CBSE Board Examination – 2025
BIOLOGY
Solved Paper
Class– 12th

(All Sets of Delhi & Outside Delhi)

Maximum Marks: 70 *Time allowed: 3 hours*

GENERAL INSTRUCTIONS:

Read the following instructions carefully and follow them:

*(i) This question paper contains **33** questions. **All** questions are compulsory.*

*(ii) Question paper is divided into **FIVE** sections – **Section A, B, C, D** and **E**.*

*(iii) Section **A** – question numbers **1** to **16** are multiple choice type questions. Each question carries **1** mark.*

*(iv) Section **B** – question numbers **17** to **21** are very short answer type questions. Each question carries **2** marks.*

*(v) Section **C** – question numbers **22** to **28** are short answer type questions. Each question carries **3** marks.*

*(vi) Section **D** – question numbers **29** and **30** are case-based questions. Each question carries **4** marks. Each question has subparts with internal choice in one of the subparts.*

*(vii) Section **E** – question numbers **31** to **33** are long answer type questions. Each question carries **5** marks.*

*(viii) There is no overall choice. However, internal choices have been provided in some questions. A student has to attempt only **one** of the alternatives in such questions.*

(ix) Kindly note that there is a separate question paper for Visually Impaired candidates.

(x) Wherever necessary, neat and properly labelled diagrams should be drawn.

Delhi Set– 1 **57/1/1**

SECTION – A

Question Nos. **1** to **16** are multiple choice questions. Each question carries **1** mark. Only one of the choices is correct. Select and write the correct choice.

1. A man whose father was colour-blind marries a woman who had a: colour- blind mother and normal father. What percentage of male children of this couple will be colour-blind?

(A) 25% **(B)** 0%

(C) 50% **(D)** 75%

2. GEAC stands for

(A) Genome Engineering Action Committee

(B) Ground Environment Action Committee

(C) Genetic and Environment Approval Committee

(D) Genetic Engineering Approval Committee

3. Match the items in Column-A with that of Column-B:

	Column-A		**Column-B**
(i)	Lady bird beetle	(a)	Methanobacterium
(ii)	Mycorrhiza	(b)	Trichoderma
(iii)	Biological control	(c)	Aphids
(iv)	Biogas	(d)	Glomus

Choose the option that matches the items of Column-A with that of Column-B correctly.

Options:

	(i)	(ii)	(iii)	(iv)
(A)	(b)	(d)	(c)	(a)
(B)	(c)	(d)	(b)	(a)
(C)	(d)	(a)	(b)	(c)
(D)	(c)	(b)	(a)	(d)

4. The process of mineralization by microorganisms help in the release of:

(A) inorganic nutrients from humus.

(B) both organic and inorganic nutrients from detritus.

(C) organic nutrients from humus.

(D) inorganic nutrients from detritus and formation of humus.

5. Transplantation of tissues/organs to some patients often fails due to rejection of such tissues/organs by the body of the patient. Which type of immune response is responsible for such rejections?

(A) Autoimmune response

(B) Humoral immune response

(C) Physiological immune response

(D) Cell mediated immune response

6. Match the following items of Column-I with that of Column-II:

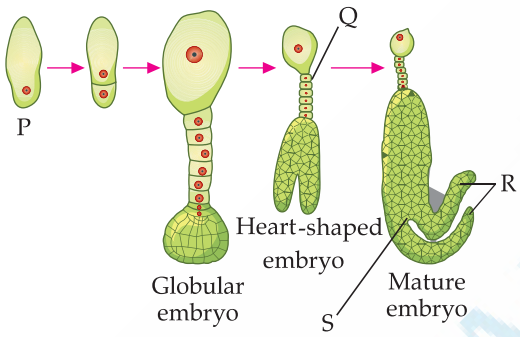
	Column-I		Column-II
(a)	Trophoblast	(i)	Embedding of blastocyst in the endometrium
(b)	Implantation	(ii)	Group of cells that would differentiate as embryo
(c)	Inner cell mass	(iii)	Embryo with 8–16 blastomers
(d)	Morula	(iv)	Outer layer of blastocyst

Choose the option that matches Column-I with Column-II correctly.

Options:

	(a)	(b)	(c)	(d)
(A)	(iv)	(i)	(ii)	(iii)
(B)	(i)	(ii)	(iii)	(iv)
(C)	(ii)	(i)	(iv)	(iii)
(D)	(ii)	(iv)	(iii)	(i)

7. The diagram given below shows labelling of four parts of a dicot embryo during its development as P, Q, R and S.



Choose the option that indicates correct labelling of 'P', 'Q', 'R' and 'S' of embryo in different stages of its development:

	P	Q	R	S
(A)	Egg	Suspensor	Radicle	Cotyledon
(B)	Zygote	Suspensor	Cotyledon	Plumule
(C)	Egg	Radicle	Suspensor	Cotyledon
(D)	Zygote	Suspensor	Cotyledon	Radicle

8. Amplification of gene of interest by using DNA polymerase may go upto

(A) 0.1 million times **(B)** 1 million times

(C) 1 billion times **(D)** 1 trillion times

9. The sequence of nitrogenous bases in a segment of a coding strand of DNA is 5′ – AATGCTAGGCAC – 3′. Choose the option that shows the correct sequence of nitrogenous bases in the mRNA transcribed by the DNA.

(A) 5′ – UUACGAACCGAG – 3′

(B) 5′ – AAUGCUAGGCAC – 3′

(C) 5′ – UUACGUACCGUG – 3′

(D) 5′ – AACGUAGGCAGC – 3′

10. How many pollen grains and ovules are likely to be formed in the anther and the ovary of an angiosperm bearing 50 microspore mother cells and 50 megaspore mother cells respectively?

(A) 100, 25 **(B)** 200, 50

(C) 50, 50 **(D)** 200, 100

11. Evolution of modern man involves the following man-like primates. Choose the correct series of human evolution.

(A) *Dryopithecus* → *Homo erectus* → *Australopithecines* → *Homo sapiens*

(B) *Australopithecines* → *Homo erectus* → Neanderthal → *Homo sapiens*

(C) *Australopithecines* → *Ramapithecus* → *Dryopithecus* → *Homo sapiens*

(D) *Homo erectus* → *Australopithecines* → *Homo sapiens* → Neanderthal

12. RNA interference (RNAi) helps in making tobacco-plant resistant to a nematode (*Meloidegyne incognitia*)

Choose the correct option that shows how RNAi is achieved:

(A) Preventing the process of translation of mRNA of the nematode.

(B) Preventing the process of replication of DNA of the nematode.

(C) Preventing the process of transcription of DNA of the plant.

(D) Preventing the process of replication of DNA of the plant.

For Question numbers 13 to 16, two statements are given — one labelled as Assertion (A) and the other labelled as Reason (R). Answer these questions by selecting the appropriate option given below:

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

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

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

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

13. **Assertion (A):** Saheli is the World's first non-steroidal oral contraceptive pill.

Reason (R): It has been developed by National Institute of Immunology, New Delhi.

14. **Assertion (A):** One of the property of genetic code is degeneracy.

Reason (R): Some amino acids can be coded by more than one codon.

15. **Assertion (A):** A bioreactor provides the optimal conditions for achieving the desired product by providing optimum growth conditions.

Reason (R): The most commonly used bioreactors are of stirring type.

16. **Assertion (A):** When the two genes in a dihybrid cross are situated on the same chromosome, the proportion of parental gene combinations is much higher than non-parental type.

Reason (R): Higher parental gene combinations can be attributed to crossing over between two genes.

SECTION – B

17. Student to attempt **either** option – (A) or (B):

(A) How are morphine and heroin related? Mention their effect on the human body.

OR

(B) (i) Name an alcoholic drink which is produced by the help of microbes:

(1) With distillation

(2) Without distillation

(ii) Explain how cyanobacteria can be used as bio-fertilizer.

18. Student to attempt **either** option – (A) or (B):

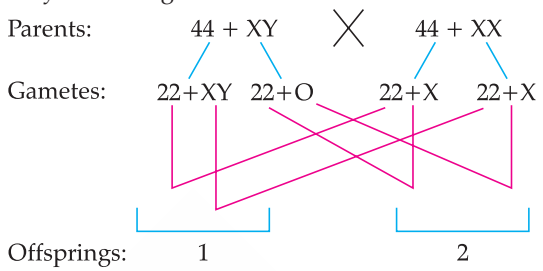
(A) Analyse the following ecosystems and discuss, which will be more productive in terms of primary productivity:

A young forest, a natural old forest, a shallow polluted lake.

OR

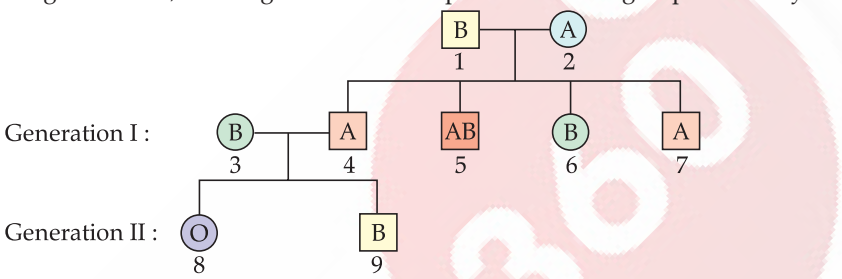
(B) Differentiate between Net primary productivity and Gross primary productivity in an ecosystem.

19. Study the cross given below:



Identify the abnormalities '1' and '2' in the offsprings of a cross done between a couple and distinguish between them.

20. Study the pedigree chart given below, showing the inheritance pattern of blood group in a family:



Answer the following questions:

(a) Give the possible genotypes of individual 1 and 2.

(b) Which antigen or antigens will be present on the plasma membranes of the R.B.Cs of individuals '5' and '8'?

21. Student to attempt **either** option – (A) or (B):

(A) A patient with ADA deficiency requires periodic infusion of genetically engineered lymphocytes. Explain why such periodic infusion is required and also suggest a permanent cure for such ADA deficiency.

OR

(B) Describe in brief any two techniques that can be utilised to transfer recombinant DNA into the host cell directly without using any vector.

SECTION – C

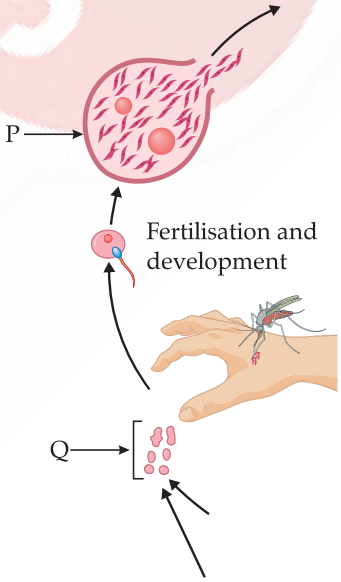
22. (a) Write the palindromic nucleotide sequence for following sequence of DNA segment:

5′ – GAATTC – 3′

(b) Name the restriction endonuclease that recognizes this sequence.

(c) How are sticky ends produced? Mention their role.

23. Study a part of life cycle of Plasmodium given below:



Answer the following questions:

(a) Name the infective stage of Plasmodium that is stored in the female Anopheles mosquito.

(b) Where does fertilization and development of parasite take place?

(c) Identify labels P and Q in the given diagram.

(d) Asexual and sexual phase of the life cycle of the Plasmodium takes place in two different hosts. Write their names.

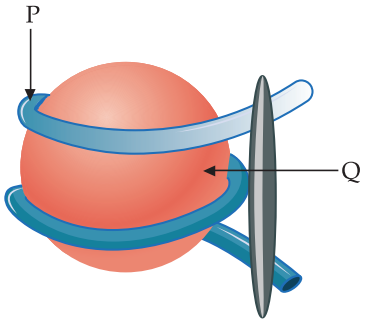
24. **(a)** Indiscriminate human activities such as alien species invasion, fragmentation and habitat loss have accelerated the loss of biodiversity. Justify by taking one example for each.

(b) State the importance of the following:

(i) IUCN Red data list

(ii) Hot spots in conservation of biodiversity

25. Study the diagram given below and answer the questions that follows:



(a) Identify the structure shown in the above figure.

(b) Identify the labels P and Q.

(c) Write the nature of histone proteins.

(d) Distinguish between Euchromatin and Hetero-chromatin.

26. Shyam and Radha are expecting their first child with Radha being in her second month of pregnancy with no complications. Shyam's family has a history of cystic fibrosis while Radha's family has a history of Down's syndrome, leading to a concern that the baby may have one of these conditions.

(a) Suggest and explain a way of testing if their baby is at risk for any genetic disorders.

(b) In case of presence of one or both of the abnormalities and posing a risk to the mother's health, mention one possible option for them to consider. Is that option safe for Radha at the current gestational age? Justify.

(c) Under what conditions is the process mentioned in (b) illegal?

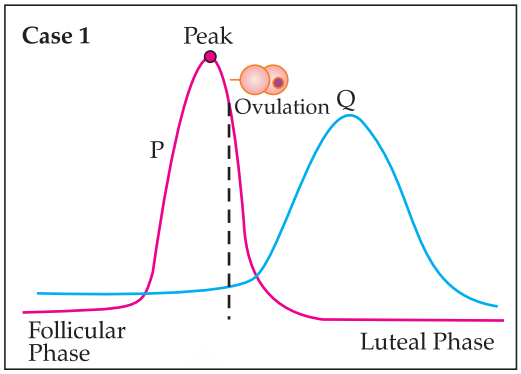
27. Explain the basis on which gel electrophoresis technique works. Write any two ways the products obtained through this technique can be utilised.

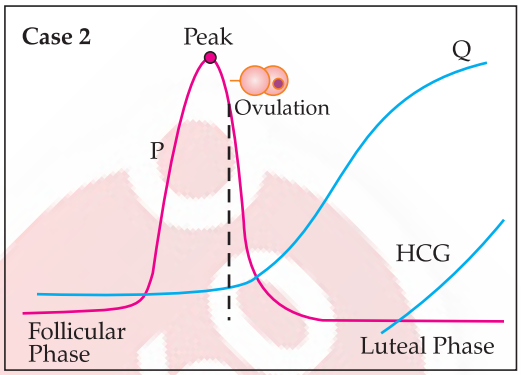
28. Compare and contrast convergent and divergent evolution.

SECTION – D

Question Nos. **29** and **30** are case-based questions. Each question has **3** sub-questions with internal choice in one sub-question.

29. Study the graphs given below for Case 1 and Case 2 showing different levels of certain hormones and answer the question that follows:





(a) Which hormone is responsible for the peak observed in Case 1 and Case 2? Write one function of that hormone.

(b) Write changes that take place in the ovary and uterus during follicular phase.

Student to attempt either sub-part (c) or (d):

(c) Name the hormone Q of Case 2. Write one function of hormone Q.

OR

(d) Which structure in the ovary will remain functional in Case 2? How is it formed?

30. Read the following passage and answer the questions that follow:

In nature, we rarely find isolated, single individuals of any species; majority of them live in groups in a well-defined geographical area, share or compete for similar resources, potentially interbreed and thus constitute a population. The population has certain attributes whereas, an individual organism does not. A population at a given time is composed of individuals of different ages. The size of the population tells us a lot about its status in the habitat. Whatever ecological processes we wish to investigate in a population, be it the outcome of competition with another species, the impact of the predator or the effect of pesticide application, we always evaluate in terms of any change in the population size. The size, in nature, could be low or go into millions. Population size, technically called population density (N) need not necessarily be measured in numbers only. The size of a population for any species is not a static parameter. It keeps on changing with

time depending on various factors including food availability, predation pressure and adverse weather.

(a) The Monarch butterfly is highly distasteful to its predator because of a special chemical present in its body. How does the butterfly acquire this chemical?

(b) If population density at a time $t + 1$ is 800, Emigration = 100, Immigration = 200, Natality = 200 and Mortality = 150, calculate the population density at time t and comment upon the type of age pyramid that will be formed in this case.

Student to attempt **either** sub-part (c) or (d):

(c) What is the difference in a method of measuring population density in an area if there are 200 carrot grass plants to only single huge banyan tree?

OR

(d) Name two methods to measure the population density of tigers.

SECTION – E

31. Student to attempt **either** option – (A) or (B):

(A) Answer the following questions:

(i) State what do you understand by "MALT"? Where is it located inside our body?

(ii) Explain cytokine barriers.

(iii) Name the diagnostic test for AIDS. On what principle does it work?

(iv) Bone marrow and thymus play an important role in human immune system. Explain how are they able to achieve this.

OR

(B) (i) Study the following table & fill 'H', 'I', 'J', 'K', 'L' and 'M' in following table with suitable words:

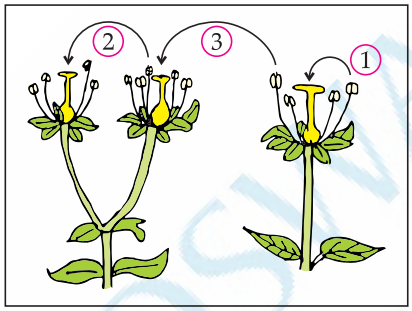
	Chemical/Bioactive Molecule	Micro-organism	Category	Use
(a)	Butyric acid	H	I	Important applications in food, chemical & pharma industry
(b)	J	Monoscus purpureus	K	Inhibit cholesterol biosynthesis pathway
(c)	Cyclosporin A	L	Fungus	M

(ii) Why are baculoviruses used as biological control agents?

32. Student to attempt **either** option – (A) or (B):

(A) (a) Distinguish between the two cells enclosed in a mature male gametophyte of an angiosperm.

(b) Study the diagram given below showing the modes of pollination. Answer the questions that follow.



(i) The given diagram shows three methods of pollen transfer in plants. Examine them carefully and write the technical terms used for pollen transfer methods '1', '2' and '3'.

(ii) How do the following plants achieve pollination successfully?

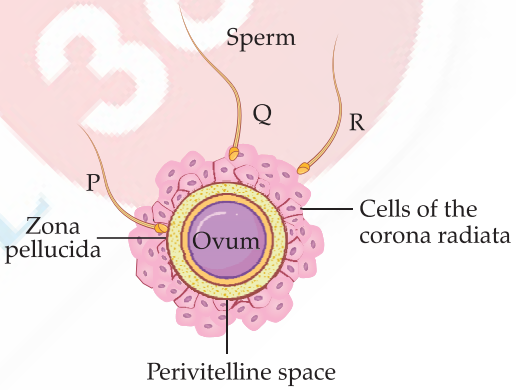
(a) Water lily

(b) Vallisneria

(iii) Write advantages of pollen transfer in method '3'.

