

Question 1

Production of seeds without fertilization is known as:

Options:

- A. Parthenogenesis
- B. Apomixis
- C. Polyembryony
- D. Syngamy

Answer: B

Solution:

The correct answer is **Apomixis**

Explanation:

- Apomixis is a form of asexual reproduction that allows plants to produce **seeds without the process of fertilization**. This means that the offspring are genetically identical to the parent plant.
- Apomixis is a form of asexual reproduction that mimics sexual reproduction.
- There are several ways of development of apomictic seeds.
- In some species, the diploid egg cell is formed without reduction division and develops into the embryo without fertilisation.
- Examples are some species of *Asteraceae* and grasses.

Other Options:

- **Parthenogenesis:** This is a form of asexual reproduction where an **egg develops into an individual without fertilization**. It is more common in animals, particularly invertebrates and some vertebrates, but not typically used to describe seed production in plants.
 - **Polyembryony:** This refers to the phenomenon where multiple embryos develop from a single fertilized egg. It is different from apomixis as polyembryony still involves fertilization. The occurrence of more than one embryo in a seed is referred to as polyembryony.
 - **Syngamy:** This is the process of fertilization where two gametes (sperm and egg) fuse to form a zygote.
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Question 2

Arrange the given stages of Megasporogenesis in chronological order.

(A) Megaspore tetrad

(B) Megaspore dyad

(C) Megaspore mother cell

(D) Female gametophyte

Choose the correct answer from the options given below:

Options:

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

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

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

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

Answer: D

Solution:

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

Explanation:

Megasporogenesis is the process of formation of megaspores from the megaspore mother cell in the ovules of seed plants. This process is a part of the larger reproductive cycle of plants, leading to the formation of the female gametophyte.

- **Megaspore Mother Cell (C):** The process begins with the megaspore mother cell (MMC), which is a diploid cell located within the ovule. The MMC undergoes meiosis to produce four haploid cells.
- **Megaspore Dyad (B):** After the first meiotic division, the MMC divides to form two haploid cells, known as the megaspore dyad.
- **Megaspore Tetrad (A):** The second meiotic division results in a tetrad of four haploid megaspores. Typically, only one of these megaspores will survive and develop further, while the others degenerate.
- **Female Gametophyte (D):** The surviving megaspore undergoes mitotic divisions to form the female gametophyte, also known as the embryo sac. This structure contains the egg cell that will participate in fertilization.

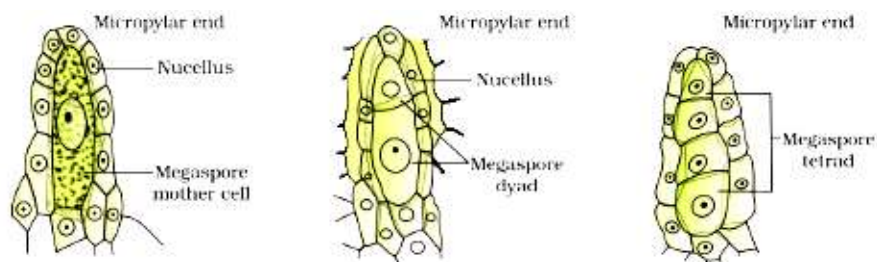


Fig: Parts of the ovule showing a large megaspore mother cell, a dyad and a tetrad of megaspores.

Question 3

Match List-I with List-II:

List – I		List - II	
Kind of Pollinations		Features	
A.	Autogamy	I.	Pollination involving flower of two different plants
B.	Geitonogamy	II.	Pollination involving water
C.	Xenogamy	III.	Pollination involving two flowers of same plant
D.	Hydrophyily	IV.	Pollination involving same flower

Choose the correct answer from the options given below :

Options:

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

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

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

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

Answer: C

Solution:

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

Explanation:

- Pollination is the transfer of pollen grains from the male anther of a flower to the female stigma.
- There are different types of pollination mechanisms based on the source of pollen and the agent responsible for pollination.
- The primary types of pollination are autogamy, geitonogamy, xenogamy, and hydrophily, each with distinct features and mechanisms.

Explanation:

- **Autogamy (A - IV):** This type of pollination involves the transfer of pollen from the anther to the stigma of the same flower. This ensures that the flower can reproduce without the need for external pollinators.
 - **Geitonogamy (B - III):** This involves the transfer of pollen from the anther of one flower to the stigma of another flower on the same plant. Although geitonogamy is functionally cross-pollination involving a pollinating agent, **genetically it is similar to autogamy** since the pollen grains come from the same plant.
 - **Xenogamy (C - I):** This is the transfer of pollen from the anther of a flower of one plant to the stigma of a flower of another plant. This is the only type of pollination which during pollination brings genetically different types of pollen grains to the stigma.
 - **Hydrophily (D - II):** This type of pollination occurs with the help of water. Pollination by water is quite rare in flowering plants and is limited to about 30 genera, mostly monocotyledons.
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Question 4

Hormone releasing Intra Uterine Device is :

Options:

- A. Lippes loop
- B. LNG -20
- C. Multiload 375
- D. Cu 7

Answer: B

Solution:

The correct answer is **LNG-20**

Concept:

- Intra Uterine Devices (IUDs) are inserted by doctors or expert nurses in the uterus through vagina.
- These Intra Uterine Devices are presently available as the non-medicated IUDs (e.g., Lippes loop), copper releasing IUDs (CuT, Cu7, Multiload 375) and the hormone releasing IUDs (Progestasert, LNG-20).
- IUDs increase phagocytosis of sperms within the uterus and the Cu ions released suppress sperm motility and the fertilising capacity of sperms. The hormone releasing IUDs, in addition, make the uterus unsuitable for

implantation and the cervix hostile to the sperms

Explanation:

- **LNG-20:** This is a hormone-releasing intrauterine device that releases levonorgestrel, a form of progestin. It thickens the cervical mucus, inhibits sperm movement, reduces sperm survival, and thins the endometrium, making it less suitable for implantation.
 - **Lippes Loop:** This is a type of non-hormonal IUD made of plastic. It does not release any hormones and works primarily by creating a physical barrier to prevent sperm from reaching the egg.
 - **Multiload 375:** This is a copper IUD, which releases copper ions that are toxic to sperm, thereby preventing fertilization. It does not release any hormones.
 - **Cu 7:** This is another type of copper IUD, similar to the Multiload 375, which also works by releasing copper ions to prevent fertilization and is non-hormonal.
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Question 5

Which of the following is incorrect regarding oral contraceptives ?

Options:

- A. These are small doses of progestogens or progestogen - estrogen combinations
- B. They inhibit ovulation and implantation
- C. They suppress the sperm motility and its fertilizing capacity
- D. They may contain non-steroidal preparation with few side effects and high contraceptive value

Answer: C

Solution:

The correct answer is **They suppress the sperm motility and its fertilizing capacity**

Explanation:

- **These are small doses of progestogens or progestogen-estrogen combinations:** This statement is correct. Oral contraceptives typically contain either a combination of estrogen and progestogen or just progestogen.
- **They inhibit ovulation and implantation:** This statement is incorrect. The primary mechanism of action for oral contraceptives is to prevent ovulation and make the uterine lining less receptive to a fertilized egg.
- **They suppress the sperm motility and its fertilizing capacity:** This statement is incorrect. Oral contraceptives do not directly affect sperm motility or their ability to fertilize an egg. They inhibit ovulation and implantation as well as alter the quality of cervical mucus to prevent/retard entry of sperms.
- **They may contain non-steroidal preparations with few side effects and high contraceptive value:** This statement is correct to some extent. While most oral contraceptives are steroidal (hormonal), there are non-steroidal options available with fewer side effects and effective contraceptive properties. **Saheli** is a new oral contraceptive for the females contains a non-steroidal preparation. It is a 'once a week' pill with very few side effects and high contraceptive value.

Question 6

Choose the statements which are correct with respect to the Medical Termination of Pregnancy (MTP) Act, 2017 :

- (A) Approximately 20% of the conceived pregnancies undergone MTP globally in a year**
- (B) MTP is legalized in India upto four months unconditionally**
- (C) Amniocentesis is mandatory before performing MTP**
- (D) MTPs are considered relatively safe upto 12 weeks of pregnancy**

Choose the correct answer from the options given below :

Options:

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

Answer: D

Solution:

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

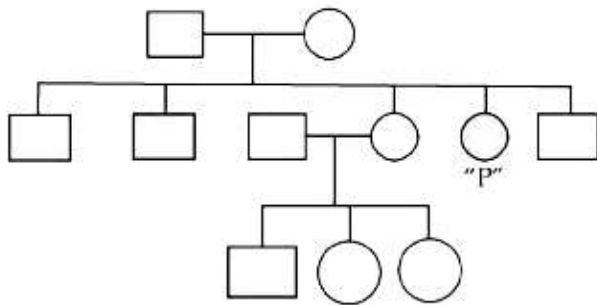
Explanation:

- **(A) Approximately 20% of the conceived pregnancies undergo MTP globally in a year:** This statement is correct. Nearly 45 to 50 million MTPs are performed in a year all over the world which accounts to 1/5th (20%) of the total number of conceived pregnancies in a year.
- **(B) MTP is legalized in India up to four months unconditionally:** This statement is incorrect. The MTP Act allows for termination of pregnancy up to 12 weeks. For pregnancies between 20 to 24 weeks, the approval of two registered medical practitioners is required, and certain conditions must be met.
- **(C) Amniocentesis is mandatory before performing MTP:** This statement is incorrect. Amniocentesis is not mandatory for performing MTP. It is a procedure used to diagnose genetic conditions and fetal abnormalities, and it may be recommended in certain cases but is not a requirement for MTP.

- **(D) MTPs are considered relatively safe up to 12 weeks of pregnancy:** This statement is correct. Medical and surgical abortions are generally considered safe when performed within the first trimester (up to 12 weeks) by a qualified healthcare provider. The risks associated with the procedure increase with the duration of the pregnancy.
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Question 7

In the given pedigree chart 'P' is a female suffering from a disease, which is denoted by 'A' dominant allele and 'a' recessive allele ? Find the genotype of 'P'.



