ISC Board Examination - 2024
BIOLOGY PAPER 1 (THEORY)
Solved Paper
Class-12th

Maximum Marks: 70
Time allowed: Three hours

(Candidates are allowed additional 15 minutes for only reading the paper. They must NOT start during this time)

This paper is divided into four sections - A, B, C and D.
Answer all questions.
***Section - A** consists of one question having sub-parts of one mark/two marks each.*
***Section - B** consists of seven questions of two marks each .*
***Section - C** consists of seven questions of three marks each, and*
***Section - D** consists of three questions of five marks each.*
Internal choices have been provided in one question each in Section B, Section C and Section D.
The intended marks for questions or parts of questions are given in brackets [].

SECTION–A

20 MARKS

Question 1

(i) In human plasma, five different types of immunoglobulins are found. Which type of immunoglobulin is responsible for allergic reactions? **[1]**

(ii) Some orchids live on the branches of mango trees. Name the type of interaction that exists between mango tree and the orchid. **[1]**

(iii) Four triplet codons code for the amino acid valine. Three of them are given below. **[1]**

GUU GUC GUA

Write the fourth codon.

(iv) A haemophilic man marries a carrier woman and they have a daughter. What is the probability of their daughter being haemophilic? **[1]**

(v) Home-made fruit juices are turbid, while the bottled fruit juices purchased from the market are clear. Give a reason for this difference. **[1]**

(vi) The number of lily plants in a pond was found to be 50. After one year, the number increased to 65. Calculate the natality of lily plants. **[1]**

(vii) Based on the table given below, identify the type of natural selection taking place. **[1]**

Size of the seeds	% of germination
Small	75%
Medium	15%
Large	75%

(viii) Give the name of the target pest of gene cry IAc. **[1]**

(ix) If a person shows the production of interferons in his body, then he is suffering from: **[1]**

(a) Malaria **(b)** Ringworm

(c) Dengue **(d)** Typhoid

(x) Match the Columns I and II with reference to weeks of pregnancy and development of human embryo. Select the correct option from the choices given below: **[1]**

	Column I		**Column II**
I.	8 weeks	(P)	Limbs and external genital organs become well developed
II.	12 weeks	(Q)	Limbs and digits develop
III.	20 weeks	(R)	Body hair develops
IV.	24 weeks	(S)	Eyelids separate

(a) I–(P), II–(Q), III–(R), IV–(S) **(b)** I–(Q), II–(P), III–(R), IV–(S)

(e) I–(R), II–(S), III–(P), IV–(Q) **(d)** I–(S), II–(R), III–(Q), IV–(P)

(xi) Assertion: In a bioreactor, it is not necessary to maintain sterile ambience. **[1]**

Reason: Sterile conditions promote the growth of unwanted microbes in the culture medium.

(a) Both Assertion and Reason are true, and Reason is the correct explanation for Assertion.

(b) Both Assertion and Reason are true, but Reason is not the correct explanation for Assertion.

(c) Assertion is true and Reason is false.

(d) Both Assertion and Reason are false.

(xii) Assertion: Lymphocytes originate and proliferate in primary lymphoid organs. **[1]**

Reason: Spleen is a secondary lymphoid organ.

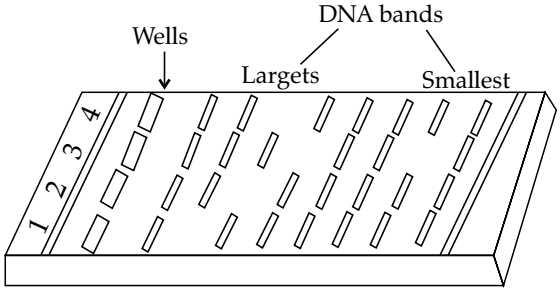
(a) Both Assertion and Reason are true, and Reason is the correct explanation for Assertion.

(b) Both Assertion and Reason are true, but Reason is not the correct explanation for Assertion.

(c) Assertion is true and Reason is false.

(d) Both Assertion and Reason are false.

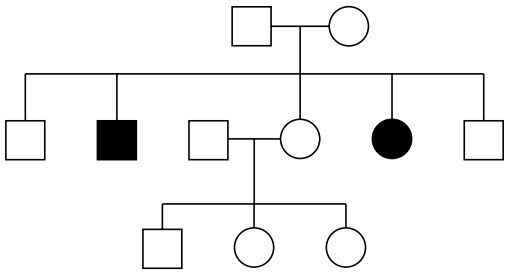
(xiii) The equipment shown below is used for the separation of DNA fragments. **[1]**



Name the chemical used to visualise the movement of DNA fragments in the gel.

(xiv) In humans, somatic gene therapy was carried out to correct an immunodeficiency disease. Name this disease. **[1]**

(xv) The pedigree chart given below represents the pattern of inheritance of thalassaemia in a family.