OR

(B) Given below is the diagram of a human ovum surrounded by a few sperms. Observe the diagram and answer the questions that follow:



(i) Compare the fate of sperms 'P', 'Q' and 'R' shown in the diagram.

(ii) Write the role of Zona pellucida in this process.

(iii) Analyse the changes occurring in the ovum after the entry of sperm.

(iv) How acrosome and middle piece of a human sperm are able to play an important role in human fertilization?

33. Student to attempt **either** option – (A) or (B):

(A) (i) Perform a cross between two sickle cell carriers. What ratio is obtained between carrier, disease free and diseased individuals in F_1 progeny? Name the nitrogenous base substituted, in the haemoglobin molecule in this disease.

(ii) Explain the difference in inheritance pattern of flower colour in garden pea plant and snap-dragon plant with the help of monohybrid crosses.

OR

(B) Explain with the help of well-labelled diagrams how lac operon operates in *E. coli*:

(i) In presence of an inducer.

(ii) In absence of an inducer.

Delhi Set– 2 **57/1/2**

Note: Except these, all other questions are available in Delhi – Set 1.

SECTION – A

Question Nos. **1** to **4** are Multiple Choice Questions. Each question carries **1** mark. Only one of the choices is correct. Select and write the correct choice.

1. Mohit performed an analysis of two different soil samples from two areas A and B. He recorded these results:

Soil Sample A: Lignin 40%, Sugar 10%, Chitin 45%, Nitrogen 5%

Soil Sample B: Lignin 5%, Sugar 35%, Chitin 15%, Nitrogen 45%

Which of these is true about their rate of decomposition in both the soil?

(A) Soil A has a slower rate of decomposition than Soil B.

(B) Soil A has a faster rate of decomposition than Soil B.

(C) Both have the same rate of decomposition.

(D) No decomposition occurs in A and B.

2. Diameter of the pollen grain generally is

(A) 5 to 10 micrometre

(B) 10 to 15 micrometre

(C) 25 to 50 micrometre

(D) 50 to 100 micrometre

3. Menstrual cycle in human females consists of various events.

Select the option that indicates the correct sequence of these events of menstrual cycle.

(A) Menstrual phase, Follicular phase, Luteal phase, Ovulatory phase

(B) Luteal phase, Follicular phase, Ovulatory phase, Menstrual phase

(C) Menstrual phase, Follicular phase, Ovulatory phase, Luteal phase

(D) Follicular phase, Luteal phase, Menstrual phase, Ovulatory phase

4. A Dihybrid cross is done between two parent pea plants (pure line) who differ in two pairs of contrasting traits: Seed colour and seed shape.

In the F_2 generation the number of phenotypes and genotypes will be:

(A) phenotypes = 4; genotypes = 16

(B) phenotypes = 9; genotypes = 14

(C) phenotypes = 4; genotypes = 8

(D) phenotypes = 4; genotypes = 9

For Question numbers **13** and **14**, two statements are given – one labelled as Assertion (A) and the other labelled as Reason (R). Answer these questions by selecting the appropriate option given below:

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

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

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

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

13. **Assertion (A):** Perisperm is a diploid tissue.

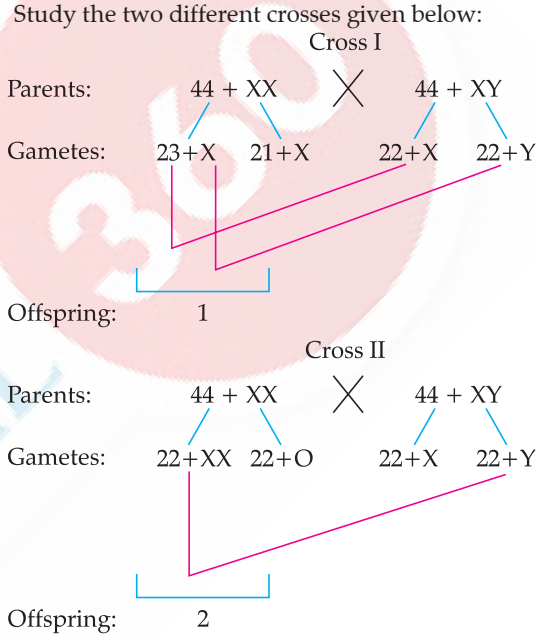
Reason (R): Perisperm is the remains of nucellus which surrounds the embryo in certain seeds.

14. **Assertion (A):** While working on Staphylococci, Alexander Fleming observed that Penicillium notatum inhibits the growth of bacteria.

Reason (R): The inhibiting chemical was commercially extracted and its full potential was established by Alexander Fleming.

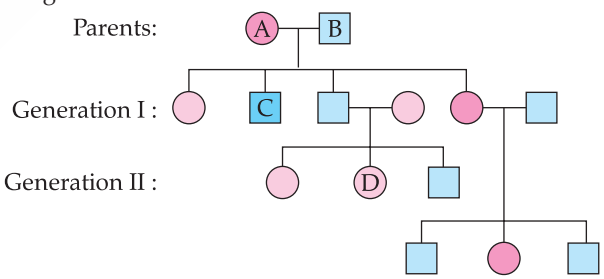
SECTION – B

17. Study the two different crosses given below:



Identify the abnormalities 1 and 2 in the offsprings of given crosses and distinguish between them.

18. Study the pedigree analysis of Myotonic dystrophy given below :



Answer the following questions:

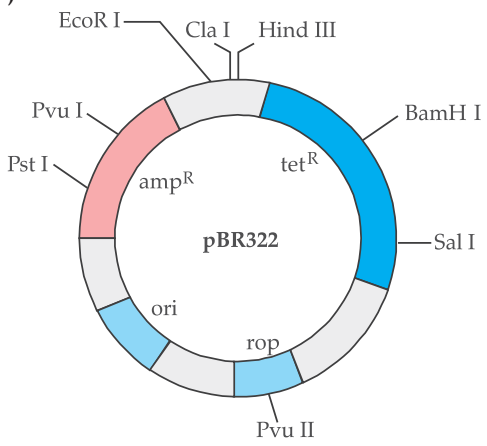
(a) Write genotype of A, B, C and D

(b) Identify whether the trait is

(i) Sex linked or autosomal
(ii) Dominant or recessive

SECTION – C

22. (a)



Explain the importance of 'ori' and 'rop' in the *E. coli* cloning vector shown in the above given diagram.

(b) Differentiate between exonucleases and endonucleases.

23. The great German naturalist and geographer Alexander Von Humboldt observed that within a region species richness increased with increasing explored area, but only upto a limit.

(a) For the above situation, construct a graph and write an equation.

(b) Also write various values of Z (regression coefficient).

SECTION – E

33. Student to attempt **either** option – (A) or (B):

(A) (i) Haemophilia and red green colourblindness are usually observed in men. Why?

(ii) Perform a cross(es) where haemophilic daughter(s) and haemophilic son(s) are produced in same ratio.

OR

(B) (i) Where do transcription and translation occur in bacteria and eukaryotes respectively?

(ii) Draw a labelled schematic sketch of replication fork of DNA.

(iii) A DNA segment has a total of 1000 nucleotides, out of which 240 of them are Adenine containing nucleotides. How many pyrimidine bases this segment possesses?

Delhi Set– 3 **57/1/3**

Note: Except these, all other questions are available in Delhi – Set 1 + 2.

SECTION – A

Question Nos. **1, 2, 6 and 12** are Multiple Choice Questions. Each question carries **1** mark. Only one of the choices is correct. Select and write the correct choice.

1. What type of ecological pyramid would be obtained with the following data?

Primary producer = 10 g

Secondary consumer = 120 g

Primary consumer = 60 g

(A) Upright pyramid of biomass
(B) Upright pyramid of number
(C) Inverted pyramid of biomass
(D) Upright pyramid of energy

2. Flowers which have single ovule in the ovary and are packed into inflorescence are usually pollinated by

(A) Water **(B)** Bat
(C) Bee **(D)** Wind

6. Endosperm is completely consumed by the developing embryo in which of the following?

(A) Maize and Castor **(B)** Castor and Groundnut
(C) Maize and Pea **(D)** Pea and Groundnut

12. Which of the following is correct for the condition when plant YyRr is back crossed with the double recessive parent?

(A) 9:3:3:1 ratio of phenotypes only
(B) 9:3:3:1 ratio of genotypes only
(C) 1:1:1:1 ratio of phenotypes only
(D) 1:1:1:1 ratio of phenotypes and genotypes

For Questions number **13** and **14** two statements are given – one labelled as Assertion (A) and the other labelled as Reason (R). Answer these questions by selecting the appropriate option given below:

(A) Both (A) and (R) are true and (R) is the correct explanation of (A).
(B) Both (A) and (R) are true, but (R) is not the correct explanation of (A).
(C) (A) is true, but (R) is false.
(D) (A) is false, but (R) is true.

13. Assertion (A): The mammary glands secrete milk for the nourishment of the young ones.

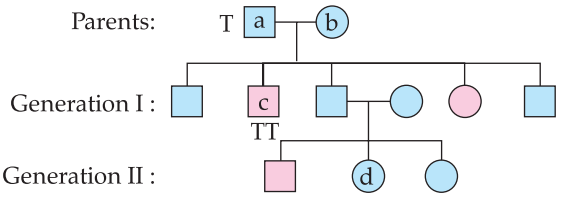
Reason (R): These are modified sweat glands.

14. Assertion (A): Scaffold proteins are non-histone chromosomal proteins.

Reason (R): They are rich in lysine and arginine.

SECTION – B

17. Study the pedigree analysis given below:



Answer the following questions:

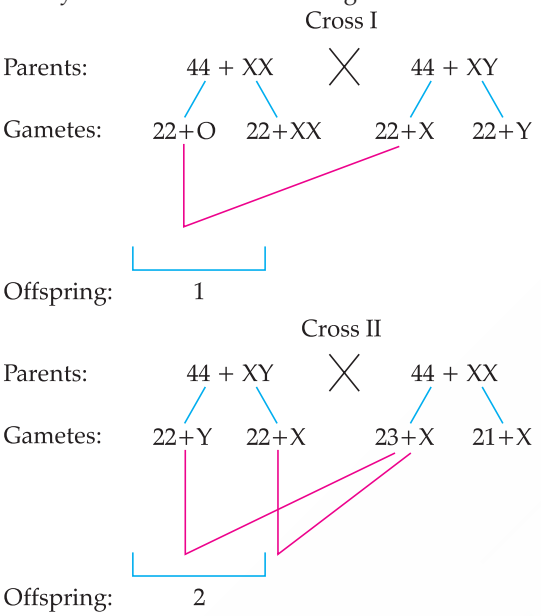
(A) Write genotypes of c and d.

(B) Identify whether the trait is

(i) Sex-linked or autosomal

(ii) Dominant or recessive

18. Study the two different crosses given below:



Identify the abnormalities '1' and '2' in the offsprings of given crosses and distinguish between them.

SECTION – C

27. **(A)** Who is having more species diversity – Columbia or Greenland and why?

(B) Explain the concept proposed by Paul Ehlrich.

28. **(A)** Differentiate between Recombinant DNA and cDNA.

(B) Explain the method to increase the competency of the bacterial cell membrane to take up recombinant DNA.

SECTION – E

31. Student to attempt **either** option – (A) or (B).

(A) **(i)** You are given axial pea flowers with violet colour whose genotypes are unknown. How would you find the genotype of these plants? Explain with the help of cross.

(ii) Explain Haplodiploidy in honey-bees.

OR

(B) Explain the steps of DNA fingerprinting that will help in processing of the two blood samples R and S picked up from the crime scene.

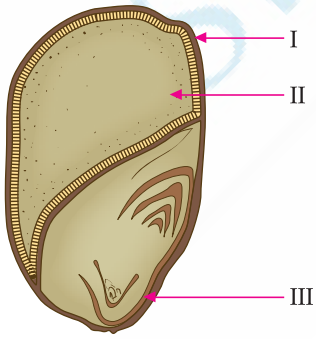
Outside Delhi Set– 1 **57/2/1**

For General Instructions refer Delhi Set – 1

SECTION – A

Question Nos. **1** to **16** are Multiple Choice type Questions, carrying **1** mark each.

1. Given below is a diagram of T.S. of a monocot seed with parts I, II & III labelled:



Choose the option where parts I, II and III are identified correctly.

	I	II	III
(A)	Pericarp,	Endosperm,	Scutellum
(B)	Pericarp,	Endosperm,	Coleorhiza
(C)	Scutellum,	Pericarp,	Coleorhiza
(D)	Coleorhiza,	Scutellum,	Pericarp

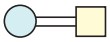
2. The number of autosomes present in a human secondary spermatocyte

(A) 44 **(B)** 22

(C) 23 **(D)** 46

3. A child with blood group A has father with blood group B and the mother with blood group AB. Choose the option that gives the correct genotypes of father, mother and the child:

	Father	Mother	Child
(A)	$I^A i$	$I^B i$	$I^A i$
(B)	$I^A I^B$	$I^A i$	$I^A I^A$
(C)	$I^B i$	$I^A I^B$	$I^A i$
(D)	$I^B I^B$	$I^A I^B$	$I^A I^A$

4. In a pedigree chart  represents:

(A) unrelated mating

(B) affected individuals

(C) mating between relatives (consanguineous mating)

(D) Non-identical twins

5. Which one of the following options shows the correct evolutionary order of the plants mentioned below?

(i) Ferns **(ii)** Ginkgo

(iii) Zosterophyllum **(iv)** Gnetales

Choose the correct option.

(A) (i), (iii), (ii), (iv) **(B)** (iii), (i), (ii), (iv)

(C) (i), (ii), (iii), (iv) **(D)** (iv), (ii), (i), (iii)

6. The phosphoester linkage in the nucleotides is between

(A) phosphate group and OH of 3'C of a nucleoside.

(B) phosphate group and OH of 5'C of a nucleoside.

(C) phosphate group and H of 3'C of a nucleoside.

(D) phosphate group and H of 5'C of a nucleoside.

7. Given below is a heterogeneous RNA formed during Eukaryotic transcription:

How many introns and exons respectively are present in the hnRNA?

(A) 7, 7 **(B)** 8, 7

(C) 8, 8 **(D)** 7, 8

8. Study the items of Column-I and those of Column-II:

	Column-I		**Column-II**
(a)	RNA polymerase I	(i)	18s rRNA
(b)	RNA polymerase II	(ii)	SnRNAs
(c)	RNA polymerase III	(iii)	hnRNA

Choose the option that correctly matches the items of Column-I with those of Column-II:

	(a)	(b)	(c)
(A)	(i)	(ii)	(iii)
(B)	(iii)	(ii)	(i)
(C)	(ii)	(iii)	(i)
(D)	(i)	(iii)	(ii)

9. For commercial and industrial production of citric acid, which one of the following microbes is used?

(A) *Aspergillus niger*

(B) *Lactobacillus sp.*

(C) *Clostridium butylicum*

(D) *Saccharomyces cerevisiae*

10. If Meselson and Stahl's experiment is continued for 80 minutes (till III generation) then what would be the ratio of DNA containing N^{15}/N^{15}: N^{15}/N^{14}: N^{14}/N^{14} in the medium?

(A) 1 : 1 : 0 **(B)** 0 : 1 : 3

(C) 0 : 1 : 8 **(D)** 1 : 4 : 0

11. Select the correct statement from the following biotechnological procedures:

(A) The polymerase enzyme joins the gene of interest and the vector DNA.

(B) Gel electrophoresis is used for amplification of a DNA segment.

(C) PCR is used for isolation and separation of gene of interest.

(D) Plasmid DNA acts as vector to transfer the piece of DNA attached to it.

12. The decrease in the T-Lymphocytes count in human blood will finally result in

(A) decrease in antigens

(B) decrease in antibodies

(C) increase in antibodies

(D) increase in antigens

Question numbers **13** to **16** consist of two statements – Assertion (A) and Reason (R). Answer these questions selecting the appropriate option given below:

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

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

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

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

13. **Assertion (A):** Corpus luteum secretes the hormone progesterone.

Reason (R): Hormone progesterone is essential for maintenance of the endometrium.

14. **Assertion (A):** The number of white winged moths decreased after industrialisation in England.

Reason (R): Effects of industrialisation were more marked in rural areas of England.

15. **Assertion (A):** *Streptococcus pneumoniae* and *Haemophilus influenzae* are responsible for causing infectious disease in human beings.

Reason (R): A healthy person acquires the infection by inhaling the aerosols released by an infected person.

16. **Assertion (A):** Restriction endonuclease recognises sequence in DNA and cuts them.

Reason (R): Palindromic sequence has two unique recognition sites PstI and PvuI recognised by restriction endonuclease.

SECTION – B

17. Student to attempt **either** option – (A) or (B):

(A) (i) Write two crucial changes, the seed undergoes while reaching maturity that enable them to be in a viable state until the onset of favourable conditions.

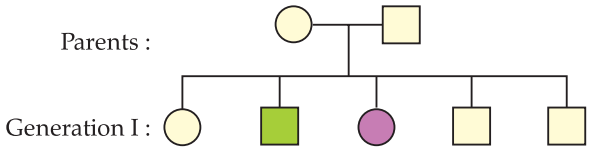
(ii) Name the oldest viable seed excavated from Arctic Tundra as per the records.

OR

(B) (i) Pea flower produce assured seed sets. Give reason.

(ii) In case of Polyembryony, an embryo 'P' develops from a synergid and the embryo 'Q' develops from the nucellus. State the ploidy of embryo 'P' and 'Q'.

18. Study the given pedigree chart in which neither of the parents shows the trait but the trait is present in both male and female children.



Answer the following questions:

(a) Write about the trait, also explain the inheritance of such trait in the progeny on the basis of given pedigree chart.

(b) Give one example of such trait in human beings.

19. Student to attempt **either** option – (A) or (B).

(A) Describe any two situations where a medical doctor would recommend injection of a pre-formed antibodies (antitoxins) into the body of a patient.

OR

(B) The symptoms of malaria do not appear immediately after the entry of sporozoites into the human body when bitten by female Anopheles mosquito. Explain why it happens.