Options:

- A. AA
- B. $X^A X$
- C. $X^A X^A$
- D. aa

Answer: D

Solution:

The correct answer is aa

Explanation:

The given pedigree is an example of Autosomal recessive disorder.

An **autosomal recessive disorder** is a type of genetic condition that occurs when an individual inherits two copies of an altered gene, one from each parent, on one of the autosomes (non-sex chromosomes). Individuals who have only one copy of the altered gene are carriers of the disorder but typically do not show any symptoms.

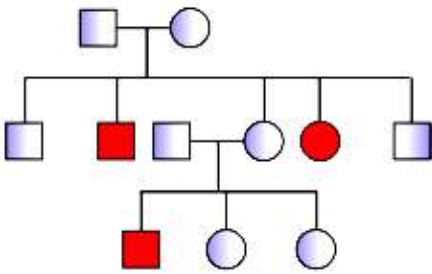
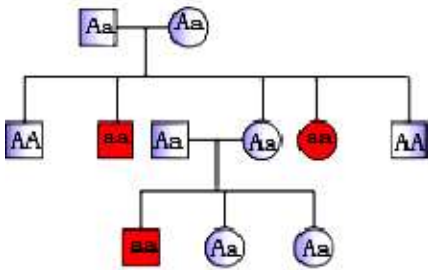


Fig: Autosomal recessive trait for example: Sickle cell anaemia



An **autosomal dominant disorder** is a type of genetic condition that occurs when an individual inherits just one copy of an altered gene on one of the autosomes. This single copy of the altered gene is sufficient to cause the disorder, even if the other copy of the gene is normal.

Question 8

Gene HBB for β -thalassemia is present on which chromosome ?

Options:

- A. 5
- B. 22
- C. 11
- D. 9

Answer: C

Solution:

The correct answer is **11**

Explanation:

- Thalassemia is an autosome-linked recessive blood disease transmitted from parents to the offspring when both the partners are unaffected carrier for the gene (or heterozygous).

- The defect could be due to either mutation or deletion, which ultimately results in a reduced rate of synthesis of one of the globin chains (α and β chains) that make up haemoglobin.
 - This causes the formation of abnormal haemoglobin molecules, resulting in anaemia, which is characteristic of the disease.
 - Thalassemia can be classified according to which chain of the haemoglobin molecule is affected.
 - In α Thalassemia, production of α globin chain is affected, while in β Thalassemia, production of β globin chain is affected.
 - **α Thalassemia** is controlled by two closely linked genes, **HBA1 and HBA2** on **chromosome 16** of each parent
 - **β Thalassemia** is controlled by a single gene, **HBB** on **chromosome 11** of each parent and occurs due to a mutation of one or both the genes.
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Question 9

Of the following statements which is/are correct?

- (A) During incomplete dominance, modified allele is the dominant allele**
- (B) In polygenic inheritance, the effect of each allele is additive**
- (C) A gene is called pleiotropic when it exhibit multiple phenotypic expression**
- (D) Mutation means alteration of DNA sequence which ensures change only in the phenotype of an organism**

Choose the correct answer from the options given below:

Options:

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

Answer: B

Solution:

The correct answer is **2)(B) and (C) only**

Concept:

- **Polygenic Inheritance:** Polygenic inheritance refers to the kind of inheritance in which the phenotype is determined by the additive effects of two or more genes. These genes are called polygenes. Each allele contributes to the final phenotype, and the overall effect is typically a continuous range of phenotypes (e.g., human skin color, height).
- **Pleiotropy:** Pleiotropy occurs when a single gene exhibits multiple phenotypic traits. An example of pleiotropy is the phenylketonuria, which occurs in humans. The disease is caused by mutation in the gene that codes for the enzyme phenylalanine hydroxylase (single gene mutation). The phenotypic expression characterised by mental retardation and a reduction in hair and skin pigmentation.

Explanation:

- **Statement (A):** During incomplete dominance, neither allele is completely dominant over the other. Instead, the heterozygous phenotype is a blend of the two homozygous phenotypes. Therefore, the statement that the modified allele is the dominant allele is **incorrect**.
- **Statement (B):** In polygenic inheritance, the effect of each allele is indeed additive. Multiple genes contribute to a single trait, and the combined effect of these genes produces a continuous range of phenotypes.
- **Statement (C):** A gene is called pleiotropic when it exhibits multiple phenotypic expressions. This is true as one gene can have multiple effects on an organism's phenotype.
- **Statement (D):** Mutation refers to any change in the DNA sequence of an organism. Mutations can be silent, meaning they do not result in any observable change in phenotype. Therefore, the statement that mutations ensure changes only in the phenotype is **incorrect**.

Question 10

Match List-I with List-II:

List – I		List - II	
A.	Thalassemia	I.	47, XXY
B.	Klinefelter's syndrome	II.	Sex linked recessive disorder
C.	Turners' syndrome	III.	45, XO
D.	Colour blindness	IV.	Autosomal recessive disease

Choose the correct answer from the options given below :

Options:

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

Answer: D

Solution:

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

Explanation:

Klinefelter's Syndrome:

- It is due to an extra copy of the X chromosome.
- Its karyotype is **47, XXY**.
- It results in the development of the breast (Gynaecomastia).

Turner's Syndrome:

- Turner syndrome occurs when one of the X chromosomes is completely or partially missing in a female (denoted as **45,XO**).
- This condition affects only females and can result in a variety of symptoms, including short stature, failure of the ovaries to develop (which can lead to infertility), heart defects, and certain learning disabilities, although intelligence is often normal.

Thalassemia:

- Thalassemia is also an **autosomal-linked recessive blood disease** transmitted from parents to the offspring when both the partners are unaffected carrier for the gene (or heterozygous).
- 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.
- This causes the formation of abnormal haemoglobin molecules resulting into anaemia which is characteristic of the disease.
- Thalassemia can be classified according to which chain of the haemoglobin molecule is affected.
- In α Thalassemia, production of α globin chain is affected while in β Thalassemia, production of β globin chain is affected.

Color blindness:

- It is a **sex-linked recessive disorder** due to defect in either red or green cone of eye resulting in failure to discriminate between red and green colour.
 - This defect is due to mutation in certain genes present in the X chromosome.
 - It occurs in about 8 per cent of males and only about 0.4 per cent of females.
 - This is because the genes that lead to red-green colour blindness are on the X chromosome.
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Question 11

RNA is a labile molecule due to the presence of :

Options:

A. 3'-OH group

B. 5'-OH group

C. 4' -OH group

D. 2'-OH group

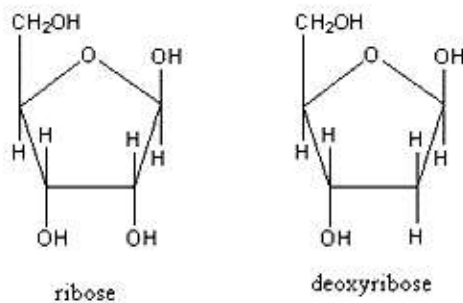
Answer: D

Solution:

The correct answer is **2'-OH group**

Explanation:

- RNA is considered a labile (less stable) molecule compared to DNA due to the presence of the 2'-OH group on the ribose sugar.
- 2'-OH group present at every nucleotide in RNA is a reactive group and makes RNA labile and easily degradable.
- This hydroxyl group can participate in intramolecular reactions, making the RNA backbone more susceptible to hydrolysis.
- RNA is also now known to be catalytic, hence reactive.
- DNA, chemically is less reactive and structurally more stable when compared to RNA.



Question 12

Enzyme helpful in polymerizing RNA with defined sequences in a template independent manner is:

Options:

- A. Mononucleotide phosphorylase
- B. Polynucleotide phosphorylase
- C. RNA polymerase - 1
- D. DNA dependent RNA polymerase

Answer: B

Solution:

The correct answer is **Polynucleotide phosphorylase**

Explanation:

- **Polynucleotide phosphorylase** is an enzyme that polymerizes RNA molecules in a **template-independent manner**, which means it does not require a DNA template to synthesize RNA.
- Severo Ochoa enzyme (polynucleotide phosphorylase) was helpful in polymerising RNA with defined sequences in a template independent manner (enzymatic synthesis of RNA).
- This enzyme was first discovered in bacteria and has been extensively studied for its ability to generate RNA sequences without the need for a template strand.
- It catalyzes the addition of ribonucleotides to the 3' end of an RNA strand, utilizing ribonucleoside diphosphates as substrates.

Other Options:

- **Mononucleotide phosphorylase:** This enzyme is not involved in RNA polymerization. It mainly functions in the metabolism of nucleotides rather than synthesizing RNA.
 - **RNA polymerase I:** This enzyme is responsible for transcribing ribosomal RNA (rRNA) in eukaryotes. It requires a DNA template to synthesize RNA and is not involved in template-independent RNA polymerization.
 - **DNA-dependent RNA polymerase:** This is a general term for RNA polymerases that require a DNA template to synthesize RNA. Examples include RNA polymerase II, which synthesizes mRNA in eukaryotes. These enzymes are not capable of template-independent RNA synthesis.
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Question 13

Which of the following is not a component of DNA ?