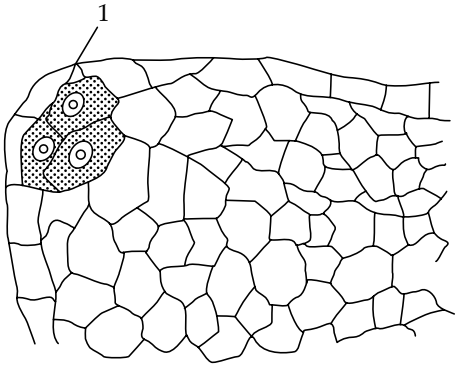
What could be the genotype of the affected male? **[1]**

(xvi) Answer the following questions: **[2]**

(a) In a karyotype analysis, X and Y chromosomes represent sex chromosomes. Name the scientist who discovered the X chromosome.

(b) Expand the abbreviation NACO.

(xvii) The figure given below shows the early stage of development of microsporangium. **[1]**



Name the hypodermal cell labelled '1' which divides periclinally.

(xviii) Give a reason for each of the following: **[2]**

(a) The second half of the menstrual cycle is called luteal phase as well as secretory phase.

(b) Streptokinase is administered to the patients having myocardial infarction.

SECTION–B

14 MARKS

Question 2 **[2]**

Name any two Cu-ions releasing IUDs. Explain any two ways by which these devices act as contraceptives.

Question 3 **[2]**

A population of 200 fruit flies is in Hardy–Weinberg equilibrium. The frequency of the allele (a) is 0.4.

Calculate the following:

(i) Frequency of allele (A).

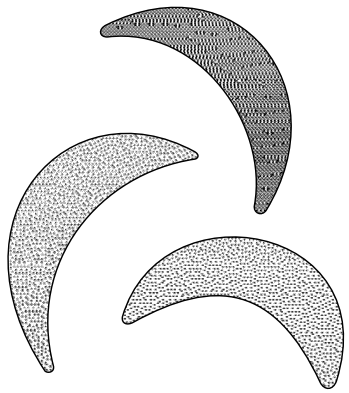
(ii) The number of homozygous dominant fruit flies.

(iii) The number of homozygous recessive fruit flies.

(iv) The number of carrier fruit flies.

Question 4 **[2]**

Jacob is genetically a carrier of the disorder that affects the shape of the RBCs, as shown in the diagram below. His son James suffers from the same disorder.



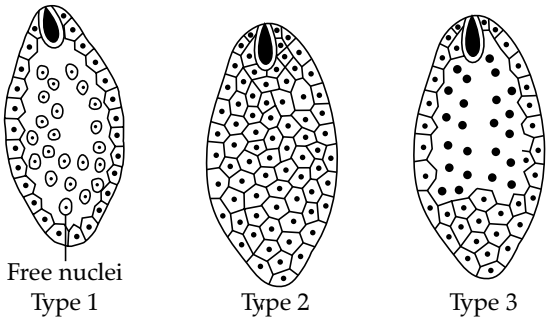
(i) Give the biochemical reason for the disorder that changes the shape of the RBCs, as shown above.

(ii) Draw a Punnett square to show the genotype of the mother of James.

(iii) Name and define the type of 'point mutation' responsible for this disorder.

Question 5 **[2]**

(i) The diagram given below shows three types of endosperms in angiosperms.

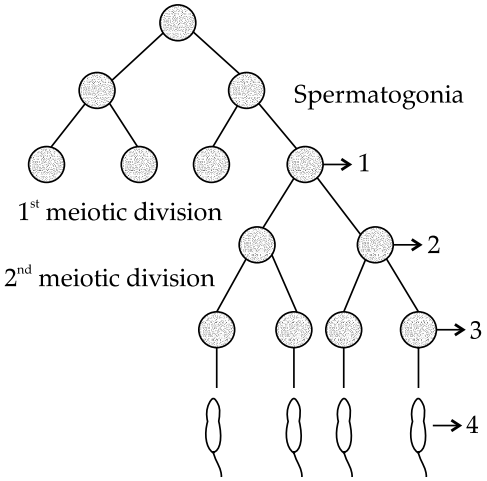


(a) Identify the three types of endosperms shown above.

(b) Name the type of endosperm which commonly occurs in polypetalous dicots.

OR

(ii) The diagram given below shows the various steps in spermatogenesis.



(a) Name the parts labelled '1', '2' and '3'.

(b) Name the process by which Part '3' changes to Part '4'.

Question 6 **[2]**

Write the scientific name of the causative agent and the mode of transmission for each of the following diseases.

(i) Filariasis **(ii)** Typhoid

Question 7 **[2]**

A male plant, bearing red flowers, was crossed with a female plant bearing yellow flowers. In the F_1 generation, all the flowers were orange in colour.

(i) Give a reason to explain the change of colours in F_1 generation.

(ii) Mention the ratio of red flowers, yellow flowers and orange flowers in the F_2 generation.

Question 8 **[2]**

Microbes are useful to human beings in diverse ways. Give the biological names of each of the following microbes:

(i) Lactic acid producing bacterium.

(ii) Microbe known as Baker's yeast.

(iii) Fungus which helps in the production of Cyclosporin-A.