20. Observe the given sequence of nitrogenous bases on a DNA fragment and answer the following questions:

5′	C	A	G	A	A	T	T	C	T	T	A	3′
3′	G	T	C	T	T′	A	A	G	A	A	T	5′

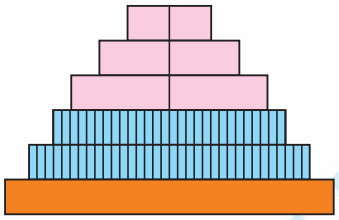
(a) Name the restriction enzyme which can recognise the DNA sequence.

(b) Write the sequence after restriction enzyme cut the palindrome.

(c) Why are the ends generated after digestion called as 'Sticky Ends'?

21. Student to attempt **either** option – (A) or (B).

(A) Identify the type of pyramid given below and write two identifying features of such a pyramid:



OR

(B) (i) Construct an ideal pyramid of energy when 10,00,000 Joules of sunlight is available.

(ii) Mention the energy obtained by the fourth level of this pyramid.

SECTION – C

22. (a) A bilobed dithecous anther has 200 microspore mother cells per microsporangium. How many male gametophytes can be produced by this anther?

(b) Write the composition of intine and exine layers of a pollen grains.

23. (a) List two reasons that make copper releasing IUDs as effective contraceptives.

(b) Explain how the intake of oral contraceptive pills prevent pregnancy in humans.

24. Using a Punnett square workout the distribution of an autosomal phenotypic feature in the first filial generation after a cross between a homozygous female and a heterozygous male for a single locus.

25. How does the process of Natural Selection affect Hardy–Weinberg equilibrium? Explain with the help of graphs.

26. Samples of blood and urine of a sportsperson are collected before any sports event for drug tests.

(a) Why there is a need to conduct such tests?

(b) Name the drugs the authorities usually look for.

(c) Write the generic names of two plants from which these drugs are obtained.

27. (a) The insulin synthesised in our body is different from that synthesised by Eli Lilly company using recombinant DNA technology. Differentiate between them.

(b) Why the insulin extracted from an animal source is not in use these days?

28. (a) Draw a graph for a population whose population density has reached the carrying capacity.

(b) Out of the two population growth curves, which one is considered a more realistic for most populations? Why?

(c) Draw a growth curve where resources are not limiting for the growth of a population and give its equation.

SECTION – D

Question Nos. **29** and **30** are case based questions.

29. Immunity in our body is of two types: (i) Innate immunity and (ii) acquired immunity. Innate immunity is a non-specific defence mechanism, whereas acquired immunity is pathogen-specific; it is called specific immunity too. Acquired immunity is characterised by memory. Antibodies are specific to antigens and there are different types of antibodies

produced in our body: they are IgA, IgE, IgG and IgM. It shows primary response when it encounters the pathogen for the first time and secondary response during the subsequent encounters with the same Antigen/Pathogen.

(a) Name the two types of specialised cells which carry out the primary and secondary immune response.

(b) Why is the antibody-mediated immunity also called as humoral immune response?

Attempt **either** sub-part (c) or (d):

(c) The organ transplants are often rejected if not taken from suitable compatible persons.

(i) Mention the characteristic of our immune system that is responsible for the graft rejection.

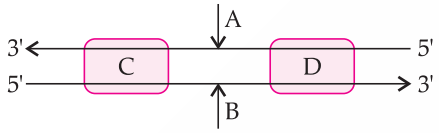
(ii) Name the type of immune response and the cell involved in it.

OR

(d) How is active immunity different from passive immunity?

30. The process of copying the genetic information from one strand of DNA into RNA is termed as transcription. The principle of complementarity of bases governs the process of transcription, also except that uracil comes in place of thymine.

Study the complete transcription unit given below and answer the following questions:



(a) Name the main enzyme involved in the process of transcription.

(b) Identify coding strand and template strand of DNA in the transcription unit.

Attempt **either** sub-part (c) or (d):

(c) Identify (C) and (D) in the diagram, mention their significance in the process of transcription.

OR

(d) Describe the location of (C) and (D) in the transcription unit.

SECTION – E

31. Student to attempt **either** option – (A) or (B).

(A) (i) Describe the process of megasporogenesis in an angiosperm.

(ii) Draw a diagram of a mature embryo sac of an angiosperm. Label its any four parts.

OR

(B) The reproductive cycle in the female primates is called menstrual cycle. The first menstruation begins at puberty.

Answer the following questions:

(i) Name the four phases of menstrual cycle in a proper sequence.

(ii) How long does the menstrual phase last in a menstrual cycle?

(iii) When and why hormones estrogen and progesterone reach their peak levels respectively, in the menstrual cycle?

(iv) Give the significance of LH surge.

32. Student to attempt **either** option – (A) or (B).

(A) (i) Explain how is a bacterial cell made 'competent' to take up recombinant DNA from the medium.

(ii) Explain the steps of amplification of gene of interest using PCR technique.

OR

(B) (i) What are transgenic animals?

(ii) Why are these animals being produced? Explain any four reasons.

33. Student to attempt **either** option – (A) or (B).

(A) (i) Explain giving three reasons why tropics show greatest levels of species diversity.

(ii) Draw a graph showing species-area relationship. Name the naturalist who studied such relationship. Write the observation made by him.

OR

(B) (i) The world is facing the accelerated rate of species extinctions due to human activities. Explain any three major causes of biodiversity losses.

(ii) Describe 'Ex situ' approach for conserving biodiversity. Give any two examples.

Outside Delhi Set– 2 **57/2/2**

Note: Except these, all other questions are available in Outside Delhi – Set 1.

SECTION – A

Question Nos. **9** to **12** are Multiple Choice type Questions, carrying **1** mark each.

9. The foetus receives some antibodies from their mother through the placenta during pregnancy. Choose the correct option that shows the type of immunity developed in the foetus.

(A) Naturally acquired active immunity
(B) Artificially acquired passive immunity
(C) Naturally acquired passive immunity
(D) Artificially acquired active immunity

10. A diploid organism is heterozygous for three loci, how many types of gametes can be produced by that organism?

(A) 4 **(B)** 8
(C) 16 **(D)** 32

11. During gel electrophoresis migration of DNA fragments leading to their separation takes place on the agarose gel.

Choose the correct option:

(A) The smaller the fragment size, the farther it moves.
(B) Positively charged fragments moves to farther end.
(C) The larger the fragment size, the farther it moves.
(D) The negatively charged fragments do not move.

12. Identify the organism whose product has been commercialised as blood cholesterol lowering agent.
(A) *Trichoderma polysporum*
(B) *Monascus purpureus*
(C) *Saccharomyces cerevisiae*
(D) *Aspergillus niger*

For Question numbers **13, 15** and **16,** two statements – Assertion (A) and Reason (R). Answer these questions by selecting the appropriate option given below:
(A) Both (A) and (R) are true and (R) is the correct explanation of (A).
(B) Both (A) and (R) are true, but (R) is not the correct explanation of (A).
(C) (A) is true, but (R) is false.
(D) (A) is false, but (R) is true.

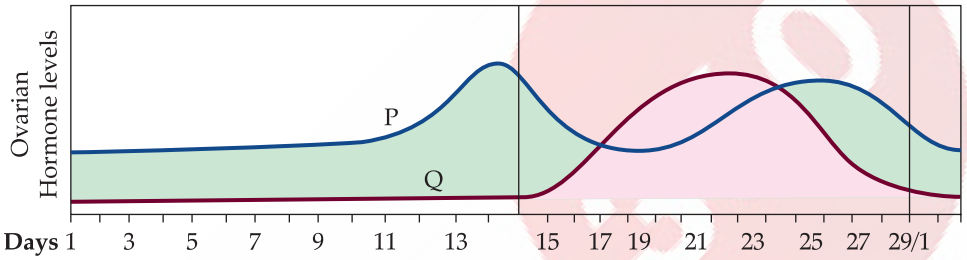
13. Assertion (A): 'XX – XY' type of sex-determination mechanism is an example of male heterogamety.
Reason (R): In birds male heterogamety is observed as males produce two different types of gametes.

15. Assertion (A): Secondary immune response is quicker and stronger than the primary immune response.
Reason (R): Our body appears to have the memory of the first encounter therefore response to the subsequent encounter with the same pathogen is quick.

16. Assertion (A): A patient of ADA-deficiency requires periodic or repeated infusion of genetically-engineered lymphocytes.
Reason (R): Lymphocytes are not immortal, but have life span.

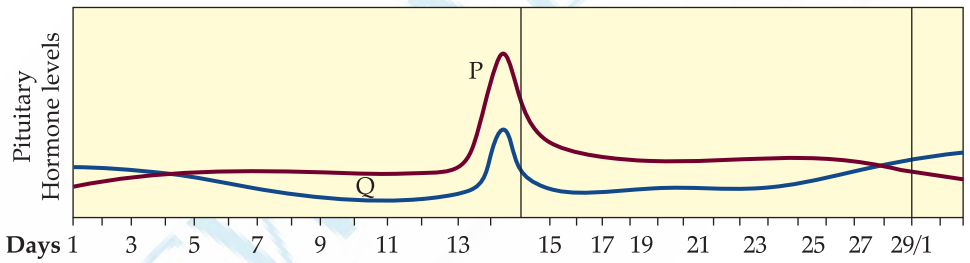
SECTION – B

17. Student to attempt **either** option – (A) or (B).



(i) Identify 'P' and 'Q' labelled in the diagram.
(ii) Specify the source of the hormone 'P' and 'Q' marked in the diagram.

OR



(i) Identify 'P' and 'Q' labelled in the above diagram.
(ii) Write down the role of hormone 'P' in both males and females.

18. (a) Write two closely linked genes that control α-thalassemia.
(b) Differentiate between thalassemia and sickle cell anaemia on the basis of their effect on globin molecule of Haemoglobin.

21. Student to attempt **either** option – (A) or (B).
(A) Construct a pyramid of biomass starting with phytoplankton, label its three trophic levels. Is the pyramid upright or inverted? Justify your answer.

OR

(B) Draw a pyramid of number where a large population of insects feed upon a very big tree. The insects in turn, are eaten by small birds which in turn are fed upon by big birds.

SECTION – C

23. (a) Abbreviations used for the different modes of assisted reproductive technology are given below. Expand the abbreviations:
(i) ZIFT **(ii)** ICSI
(iii) IUT **(iv)** GIFT
(b) Why is there a statutory ban on Amniocentesis? Give at least two reasons.

SECTION – E

31. Student to attempt **either** option – (A) or (B).

(A) (i) Draw a diagrammatic sectional view of human seminiferous tubule (enlarged) and label the following:

(a) cell that undergoes spermiogenesis

(b) cell that nourish male gametes

(c) cell which undergoes meiosis I and meiosis II.

(ii) State what is seminal plasma. Mention two constituents of seminal plasma. How is it different from semen?

OR

(B) (i) Mention the event that induces the completion of the meiotic division of the secondary oocyte in humans.

(ii) Trace the journey of the zygote until its implantation inside the uterus.

Outside Delhi Set– 3 **57/2/3**

Note: Except these, all other questions are available in Outside Delhi – Set 1 + 2.

SECTION – A

Question Nos. **1, 2, 4** and **6** are Multiple Choice type Questions, carrying **1** mark each.

1. Some flowers are unisexual, this property of unisexuality of flowers prevents which kind of pollination?

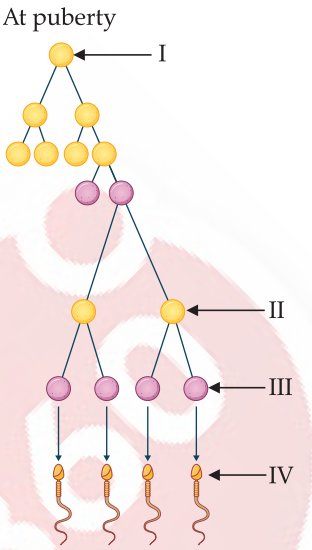
(A) Both Autogamy and Geitonogamy

(B) Both Geitonogamy and Xenogamy

(C) Geitonogamy but not Xenogamy

(D) Autogamy but not Geitonogamy

2. Given below is the schematic representation of spermatogenesis in human males:



Choose the option that shows the correct labelling of 'I', 'II', 'III' and 'IV' in the given diagram.

	I	II	III	IV
(A)	spermatozoa	spermatid	sec. spermatocyte	spermatogonia
(B)	spermatid	spermatogonia	sec. spermatocyte	spermatozoa
(C)	spermatogonia	sec. spermatocyte	spermatozoa	spermatid
(D)	spermatogonia	sec. spermatocyte	spermatid	spermatozoa

4. In molecular biology, who proposed that genetic information flows in one direction?

(A) Hargobind Khorana

(B) Francis Crick

(C) Watson and Crick

(D) Marshall Nirenberg

6. Which of the following features correctly show the mechanism of sex-determination in honey-bees?

(i) A zygote formed from the union of a sperm and an egg develops into a male.

(ii) Males have half the number of chromosomes as that of females.

(iii) The females are diploid having 32 chromosomes.

(iv) Males have a father and can produce sons.

Choose the correct option:

(A) (i) and (ii) **(B)** (ii) and (iii)

(C) (i) and (iv) **(D)** (ii) and (iv)

SECTION – B

20. (a) Write the scientific name of the source organism of the thermostable DNA polymerase used in PCR.

(b) State the advantage of using thermostable DNA polymerase.

21. State the conclusions derived by David Tilman's long term ecosystem experiments using outdoor plots.

SECTION – C

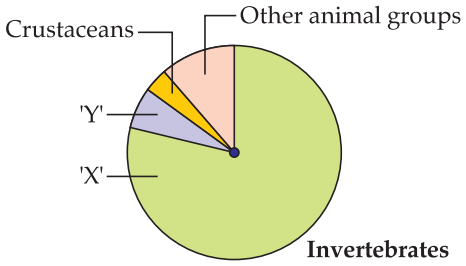
27. An application of biotechnology in agriculture involves the production of pest resistant plants, using "cry" gene from a bacterium, *Bacillus thuringiensis*.

(a) Proteins coded by which specific Bt. toxin gene control corn borer?

(b) How does Bt. toxin produced by the bacterium kill the insect? Explain.

28. Study the pie chart given below, representing the global biodiversity and proportionate number of

species of major taxa.



Answer the following questions:

(a) Identify 'X' and 'Y' in the given pie chart.

(b) Which one of the two 'X' or 'Y', is the most species-rich taxonomic group and by what percentage?

(c) Name the level of Biodiversity represented by the following:

(i) Estuaries and alpine meadows in India.

(ii) The medicinal plant *Rauwolfia vomitoria*.

SECTION – E

31. Student to attempt **either** option – (A) or (B).

(A) (i) Give a schematic representation of oogenesis in human females.

(ii) Mention the number of chromosomes at each stage. Correlate the life phases of the individual with the stages of the process.

OR

(B) (i) Describe the three types of pollination that can occur in a chasmogamous bisexual flower.

(ii) Draw the diagram of a mature pollen grain released at the two celled stage and label four parts in it.

■■

OSWAAL 360

ANSWERS

Delhi Set– 1 **57/1/1**

SECTION – A

1. Option (C) is correct.

Explanation: Colour blindness is an X-linked recessive disorder.

The man's, colour-blind father (X^cY) passes his X^c chromosome only to his daughters, not his son; therefore, the son is not color-blind. The woman's mother is colour-blind (X^cX^c), and her father is normal (XY), making her a carrier (XX^c).

The possible offspring in given case

XY (father) × XX^c (mother)

- **Sons:** 50% XY (normal), 50% X^cY (colour-blind)
- **Daughters:** 50% XX^c (carrier), 50% XX (normal)

2. Option (D) is correct.

Explanation: GEAC stands for Genetic Engineering Appraisal Committee (formerly known as Genetic Engineering Approval Committee). It responsible for approving genetically modified organisms (GMOs) in India. It ensures safety regulations in biotechnology and environmental protection.

3. Option (B) is correct.

Explanation: Ladybird beetles are natural predators of aphids, which are common plant pests. Mycorrhiza is a symbiotic association between fungi and plant roots. The genus *Glomus* is a common mycorrhizal fungus that helps plants absorb nutrients. *Trichoderma* is a fungus used as a biocontrol agent to suppress plant pathogens. *Methanobacterium* is a methane-producing (methanogenic) bacterium found in anaerobic digesters, essential for biogas production.

4. Option (A) is correct.

Explanation: Mineralisation is the process by which microorganisms break down organic matter in humus, releasing inorganic nutrients like nitrogen, phosphorus, and sulfur into the soil.

5. Option (D) is correct.

Explanation: Cell-mediated immunity (CMI), controlled by T-lymphocytes, is responsible for organ rejection. The body detects the transplanted organ as foreign and attacks it. Immunosuppressants like cyclosporine are used to prevent rejection.

6. Option (A) is correct.

Explanation: Trophoblast is the outer layer of the blastocyst, which later contributes to the formation of the placenta. Implantation is the process where the blastocyst embeds itself into the endometrium of the uterus for further development. Inner cell mass consists of a group of cells inside the blastocyst that later differentiate into the embryo proper. Morula is an early stage embryo consisting of 8 —16 blastomeres formed by cleavage of the zygote before the blastocyst stage.

7. Option (B) is correct.

Explanation: P is zygote, a fertilised egg.

Q is suspensor that pushes the embryo into the nutrient-rich endosperm.

R are cotyledons – The first seed leaves store food for the growing embryo.

S is plumule, the embryonic stem tip, which later develops into the main stem.

8. Option (C) is correct.

Explanation: In Polymerase Chain Reaction (PCR), the target DNA sequence is amplified exponentially. Each PCR cycle doubles the number of DNA molecules. After 30—40 cycles, the amplification can reach up to 1 billion times (10^9) the initial DNA template.

9. Option (B) is correct.

Explanation: The given coding strand of DNA is: 5′ – AATGCTAGGCAC – 3′

The template strand (complementary to the coding strand) would be: 3′ – TTACGATCCGTG – 5′

mRNA is transcribed using the template strand, following base-pairing rules: A → U, T → A, C → G, G → C

Therefore, the transcribed mRNA sequence (complementary to the template strand) will be:

5′ – AAUGCUAGGCAC – 3′

10. Option (B) is correct.

Explanation: Each microspore mother cell (MMC) undergoes meiosis, producing four pollen grains. So, 50 MMCs → 200 pollen grains. Each megaspore mother cell (MMC) produces four megaspores, but only one functional megaspore develops into an ovule. So, 50 MMCs → 50 ovules.