Options:

- A. Thiamine
- B. Adenine
- C. Guanine
- D. Cytosine

Answer: A

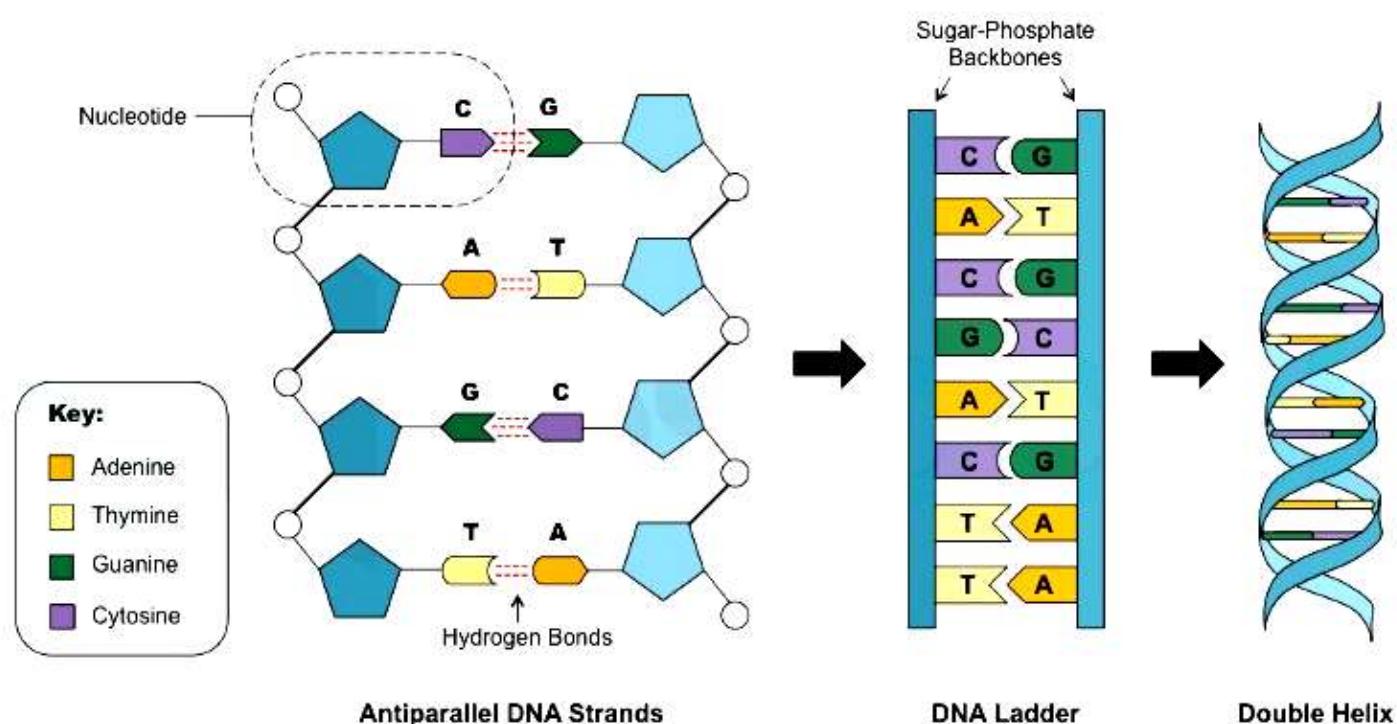
Solution:

The correct answer is **Thiamine**

Explanation:

- DNA (Deoxyribonucleic acid) is the molecule that contains the genetic instructions for life. It is composed of four types of nitrogenous bases: **adenine, guanine, cytosine, and thymine**.
- Adenine pairs with thymine through two hydrogen bonds
- Guanine pairs with Cytosine through three hydrogen bonds

- These bases pair specifically (adenine with thymine and guanine with cytosine) to form the double helix structure of DNA.
- Each base is attached to a sugar molecule (deoxyribose) and a phosphate group, creating the backbone of the DNA strand.
- **Thiamine** is not a component of DNA. Thiamine, also known as vitamin B1, is a vitamin that plays a key role in the metabolism of sugars and amino acids, but it does not participate in the structure of DNA.



Question 14

Match List-I with List-II:

List – I		List - II	
Scientist		Contribution	
A.	A. Jeffreys	I.	Nuclein
B.	Miescher	II.	Amino acid formation
C.	J. Monod	III.	DNA fingerprinting
D.	S.L. Miller	IV.	Transcriptionally regulated system

Choose the correct answer from the options given below :

Options:

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

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

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

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

Answer: A

Solution:

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

Explanation:

- **A. Jeffreys:** 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. It was called as Variable Number of Tandem Repeats (VNTR). The technique, as used earlier, involved Southern blot hybridisation using radiolabelled VNTR as a probe.
 - **B. Miescher:** DNA as an acidic substance present in nucleus was first identified by Friedrich Meischer in 1869. He named it as 'Nuclein'.
 - **C. J. Monod:** Francois Jacob and a biochemist, Jacques Monod. They were the first to elucidate a transcriptionally regulated system.
 - **D. S.L. Miller:** Stanley L. Miller is famous for the Miller-Urey experiment, which demonstrated that amino acids could be formed from simple molecules under prebiotic conditions.
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Question 15

Homologous Organs are :

Options:

- A. Similar in structure and same in functions
- B. Similar in structure and different in functions
- C. Different in structure and same in function
- D. Similar in structure and have same or different functions

Answer: B

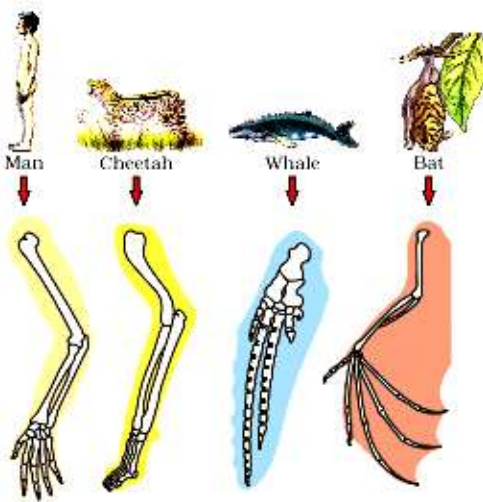
Solution:

The correct answer is **Similar in structure and different in functions**

Explanation:

Homologous organs:

- These are defined as the organs of different animals having **similar structures but differ in their functions**.
- Homology indicates common ancestry.
- Examples:
 - **Forelimbs of man, cheetah, whale and bat**
 - Thorns of *Bougainvillea* and *Cucurbita*



Additional Information

Analogous organs:

- These are defined as the organs of different animals having **different structures but performing the same functions**.
- Examples:
 - **Wings of insects and birds.**
 - Sweet potatoes and potatoes.
 - The tailfin of a lobster and the flukes of a whale.

Question 16

Arrange the following on the basis of their origin earliest to latest:

(A) *Homo habilis*

(B) Neanderthal Man

(C) *Ramapithecus*

(D) *Homo sapiens*

(E) *Homo erectus*

Choose the correct answer from the options given below:

Options:

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

Answer: B

Solution:

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

Explanation:

- **Ramapithecus (C):** About 15 mya, primates called Dryopithecus and Ramapithecus were existing. They were hairy and walked like gorillas and chimpanzees.
- **Homo habilis (A):** This species is one of the earliest members of the genus Homo and lived approximately 2.1 to 1.5 million years ago. This creature was called the first human-like being the hominid and was called Homo habilis. The brain capacities were between 650-800cc. They probably did not eat meat.
- **Homo erectus (E):** Fossils discovered in Java in 1891 revealed the next stage, i.e., Homo erectus about **1.5 mya**. Homo erectus had a large brain around 900cc. They were more advanced in terms of tool use and possibly the first to use fire.
- **Neanderthal Man (B):** The Neanderthal man with a brain size of 1400cc lived in near east and central Asia between **1,00,000-40,000** years back.
- **Homo sapiens (D):** During ice age between **75,000-10,000 years ago** modern Homo sapiens arose. They are characterized by a high degree of cognitive ability, complex tool use, and culture.

Question 17

Arrange the following steps of decomposition in correct order of their sequence:

- (A) Humification**
- (B) Fecal Matter**
- (C) Leaching**

(D) Mineralisation

Choose the correct answer from the options given below:

Options:

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

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

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

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

Answer: C

Solution:

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

Explanation:

- Dead plant remains such as leaves, bark, flowers and dead remains of animals, including fecal matter, constitute detritus, which is the raw material for **decomposition**.
- The important steps in the process of decomposition are fragmentation, leaching, catabolism, humification and mineralisation.
 - **Fecal Matter (B):** This is the initial stage where organic waste and dead matter are broken down by detritivores and decomposers like bacteria and fungi.
 - **Leaching (C):** By the process of leaching, water-soluble inorganic nutrients go down into the soil horizon and get precipitated as unavailable salts
 - Bacterial and fungal enzymes degrade detritus into simpler inorganic substances. This process is called as **catabolism**.
 - **Humification (A):** Humification leads to the accumulation of a dark coloured amorphous substance called humus that is highly resistant to microbial action and undergoes decomposition at an extremely slow rate. Being colloidal in nature it serves as a reservoir of nutrients
 - **Mineralisation (D):** The humus is further degraded by some microbes and release of inorganic nutrients occur by the process known as mineralisation

Question 18

Match List-I with List-II:

List – I		List - II	
Evolutionary Processes		Example	
A.	Divergent evolution	I.	Wings of butterfly and birds

B.	Convergent evolution	II.	Lemur and spotted cuscus
C.	Anthropogenic evolution	III.	Hearts of vertebrates
D.	Adaptive Radiation	IV.	Antibiotic resistant microbes

Choose the correct answer from the options given below :

Options:

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

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

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

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

Answer: B

Solution:

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

Explanation:

- **Divergent evolution (A - III):** This process results in the development of different traits in species that share a common ancestor.
 - For example, the **hearts of vertebrates** demonstrate divergent evolution as they share a common ancestral heart but have evolved differently in fish, amphibians, reptiles, birds, and mammals.
- **Convergent evolution (B - I):** This occurs when species with different ancestral origins develop similar traits due to similar environmental pressures.
 - An example is the **wings of butterflies and birds**, which evolved independently to serve the function of flight.
- **Anthropogenic evolution (C - IV):** This type of evolution is driven by human activities, such as the development of antibiotic-resistant microbes due to the overuse and misuse of antibiotics.
- **Adaptive Radiation (D - II):** This refers to the rapid diversification of a species into new forms.
 - An example is the lemur and spotted cuscus, which adapted to different ecological niches in Madagascar and Australia, respectively.