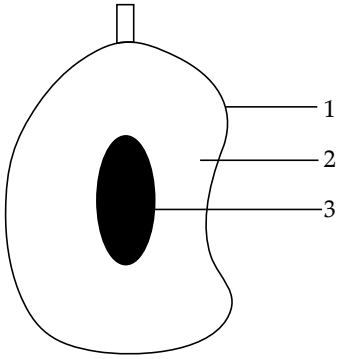
(iv) Microbe used in the production of statins.

SECTION–C

21 MARKS

Question 9 **[3]**

The diagram given below is L.S. of a typical fruit.



Microbes are useful to human beings in diverse ways. Give the biological names of each of the following microbes: **[2]**

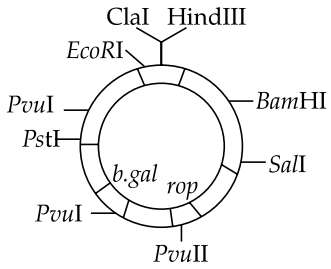
(i) Identify the parts labelled '1', '2' and '3'.

(ii) State the difference between a *true fruit* and a *false fruit*.

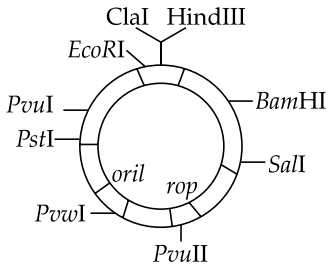
(iii) What is the significance of formation of fruit in angiosperms?

Question 10 **[3]**

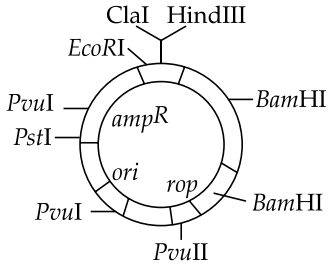
Suneeta is planning an experiment to clone a gene in a vector. So, she has to choose a good cloning vector. Which one of the vectors shown below should she choose? Justify your answer by giving two reasons.



Vector A



Vector B



Vector C

Question 11 **[3]**

Study the two figures shown below that represent two growth models.

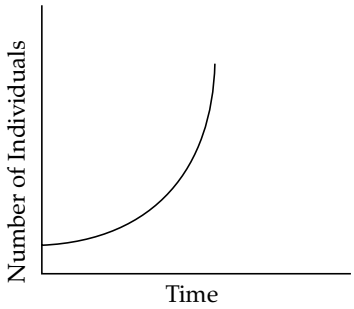


Figure A

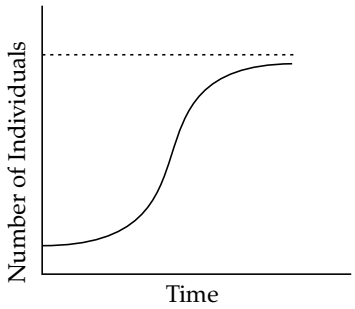


Figure B

(i) Which one of the two figures represents an unlimited supply of nutrients? Give a reason.

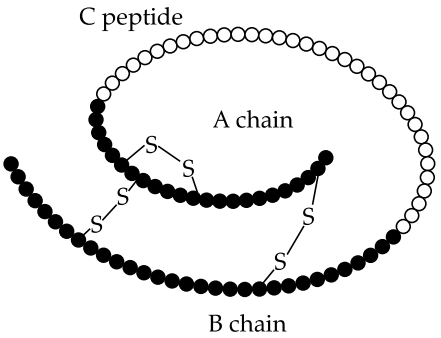
(ii) Which figure depicts a challenge to population growth?

(iii) Explain the term reproductive fitness.

(iv) Give the mathematical expressions for Figure A and Figure B.

Question 12 **[3]**

The diagram given below represents the schematic structure of proinsulin which undergoes certain modifications before it becomes a fully functional insulin. Study the diagram carefully and answer the questions that follow:



(i) State the change the proinsulin undergoes to become fully functional.

(ii) Name the modern scientific technique used for the production of human insulin.

(iii) How are the two polypeptide chains of the fully functional insulin held together?

Question 13 **[3]**

A patient was given an anti-retroviral drug by the doctor.

(i) Which disease was the patient diagnosed with? Mention any one symptom of this disease.

(ii) Give the scientific name of the causative agent of this disease.

(iii) Which method was used to diagnose this disease?

(iv) What is the role of reverse transcriptase and integrase in the life cycle of a retrovirus?

Question 14 **[3]**

(i) Draw a neat and well labelled diagram of T.S. of anther.

OR

(ii) Draw a neat and well labelled diagram of T.S. of mammalian ovary.

Question 15 **[3]**

The table given below shows the area, Y-intercept and the regression coefficient of the continents namely, Africa and Europe. Study the table carefully and answer the questions that follow:

	Africa	Europe
Area(A)	62,000 km sq.	65,000 kmsq
Y-intercept (C)	10	20
Regression Coefficient(Z)	I	I

(i) Calculate the species richness (S) of each continent.

(ii) Which of these continents shows a higher biodiversity?

