SAMPLE QUESTION PAPER

BLUE PRINT

Time Allowed : 3 hours **Maximum Marks :** 70

S. No.		Chapter	VSA /Case based/ AR (1 mark)	SA-I (2 marks)	SA-II (3 marks)	LA (5 marks)	Total	
1.	Unit-VI	Sexual Reproduction in Flowering Plants	2(2)	–	–	–	**2(2)**	**14**
2.		Human Reproduction	2(2)	–	1(3)	1+1*(5)	**4(10)**	
3.		Reproductive Health	–	1+1*(2)	–	–	**1(2)**	
4.	Unit-VII	Principles of Inheritance and Variation	3(6)	1(2)	–	–	**4(8)**	**18**
5.		Molecular Basis of Inheritance	2(2)	–	1(3)	1+1*(5)	**4(10)**	
6.	Unit-VIII	Human Health and Diseases	–	–	–	1+1*(5)	**1(5)**	**14**
7.		Microbes in Human Welfare	–	3(6)	1(3)	–	**4(9)**	
8.	Unit-IX	Biotechnology : Principles and Processes	2(2)	2+1*(4)	1(3)	–	**5(9)**	**12**
9.		Biotechnology and Its Applications	1+1*(1)	1(2)	1*	–	**2(3)**	
10.	Unit-X	Organisms and Populations	3(6)	1(2)	1(3)	–	**5(11)**	**12**
11.		Biodiversity and Conservation	1(1)	–	–	–	**1(1)**	
		Total	**16(22)**	**9(18)**	**5(15)**	**3(15)**	**33(70)**	

*It is a choice based question.

Subject Code : 044

BIOLOGY

Time allowed : 3 hours ***Maximum marks : 70***

General Instructions :

(i) All questions are compulsory.

(ii) The question paper has four sections: Section A, Section B, Section C and Section D. There are 33 questions in the question paper.

(iii) Section-A has 14 questions of 1 mark each and 02 case-based questions. Section-B has 9 questions of 2 marks each. Section-C has 5 questions of 3 marks each and Section-D 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. State the function of filiform apparatus found in mature embryo sac of an angiosperm.

2. Normally one embryo develops in one seed but when an orange seed is squeezed many embryos of different shapes and sizes are seen. Mention how it has happened.

3. Write the function of oxytocin.

4. Define antrum.

5. Identify and write the correct statement :

(a) *Drosophila* male has one X and one Y chromosome.

(b) *Drosophila* male has two X chromosomes.

6. A garden pea plant produced axial white flowers. Another of the same species produced terminal violet flowers. Identify the dominant traits.

7. Which one of the two sub-units of ribosome encounters an *m*RNA?

8. Which transgenic fish was first produced for the food production?

9. Name the source of thermostable DNA polymerase mostly used in polymerase chain reaction.

10. Name the type of biodiversity represented by the following:

(i) 1000 varieties of mangoes in India.

(ii) Variations in terms of potency and concentration of reserpine in *Rauwolfia vomitoria* growing in different regions of Himalayas.

11. **Assertion :** RNA is usually a single stranded polynucleotide.
Reason : RNA contains purine uracil instead of thymine found in DNA.
(a) Both assertion and reason are true, and reason is the correct explanation of assertion.
(b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
(c) Assertion is true but reason is false.
(d) Both assertion and reason are false.

12. **Assertion :** Type I restriction endonucleases are not used in recombinant DNA technology.
Reason : Type I restriction endonucleases recognise specific sites within the DNA but do not cut these sites.
(a) Both assertion and reason are true, and reason is the correct explanation of assertion.
(b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
(c) Assertion is true but reason is false.
(d) Both assertion and reason are false.

OR

Assertion : Mouse is the most preferred mammal for studies on gene transfers.
Reason : Mouse possesses features like short oestrous cycle and gestation period, relatively short generation time, production of several offspring per pregnancy, etc.
(a) Both assertion and reason are true, and reason is the correct explanation of assertion.
(b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
(c) Assertion is true but reason is false.
(d) Both assertion and reason are false.

13. **Assertion :** In parasite-host relationship, the weaker organism is benefitted.
Reason : Parasites are commonly host specific.
(a) Both assertion and reason are true, and reason is the correct explanation of assertion.
(b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
(c) Assertion is true but reason is false.
(d) Both assertion and reason are false.