Question 19

Toxic substance released with rupturing of RBC during malaria fever is :

Options:

A. Haematoxyline

B. Haematin

C. Haemozoin

D. Haemin

Answer: C

Solution:

The correct answer is **Haemozoin**

Explanation:

- Malaria is a life-threatening disease caused by parasites of the genus *Plasmodium*. The disease is transmitted to humans through the bites of infected female Anopheles mosquitoes. There are several species of Plasmodium, but the most deadly is *Plasmodium falciparum*.
- Once inside the human body, the parasites travel to the liver, where they mature and reproduce. After an incubation period, the parasites enter the bloodstream and infect red blood cells (RBCs). Inside the RBCs, the parasites grow and multiply. This cycle leads to the rupture of the infected RBCs, releasing new parasites into the bloodstream to infect more RBCs.
- During this process, the parasite digests the hemoglobin in RBCs to obtain nutrients. This digestion produces a toxic byproduct called **haemozoin**.
- **Haemozoin** is a crystalline product formed from the detoxification of hemoglobin.
- Since free heme (a component of hemoglobin) is toxic to the parasite, it polymerizes the heme into haemozoin.
- When the infected RBCs rupture, haemozoin is released into the bloodstream.

Other Options:

- **Haematoxylin:** This is a dye used in histology to stain cell nuclei.
- **Haematin:** This is a derivative of hemoglobin, but it is not the toxic substance released during malaria. It is sometimes used to refer to oxidized forms of hemoglobin or its degradation products.
- **Haemin:** This is a chloride of heme, an iron-containing compound found in hemoglobin. Haemin can be used in laboratory settings to support the growth of certain bacteria.

Question 20

The yellowish fluid secreted by mother during initial days of lactation has abundant :

Options:

A. IgA

B. IgM

C. IgE

D. IgG

Answer: A

Solution:

The correct answer is **IgA**

Explanation:

- The yellowish fluid secreted by mothers during the initial days of lactation is known as colostrum. It is rich in nutrients and antibodies and plays a crucial role in the newborn's immune system.
- Colostrum contains a high concentration of immunoglobulins, particularly **Immunoglobulin A (IgA)**, which provides passive immunity to the newborn and helps protect against infections.
- IgA is critical for mucosal immunity and is found in mucous membranes lining the respiratory and gastrointestinal tracts.

Other Options:

- **IgM:** This immunoglobulin is the first antibody to respond during an initial exposure to an antigen.
 - **IgE:** This antibody is involved in allergic reactions and defense against parasitic infections.
 - **IgG:** This is the most common antibody in the bloodstream and provides long-term immunity. IgG can cross the placenta to provide passive immunity before birth.
-

Question 21

Identify the incorrect statements.

(A) Gametocytes of Plasmodium develop in the RBCs.

(B) Ascariasis pathogens are transmitted to a healthy person through the bite by the female mosquito vectors.

(C) Entamoeba histolitica is a helminth parasite in the small intestine of human which causes amoebiasis.

(D) Malarial parasite reproduces asexually in the gut of mosquito.

(E) Filarial worms reside in the lymphatic vessels of the lower limbs.

Choose the correct answer from the options given below:

Options:

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

Answer: B

Solution:

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

Explanation:

Statement (A): Gametocytes of *Plasmodium* develop in the RBCs.

- This statement is correct as the gametocytes of the malarial parasite *Plasmodium* develop inside the red blood cells (RBCs) of the human host.

Statement (B): Ascariasis pathogens are transmitted to a healthy person through the bite by the female mosquito vectors.

- This statement is incorrect. Ascariasis is caused by the ingestion of *Ascaris lumbricoides* eggs from contaminated soil, food, or water, not by mosquito bites.

Statement (C): *Entamoeba histolytica* is a helminth parasite in the small intestine of humans which causes amoebiasis.

- This statement is incorrect.
- *Entamoeba histolytica* is a protozoan parasite, not a helminth.
- It resides in the large intestine and causes amoebiasis.

Statement (D): Malarial parasite reproduces asexually in the gut of mosquito.

- This statement is incorrect.
- The malarial parasite reproduces asexually in the human host's liver and RBCs.
- In the mosquito's gut, it undergoes sexual reproduction.

Statement (E): Filarial worms reside in the lymphatic vessels of the lower limbs.

- This statement is correct.
- Filarial worms such as *Wuchereria bancrofti* reside in the lymphatic vessels and can cause lymphatic filariasis, commonly affecting the lower limbs.

Question 22

Match List-I with List-II:

List – I		List - II	
Diseases		Pathogen	
A.	Pneumonia	I.	Wuchereria bancrofti
B.	Typhoid	II.	Microsporium
C.	Ringworm	III.	Salmonella
D.	Elephantiasis	IV.	Haemophilus influenzae

Choose the correct answer from the options given below :

Options:

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

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

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

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

Answer: B

Solution:

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

Explanation:

- **Pneumonia:** This is a bacterial infection primarily caused by *Haemophilus influenzae*. It affects the lungs and causes symptoms like cough, fever, and difficulty in breathing.
 - **Typhoid:** This is caused by the bacterium *Salmonella*. It is a severe systemic illness characterized by fever, abdominal pain, and a rash.
 - **Ringworm:** This is a fungal infection caused by *Microsporium*. It affects the skin, hair, and nails, leading to ring-shaped rashes.
 - **Elephantiasis:** This is a parasitic infection caused by *Wuchereria bancrofti*. It leads to severe swelling of limbs and other body parts.
-

Question 23

Which vitamin is increased during the conversion of fresh milk to curd ?

Options:

A. B₂

B. B₅

C. B₁₂

D. B₁

Answer: C

Solution:

The correct answer is **B₁₂**

Explanation:

- Lactobacillus and others commonly called lactic acid bacteria (LAB) grow in milk and convert it to curd.
- During growth, the LAB produce acids that coagulate and **partially digest** the milk proteins.
- A small amount of curd added to the fresh milk as inoculum or starter contain millions of LAB, which at suitable temperatures multiply, thus converting milk to curd, which also improves its nutritional quality by increasing **vitamin B₁₂**.
- Vitamin B₁₂, also known as cobalamin, is one such vitamin that can be increased during this process.

Other Options:

- **Vitamin B₂ (Riboflavin):** This vitamin is essential for energy production and the metabolism of fats, drugs, and steroids.
 - **Vitamin B₅ (Pantothenic Acid):** Important for the synthesis of coenzyme-A, which is involved in the synthesis and oxidation of fatty acids.
 - **Vitamin B₁ (Thiamine):** Essential for glucose metabolism and plays a key role in nerve, muscle, and heart function.
-

Question 24

Match List-I with List-II:

List – I		List - II	
Function		Organism	
A.	Nitrogen fixation (bacterium)	I.	Saecharomyces
B.	Phosphorous absorption	II.	Azospirillum
C.	Nitrogen fixation (cyanobacterium)	III.	Glomus
D.	Ethanol Production	IV.	Oscillatoria

Choose the correct answer from the options given below :

Options:

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

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

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

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

Answer: A

Solution:

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

Explanation:

- **Nitrogen fixation (bacterium) - Azospirillum:** *Azospirillum* is a nitrogen-fixing bacterium that converts atmospheric nitrogen into a form that plants can absorb and use.
 - **Phosphorus absorption - Glomus:** Fungi are also known to form symbiotic associations with plants (mycorrhiza). Many members of the genus **Glomus** form mycorrhiza. The fungal symbiont in these associations **absorbs phosphorus** from soil and passes it to the plant.
 - **Nitrogen fixation (cyanobacterium) - Oscillatoria:** Cyanobacteria are autotrophic microbes widely distributed in aquatic and terrestrial environments many of which can fix atmospheric nitrogen, e.g. *Anabaena*, *Nostoc*, *Oscillatoria*.
 - **Ethanol Production - Saccharomyces:** *Saccharomyces*, particularly *Saccharomyces cerevisiae*, is a yeast used in the fermentation process to produce ethanol from sugars.
-

Question 25

Match List-I with List-II:

List – I		List - II	
Microbes		Acid Produced	
A.	<i>Aspergillus</i>	I.	Lactic acid
B.	<i>Acetobacter</i>	II.	Butyric acid
C.	<i>Clostridium</i>	III.	Acetic acid
D.	<i>Lactobacillus</i>	IV.	Citric acid

Choose the correct answer from the options given below :

Options:

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

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

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

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

Answer: A

Solution:

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

Explanation:

Aspergillus: *Aspergillus niger* is a fungus that is widely used in the industrial production of citric acid. It produces citric acid through fermentation of various carbohydrates, typically in submerged culture conditions. Citric acid is used as a food additive, flavoring agent, and in various industrial applications.

Acetobacter: *Acetobacter aceti* is a bacterium involved in the production of vinegar. It metabolizes ethanol, the primary component of alcoholic beverages, into acetic acid through oxidation. This process occurs during the fermentation of alcoholic liquids such as wine, cider, or beer to produce vinegar.

Clostridium: This genus of bacteria includes species that produce butyric acid through anaerobic fermentation. *Clostridium butyricum* is a well-known example.

Lactobacillus: This genus of lactic acid bacteria is known for producing lactic acid, which is widely used in the dairy industry for products like yogurt and cheese. *Lactobacillus* species are also used as probiotics.

Question 26

Which of the following product is not developed by the use of biotechnology ?

Options:

A. Bt cotton

B. DNA vaccine

C. Human protein enriched milk

D. Basmati Rice

Answer: D

Solution:

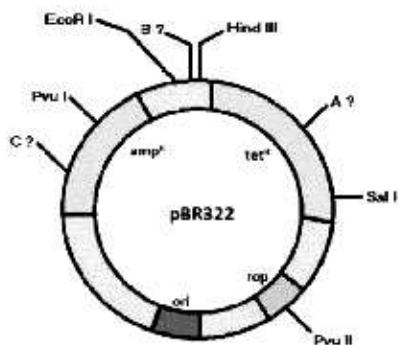
The correct answer is **Basmati Rice**

Explanation:

- **Basmati Rice:** Basmati rice is a variety of long, slender-grained aromatic rice traditionally grown in India, Pakistan, and Nepal. Basmati rice is distinct for its unique aroma and flavour and 27 documented varieties of Basmati are grown in India. Its development does not typically involve modern biotechnological methods but rather **traditional breeding** techniques. Therefore, it is not considered a product of biotechnology.
 - **Bt Cotton:** Bt cotton is genetically modified to express the *Bacillus thuringiensis* (Bt) toxin, which is effective against certain pests. This is an example of biotechnology being used to enhance agricultural productivity and pest resistance.
 - **DNA Vaccine:** DNA vaccines use genetically engineered DNA to induce an immune response. This modern biotechnological approach is used to develop vaccines for various infectious diseases, showcasing the application of biotechnology in medicine. Transgenic mice are being developed for use in testing the safety of vaccines before they are used on humans.
 - **Human Protein Enriched Milk:** This involves the genetic modification of animals to produce milk that contains human proteins. In 1997, the first transgenic cow, Rosie, produced human protein-enriched milk (2.4 grams per litre). The milk contained the human alpha-lactalbumin and was nutritionally a more balanced product for human babies than natural cow-milk.
-

Question 27

Identify the missing restriction sites (A, B and C) in the given *E. coli* cloning vector pBR322.