(iii) State any two factors that cause an increase in biodiversity.

SECTION–D **15 MARKS**

Question 16 **[5]**

(i) Meena had grown rose and China-rose plants in her garden. She collected pollen grains from China-rose plants and sprinkled them on stigma of the rose flowers, as she wanted to grow a hybrid variety of Rose.

(a) Will this pollination give the desired results? Give a reason for your answer.

(b) What is geitonogamy? Why is it considered equivalent to cross-pollination in ecological context and self-pollination in genetic context?

OR

(ii) Fertilisation is the key process in sexually reproducing organisms and it acts as a vital link between two generations. Flowering plants adopt a unique pattern of sexual reproduction as compared to other organisms.

(a) Explain the process of fertilisation in angiosperms.

(b) What is the precise location and function of filiform apparatus in the embryo sac of angiosperms?

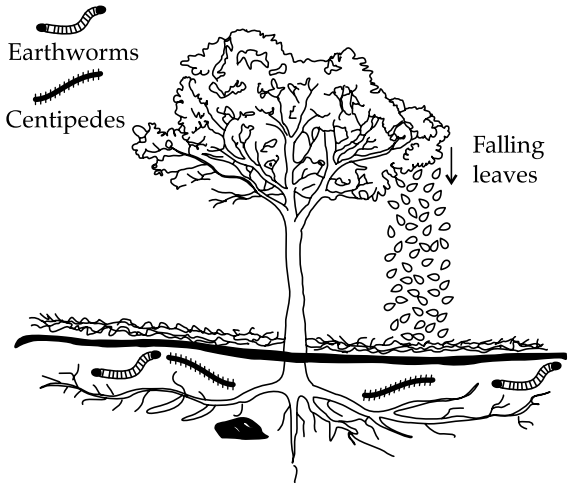
(c) Fruits and seeds are generally formed due to fertilisation. Name the processes involved in the production of the following without fertilisation:

(1) Fruits

(2) Seeds

Question 17 **[5]**

The diagram given below shows the process of decomposition in the forest ecosystem.



(i) Why is breakdown of the complex organic matter an important event in the ecosystem?

(ii) The forest soil has a higher humus content than the desert soil. Give a reason to justify this statement.

(iii) Earthworms and centipedes play an important role in the decomposition process of forest ecosystem. At which stage of the decomposition are these organisms involved?

(iv) The net annual primary productivity of a particular wetland ecosystem is found to be 8,000 kcal/m^2 per year. If respiration by the aquatic producers is 11,000 kcal/m^2 per year, calculate the gross primary productivity for this ecosystem.

Question 18 **[5]**

F. Griffith conducted a series of experiments on mice with two different strains of the bacterium Diplococcus pneumoniae.

(i) Describe the entire procedure of this experiment.

(ii) Write the conclusion of this experiment.

(iii) What would have been the result of the experiment if both the strains of the bacteria were first heat-killed, mixed and then injected in the mice?

■■

ANSWERS

SECTION–A

20 MARKS

Answer 1

(i) Immunoglobulin E (IgE) is the antibody that is responsible for the allergic reactions. **[1]**

(ii) The interaction between an orchid and a mango tree is commensalism, which is when one species benefits while the other is unaffected. **[1]**

(iii) For example, GUU, GUC, GUA and GUG, all code for the amino acid valine. Thus, GUG is the fourth codon. **[1]**

(iv) When a haemophilic man (X^hY) marries a carrier woman (XX^h) their female progeny will be either X^hX^h (haemophilic) or X^hX (carrier). Thus, 50% daughters are carriers and 50% are haemophilic. **[1]**

(v) Home-made juices are cloudy and turbid because they contain fibres and pectin whereas fruit juices purchased from the market are clear because they are clarified with the enzymes pectinase and proteases. **[1]**

(vi) The number of new plants in the pond will be

65 - 50 = 15

Then the natality or the birth rate is obtained by dividing the number of new plants by the original number of plants, i.e., 15/50 = 0.3 **[1]**

(vii) Both extreme variations, small and large size of seeds of a trait show higher percentage of germination. These are selected to show that extreme phenotypes have a higher fitness than intermediate phenotype. Thus, this type of natural selection is disruptive selection.

Consequently, the original population is disrupted into two or more separate groups, that later evolve into new species. **[1]**

(viii) Target pest of gene cry IAc produced by *Bacillus thuringienis* is cotton bollworms. **[1]**

(ix) Interferons are proteins produced by cells infected by a virus to protect other healthy cells. When the immune system is activated due to a viral infection, white blood cells produce interferons, which are a group of proteins called cytokines. Production of interferons in the body indicates that a person may be suffering from dengue, a viral infection caused by the dengue virus. **[1]**

(x) Option (b) is correct. **[1]**

By the end of 8 weeks of pregnancy, the foetus develops limbs and digits.

By the end of 12 weeks (first trimester), the limbs and external genital organs are well developed. The appearance of hair on the head is usually observed during the fifth month (20 weeks).

By the end of about 24 weeks (end of second trimester), the body is covered with fine hair, eye-lids separate, and eyelashes are formed.