14. **Assertion :** Diapause is a dormant stage in the development of an organism.
Reason : It occurs only in favourable condition.
(a) Both assertion and reason are true, and reason is the correct explanation of assertion.
(b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
(c) Assertion is true but reason is false.
(d) Both assertion and reason are false.

15. **Read the following and answer any four questions from 15(i) to 15(v) given below :**
In a habitat, the size of the population is self explanatory of its status in the habitat, therefore the population size is the best way to study the impact of various ecological processes such as competition, predation, etc. on population. Population size, technically called population density (designated as N). It is not always in numbers as it will not provide a meaningful result. As in case of an area where there are 200 *Parthenium hysterophorus* plants but only a single huge banyan tree with a large canopy, stating that the population density of banyan is low relative to that of *Parthenium* amounts to underestimating the enormous role of the Banyan in that community. In such cases, the per cent cover or biomass is a more meaningful measure of the population size. In some ecological studies, the estimation of relative densities in place of absolute population densities also serves the purpose. For instance, the number of fish caught per trap is good enough measure of its total population density in the lake. Sometime population size is estimated by indirect means based on pug marks and fecal pellets, *e.g.,* tiger census in our national parks and tiger reserves.

(i) Population is a number of
(a) all the organisms of same species in a particular area
(b) all the inhabitants of a particular area
(c) all the human beings and plants of a particular area
(d) increase in the number of organisms in a particular area.

(ii) The impact of ecological process on a population can be studied by
(a) absolute population density (b) relative population density
(c) population size (d) all of these.

(iii) In a ecosystem having one banyan tree approximately 400 carrot grass and other 4-5 small medicinal plants, the comparative benefits provided by different plants can be best calculated by their
(a) biomass estimation. (b) absolute population size
(c) relative population size (d) population size

(iv) What parameters are used for tiger census in our country's national parks and sanctuaries?
(a) Actual head counts (b) Pugmarks only
(c) Fecal pellets only (d) Pugmarks and fecal pellets

(v) **Assertion :** The estimation of population density is very useful in various ecological studies.
Reason : Population size in area is affected by various ecological processes such as competition, predation etc.
(a) Both assertion and reason are true, and the reason is the correct explanation of the assertion.
(b) Both assertion and reason are true, but the reason is not the correct explanation of the assertion.
(c) Assertion is true but reason is false.
(d) Both assertion and reason are false

16. Read the following and answer any four questions from 16(i) to 16(v) given below :

Gregor John Mendel conducted hybridisation experiments on garden pea. Mendel crossed tall and dwarf pea plants to study the inheritance of one gene. He emasculated flower of tall pea plant and after emasculation and hybridised flower of tall pea plant with the anthers of flower of dwarf pea plant. He collected the seeds produced by this cross and further grew them to generate plants of the first hybrid generation called Filial$_1$ progeny (F_1) which had all tall plants. Further the self-pollinated of F_1 generation lead to the production of tall as well as dwarf pea plants (the character that was not seen in the F_1 generation) in Filial$_2$ generation (F_2) in the ratio of 3/4 tall plants and 1/4 dwarf pea plants. These results revealed that there is no blending of characters and both the characters were identical to their parental type. On the basis of his results, Mendel proposed "Law of Dominance" and "Law of Segregation".

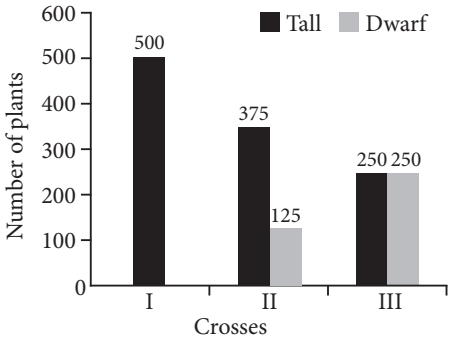
(i) Gregor John Mendel is known as _____.
(a) Father of genetics (b) Father of botany
(c) Father of breeding (d) Father of agriculture

(ii) Mendel crossed purple flowered pea plant with white flowered pea plant and got _____ purple flowered in F_2 generation.
(a) 100% (b) 25 % (c) 50% (d) 75%

(iii) Rahul crossed tall pea plants with dwarf pea plants and got 250 seeds in F_1 generation which further grown and selfing was performed. 1000 seeds were procured in F_2 generation that would generate _____ tall plants and _____ dwarf plants.
(a) 250 and 750 (b) 500 and 500
(c) 750 and 250 (d) 1000 and 0

(iv) Law of segregation is also termed as law of purity of gametes because
(a) both characters appears in F_1 generation
(b) characters produce a intermediate new character
(c) characters do not blend
(d) none of these.