Options:

- A. A - BamH I; B - Cla I; C - Pst I
- B. A - Pst I; B - Cla I; C - Hind II
- C. A - Bam H I; B - Hind II; C - Cla I

D. A - Cla I; B - Pst I; C - BamH I

Answer: A

Solution:

The correct answer is **A - BamH I, B - Cla I; C - Pst I**

Explanation:

- pBR322 is a commonly used *E. coli* cloning vector in molecular biology. It contains multiple restriction sites for various enzymes, which allows for the insertion of foreign DNA.
- pBR322 is a commonly used plasmid cloning vector in molecular biology, developed by Bolivar and Rodriguez in 1977.
- **Key Features:**
 - It is one of the first artificial cloning vectors.
 - It is widely used due to its versatility and ease of manipulation.
 - It contains two antibiotic resistance genes, tet^R (tetracycline resistance) and amp^R (ampicillin resistance), which allow for selection of successful recombinants.
 - pBR322 has multiple restriction sites for different enzymes, including Sal I.

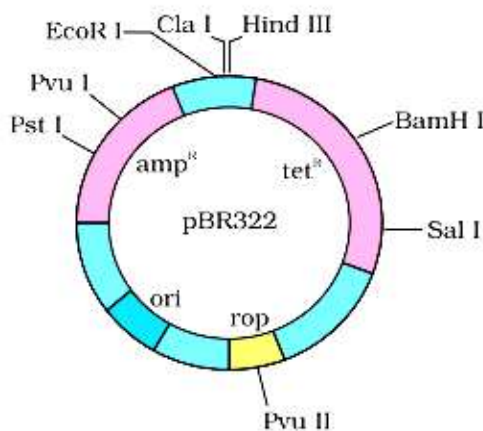


Fig: E. coli cloning vector pBR322 showing restriction sites (Hind III, EcoR I, BamH I, Sal I, Pvu II, Pst I, Cla I), ori and antibiotic resistance genes (amp^R and tet^R).

Question 28

Arrange the following steps in recombinant DNA technology on the basis of their sequence of occurrence:

(A) Isolation of desired DNA fragments

(B) Culturing the host cells

(C) Extraction of desired product

(D) Ligation of DNA fragment into vector

(E) Transferring of recombinant DNA to host

Choose the correct answer from the options given below:

Options:

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

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

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

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

Answer: B

Solution:

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

Concept:

Recombinant DNA technology involves several steps in specific sequence such as

- Isolation of DNA,
- Fragmentation of DNA by restriction endonucleases
- Isolation of a desired DNA fragment
- Ligation of the DNA fragment into a vector
- Transferring the recombinant DNA into the host
- Culturing the host cells in a medium at large scale
- Extraction of the desired product.

Explanation:

A. Isolation of desired DNA fragments: The first step is to isolate the DNA fragment that contains the gene of interest.

D. Ligation of DNA fragment into vector: The next step is to insert the isolated DNA fragment into a suitable vector (plasmid or viral vector).

E. Transferring of recombinant DNA to host: The recombinant vector is then introduced into a host cell, often a bacterial cell.

B. Culturing the host cells: The host cells containing the recombinant DNA are then cultured to produce many copies or express the gene of interest.

C. Extraction of desired product: Finally, the desired product (such as a protein) is extracted and purified from the cultured host cells.

Question 29

Which of the following is not a cause of biodiversity loss ?

Options:

- A. Fragmentation
- B. Over-exploitation
- C. Co-evolution
- D. Alien species invasion

Answer: C

Solution:

The correct answer is **Co-evolution**

Concept:

- Biodiversity loss refers to the reduction or disappearance of various species and ecosystems in a particular habitat or across the globe.
- The major causes that are responsible for the loss of Biodiversity are described or called "The Evil Quartet".
- The following are the four factors impacting the environment that leads to the loss of Biodiversity:
 - Habitat Loss and Fragmentation
 - Over- Exploitation
 - Co-extinctions
 - Invasion of Alien species

Explanation:

- **Fragmentation:** This refers to the breaking up of continuous habitats into smaller, isolated patches.
 - Habitat loss and Fragmentation is the most important cause of driving animals and plants to extinction.
 - The examples of habitat loss come from tropical rain forests. Once covering more than 14 per cent of the earth's land surface, these rain forests now cover no more than 6 per cent.
 - **Over-exploitation:** This occurs when natural resources are used at an unsustainable rate.
 - Over-exploitation can lead to the depletion of species, such as overfishing, hunting, and logging, resulting in biodiversity loss.
 - Many species extinctions in the last 500 years (Steller's sea cow, passenger pigeon) were due to overexploitation by humans.
 - **Co-evolution:** This is a process where two or more species reciprocally affect each other's evolution. Co-evolution is a natural and typically beneficial interaction that leads to mutual adaptations. It is not a cause of biodiversity loss but rather a mechanism of evolutionary change.
 - **Alien species invasion:** When alien species are introduced unintentionally or deliberately for whatever purpose, some of them turn invasive and cause the decline or extinction of indigenous species.
 - The Nile perch introduced into Lake Victoria in east Africa led eventually to the extinction of an ecologically unique assemblage of more than 200 species of cichlid fish in the lake.
-

Question 30

For which of the following human disease, transgenic model was not developed ?

Options:

- A. AIDS
- B. Cancer
- C. Cystic Fibrosis
- D. Rheumatoid arthritis

Answer: A

Solution:

The correct answer is **AIDS**

Explanation:

- Transgenic models are genetically modified organisms, often animals, that have had a foreign gene inserted into their genome. These models are used extensively in biomedical research to study diseases and develop new treatments.
- Many transgenic animals are designed to increase our understanding of how genes contribute to the development of disease.
- These are specially made to serve as models for human diseases so that investigation of new treatments for diseases is made possible.
- Today transgenic models exist for many human diseases such as **cancer, cystic fibrosis, rheumatoid arthritis and Alzheimer's**.

AIDS: AIDS (Acquired Immunodeficiency Syndrome) is caused by the HIV (Human Immunodeficiency Virus). While there have been significant advancements in understanding HIV/AIDS, creating a transgenic model for this disease has proven to be particularly challenging due to the complexity of the virus and its interaction with the human immune system. Currently, no transgenic model for AIDS has been successfully developed.

Question 31

Transposons are :

Options:

- A. House keeping genes

- B. Jumping genes
- C. Transporting gene
- D. Stationary gene

Answer: B

Solution:

The correct answer is **Jumping genes**

Explanation:

- Transposons, also known as "jumping genes," are sequences of DNA that can move or "transpose" themselves to new positions within the genome of a single cell.
- They were discovered by Barbara McClintock in the 1940s and have since been recognized as a major component of genetic variation and evolution.
- Transposons can create or reverse mutations and alter the cell's genetic identity and genome size.
- They play a significant role in genetic research and biotechnology, including the study of gene function.
- Transposons (mobile genetic elements) help in providing the source of complementary RNA in RNA interference (RNAi) process

Other Options:

- **Housekeeping genes:** These are genes that are required for the maintenance of basic cellular function and are generally expressed in all cells of an organism.
 - **Stationary genes:** This refers to genes that remain in a fixed position within the genome. Most genes are stationary, unlike transposons, which can move.
-

Question 32

Identify the incorrect statements.

- (A) *Bacillus thuringiensis* is a transgenic organism.**
- (B) Bt toxin enter the testes or the ovaries of the insect pest, sterilize it and thus prevent it's multiplication.**
- (C) Proteins encoded by cryIAc and cryIIAb control cotton bollworms.**
- (D) Bt protein exists as active toxin in the *Bacillus*.**
- (E) Alkaline pH of the insect gut solubilizes the toxin protein crystals.**

Choose the correct answer from the options given below:

Options:

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

Answer: A

Solution:

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

Explanation:

Bacillus thuringiensis is a bacterium that produces proteins toxic to certain insects. These proteins are used in genetically modified crops to provide resistance against insect pests. The Bt toxin, produced by *Bacillus thuringiensis*, is toxic to insect pests. It is not active in the bacterial form but becomes active once ingested by the insect.

- **(A) *Bacillus thuringiensis* is a transgenic organism:** This statement is incorrect. *Bacillus thuringiensis* itself is not a transgenic organism. However, genes from Bt can be inserted into plants to create transgenic crops that produce Bt toxin, making them resistant to certain pests.
- **(B) Bt toxin enters the testes or the ovaries of the insect pest, sterilizes it, and thus prevents its multiplication:** This statement is incorrect. Bt toxin does not sterilize insect pests. Instead, it kills the insects by disrupting their digestive systems when they ingest the toxin, leading to their death.
- **(C) Proteins encoded by cry1Ac and cry2Ab control cotton bollworms:** This statement is correct. The proteins encoded by the cry1Ac and cry2Ab genes are effective against cotton bollworms, providing protection to the crops.
- **(D) Bt protein exists as an active toxin in the Bacillus:** This statement is incorrect. Bt protein exists as an inactive protoxin in *Bacillus thuringiensis*. It becomes active only after being ingested by an insect, where it is solubilized and activated by the alkaline conditions in the insect's gut.
- **(E) Alkaline pH of the insect gut solubilizes the toxin protein crystals:** This statement is correct. The alkaline pH in the insect's gut helps to solubilize the Bt toxin protein crystals, allowing them to become active and disrupt the insect's digestive system.

