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 F TVE 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.

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 colourblind 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 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)

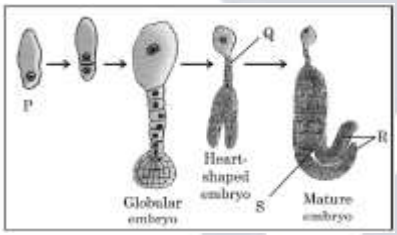
4. **The process of mineralization by microorganisms help in the release of :**
   (a) inorganic nutrients from humus.
   (b) both organic and inorganic nutrients from detritus.
   (c) organic nutrients from humus.
   (d) inorganic nutrients from detritus and formation of humus.
5. **Transplantation 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 blastomeres
(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

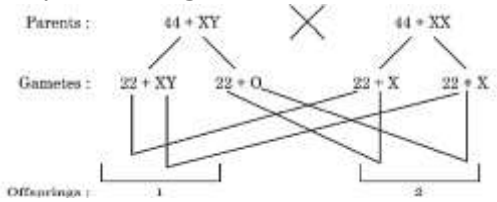
17. **Student to attempt either option-(A) or (B):**
    (A) How are morphine and heroin related ? Mention their effect on the human body.

    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.

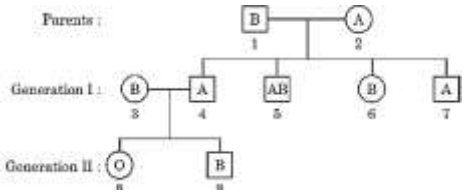
    OR

    (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

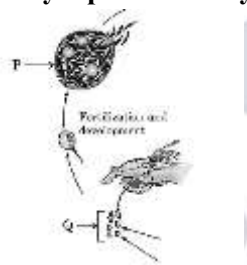
22. (a) Write the palindromic nucleotide sequence for following sequence of DNA segment:

$5' -$ 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.

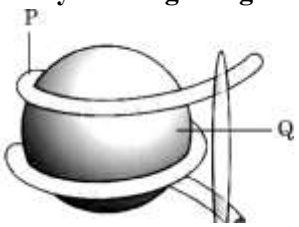
24. (a) Indiscriminate human activities such as alien species invasion, fragmentation and habitat loss have accelerated the loss of biodiversity. Justify by taking one example for each.

(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 Heterochromatin.

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 ?

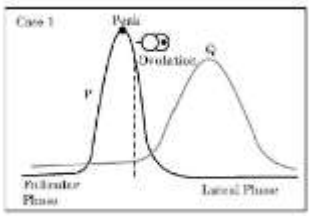
27. Explain the basis on which gel electrophoresis technique works. Write any two ways the products obtained through this technique can be utilised.

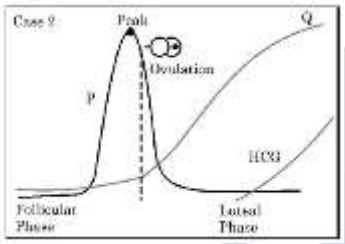
28. Compare and contrast convergent and divergent evolution.

SECTION - D

Question Nos. 29 and 30 are case-based questions. Each question has 3 subquestions 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.

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

(a) Answer the following questions:

(i) State what do you understand by "MALT" ? Where it is 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:

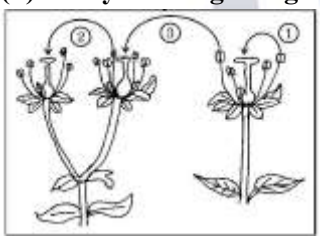
	Chemical / Bioactive Molecule	Microorganism	Category	Use
(a)	Butyric acid	H	I	Important applications in food, chemical &
(b)	J	Monoscus purpureus	K	pharma industry Inhibit cholesterol biosynthesis pathway
(c)	Cyclosporin A	L	Fungus	M

(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?

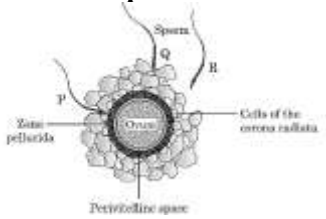
(a) Water lily

(b) Vallisneria

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

OR

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



(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.

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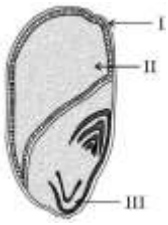
(ix) Kindly note that there is a separate question paper for Visually Impaired candidates.
(x) Wherever necessary, neat and properly labelled diagrams should be drawn.

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.

34. 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.

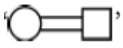
	I	II	III
(a)	Pericarp,	Endosperm,	Scutellum
(b)	Pericarp,	Endosperm,	Coleorhiza
(c)	Scutellum,	Pericarp,	Coleorhiza
(d)	Coleorhiza,	Scutellum,	Pericarp

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

(a) 44 (b) 22
(c) 23 (d) 46

36. 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)	$I^B I^B$	$I^A I^B$	$I^A I^A$

37. In a pedigree chart  represents:

(a) unrelated mating
(b) affected individuals
(c) mating between relatives (consanguineous mating)
(d) Non-identical twins

38. 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) (c) (iv), (ii), (i), (iii)

39. 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.

40. 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

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

Column-I	**Column-II**
(A) RNA POLYMERASE I	**(I)** 18 S 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)

42. 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

43. 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

44. 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.

45. 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.

46. **Assertion (A):** Corpus luteum secretes the hormone, progesterone.
Reason (R): Hormone Progesterone is essential for maintenance of the endometrium.

47. **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.

48. **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.

49. **Assertion (A):** Restriction endonuclease recognises palindromic sequence in DNA and cuts them.
Reason (R): Palindromic sequence has two unique recognition sites PstI and PvuI recognised by restriction endonuclease.

SECTION - B

50. **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.

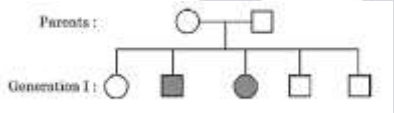
(ii) Name the oldest viable seed excavated from Arctic Tundra as per the records.

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 '.

51. **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.

52. **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.

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

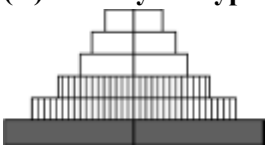
5′	3′
C	G
A	T
G	C
A	T
A	T
T	A
T	A
C	G

T	A
T	A
A	T
3′	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'?

54. 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

55. (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.

56. (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.

57. 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.

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

59. 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.

60. (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?

61. (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.

62. 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):

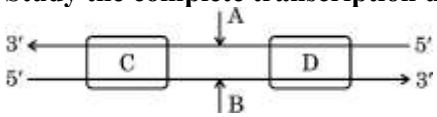
(c) The organ transplants are often rejected if not taken from suitable compatible persons.

(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?

63. 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

64. 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.

65. 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.

66. 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.

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 F TVE 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.

SECTION-A

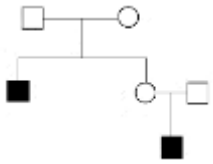
Question Nos. 1 to 16 are multiple choice questions. Each question carries 1 mark. Only one of the choices is correct. Select and write the correct choice.

67. In its extended 'beads-on-string' form of chromatin, the 'beads' in the string represent:
(a) Linker DNA (b) Histone proteins
(c) Nucleosomes (d) NHC proteins

68. Given below are a few statements with reference to the accessory ducts of the human male reproductive system :
(i) The seminiferous tubules of the testes open into rete testis then into the vas deferens.
(ii) The vasa efferentia leave the testes and open into the epididymis.
(iii) The epididymis leads to vas deferens that ascends into the abdomen.
(iv) The vas deferens receives a duct from the prostrate gland and opens into the urethra as ejaculatory duct.
(v) The urethra originates from the urinary bladder and extends through the penis to its external opening, urethral meatus.
Choose the option with all true statements from the given options:
(a) (i), (ii), (iv) (b) (ii), (iii), (v)
(c) (ii), (iv), (v) (d) (i), (iii), (iv)

69. The substrate used during DNA replication by the enzyme DNA-dependent DNA polymerase is:
(a) Deoxyribonucleotide triphosphate
(b) Deoxyribonucleoside triphosphate
(c) Ribonucleotide triphosphate
(d) Ribonucleoside triphosphate

70. In the given pedigree chart, a cross between a normal couple resulted in a son who was haemophilic and a normal daughter. In course of time, when the daughter was married to a normal man, to their surprise the grandson was also haemophilic.



