

BIOLOGY – FULL SYLLABUS
MOCK TEST PAPER - 3
CBSE BOARD CLASS – XII (2025-26)

Maximum Marks : 70

Time : 3 Hours

General Instructions :

- (i) All questions are compulsory.
- (ii) The question paper has five sections and 33 questions. All questions are compulsory.
- (iii) Section-A has 16 questions of 1 mark each; Section-B has 5 questions of 2 marks each; Section- C has 7 questions of 3 marks each; Section- D has 2 case-based questions of 4 marks each; and Section-E has 3 questions of 5 marks each.
- (iv) 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.
- (v) Wherever necessary, neat and properly labeled diagrams should be drawn.

SECTION - A

1. To prove that DNA is the genetic material, which radioactive isotopes were used by Hershey and Chase (1952) in their experiments?
(a) ^{35}S and ^{15}N (b) ^{32}P and ^{35}S (c) ^{32}P and ^{15}N (d) ^{14}N and ^{15}N
2. Complete the given table showing different possibilities of genotypes and their corresponding blood groups, by selecting the correct option.

Genotypes	Blood groups
$I^A I^A$, (i)	A
$I^B I^B$, (ii)	B
(iii)	AB
(iv)	O

- (i) (ii) (iii) (iv)

(a) ii $I^B i$ $I^A i$ $I^A I^B$
(b) $I^A i$ $I^B i$ ii $I^A I^B$
(c) $I^A i$ $I^B i$ $I^A I^B$ ii
(d) $I^A i$ $I^B i$ $I^A I^B$ $I^B i$
3. The theory of natural selection was given by
(a) Lamarck (b) Alfred Wallace (c) Charles Darwin (d) Oparin and Haldane.
4. The biomass available for consumption by the herbivores is called
(a) net primary productivity (b) secondary productivity
(c) standing crop (d) gross primary productivity.
5. Which of the following is correctly matched for the product produced by them?
(a) *Methanobacterium* : Lactic acid (b) *Penicillium notatum* : Penicillin
(c) *Saccharomyces cerevisiae* : Acetic acid (d) *Acetobacter aceti* : Antibiotics

7. Match column I with column II and select the correct answer from the given codes.

	Column I		Column II
A.	amp^R gene	(i)	Artificial plasmid
B.	Separation of DNA fragments	(ii)	Selectable marker
C.	<i>Hind</i> II	(iii)	Electrophoresis
D.	pBR322	(iv)	<i>Haemophilus influenzae</i> Rd

8. A country with a high rate of population growth took measures to reduce it. The figure below shows age-sex pyramids of populations A and B twenty years apart. Select the correct interpretation about them.



Interpretations:

- (a) "B" is earlier pyramid and shows stabilised growth rate.
- (b) "B" is more recent showing that population is very young.
- (c) "A" is the earlier pyramid and no change has occurred in the growth rate.
- (d) "A" is more recent and shows slight reduction in the growth rate.

9. A plant has 24 chromosomes in “microspore mother cell”. The number of chromosomes in its endosperm will be

Which of the following microbes is used for the commercial production of ethanol?

- (a) *Clostridium butylicum*
- (b) *Trichoderma polysporum*
- (c) *Mycobacterium tuberculosis*
- (d) *Saccharomyces cerevisiae*

¹¹ Match 1 and 2 with 1 and 2. Hand 1 and 2 with 1 and 2.

Match column I with column II and select the correct			
	Column I		Column II
A.	Apomixis	(i)	Mango
B.	Polyembryony	(ii)	Seedless fruit
C.	Parthenocarpy	(iii)	Asteraceae

12. Which of the following is used as 'clot buster' for removing clots from blood vessels of patient who have undergone myocardial infarction?

- Ethanol
- Statins
- Cyclosporin-A
- Streptokinase

Question No. 13 to 16 consist of two statements – Assertion (A) and Reason (R). Answer these questions selecting the appropriate option given below:

- Both A and R are true and R is the correct explanation of A.
- Both A and R are true and R is not the correct explanation of A.
- A is true but R is false.
- A is false but R is true.