Question 33

Match List-I with List-II:

List – I	List - II
Genes/Products	Used in/for
A. C- Peptide	I. Corn borer

B.	α -l-antitrypsin	II.	Rosie
C.	cryIAb	III.	Insulin
D.	α -lactalbumin	IV.	Emphysema

Choose the correct answer from the options given below :

Options:

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

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

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

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

Answer: B

Solution:

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

Explanation:

- **(A) C peptide: Insulin:** Insulin is a crucial hormone for glucose metabolism and is produced by the pancreas.
 - Insulin is initially synthesized as a precursor molecule called pro-insulin, which consists of A-chain, B-chain, and C-peptide.
 - The maturation of pro-insulin involves the removal of the C-peptide, resulting in the formation of mature and active insulin, composed of the A-chain and B-chain linked by disulphide bridges.
- **(B) α -1-antitrypsin - (IV) Treat emphysema:** α -1-antitrypsin is a human protein used in the treatment of emphysema, a condition that causes shortness of breath.
- **(C) cryIAb - (I) Corn borer:** The cryIAb gene also from *Bacillus thuringiensis* produces a protein that is toxic to the corn borer, a pest that affects corn crops.
- **(D) α -lactalbumin - (II) Rosie:** In 1997, the first transgenic cow, Rosie, produced human protein-enriched milk (2.4 grams per litre). The milk contained the human alpha-lactalbumin and was nutritionally a more balanced product for human babies than natural cow-milk.

Question 34

In which of the following ecosystems, detritus food chain (DFC) is the major conduit for energy flow ?

Options:

A. Pond Ecosystem

B. River Ecosystem

C. Forest Ecosystem

D. Marine Ecosystem

Answer: C

Solution:

The correct answer is **Forest Ecosystem**

Explanation:

- The detritus food chain (DFC) involves the breakdown of organic matter and the recycling of nutrients within ecosystems.
- It is a crucial part of the decomposition process where dead organic matter is broken down by decomposers like fungi and bacteria.
- In a DFC, energy flow is primarily from dead organic matter through detritivores (organisms that feed on dead material) and decomposers, which play a key role in nutrient cycling and maintaining ecosystem productivity.
- **Forest Ecosystem:** In forest ecosystems, the detritus food chain is the **major conduit for energy flow** due to the large amount of leaf litter, fallen branches, and dead trees.



Additional Information

Grazing food chain (GFC):

- This type of food chain begins with the producers (green plants).
- From the producers, the energy is transferred to the grazing herbivores followed by the carnivores.

Thus the flow of energy in GFC is as follows: **Autotrophs → Herbivores → Carnivores.**

- GFC is directly dependent on the influx of solar radiation.
- **GFC is the major energy conduit in an aquatic ecosystem.**
- Example of GFC: Phytoplankton → Zooplankton → Fish.

Detritus food chain (DFC):

- This type of food chain **begins with dead organic matter.**
- Energy from dead organic matter is then transferred to the **decomposers** that feed on it.
- **Fungi and microorganisms like bacteria** are the chief decomposers in an ecosystem.
- These decomposers are then fed on by other organisms called **detritivores (E.g.: Earthworms).**
- These are finally fed on by their **predators (E.g., Birds feed on worms).**

Thus the flow of energy in a DFC is as follows:

Dead matter → Decomposers → Detritivores → Predators.

- (Inorganic material released is also taken up by autotrophs)
- **DFC is the major energy conduit in a terrestrial ecosystem.**

Question 35

Which one of the following statements is wrong regarding ecological pyramids ?

Options:

- A. They do not include saprophytes (decomposers)
- B. Insect feeding on a big tree is an example of inverted pyramid of numbers
- C. The pyramid of biomass in a sea is inverted
- D. They considered the same species belonging to two or more trophic levels

Answer: D

Solution:

The correct answer is **They considered the same species belonging to two or more trophic levels**

Concept:

- Ecological pyramids are graphical representations that show the relative amounts of energy or matter contained within each trophic level in a given ecosystem.
- There are three main types of ecological pyramids: pyramid of numbers, pyramid of biomass, and pyramid of energy.
- There are certain **limitations of ecological pyramids** such as
 - It does not take into account the same species belonging to two or more trophic levels.
 - It assumes a simple food chain, something that almost never exists in nature
 - It does not accommodate a food web.
 - Saprophytes are not given any place in ecological pyramids even though they play a vital role in the ecosystem.

Explanation:

- **They do not include saprophytes (decomposers):** This statement is correct. Ecological pyramids typically do not include decomposers because they break down dead organic matter and recycle nutrients back into the ecosystem, operating outside of the traditional trophic levels.
 - **Insect feeding on a big tree is an example of inverted pyramid of numbers:** This statement is correct. In such a scenario, a single large tree supports numerous insects, resulting in an inverted pyramid of numbers where the number of primary consumers (insects) is greater than the number of producers (trees).
 - **The pyramid of biomass in a sea is inverted:** This statement is correct. In marine ecosystems, the biomass of phytoplankton (producers) is less than the biomass of zooplankton (primary consumers), leading to an inverted pyramid of biomass.
 - **They considered the same species belonging to two or more trophic levels:** This statement is incorrect. Ecological pyramids do not account for organisms that occupy multiple trophic levels. They assume a clear and distinct division between each level.
-

Question 36

The total energy fixed by a green plant is called :

Options:

- A. Net Production
- B. Primary Production
- C. Secondary Production
- D. Gross Production

Answer: D

Solution:

The correct answer is **Gross Production**

Explanation:

- Gross Production, also known as Gross Primary Production (GPP), refers to the total amount of energy captured by green plants through the process of photosynthesis.
- This energy is measured over a specific period and is usually expressed in units of energy per unit area per unit time
- GPP represents the total energy fixed by plants before any is used for their own metabolic processes.
- A large amount of GPP is lost by plants during respiration.

Other Options:

- **Net Production:** It is defined as the difference between gross primary productivity and the respiration losses (R) by plants.
 - $NPP = GPP - R$;
 - It is the measure of net available biomass for heterotrophs (herbivores and decomposers).
 - **Primary Production:** This term generally refers to the creation of organic compounds from carbon dioxide through photosynthesis, carried out by primary producers such as green plants and algae. It encompasses both Gross and Net Production.
 - **Secondary Production:** This refers to the generation of biomass of heterotrophic (consumer) organisms in a system. It is the result of the consumption of primary producers (plants and algae) by herbivores and the subsequent energy transfer through the food web.
-

Question 37

Tropical regions account for greater biological diversity because of the following reasons, except:

Options:

- A. Higher productivity due to more availability of solar energy

B. Lower predation due to diversity of food availability

C. Tropics are less seasonal and relatively more constant and predictable

D. These latitudes are relatively undisturbed for many years leads to long evolutionary time for diversification

Answer: B

Solution:

The correct answer is **Lower predation due to diversity of food availability**

Concept:

Tropical regions account for greater biological diversity because

- (a) Speciation is generally a function of time, unlike temperate regions subjected to frequent glaciations in the past, tropical latitudes have remained relatively undisturbed for millions of years and thus, had a longevolutionary time for species diversification.
- (b) Tropical environments, unlike temperate ones, are less seasonal, relatively more constant and predictable. Such constant environments promote niche specialisation and lead to a greater species diversity
- (c) There is more solar energy available in the tropics, which contributes to higher productivity; this in turn might contribute indirectly to greater diversity.

Explanation:

- **Higher productivity due to more availability of solar energy:** Tropical regions receive more direct sunlight throughout the year, leading to higher productivity. This abundant solar energy supports a rich and diverse plant life, which in turn supports a wide variety of animal species.
 - **Tropics are less seasonal and relatively more constant and predictable:** The tropical climate is relatively stable, with minimal seasonal variations. This stability allows species to thrive and diversify without the pressures of adapting to extreme seasonal changes.
 - **These latitudes are relatively undisturbed for many years, leading to long evolutionary time for diversification:** Tropical regions have remained relatively undisturbed by glacial periods and other large-scale environmental changes. This long evolutionary history has provided ample time for species to diversify and evolve.
 - **Lower predation due to diversity of food availability:** This statement is incorrect because the diversity of food availability does not directly reduce predation pressure. A diverse food web can support a variety of predators and prey, maintaining the balance within the ecosystem.
-

Question 38

Deserts, rain forests, mangroves, coral reefs, wetlands, estuaries and alpine meadows in India represent :

Options:

A. Ecological diversity

- B. Genetic diversity
- C. Species diversity
- D. Species diversity and ecological diversity

Answer: A

Solution:

The correct answer is **Ecological diversity**

Explanation:

Biodiversity is the term popularised by the sociobiologist Edward Wilson to describe the combined diversity at all the levels of biological organisation. The most important of them are Genetic diversity, Species diversity and Ecological diversity.

- **Ecological diversity:** This is the correct answer as it encompasses the variety of ecosystems such as deserts, rainforests, mangroves, coral reefs, wetlands, estuaries, and alpine meadows. Each of these ecosystems has distinct physical environments and biological communities, contributing to the overall ecological diversity of India.
- **Genetic diversity:** This refers to the variation of genes within species. A single species might show high diversity at the genetic level over its distributional range. India has more than 50,000 genetically different strains of rice, and 1,000 varieties of mango.
- **Species diversity:** This refers to the variety of species within a particular region. The diversity at the species level, for example, the Western Ghats have a greater amphibian species diversity than the Eastern Ghats.

Question 39

The increase in rate of species loss in the world is due to:

- (A) Less use of natural resources**
- (B) Introduction of alien species**
- (C) Species confined to a particular area**
- (D) Removal of one species from co-existed species**
- (E) Destruction of large landscape into small area**

Choose the correct answer from the options given below:

Options:

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

Answer: B

Solution:

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

Concept:

The major causes that are responsible for the loss of Biodiversity are described or called "The Evil Quartet". The following are the four factors impacting the environment that leads to the loss of Biodiversity:

- Habitat Loss and Fragmentation
- Over- Exploitation
- Co-extinctions
- Invasion of Alien species

Explanation:

- **Introduction of alien species (B):** When alien species are introduced unintentionally or deliberately for whatever purpose, some of them turn invasive and cause the decline or extinction of indigenous species. The Nile perch introduced into Lake Victoria in east Africa led eventually to the extinction of an ecologically unique assemblage of more than 200 species of cichlid fish in the lake.
- **Removal of one species from co-existed species (D):** In an ecosystem, species often rely on each other for food, shelter, and other needs. Removing one species can disrupt these relationships and lead to the decline or extinction of other species that depended on it.
- **Destruction of large landscape into small area (E):** Habitat fragmentation occurs when large habitats are divided into smaller, isolated patches. This is the most important cause of driving animals and plants to extinction.