11. Option (B) is correct.

Explanation: *Australopithecines* were the first bipedal primates. *Homo erectus* evolved next, showing better brain development and tool use. *Neanderthals* were early *Homo sapiens* with a robust body and cultural advancements. *Homo sapiens* (modern humans) evolved with advanced cognition and social structure

12. Option (A) is correct.

Explanation: RNA interference (RNAi) is a gene-silencing mechanism that prevents the expression of specific genes by degrading their mRNA before translation. In genetically engineered tobacco plants, RNAi targets the *Meloidogyne incognita* nematode by producing double-stranded RNA (dsRNA) that is

complementary to the nematode's mRNA. This leads to mRNA degradation and prevents the synthesis of essential proteins, thereby inhibiting nematode survival.

13. Option (C) is correct.

Explanation: Saheli is a unique oral contraceptive pill that was developed in India. Unlike conventional steroidal contraceptive pills, Saheli contains Centchroman, which is a non-steroidal compound. It works by preventing implantation while allowing ovulation to occur. It was developed by Dr Nitya Anand and his team at Central Drug Research Institute (CDRI) Lucknow.

14. Option (A) is correct.

Explanation: The genetic code is said to be degenerate because multiple codons can code for the same amino acid. This property ensures that mutations in the third base of a codon (wobble hypothesis) do not always lead to a change in the amino acid sequence. For example, leucine (Leu) is coded by UUA, UUG, CUU, CUC, CUA and CUG.

15. Option (B) is correct.

Explanation: Bioreactors are vessels used for large-scale production of biological products such as enzymes, antibiotics and hormones. They provide controlled conditions such as temperature, pH, oxygen supply and nutrient availability to ensure optimal microbial or cell growth and product formation. Stirring-type bioreactors, also called stirred-tank bioreactors, are widely used due to their efficient mixing, aeration and ability to maintain uniform conditions throughout the culture medium. However, while stirring bioreactors are common, they are not the sole reason why bioreactors provide optimal conditions.

16. Option (C) is correct.

Explanation: When two genes are on the same chromosome (linked genes), parental gene combinations appear more frequently than recombinant types due to reduced chances of crossing over. However, higher parental gene combinations occur due to linkage, not crossing over. Crossing over increases recombinant types, not parental ones.

SECTION – B

17. (A) Morphine and heroin are opioid drugs derived from the poppy plant (*Papaver somniferum*).

Heroin (diacetylmorphine) is a chemically modified form of morphine, making it more potent.

- **Effects on the body:**
  - Act on the central nervous system (CNS) as depressants.
  - Induce euphoria, drowsiness, and pain relief but can lead to addiction and respiratory failure.

OR

(B) (i) Alcoholic beverages are produced by microbial fermentation of sugars using yeast ***(Saccharomyces cerevisiae).***

(1) With distillation: Whiskey, rum and vodka

(2) Without distillation: Beer and wine

(ii) Cyanobacteria (also called blue-green algae), such as *Anabaena* and *Nostoc*, act as bio-fertilisers by fixing atmospheric nitrogen into ammonia. They form symbiotic relationships with plants, enriching soil fertility, especially in rice paddies.

18. (A) Young forest will be more productive , as young trees grow actively that leads to rapid biomass accumulation.

Old natural forest is moderate productive, as the ecosystem is stable while shallow polluted lake has low productivity, as pollution reduces oxygen and nutrient availability.

OR

(B) Difference Between Gross Primary Productivity (GPP) and Net Primary Productivity (NPP)

Feature	(GPP)	(NPP)
Definition	Total amount of organic matter produced by photosynthesis	The actual amount of energy stored as biomass after respiration
Formula	GPP = NPP + Respiration (R)	NPP = GPP – Respiration (R)
Usage	Includes energy used for plant growth, reproduction, and maintenance	Only the energy used for new biomass formation
Represents	Total energy input into an ecosystem	Energy available for herbivores and decomposers

19. Abnormality 1: Klinefelter Syndrome (44+ XXY) – Extra X chromosome in males, causing tall height, weak muscles and low testosterone.

Abnormality 2: Turner Syndrome (44+X0) – Missing one X chromosome, leading to short stature and infertility in females.

20. (a) Possible genotypes:

- Individual 1 is I^Bi
- Individual 2 is I^Ai

(b) Individual 5– Blood group AB → antigen A and B both

Individual 8– Blood group O → No antigen

21. (A) A patient with ADA (Adenosine Deaminase) deficiency requires periodic infusion of genetically engineered lymphocytes because these cells have a limited lifespan and lymphocytes do not self-replicate indefinitely. The permanent cure is bone marrow transplant (if a suitable donor is available) or

gene therapy at the embryonic stage (before birth).

OR

(B) Direct gene transfer techniques: **(ANY TWO)**

- **Microinjection:** Directly injects DNA into the nucleus using a fine needle. Used in animal cells (e.g., transgenic mice).
- **Gene Gun Method (Biolistics):** DNA-coated gold or tungsten particles are shot into plant cells. Used in genetically modified crops (e.g., Bt cotton).
- **Electroporation:** Electric pulses, temporarily create pores in the cell membrane, allowing DNA to enter. Used in bacteria and mammalian cells.

SECTION – C

22. **(a)** A palindromic sequence is a DNA sequence that reads the same on both strands in opposite directions. For 5′ – GAATTC – 3′, the complementary strand would be: 3′ – CTTAAG – 5′

Thus, the palindromic sequence is:

5′ – GAATTC – 3′

3′ – CTTAAG – 5′

(b) The restriction enzyme that recognises this sequence is *EcoRI*. *EcoRI* is isolated from *Escherichia coli* and is widely used in genetic engineering.

(C) Sticky ends are produced when restriction enzymes cut DNA at specific recognition sites in a staggered manner, leaving short, single-stranded overhangs that can easily pair with complementary sequences.

- **Role of Sticky Ends in Genetic Engineering:** Sticky ends facilitate the precise joining of DNA fragments by complementary base pairing, enabling efficient gene cloning and recombinant DNA formation in genetic engineering.

23. **(a)** The infective stage of *Plasmodium* is called sporozoite. Sporozoites are injected into the human bloodstream by the bite of an infected female *Anopheles* mosquito.

(b) Fertilisation and development of *Plasmodium* occur inside the gut of the female *Anopheles* mosquito.

(c) P – Salivary gland of mosquito. It releases sporozoites into human body.

Q – Red blood cells in which gametocytes are developed.

(d) Asexual Phase – Occurs in the human. Sexual Phase – Occurs in the mosquito.

24. **(a) Indiscriminate human activities have accelerated biodiversity loss:**

(i) Alien Species Invasion: Non-native species outcompete native ones.
Example: *Eichhornia crassipes* (Water Hyacinth) introduced in Indian water bodies causes oxygen depletion and kills aquatic life.

(ii) Habitat Fragmentation: Divides ecosystems, isolating species.
Example: Amazon rainforest deforestation threatens species like jaguars and macaws.

(iii) Habitat Loss: Destruction of natural habitats reduces species survival.
Example: Palm oil plantations in Indonesia endanger orangutans.

(b) **(i) IUCN Red Data List**: It categorises species based on their risk of extinction. It helps in conservation planning and policy-making. It raises awareness about endangered species.

(ii) Hotspots in Conservation of Biodiversity: Biodiversity hotspots are regions with high species diversity but under threat. Conservation of these areas helps protect many endemic species.
Example: The Western Ghats and Indo-Burma region are biodiversity hotspots in India.

25. **(a)** Nucleosome (basic unit of chromatin)

(b)
- P – DNA wrapped around histones.
- Q – Histone core (H2A, H2B, H3, H4).

(c) Histone proteins are basic, positively charged proteins that play a crucial role in DNA packaging within eukaryotic cells.

(d) Difference between euchromatin and heterochromatin

Feature	Euchromatin	Heterochromatin
Definition	Loosely packed form of chromatin that is transcriptionally active.	Tightly packed chromatin that is transcriptionally inactive.
Appearance	Lightly stained in microscopic observations (less dense).	Darkly stained in microscopic observations (highly condensed).
Function	Allows gene transcription and expression.	Mainly involved in structural support and gene regulation.
Examples	Genes involved in cellular functions like protein synthesis.	Centromeric and telomeric DNA, Barr body (inactivated X chromosome in females).

26. **(a)** One method to test for genetic disorders in the fetus is amniocentesis. This is a prenatal diagnostic procedure where a small amount of amniotic fluid is extracted from the mother's uterus using a thin needle. The fluid contains fetal cells, which can be analysed for chromosomal abnormalities like Down's syndrome or genetic mutations causing cystic fibrosis. This test is typically performed between the 15^{th} and 20^{th} week of pregnancy.

(b) If the fetus is diagnosed with severe genetic abnormalities that may pose risks to the baby's survival or Radha's health, medical termination of pregnancy (MTP) can be considered. However, since Radha is in her second month (approximately 8 weeks) of pregnancy, termination is legally and medically possible under the Medical Termination

of Pregnancy (MTP) Act in India. MTP at 8 weeks of pregnancy is generally considered safe for the mother when performed under medical supervision, therefore its safe for Radha. Early-stage abortion (up to 9 weeks) is usually done using medication (medical abortion) or a minor surgical procedure.

(c) The process of medical termination of pregnancy (MTP) is illegal if:

(i) Sex-selective abortion is performed (banned under the PCPNDT Act in India).

(ii) The pregnancy has crossed 24 weeks and is not life-threatening for the mother.

(iii) The abortion is done without the mother's informed consent.

(iv) The pregnancy does not pose any serious risk to the mother or fetus, and the termination is sought for non-medical reasons.

(v) It is performed by an unauthorised person or outside a registered medical facility.

27. Principle of Gel Electrophoresis: Gel electrophoresis is a technique used to separate DNA, RNA, or proteins based on their size and charge using an electric field. DNA fragments move through an agarose gel from the negative (cathode) to the positive (anode) end because DNA is negatively charged. Smaller fragments travel faster and farther than larger ones, allowing separation based on size.

Uses of Gel Electrophoresis:

(i) DNA Fingerprinting: Used in forensic investigations to identify individuals based on unique DNA patterns.

(ii) Genetic Disease Diagnosis: Helps detect genetic mutations and inherited disorders by analysing variations in DNA sequences.

28. Difference between convergent and divergent evolution.

Feature	Convergent Evolution	Divergent Evolution
Definition	Unrelated species evolve similar traits due to similar environments.	A common ancestor gives rise to species with different traits over time.
Cause	Similar selective pressures in the environment.	Different environmental conditions or adaptive needs.
Example	Wings in bats and birds (both used for flying but evolved independently).	Darwin's finches (different beak shapes evolved from a common ancestor due to different diets).
Type of Structures	Analogous structures (different origin, same function).	Homologous structures (same origin, different functions).

SECTION – D

29. Given graphs represent hormonal regulation in menstrual cycle

(a) • In Case 1 and 2, the peak represents the Luteinizing Hormone (LH).

Function of LH: LH triggers ovulation (release of the egg) from the Graafian follicle around the 14^{th} day of the cycle. It also stimulates the transformation of the ruptured follicle into the corpus luteum.

(b) The follicular phase occurs from Day 6 to Day 14 of the menstrual cycle.

(i) Ovarian Changes:

- FSH (Follicle Stimulating Hormone) stimulates follicular growth.
- The primary follicle matures into a Graafian follicle.
- Estrogen secretion increases, leading to a surge in LH just before ovulation.

(ii) Uterine Changes:

- Endometrial lining thickens due to rising estrogen levels.
- Increased vascularisation occurs to prepare for potential implantation of embryo after fertilisation.

(c) • Hormone Q in case 2 is progesterone.

- **Function:** It maintains the endometrial lining, ensuring the uterus is suitable for embryo implantation and growth.

OR

(d) Corpus luteum remains functional in Case 2.

- **Formation:** After ovulation, the ruptured Graafian follicle transforms into the corpus luteum under the influence of LH. The corpus luteum secretes progesterone, which is essential for maintaining pregnancy. If fertilisation does not occur, the corpus luteum degenerates, leading to a drop in progesterone and the onset of menstruation.

30. (a) Monarch Butterfly and Chemical Defense

- The larva of monarch butterflies feed on milkweed plants, which contain toxic cardiac glycosides.

  This toxins accumulate in their body, making them distasteful to predators (chemical defense).

(b) Population Density Calculation

Given Data:

- Population density (N) at t+1 = 800
- Emigration (E) = 100
- Immigration (I) = 200
- Natality (birth rate) (B) = 200
- Mortality (death rate) (D) = 150

Formula:

$N_{(t)} + (B + I) - (D + E) = N_{(t+1)}$

$N_{(t)} + (200 + 200) - (150 + 100) = 800$

$N_{(t)} + 400 - 250 = 800$

$N_{(t)} = 650$

Population Density at t = 650.

Type of Age Pyramid:

- Since birth rate > death rate, the population is increasing, forming an expanding age pyramid or upright pyramid.

  This is wide at the base, indicating a higher proportion of young individuals.

(c) The method of measuring population density differs based on the organism's size and distribution.

- For carrot grass, which consists of many small plants, numerical density is used, calculated as the number of individuals per unit area (e.g., 200 plants per square meter).
- In contrast, a single huge banyan tree is better measured using canopy cover or biomass density. – Instead of counting individuals, scientists measure the area covered by its branches and roots.

OR

(d) (i) Camera Trapping Method

- **Process:** Infrared motion-sensor cameras are placed in tiger habitats. When a tiger moves in front of the camera, it automatically captures images. Each tiger has a unique stripe pattern, allowing scientists to identify and count them.

(ii) Pugmark Analysis (Footprint Identification Method)

- **Process:** Tigers leave unique footprints (pugmarks) on soft soil or mud. Wildlife researchers collect plaster casts of pugmarks and analyse their size, shape and pattern to estimate the number of individuals.

SECTION – E

31. (A) (i) MALT – Mucosa-Associated Lymphoid Tissue

- MALT is a collection of lymphoid tissue in mucosal linings.
- Found in the respiratory tract, gut (Peyer's patches) and urogenital tract.
- Provides local immunity against pathogens.

(ii) Cytokine Barriers in Immunity:

- Cytokines are signaling proteins released by immune cells.
- **Example:** Interferons released by virus-infected cells prevent viral replication in nearby cells.

(iii) AIDS Diagnostic Test:

- ELISA (Enzyme-Linked Immunosorbent Assay).
- **Principle:** Detects HIV antibodies in blood using an antigen-antibody reaction.

(iv) Role of Bone Marrow and Thymus in Immunity:

- **Bone Marrow:** B-cells are produced in the bone marrow, they also mature there before migrating to lymphoid tissues to initiate immune responses.
- **Thymus:** Site of T-cell maturation, helps in adaptive immunity.

OR

(B) (i) H- *Clostridium butyricum*, I- Bacterium

J- Statin, K- Fungi

L- *Trichoderma polysporum*, M- Immunosuppressive drug

(ii) Baculoviruses as Biocontrol Agents:

- Example Nuclear Polyhedrosis Virus (NPV) is a well-known baculovirus used to control pests like *Helicoverpa armigera* (cotton bollworm).
- Baculoviruses infect target insect pests when ingested, replicate inside their cells, cause tissue breakdown, and ultimately kill the host.
- Infect only specific insect pests, leaving beneficial insects unharmed.
- Eco-friendly alternative to chemical pesticides.

32. (A) (a) A mature male gametophyte (pollen grain) of an angiosperm contains two cells: generative cell and vegetative cell. Following is the difference between these two.

Feature	Generative Cell	Vegetative Cell
Function	Divides to form two male gametes (sperm cells) for fertilisation.	Helps in pollen tube formation for gamete transport.
Size	Smaller and spindle-shaped.	Larger and irregular in shape.
Cytoplasm	Dense cytoplasm with a nucleus.	Abundant cytoplasm with a large nucleus.
Fate	Undergoes mitotic division to form two sperm cells.	Does not divide; degenerates after pollen tube formation.

(b) (i) Pollen transfer methods:

- Method 1 → Autogamy (Self-pollination)
- Method 2 → Geitonogamy (Pollination between flowers of the same plant)
- Method 3 → Xenogamy (Cross-pollination between different plants)

(ii) (a) Water Lily (*Nymphaea*) – Entomophily (Insect Pollination):

- Pollinated by insects like bees and beetles.
- Insects transfer pollen while visiting flowers for nectar.

(b) *Vallisneria* – Hydrophily (Water Pollination):

- Male flowers Or pollen grains detach and float on water surface.
- Water currents carry pollen to the female flowers.

(iii) Advantages of pollen transfer in method 3 (Xenogamy – Cross-pollination):

- **Genetic Variation** – Leads to stronger offspring with better adaptability.
- **Disease Resistance** – Reduces risk of hereditary diseases.

- **Improved Yield** – Produces healthier seeds with better survival chances.

OR

(B) (i) Sperm P: This sperm appears to be in the process of penetrating the zona pellucida, the outer layer of the ovum (egg). It is likely that sperm P will successfully fertilise the ovum.

Sperm Q: This sperm is located among the cells of the corona radiata, which encircle the zona pellucida. It is likely that sperm Q will eventually reach the zona pellucida and attempt to fertilise it.

Sperm R: This sperm is outside the corona radiata. Sperm R may reach the ovum, but it might fail to penetrate and fertilise the egg.

(ii) Role of Zona Pellucida in fertilisation:

The zona pellucida facilitates species-specific sperm binding and prevents polyspermy by preventing entry of other sperms after one sperm enters.

(iii) Changes in the ovum after sperm entry:

Zona pellucida hardens to prevent multiple sperm entry.

Completion of meiosis II: The secondary oocyte completes meiosis, forming the ovum and second polar body.

Formation of male and female pronuclei: The sperm nucleus decondenses and fuses with the female nucleus.

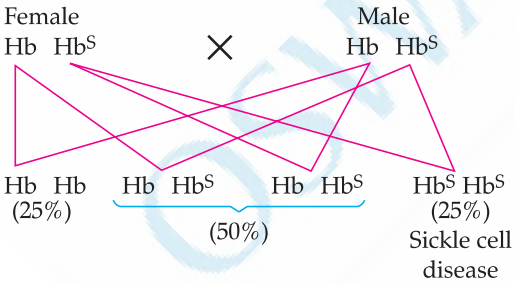
(iv) Role of acrosome and middle piece in fertilisation:

Acrosome: Contains enzymes (hyaluronidase, acrosin) that digest the zona pellucida for sperm entry.