(xi) Option (d) is correct. **[1]**

In a bioreactor, its always necessary to maintain sterile environment so as to prevent growth of the unwanted microbes.

(xii) Option (b) is correct. **[1]**

Lymphocytes originate and develop in thymus and bone marrow which are primary lymphoid organs. Whereas spleen is an secondary lymphoid organ.

(xiii) Ethidium bromide is the chemical used to stain DNA fragments and visualise their movement in an agarose gel. It binds to the DNA molecule and appears as orange bands under UV light. **[1]**

(xiv) Somatic gene therapy has been used to correct an primary immunodeficiency disease–Adenosine Deaminase (ADA) which causes Severe Combined Immunodeficiency (SCID).

(xv) For a thalassaemic male with both parents as carriers, the genotype would be written as:

HbA/HbA (normal haemoglobin gene inherited from one parent) HbA/Hb (thalassemia gene inherited from the other parent). **[1]**

(xvi) (a) Hermann Henking discovered the X chromosome

(b) NACO: National AIDS Control Organisation **[2]**

(xvii) The hypodermal cells which is surrounded by a single layer of epidermis are called archesporial cells which divides periclinally. **[1]**

(xviii) (a) The second half of the menstrual cycle is commonly referred to as both the luteal phase and the secretory phase because during this time, the ovary releases a hormone called progesterone which helps to thicken the uterine lining in preparation for a possible pregnancy. This phase is characterised by the development of the corpus luteum, which is the temporary endocrine structure that forms from the remnants of the follicle after ovulation.

The corpus luteum produces progesterone, which is responsible for maintaining the thickened uterine lining and preparing the body for potential implantation of a fertilised egg. Because of the secretion of progesterone during this phase, it is also referred to as the secretory phase.

(b) Streptokinase is administered to patients having myocardial infarction because it helps in the breaking down of blood clots that are blocking the blood vessels supplying blood to the heart. By dissolving these blood clots, streptokinase helps to restore the blood flow to the heart muscle, reducing damage and improving outcomes for patients with myocardial infarction.

SECTION–B

14 MARKS

Answer 2

Two Cu-ions releasing intra uterine devices are Cu7 and Multiload 375.

They release copper ions which suppress sperm motility and the fertilising capacity of sperms.

Answer 3

Given that the population is in Hardy–Weinberg equilibrium, we can use the Hardy–Weinberg equation to calculate the frequency of the dominant allele (A) in the population.

The equation is: $p^2 + 2pq + q^2 = 1$

where:

p is the frequency of the A allele

$q = 1 - p$

p^2 is the frequency of the homozygous dominant genotype (AA).

$2pq$ is the frequency of the heterozygous genotype (Aa).

q^2 is the frequency of the homozygous recessive genotype (aa).

(i) Given that the frequency of the recessive allele (a) is 0.4, then the frequency of the dominant allele (A) is:

$p = 1 - q$, $p = 1 - 0.4$, $p = 0.6$

Therefore, the frequency of the dominant allele (A) in the population is 0.6.

(ii) Homozygous dominant individuals have the genotype AA.

Since the total population is 200, the number of dominant alleles is $0.6 \times 200 = 120$.

Each individual has 2 alleles, so the number of homozygous dominant individuals is $120/2 = 60$.

Therefore, there are 60 homozygous dominant individuals in the population of 200 fruit flies.

(iii) Given that the frequency of the allele (a) is 0.4, the frequency of the homozygous recessive genotype (aa) can be calculated using the formula: $8^2 = 0.4^2 = 0.16$

To find the number of homozygous recessive individuals, we multiply the frequency of the homozygous recessive genotype by the total population size, $0.16 \times 200 = 32$.

(iv) To calculate the frequency of carrier fruit flies:

$\therefore 2pq = 2 \times 0.6 \times 0.4 = 0.48$

This means that 48% of the population are carrier fruit flies.

To find the number of carrier fruit flies in a population of 200, we can calculate:

Number of carrier fruit flies $= 0.48 \times 200$

$\therefore$ Number of carrier fruit flies $= 96$

Therefore, there are 96 carrier fruit flies in the population.

Answer 4

(i) The defect is caused by the substitution of Glutamic acid (Glu) by Valine (Val) at the sixth position of the beta globin chain of the haemoglobin molecule. The substitution of amino acid in the globin protein results due to the single substitution at the sixth codon of the beta globin gene from GAG to GUG. 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.

(ii) Jacob = Hb^AHb^S

James = Hb^SHb^S

Possible genotype of Mother may be Hb^AHb^S and Hb^SHb^S. She may be carrier for the disease or may be suffer from the disease according to below drawn punett square.