13. **Assertion :** Relationship between *Balanus* and *Chthamalus* is said to be an example of competition.

Reason : In amensalism, one species is harmed whereas the other is unaffected.

14. **Assertion :** Dodo, Passenger pigeon, Steller's sea cow have become extinct due to over exploitation.

Reason : Excessive exploitation of a species, whether animal or plants reduces size of its population so that it becomes vulnerable to extinction.

15. **Assertion :** Threatened species are those living species which have been greatly reduced in their number and are liable to become extinct if the causative factors continue.

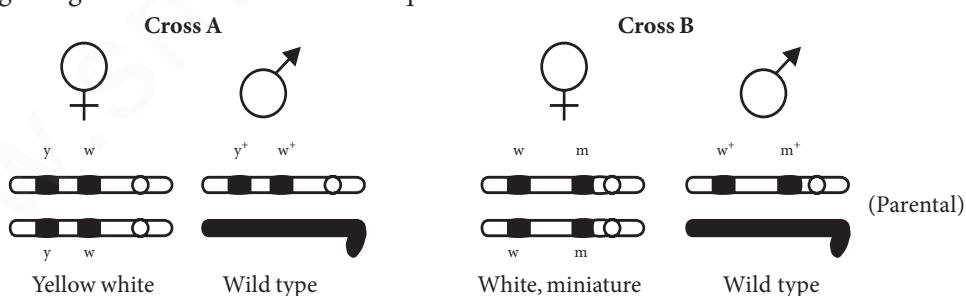
Reason : IUCN is an international organisation which maintains the IUCN Red List of threatened species, to assess the conservation status of different species.

16. **Assertion :** In a microsporangium, the tapetal cells possess little cytoplasm and generally have a single prominent nucleus.

Reason : During microsporogenesis, the microspore mother cells (MMCs) undergo meiotic divisions to produce haploid microspore tetrads.

SECTION - B

17. Study the figures given below and answer the question.

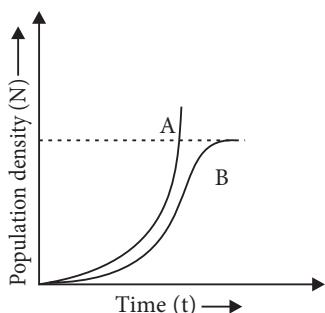


Identify in which of the given crosses, the strength of linkage between the genes is higher. Give reason in support of your answer.

- List the different parts of the human oviduct through which the ovum travels till it meets the sperm for fertilisation.
- How is insertional inactivation of an enzyme used as a selectable marker to differentiate recombinants from non-recombinants?

20. Explain, giving two reasons, how immune response by "vaccine" is different from that by "antitoxin injected to humans.

21. Study the graph given below and answer the questions that follow.



(a) Write the status of food and space in the curves A and B.

(b) Time has been shown on X-axis and there is a parallel dotted line above it. Give the significance of this dotted line.

OR

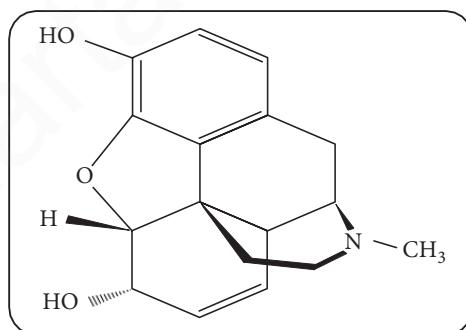
What is mutualism? Explain with an example.

SECTION - C

22. Why is the possibility of a human female suffering from haemophilia rare ? Explain.

23. How would *lac* operon operate in *E. coli* growing in a culture medium where lactose is present as source of sugar?

24. Identify the chemical structure of compound shown below. State any three of its physical properties.



25. Explain the roles of the following with the help of an example each, in recombinant DNA technology :

(a) Restriction endonucleases

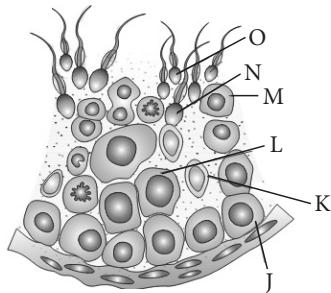
(b) Plasmids

26. Many plant and animal species are on the verge of their extinction because of loss of forest land by indiscriminate use by the humans. As a biology student what method would you suggest along with its advantages that can protect such threatened species from getting extinct?