Middle Piece: Contains mitochondria, providing ATP for sperm motility, enabling it to reach the ovum.

33. (A) Sickle cell anemia is an autosomal recessive disorder, requiring two copies of the Hb^S gene for the disease to manifest, and it is not linked to sex chromosomes.

(i) Sickle Cell Carrier Cross and F_1 Ratio



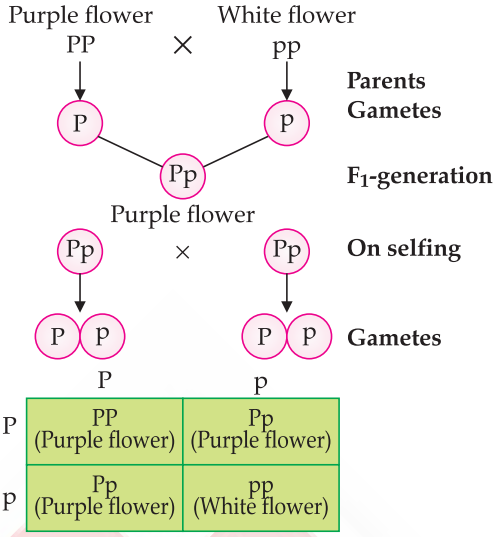
- Carrier- 50%, Disease free- 25%, Diseased individuals- 25%
- Ratio- 2: 1: 1

Mutation in Sickle Cell Anaemia:

Base substitution of Glutamic acid (GAG) to Valine (GUG) at the 6th codon of β-globin gene. This causes RBCs to form sickle shapes, leading to oxygen transport issues.

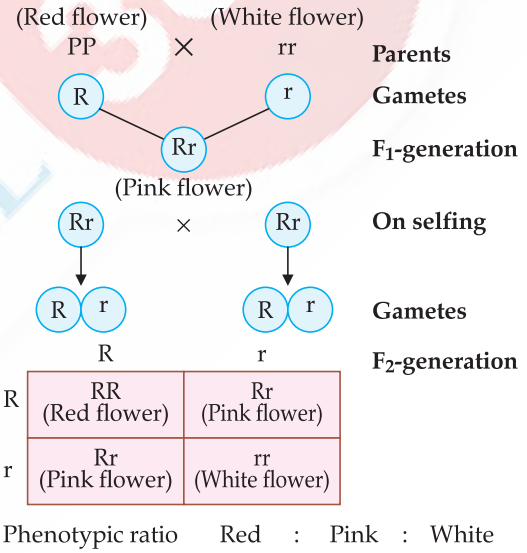
(ii) Flower Colour Inheritance – Pea vs Snapdragon

- In pea plants, flower color follows Mendelian inheritance, where purple flowers are dominant over white flowers.



Phenotypic ratio	Purple	:	White	
	3	:	1	
Genotypic ratio	PP	:	Pp	: pp
	1	:	2	: 1

- In snapdragons, flower color follows incomplete dominance, where crossing red (RR) and white (rr) plants produces pink (Rr) offspring in F_1.



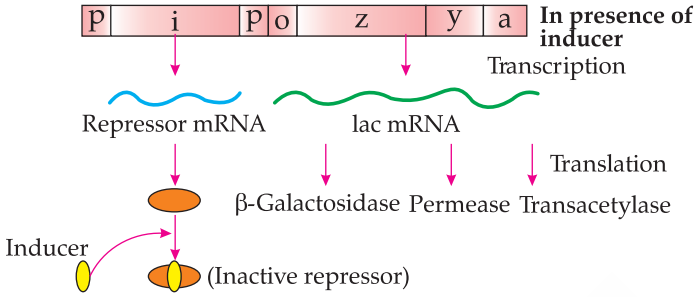
Phenotypic ratio	Red	:	Pink	:	White
	1	:	2	:	1
Genotypic ratio	RR	:	Rr	:	rr
	1	:	2	:	1

OR

(B) Regulation of the lac operon in *E. coli* (i) Presence of Lactose (inducer) -Operon is ON

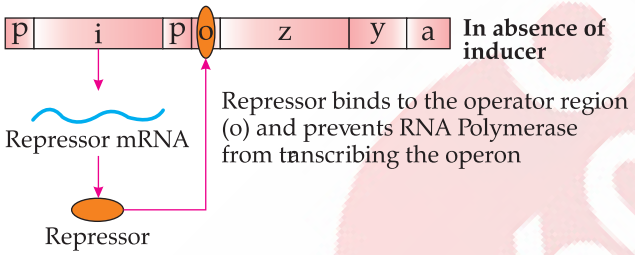
- Lactose (inducer) binds to the repressor protein (LacI), inactivating it.
- This allows RNA polymerase to bind to the promoter and transcribe the lac operon genes.
- LacZ, LacY and LacA genes produce enzymes to digest lactose:

- LacZ: β-galactosidase (breaks lactose into glucose + galactose).
- LacY: Permease (transports lactose into the cell).
- LacA: Transacetylase (function unclear).



(ii) Absence of Lactose (inducer) -Operon is OFF

- Repressor (LacI) binds to the operator region, blocking RNA polymerase.
- No transcription of lac genes, so no enzyme production.



Delhi Set– 2 **57/1/2**

SECTION – A

1. Option (A) is correct.

Explanation: Lignin and chitin are complex, tough-to-decompose substances, while sugar and nitrogen-rich materials decompose faster. Since Soil A has higher lignin (40%) and chitin (45%), it resists decomposition. Soil B, with lower lignin (5%) and higher nitrogen (45%), decomposes faster.

2. Option (C) is correct.

Explanation: The pollen grain's diameter varies among plant species, but generally, it ranges between 25 to 50 micrometers in size.

3. Option (C) is correct.

Explanation: The menstrual cycle consists of the following phases in order:

- Menstrual phase (shedding of the uterine lining)
- Follicular phase (primary follicle in the ovary grows into a fully mature Graafian follicle): Maximum oestrogen level.
- Ovulatory phase (release of an egg due to the rupture of the Graafian follicle): LH and FSH levels peak
- Luteal phase (cells of ruptured Graafian follicle enlarge and form golden coloured corpus luteum and secretes progesterone. If the ovum is not fertilised, the corpus luteum degenerates into the corpus albicans, a white mass, and the progesterone level decreases).

4. Option (D) is correct.

Explanation: A dihybrid cross follows a 9:3:3:1 phenotypic ratio and 1:2:1:2:4:1:2:2:1 genotypic ratio in the F_2 generation, meaning there are:

- 4 phenotypes (different physical traits)
- 9 genotypes (genetic combinations)

13. Option (B) is correct.

Explanation: Perisperm is indeed diploid as it originates from the nucellus, a diploid maternal tissue.

The nucellus is used up during embryo development; however, in some cases, it persists, which is unrelated to its ploidy.

14. Option (C) is correct

Explanation: Fleming discovered that *Penicillium notatum* inhibited bacterial growth, leading to the discovery of penicillin. However, commercial extraction and large-scale production of penicillin were done by Howard Florey and Ernst Boris Chain, not Fleming.

SECTION – B

17. Cross I Analysis:

- **Gametes involved:**
  - Mother (44 + XX) produces abnormal (23 + X) and (21 + X) gametes.
  - Father (44 + XY) produces normal (22 + X) and (22 + Y) gametes.
- **Resulting Offspring:**
  - (23 + X) + (22 + X) = (45 + XX) → Autosomal trisomy (such as Down Syndrome)

- **Abnormality 1:** Autosomal trisomy such as Down syndrome (45 + XX)

Cross II Analysis:

- **Gametes involved:**
  - Mother (44 + XX) produces (22 + XX) and tr. (22 + O) (O means no sex chromosome).
  - Father (44 + XY) produces normal (22 + X) and (22 + Y) gametes.
- **Resulting Offspring:**
  - (22 + XX) + (22 + Y) = (44 + XXY) → Klinefelter syndrome
- **Abnormality 2:** Klinefelter syndrome

Distinguishing between the two conditions:

Condition	Karyotype	Cause	Features
Down Syndrome	45, XX	Trisomy of 21 chromosome	Short stature, furrowed tongue, broad palm, mentally retarded.
Klinefelter Syndrome	47, XXY	Trisomy X(sex chromosome)	Taller height, learning difficulties, underdeveloped genitalia

18. Pedigree Analysis of Myotonic Dystrophy:

(a) Writing the Genotype of A, B, C and D:

- Myotonic dystrophy is an autosomal dominant disorder, meaning affected individuals must have at least one dominant allele (D).
- Unaffected individuals must be homozygous recessive (dd).

Individual	Affected Status	Possible Genotype
A (Mother)	Affected	Dd
B (Father)	Unaffected	dd
C (Affected Male Child)	Affected	Dd
D (Unaffected Female Child)	Unaffected	dd

(b) Identifying the Trait Type

(i) The trait is present in both male and female offspring in roughly equal proportions in the first generation. This indicates it is an autosomal disorder rather than sex-linked.

(ii) The disorder appears in every generation, which is a characteristic of dominant inheritance. Heterozygous individuals (Dd) are affected, showing that the disease is autosomal dominant.

SECTION – C

22. (a) Importance of 'ori' and 'rop' in the *E. coli* Cloning Vector (pBR322):

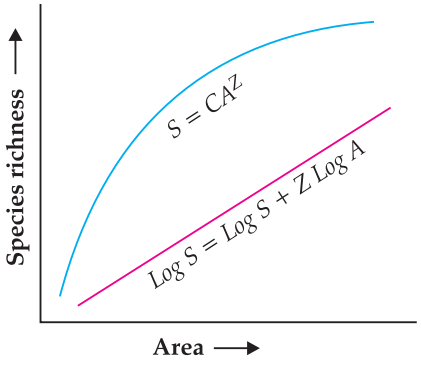
- **'ori' (Origin of Replication):**
  - It is the unique sequence of nitrogenous bases where replication of vector DNA molecule starts.
  - It serves as the binding site for initiator protein (helicase) enzyme that starts replication.
  - It controls the copy number of recombinant DNA.
  - A high-copy-number plasmid allows more gene expression, whereas a low-copy-number plasmid is used for controlled gene expression.
- **'rop' (Repressor of Primer):**
  - It regulates the replication of the plasmid by controlling the formation of RNA primers.
  - It ensures low copy numbers of the plasmid in the host cell to maintain stability and expression of any gene it carries.
  - If 'rop' is absent, the plasmid copies number increases in the host cell.

(b) Difference Between Exonucleases and Endonucleases

Feature	Exonuclease	Endonuclease
Cleavage Site	Removes nucleotides from the ends of DNA/ RNA.	Cuts DNA within the strand at specific sites.
Requirement of Free Ends	Requires free 3′ or 5′ ends(in one strand of duplex)	Does not require free ends; and involve only one or both strands of the DNA duplex.
Mode of Action	Progressively removes nucleotides one by one.	Cuts at specific recognition sequences.
Example	DNA polymerase I (has exonuclease activity).	EcoRI, HindIII, BamHI (restriction enzymes).

23. (a) Graph and Equation

The relationship between species richness (S) and explored area (A), as observed by Alexander Von Humboldt, follows a logarithmic pattern. The graph is a species-area curve, which shows that species richness increases with the explored area but at a decreasing rate.



The equation for this relationship is:

$S = CA^Z$

Where:

- S = Species richness
- C = A constant (specific to the ecosystem)
- A = Area explored
- Z = Regression coefficient (slope of the log—log graph)

Graph Representation

The curve starts steep but levels off as the area increases, indicating a saturation point where adding more area results in a negligible increase in species richness.

(b) Various Values of Z (Regression Coefficient)

The value of Z varies depending on the type of ecosystem:

Ecosystem Type	Value of Z
Small areas within a single region (e.g., a forest)	0.1 – 0.2
Large areas across a continent	0.6 – 1.2
Entire continents (Fruit eating birds and mammals in the tropical forests)	~1.15 (approaching 1)

- When Z is between 0.1 and 0.2, the species richness increases gradually with area.
- When Z is around 0.6 – 1.2, species richness increases rapidly for a large area.
- When Z approaches 1, it indicates high species turnover across different regions.

SECTION – E

33 (A) (i) Haemophilia and red-green colour blindness are **X-linked recessive disorders.** Males have **one X chromosome (XY),** so if they inherit a defective gene from their mother (because the X-chromosome in males come from mother) they will express the disorder as there is no corresponding allele in the Y chromosome. Females have **two X chromosomes (XX),** so they need two defective copies to show the disorder, making it **less common in females,** that is females can be carriers (heterozygous condition), normal or show the disease (homozygous recessive).

(ii) Cross for equal production of haemophilic daughters and sons

- Let X^H = Normal allele, X^h = Haemophilia allele
- Consider a cross between a carrier mother (X^HX^h) and a haemophilic father (X^hY)

Parental Genotypes:	X^HX^h (Carrier Female) × X^hY (Haemophilic Male)
Gametes:	X^H, X^h, X^h, Y

Punnett Square

	X^h	Y
X^H	X^HX^h (Carrier Daughter)	X^HY (Normal Son)
X^h	X^hX^h (Haemophilic Daughter)	X^hY (Haemophilic Son)

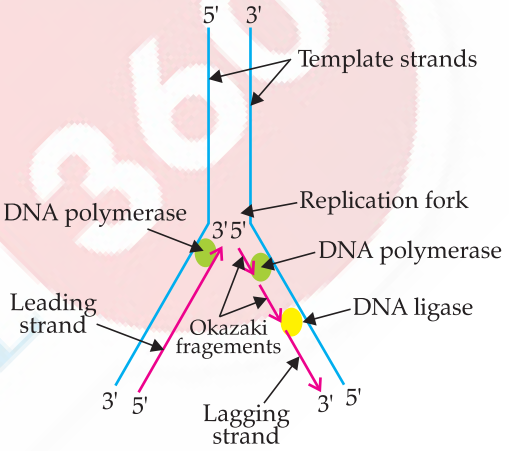
- Ratio: 1 Haemophilic Daughter : 1 Haemophilic Son

OR

(B) (i) Bacteria (Prokaryotes): Transcription and Translation occur simultaneously in the cytoplasm.

Eukaryotes: Transcription occurs in the nucleus. Translation occurs in the cytoplasm, when mRNA (that is transcribed as hnRNA in the nucleus) binds to ribosomes.

(ii) Labelled schematic sketch of the replication fork



(iii) DNA Nucleotide Calculation

- Total nucleotides = 1000
- Adenine (A) = 240
- Thymine (T) = 240 (A pairs with T)
- Cytosine (C) + Guanine (G) = Remaining nucleotides

  $C + G = 1000 - (A+T) = 1000 - 480 = 520$
- Pyrimidines (Cytosine + Thymine)

  $Pyrimidines = T + C = 240 + 260 = 500$

Delhi Set– 3 **57/1/3**

SECTION – A

1. Option (C) is correct.

Explanation: An inverted pyramid of biomass occurs when the biomass of higher trophic levels exceeds that of lower trophic levels. In this case, the primary producer has 10g of biomass, while the primary consumer has 60g, and the secondary consumer has 120g. This suggests that the secondary consumers, which are typically larger or more numerous, are consuming a larger amount of biomass than what is available from the producers, leading to an unusual, inverted relationship in terms of biomass distribution.

2. Option (D) is correct.

Explanation: Flowers with a single ovule in the ovary and packed in an inflorescence are often

wind-pollinated. These flowers typically produce a large amount of pollen, which is lightweight and easily carried by the wind to other flowers. The single ovule ensures that only one seed will develop after pollination, and the crowded arrangement in an inflorescence increases the chances of successful wind pollination. Examples of such plants include grasses and many trees like pines.

6. Option (D) is correct.

Explanation: In non-endospermic seeds, the endosperm is completely consumed during seed development, and the food reserves are stored in the cotyledons (seed leaves). Examples: peas and groundnut. Maize and castor are endospermic seeds.

12. Option (D) is correct.

Explanation: The plant with genotype YyRr produces 4 types of gametes, which are YR: Yr: yR:yr. The double recessive plant has genotype yyrr and produces only one type of gamete with genotype yr. When crosses, it gives a 1:1:1:1 phenotypic and genotypic ratio.

Parents: YyRr x yyrr

	YR	Yr	yR	yr
yr	YyRr	Yyrr	yyRr	yyrr

13. Option (A) is correct.

Explanation: Assertion (A) is correct because mammary glands secrete milk to nourish the young ones. Reason (R) is also correct, as mammary glands are modified sweat glands, having evolved from sweat glands to produce milk. Both the assertion and reason are related, as the mammary glands share a common origin with sweat glands but have specialised to secrete milk instead of sweat.

14. Option (C) is correct.

Explanation: Assertion (A) is correct. Scaffold proteins are non-histone chromosomal proteins that help in organising and stabilising the structure of chromosomes.

Reason (R) is incorrect. Scaffold proteins are not particularly rich in lysine and arginine. Instead, they are typically rich in other amino acids like proline and glutamine, which help in forming the scaffold structure.

SECTION – B

17. (A) Genotype of c: homozygous recessive (aa)

Genotype of d: Heterozygous ressecive (carrier) or Homozygous dominent (Unaffected) (Aa or AA)

(B) (i) Autosomal: Since the unaffected father in the parental generation has an affected daughter, it is autosomal. The sex-linked trait requires the affected father to have an affected daughter.

(ii) Recessive: The trait skips a generation, and normal appearing parents have an affected son and daughter; the trait is recessive.

18. Offspring 1: It has genotype 44 + XO. The abnormality is called Turner syndrome.

Offspring 2: They have genotypes 45+XY and 45+XX. The abnormality is called autosomal trisomy.

Difference:

- Turner Syndrome is caused by monosomy of the X chromosome, while autosomal trisomy refers to the presence of an extra chromosome in one of the autosomal pairs, such as Trisomy 21 (Down syndrome), where there are three copies of chromosome 21.
- Turner Syndrome affects females only, while autosomal trisomy affects both males and females.
- In Turner Syndrome, individuals may have short stature, infertility, heart defects, and learning difficulties. In Autosomal Trisomy, features depend on the specific trisomy but may include intellectual disability, facial abnormalities, and other organ-related issues (e.g., Down syndrome has distinct facial features and intellectual impairment).
- In Turner Syndrome, failure of nondisjunction of sex chromosomes results in a missing X chromosome, while in autosomal trisomy, the failure of nondisjunction leads to an extra chromosome, such as an additional copy of chromosome 21 in Down syndrome.