(v)



The following statements are drawn as conclusions from the above data .
I. It is the cross of homozygous tall pea plant and homozygous dwarf pea plant.
II. It is the cross of heterozygous tall pea plant and homozygous dwarf pea plant.
III. It is the cross of heterozygous tall pea plants.
Select the incorrect statement.
(a) Only I (b) I and II (c) II and III (d) I, II and III

SECTION - B

17. Why is "Saheli" considered an effective contraceptive for women to space children?

OR

State any two methods to overcome infertility in human couples.

18. State what are Mendelian disorders. Both thalassemia and colour blindness are categorised as Mendelian disorders. Justify.

19. Explain the significant role of the genus *Nucleopolyhedrovirus* in an ecological sensitive area.

20. **(a)** State one difference between an exonuclease and an endonuclease.
(b) How does restriction endonuclease enzymes function?

21. **(a)** State the principle on which ELISA is based.
(b) How does transgenic animals are used for chemical safety testing?

22. What is complementary DNA? How does it differ from synthetic DNA?

OR

What is genetic engineering ? List the steps in rDNA technology.

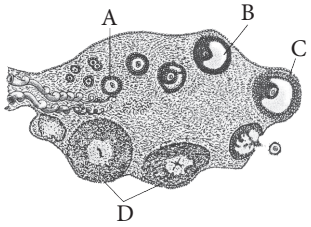
23. Give the scientific name of the microbes from which cyclosporin A and statin are obtained. Write one medical use of each one of these drugs.

24. Name two organisms belonging to two different kingdoms that are commonly used as biofertilisers and how?

25. How do the following organisms pull through the adverse environmental conditions?
(i) Fungi (ii) Zooplankton (iii) Bear (iv) Snail

SECTION - C

26. Study the transverse section of human ovary given below and answer the questions that follow.



(i) Name the hormone that helps in growth of A → B → C.
(ii) Name the hormone secreted by A and B.
(iii) State the role of hormone produced by D.

27. Explain the discovery made by Hershey and Chase using radioactive sulphur and phosphorus in their experiment.

28. What are methanogens? How do they help to generate biogas?

29. What is plasmid? State its significant characteristics with respect to human insulin synthesis.

OR

How is gene therapy being used in treating ADA deficient patients?

30. Construct an age pyramid which reflects a stable growth status of human population.

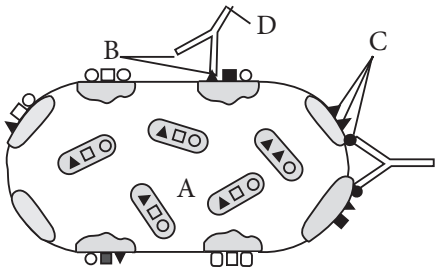
SECTION - D

31. **(a)** Explain the menstrual phase in a human female. State the levels of ovarian and pituitary hormones during this phase.
(b) Why is follicular phase in the menstrual cycle also referred as proliferative phase? Explain.
(c) Explain the events that occur in a Graafian follicle at the time of ovulation and thereafter.
(d) Draw a Graafian follicle and label antrum and secondary oocyte.

OR

(a) Describe with the help of schematic diagram the process of spermatogenesis in a human male.
(b) Draw a labelled diagram of mature sperm.

32. Refer to the given figure and answer the following questions.



(i) Identify the labelled parts as A, B, C and D in the given figure.
(ii) What is the function of B?
(iii) What exactly happens after the binding of D with A?
(iv) What are the different types of A found in ABO blood groups?

OR

Carefully observe the given structure and answer the following questions.

(i) Name the compound obtained from given plant.
(ii) What is the chemical nature of the compound obtained from this plant?
(iii) What are the major effects of the compound obtained from the given plant?
(iv) Write the chemical formula of compound obtained from given plant.

33. Explain the expression of *lac* operon genes in *E. coli* growing in lactose containing cultural medium.

OR

(a) Explain the chemical structure of a single stranded polynucleotide chain.
(b) Describe the salient features of the double-helix structure of DNA molecule.