OR

Compare narrowly utilitarian and broadly utilitarian approaches to conserve biodiversity, with the help of suitable examples.

27. Study the transverse section of part of seminiferous tubule and answer the following questions.



- (a) Identify the cell that undergo reduction division to form secondary spermatocyte.
- (b) How many among the labelled parts have 46 chromosomes?
- (c) State the role of 'K' in this figure.

28. Explain the events in a normal woman during her menstrual cycle on the following days :

- (a) Pituitary hormone levels from 8 to 12 days.
- (b) Uterine events from 13 to 15 days.
- (c) Ovarian events from 16 to 23 days.

SECTION - D

Q. No. 29 and 30 are case based questions. Each question has 3 subparts with internal choice in one subpart.

29. A person gave blood at a blood donation camp where the nurse recklessly injected used syringe. After that, he suffered from bouts of fever, diarrhoea and weight loss and experienced weakness. The levels of helper T-lymphocytes and interferons showed significant change. Doctor suggested he was suffering from severe viral infection.

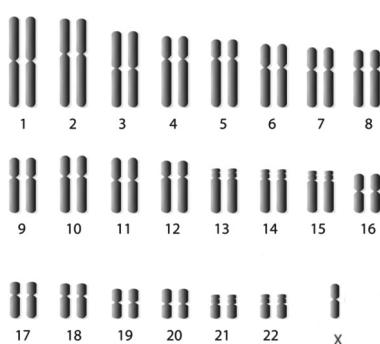
- (a) Name the diagnostic test for the given condition.

OR

Name the virus and enzyme responsible for its replication.

- (b) Mention two measures for preventing this viral infection.
- (c) Name the cells of immune system of body that are affected by this infection. Also, mention its role.

30. Given below shows karyotype of a child who is suffering from a sex chromosomal abnormality which occurs during failure of segregation of chromatids during cell division cycle. This results in the gain or loss of a chromosome (s), called aneuploidy.



- (a) Name the type of aneuploidy shown in this disease.
- (b) Write the chromosomal complement of the child.
- (c) How does sex chromosomal abnormality occurred in the child?

OR

Mention the diagnostic features of the disease.

SECTION - E

31. (a) What is gene therapy?
(b) Mention the cause of ADA deficiency in humans. How has genetic engineering helped patients suffering from it?

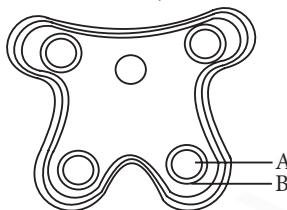
OR

Explain with the help of diagram the process of amplification of a gene of interest using polymerase chain reaction.

32. (a) IUDs are said to be effective contraceptives. Name any two commonly used IUDs and write their mode of action.
(b) Name and explain the surgical method advised to human males and females as a means of birth control. Mention its one advantage and one disadvantage.

OR

(a) In the T.S. of a mature anther given below, identify "A" and "B" and mention their functions.



(b) Name the organic material present in outer layer of pollen grain.
(c) How are 'pollen banks' useful?
33. Work out a monohybrid cross upto F_2 generation between two pea plants and two *Antirrhinum* plants both having contrasting traits with respect to colour of flower. Comment on the pattern of inheritance in the crosses carried above.

OR

(a) Dihybrid cross between two garden pea plant, one homozygous tall with round seeds and the other dwarf with wrinkled seeds was carried.
(i) Write the genotype and phenotype of the F_1 progeny obtained from this cross.
(ii) Give the different types of gametes of the F_1 progeny.
(iii) Write the phenotypes and its ratios of the F_2 generation obtained in this cross along with the explanation provided by Mendel.
(b) How were the observations of F_2 progeny of dihybrid crosses in *Drosophila* by Morgan different from that of Mendel carried in pea plants? Explain giving reasons.