27. (A) Colombia has more species diversity than Greenland. This is because Colombia is located in the tropical zone, while Greenland is in the Arctic and subarctic zones. Tropical environments are less seasonal, relatively more constant, and predictable. Such constant environments promote niche specialisation and lead to greater species diversity. More solar energy is available in the tropics, which contributes to higher productivity, which might contribute indirectly to greater diversity. In contrast, Greenland has a harsh, cold climate with limited vegetation and fewer habitats, resulting in lower species diversity.

(B) Paul Ehrlich proposed the "Rivet Popper Hypothesis" to emphasise the importance of biodiversity in maintaining the stability of ecosystems.

He compared ecosystems to an airplane and the species within the ecosystem to rivets holding the airplane together. According to this concept, each species has a specific role in maintaining the stability and functioning of an ecosystem, just as each rivet is important to the structure of the airplane.

If too many species (rivets) are lost, the ecosystem can become unstable, and eventually, it may collapse,

similar to how an airplane might fail if too many rivets are removed. Therefore, even though some species might seem less important, the overall loss of species can lead to significant ecological disruptions.

So, Ehrlich's hypothesis highlights that every species is important for the overall health and function of an ecosystem, and the loss of species can jeopardise the ecological balance, leading to environmental degradation.

28. (A) Difference between Recombinant DNA and cDNA:

Recombinant DNA refers to a DNA molecule that is artificially created by combining DNA from different sources, often through the use of restriction enzymes and ligases. This DNA contains genes or sequences from different organisms.

cDNA (complementary DNA) is synthesised from an mRNA template through the process of reverse transcription. cDNA represents only the expressed genes (mRNA), lacking introns, and is used to study gene expression.

(B) Method to Increase Competency of Bacterial Cell Membrane to Take Up Recombinant DNA:

To increase the competency of bacterial cells (such as *E. coli*) to take up recombinant DNA, the calcium chloride method is commonly used. In this method, bacterial cells are treated with a cold calcium chloride solution, which makes the cell membrane more permeable. This treatment allows the cells to take up foreign DNA more easily during a heat shock, which helps in the transformation process. Another method is electroporation, where an electric field is applied to create temporary pores in the cell membrane to allow DNA entry.

SECTION – E

31. (A) (i) To determine the genotype of a pea plant with axial flowers and violet colour, a test cross is performed. The unknown genotype plant (with axial flowers and violet colour) is crossed with a homozygous recessive pea plant having terminal flowers and white colour. The genotype of the recessive plant is aa bb.

Let us assume that alleles A and a determine the position of the flower while alleles B and b determine the flower colour. For the pea plant, axial flowers (A) are dominant over terminal flowers (a), and violet flowers (B) are dominant over white flowers (b).

So, the unknown plant could either be homozygous dominant (AA BB) or heterozygous (Aa Bb).

Possible Outcomes:

- If the unknown plant is AA BB (homozygous dominant): The homozygous dominant pea plant and homozygous recessive pea plant will form only one type of gamete. All offspring will show axial, violet flowers in F_1 generation, as the dominant alleles will be inherited.

Parents: AABB X aabb

Gametes: AB x ab

	AB
Ab	AaBb Axial, violet flowers

- If the unknown plant is Aa Bb (heterozygous): The heterozygous dominant pea plant will form four types of gametes (AB, Ab, aB, ab). The offspring will show a 1:1:1:1 phenotypic ratio for axial, violet flowers, Axial, white flower, Terminal, violet flower and terminal, white flowers.

Parents: AaBb x aabb

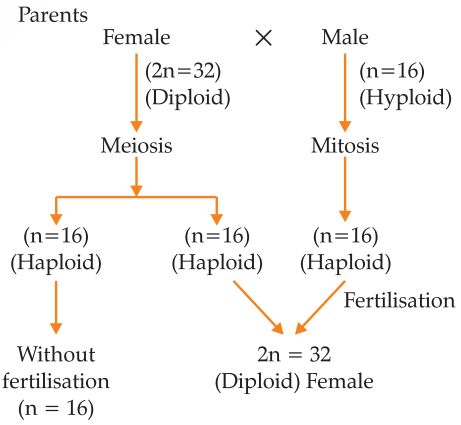
	AB	Ab	aB	ab
ab	AaBb Axial, violet flowers	Aabb Axial, white flowers	aaBb Terminal, violet flowers	aabb Terminal, white flowers

(ii) Haplodiploidy in Honey Bees refers to a sex determination system where the sex of an individual is determined by the number of sets of chromosomes it receives.

In honey bees:

- Females (queen and worker bees) are diploid (2 sets of chromosomes) and develop from fertilised eggs.
- Males (drones) are haploid (1 set of chromosomes) and develop from unfertilised eggs. This system ensures that males have only one set of chromosomes, inherited entirely from the queen, while females inherit two sets—one from the queen and one from a male drone.

Haplo-diploid sex determination system



OR

(B) DNA Fingerprinting involves the following key steps to compare DNA samples, such as blood samples R and S from a crime scene, to identify or match individuals.

- **Collection of DNA:** Blood samples R and S are collected from the crime scene and a suspect or other relevant source.
- **Extraction of DNA:** The DNA is extracted from the cells in the blood samples using chemical solutions that break open the cell membranes.
- **Cutting DNA with Restriction Enzymes:** The extracted DNA is treated with restriction enzymes, which act as molecular scissors to cut the DNA at specific sequences, creating fragments of different lengths.
- **Gel Electrophoresis:** The DNA fragments are separated based on size through gel electrophoresis, where an electric field is applied, causing smaller fragments to move faster through the gel and larger fragments to move slower.
- **Transfer and Hybridisation:** The separated DNA fragments are transferred to a membrane (a process known as Southern blotting). Probes, which are short sequences of DNA that are complementary to the repeated regions of the DNA, are used to bind to the specific fragments of interest.
- **Analysis of Banding Patterns:** The pattern of DNA bands formed by the probes is visualised and compared. The unique pattern of bands (DNA fingerprint) from samples R and S is analysed. If the banding patterns match, it suggests the samples are from the same individual. If they differ, they come from different individuals.

Outside Delhi Set– 1 **57/2/1**

SECTION – A

1. Option (B) is correct.

Explanation: Parts I, II and III are Pericarp, Endosperm and Coleorhiza, respectively.

In monocot seeds, the pericarp, which usually forms the fruit wall, is fused with the seed coat. The endosperm is the nutritive tissue that provides nourishment to the developing embryo. The coleorhiza is an undifferentiated sheath that covers the radicle and root cap of the embryonal axis.

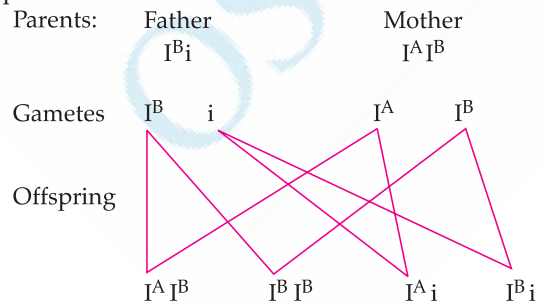
2. Option (B) is correct.

Explanation: Human beings are diploid with 23 pairs of chromosomes: 22 pairs being autosomes and 1 pair being the sex chromosome.

A human secondary spermatocyte, being haploid, contains 22 autosomes.

3. Option (C) is correct.

Explanation: The genotype of the mother with AB blood group is I^AI^B. The father has blood group B. For the child to have blood group A, it is essential that the father's genotype is I^Bi. The following cross will explain:



4. Option (C) is correct.

Explanation: The symbol given in the question indicates consanguineous marriage or marriage within blood relations.

5. Option (B) is correct.

Explanation: *Zosterophyllum* is a fossilised pteridophyte, an extinct genus of early land plants without the leaves. Ferns are the seedless land plants that appeared later, possessing more complex leaves and reproductive structures. Ginkgo is a genus of gymnosperms appearing later with the development of seeds. Gnetales are the genus of gymnosperms but are considered closely related to the flowering plants.

6. Option (B) is correct.

Explanation: A phosphate group is linked to the OH of 5′ C of a nucleoside through phosphoester linkage, forming a corresponding nucleotide (or deoxynucleotide depending upon the type of sugar present). Two nucleotides are linked through a 3′-5′ phosphodiester linkage to form a dinucleotide. More nucleotides can be joined in such a manner to form a polynucleotide chain.

7. Option (D) is correct.

Explanation: The figure shows 7 introns and 8 exons. The coding sequences, or expressed sequences, are defined as exons. Exons are said to be those sequences that appear in mature or processed RNA. The exons are interrupted by introns. Introns or intervening sequences do not appear in mature or processed RNA.

8. Option (D) is correct.

Explanation: RNA polymerases are enzymes that transcribe DNA into RNA. In eukaryotes, there are three main types of RNA polymerases, each responsible for transcribing different types of RNA:

RNA polymerase I: Transcribes most ribosomal RNA (rRNA) genes, including the 18S rRNA.

RNA polymerase II: Transcribes messenger RNA

(mRNA) precursors, also known as heterogeneous nuclear RNA (hnRNA), and some small nuclear RNAs (snRNA) and microRNAs.

RNA polymerase III: Transcribes transfer RNA (tRNA) genes, 5S rRNA, and other small RNAs, including some snRNAs.

9. Option (A) is correct.

Explanation: Microbes are used for commercial and industrial production of certain chemicals like organic acids, alcohols and enzymes. Examples of acid producers are *Aspergillus niger* (a fungus), which produces citric acid; *Clostridium butylicum* (a bacterium), which produces butyric acid; and *Lactobacillus* (a bacterium), which produces lactic acid.

10. Option (B) is correct.

Explanation: Here's how the ratio is determined after 3 generations (assuming each generation takes 20 minutes):

Generation 0: All DNA is N^{15}/N^{15}.

Generation 1: All DNA is N^{15}/N^{14} (hybrid).

Generation 2: 2 DNA molecules, one N^{15}/N^{14} and one N^{14}/N^{14}; 50% parental and 50% hybrid.

Generation 3: 4 DNA molecules, one N^{15}/N^{14} and three N^{14}/N^{14}; 25% parental and 75% hybrid.

Thus, the ratio of N^{15}/N^{14}: N^{14}/N^{14} is 1:3. However, since the question asks for the ratio N^{15}/N^{15}: N^{15}/N^{14}: N^{14}/N^{14}, it would be 0 : 1 : 3.

11. Option (D) is correct.

Explanation: The plasmid DNA acts as a vector to transfer the piece of DNA of interest attached to it.

The gene of interest and the vector DNA are joined by the enzyme DNA ligase.

Gel electrophoresis is used to isolate and separate the DNA of interest.

PCR is used for the amplification of a DNA segment.

12. Option (B) is correct.

Explanation: A decrease in T-lymphocyte count in human blood will result in a decrease in antibodies. T-lymphocytes, specifically helper T cells, play a crucial role in activating B cells, which are responsible for producing antibodies. When T-lymphocyte numbers decrease, the body's ability to produce antibodies in response to antigens is compromised.

13. Option (A) is correct.

Explanation: Assertion (A) is correct in stating that corpus luteum, formed by follicular cells after the release of secondary oocyte during ovulation, is the structure that produces progesterone. Progesterone is the hormone that stimulates the thickening of the endometrium, which supports the embryo if fertilisation takes place. Therefore, Reason (R) is the correct explanation of the Assertion (A).

14. Option (C) is correct.

Explanation: The assertion that the number of white-winged moths decreased after industrialisation in England is true, but the reason that the effects of industrialisation were more marked in rural areas is false.

The number of white-winged moths decreased significantly after industrialisation in England. This is due to increased pollution, which darkened the tree trunks and made white moths more visible to predators.

The effects of industrialisation were more marked in urban areas, not rural areas. Industrial pollution, like soot and smoke, heavily affected urban environments, leading to the darkening of tree bark. This environmental change is what drove the shift in moth populations.

15. Option (A) is correct.

Explanation: *Streptococcus pneumoniae* and *Haemophilus influenzae* are indeed responsible for causing infectious diseases in humans, including pneumonia and meningitis.

A healthy person can acquire these infections by inhaling aerosols released by an infected person. These bacteria are transmitted through droplet infection, where an infected person releases droplets or aerosols while coughing or sneezing, which can then be inhaled by others.

16. Option (C) is correct.

Explanation: Restriction endonucleases do recognise palindromic sequences and cut DNA at specific sites. However, palindromic sequences are defined by reading the same forwards and backwards on complementary strands, not by having two unique recognition sites for different enzymes like PstI and PvuI.

SECTION – B

17. (i) Two crucial changes a seed undergoes to remain viable until favourable conditions are:

Dehydration: Reduction of water content to a very low level to slow down metabolic activities.

Dormancy: Entering a state of suspended animation, ceasing growth and development.

(ii) The oldest viable seed excavated from the Arctic Tundra is *Lupinus arcticus* (Arctic lupine), estimated to be at least 10,000 years old.

OR

(i) Pea flowers produce assured seed sets because they are cleistogamous, meaning the flowers do not open. This ensures self-pollination as the anther and stigma

lie close to each other within the closed flower. When the anthers dehisce, the pollen grains come into contact with the stigma, effecting pollination and resulting in assured seed production, even in the absence of pollinators.

(ii) In the case of polyembryony, if embryo 'P' develops from a synergid and embryo 'Q' develops from the nucellus, their ploidy levels would be:

Embryo 'P' (from synergid cells): Haploid (n)

Embryo 'Q' (from nucellus): Diploid (2n)

The synergids are part of the female gametophyte and are haploid, while the nucellus is a diploid tissue. Therefore, embryos developing from these tissues retain their respective ploidy levels.

18. (a) The trait shown in the pedigree chart is autosomal recessive. This means that an individual must inherit two copies of the recessive allele (one from each parent) to express the trait. In this case, neither parent shows the trait, indicating they are likely heterozygous carriers (possessing one copy of the recessive allele and one dominant allele). The trait is autosomal because a normal father has an affected daughter. When both parents are carriers, there is a 25% chance that their offspring will inherit two copies of the recessive allele and express the trait, as seen in the chart.

(b) An example of autosomal recessive trait in human beings is phenylketonuria. Other examples include cystic fibrosis, sickle cell anaemia, and Tay-Sachs disease.

19. (A) A medical doctor would recommend an injection of pre-formed antibodies (antitoxins) in the following situations:

Snake Bites: To neutralise the snake venom quickly.

Tetanus: If a person is infected with tetanus, pre-formed antibodies provide immediate protection.

This type of immunisation is called passive immunisation. It provides immediate relief and can be used prophylactically or therapeutically.

OR

(B) The symptoms do not appear immediately after the entry of sporozoites because hemozoin is not released. Only after the release of hemozoin the malarial symptoms are released. The life cycle of malaria is completed in two different hosts: humans and female anopheles. It involves the following stages:

I. Entry and Liver Stage:

When an infected female Anopheles mosquito bites a human, it injects sporozoites into the bloodstream. These sporozoites travel to the liver and invade liver cells.

II. Multiplication in the Liver:

Inside the liver cells, the sporozoites multiply asexually, forming thousands of merozoites.

III. Release and Invasion of Red Blood Cells:

The infected liver cells eventually rupture, releasing merozoites into the bloodstream. These merozoites then invade red blood cells (RBCs).

IV. Asexual Reproduction in RBCs:

Inside the RBCs, the merozoites undergo further asexual reproduction, multiplying and forming more merozoites.

V. Hemozoin Release and Symptoms:

When the infected RBCs rupture, they release merozoites and a toxic substance called hemozoin. It is the release of hemozoin that triggers the characteristic symptoms of malaria, such as fever, chills and sweating.

Therefore, the delay between the entry of sporozoites and the appearance of symptoms is due to the time it takes for the parasite to complete its development in the liver, invade RBCs, multiply to a significant level, and release hemozoin.

20. (a) The restriction enzyme that recognises the given palindromic sequence (5′–GAATTC–3′) is EcoRI.

(b) EcoRI cuts the DNA sequence between G and A, resulting in the following fragments with sticky ends:

5′–CAG AATTC TTA–3′ becomes 5′CAG3′ + 5′AATTCTTA3′

3′–GTC TTAAG AAT–5′ becomes 3′GTCTTAA5′ + 3′GAAT5′

(c) The ends generated after digestion are called 'sticky ends' because they have single-stranded overhangs. These overhangs can easily form base pairs with complementary sequences, allowing them to "stick" to other DNA fragments with matching ends. This property is crucial for recombinant DNA technology, as it enables the joining of different DNA fragments.

21. (A) It shows age pyramid for expanding human population.

Identifying features:

I. These types of pyramids have a much larger population of pre-reproductive and reproductive age groups.

II. The population of post-reproductive age groups is very less compared to pre-reproductive and reproductive age groups.

OR

(B) (i) If 10,00,000 J of sunlight are available, plants utilise approximately 1% of that energy for photosynthesis, meaning they use around 10,000 Joules.

Primary consumers (herbivores) would receive about 10% of the energy from plants:

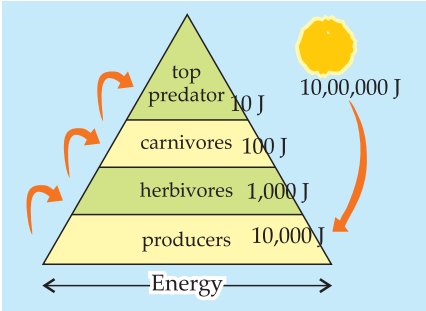
Energy at primary consumers = 10% of 10,000 J = 1,000 J

Secondary consumers (carnivores that eat herbivores) would receive about 10% of the energy from primary consumers:

Energy at secondary consumers = 10% of 1,000 J = 100 J

Tertiary consumers (carnivores that eat other carnivores) would receive about 10% of the energy from secondary consumers:

Energy at tertiary consumers = 10% of 100 J = 10 J



(ii) The energy obtained by the fourth level (tertiary consumers) of this pyramid is 10 Joules.

SECTION – C

22. **(a)** A bilobed dithecous anther with 200 microspore mother cells per microsporangium can produce 3200 male gametophytes. This is calculated as follows:

- A bilobed dithecous anther has 4 microsporangia.
- Total microspore mother cells = 200 cells/microsporangium × 4 microsporangia = 800 microspore mother cells
- Each microspore mother cell produces 4 microspores (through meiosis).