SOLUTIONS

1. Filiform apparatus is present at the micropylar tip of synergids. They play an important role in distribution of nutrients in the embryo sac, secretion of substances that attract pollen tube thereby guiding the pollen tube into synergid and also provide mechanical strength to synergids.

2. In orange seed, embryos originate by adventive embryony from diploid cells of nucellus or integuments and thus, if orange seed is squeezed many embryos of different sizes can be observed.

3. Oxytocin acts on the uterine muscle causing their contractions that help in the expulsion of the baby out of the uterus through the birth canal.

4. The secondary follicle transforms into a tertiary follicle which is characterised by a fluid filled cavity called antrum.

5. Statement (a) is correct. *Drosophila* male has one X and one Y chromosome.

6. Axial flower position is dominant over terminal flower position. Violet colour is dominant over white colour.

7. Smaller sub-unit of ribosome encounters *m*RNA during initiation of protein synthesis.

8. Genetically modified salmon was the first transgenic fish for food production.

9. *Taq* polymerase is the thermostable DNA polymerase used in PCR and is isolated from bacterium *Thermus aquaticus*.

10. (i) Genetic diversity
(ii) Genetic diversity

11. (c) : RNA contains pyrimidine uracil instead of thymine that is found in DNA.

12. (a) : Type I restriction endonucleases consists of three different subunits. They require ATP Mg^{2+} and S-adenosyl methionine for restriction. Type I restriction endonucleases recognise specific sites within the DNA but do not cut these sites. Thus they are not used in recombinant DNA technology.

OR

(a)

13. (b)

14. (c) : Under unfavourable conditions many Zooplankton species in lakes and pond are known to a stage of suspended development called diapause.

15. (i) (a) : A population is all the organisms of the same group or species who live in a particular geographical area and are capable of interbreeding.

(ii) (d) : In population ecology, the impact of processes on distribution and abundance of animal and plant populations is studied. The size of the population is self explanatory of its status in the habitat, therefore according to the situation, different types of population study such as absolute population density, relative population density are studied.

(iii) (a) : In case of an area where many carrot grass plants with a single huge banyan tree with a large canopy, stating that the population density of banyan is low relative to that of carrot grass amounts to underestimating the enormous role of the Banyan in that community. In such cases, the per cent cover or biomass is a more meaningful measure of the population size.

(iv) (d) : Pugmarks and fecal pellets are used, for tiger census in our country's national parks and sanctuaries. These are used as parameters for official counting of animals

(v) (b) : The size of the population is self explanatory of its status in the habitat, therefore population density (population size) is very important. The impact of various ecological processes is easily seen in population size.

16. (i) (a)

(ii) (a) : When the individuals with one or more sets of contrasting characters are crossed, then only dominant characters appear in F_1 generation, and the recessive characters remain hidden. When the pureline pea plants having purple flowers were crossed with pureline pea plants having white flowers, the F_1 generations obtained shows only purple flower (dominant allele) which will hide the phenotypic effects of the white flower (recessive allele) .

(iii) (c) : When the pureline tall pea plants were crossed with pureline (homozygous) dwarf pea plants the F_1 generations obtained resulted in the production of only tall pea plants (heterozygous), Further the selfing of heterozygous tall pea plant lead to the production of tall and dwarf pea plants in the ratio of 3/4 and 1/4 respectively .

(iv) (c) : Law of segregation is also called the law of purity of gametes because the two members of a pair of factors do not blend but segregate or separate into different gametes in F_2 generation.

(v) (c)

17. 'Saheli' is an oral contraceptive pill containing non-steroidal preparation called centchroman. It has high contraceptive value with little side effects. Saheli acts by inhibiting ovulation, inhibiting the motility and secretory activity of oviducts, impairs cervix to unable transport of sperms and make uterus unsuitable for implantation. Hence, it is considered as effective contraceptive to space children.

OR

Following are the two methods to overcome infertility problems in human couples :

(i) Test tube baby programme : In this method, the fusion of ovum and sperm is done outside the body of a woman (*in vitro* fertilisation), to form zygote which is allowed to divide to form embryo. The embryo is then implanted in the uterus where it develops into a fetus and then into the child.

(ii) Intra Cytoplasmic Sperm Injection (ICSI) : In this technique, embryo is formed in the laboratory by directly injecting the sperm into the ovum followed by embryo transfer.

18. Mendelian disorders are gene related human disorders that are determined by mutations in single gene. They are transmitted to the offspring as per Mendelian principles. The pattern of inheritance of such disorders can be traced in a family of pedigree analysis.