SOLUTIONS

1. (b) : Hershey and Chase experiment is based on the fact that DNA contains phosphorus and similarly sulphur is present in proteins but not in DNA. They incorporated radioactive isotope of phosphorus (^{32}P) into phage DNA and that of sulphur (^{35}S) into proteins of a separate phage culture. Viruses grown in the presence of radioactive phosphorus contained radioactive DNA because DNA contains phosphorus but proteins do not. Similarly, viruses grown on radioactive sulphur contain radioactive protein because DNA does not contain sulphur.

2. (c) : In human beings, *ABO* blood groups are controlled by gene *I* which has three alleles I^A , I^B and *i*. The six possible genotypes are $I^A I^A$, $I^A I^B$, $I^A i$, $I^B I^B$, $I^B i$ and *ii*. The phenotypes which occur by these genotypes are A ($I^A I^A$, $I^A i$), B ($I^B I^B$, $I^B i$), AB ($I^A I^B$) and O (*ii*).

3. (c)

4. (a) : The total organic matter synthesised by the producers in the process of photosynthesis per unit time and area is known as gross primary productivity. Net primary productivity is equal to the rate of organic matter created by photosynthesis minus the rate of respiration and other losses. It is actually the biomass available for consumption by the herbivores.

5. (b) : *Methanobacterium* is useful in the production of biogas. *Penicillium notatum* is used to produce penicillin, an antibiotic. *Saccharomyces cerevisiae* is used for commercial production of ethanol. *Acetobacter aceti* is used to obtain acetic acid.

6. (c) : *Sal I* is a restriction enzyme isolated from *Streptomyces albus*.

7. (c) 8. (d) 9. (a)

10. (d) : Yeast (*Saccharomyces cerevisiae*) is used for commercial production of alcohol (ethanol).

11. (a)

12. (d) : Streptokinase is used as 'clot buster' for removing clots from blood vessels of patients who have undergone myocardial infarction.

13. (c) : In competition, both species are harmed. Interaction between *Balanus* and *Chthamalus* is an example of competition.

14. (a)

15. (b)

16. (d) : Tapetum is the innermost wall layer of a microsporangium. It nourishes the developing pollen grains. The tapetal cells enlarge radially and become filled with dense protoplasmic contents as well as nutrients. Tapetal cells are generally multinucleate or their nucleus becomes polyploid due to endopolyploidy. Microsporogenesis refers to the process of formation of haploid microspores or pollen grains from a microspore mother cell (MMC) or pollen mother cell (PMC) through meiosis.

17. In cross A, the strength of linkage between the genes is higher. The distance between the linked genes in the chromosome determines the strength of linkage. The closely located genes show stronger linkage than the distant genes, because the latter are more likely to undergo crossing over than the former.

18. Fimbriae, infundibulum, ampulla and isthmus are the main parts of oviduct, through which ovum travels till it meets the sperm for fertilisation. Finally it reaches the ampullary-isthmic junction of oviduct where fertilisation occurs.

19. Insertional inactivation refers to the process where insertion of rDNA within the coding sequence of an enzyme β -galactosidase causes its inactivation. The non-recombinants having intact functional gene, e.g., β -galactosidase produce blue colour with chromogenic substrate but when rDNA is inserted within the coding sequence of enzyme β -galactosidase, recombinants do not produce any colour. Hence recombinants can be easily differentiated from non-recombinants due to insertional inactivation.

20. The immune response by "vaccine" is different from that by "antitoxin" injected to humans due to the following reasons:

(i) Vaccines are antigenic preparation made out of pathogen, which when introduced into body, causes antibody formation against antigen, whereas antitoxins are preformed antibodies which are injected for quick immune response.

(ii) Vaccines provide active immunity whereas antitoxin provide passive immunity. So vaccines provide relief only after long period as they are based on the property of 'memory' of the immune system and generates memory B and T cells that recognises the pathogen quickly whereas antitoxin provide immediate relief.