  Total microspores = 800 microspore mother cells × 4 microspores/1 microspore mother cell = 3200 microspores
- Each microspore develops into a male gametophyte.

  So, total male gametophytes = 3200

(b) The composition of the intine and exine layers of a pollen grain is:

Intine: This inner layer is made of cellulose and pectin.

Exine: This outer layer is composed of sporopollenin, a complex polymer of fatty acids, which makes it highly resistant to degradation.

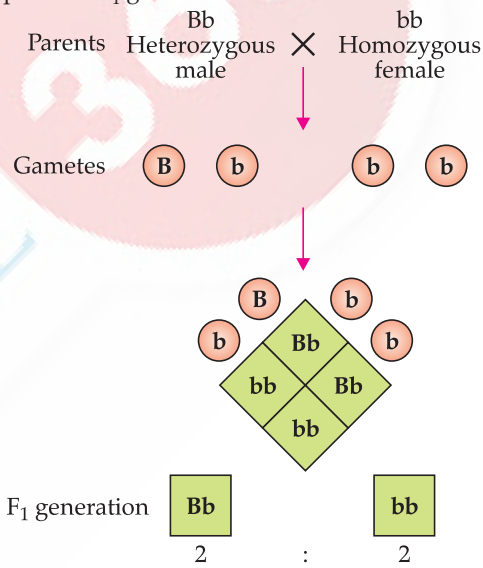
23. **(a)** Two reasons that make copper-releasing IUDs effective contraceptives:

- **Increase phagocytosis of sperm:** Copper IUDs promote the engulfment and destruction of sperm cells by phagocytes within the uterus.
- **Suppress sperm motility and fertilisation capacity:** Copper ions released by the IUDs interfere with sperm movement and their ability to fertilise an egg.

(b) Oral contraceptive pills typically contain synthetic hormones that regulate the menstrual cycle. These hormones can:

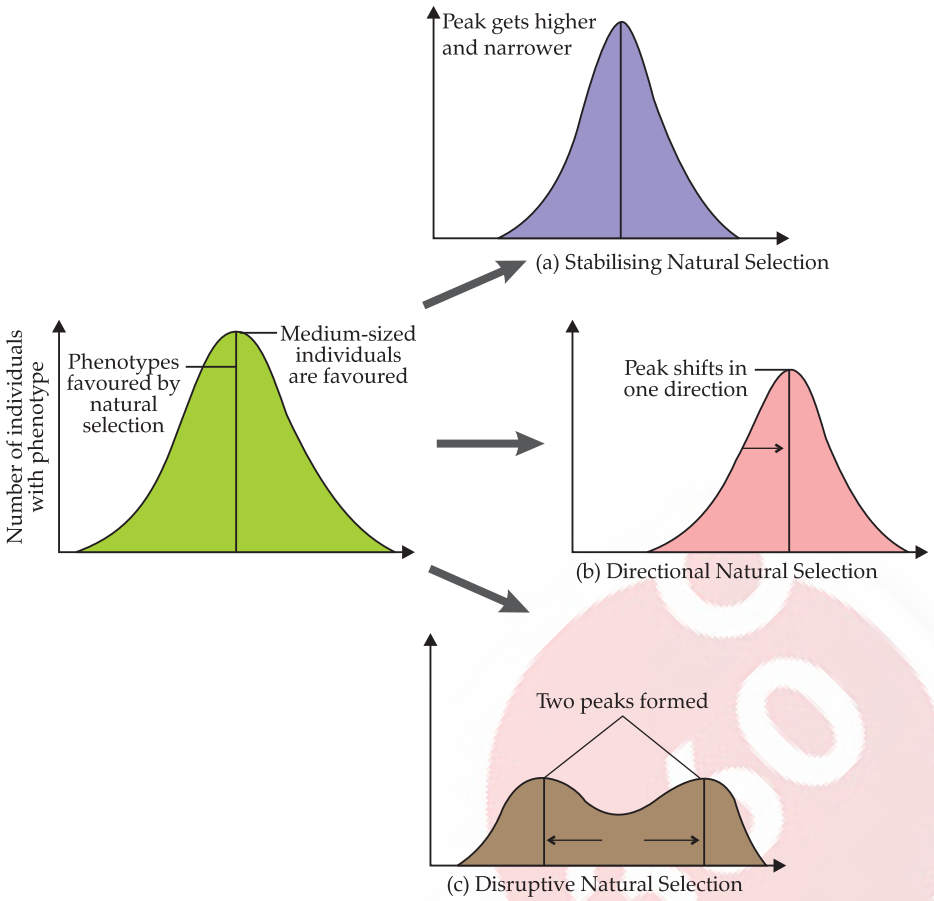
- **Prevent ovulation:** The hormones can stop the release of an egg from the ovaries.
- **Thicken cervical mucus:** This makes it difficult for sperm to reach the egg.
- **Thin the uterine lining:** This makes it less likely for a fertilised egg to implant.

24. As per the question, the heterozygous male (let its genotype be Bb) is crossed with the homozygous female (let its genotype be bb). The male will produce two types of gametes, B and b, while the female will produce only one kind of gamete, b. The Punnett square for F_1 generation of the above cross is:



25. Natural selection disrupts the Hardy–Weinberg equilibrium, which states that allele and genotype frequencies in a population remain constant across generations in the absence of evolutionary influences. Natural selection, by favouring certain traits, leads to changes in these frequencies over time.

Effect of natural selection on Hardy–Weinberg equilibrium can be understood with the help of the following graphs.



- **Stabilising Selection:** Favours the average phenotype, reducing variation in the population. A graph illustrating this shows a narrowing of the distribution curve around the mean.
- **Directional Selection:** Favours one extreme phenotype, causing a shift in the population's trait distribution over time. Graphically, this would be represented by the curve shifting towards one end of the spectrum.
- **Disruptive Selection:** Favours both extreme phenotypes and selects against the average phenotype, potentially leading to a bimodal distribution. The graph would show peaks at both ends of the phenotypic range with a dip in the middle.

26. (a) The blood test is conducted to check the level of certain drugs in the blood which are banned by sports authorities.

(b) Authorities look for certain drugs, such as narcotic analgesics, anabolic steroids, diuretics and certain hormones.

(c) The generic name of the plants from which drugs are obtained is *Cannabis sativa* and *Papaver somniferum.*

27. (a) Differences between Human Insulin and Recombinant Insulin

Feature	Human Insulin	Recombinant Insulin (e.g., by Eli Lilly)
1. Synthesis Process	Synthesised as proinsulin, containing an extra peptide chain (C peptide), which is removed during maturation.	Synthesised without the C peptide, directly as mature insulin.
2. Structure	Contains A and B chains linked by disulphide bonds, processed from proinsulin which includes C-peptide.	Consists of A and B chains linked by disulphide bridges, but lacks the C peptide.
3. Production	Produced in the pancreas by beta cells within the islets of Langerhans.	Produced in bacteria or yeast using recombinant DNA technology.
4. Processing	Requires post-translational modification to remove the C peptide and form mature insulin.	Does not require post-translational modification as it is synthesised directly in its mature form.

(b) Reasons for discontinuing animal-sourced insulin are:

I. **Allergic Reactions:** Insulin extracted from animals, such as pigs and cows, could cause allergic reactions or other adverse responses in some patients due to it being a foreign protein.

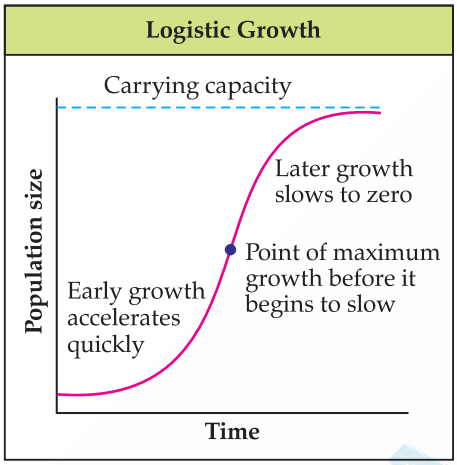
II. **Purity and Safety Concerns:** Animal-sourced insulin carried the risk of contamination and potential transmission of animal diseases, such as Bovine Spongiform Encephalopathy (mad cow disease).

III. **Supply and Ethical Considerations:** Reliance on animal sources for insulin was unsustainable and raised ethical concerns.

28. Population growth curves are graphical representations of how a population's size changes over time.

(a) Graph for a population at carrying capacity:

The graph shows an S-shaped curve (logistic growth). Initially, the population grows exponentially, then the growth rate slows down as it approaches the carrying capacity, eventually stabilising at the carrying capacity level.

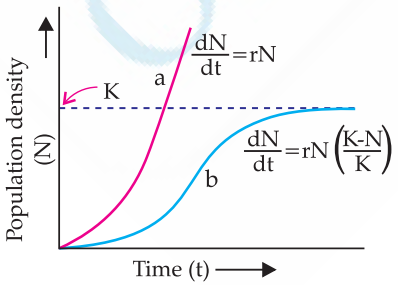


(b) Realistic population growth curve:

The logistic growth curve is considered more realistic for most populations because it considers the limitation of resources.

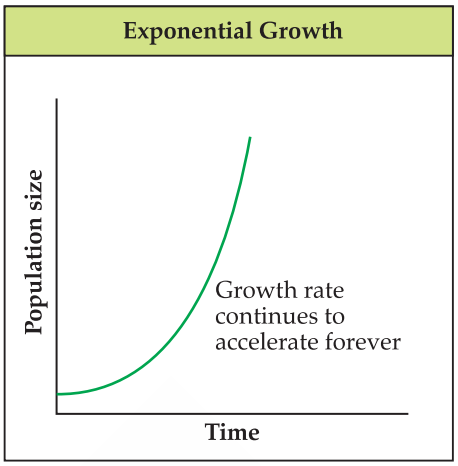
In reality, resources are finite, which limits population growth as it reaches the carrying capacity.

The exponential growth curve assumes unlimited resources, which is rarely the case in natural environments.



(c) Growth curve with unlimited resources:

The graph shows a J-shaped curve (exponential growth).



Equation: $dN/dt = rN$, where:

dN/dt is the rate of population change over time

r is the intrinsic rate of natural increase

N is the population size

This equation demonstrates that the population grows at a constant rate, resulting in a continuously increasing curve.

SECTION – D

29. (a) Cells responsible for primary and secondary immune response: B cells (B-lymphocytes) and T lymphocytes

When the body encounters a pathogen for the first time, B lymphocytes are activated. The T cells facilitate the activation of B cells. The activated B cells then produce plasma cells which in turn produce antibodies and memory B cells. The antibodies mount the primary immune response and are short lived. Upon subsequent exposure to the same pathogen, the immune system responds more quickly and effectively due to the presence of memory B cells that were generated during the initial encounter. This is called the secondary immune response.

(b) The antibody-mediated immune system involves the antibodies that are released into the body fluids (humour) like lymph and blood plasma against the pathogens entering these fluids. Hence, also called the 'humoural immune system'.

These antibodies fight off the infection in the body fluids. The antibodies are produced by the plasma cells which are in turn produced by the B-lymphocytes.

(c) (i) The characteristic of the immune system responsible for graft rejection is its ability to distinguish between 'self' and 'non-self' tissue.

(ii) Cell-mediated immune response, primarily comprising cytotoxic T-cells, attack the transplanted organ and result in graft rejection.

OR

(d) Active immunity is developed when your body's

own immune system produces antibodies after encountering a pathogen or vaccine, providing long-lasting protection, while passive immunity involves receiving pre-made antibodies from an external source, offering immediate but temporary protection.

30. (a) The main enzyme involved in the process of transcription is RNA polymerase.

(b) Strand B is the coding strand while strand A is the template strand.

(c) C is the promoter region which is the proximal area of the transcription unit, which provides for the attachment of transcription factors and RNA polymerase. D is the terminator region which is present at the distal end of transcription unit. It provides site for the attachment of termination factors for release of RNA polymerase.

OR

(d) C is present upstream at 5′ end of the coding strand. D is present downstream at 5′ end of template strand.

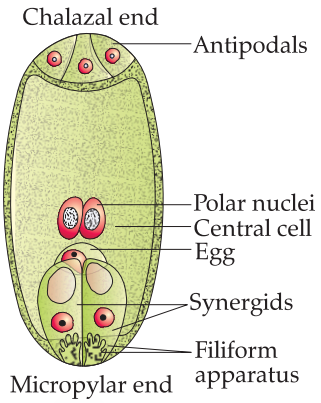
SECTION – E

31. (A) (i) In angiosperms, megasporogenesis involves the formation of megaspores.

The process of megasporogenesis takes place in the following way:

- **Megaspore Mother Cell (MMC):** A large, diploid cell within the ovule, containing a prominent nucleus and dense cytoplasm, differentiates into the MMC.
- **Meiosis:** The MMC undergoes meiosis (reductional division) to produce four haploid megaspores. The four megaspores are arranged linearly, forming a linear tetrad.
- **Degeneration and Function:** In most angiosperms, three of the four megaspores degenerate, and only one survives and becomes functional.
- **Embryo Sac Development:** The functional megaspore undergoes mitotic divisions to form the embryo sac (also known as the female gametophyte).
- **Eight-Nucleate Stage:** The embryo sac develops into an eight-nucleate structure with the nuclei migrating to specific locations within the sac.
- **Embryo Sac Structure:** The embryo sac contains the egg cell (which is fertilised to form the embryo), a central cell containing two polar nuclei (which fuse with a sperm nucleus to form the endosperm), synergids with filiform apparatus (which help attract and guide the pollen tube), and vegetative cells called the antipodal cells.

(ii) Diagram of mature embryo sac in angiosperms



OR

(B) i. The four phases of the menstrual cycle are the menstrual phase (period), follicular phase, ovulation and luteal phase.

ii. Menstrual phase lasts for 3–5 days and extends from 1st to 4th day of the menstrual cycle.

iii. Oestrogen levels gradually increase during the follicular phase, peaking about a day before ovulation, typically around day 12–14 of a 28-day cycle. This peak is triggered by a surge in luteinising hormone (LH). Progesterone levels rise after ovulation, during the luteal phase, reaching their peak about 5–9 days post-ovulation (around day 21 in a 28-day cycle). This occurs because, after ovulation, the ruptured follicle transforms into the corpus luteum, which produces progesterone.

iv. The significance of the LH surge:

- The LH surge triggers ovulation, causing the mature follicle to rupture and release the egg. Ovulation occurs about 28–36 hours after the onset of the LH surge and 10–12 hours after it reaches its peak.
- It also causes the luteinisation of theca and granulosa cells, forming the corpus luteum, which is responsible for progesterone synthesis.

32. (A) (i) To make a bacterial cell "competent" to take up recombinant DNA, it is commonly treated with a solution containing divalent cations like calcium or magnesium. This process increases the permeability of the cell membrane, facilitating the entry of DNA. The cells are incubated with the recombinant DNA on ice, followed by a brief heat shock at 42°C, and then returned to ice. This rapid temperature change creates pores in the cell membrane, allowing the recombinant DNA to enter.

(ii) The steps of amplification of a gene of interest using the polymerase chain reaction (PCR) technique are:

- **Denaturation:** The double-stranded DNA is heated to a high temperature (94–96°C) to separate it into single strands.
- **Annealing:** The temperature is lowered (typically 50–65°C) to allow primers to bind to the complementary sequences on the single-stranded DNA.

- **Extension:** The temperature is raised to 72°C, the optimal temperature for Taq polymerase, which adds nucleotides to the 3′ end of the primers, synthesising a new DNA strand complementary to the template.
- **Cycling:** These three steps are repeated multiple times (usually 25–35 cycles), resulting in exponential amplification of the target DNA sequence.

OR

(B) (i) Transgenic animals are animals that have had their DNA manipulated to possess and express an extra, foreign gene.

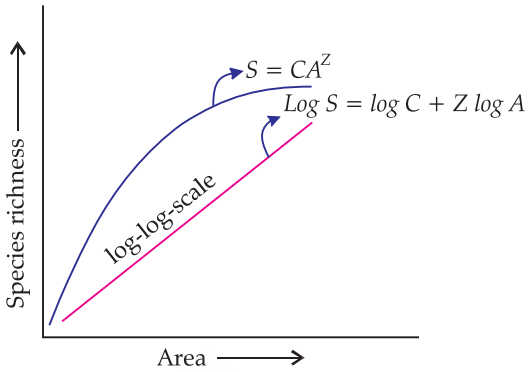
(ii) These animals are produced for several reasons:

- **Study of Normal Physiology and Development:** Transgenic animals are used to study how genes are regulated and their effect on normal body functions and development. For example, the study of complex growth factors such as insulin-like growth factor.
- **Study of Diseases:** They are used to study genes responsible for human diseases and their treatments. Transgenic models have been developed for diseases like cancer, cystic fibrosis, rheumatoid arthritis and Alzheimer's.
- **Production of Biological Products:** Transgenic animals can produce valuable biological products, such as hormones, antibodies and therapeutic proteins. For example, transgenic cows can produce milk containing human proteins beneficial for medical use.
- **Vaccine and Chemical Safety Testing:** Transgenic animals, particularly mice, are developed to test the safety of vaccines before they are used on humans, such as the polio vaccine. Transgenic animals can be made more sensitive to toxic substances than non-transgenic animals, allowing for faster study of the effects of these substances.

33. (A) (i) The tropics exhibit the greatest levels of species diversity for these reasons:

- **High solar energy:** Tropical regions receive more solar energy, leading to higher productivity and greater biodiversity due to the increased availability of food.
- **Stable climate:** Less seasonal variation in the tropics promotes niche specialisation, allowing more species to coexist.
- **Evolutionary history:** Tropical regions have remained relatively undisturbed by glaciation, allowing for a longer period of uninterrupted evolution and diversification of species.

(ii)



The species–area relationship graph illustrates how the number of species increases with the area explored. It was studied by the naturalist Alexander von Humboldt.

Observations made by Alexander von Humboldt are as follows:

- Species richness increases with the explored area, but only up to a certain limit. The relationship is represented by a rectangular hyperbola, described by the equation: $S = CA^Z$, where:

  S = species richness

  A = area

  C = constant

  Z = regression constant
- The graph typically shows a curve that rises steeply at first, then levels off, showing that after a certain point, increasing the area does not lead to a significant increase in the number of species.
- **Logarithmic scale:** On a logarithmic scale, the relationship becomes a straight line, represented by the equation $\log S = \log C + Z \log A$.
- **Slope (Z):** The value of Z varies depending on the area and taxa studied.

