose the correct answer from the options given below :

Options:

A.

(A) - (II), (B) - (IV), (C) - (III), (D) - (I)

B.

(A) - (III), (B) - (II), (C) - (I), (D) - (IV)

C.

(A) - (IV), (B) - (III), (C) - (II), (D) - (I)

D.

(A) - (II), (B) - (IV), (C) - (I), (D) - (III)

Answer: C

Solution:

The correct answer is (A) - (IV), (B) - (III), (C) - (II), (D) - (I)

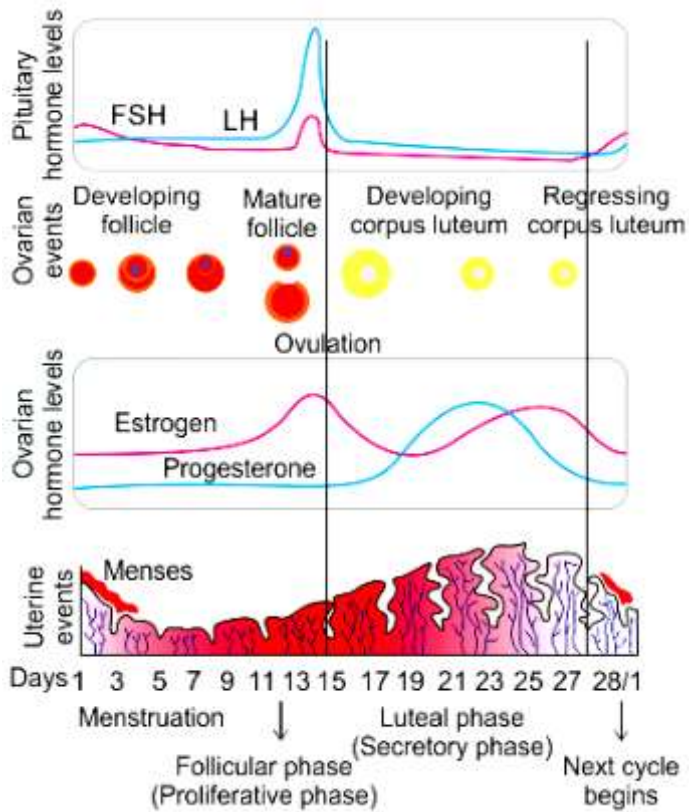
Concept:

- The menstrual cycle is a series of natural changes in hormone production and the structures of the uterus and ovaries of the female reproductive system that make pregnancy possible.
- The cycle is divided into several phases, each characterized by specific events and hormonal changes.
- The key phases are the menstrual phase, proliferative phase, ovulatory phase, and secretory phase.

Explanation:

- **Proliferative Phase (A):** This phase lasts from the end of menstruation to ovulation, approximately from the 5th to the 13th day of the cycle. During this phase, the endometrium (lining of the uterus) thickens in preparation for a possible pregnancy.
- **Menstrual Phase (B):** This is the phase when the menstrual bleeding occurs, marking the shedding of the endometrial lining from the previous cycle. This phase typically lasts from the 1st to the 5th day.
- **Secretory Phase (C):** Following ovulation, the endometrium enters the secretory phase, preparing for potential implantation of an embryo. This phase lasts from approximately the 15th to the 28th/29th days.

- **Ovulatory Phase (D):** Ovulation occurs around the midpoint of the cycle, typically on the 14th day, when the mature egg is released from the ovary.



Question 37

Name the population interaction which takes place when one species is benefitted and another species has no effect (no benefit no harm).

Name the population interaction which takes place when one species is benefitted and another species has no effect (no benefit no harm).

Options:

- A. Competition
- B. Predation
- C. Commensalism

D. Amensalism

Answer: C

Solution:

The correct answer is **Commensalism**

Explanation:

Population interactions refer to the various ways species within an ecosystem interact with one another. These interactions can have positive, negative, or neutral effects on the species involved.

Commensalism: It is the interaction between two species, where one species is benefitted and the other is neither harmed nor benefitted.

- An **Orchid growing** as an epiphyte on a mango tree gets shelter and nutrition from the mango tree, while the mango tree is neither benefitted or harmed.
- **Sea anemone** has stinging tentacles and the clown fish lives among them. The fish gets protection from predators, which stay away from the stinging tentacles. The anemone does not appear to derive any benefit by hosting the clown fish.