Thalassemia is an autosomal recessive disorder caused due to mutation or deletion of genes controlling the formation of globin chains of haemoglobin. This causes the formation of abnormal haemoglobin molecules resulting into anaemic. Colourblindness is a sex-linked recessive disorder in which the eye fails to distinguish red and green colours. The gene for normal vision is dominant whereas recessive allele causes colourblindness. Both these allelles are carried on X chromosome.

As both disorders are gene related so can be categorised as Mendelian disorders.

19. *Nucleopolyhedrovirus* a genus of baculoviruses are useful in controlling many insects and other arthropods. They are species specific narrow spectrum bioinsecticides with no side effects on plants, mammals, birds, fish and non-target insects. Therefore, they serve as an important component of integrated pest management programme in dealing with ecological sensitive areas. These properties are useful in organic farming.

20. (a) Exonucleases remove nucleotides from the terminal ends of the DNA whereas, endonucleases make cuts at specific positions within the DNA.

(b) Each restriction endonuclease functions by 'inspecting' the length of a DNA sequence. Once it finds its specific recognition sequence, it will bind to the DNA and cut each of the two strands of the double helix at specific points in their sugar-phosphate backbones. Each restriction endonuclease recognises a specific palindromic nucleotide sequences in the DNA.

21. (a) ELISA is based on the principle of antigen-antibody interaction. Infection by pathogens can be detected by the presence of antigens (proteins, glycoproteins, etc.) or by detecting the antibodies synthesised against the pathogen.

(b) Transgenic animals carry genes which make them more sensitive to toxic substances than non-transgenic animals. They are then exposed to the toxic substances and the effects studied. Toxicity testing in such animals will allow us to obtain results in less time.

22. Complementary DNA (cDNA) is synthesised on RNA template with the help of reverse transcriptase enzyme (discovered by Temin and Baltimore in 1970) and essential nucleotides. The DNA is separated from the RNA-DNA complex in the presence of alkaline phosphatase enzyme. A cDNA strand is formed on the separate single-stranded DNA template with the help of DNA polymerase enzyme.

Synthetic DNA is synthesised on DNA template or without a template.

OR

Genetic engineering refers to artificial synthesis, isolation, modification, combination, addition and repair of genetic material (DNA) to alter the phenotype of the host organism to suit human needs. It includes formation of recombinant DNA, use of gene cloning in gene transfer. Process of rDNA technology involves (i) Isolation of genetic material, (ii) Cutting of DNA at specific locations, (iii) Amplification of gene of interest using PCR, (iv) Preparation and insertion of rDNA, into host cell and (v) obtaining desirable gene product.

23. Cyclosporin A is obtained from fungus *Trichoderma polysporum* whereas statin is obtained from yeast *Monascus purpureus*.

Cyclosporin A has immunosuppressive properties. It inhibits activation of T cells and therefore prevents rejection of transplants.

Statin inhibits cholesterol synthesis and is therefore used in lowering blood cholesterol.

24. *Rhizobium* (Kingdom Monera) and *Glomus* (Kingdom Fungi) are commonly used as biofertilisers. *Rhizobium* forms symbiotic association with root

nodules of leguminous plants. They fix nitrogen in the nodules which becomes available to the plant and to the soil.

Glomus forms mycorrhizal association with roots of higher plants which is mutually beneficial to both the partners. The fungus performs functions like:

(i) absorption of water

(ii) solubilisation of organic matter of soil humus

(iii) direct absorption of minerals from the soil

(iv) secretion of anti-microbial substances that protect the plant root from pathogenic attack.

In return it gets sugar and other food ingredients from the plant.

25. (i) Fungi : They form various kinds of thick walled spores that are capable of surviving in adverse conditions and germinate on arrival of favourable conditions to give rise to new fungal hyphae.

(ii) Zooplankton : Under unfavourable conditions many zooplanktons enter diapause, *i.e.*, a stage of suspended development.

(iii) Bear : Polar bears go into hibernation (winter sleep) during winter season to escape extreme cold.

(iv) Snail : Snails undergo aestivation (summer sleep) to avoid summer related problems like heat and desiccation.

26. (i) In the given figure A is primary follicle, B is tertiary follicle showing antrum and C is Graafian follicle.