	Hb^A	**Hb^S**
Hb^A	Hb^AHb^A	Hb^AHb^S
Hb^S	Hb^AHb^S	Hb^SHb^S

	Hb^A	**Hb^S**
Hb^S	Hb^AHb^S	Hb^SHb^S
Hb^S	Hb^AHb^S	Hb^SHb^S

(iii) The type of point mutation responsible for sickle cell anemia is a substitution mutation. This mutation occurs in the gene that encodes for the beta-globin subunit of haemoglobin. In sickle cell anemia, a single nucleotide in the gene is changed from adenine to thymine, leading to the substitution of the amino acid valine for glutamic acid at Position 6 of the beta-globin subunit. This results in the production of abnormal haemoglobin known as haemoglobin S, which cause red blood cells to become sickle-shaped.

Answer 5

(i) **(a)** Type- I: Nuclear endosperm, Type-II: Cellular endosperm and Type- III: Hlobial endosperm

(b) In polypetalous dicots, the endosperm is typically of the nuclear type.

OR

(ii) **(a)** **(1)** Primary spermatocyte

(2) Secondary spermatocyte

(3) Spermatid

(b) Spermiogenesis

Answer 6

(a) **Causative agent:** *Wuchereria bancrofti* and *W. malayi*.

Mode of Transmission: The pathogens are transmitted to a healthy person through the bite by the female mosquito vectors. Mosquitoes become infected with the parasitic larvae when they feed on the blood of an infected human. The larvae develop in the mosquito and then are transmitted to another human when the infected mosquito bites them. This is how the filarial worms are passed from person to person, leading to the spread of filariasis.

(b) **Causative agent:** *Salmonella typhi*

Mode of Transmission: Typhoid pathogens are transmitted primarily through the consumption of contaminated food or water. The main sources of contamination are food and water, contaminated with the faeces of an infected person. Food can become contaminated if prepared by an infected person who does not practice proper hygiene, such as washing hands after using the bathroom.

Answer 7

(i) The change in flower colour from red and yellow in the parent plants to orange in the F_1 generation is due to a phenomenon known as incomplete dominance.

In incomplete dominance, neither allele (red nor yellow) is completely dominant over the other, resulting in a blending of the two traits. When red and yellow alleles are combined in the F_1 generation, the resulting flowers exhibit a colour that is a blend of the two parent colours, which in this case is orange.

(ii) In incomplete dominance, the phenotypic ratio of monohybrid cross in F_2 generation is 1 Red :

2 Orange : 1 Yellow.

Answer 8

(i) *Lactobacillus* sp.

(ii) *Sachharomyces cerevisiae*

(iii) *Trichoderma polysporum*

(iv) *Monascus purpureus*

SECTION–C

21 MARKS

Answer 9

(i) 1–Epicarp; 2–Mesocarp; 3–Endocarp

(ii) True fruits develop from the ovary of a flower after fertilisation, containing seeds within the fruit whereas false fruits develop from other parts of the flower such as the receptacle or flower parts surrounding the ovary and do not contain seeds within the fruit.

Examples of true fruits include mango and coconut, while examples of false fruits include apples, strawberries and blackberries.

(iii) The formation of fruit in angiosperms is significant for several reasons:

1. Fruits are the mature ovary of a flower, which contains seeds. The development of fruits ensures the dispersal of seeds, which is essential for the reproduction and survival of angiosperms.
2. Fruits protect the seeds from mechanical damage, desiccation and predation. They provide a safe environment for the seeds to germinate and grow into new plants.
3. Being rich in nutrients, such as sugars, vitamins and minerals, fruits attract animals to eat them. The animals help in dispersing the seeds by carrying them away from the parent plant and depositing them in a new location.
4. Fruits have different adaptations to facilitate seed dispersal, such as being attractive to animals, having wings or hooks for wind dispersal, or floating on water. This ensures that the seeds are dispersed away from the parent plant, reducing competition for resources and increasing the chances of successful germination.

Answer 10

Vector C is a good cloning vector for several reasons: (Choose Any Two)

1. The presence of multiple restriction sites such as Hind III, EcoR I, BamH I, Pvu II, Pvu I and Cla I allows for easy insertion of DNA fragments during the cloning process.
2. The presence of an origin of replication (ori) ensures that the plasmid can replicate within the host cell, allowing for the amplification of the cloned gene of interest.
3. The presence of antibiotic resistance genes (amp^R and tet^R) allows for the selection of cells that have successfully taken up the plasmid during transformation. This ensures that only cells containing the desired insert survive and grow.
4. The rop gene codes for proteins involved in the replication of the plasmid, ensuring efficient replication of the plasmid in the host cell.

Vector A and Vector B do not have antibiotic resistance genes which will not allow for the selection of transformant cells.

Answer 11

(i) Figure A represents an unlimited supply of nutrients as it shows exponential growth. In this, the population growth rate increases over time as a result of the number of individuals available to reproduce without regard to resource limits. The population size increases at an exponential rate over time, continuing upward.

(ii) The graph for the exponential model depicts a challenge to population growth. Such kind of population growth is not sustainable because the resources of energy are limited and are about to extinct in the near future which may pose threat to the upcoming generation.

(iii) Reproductive fitness, also known as Darwinian fitness, is the ability of an individual to survive and reproduce in its environment and to pass on its genes to future generations. In other words, those who are a better fit in the environment leave more progeny than others. This is called reproductive fitness.