Choose the option that indicates the correct inheritance of trait in the above pedigree chart:
(a) Autosome linked dominant trait
(b) Sex-linked dominant trait
(c) Autosomal recessive trait
(d) Sex-linked recessive trait

71. In which of the following human diseases does the body's self-defence mechanism attack self-cells?
(a) Thalassemia (b) Phenylketonuria
(c) Filariasis (d) Rheumatoid arthritis

72. Select the statements that are true for a typical dicotyledonous embryo from the given options.
(i) It consists of an embryonal axis and scutellum.
(ii) The portion of embryonal axis above the level of cotyledon is epicotyl.
(iii) The portion of embryonal axis below the level of cotyledon is coleorhiza.
(iv) The lower end of the embryo has radicle covered with a root cap.

Choose the correct answer:

(a) (i) and (ii) (b) (i) and (iii)
(c) (iii) and (iv) (d) (ii) and (iv)

73. About 15 mya during human evolution, the primates which used to walk like gorillas and chimpanzees were:

(a) Australopithecine and Neanderthal
(b) Dryopithecus and Ramapithecus
(c) Homo erectus and Homo sapiens
(d) Homo habilis and Homo erectus

74. Use the given information to select the amino acid attached to the 3′ end of tRNA during the process of translation, if the coding strand of the structural gene being transcribed has the nucleotide sequence TAC.

Codons for the amino acids :
AUC - Isoleucine
AUG-Methionine
UAC - Tyrosine
GUA - Valine

(a) Isoleucine (b) Methionine
(c) Tyrosine (d) Valine

75. The technique for the early detection of a disease based on the principle of antigen-antibody interaction is:

(a) RNAi (b) EST
(c) PCR (d) ELISA

76. The correct depiction of the experiment performed by Matthew Meselson and Franklin Stahl to prove that DNA replicates semi-conservatively on separation of DNA by centrifugation after 40 minutes is:

(a) 
(b) 
(c) 
(d) 

77. Bioactive molecule Cyclosporin A used for human welfare is derived from :

(a) Propionibacterium sharmanii
(b) Monascus purpureus
(c) Trichoderma polysporum
(d) Aspergillus niger

78. In a pea plant (Pisum sativum) inflated pod shape is dominant over constricted pod shape. The expected ratio of phenotypes of the offspring in a cross between both the parents with heterozygous inflated pod shape will be:

(a) 1: 0 (b) 1: 1
(c) 2: 1 (d) 3: 1

For Questions number 13 to 16, two statements are given - one labelled as Assertion (A) and the other labelled as Reason (R). Select the correct answer to these questions from the codes (A), (B), (C) and (D) as given below.

(a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
(c) Assertion (A) is true, but Reason (R) is false.
(d) Assertion (A) is false, but Reason (R) is true.

79. Assertion (A): The meristems are grown 'in vitro' to obtain virus-free plants from an infected plant.
Reason (R): If the plant is infected with a virus, the roots and the stems are free of virus.

80. **Assertion (A):** A person infected with malaria suffers from chill and high fever, recurring every three or four days.
Reason (R): The parasite attacks the RBC resulting in their rupture and release of haemozoin.
81. **Assertion (A):** 'Saheli', an oral contraceptive inhibits ovulation and increases phagocytosis of sperms.
Reason (R): It is a non-steroidal preparation.
82. **Assertion (A):** ABO blood grouping in humans is an example of multiple allelism.
Reason (R): More than two genes in a population govern the same character in ABO blood grouping in humans.

SECTION B

83. **(a) Explain how the immunity of a person is affected if there is atrophy (degeneration) of the thymus gland at an early stage of life.**

OR

(b) (i) What are interferons ? Explain their role in providing immunity to a person.
(ii) Which category of innate immunity defence barrier can interferons be classified into?

84. **Assume that the given mRNA (start site is not depicted) is theoretically translated in two reading frames.**
(a) Translation starting from the first nucleotide (Reading frame 1)
(b) Translation starting from the second nucleotide (Reading frame 2)

Frame 1
5' - CUCGCUUGCCGAUCAAGGGUUA - 3'
Frame 2
5' - GUGGCACUCAGUCCUUAAUGGCG - 3 '

Answer the following question:
How many amino acids will be specified in case (a) and case (b) on translation ? Justify your answer.

85. **(a) Explain what is meant by the term MTP. What was the main reason to legalize MTP by the Government of India?**

OR

(b) Name any two STIs which might occur in a human female. State its two early symptoms.

86. **The basic scheme of the essential steps involved in the process of recombinant DNA technology is summarized below in the form of a flow diagram. Study the given flow diagram and answer the questions that follow.**

Step-1 Vector DNA (cut using Restriction Enzyme EcoRI) + Alien DNA (cut using Restriction Enzyme EcoR I)
↓ Enzyme A
Step-2 Recombinant DNA molecule
↓
Step-3 Transfer of recombinant DNA molecule in E. coli (Host)
↓
Step-4 Replication of recombinant DNA molecule in E. coli

(a) Name the enzyme used in Step-1 to join the cut plasmid and alien DNA.
(b) State the technical term used for Step-3.
(c) Justify the use of same Restriction Enzyme EcoR I to cut both the vector DNA and the alien DNA.

87. **(a) Explain how the interaction between sea anemone and clownfish is one of the best examples of commensalism in nature.**

OR

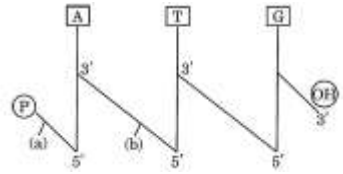
(b) Correctly depict (also indicate the trophic level) and describe the ecological pyramid of biomass in sea with 40 standing crop of phytoplankton supporting 90 standing crop of zooplankton which further supports 120 small fishes.

SECTION C

88. **Explain the process of formation of placenta in a human female after the implantation of the blastocyst in the endometrium of the uterus.**
89. **Gregor Mendel conducted hybridisation experiments in garden pea for seven years and proposed the law of inheritance.**

(a) Why was he successful in his hybridisation experiments? Give two reasons.
(b) State the law of independent assortment as proposed by Mendel after his dihybrid crosses.

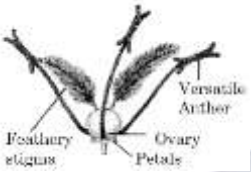
90. Study the given below single strand of deoxyribonucleic acid depicted in the form of a "stick" diagram with 5 ' -3 ' end directionality, sugars as vertical lines and bases as single letter abbreviations and answer the questions that follow.



(a) Name the covalent bonds depicted as (a) and (b) in the form of slanting lines in the diagram.
(b) How many purines are present in the given "stick" diagram ?
(c) Draw the chemical structure of the given polynucleotide chain of DNA.

91. Explain the biological treatment of primary effluent when passed into the large aeration tanks in a sewage treatment plant (STP).

92. Given below is a flower with its characteristic features specialised for the most common type of abiotic pollination.



Answer the following questions based on the above diagram :
(a) Name the mode of abiotic pollination that will be adopted by the given plant species in the above picture.
(b) State the need of exposed large feathery stigmas for the flower.
(c) What will be the two important adaptations in the pollen grains of the flowers pollinated by the above mode of pollination?
(d) What could be the probable reason for the petals being small and non-green?

93. According to a recent wildlife report, the biggest threat to the tiger's survival in Mudumalai Tiger Reserve (MTR) was found to be a small, beautiful flower, Lantana camara, a tropical American shrub, that invaded 40% of India's tiger range. Tamil Nadu department's Lantana weed eradication drive helped to restore the dying MTR thereby also reducing human-wildlife conflicts. MTR is home to 25 species of grasses and legumes.
Answer the given questions based on the information given above.
(a) Explain how did the removal of Lantana help in restoring the dying Mudumalai Tiger Reserve.
(b) Why is the invasion of Lantana camara a cause of concern in MTR.

94. Enlist one advantage and two disadvantages of green revolution.

SECTION D

Questions No. 29 and 30 are case-based questions. Each question has 3 sub-questions with internal choice in one sub-question.

95. Read the following passage and answer the questions that follow.
The most convincing evidence to trace evolutionary relationships between humans and different groups of animals come from the basic similarities seen at the molecular level. Study the table given below that depicts the number of amino acid differences between the haemoglobin polypeptide of few animals with that of humans and answer the questions that follow.

S.No.	Animal	No. of amino acid differences in haemoglobin with that of humans
1.	Macaque	08

2.	Dog	32
3.	Bird	45
4.	Frog	67
5.	Lamprey	125

(a) To which category of evolution (Divergent or Convergent) do the following evolutionary relationships belong to:
(i) Humans and Macaque
(ii) Humans and Frog
(b) What do the biochemical similarities in haemoglobin suggest about the evolutionary relationship between humans, frog and lamprey?
(c) (i) Which one of the two-lampreys' or macaques' evolution is more closely related to humans and why?