Other Options Explanation:

- **Less use of natural resources (A):** This option is incorrect because using fewer natural resources would typically help in conservation efforts rather than leading to species loss.
- **Species confined to a particular area (C):** While species being confined to a particular area can make them more vulnerable to extinction, this is not a primary cause of the increasing rate of species loss. The main factors are more related to human activities and environmental changes.

Question 40

Choose the following statements which are correct with respect to continuous culture systems:

(A) In simple stirred tank bioreactor, the stirring happens through sparging of air bubbles

(B) Bioreactor has an agitator system, oxygen delivery system and foam control system

(C) Sampling ports provides vents to withdraw small volumes of culture periodically

(D) Culturing in bio reactors is classified as downstream processing

Choose the correct answer from the options given below:

Options:

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

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

C. (B) and (C) only

D. (A) and (D) only

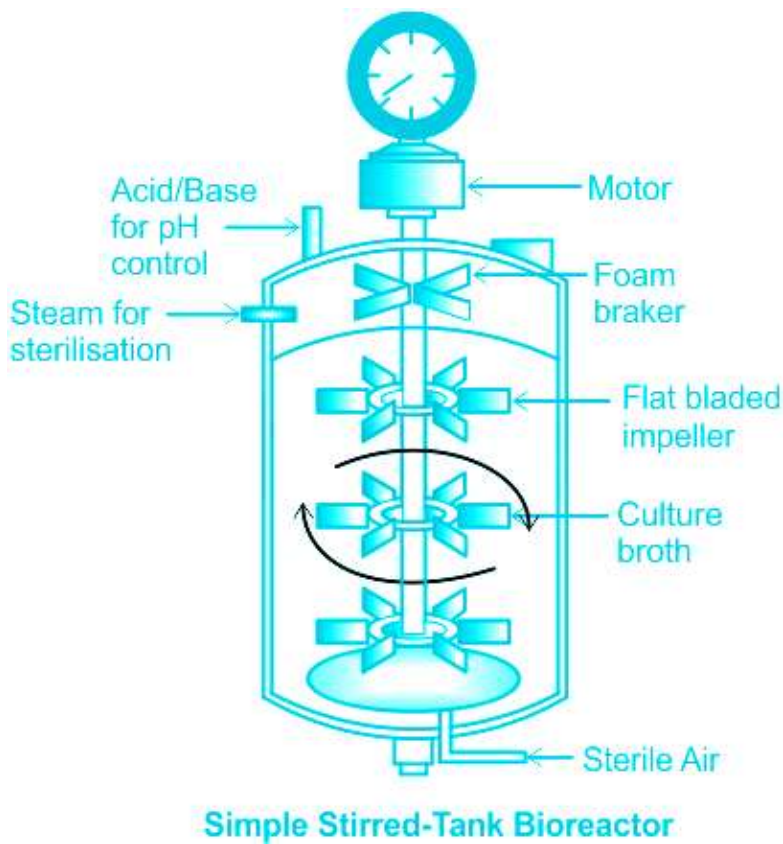
Answer: C

Solution:

The correct answer is **(B) and (C) only**

Concept:

- Continuous culture systems are used to maintain microbial cultures in a state of exponential growth for extended periods of time.
- Bioreactors are specialized vessels designed to support the growth of microorganisms or cells under controlled conditions.
- The **stirrer** facilitates even mixing and oxygen availability throughout the bioreactor. Alternatively air can be bubbled through the reactor.
- The bioreactor has an agitator system, an oxygen delivery system and a foam control system, a temperature control system, pH control system and sampling ports so that small volumes of the culture can be withdrawn periodically.
- Downstream processing refers to the series of steps required to purify and process the desired product after culturing.



Explanation:

- **Statement (B):** This statement is correct. Bioreactors are equipped with an agitator system to ensure even mixing, an oxygen delivery system to supply the necessary oxygen for aerobic cultures, and a foam control system to prevent foam formation, which can interfere with the process.
- **Statement (C):** This statement is also correct. Sampling ports are essential for withdrawing small volumes of culture periodically to monitor the growth and metabolic state of the microorganisms or cells.
- **Statement (A):** This statement is incorrect. In a simple stirred tank bioreactor, stirring is typically accomplished by mechanical agitation using impellers, not by sparging air bubbles. Sparging is primarily used for oxygenation.
- **Statement (D):** This statement is incorrect. Culturing in bioreactors is part of the upstream processing, which involves the preparation and cultivation of cells or microorganisms. Downstream processing refers to the steps taken after culturing to purify and process the desired product.

Question 41

What is the first sign of growing foetus ?

What is the first sign of growing foetus ?

Options:

A. Development of limbs and digits

- B. Movement of foetus
- C. Formation of heart
- D. Development of head

Answer: C

Solution:

The correct answer is **Formation of heart**

Explanation:

- The development of a foetus is a complex and intricate process that involves various stages and significant milestones.
- The human pregnancy lasts 9 months.
- In human beings, after one month of pregnancy, the embryo's heart is formed.
- The first sign of growing foetus may be noticed by listening to the heart sound carefully through the stethoscope.

Other Options:

- **Development of limbs and digits:** This occurs later in the By the end of the second month of pregnancy, the foetus develops limbs and digits.
- **Movement of foetus:** The first movements of the foetus and appearance of hair on the head are usually observed during the fifth month.
- **Development of head:** The development of the head and brain structures begins early but is more prominent around the 4th to 5th week of pregnancy.

Question 42

How many chromosomes are present in human primary spermatocytes?

How many chromosomes are present in human primary spermatocytes?

Options:

- A. 46
- B. 23
- C. 92

D. 12

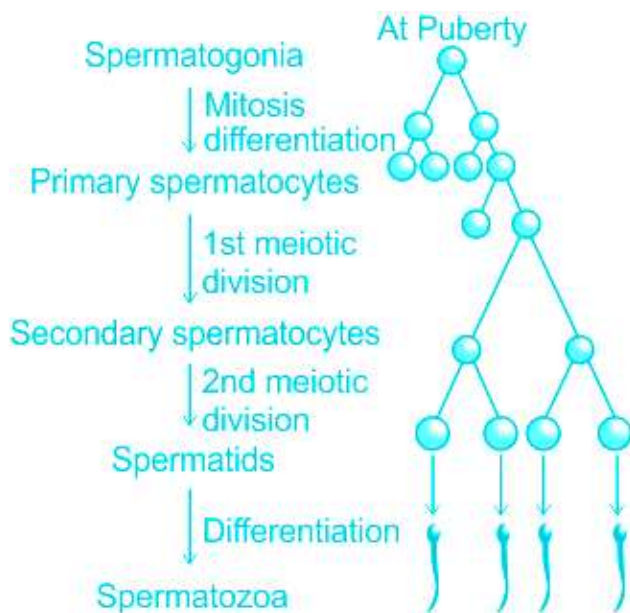
Answer: A

Solution:

The correct answer is **46**

Explanation:

- Primary spermatocytes are diploid cells that undergo meiosis during spermatogenesis to eventually form haploid sperm cells. Human primary spermatocytes are diploid cells and hence contain 46 chromosomes. This is before they undergo meiosis to produce haploid cells.
- These cells are derived from spermatogonia and contain the full complement of chromosomes, which is 46 in humans.
- The process of meiosis in primary spermatocytes results in the formation of secondary spermatocytes, which are haploid, containing 23 chromosomes.



Question 43

The transformation of spermatids into spermatozoa is known as ;

The transformation of spermatids into spermatozoa is known as ;

Options:

A. Spermiation

- B. Spermiogenesis
- C. Spermatogenesis
- D. Spermatogoniasis

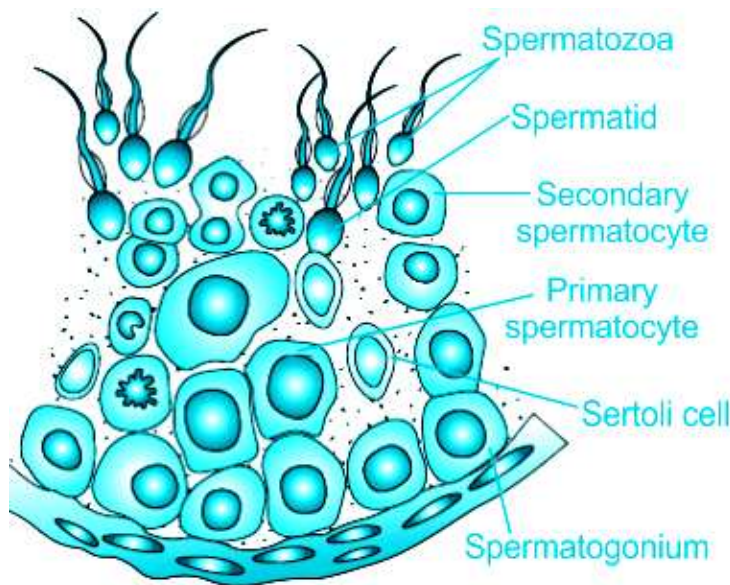
Answer: B

Solution:

The correct answer is **Spermiogenesis**

Explanation:

Spermiogenesis: This is the final stage of spermatogenesis where spermatids transform into mature spermatozoa. It involves morphological and physiological changes. This includes the development of the sperm tail (flagellum), condensation of the genetic material into the head, formation of the acrosome, and shedding of excess cytoplasm.



- **Spermiation:** After spermiogenesis, sperm heads become embedded in the Sertoli cells, and are finally released from the seminiferous tubules by the process called spermiation.
- **Spermatogenesis:** Spermatogenesis is the overall process of the production and development of sperm cells from the primordial germ cells in the testes. It includes several stages: mitotic division of spermatogonia, meiotic division to form spermatids, and finally, the transformation of these spermatids into mature spermatozoa (spermiogenesis).