Other Options:

- **Competition:** Both the species **benefit in mutualism** and both **lose in competition** in their interactions with each other.
- **Predation:** In this interaction, one species (the predator) benefits by hunting and consuming another species (the prey), which is harmed in the process. For example, a lion hunting a zebra.
- In **amensalism**, one species is harmed whereas the other is unaffected.

Table: Population Interactions

Species A	Species B	Name of Interactions	Examples
+	+	Mutualism	Fungi and root of a higher plant in Mycorrhizae
-	-	Competition	A Leopard and a Lion in a forest/grassland
+	-	Predation	In the rocky intertidal communities of the American Pacific Coast the starfish Pisaster is an important predator.
+	-	Parasitism	A Cuckoo laying egg in a Crow's nest (Brood Parasitism)
+	0	Commensalism	A cattle egret and a Cattle in a field
-	0	Amensalism	Grazing cattle and insects. When cattle graze in grass, birds eat the insects, but the cattle are unharmed.

Question 38

Identify the incorrect matching from the following population interaction :

	Species A	Species B	Name of interaction
(1)	+	+	Mutualism
(2)	+	-	Parasitism
(3)	-	-	Predation
(4)	-	0	Amensalism

Identify the incorrect matching from the following population interaction :

	Species A	Species B	Name of interaction
(1)	+	+	Mutualism
(2)	+	-	Parasitism
(3)	-	-	Predation
(4)	-	0	Amensalism

Options:

A. 1

B. 2

C. 3

D. 4

Answer: C

Solution:

The correct answer is **Predation**

Explanation:

- Population interactions refer to various ways species interact with each other within an ecosystem. These interactions can have positive, negative, or neutral effects on the interacting species.
- Common types of population interactions include mutualism, parasitism, predation, and amensalism.
- In Predation only one species i.e. predator benefits and the interaction is detrimental to the other species (prey).

Table: Population Interactions

Species A	Species B	Name of Interactions	Examples
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+	-	Predation	In the rocky intertidal communities of the American Pacific Coast the starfish <i>Pisaster</i> is an important predator.
+	-	Parasitism	A Cuckoo laying egg in a Crow's nest (Brood Parasitism)
+	0	Commensalism	A cattle egret and a Cattle in a field
-	0	Amensalism	Grazing cattle and insects. When cattle graze in grass, birds eat the insects, but the cattle are unharmed.

Question 39

Given below are two statements :

Statement I : An orchid grows as an epiphyte on a mango branch where mango tree does not derive any apparent benefit from it.

Statement II : A orchid growing on a mango tree is an example of commensalism.

In the light of the above statements, choose the correct answer from the options given below :

Given below are two statements :

Statement I : An orchid grows as an epiphyte on a mango branch where mango tree does not derive any apparent benefit from it.

Statement II : A orchid growing on a mango tree is an example of commensalism.

In the light of the above statements, choose the correct answer from the options given below :

Options:

- A. Both Statement I and Statement II are true
- B. Both Statement I and Statement II are false
- C. Statement I is true, but Statement II is false
- D. Statement I is false, but Statement II is true

Answer: A

Solution:

The correct answer is **Both Statement I and Statement II are true**

Concept:

- Commensalism is a type of symbiotic relationship in which one species benefits while the other species is neither helped nor harmed. This relationship enhances the survival, growth, or reproduction of the commensal species without affecting the host species.
- **Epiphytes** are plants that grow on other plants for physical support. They are not parasitic and do not harm the host plant from which they derive support.

Examples of Commensalism:

- **Orchid growing on a mango tree:** The orchid benefits by gaining physical support from the mango tree, which elevates it to a position where it can receive more sunlight. The mango tree is neither helped nor harmed.
- **Barnacles growing on a whale:** Barnacles attach themselves to the whale's skin, gaining mobility to different feeding areas and avoiding predators. The whale is unaffected by their presence.
- **Cattle egrets foraging near grazing cattle:** The cattle egrets benefit by feeding on insects stirred up by the movement of the grazing cattle. The cattle are unaffected by the presence of the egrets.
- Interaction between sea anemone that has stinging tentacles and the clownfish that lives among them.