For small areas, Z typically ranges from 0.1 to 0.2.

For larger areas, like entire continents, Z can range from 0.6 to 1.2.

OR

(B) (i) Three major causes of biodiversity loss due to human activities are:

- **Habitat Loss and Fragmentation:** Deforestation, urbanisation and agricultural expansion lead to the destruction and fragmentation of natural habitats, reducing the space and resources available for species to survive.
- **Overexploitation:** Overhunting, overfishing and unsustainable harvesting of natural resources deplete populations faster than they can recover, leading to decline and extinction.
- **Invasive Species:** The introduction of non-native species can disrupt ecosystems, outcompete native species for resources, and spread diseases, causing significant harm to biodiversity.

(ii) Ex-situ conservation involves conserving biodiversity components outside their natural habitats. This approach is employed when in-situ conservation is not feasible or when a species is critically endangered. It includes breeding and maintaining endangered species in artificial environments.

Examples of Ex-situ Conservation:

- **Zoos:** Facilities that house animal species for conservation, education and breeding programmes.
- **Botanical Gardens:** Institutions that protect and conserve a wide variety of plant species, often including rare and endangered ones.

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SECTION – A

9. Option (C) is correct.

Explanation: The foetus receives antibodies (IgG) from the mother through the placenta during pregnancy. This provides temporary immunity without the foetus generating its own immune response. Since the immunity is naturally transferred in the form of preformed antibodies and does not include the production of memory cells. Therefore, it is naturally acquired passive immunity.

10. Option (B) is correct.

Explanation: A heterozygous organism for three loci means each locus has two alleles. The number of different gametes is calculated using the formula: 2^n, where n = number of heterozygous loci. Since $n = 3$, the number of gametes = $2^3 = 8$.

11. Option (A) is correct.

Explanation: Gel electrophoresis separates DNA fragments based on size using an electric field. DNA fragments are negatively charged and move towards the positive electrode. Smaller fragments move faster and farther through the gel matrix, while larger fragments move slower.

12. Option (B) is correct.

Explanation: *Monascus purpureus* produces statins, particularly lovastatin, which is used to lower blood cholesterol levels. *Trichoderma polysporum* produces Cyclosporin A (used as an immunosuppressant). *Saccharomyces cerevisiae* is used in fermentation and recombinant insulin production. *Aspergillus niger* produces citric acid, not statins.

13. Option (C) is correct.

Explanation: In many animals, including humans, the XX–XY system determines sex. Males have XY chromosomes, meaning they produce two types of sperm (one carrying X and the other carrying Y), making them heterogametic. Females have XX chromosomes, meaning they produce only one type of egg (X). However, in birds, the opposite is true—males have ZZ sex chromosomes (homogametic), while females have ZW sex chromosomes (heterogametic). Since the reason given talks about birds instead of humans, it is incorrect.

15. Option (A) is correct.

Explanation: When our body encounters a pathogen (virus or bacteria) for the first time, it takes time to recognise it and produce antibodies. However, our immune system remembers the pathogen and stores information in memory cells. If the same pathogen attacks again, the body quickly recognises and destroys it. Since the reason explains exactly why the secondary immune response is faster, both statements are correct.

16. Option (A) is correct.

Explanation: ADA (Adenosine Deaminase) deficiency is a genetic disorder that weakens the immune system. A common treatment is to inject the patient with genetically modified lymphocytes that can temporarily produce the missing enzyme. However, since lymphocytes have a limited lifespan, the treatment has to be repeated regularly.

SECTION – B

17. (A). (i) Identification of 'P' and 'Q': 'P' represents Oestrogen. 'Q' represents Progesterone.

(ii) Source of Hormones: Developing graafian follicle

Progesterone (Q): Secreted by the corpus luteum in the ovary.

OR

(B) (i) Identification of 'P' and 'Q': 'P' represents Luteinising Hormone (LH). 'Q' represents Follicle-Stimulating Hormone (FSH).

(ii) Role of Hormone 'P' (LH) in Both Males and Females:

In females: LH triggers ovulation and stimulates the formation of the corpus luteum.

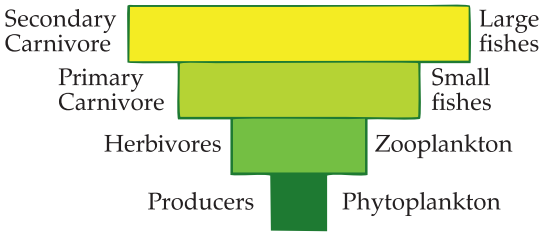
In males: LH stimulates the Leydig cells in the testes to produce testosterone, which is crucial for spermatogenesis.

18. (a) Two closely linked genes that control α-thalassemia: HBA1 and HBA2 genes, located on chromosome 16, are responsible for α-thalassemia.

(b) Difference between Thalassemia and Sickle Cell Anemia:

- **Thalassemia:** Caused by mutations or deletions in the genes encoding the alpha or beta globin chains, leading to a reduction or absent globin production.
- **Sickle Cell Anaemia:** Caused by a point mutation in the β-globin gene (HBB), where glutamic acid is replaced by valine at position 6, resulting in abnormal haemoglobin (HbS) that causes red blood cells to become sickle-shaped.

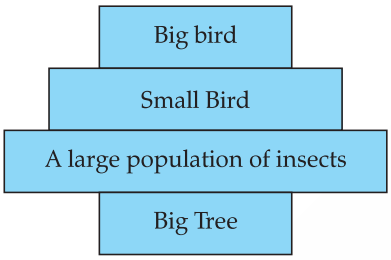
21. (A)



The pyramid of biomass in an aquatic ecosystem is inverted because the total biomass of phytoplankton (producers) is lower than that of zooplankton (primary consumers), and the biomass of small fish (secondary consumers) can be even higher. This occurs because phytoplankton have a very high reproductive rate and are consumed rapidly, whereas zooplankton and fish have longer lifespans, leading to an inverted biomass pyramid.

OR

(B)



The pyramid of numbers in this case is inverted because a single tree supports a large population of insects, which in turn supports a smaller population of small birds, and an even smaller population of big birds at the top.

SECTION – C

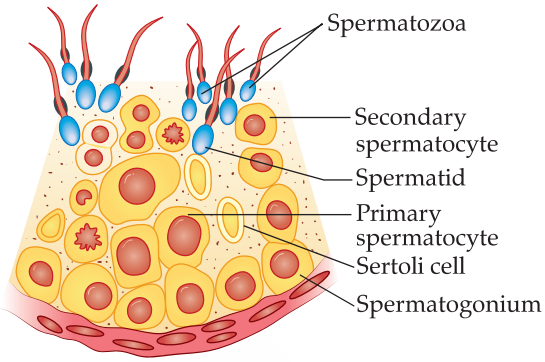
23. (a) Expansion of Abbreviations in Assisted Reproductive Technology (ART):

i. **ZIFT** – Zygote Intrafallopian Transfer
ii. **ICSI** – Intracytoplasmic Sperm Injection
iii. **IUT** – Intrauterine Transfer
iv. **GIFT** – Gamete Intrafallopian Transfer

(b) Reasons for Statutory Ban on Amniocentesis:

1. **Prevention of Female Foeticide:** Amniocentesis can be used for prenatal sex determination, leading to selective abortion of female fetuses, which causes gender imbalance in society.
2. **Ethical and Legal Concerns:** Misuse of this technique for non-medical reasons violates ethical principles and human rights, leading to its regulation and ban under laws like the Pre-Conception and Pre-Natal Diagnostic Techniques (PCPNDT) Act in India.

31. (A) (i) Diagrammatic Sectional View of Seminiferous Tubule:



The **seminiferous tubules** are the site of sperm production in the testes. The labelled parts include:

(a) Cell that undergoes spermiogenesis: Spermatid
(b) Cell that nourish male gametes: Sertoli cell
(c) Cell which undergoes meiosis I and meiosis II: Spermatogonium

(ii) Seminal Plasma:

Seminal plasma is the fluid part of semen, secreted by accessory glands like the seminal vesicles, prostate gland and bulbourethral glands.

Two constituents of seminal plasma:

1. **Fructose** – Provides energy for sperm motility.
2. **Prostaglandins** – Helps sperm movement and fertilisation.

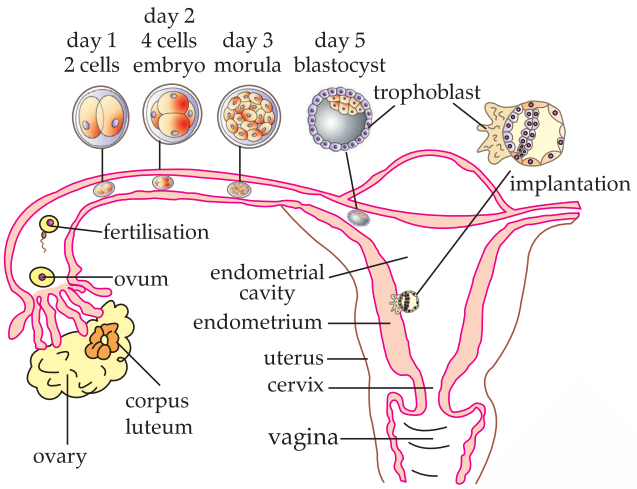
Difference between seminal plasma and semen: Seminal plasma is the fluid part, whereas semen is a combination of seminal plasma and sperm cells.

OR

(B) (i) The fusion of the sperm with the secondary oocyte (fertilisation) triggers the completion of meiosis II in the oocyte, leading to the formation of a mature ovum and the second polar body.

(ii) Journey of the Zygote Until Implantation:

1. **Fertilisation:** Occurs in the ampulla of the fallopian tube.
2. **Cleavage:** The zygote undergoes mitotic divisions, forming a morula.
3. **Blastocyst Formation:** The morula transforms into a blastocyst.
4. **Transport to Uterus:** The blastocyst moves through the fallopian tube into the uterus.
5. **Implantation:** Around day 6–7 after fertilisation, the blastocyst embeds itself into the endometrial lining of the uterus, initiating pregnancy.



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SECTION – A

1. Option (A) is correct.

Explanation: Unisexual flowers have either male or female reproductive organs, preventing self-pollination (Autogamy) and pollination between flowers of the same plant (Geitonogamy). However, they allow cross-pollination between different plants (Xenogamy).

2. Option (D) is correct.

Explanation: Spermatogenesis follows these stages:

1. **Spermatogonia (I) –** Diploid stem cells that divide by mitosis.
2. **Secondary Spermatocyte (II) –** Undergoes Meiosis II to form spermatids.
3. **Spermatids (III) –** Differentiate into mature spermatozoa (sperm).
4. **Spermatozoa (IV) -** Mature male gametes are called spermatozoa or sperm.

Thus, the correct labelling is:

- **I –** Spermatogonia
- **II –** Secondary Spermatocyte
- **III –** Spermatid
- **IV –** Spermatozoa

4. Option (B) is correct.

Explanation: Francis Crick proposed the "Central Dogma of Molecular Biology", which states that genetic information flows in one direction: DNA → RNA → Protein

This concept describes how genetic information is transcribed from DNA to RNA and then translated into proteins.

6. Option (B) is correct.

Explanation: The mechanism of sex determination in honey bees is based on haplodiploidy: Females (queens and workers) are diploid with 32 chromosomes. Males (drones) are haploid with 16 chromosomes, having developed from unfertilised eggs.

SECTION – B

20. (a) The scientific name of the source organism of the thermostable DNA polymerase used in PCR is *Thermus aquaticus*. This bacterium is thermophilic, meaning it thrives in high-temperature environments.

(b) The advantage of using thermostable DNA polymerase is that it remains active at high temperatures and does not denature during the DNA denaturation step in PCR. This allows the PCR process to be automated and repeated many times without adding new enzyme.

21. David Tilman's long-term experiments using outdoor plots led to the following key conclusions about biodiversity and ecosystem functioning:

1. **Higher Biodiversity Increases Productivity –** Plots with a greater number of plant species showed higher overall biomass production.
2. **Biodiversity Enhances Ecosystem Stability –** More diverse ecosystems were more resilient to environmental fluctuations such as droughts.
3. **Efficient Resource Utilisation –** Species-rich plots used resources like nitrogen, water and sunlight more efficiently than monocultures.
4. **Reduced Invasion by Weeds –** Higher biodiversity reduced the likelihood of invasive species establishing in the ecosystem.
5. **Long-term Benefits of Species Diversity –** The advantages of biodiversity, such as increased productivity and stability, became more pronounced over time.

SECTION – C

27. (a) The proteins coded by the cryIAb gene control corn borer, while cryIAc and cryIIAb control cotton bollworms.

(b) The Bt toxin produced by the bacterium *Bacillus thuringiensis* kills insects through the following mechanism: The bacterium produces an inactive protoxin (crystal protein) during sporulation. When an insect ingests the Bt toxin, it reaches the gut, where the alkaline pH activates the toxin. The activated toxin binds to receptors on the surface of midgut epithelial cells, creating pores. These pores disrupt the midgut epithelium, leading to paralysis, and eventually, the insect stops feeding and dies within 2–3 days.

28. (a) In the given pie chart:

'X' represents Insects.

'Y' represents Molluscs.

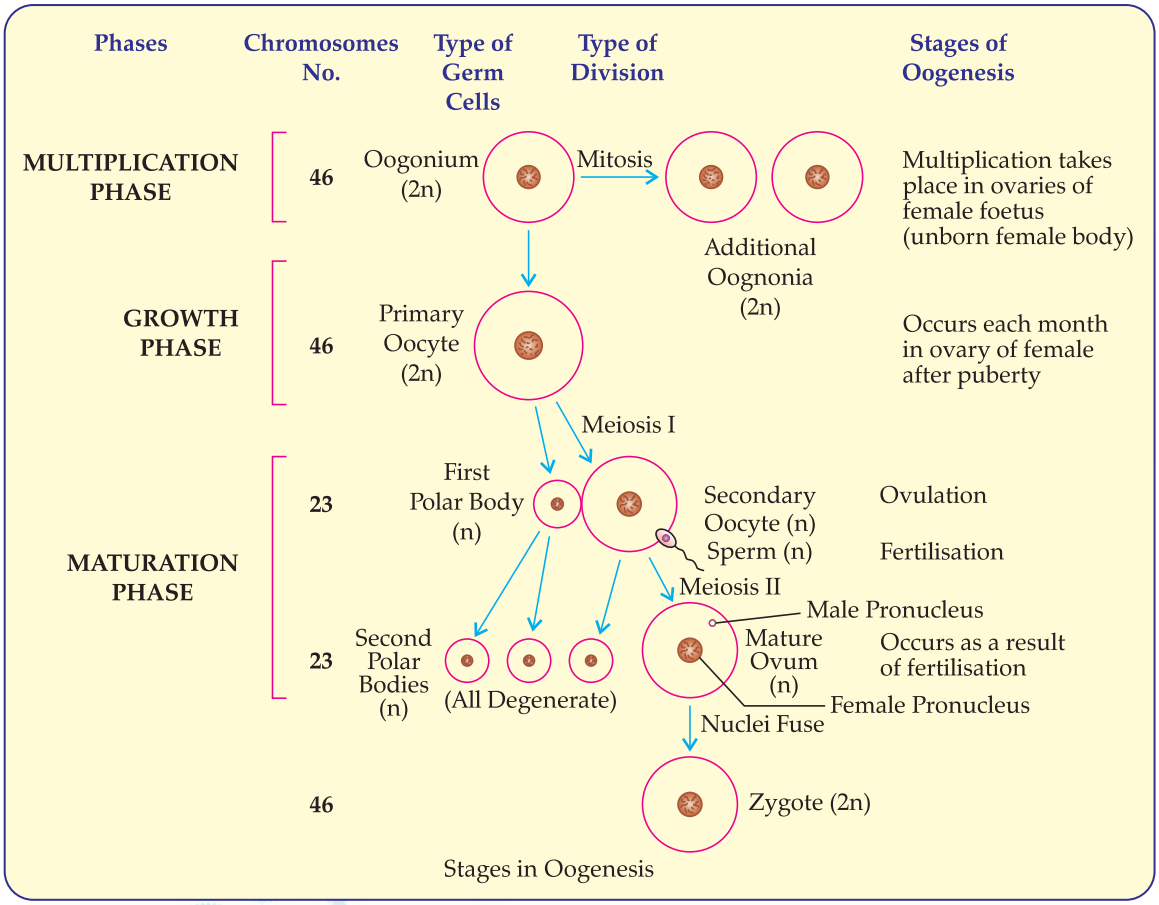
(b) Insects ('X') are the most species-rich taxonomic group, accounting for more than 70% of the total [no percentage specified in the pie chart].

(c) (i) Estuaries and alpine meadows in India represent ecological diversity.

(ii) The medicinal plant *Rauwolfia vomitoria* represents genetic diversity.

SECTION – E

31. (A) (i) Oogenesis in human females:



(ii) Chromosome number and life phases:

Stage	Chromosome Number	Life Phase Correlation
Oogonium	2*n* (46)	Fetal development
Primary oocyte	2*n* (46)	Fetal development, arrested at prophase I until puberty
Secondary oocyte	*n* (23)	From puberty until menopause, released monthly during ovulation, arrested at metaphase II
Ovum	*n* (23)	After fertilisation, completes meiosis II
Polar bodies	*n* (23)	Degenerate and play no further role

OR

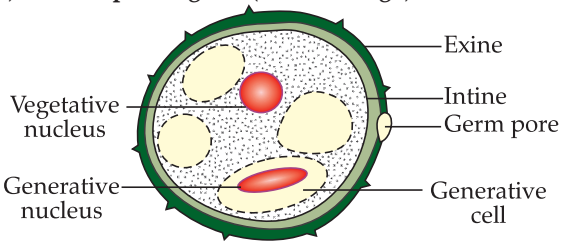
(B) (i) Three types of Pollination in a chasmogamous bisexual flower:

a. Autogamy: Self-pollination within the same flower. Pollen grains from the anther are transferred to the stigma of the same flower.

b. **Geitonogamy:** Transfer of pollen grains from the anther of one flower to the stigma of another flower on the same plant.

c. **Xenogamy:** Cross-pollination, where pollen grains are transferred from the anther of a flower on one plant to the stigma of a flower on a different plant of the same species.

(ii) Mature pollen grain (2-celled stage):



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