(iv) The equation of Figure A (exponential growth) is $dn/dt = rN$

Figure B:

Logistic Growth and is described by the following equation:

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

Answer 12

(i) In mammals, insulin is synthesised as a pro-hormone. The pro-hormone needs processing before it becomes a fully mature and functional hormone. The pro-hormone contains an extra stretch called the C-peptide. This C peptide is not present in the mature insulin and is removed during maturation into insulin.

(ii) Insulin is prepared by recombinant DNA (rDNA) technology.

(iii) The two short polypeptide chains namely, Chain A and Chain B of the fully functional insulin are linked together by disulphide bridges.

Answer 13

(i) If a patient is prescribed anti-retroviral therapy, he is likely to be suffering from AIDS,

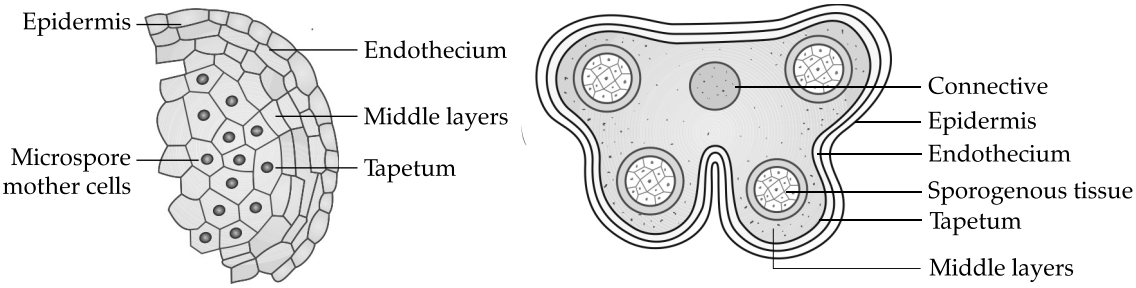
(ii) AIDS is caused by the Human Deficiency Virus (HIV). The common symptoms of HIV include: fever, diarrhoea, red rashes on the body, etc.

(iii) ELISA test which stands for enzyme-linked immunosorbent assay, is used to detect HIV infection.

(iv) Reverse transcriptase is an enzyme that plays a critical role in the replication of retroviruses. It is responsible for converting the single-stranded RNA genome of the retrovirus into double-stranded DNA, which can then be integrated into the host cell's genome. This process is known as reverse transcription and it is essential for the virus to establish a persistent infection.

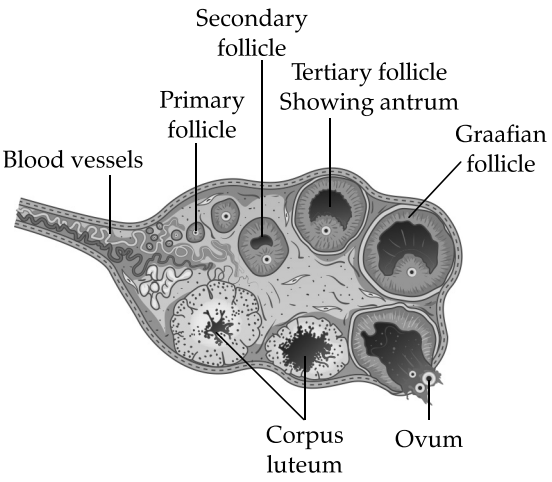
Integrase is an enzyme that is involved in the life cycle of retroviruses. It is responsible for integrating the double-stranded DNA copy of the viral genome into the host cell's genome. This integration is a crucial step in the replication of retroviruses, as it allows the viral genetic material to be passed on to daughter cells when the host cell divides.

Answer 14



T.S. of anther

OR



T.S. of mammalian ovary

Answer 15

(i) In the case of Africa:

Species richness (S) can be calculated using the equation:

$S = C + A^Z$

Putting the values given:

$S = 10 + 62{,}000^{(1)} = 62{,}010$

Therefore, the species richness of the continent is 62,010.

In the case of Europe:

$S = C + A^Z$

Putting the values given:

$S = 20 + 65{,}000(1) = 65{,}020$

Therefore, the species richness of the continent is 65,020.

(ii) Europe shows a higher biodiversity.

(iii) A greater variety of habitats within an ecosystem can support a wider range of species, leading to increased biodiversity. Habitats provide diverse resources, such as food sources and shelter, which can support different species with varying ecological requirements.

Positive interactions between different species, such as mutualism and symbiosis, can promote diversity by allowing species to coexist and thrive together.

SECTION–D

15 MARKS

Answer 16

(i) **(a)** Growth of pollen tube will only happen if compatible pollen grains of same plant lands on the stigma of the same species. The pistil has the ability to recognise the pollen, whether it is of the right type (compatible) or of the wrong type (incompatible). If it is of the right type, the pistil accepts the pollen and promotes post-pollination events that leads to fertilisation. If the pollen is of the wrong type, the pistil rejects the pollen by preventing pollen germination on the stigma or the pollen tube growth in the style. Therefore, the pollen grains from China-rose plants will not form the pollen tube to reach the ovary and affect fertilisation.