Question 40

Match List-I with List-II :

List – I		List - II	
Examples		Interactions	
A.	Extinction of Abingdon tortoise after introduction of goats on Galapagos Islands	I.	Parasitism
B.	Infestations of marine fish by copepods	II.	Commensalism
C.	Cattle egret and grazing cattle	III.	Mutualism
D.	Fig tree and wasp	IV.	Competition

Choose the correct answer from the options given below :

Match List-I with List-II :

List – I	List - II
Examples	Interactions

A.	Extinction of Abingdon tortoise after introduction of goats on Galapagos Islands	I.	Parasitism
B.	Infestations of marine fish by copepods	II.	Commensalism
C.	Cattle egret and grazing cattle	III.	Mutualism
D.	Fig tree and wasp	IV.	Competition

Choose the correct answer from the options given below :

Options:

- A. (A) - (IV), (B) - (II), (C) - (I), (D) - (III)
- B. (A) - (II), (B) - (III), (C) - (I), (D) - (IV)
- C. (A) - (III), (B) - (II), (C) - (IV), (D) - (I)
- D. (A) - (IV), (B) - (I), (C) - (II), (D) - (III)

Answer: D

Solution:

The correct answer is (A) - (IV), (B) - (I), (C) - (II), (D) - (III)

Concept:

- Interactions between species can be broadly categorized into several types, including competition, parasitism, commensalism, and mutualism.
- **Competition:** This occurs when two species compete for the same resources, which can lead to the extinction of one species or the migration of one species to a different location.
- **Parasitism:** This is an interaction where one organism (the parasite) benefits at the expense of another organism (the host).
- **Commensalism:** This is an interaction where one organism benefits while the other is neither helped nor harmed.
- **Mutualism:** This is an interaction where both organisms involved benefit from the relationship.

Explanation:

(A) - (IV): Extinction of Abingdon tortoise after introduction of goats on Galapagos Islands - Competition

- This is a classic example of competition. The introduction of goats led to overgrazing and depletion of vegetation, which the Abingdon tortoise depended on for food. This competition for resources ultimately led to the extinction of the tortoise.

(B) - (I): Infestations of marine fish by copepods - Parasitism

- Copepods are parasites that attach themselves to marine fish, feeding on their blood and tissues, thus harming the fish while benefiting themselves.

(C) - (II): Cattle egret and grazing cattle - Commensalism

- The cattle egret benefits by eating insects stirred up by the movement of grazing cattle. The cattle are neither harmed nor helped by the presence of the egrets.

(D) - (III): Fig tree and wasp - Mutualism

- The relationship between the fig tree and the wasp is mutualistic. The wasp pollinates the fig tree while laying its eggs inside the fig fruit, providing a habitat and food source for its larvae.

Question 41

Select the incorrect pair in response to abiotic factors :

Select the incorrect pair in response to abiotic factors :

Options:

A.

We maintain a constant body temperature of 37°C – Conformer

B.

Every winter Keoladeo National Park hosts the birds coming from Siberia – Migration

C.

Under unfavourable conditions many zooplankton species in ponds enter the stage of suspended development – Diapause

D.

If a predator is too efficient it overexploits its prey – Extinction

Answer: A

Solution:

The correct answer is **We maintain a constant body temperature of 37°C – Conformer**

Concept:

- Abiotic factors refer to the non-living components of an ecosystem such as temperature, water, light, and nutrients that affect the living organisms (biotic components).
- Organisms have various strategies to cope with abiotic stress. Some organisms are conformers, regulators, or have other adaptations such as migration or diapause.

Explanation:

We maintain a constant body temperature of 37°C – Regulator: Humans and other mammals are regulators, not conformers. Regulators maintain a constant internal environment (homeostasis) despite changes in external environmental conditions. This includes maintaining a constant body temperature. All birds and mammals and a very few lower vertebrate and invertebrate species are indeed capable of such regulation (thermoregulation and osmoregulation)

- Most of the animals and nearly all plants cannot maintain a constant internal environment. Their body temperature changes with the ambient temperature. In aquatic animals, the osmotic concentration of the body fluids changes with that of the ambient air, water osmotic concentration. These animals and plants are simply conformers

Every winter Keoladeo National Park hosts the birds coming from Siberia – Migration: Many bird species migrate to different geographical locations to escape harsh climatic conditions and find better breeding or feeding grounds.