21. (a) There is ample food and space for the population depicted by the curve A because the resources are unlimited and the curve is exponential. In curve B, there is limited food and space for the population, because the resources are limited and the curve becomes sigmoid.

(b) The dotted line represents the carrying capacity (*i.e.*, represented by 'K') of the environment. The carrying capacity represents the size of population that the environment can hold by providing necessary resources. When a population reaches this line its population size is stabilised by various environmental factors.

OR

Mutualism is an interaction between two organisms of different species where both the partners are benefitted and the association is obligatory. Mycorrhizae are associations between fungi and the roots of higher plants the fungi help the plant in the absorption of essential nutrients from the soil while the plant in turn provides the fungi with energy yielding carbohydrates.

22. Haemophilia is genetic disorder caused due to the presence of a recessive sex linked gene 'h', carried by X chromosome. It is generally observed in males as a single gene for the defect is able to express itself as the Y chromosome is devoid of any corresponding allele (X^hY). Women will only suffer from this disorder when a carrier woman (XX^h) marries with haemophilic man (X^hY). 50% girl babies will be carriers (XX^h) while the remaining 50% will be haemophilic (X^hX^h).

23. When lactose is present in the culture medium, then the *lac* operon in *E. coli* is switched on. It is because the inducer (lactose) binds to the repressor protein thereby inactivating it. It prevents binding of repressor to the operator. Consequently, RNA polymerase gets access to the promoter and transcription of structural genes proceeds.

24. The given structure represents morphine. Following are the three physical properties of morphine.

- (i) It is white in colour.
- (ii) It is odourless compound.
- (iii) It is crystalline in nature.

25. (a) Restriction endonucleases : Restriction endonucleases serve as a tool for cutting DNA molecules at predetermined sites, which is the basic requirement for gene cloning or recombinant DNA technology. For example, restriction endonuclease

EcoRI found in the colon bacteria *Escherichia coli*, recognises the base sequence GAATTC in DNA duplex and cuts its strands between G and A as shown :



(b) Plasmids : Plasmids are essential in biotechnological experiment as they help in transferring a segment of foreign DNA (gene of interest) into suitable host. Ti plasmid is widely used vector for cloning genes in plants. Plasmids have been modified to serve as vectors in the laboratory. The most widely used, versatile, easily manipulated vector, pBR322 is an ideal plasmid vector. It was the first artificially cloned vector and is used widely in gene cloning experiments.

26. Conservation of biodiversity is protection, uplift and scientific management of biodiversity so as to maintain it at its optimum level and derive sustainable benefits for the present as well as future generations. There are two types of conservation strategies – *in situ* (on site) and *ex situ* (offsite).

In situ conservation is conservation and protection of the whole ecosystem and its biodiversity at all levels in their natural habitat in order to protect the threatened species. It involves hotspots and protected areas. Hotspots are areas of high endemism and high level of species richness. Protected areas are ecological/biogeographical areas where biological diversity along with natural and cultural resources is protected, maintained and managed through legal or other effective measures. Protected areas include National parks, sanctuaries and biosphere reserves.

Ex-situ conservation is conservation of threatened plants and animals in places outside their natural homes under full protection and supervision. It includes offsite collections and gene banks.

OR

There are a number of reasons to conserve biodiversity which can be grouped as:

Narrow utilitarian : Human derive a major part of their requirement from organisms. Their direct benefits are countless. For example: (i) Food cereals : Pulses, fruits and vegetables are derived from plants and milk, egg and meat are derived from animals (ii) Fats and oils are obtained from plants and animals. (iii) Firewood as a source of energy for cooking and heating. (iv) Fibres, *e.g.*, cotton, flax silk, wool.

(v) Industrial products like tannins, lubricant, dyes, resins, and perfumes. (vi) Drugs: Nearly 25% of drugs being used by us are directly coming from plants.

Broadly utilitarian : Biodiversity is fundamental to ecosystem services of nature. For example,

(i) Oxygen: Through their photosynthetic activity plants are replenishing oxygen of the atmosphere. Amazon rainforest is estimated to contribute 20% of it. (ii) Pollination: Bees, bumble bees, butterflies, moths, beetles, birds and bats are engaged in pollination of plants which is essential for formation of fruits and seeds. (iii) Climate regulation: Forest and oceanic systems regulate global climate. (iv) Aquifers: Plant cover is essential for retention of rain water, its percolation and storage in aquifers and reservoirs.