(b) Geitonogamy is the transfer of pollen from an anther of a flower to the stigma of another flower on the same plant.

In an ecological context, geitonogamy is considered equivalent to cross-pollination because it involves the transfer of pollen between different flowers, which can lead to genetic diversity and adaptation within a population.

In a genetic context, geitonogamy is considered similar to self-pollination because it involves pollen transfer within the same plant. Self-pollination generally leads to lower genetic diversity compared to cross-pollination, as it does not involve the mixing of genetic material from different individuals.

OR

(ii) **(a)** Fertilisation in angiosperms, or flowering plants, involves the fusion of male and female gametes to form a zygote, which develops into a new plant embryo. There are four steps of fertilisation, namely pollination, germination, penetration into the ovule and fertilisation.

Pollination is the transfer of pollen from the anther of a male flower to the stigma of a female flower. This can occur through various mechanisms such as wind, water or animals. Once the pollen lands on the stigma, it germinates and forms a pollen tube. Only one pollen tube reaches the embryo sac. The pollen tube has two male nuclei, which migrate to the tip of the pollen tube. The pollen tube penetrates the ovule through the micropyle and two male gametes are then released into it.

One of the male gametes moves towards the egg cell and fuses with its nucleus thus completing the syngamy. This results in the formation of a diploid cell, the zygote (2n). The other male gamete moves towards the

two polar nuclei located in the central cell and fuses with them to produce a triploid primary endosperm nucleus. As this involves the fusion of three haploid nuclei it is termed triple fusion. Since two types of fusions, syngamy and triple fusion take place in an embryo sac the phenomenon is termed double fertilisation, an event unique to flowering plants. The central cell after triple fusion becomes the primary endosperm cell (PEC) and develops into the (3n) endosperm while the zygote develops into an embryo.

(b) The filiform apparatus is located at the micropylar end of the embryo sac in angiosperms. Its main function is to guide the entry of the pollen tube to the egg cell during fertilisation. The filiform apparatus consists of specialised cells that help in the recognition and reception of the pollen tube, ensuring successful fertilisation.

(c) **1.** Parthenocarpy is the development of fruit without fertilisation.

2. Apomixis is the processes involved in the production of seeds without fertilisation.

Answer 17

(i) The breaking down of complex organic matter plays a crucial role in the ecosystem for several reasons:

Decomposition breaks down organic matter into simpler substances like carbon, nitrogen and phosphorus, which can then be recycled and reused by plants and other organisms. This helps to maintain a healthy nutrient cycle in the ecosystem.

Decomposition also releases energy in the form of heat which is then transferred to other organisms in the food chain, helping to sustain life in the ecosystem.

Decomposition contributes to the formation of humus, a dark, nutrient-rich organic material that helps improve soil structure and fertility.

(ii) The forest soil has a higher humus content than the desert soil because the forest ecosystem receives a higher input of organic matter in the form of dead leaves, branches, animal droppings and decaying plant material. This organic matter accumulates and decomposes over time, enriching the soil with humus. In contrast, the desert soil typically receives less organic matter input due to the sparse vegetation and limited biological activity, resulting in lower humus content.

(iii) Earthworm and centipedes are detritivores which break down detritus into smaller particles. This process is called fragmentation.

(iv) Gross Primary Productivity (GPP) can be calculated by adding respiration to Net Primary Productivity (NPP).

Given:

Net Primary Productivity (NPP) = 8,000 kcal/m^2/year

Respiration (R) by aquatic producers = 1,000 kcal/m^2/year

GPP = NPP + (R) Respiration

GPP = 8,000 + 1,000

GPP = 9,000 kcal/m^2/year

Therefore, the gross primary productivity for this ecosystem is 9,000 kcal/m^2/year.

Answer 18

(i) Griffith first obtained two different strains of the bacterium *Streptococcus pneumoniae* – a virulent (smooth) strain and a non-virulent (rough) strain. He injected mice with the virulent strain of the bacteria, which caused the mice to die due to pneumonia. He then injected mice with the non-virulent strain of the bacteria, which did not cause any harm to the mice.

Next, Griffith heat-killed the virulent strain of bacteria by exposing them to high temperatures, which killed the bacteria but preserved their outer capsule. He injected mice with the heat-killed virulent strain of bacteria, expecting that they would not get infected, given that the bacteria were dead. Surprisingly, some of the mice injected with the heat-killed virulent strain of bacteria still developed pneumonia and died.

(ii) Griffith concluded that something in the heat-killed bacteria had transformed the non-virulent strain into a virulent strain, causing the mice to become infected and die.

(iii) If both strains of the bacteria were first heat-killed, mixed and then injected into the mice, the mice would not have developed pneumonia as there would be no live bacteria present to cause the infection. The heat-killed bacteria would not be able to transform the non-virulent strain into a virulent strain, so there would be no transformation

observed. The result would be similar to injecting a non-virulent strain alone, with no pneumonia developing in the mice.