OR

(c) (ii) Which one of the two - frogs' or dogs' evolution is more closely related to humans and why?

96. Read the following passage and answer the questions that follow.

Deaths related to the use of drugs were estimated at about 5,00,000 in 2019, 17.5 percent more than in 2009. Liver diseases attributed to Hepatitis B are a major cause of drug-related deaths, according to UNODC, accounting for more than half of the total number of deaths attributed to the use of drugs. Drug overdoses account for a quarter of drug-related deaths.
Opioids contribute to account for the most severe drug-related harm, including fatal overdoses, when used non-medically. At the global level, two-third of direct drug-related deaths are due to opioids, and in some sub-regions the proportion can be as high as three-quarters of such deaths.
(a) Why are people taking opioids more prone to liver diseases attributed to Hepatitis B ?
(b) What is meant by direct drug-related disease?
(c) (i) What is the scientific name of the plant from which the opioids are derived and from which part of the plant is it extracted ?

OR

(c) (ii) State two common warning signs of drug abuse among the youth.

SECTION E

97. (a) (i) Explain how does double fertilisation take place in a flowering plant.
(ii) Write the fate of the products of double fertilization in these plants.

OR

(b) (i) Explain the structure of testicular lobules in human male reproductive system. Name the two types of cells present in the seminiferous tubules and state their role.
(ii) Describe the role of hypothalamic hormone GnRH in spermatogenesis.

98. (a) Name and explain the biotechnological strategy wherein the infection by the nematode Meloidegyne incognitia can be prevented using Agrobacterium vectors in the roots of tobacco plant by RNA interference.

OR

(b) Explain the amplification of gene of interest using the technique of Polymerase chain reaction (PCR).

99. (a) (i) Describe the population growth curve applicable in a population of any species in nature that has limited resources at its disposal.
(ii) Give the equation of this growth curve.
(iii) Name the growth curve and depict a graphical plot for this type of population growth.

OR

(b) (i) Explain the Species-Area relationship within a natural forest and also predict the nature of graph when species richness is plotted against the area for a wide variety of taxa.
(ii) Depict the graphical relationship between species richness and area.
(iii) Give the equation of the Species-Area relationship for a wide variety of taxa on a logarithmic scale.

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 - Sections A, B, C, D and E.

(iii) Section A-questions number 1 to 16 are multiple choice type questions. Each question carries 1 mark.
(iv) Section B - questions number 17 to 21 are very short answer type questions. Each question carries 2 marks.
(v) Section C-questions number 22 to 28 are short answer type questions. Each question carries 3 marks.
(vi) Section D - questions number 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 - questions number 31 to 33 are long answer type questions. Each question carries 5 marks.
(viii) There is no overall choice. However, an internal choice has been provided in Sections B, D and E of the question paper. A candidate has to write answer for 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.

SECTION A

Questions no. 1 to 16 are Multiple Choice Type Questions, carrying 1 mark each. Choose the best option.

100. The histone core in a nucleosome of chromatin thread is a/an:

(a) pentamer (b) hexamer
(c) heptomer (d) octamer

101. Given below are few statements with reference to the uterus in the female reproductive system :

(i) The myometrium exhibits strong contractions during the delivery of the baby.
(ii) The uterus opens into the cervix through a narrow opening called vagina.
(iii) The cavity of the cervix and the vagina forms the birth canal.
(iv) The outermost layer of uterus is a thin membranous perimetrium.
(v) The uterus is supported by tendons attached to the pelvic wall.

Choose the option with all true statements from the given options:

(a) (i), (ii) and (iv) (b) (ii), (iii) and (v)
(c) (ii), (iv) and (v) (d) (i), (iii) and (iv)

102. During the process of transcription, after binding to a promoter, RNA polymerase catalyses and makes the bases in the template strand of DNA available for base pairing, with the bases of :

(a) Deoxyribonucleotide triphosphate
(b) Deoxyribonucleoside triphosphate
(c) Ribonucleotide triphosphate
(d) Ribonucleoside triphosphate

103. Which of the following is not an example of aneuploidy?

(a) Turner's syndrome
(b) Down's syndrome
(c) Phenylketonuria
(d) Klinefelter's syndrome

104. Colostrum secreted by the mother's mammary glands in a human female during the initial days of lactation is rich in antibody:

(a) IgE (b) IgD
(c) IgA (d) IgG

105. Select the statements that are true for pollination mechanism in flowering plants from the given options.

(i) In Vallisneria, the female flowers are pollinated by pollen grains inside the water.
(ii) In Zostera, pollen grains are released on the surface of water.
(iii) In most of the water-pollinated species, pollen grains are covered by a mucilaginous coating.
(iv) Pollination by water is quite rare and limited to about 30 genera.

Choose the correct answer:

(a) (i) and (ii) (b) (ii) and (iii)
(c) (iii) and (iv) (d) (i) and (iv)

106. Which of the following combinations is a correct example of convergent evolution in Australian marsupials and Placental mammals?

	Australian Marsupials	**Placental Mammals**

(a)	Lemur	Spotted cuscus
(b)	Tasmanian tiger cat	Anteater
(c)	Bobcat	Lemur
(d)	Numbat	Anteater

107. Isolation of DNA from a fungal cell can be achieved by using :

(a) Cellulase (b) Chitinase

(c) Lysozyme (d) Protease

108. During a monohybrid cross involving a tall pea plant with a dwarf pea plant, the offspring populations were tall and dwarf in equal ratio. Find out the genotype of parent pea plants.

(a) $Tt \times tt$ (b) $TT \times Tt$

(c) $tt \times tt$ (d) $Tt \times Tt$

109. What would happen if a gene encoding a polypeptide of 50 amino acids, 25^{th} Codon (UAU) is mutated to "UAA" ?

(a) A polypeptide of 49 amino acids will be formed.

(b) A polypeptide of 25 amino acids will be formed.

(c) A polypeptide of 24 amino acids will be formed.

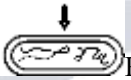
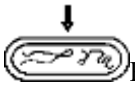
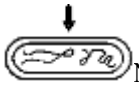
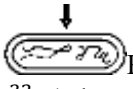
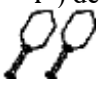
(d) A polypeptide of 50 amino acids will be formed.

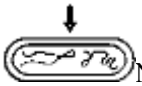
110. Large scale industrial production of Butyric acid for human welfare is done using the microbe:

(a) Aspergillus sp. (b) Streptococcus sp.

(c) Clostridium sp. (d) Trichoderma sp.

111. The correct depiction of the centrifugation step of the experiment conducted by Alfred Hershey and Martha Chase on using radioactive labelled phages to prove that DNA is the genetic material is:

(a)	 No Radioactive (^{35}S) detected in cells +  Radioactive (^{35}S) detected in supernatant	 Radioactive (^{32}P) detected in cells +  No Radioactivity detected in supernatant
(b)	 Radioactive (^{35}S) detected in cells +  Radioactive (^{35}S) detected in supernatant	 No Radioactive (^{32}P) detected in cells +  No Radioactivity detected in supernatant
(c)	 No Radioactive (^{35}S) detected in cells +  No Radioactivity detected in supernatant	 Radioactive (^{32}P) detected in cells +  Radioactive (^{35}S) detected in supernatant

(d)	 Radioactive (^{35}S) detected in cells +  No Radioactivity detected in supernatant	 No Radioactive (^{32}P) detected in cells +  Radioactive (^{35}S) detected in supernatant

For Questions number 13 to 16, two statements are given - one labelled as Assertion (A) and the other labelled as Reason (R). Select the correct answer to these questions from the codes (A), (B), (C) and (D) as given below.

(a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
(c) Assertion (A) is true, but Reason (R) is false.
(d) Assertion (A) is false, but Reason (R) is true.

112. **Assertion (A):** To generate only a part of the plant from a cell is totipotency.
Reason (R): Suitable special nutrient media and sterile conditions are required in 'in vitro' conditions for the division of cells in explants.

113. **Assertion (A):** Biogas plants are more often built in rural areas.
Reason (R): The excreta or gobar of cattle is rich in Methanobacterium.

114. **Assertion (A):** Gene pairs present on the same chromosome may be tightly linked or loosely linked.
Reason (R): Frequency of recombination between gene pairs on different chromosomes as a measure of the distance between genes can be used for 'mapping' their position on the chromosomes.

115. **Assertion (A):** Cu-T, Cu-7 and LNG-20 are the most widely used copper-releasing IUDs.
Reason (R): Cu-ions in IUDs effectively suppress sperm motility and the fertilising capacity of sperms.