(v) Flood and erosion control: Plant cover protects the soil from wind and water erosion. Run off of rain water is reduced so that flood water is rarely formed. (vi) Nutrient cycling : It is essential for continued availability of nutrients to plants without which there would be no photosynthetic activity.

27. (a) L represents primary spermatocyte, that undergo meiosis, which forms two equal haploid cells called secondary spermatocytes.

(b) Spermatogonium (J) and primary spermatocytes (L) are diploid ($2N$), *i.e.*, have 46 chromosomes.

(c) The cells that nourish the germ cells in the testes are called Sertoli cells (K). Sertoli cells are located in the germinal epithelium of the seminiferous tubules.

28. (a) From 8-12 days (follicular phase), the level of gonadotropins (LH and FSH) increase gradually and stimulate follicular development as well as secretion of estrogens by growing follicles.

(b) From 13 to 15 days, the endometrium becomes thicker by rapid cell multiplication and there is increase in uterine glands and blood vessels.

(c) From 16 to 23 days, the remaining cells of the ovarian follicles are stimulated by the LH to develop corpus luteum. The corpus luteum secretes progesterone which is required for the maintenance of endometrium. In the absence of fertilisation, corpus luteum degenerates causing disintegration of endometrium leading to menstruation that takes place for 3-5 days.

29. (a) AIDS can be diagnosed by enzyme linked immuno sorbent assay (ELISA).

OR

HIV is a member of a group of viruses called retrovirus

which have an envelope enclosing the RNA genome. Reverse transcriptase catalyses replication of viral RNA to viral DNA in host cell.

(b) (i) Ensuring the use of only fresh needles or syringe.

(ii) Screening blood before transfusion.

(c) HIV attacks helper T-lymphocytes, (also called CD_4 cell, *i.e.*, cluster of differentiation), due to which there is reduction in their number. Helper T-cells stimulate antibody production by B-cells. This result in loss of natural defence against viral infection.

30. (a) Given karyotype shows Turner syndrome which occurs due to monosomy ($2n-1$).

(b) Genotype of the child is $44 + XO$ *i.e.*, $2n = 45$ chromosomes.

(c) Turner syndrome occurs by the union of an allosome free egg ($22 + O$) and a normal X sperm or a normal egg and an allosome free sperm ($22 + O$). Thus, the individual has $2n = 45$ chromosomes ($44 + XO$) instead of 46.

OR

Diagnostic features of Turner's syndrome are:

Underdevelop ovaries and breasts, small uterus, absence of menstruation, short stature, webbed neck, cardiovascular abnormalities, abnormal intelligence.

31. (a) Gene therapy is the technique of genetic engineering which involves replacement of a defective gene by a normal healthy functional gene.

(b) Adenosine deaminase (ADA) enzyme deficiency is caused due to the deletion of the gene for adenosine deaminase. In some patients, ADA deficiency can be cured by the bone marrow transplantation. It can be treated by enzyme replacement therapy, in which functional ADA is given to the patient by injection. But the problem with both of these approaches that they are not completely curative.

The first step towards gene therapy for an ADA deficient patient is extraction of lymphocytes. Lymphocytes, a kind of white blood cells, are extracted from the bone marrow of the patient and are grown in a culture outside the body. A functional ADA cDNA (using a retroviral vector) is then introduced into these lymphocytes, which are reinjected to the patient's bone marrow.