Under unfavourable conditions many zooplankton species in ponds enter the stage of suspended development – Diapause: Diapause is a period of suspended development in an organism, often to avoid unfavorable environmental conditions.

If a predator is too efficient it overexploits its prey – Extinction: When a predator is highly efficient, it can lead to the overexploitation of its prey, potentially driving the prey species to extinction.

Question 42

Which one is the correct example of hermaphrodites ?

Options:

- A. Tapeworm and leech
- B. Cockroach and frog
- C. Cockroach and earthworm
- D. Carp fish and pigeon

Answer: A

Solution:

The correct answer is **Tapeworm and leech**

Explanation:

- Hermaphrodites are organisms that have both male and female reproductive organs. This allows them to produce both eggs and sperm, enabling them to reproduce in a variety of conditions.
- Earthworms, sponge, Tapeworm and leech are examples of bisexual animals that possess both male and female reproductive organs, are hermaphrodites.
- Cockroach is an example of unisexual species

Explanation:

- **Cockroach and frog:** These are not hermaphrodites. Cockroaches and frogs have distinct male and female individuals, requiring mating between opposite sexes for reproduction.
 - **Carp fish and pigeon:** Neither carp fish nor pigeons are hermaphrodites. Both species have distinct male and female individuals and require mating between opposite sexes for reproduction.
-

Question 43

In diploid organisms, which of the following undergoes meiosis ?

Options:

- A. Vegetative cell
- B. Sporogenous tissue
- C. Pollen grain
- D. Synergids

Answer: B

Solution:

The correct answer is **Sporogenous tissue**

Concept:

- Sporogenous tissue is a specialized tissue in plants that is responsible for the production of spores. It is a crucial part of the reproductive system in flowering plants.
- In flowering plants, the anther is a part of the stamen, which is the male reproductive organ.
- The anther contains sporogenous tissue which gives rise to pollen grains (microspores) through the process of meiosis.

Explanation:

Sporogenous tissue:

- This tissue is involved in the formation of spores in plants.
- It undergoes meiosis to produce haploid spores, which can develop into a new organism.
- Sporogenous tissue is crucial for the alternation of generations in the plant life cycle, where it transitions from the diploid sporophyte to the haploid gametophyte stage.

Vegetative cell:

- This type of cell is involved in the growth and development of the plant body.
- It does not undergo meiosis but rather mitosis, which is essential for growth and asexual reproduction.

Pollen grain:

- Pollen grains are the male gametophytes in flowering plants.
- They are haploid and are the product of meiosis that occurs in the sporogenous tissue of the anther.

Synergids:

- These are cells located in the ovule of flowering plants.
- They are part of the female gametophyte and play a role in the fertilization process.
- Synergids do not undergo meiosis; they are derived from the megaspore mother cell, which undergoes meiosis to form the female gametophyte.

Question 44

Who proposed that the first form of life could have come from pre-existing non-living organic molecules ?

Options:

- A. Darwin
- B. Oparin and Haldane
- C. Lamarck
- D. Thomas Malthus

Answer: B

Solution:

The correct answer is **Oparin and Haldane**.

Explanation:

- Oparin of Russia and Haldane of England proposed that the first form of life could have come from pre-existing non-living organic molecules (e.g. RNA, protein, etc.) and that formation of life was preceded by

chemical evolution, i.e., formation of diverse organic molecules from inorganic constituents.

- The conditions on earth were high temperature, volcanic storms, reducing atmosphere containing CH_4 , NH_3 , etc.
- He created electric discharge in a closed flask containing CH_4 , H_2 , NH_3 and water vapour at 800°C . He observed formation of amino acids. In similar experiments others observed, formation of sugars, nitrogen bases, pigment and fats.

Other Options:

- **Darwin:** Charles Darwin is known for his theory of evolution by natural selection, not for the origin of life from non-living organic molecules.
 - **Lamarck:** Jean-Baptiste Lamarck is known for his theory of inheritance of acquired characteristics.
 - **Thomas Malthus:** Thomas Malthus is known for his work on population growth and its effects on resources.
-

Question 45

Given below are two statements :

Statement I : In a bioreactor, small volume of cultures are developed in which useful bio-products are produced.