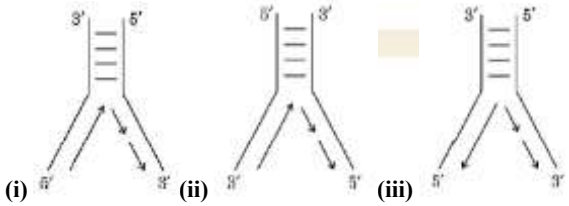
SECTION B

116. **(a) Give an account of the generalised structure of an antibody molecule produced by B-lymphocytes in response to the pathogen.**

OR

(b) Other than public awareness and counselling, enlist four measures taken up by NACO, WHO and other NGOs to prevent the spread of HIV infection in the society.

117. **Given below are the diagrammatic representations of the replicating fork of DNA in E. coli. Study the diagrams and answer the questions that follow.**



(i) (ii) (iii)

(a) Which one of the three diagrams (i), (ii) or (iii) is the correct representation of the replicating fork of DNA replication? Explain your answer.
(b) Name the enzyme used in E. coli to join the newly synthesised fragments of DNA.

118. **(a) Explain what is meant by the term amniocentesis. How is this technique misused in India?**

OR

(b) Name any two VDs which might occur in a human female. State any two complications in a female if it is left untreated.

119. The basic scheme of the essential steps involved in the process of recombinant DNA technology is summarised below in the form of a flow diagram. Study the given flow diagram and answer the questions that follow:

Step-1 **Plasmid DNA (cut using Restriction Enzyme EcoR I)** + **Foreign DNA (cut using Restriction Enzyme EcoR I)**

↓ **DNA ligase**

Step-2 **Recombinant DNA molecule**

↓

Step-3 **Transfer of recombinant DNA molecule to the host cell**

↓

Step-4 **Replication of recombinant DNA molecule in the host cell**

(a) Name the specific enzyme that might have been used to make the multiple copies of foreign DNA before undergoing Step-1 of the process.

(b) How does the use of restriction enzyme EcoR I in Step-1 facilitate the action of DNA ligase to form the recombinant DNA molecule? Explain.

(c) Name the most commonly used host in the above process.

120. (a) Explain how the interaction between a fig tree and its tight one-to-one relationship with the pollinator species of wasp is one of the best examples of mutualism.

OR

(b) Correctly depict (also indicate the trophic level) and describe the ecological pyramid of number with 32 birds dependent on 20 insects feeding on one banyan tree.

SECTION C

121. Explain the neuroendocrine mechanism involved in the process of parturition in a human female leading to the expulsion of the baby out of the uterus through the birth canal.

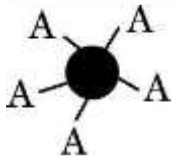
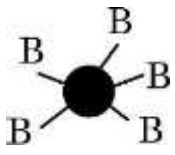
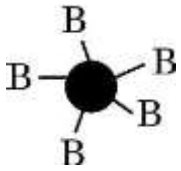
122. During a medical investigation, an infant was found to possess an extra copy of chromosome no. 21. Identify the disorder the child is suffering from. Describe the symptoms the child is likely to develop later in life.

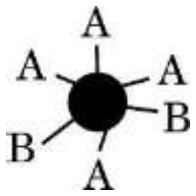
123. (a) Write the full form of BOD.

(b) Define BOD. Explain how it is a measure of the organic matter present in the water body.

124. Enlist three advantages of genetically modified plants.

125.

Genotype	RBC	Phenotype
$I^{AI\ A}$		A
I^{A}		A
$I^{B}I^{B}$		B
$I^{B}i$		B

I $^{AI\ B}$		AB
ii		O

Study the diagram above and answer the following questions :

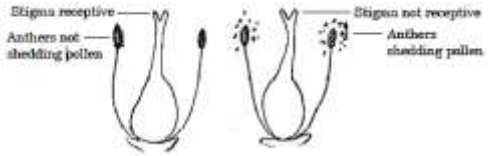
(a) How many alleles are involved in blood grouping?

(b) A person having ' AB ' blood group has both dominant alleles. What is this inheritance type called?

(c) A man with 'A' blood group marries a woman with 'B' blood group. Can they have a child with 'O' blood group ? Explain with the help of a cross.

126. Explain how the loss of habitat and fragmentation drives plants and animals to extinction with the help of an example of habitat loss in the Tropical Rain Forest. Also write the effect of fragmentation of a habitat on the population decline.

127. Many of the flowering plants producing hermaphrodite flowers have developed many devices to discourage self-pollination and to encourage cross-pollination. Given below is a picture of one such outbreeding device in a flowering plant. Study the picture and answer the questions that follow:



Flowers present on different plants of same species

(a) Explain how the given type of pollination is advantageous to the plant.

(b) Can this flowering plant show geitonogamy? Justify your answer.

SECTION D

Questions No. 29 and 30 are case-based questions. Each question has 3 sub-questions with internal choice in one sub-question.

128. Highly conserved proteins such as Haemoglobin and Cytochrome-C provide the best biochemical evidences to trace evolutionary relationships between different groups. Cytochrome-C is formed of 104 amino acids. Cytochrome-C is the respiratory pigment present in all eukaryotic cells. It has evolved at a constant rate during evolution. In chimpanzees and humans, Cytochrome-C genes are identical. The given data shows the evolution of the Cytochrome-C gene in different mammals from kangaroos, cows, rodents to humans:

Groups	Nucleotide substitution in the gene of Cytochrome-C	Millions of years ago
Human/Kangaroo	100	125 mya
Human/Cow	75	120 mya
Human/Rodent	60	75 mya

(a) Select the correct option for the time of separation of two groups and the number of nucleotide substitutions in the gene of Cytochrome-C :

Options	Time of separation of two groups during evolution	Number of nucleotide substitutions

(i)	Lesser	Greater
(ii)	Greater	Lesser
(iii)	Greater	Greater

(b) What do you infer about the type of evolution (convergent or divergent) for the given pair of groups and why ?
(i) Human and Kangaroo
(ii) Human and Rodent
(c) (i) Define convergent evolution.

OR

(c) (ii) Define divergent evolution.

129. In 2021, 5 · 3 percent of 15 to 16-year-olds worldwide (13 · 5 million individuals) had used Cannabis in the past year according to UNODC. The adolescent brain is still developing and drug use can have long-term negative effects. Early drug use initiation can lead to faster development of dependence than in adults and other problems in adulthood. Parts of the Amazon Basin are at the intersection of multiple forms of organised crimes that are accelerating devastation, with severe implications for the security, health and well-being of the population across the region. The direct impact of coca cultivation on deforestation is minimal, but indirectly it acts as a catalyst for "Narco-deforestation". The laundering of drug trafficking profits into land speculation etc. is posing a growing danger to the world's largest rainforest.

(a) Which age group or period of growth people are more vulnerable to drug abuse ?
(b) Explain the negative impact of coca cultivation on the world's largest rainforest.
(c) (i) From which part of the plant are cannabinoids mainly obtained? Mention any one negative effect of this drug on adolescents.

OR

(c) (ii) State the scientific name of the plant from which coca alkaloids are derived and state one negative impact of use of excessive dosage of cocaine.

SECTION E

130. (a) Define transgenic animals. Explain in detail any four areas where they can be used for human benefit.

OR

(b) Describe the structure and working of a sparged stirred-tank bioreactor.

131. (a) (i) Describe the population growth curve applicable in a population of any species in nature that has unlimited resources at its disposal.
(ii) Explain the equation of this growth curve.
(iii) Name the growth curve and depict a graphical plot for this type of population growth.

OR

(b) (i) Explain the conclusion drawn by Alexander von Humboldt during his extensive explorations in the wilderness of South American jungles.
(ii) Give the equation of the Species-Area relationship.
(iii) Draw a graphical representation of the relation between species richness and area for a wide variety of taxa such as birds, bats, etc.

132. (a) (i) Explain the structure of a typical monocotyledonous embryo of a flowering plant.
(ii) How are multiple embryos formed in a citrus fruit? What is the mechanism known as?

OR

(b) (i) Name and explain the structural organisation of the male sex accessory ducts in the human male reproductive system.
(ii) Describe the role of gonadotropin FSH in the regulation of spermatogenesis.

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 - Sections A, B, C, D and E.

(iii) Section A - questions number 1 to 16 are multiple choice type questions. Each question carries 1 mark.
(iv) Section B - questions number 17 to 21 are very short answer type questions. Each question carries 2 marks.
(v) Section C - questions number 22 to 28 are short answer type questions. Each question carries 3 marks.
(vi) Section D - questions number 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 - questions number 31 to 33 are long answer type questions. Each question carries 5 marks.
(viii) There is no overall choice. However, an internal choice has been provided in Sections B, D and E of the question paper. A candidate has to write answer for 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.