OR

Polymerase chain reaction (PCR) is a technique of synthesising multiple copies of the desired gene (DNA

segment) *in vitro*. The basic requirements of PCR are DNA template, two oligonucleotide primers usually 20 nucleotides long, dNTPs and DNA polymerase which is stable at high temperature (usually *Taq* polymerase). Working mechanism of PCR is as follows :

- Denaturation : The target DNA (DNA segment to be amplified) is heated to high temperature (94°C). Heating results in the separation of two strands of DNA. Each of the two strands of the target DNA now act as template for synthesis of new DNA strand.
- Annealing : During this step, two oligonucleotide primers hybridise to each of single stranded template DNA in presence of excess of synthetic oligonucleotides.
- Extension : During this step, the enzyme DNA polymerase synthesises the DNA segment between the primers. *Taq* DNA polymerase, isolated from a thermophilic bacterium *Thermus aquaticus*, is used in most of the cases. This step requires presence of deoxynucleotide triphosphates (dNTPs) and Mg²⁺ and occurs at 72°C.

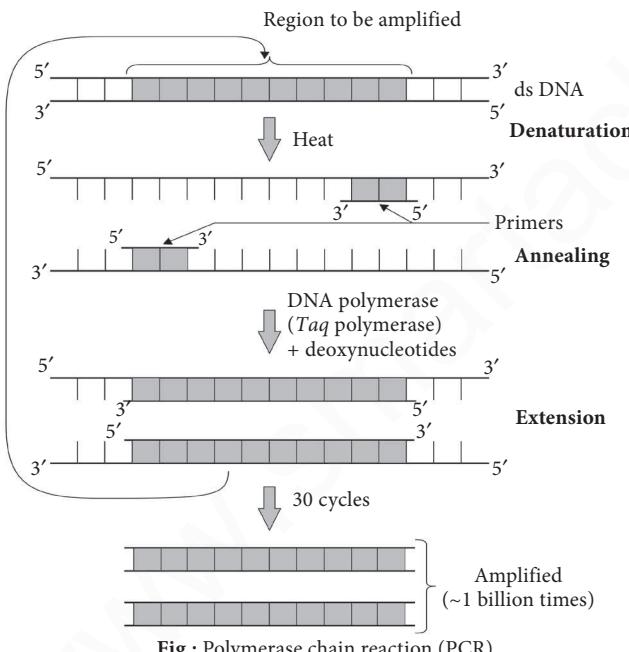


Fig.: Polymerase chain reaction (PCR)

32. (a) IUDs or intra-uterine devices are effective and popular methods of birth control. Two commonly used IUDs are copper releasing IUDs (CuT, Cu7, etc.) and hormone releasing IUDs (progestasert, LNG-20, etc.).

Cu⁺⁺ releasing IUDs are considered as an effective contraceptive for human females. Cu ions released by them suppress sperm motility and fertilising capacity

of the sperms. On the other hand hormone releasing IUD make the uterus unsuitable for implantation and the cervix hostile to the sperms.

(b) Surgical methods of birth control or sterilisation advised to human males and females are vasectomy and tubectomy respectively. In vasectomy a small part of the vas deferens is removed or tied up through a small cut on the scrotum while in tubectomy a small part of the Fallopian tube is removed or tied up through a small cut in the abdomen or through vagina. Both vasectomy and tubectomy are permanent birth control methods with no side effects but one disadvantage of this procedure is that their reversibility is very poor. So it is advised to those married couples who already have children and do not wish to have any more.

OR

(a) In the given figure, 'A' represents sporogenous tissue and 'B' represents tapetum.

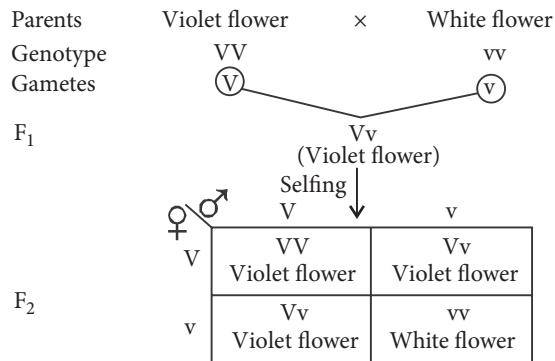
Functions of sporogenous tissue (A) : It fills the whole interior of the microsporangium. Its cells divide with the growth of anther and increase their number. Ultimately, they are transformed into microspore or pollen mother cells (PMC). Microspore mother cells undergo meiosis to produce haploid microspores or pollen grains.