Statement II : In downstream processing, the products formulated with suitable preservatives are ready for marketing without testing of their quality.

In the light of the above statements, choose the correct answer from the options given below :

Options:

- A. Both Statement I and Statement II are true
- B. Both Statement I and Statement II are false
- C. Statement I is true, but Statement II is false
- D. Statement I is false, but Statement II is true

Answer: B

Solution:

The correct answer is **Both Statement I and Statement II are false**

Concept:

Bio-reactors are typically used for the large-scale cultivation of cells or microorganisms. For small-scale bacterial cultures, laboratory techniques like shake flasks are commonly used instead.

- To produce **inlarge quantities**, the development of bioreactors, where large volumes (100-1000 litres) of culture can be processed, was required. Thus, bioreactors can be thought of as vessels in which raw materials are biologically converted into specific products, individual enzymes, etc., using microbial plant, animal or human cells.
- A bioreactor provides the optimal conditions for achieving the desired product by providing optimum growth conditions (temperature, pH, substrate, salts, vitamins, oxygen).
- The most commonly used bioreactors are of **stirring type**.

Explanation:

- **Statement I:** This statement is false because bioreactors are typically used for large-scale production of bio-products.
 - **Statement II:** This statement is false because downstream processing includes rigorous quality testing of the product. Downstream process involves the separation of the desired product from the mixture, followed by purification to achieve the required quality and concentration. Strict quality control testing for each product is required. The downstream processing and quality control testing vary from product to product.
-

Question 46

The method where an ovum is transferred from a donor into the fallopian tube of another female is _____ .

Options:

- A. IUI
- B. ICSI
- C. GIFT
- D. ZIFT

Answer: C

Solution:

The correct answer is **GIFT**

Explanation:

- Gamete Intrafallopian Transfer (GIFT) is an assisted reproductive technology (ART) used to help infertile couples conceive.
- In this method, an ovum (egg) is taken from a donor and then transferred into the fallopian tube of another female, usually along with sperm, to facilitate fertilization within the body.
- It requires at least one functional fallopian tube in the recipient female for the process to be successful.
- GIFT is often chosen when there are unexplained fertility issues or when other ART methods have not been successful.

Other Options:

- **IUI (Intra-uterine insemination):** In this technique, the semen collected either from the husband or a healthy donor is artificially introduced either into the vagina or into the uterus of the female.
 - **Intra cytoplasmic sperm injection (ICSI)** is another specialised procedure to form an embryo in the laboratory in which a sperm is directly injected into the ovum.
 - **ZIFT (Zygote intra fallopian transfer):** The zygote or early embryos (with upto 8 blastomeres) could then be transferred into the fallopian tube.
-

Question 47

When one of the parents has ‘A’ blood group and the other parent has ‘O’ blood group, then their child can have _____ blood group.

Options:

- A. Only ‘A’
- B. Only ‘O’
- C. Both ‘A’ and ‘O’
- D. Either ‘A’ or ‘O’

Answer: D

Solution:

The correct answer is **either 'A' or 'O'**

Concept:

- The ABO blood group system demonstrates Multiple allelism.
- Multiple allelism occurs when three or more alleles for a gene exist within a population.
- In the ABO blood group system, the A, B, and O alleles interact to produce the four blood types: A, B, AB, and O, showcasing multiple allelism.
- The ABO blood typing has three alleles that affect the expression of antigens on the surface of red blood cells: alleles A, B, and O.
- ABO blood typing is controlled by gene I. There are three alleles of the gene (I)- I^A , I^B , and i.

- The ABO blood typing consists of three alleles A, B, and O.
- Both A and B are dominant meanwhile O is recessive.
- Blood group A can have the genotype AA or AO.
- Blood group B can have the genotype BB or BO.

Explanation:

The genotypes of parents and child according to the ABO blood grouping system

- Blood type A: Genotype can be ($I^A I^A$) or ($I^A i$).
- Blood type B: Genotype can be ($I^B I^B$) or ($I^B i$).
- Blood type AB: Genotype is ($I^A I^B$).
- Blood type O: Genotype is (ii).

Given:

- One Parent blood group is A ($I^A I^A$) or ($I^A i$).
- Other Parent blood group is O (ii).