SECTION A

Questions no. 1 to 16 are Multiple Choice Type Questions, carrying 1 mark each. Choose the best option.

133. The process of splicing in eukaryotes represents the dominance of the :

(a) DNA world (b) RNA world
(c) Protein world (d) Lipid world

134. Regulation of lac operon by repressor is referred to as :

(a) Inducible regulation
(b) Repressible regulation
(c) Negative regulation
(d) Positive regulation

135. SNPs in Human Genome Project refers to :

(a) Polymorphism in repetitive sequences.
(b) Single-base DNA differences.
(c) Single changes in nucleotide of mRNA .
(d) Loss or gain of a gene function.

136. If a natural population with 50 individuals is in Hardy-Weinberg equilibrium for a gene with two alleles A and a, with the gene frequency of allele A of $0 \cdot 6$, the genotype frequency of A a will be :

(a) 0.16 (b) 0.36
(c) 0.24 (d) 0.48

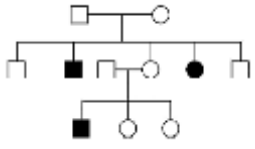
137. Given below are a few statements with respect to spermatogenesis in a human male.

(i) Sperms are released from the seminiferous tubules by the process of spermiation.
(ii) Spermiogenesis involves the maturation of spermatids into sperms.
(iii) Spermatogonia produce spermatids by the process of spermiogenesis.
(iv) Meiosis II in secondary spermatocytes results in the formation of four equal haploid spermatids.
(v) Primary spermatocyte completes the first meiotic division forming two equal, diploid cells called secondary spermatocytes.

Choose the option with all true statements from the given options:

(a) (i), (ii) and (iv) (b) (ii), (iii) and (v)
(c) (ii), (iv) and (v) (d) (i), (iii) and (iv)

138. Study the pedigree chart of a family sharing the inheritance of sickle cell anemia.



The trait traced in the above pedigree chart is:

(a) Dominant X -linked (b) Autosomal dominant
(c) Recessive X-linked (d) Autosomal recessive

139. Select the statements that are true for the seed of angiosperm from the given options:

(i) Non-albuminous seeds have no residual endosperm.
(ii) Residual, persistent nucellus in wheat is known as perisperm.

(iii) Integuments of ovules harden as tough protective seed coat.

(iv) Metabolic activity of the embryo slows down in dormancy.

Choose the correct option:

(a) (i) and (ii) (b) (ii) and (iii)

(c) (iii) and (iv) (d) (i) and (iv)

140. Which of the following do not follow the law of independent assortment ?

(a) Genes on non-homologous chromosomes and absence of linkage

(b) Two or more genes on homologous chromosomes

(c) Linked genes located on the same chromosomes

(d) Two or more distant genes present on the same chromosome

141. A characteristic property that distinguishes a malignant tumor from a benign tumor is :

(a) Metamorphosis (b) Metastasis

(c) Metabolism (d) Metagenesis

142. The cloning site present in the tetracycline resistance gene of E. coli cloning vector pBR 322 is:

(a) EcoR I (b) Pvu II

(c) Sal I (d) Pst I

143. Bottled fruit juices are clearer as compared to those made at home, as they are clarified by the use of:

(a) Lipases and pectinases

(b) Pectinases and proteases

(c) Proteases and cellulases

(d) Nucleases and lipases

144. In his observations of small black birds in the Galapagos Islands, Darwin found that all the finches arose from the original ancestor :

(a) Insect-eating finches

(b) Seed-eating finches

(c) Cactus-eating finches

(d) Fruit-eating finches

For Questions number 13 to 16, two statements are given - one labelled as Assertion (A) and the other labelled as Reason (R). Select the correct answer to these questions from the codes (A), (B), (C) and (D) as given below.

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

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

(c) Assertion (A) is true, but Reason (R) is false.

(d) Assertion (A) is false, but Reason (R) is true.

145. Assertion (A): In dihybrid crosses involving sex-linked genes in Drosophila generation of non-parental gene combinations are observed.

Reason (R) : Two genes present on different chromosomes show linkage and recombination in Drosophila.

146. Assertion (A): Male contraceptive 'Nirodh' works on the principle of avoiding chances of ovum and sperm meeting.

Reason (R) : It is made of thin rubber/latex sheath and is used to cover the penis before coitus.

147. Assertion (A): Isolated single cells can be fused to produce somatic hybrids.

Reason (R) : Cells selected for somatic hybridisation have desirable characters.

148. Assertion (A): In humans, filariasis is characteried by inflammation in the lower limbs.

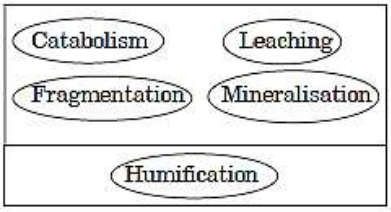
Reason (R) : Filarial worm usually lives in the lymphatic vessels of the lower limbs.

SECTION B

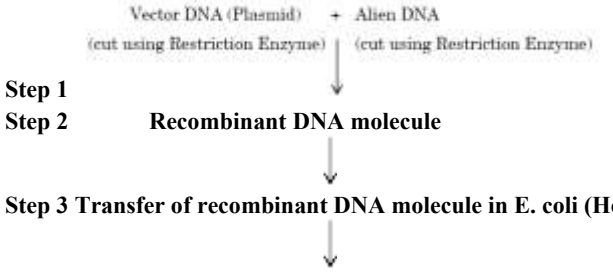
149. (a) How is the interaction between Ophrys and its specific bee pollinator one of the best examples of co-evolution? Explain.

OR

(b) Arrange the given important steps of decomposition in their correct order of occurrence in the breakdown of complex organic matter and explain the fourth step in the process.



150. The basic scheme of the essential steps involved in the process of recombinant DNA technology is summarised below in the form of a flow diagram. Study the given flow diagram and answer the questions that follow.



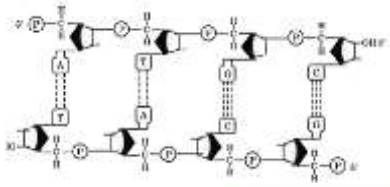
(a) What is the technical term used for Step 4 in the above process?
(b) Which of the given two combinations of restriction enzyme should be used in Step 1 ? Justify your answer.
(i) EcoR I to cut the plasmid and Hind III to cut the alien DNA.
(ii) EcoR I to cut both the plasmid and alien DNA.

151. (a) (i) Explain why the milk produced by the mother during the initial days of lactation is considered to be very essential for the newborn infant.
(ii) What is the term used for the milk produced during the initial days of lactation?

OR

(b) Many children in the metro cities are suffering from a very common exaggerated response of the immune system to certain weak antigens in air.
(i) What is the term used for the above mentioned disease?
(ii) Name the main type of antibody produced by the immune system in response to this disease.
(iii) Which two main inflammation-causing chemicals are produced by the mast cells in such an immune response?

152. Study the given molecular structure of double-stranded polynucleotide chain of DNA and answer the questions that follow.



(a) How many phosphodiester bonds are present in the given double-stranded polynucleotide chain?
(b) How many base pairs are there in each helical turn of double helix structure of DNA? Also write the distance between a base pair in a helix.
(c) In addition to H-bonds, what confers additional stability to the helical structure of DNA?

153. (a) Why are restrictions imposed on MTP in India ? Up to how many weeks or trimesters, is MTP considered relatively safe for a female, if necessary to perform, by a medical practitioner?

OR

(b) Expand PID. Name any two common viral infections transmitted through sexual contact in human females.

SECTION C

154. Flowering plants with hermaphrodite flowers have developed many reproductive strategies to ensure cross-pollination. Study the given outbreeding devices adopted by certain flowering plants and answer the questions that follow.

Pollen grains / Stigma	Pollen grains of Plant A	Pollen grains of Plant B	Pollen grains of Plant C
Stigma of Plant A	×	✓	✓
Stigma of Plant B	✓	×	✓
Stigma of Plant C	✓	✓	×

All plants belong to the same species.

× – No pollen tube growth/inhibition of pollen germination on stigma.

✓- Pollen germination on stigma.

(a) Name and define the outbreeding device described in the above table.

(b) Explain what would have been the disadvantage to the plant in the absence of the given strategy.

155. (a) Alien species are highly invasive and are a threat to indigenous species. Substantiate this statement with the help of any two examples.

(b) State any two criteria for determining biodiversity hotspots.

156. Answer the following questions with respect to the sex determining mechanism observed in honey bee.

(a) Name the type of sex determination system observed in honey bee.

(b) Fill in the blanks (i), (ii) and (iii) in the given question.