Functions of tapetum 'B' : It helps in nourishment of the developing microspore mother cells and pollen grains. It also produces lipid rich Ubsch granules containing sporopollenin for exine formation.

(b) The hard outer layer of pollen grains called exine is made up of a highly resistant fatty substance called sporopollenin. Sporopollenin is highly protective layer not degraded by any enzyme. It is not affected by high temperature, strong acid or strong alkali. Because of sporopollenin, exine provides protection during the hazardous journey of pollen from anther to stigma. Also, pollen grains are well preserved as microfossils and protected from external adversities due to the presence of sporopollenin.

(c) Pollen banks are used to store pollen grains for long time, which can be used in plant breeding programmes. In pollen banks, pollens are stored in liquid nitrogen at a temperature of -196°C.

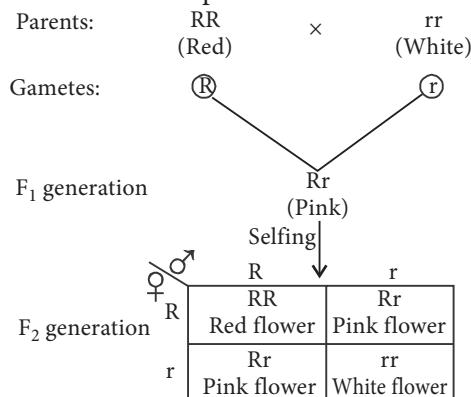
33. In case of pea plant :



Genotype : VV : Vv : vv

Phenotype : Violet : white

In case of *Antirrhinum* plant :



Genotype : RR : Rr : rr

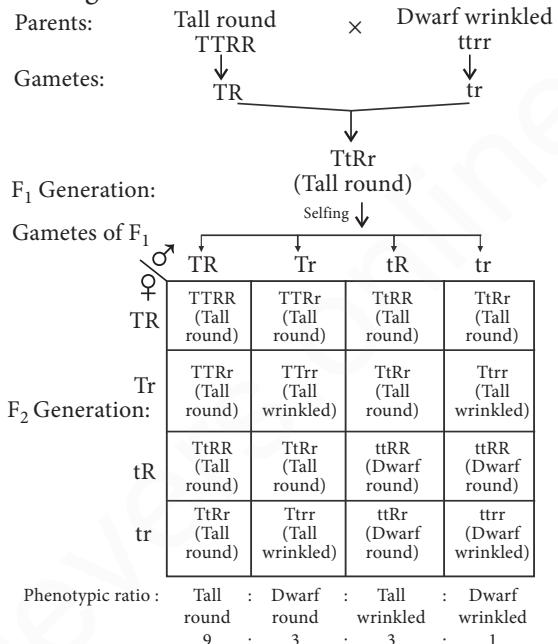
Phenotype : Red : Pink : White

The inheritance pattern of flower colour in garden pea plant is an example of complete dominance in which allele for tallness is dominant over the factor for dwarfness which is recessive. Whereas inheritance pattern of flower colour in *Antirrhinum* is an example of incomplete dominance in which none of the two alleles of a gene is dominant over each other so

that when both of them are present together, a new phenotype is formed which is intermediate between the independent expression of the two alleles.

OR

(a) Cross between parents with two different contrasting traits is as follows:



(i) Genotype and phenotype of F_1 progeny are $TtRr$ and Tall and round seeded plant respectively.

(ii) Gametes produced of F_1 progeny are TR, Tr, tR, tr .

(iii) When F_1 seeds were grown into plants, F_2 seeds were obtained which showed all the four possible combinations, *i.e.*, (i) tall and round seeds (ii) tall and wrinkled seeds, (iii) dwarf and round seeds and (iv) dwarf and wrinkled seeds in $9 : 3 : 3 : 1$ ratio.

(b) Morgan observed that the F_2 ratio obtained in the cross deviates significantly from $9 : 3 : 3 : 1$ ratio *i.e.*, Mendelian ratio. This is because the genes are linked. They are carried on the same chromosome and are inherited together. Linkage was not observed by Mendel as the characters he chose were unlinked genes.