Question 44

Which hormone is essential for maintenance of endometrium during luteal phase?

Which hormone is essential for maintenance of endometrium during luteal phase?

Options:

- A. Lutinising Hormone
- B. Relaxin
- C. Progesterone
- D. Follicle Stimulating Hormone

Answer: C

Solution:

The correct answer is **Progesterone**

Explanation:

- The luteal phase is the latter phase of the menstrual cycle, occurring after ovulation and before the start of menstruation.
- During this phase, the body prepares for a possible pregnancy.
- Progesterone is the key hormone responsible for maintaining the endometrium (the lining of the uterus) to facilitate implantation of a fertilized egg.
- The corpus luteum secretes large amounts of progesterone, which is essential for the maintenance of the endometrium (the lining of the uterus)

Other Options:

- **Luteinizing Hormone (LH):** This hormone triggers ovulation and the formation of the corpus luteum, but it is not primarily responsible for maintaining the endometrium during the luteal phase.
 - **Relaxin:** This hormone is involved in relaxing the uterus and other muscles during pregnancy.
 - **Follicle Stimulating Hormone (FSH):** This hormone is primarily involved in the growth of ovarian follicles before ovulation and does not play a direct role in maintaining the endometrium during the luteal phase.
-

Question 45

The nucleus is present in _____ of human sperm.

The nucleus is present in _____ of human sperm.

Options:

- A. Middle piece

B. Acrosome

C. Head

D. Tail

Answer: C

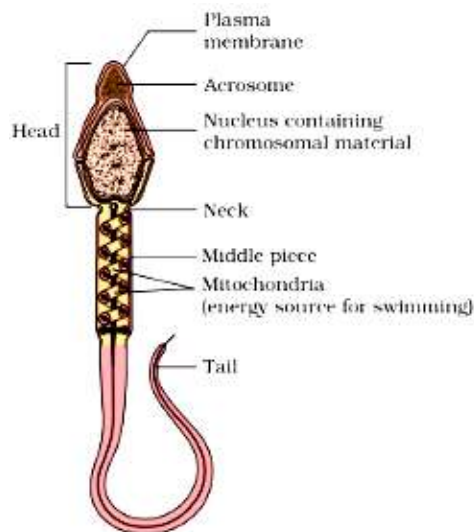
Solution:

The correct answer is **Head**

Explanation:

A sperm has three main parts:-

- The **head** of the sperm contains an elongated **haploid nucleus**, which holds the DNA of the cell and the anterior portion is covered by a cap-like structure acrosome.
- The **acrosome** is a cap-like structure present at the anterior end of the sperm. It contains enzymes that are crucial for fertilization.
These enzymes help the sperm penetrate the outer layers of the egg, facilitating the fusion of the male and female gametes.
- The acrosome contains enzymes such as hyaluronidase and acrosin, which are essential for breaking down the outer layers of the egg (zona pellucida). Without these enzymes, the sperm would not be able to penetrate the egg and fertilization would not occur.
- The **midpiece** of the sperm is packed with mitochondria. Mitochondria are organelles in cells that produce energy. Sperm use the energy in the midpiece to move.
- The **tail** of the sperm moves like a propeller, around and around. This tail is a long flagellum that pushes the sperm forward.



Question 46

Which of the following is correct among the following statements related to species interaction?

Which of the following is correct among the following statements related to species interaction?

Options:

- A. Calotropis releases a strong smell to prevent cattles and goats to eat its leaves
- B. Predators help in maintaining species diversity in a community
- C. Totally unrelated species never compete for the same resource
- D. Closely related species competing for the same resources cannot co-exist indefinitely even if the resources are unlimited

Answer: B

Solution:

The correct answer is **Predators help in maintaining species diversity in a community**

Explanation:

Species interactions are the relationships between species in a community. These interactions can be beneficial, harmful, or neutral to the organisms involved. They include predation, competition, mutualism, commensalism, and parasitism. **Calotropis releases a strong smell to prevent cattle and goats from eating its leaves:** This statement is incorrect. Calotropis does release toxic substances, but the primary defense mechanism is its milky latex which contains cardiac glycosides, making it unpalatable and toxic to herbivores.

- **Predators help in maintaining species diversity in a community:** This statement is correct. Predators control the population of prey species, which can prevent any one species from becoming too dominant.
 - This helps maintain a diverse and balanced ecosystem.
 - For example, In the rocky intertidal communities of the American Pacific Coast, the starfish *Pisaster* is an important predator.
 - In a field experiment, when all the starfish were removed from an enclosed intertidal area, more than 10 species of invertebrates became extinct within a year, because of inter-specific competition.
 - **Totally unrelated species never compete for the same resource:** This statement is incorrect. Unrelated species can compete for the same resources, such as food, water, or space. This is known as interspecific competition. An example is different species of birds competing for the same type of nesting sites.
 - **Closely related species competing for the same resources cannot co-exist indefinitely, even if the resources are unlimited.** This statement is incorrect. The **principle of competitive exclusion** states that two closely related species competing for the same resources cannot co-exist indefinitely, and the competitively inferior one will be eliminated eventually, if resources are limited.
-

Question 47

Which of the following set of organisms is an example of commensalism?

Which of the following set of organisms is an example of commensalism?

Options:

- A. Pisaster (starfish) and some invertebrates
- B. Abingdon tortoise and goats
- C. Sea anemone and clown fish
- D. Flamingo and resident fishes

Answer: C

Solution:

The correct answer is **Sea anemone and clownfish**

Explanation:

Commensalism is a type of symbiotic relationship where one organism benefits from the relationship while the other is neither helped nor harmed. This is different from mutualism (where both organisms benefit) and parasitism (where one organism benefits at the expense of the other).

- **Sea anemone and clownfish:** In this relationship, the clownfish benefits by gaining protection from predators by living among the sea anemone's tentacles, which are toxic to most other fish. The sea anemone is neither helped nor harmed by the presence of the clownfish, making this an example of commensalism.
 - **Pisaster (starfish) and some invertebrates:** This is an example of predation rather than commensalism. Pisaster starfish are predators that feed on invertebrates such as mussels and barnacles, which means one organism benefits (the starfish) while the other is harmed (the invertebrates).
 - **Abingdon tortoise and goats:** The Abingdon tortoise in Galapagos Islands became extinct within a decade after goats were introduced on the island, apparently due to the greater browsing efficiency of the goats. Goats compete with the Abingdon tortoise for food resources, potentially harming the tortoise population. This is an example of competition.
 - **Flamingo and resident fishes:** This is not an example of commensalism. In some shallow South American lakes, visiting flamingoes and resident fishes compete for their common food, the zooplankton in the lake. This is an example of competition.
-

Question 48

Which of the following is not classified into the category of parasites ?

Which of the following is not classified into the category of parasites ?

Options:

- A. Mosquito
- B. Cuckoo
- C. Cuscuta
- D. Ticks

Answer: A

Solution:

The correct answer is **Mosquito**

Explanation:

Parasites are organisms that live on or inside a host organism and get their food from or at the expense of their host. Parasites can be classified into various categories based on their relationship with the host and their lifecycle. Common examples of parasites include worms (helminths), protozoa, and arthropods like ticks and lice.

- **Mosquito:** While mosquitoes are vectors for various diseases (like malaria, dengue, etc.), they are not classified as parasites. They are considered ectoparasites because they feed on the blood of hosts but do not live on or in the host. They are more accurately described as vectors.
- **Cuckoo:** Cuckoos are known for their brood parasitism, where they lay their eggs in the nests of other bird species, relying on the host birds to raise their young. This behavior is parasitic.
- **Cuscuta:** Also known as dodder, Cuscuta is a parasitic plant that wraps around other plants and extracts nutrients and water from them, effectively behaving as a true parasite.
- **Ticks:** Ticks are arachnids that attach themselves to the skin of mammals, birds, and sometimes reptiles and amphibians to feed on their blood. They are classified as **ectoparasites**. Parasites that feed on the external surface of the host organism are called ectoparasites. The most familiar examples of this group are the lice on humans and ticks on dogs.

Question 49

The process in which the fitness of one species (measured in terms of its 'r', the intrinsic rate of increase) is significantly

lower in the presence of another species is known as :

The process in which the fitness of one species (measured in terms of its 'r', the intrinsic rate of increase) is significantly lower in the presence of another species is known as :

Options:

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

Answer: B

Solution:

The correct answer is **Competition**

Explanation:

- Competition is an interaction between organisms or species, in which the fitness of one is lowered by the presence of another.
- This occurs because both species require the same limited resource, such as food, water, or territory.
- The intrinsic rate of increase (denoted as 'r') is a measure of how quickly a population can grow under ideal conditions.
- **Competition** is best defined as a process in which the fitness of one species (measured in terms of its 'r' the intrinsic rate of increase) is significantly lower in the presence of another species.
- Both species suffer a decrease in fitness due to limited resource availability.

Other Options:

- **Parasitism:** This is a non-mutual relationship where one species (the parasite) benefits at the expense of the other (the host). The host's fitness is reduced, but this does not necessarily involve direct competition for resources.
- **Predation:** This is an interaction where one species (the predator) hunts and consumes another species (the prey). The fitness of the predator is increased while the fitness of the prey is decreased.
- **Commensalism:** This is a type of interaction where one species benefits while the other is neither helped nor harmed. There is no competition for resources in this interaction.

Question 50

Which of the following is not associated with realistic growth model ?

Which of the following is not associated with realistic growth model ?

Options:

- A. Sigmoid shaped growth curve
- B. J-shaped growth curve
- C. Verhulst - Pearl logistic growth
- D. Logistic Growth

Answer: B

Solution:

The correct answer is **J-shaped growth curve**

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.
- Logistic growth results in an **Sigmoid-shaped curve** due to the slowing of growth as the population nears its carrying capacity.
- Since resources for growth for most animal populations are finite and become limiting sooner or later, the logistic growth model is considered a more **realistic one**.

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 $\left(\frac{K-N}{K}\right)$.

J-shaped growth curve: This curve represents **exponential growth**, where the population grows without any constraints, leading to a rapid increase. It is not associated with realistic growth models because it does not consider environmental limits or carrying capacity.