Parent	Male
• Type of cell division involved during gamete formation in males • Number of chromosomes in the gametes • Number of chromosomes in the diploid cell of the progeny	(i) ___ (ii) ___ (iii) ___

(c) What will be the sex and chromosome number of the progeny formed from the unfertilised eggs of honey bee?

157. Explain how the addition of lactose in the medium regulates the switching on of the lac operon in bacteria.

158. (a) Name and explain the role of inner and middle walls of the human female uterus.

(b) Write the location and function of fimbriae in human female.

159. (a) What do you mean by activated sludge in an STP ?

(b) Explain the biological treatment of the major part of the sludge transferred from the large aeration tank into the anaerobic sludge digesters before its final release into the natural water bodies.

160. Explain the beneficial role of the following, produced as a result of the processes of biotechnology, to mankind:

(a) Cow named Rosie

(b) α-1-antitrypsin

SECTION D

Questions No. 29 and 30 are case-based questions. Each question has 3 sub-questions with internal choice in one sub-question.

161. Read the following passage and answer the questions that follow.

According to evolutionary theory, every evolutionary change involves the substitution of a new gene for the old one and the new allele arises from the old one. Continuous accumulation of changes in the DNA coding for proteins leads to evolutionary differences. The chemical composition of DNA is basically the same in all living beings, except for differences in the sequence of nitrogenous bases. Given below are percentage relative similarities between human DNA and DNA of other vertebrates:

S.No.	Vertebrates	Percentage similarities

1.	Chimpanzee	100
2.	Gibbon	94
3.	Rhesus Monkey	88
4.	Lemur	47
5.	Treeshrew	28
6.	Mouse	21
7.	Hedgehog	19
8.	Chicken	10

(a) What is the term used for the substitution of a new gene for the old one and the new allele arising from the old one during evolutionary process?

(b) Which one of the following holds true for the data provided in the above table?

(A) Greater the evolutionary distance, greater are the differences in the nitrogenous bases.

(B) Lesser the evolutionary distance, greater are the differences in the nitrogenous bases.

(C) Greater the evolutionary distance, lesser are the differences in the nitrogenous bases.

(D) Lesser the evolutionary distance, lesser are the differences in the nitrogenous bases.

(c) (i) To which category of evolution (divergent or convergent) does the following relationship belong to? Justify your answer.

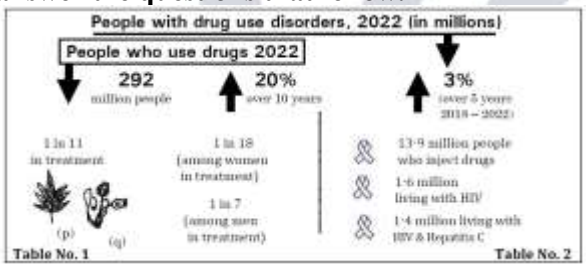
Human and Rhesus Monkey

OR

(c) (ii) Differentiate between Convergent and Divergent evolution.

162. Read the following passage and answer the questions that follow.

Prevention is the frontline response to drug use. Effective interventions address the underlying conditions contributing to drug use, such as a lack of connection to family or community, instability, insecurity, trauma, mental health issues, etc. When addressed, these factors can effectively prevent the initiation of drug use and the progression to drug use disorders. Study the few key figures of drug use given below and answer the questions that follow.



(a) What do you infer from the figures in Table No. 1 about the people with drug use disorders, 2022 (in million)? State any two of your observations.

(b) How are Hepatitis C and HIV related to drug use disorders by people, as shown in Table No. 2 ? State the correlation between the two.

(c) (i) Give the scientific name of (p) shown in Table No. 1.

OR

(c) (ii) Give the scientific name of (q) shown in Table No. 1.

SECTION E

163. (a) (i) Explain how some strains of Bacillus thuringiensis produce proteins that kill certain insects such as lepidopterans but do not kill the Bacillus.

(ii) How is the above mechanism exploited for the production of Bt cotton plant by biotechnologists?

OR

(b) (i) Explain how the amplification of gene of interest is done using PCR.

(ii) State two applications of the desired amplified fragment of DNA.

164. (a) (i) Explain the structure of a mature embryo sac of a typical flowering plant.

(ii) How is triple fusion achieved in these plants?

OR

(b) Describe the changes in the ovary and the uterus as induced by the changes in the level of pituitary and ovarian hormones during menstrual cycle in a human female.

165. (a) (i) Describe the Species-Area relationship as observed by Alexander von Humboldt, for a wide variety of taxa in nature.

(ii) Draw the graph showing Species-Area relationship for $S = CA^Z$. What is the significance of ' Z ' in Species-Area relationship?

OR

(b) (i) Describe the logistic population growth curve with the help of a suitable graphical representation.

(ii) Write the equation of Verhulst-Pearl logistic growth curve and explain what ' K ' and ' r ' suggest in the given equation.

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 - Sections A, B, C, D and E.

(iii) Section A - questions number 1 to 16 are multiple choice type questions. Each question carries 1 mark.

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

(v) Section C - questions number 22 to 28 are short answer type questions. Each question carries 3 marks.

(vi) Section D - questions number 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 - questions number 31 to 33 are long answer type questions. Each question carries 5 marks.

(viii) There is no overall choice. However, an internal choice has been provided in Sections B, D and E of the question paper. A candidate has to write answer for 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.

SECTION A

Questions no. 1 to 16 are Multiple Choice Type Questions, carrying 1 mark each. Choose the best option.

166. What are minisatellites ?

(a) $10 - 40$bp sized small sequences within the genes.

(b) Short coding repetitive sequences region on the eukaryotic genome.

(c) Short non-coding repetitive sequences forming a large portion of eukaryotic genome.

(d) Regions of coding strand of DNA.

167. Identify the incorrect statement regarding PCR.

(a) Two sets of primers are required during polymerisation.

(b) The process of replication is repeated multiple times to produce one billion copies.

(c) Thermostable DNA polymerase is used for extension of primers.

(d) Annealing is required to separate both the strands of template DNA.

168. The following information is about drugs and tobacco. Select the correct statement from the options given below.

(a) Cocaine is given to patients after surgery as it stimulates recovery.

(b) Chewing tobacco lowers blood pressure and heart rate.

(c) Barbiturates when given to criminals makes them tell the truth.

(d) Morphine is often given to persons who have undergone surgery as a painkiller.

169. Given below are the events that are observed in an artificial hybridisation programme. Arrange them in the correct sequential order and select the correct option.

(i) Re-bagging

(ii) Selection of parents

(iii) Bagging

(iv) Dusting the pollens on stigma

(v) Emasculation

(vi) Collection of pollens from male parent

(a) (ii), (iii), (v), (vi), (iv), (i)
(b) (ii), (v), (iii), (vi), (iv), (i)
(c) (v), (ii), (iii), (vi), (i), (iv)
(d) (ii), (iii), (vi), (iv), (v), (i)

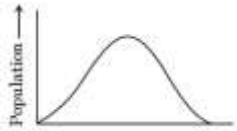
170. Which of the following conditions correctly describes the manner of determining the sex in the given options ?

(a) Homozygous sex chromosomes (ZZ) determine female sex in birds.
(b) XO type of chromosomes determine male sex in grasshoppers.
(c) XO condition in humans determines female sex.
(d) Homozygous sex chromosomes (XX) produce male in Drosophila.

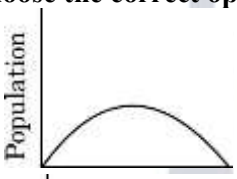
171. Choose the option that correctly describes the gynoecium of Michelia :

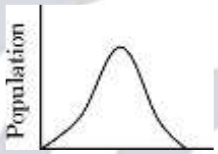
(a) Multicarpellary, Apocarpous
(b) Bicarpellary, Apocarpous
(c) Multicarpellary, Syncarpous
(d) Bicarpellary, Syncarpous

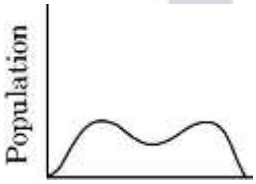
172. The given graph shows the range of variation among population members, for a trait determined by multiple genes. If this population is subjected to disruptive selection for several generations, which of the following distributions is most likely to result?

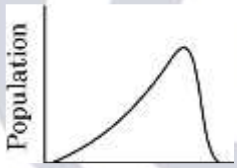


Choose the correct option:

(a) 

(b) 

(c) 

(d) 

173. Which one of the following immune system components does not correctly match with its respective role?

(a) Interferons - Secreted by virus-infected cells and protect non-infected cells from further viral infection.
(b) Macrophages - Mucus-secreting cells that trap microbes entering into the body.
(c) B-Lymphocytes - Produce antibodies in response to pathogens into blood to fight with them.
(d) IgA - Present in colostrum in early days of lactation to protect infants from diseases.