Child's blood group is A (If parents are $I^A I^A$ and ii)

	I^A	I^A
i	$I^A i$	$I^A i$
i	$I^A i$	$I^A i$

- Since all the genotypes are $I^A i$ indicating A blood group.

Child's blood group is A and O (If parents are $I^A i$ and ii)

	I^A	i
i	$I^A i$	ii
i	$I^A i$	ii

Question 48

The size of VNTR varies from :

Options:

- A. 0.1 to 20 kb
- B. 0.1 to 10 kb
- C. 0.2 to 15 kb
- D. 0.2 to 10 kb

Answer: A

Solution:

The correct answer is **0.1 to 20 kb**

Explanation:

- VNTR stands for Variable Number Tandem Repeats, which are locations in a genome where a short nucleotide sequence is organized as a tandem repeat. These can be found on many chromosomes and often show variations in length between individuals.
 - The VNTR belongs to a class of satellite DNA referred to as mini-satellite.
 - VNTRs are important for genetic fingerprinting, forensics, and paternity testing due to their high variability among individuals.
 - The length of VNTRs is determined by the number of repeat units, which can vary widely.
 - The size of VNTR varies in size from **0.1 to 20 kb**.
-

Question 49

The common approach(es) for the treatment of cancer is/are :

(A) Vaccination

(B) Surgery

(C) Physiotherapy

(D) Radiation therapy

(E) Immunotherapy

Choose the correct answer from the options given below :

Options:

A. (A) only

B. (B), (D) and (E) only

C. (A), (C) and (D) only

D. (A) and (C) only

Answer: B

Solution:

The correct answer is **B, D, and E only**

Explanation:

Cancer is a group of diseases involving abnormal cell growth with the potential to invade or spread to other parts of the body. The common approaches for treatment of cancer are surgery, radiation therapy and immunotherapy.

- **Vaccination (A):** While vaccines are crucial in preventing certain cancers caused by viruses (e.g., HPV vaccine for cervical cancer), vaccination is not a common approach for treating existing cancer.
 - **Surgery (B):** Surgery is a common treatment for cancer. It involves the physical removal of the tumor and, sometimes, surrounding tissues. It is often used for solid tumors that are localized and can be completely removed.
 - **Physiotherapy (C):** Physiotherapy is generally not a treatment for cancer itself. It may be used as a supportive therapy to help patients recover from cancer treatments and improve their quality of life.
 - **Radiation Therapy (D):** Radiation therapy uses high-energy radiation to kill cancer cells or shrink tumors. It is a common treatment method for many types of cancer and can be used alone or in combination with other treatments.
 - **Immunotherapy (E):** Immunotherapy is a type of cancer treatment that helps your immune system fight cancer. The patients are given substances called biological response modifiers such as **α -interferon** which activates their immune system and helps in destroying the tumor.
-

Question 50

Which of the following controls/control the growth of bollworms ?

Options:

- A. CryIAc and CryIIAb genes
- B. CryIAb gene
- C. RNAi
- D. dsRNA

Answer: A

Solution:

The correct answer is **CryIAc and CryIIAb genes**

Explanation:

- Bollworms are a significant pest in cotton cultivation, causing extensive damage to the crops. Effective control of bollworms is crucial for ensuring healthy cotton yields.
- Specific Bt toxin genes were isolated from *Bacillus thuringiensis* and incorporated into the several crop plants such as cotton.
- The toxin is coded by a gene cryIAc named cry.
- The proteins encoded by the genes cryIAc and cryIIAb control the cotton bollworms and that of cryIAb controls corn borer.

Other Options:

- **CryIAb gene:** While CryIAb is also a Bt gene, it is primarily used to control corn borer.
 - **RNAi:** RNA interference (RNAi) is a biological process in which RNA molecules inhibit gene expression, typically by destroying specific mRNA molecules. RNAi takes place in all eukaryotic organisms as a method of cellular defense. This method involves the silencing of a specific mRNA due to a complementary dsRNA molecule that binds to and prevents translation of the mRNA (silencing)
 - **dsRNA:** Double-stranded RNA (dsRNA) can trigger RNAi, leading to gene silencing. However, similar to RNAi, this technology is not yet employed for bollworm control in cotton cultivation.
-