174. Which one of the following is not the product of transgenic experiments ?

(a) Pest-resistant crop variety
(b) High nutritional value in grains
(c) Drought-resistant crops
(d) Production of insulin by rDNA technique

175. A biologist studied the population of rats in a granary. He found the average natality was 280, average mortality was 200 , immigration was 40 and emigration was 50 . The net increase in population is:

(a) 80 (b) 70
(c) 10 (d) 90

176. India has only 2.4% of the world's land area but its share of the global species diversity is:

(a) 8 · 1% (b) 12 · 9%

(c) 7 · 3% (d) 5 · 1%

177. Out of the following, select the correct match:

(a) Transgenic cow milk - Human beta-lactalbumin protein

(b) ELISA - Antigen antibody interaction

(c) Corn Borer-Cry II Ab gene

(d) Cotton plant-Meloidegyne Incognitia

For Questions number 13 to 16, two statements are given - one labelled as Assertion (A) and the other labelled as Reason (R). Select the correct answer to these questions from the codes (A), (B), (C) and (D) as given below.

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

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

(c) Assertion (A) is true, but Reason (R) is false.

(d) Assertion (A) is false, but Reason (R) is true.

178. Assertion (A): Swiss cheese is characterized by large holes due to CO_2 production.

Reason (R): It is ripened by growing a specific fungi.

179. Assertion (A): Replication of DNA takes place in S phase of the cell cycle.

Reason (R): DNA replication and cell division cycle should be highly coordinated.

180. Assertion (A): A male individual always inherits haemophilia from his mother.

Reason (R): The gene for haemophilia lies on X-chromosome.

181. Assertion (A): A piece of DNA inserted into an alien organism generally does not replicate, if not inserted into a chromosome.

Reason (R): Chromosomes have specific sequences called 'ori' region, where DNA replication is initiated.

SECTION B

182. (a) Name the Indian crop variety for which, in 1997, an American company got patent rights through the US Patent and Trademark Office. This is considered a case of Biopiracy. Justify.

OR

(b) State two purposes for which the Indian Government has set up GEAC (Genetic Engineering Approval Committee).

183. (a) "A fully developed foetus initiates its delivery from the mother's womb." Explain.

OR

(b) Give reasons for the following:

(i) Why can a woman generally not conceive a child after 50 years of age?

(ii) Polar bodies are formed during oogenesis and not during spermatogenesis.

184. A few stages and their respective time period in the evolutionary history of human beings are mentioned in the flowchart given below:

15 mya - Primates walking like gorillas and chimpanzees existed. (a)

↓

3-4 mya- Man-like primates walked in Eastern Africa. Fossils of their bones were discovered. (b)

↓

2 mya - This ancestor lived in the East African grasslands and ate fruits. (c)

↓

1·5 mya- This hominid had a brain size of 900 cc and probably ate meat. (d)

Based on the above information, answer the following questions :

(a) Name one primate about 15 mya.3-4

(b) Name one place where fossils of primates were discovered in Eastern Africa.

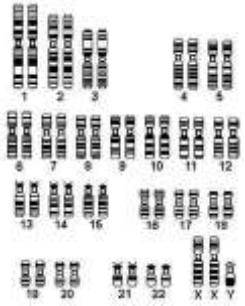
(c) Name the ancestor that lived in the East African grasslands about 2 mya.
(d) Name the hominid that was found around 1.5 mya.

185. (a) How does a human body respond when vaccine is introduced into it ? It is said that vaccinations are a must for a healthy society. Justify.

OR

(b) Humans have innate immunity for protection against pathogens that may enter the gut along with food. What are the two barriers in our body that protect it from such pathogens?

186. A karyotype of a human suffering from a certain disorder is given below:



(a) Identify the disorder.
(b) Write the symptoms of the disorder.
(c) Give reason for such a disorder.

SECTION C

187. A village health worker was taking a session with women. She tells them that one has to be careful while using oral pills as a method of birth control. Wrong usage can actually promote conception.
(a) Analyse the above statement and compare the merits and demerits of using oral pills and surgical methods of birth control.
(b) Village women are confused as to how a thin metallic copper loop can provide protection against pregnancy. Explain the mode of action of IUDs. Give two points.

188. (a) "The process of evolution of different species in a given geographical area starts from a point and literally radiates to other geographical areas." Explain it with an example.
(b) Cite an example where more than one adaptive radiation has occurred in an isolated geographical area. Name the type of evolution your example depicts.

189. A segment of DNA, 'TTG AGG GGG ATG' was translated into an oligopeptide with the amino acids, Lysine-Serine-Proline-Tyrosine.
(a) Write the codons in correct sequence for the four amino acids.
(b) If first adenine in DNA is substituted by guanine, what will be the sequence of amino acids in the new oligopeptide?
(c) Write the anticodons for these amino acids.

190. A person is suffering from high grade fever. Which symptoms will help to identify if he/she is suffering from Typhoid, Pneumonia or Malaria?

191. (a) Why are transgenic animals so called ?
(b) With the help of an example each, explain the role of transgenic animals in the following :
(i) Vaccine safety
(ii) Biological products

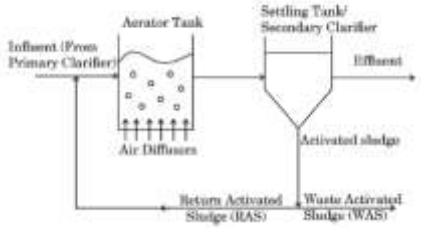
192. (a) Mention any two advantages of micropropagation techniques.
(b) Write in brief how the process is carried out in the laboratory.
(c) Name any two important food plants grown commercially by this method.

193. Name the type of food chains responsible for the flow of larger fraction of energy in an aquatic ecosystem and a terrestrial ecosystem, respectively. Mention any two differences between the two food chains.

SECTION D

Questions No. 29 and 30 are case-based questions. Each question has 3 sub-questions with internal choice in one sub-question.

194. Study the figure given below and answer the questions that follow.



(a) Identify the figure and state its importance.
(b) Why is air diffused into the aerator tank? Explain.
(c) (i) What changes take place in the settling tank ?

OR

(c) (ii) How is BOD related to organic matter present in the water?

195. The following question is based on pollination. Study the figures carefully and answer the questions that follow.

Figure A **Figure B**

(a) Give the scientific terms for the processes taking place in Figures A and *B* respectively.
(b) Mention two conditions necessary for the process occurring in Figure B.
(c) (i) State one advantage and one disadvantage of the process occurring in Figure B.

OR

(c) (ii) Name one plant where, in some flowers only, the process in Figure B takes place and give the reason responsible for it.

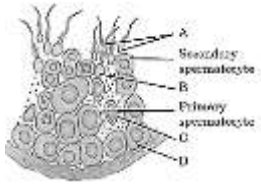
SECTION E

196. (a) Write the features a molecule should have to act as a genetic material. In the light of the above features, evaluate and justify the suitability of the molecule that is preferred as an ideal genetic material.

OR

(b) Differentiate between the following:
(i) Polygenic Inheritance and Pleiotropy
(ii) Dominance, Codominance and Incomplete dominance

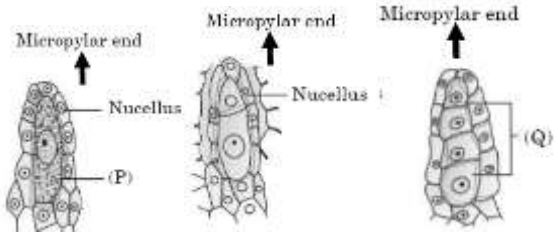
197. (a) Study the given diagram showing the sectional view of a seminiferous tubule.



Answer the following questions:
(i) Label A, B, C and D in the figure.
(ii) What will be the number of chromosomes in secondary spermatocyte and spermatid respectively?
(iii) Explain the terms - Spermiogenesis and Spermiation.

OR

(b) Study the figures given below showing initial stages in the formation of female gametophyte and answer the questions that follow.



(i) Identify (P) and (Q).
(ii) I. What kind of division does cell (P) undergo to form (Q) ?
II. How many (Q) cells form the embryo sac ? What is the name given to such kind of development?
III. How many free nuclear mitotic divisions will the functional megaspore undergo to form the embryo sac?
IV. Describe the structure of a mature female gametophyte.

198. (a) (i) How does alien species invasion cause a decline in biodiversity? Explain.
How have the following contributed to biodiversity loss?
I. Nile Perch
II. Lantana and Eichhornia
III. Clarias gariepinus
(ii) Why have certain regions been declared as biodiversity hotspots by environmentalists of the world ? Name any two such regions in India.

OR

(b) (i) Write an equation for Verhulst-Pearl Logistic Growth Curve where:
N = Population density at time ' t '
r = Intrinsic rate of natural increase
(ii) Draw a graph for a population whose population density has reached carrying capacity.
(iii) Draw a growth curve where resources are non-limiting to growth of population.
(iv) Which growth curve is considered more realistic and why ? Explain.

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 - Sections A, B, C, D and ***E***.
(iii) Section A - questions number 1 to 16 are multiple choice type questions. Each question carries 1 mark.
(iv) Section B - questions number 17 to 21 are very short answer type questions. Each question carries 2 marks.
(v) Section C - questions number 22 to 28 are short answer type questions. Each question carries 3 marks.
(vi) Section D - questions number 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* - questions number 31 to 33 are long answer type questions. Each question carries 5 marks.
(viii) There is no overall choice. However, an internal choice has been provided in Sections B, D and E of the question paper. A candidate has to write answer for only one of the alternatives in such questions.
(ix) Wherever necessary, neat and properly labelled diagrams should be drawn.

SECTION A

Questions no. 1 to 16 are Multiple Choice Type Questions, carrying 1 mark each. Choose the best option.

199. Microspores are formed by:
(a) Meiosis of pollen mother cell
(b) Mitosis of polar nuclei
(c) Mitosis of pollen mother cell
(d) Meiosis of tapetal cells

200. Which scientist's observation helps us to calculate the expected proportion of bases in a double-stranded DNA ?
(a) James Watson (b) Matthew Meselson
(c) Rosalind Franklin (d) Erwin Chargaff

201. IUD used by females as contraceptive device is :
(a) Pill (b) Diaphragm
(c) Multiload 375 (d) Vault

202. RNA was considered as the first genetic material. Out of the evidences listed below, point out the correct evidence :

(a) Essential life processes do not involve RNA
(b) RNA is a double-stranded structure
(c) RNA can act as catalysts
(d) RNA, like protein enzymes, are stable

203. Regulation of lac operon by repressor is referred to as which of the following type of regulation?

(a) Both positive and negative regulation
(b) Only negative regulation
(c) Only positive regulation
(d) Sometimes positive, sometimes negative regulation

204. Which of the following options is a Stop codon?

(a) UUU (b) UGA
(c) UGU (d) UAC

205. A disorder caused due to the absence of one of the ' X ' chromosomes, i.e. 45 with XO is known as:

(a) Down's syndrome
(b) Klinefelter's syndrome
(c) Turner's syndrome
(d) Thalassemia

206. The bioactive molecules are matched with their source organism and functions. Select the incorrect pair:

(a) Fungus-Cyclosporin A, Immunosuppressive agent
(b) Yeast-Statins, Blood-cholesterol lowering agent
(c) Fungus-Streptokinase, Clot buster
(d) Microbes - Enzyme, Lipase, used in detergent formulations

207. Which one of the following exhibits ZW (female) and ZZ (male) chromosome type of sex-determination?

(a) Grasshopper (b) Drosophila
(c) Fowl (Birds) (d) Humans

208. Species which have diverged after origin from common ancestor giving rise to new species, adapted to new habitats and ways of life is called :

(a) Adaptive radiation
(b) Divergent evolution
(c) Convergent evolution
(d) Mutation

209. Which of the following given options serves as an inoculum in sewage treatment plants?

(a) A small part of activated sludge
(b) A small part of primary sludge
(c) Aerobic microbes
(d) Floating debris

210. Select the correct option about plasmid from the given options:

(a) Extrachromosomal circular DNA
(b) Double-stranded chromosomal DNA
(c) Single stranded rRNA
(d) Single stranded tRNA

For Questions number 13 to 16, two statements are given - one labelled as Assertion (A) and the other labelled as Reason (R). Select the correct answer to these questions from the codes (A), (B), (C) and (D) as given below.

(a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion

(A).
(c) Assertion (A) is true, but Reason (R) is false.
(d) Assertion (A) is false, but Reason (R) is true.

211. **Assertion (A):** Pollen grains are well preserved as fossils.
Reason (R): Fossils are formed only from bones and teeth of animals.

212. **Assertion (A) :** The template strand has the polarity of $5' \rightarrow 3'$ and sequences are same as RNA (except thymine at the place of uracil).
Reason (R): The strand that is referred to as coding strand does not code for anything.

213. **Assertion (A):** Antibiotics are chemical substances, which are produced by some microbes and can kill or retard the growth of other disease-causing microbes.
Reason (R): All micro-organisms like fungi, bacteria, protozoans are used to produce antibiotics.

214. **Assertion (A):** Single-stranded portions of RNA are known as sticky ends.
Reason (R): DNA fragments with the same kind of 'sticky ends' can be joined together using DNA ligases.

SECTION B

215. (a) (i) What is the ploidy of primary spermatocytes and secondary spermatocytes?
(ii) Point out one difference in first meiotic division of spermatogenesis and oogenesis.

OR

(b) (i) Mention the function of trophoblast in the human embryo.
(ii) What is meant by 'Placenta'?

216. (a) How does polygenic inheritance show deviation from Mendelian inheritance?

OR

(b) Explain briefly the two non-Mendelian patterns of inheritance that are observed in blood groups of humans.

217. What function is performed by tears shed by our eyes? Which type of barrier is this in the process of immunity? Give another similar example.

218. Name and explain in brief one method which is used to introduce alien DNA into an animal cell and plant cell respectively.

219. (a) Describe the population logistic growth model and provide its equation.

OR

(b) Explain this process of decomposition of detritus till the formation of humus.

SECTION C

220. Give any three adaptations found in wind-pollinated plants.

221. Describe the structure of the uterus wall and functions performed by any of its two layers.

222. What is a replication fork? How does it aid replication of long strands of DNA?

223. What is polymorphism in DNA? Give any two applications of DNA polymorphism.

224. Though baculoviruses are pathogens, they are used as biological control agents. Give three reasons why they are preferred.

225. Mention a method that can detect a pathogen at very low concentrations even when symptoms are not visible. Which two diseases are detected by this method ?

226. Distinguish between predator and prey. Mention any two significant roles that predators play in nature.

SECTION D

Questions No. 29 and 30 are case-based questions. Each question has 3 sub-questions with internal choice in one sub-question.

227. Read the following passage and answer the questions that follow.

In a given population, the frequency of occurence of alleles of a gene or a locus is supposed to remain fixed and even remain the same through generations. Hardy-Weinberg principle stated it using algebraic equations. Certain factors are known to affect Hardy-Weinberg equilibrium. These are gene migration, genetic drift, etc. When migration of a section of population to another place and population occur, gene frequencies change in the original as well as in the new population. Sometimes the change in allele frequency is so different in the new sample of population that they become a different species.

(a) Define Hardy-Weinberg equilibrium.

(b) What do you understand by Founder effect?

(c) (i) "Gene migration can affect Hardy-Weinberg equilibrium." Explain.

OR

(c) (ii) How can mutations result in evolution ? Explain.

228. Read the following passage and answer the questions that follow.

Generally, all of us have been vaccinated at various ages according to a schedule. Certain vaccines are taken only once and yet protection is provided for a long time or even for a lifetime in some cases.

(a) What name is given to such a type of immune response? Also name the property which is responsible for it.

(b) What are the types of this immune response? Describe briefly.

(c) (i) What are the special types of blood cells that help to achieve this type of immunity and how?

OR

(c) (ii) What is anamnestic response?

SECTION E

229. (a) The study of plants shows that:

(i) Angiosperms or seed-producing plants have the widest distribution. Describe how the presence of seed is advantageous to angiosperms. Mention any three points.

(ii) Differentiate between perisperm and pericarp.

(iii) What is Polyembryony ? Give an example.

OR

(b) (i) Name the source of gonadotropins in human females. Explain the changes brought about in the ovary by these hormones during menstrual cycle.

(ii) Name any two specific hormones which are produced by placenta only during pregnancy.

(iii) Where are the stem cells located in the human embryo? What is their significance?

230. (a) Describe five benefits of genetically modified organisms.

OR

(b) Describe the structure of Insulin. How does maturation of Insulin occur? What reaction can occur in a person who is given insulin from an animal source?

231. (a) (i) Explain with an example how mutualistic interaction involves co-evolution.

(ii) What is endemism? Name any two hotspots found in India.

OR

(b) (i) If the population density (N) at a particular time (t) is 500 , what would the population density be at another specified time $(t + 1)$ with the following data?

Natality = 100

Mortality = 50

Immigration = 300

Emigration = 250

(ii) Differentiate between in situ conservation and ex situ conservation.