Anterior lobe of pituitary gland secrete LH and FSH. FSH stimulates the growth of ovarian follicles *i.e.* from $A \rightarrow B \rightarrow C$.

(ii) Hormone secreted by A and B is estrogen.

(iii) D in the given figure is corpus luteum. It secretes progesterone which helps in the maintenance of endometrium.

27. Hershey and Chase used following two types of culture media :

(i) Medium that contained radioactive phosphorus (P^{32}).

(ii) Medium that contained radioactive sulphur (S^{35}).

They used two different kinds of culture media to detect whether the genetic material is DNA or protein. Viruses grown in the medium with radioactive phosphorus contained radioactive DNA but not radioactive protein as DNA contains phosphorus but protein does not. Similarly, viruses grown on radioactive sulphur medium contained radioactive protein but not radioactive DNA because DNA does not contain sulphur.

Hence, their experiment proved that DNA is the genetic material.

28. The scientific names of various methanogenic bacteria are *Methanococcus, Methanogenium, Methanolobus, Methanosaeta,* etc.

Methanogens are a group of anaerobic bacteria which obtain their energy by reducing carbon dioxide and oxidising hydrogen with the production of methane. They are found in oxygen deficient environment such as marshes, swamps, sludge and digestive systems of ruminant animals like cow, buffalo, etc. These microorganisms are present in anaerobic sludge digester where they digest organic mass as well as aerobic microbes of the sludge to produce mixture of gases containing methane, H_2S and CO_2 called biogas.

29. Plasmids are extra-chromosomal, self-replicating, usually circular, double-stranded, DNA molecules found naturally in many bacteria.

Plasmid is a boon to biotechnology. It has certain characteristics which make it a good vector in many cases and also in the production of human insulin. These are discussed as follows :

(i) It has specific restriction sites where the enzyme restriction endonucleases make a cut and segment of DNA which codes for human insulin is inserted.

(ii) It has number of origin of replication (*ori*) where replication starts.

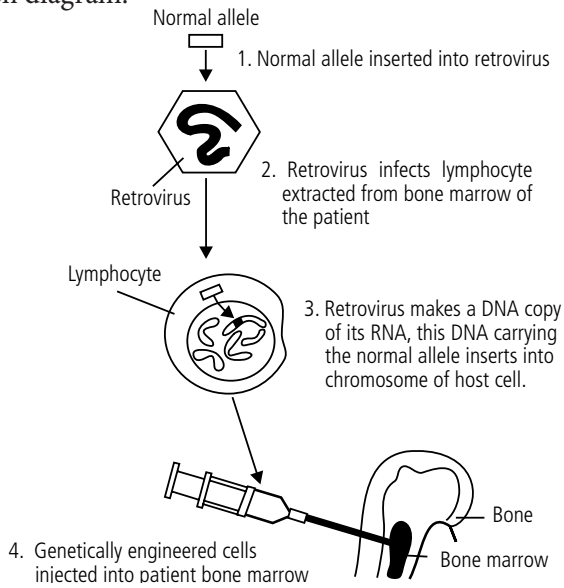
(iii) Recombinant plasmid is introduced into *E.coli* host cell where it replicates and produces large amount of insulin.

OR

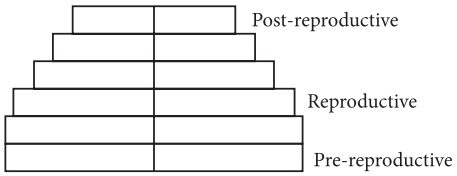
Gene therapy is the technique of genetic engineering to replace a faulty gene by a normal healthy functional gene. The first clinical gene therapy was given in 1990 to a 4 years old girl with adenosine deaminase deficiency (ADA deficiency). This enzyme is very important for the immune system to function. Severe combined immunodeficiency (SCID) is caused due to defect in the gene for the enzyme adenosine deaminase. SCID patient lacks functional T-lymphocytes and, therefore, fails to fight the infecting pathogens. Lymphocytes are extracted from the patient's bone marrow and a normal functional copy of human gene coding for ADA is introduced into these lymphocytes with the help of retroviral vector. The cells so treated are reintroduced into the patient's bone marrow. The lymphocytes produced by these cells contain functional ADA gene which reactivate the victim's immune system.

Though these cells are not immortal, the patient requires periodic infusion of such genetically engineered lymphocytes. However, if the gene isolated from marrow cells producing ADA is introduced into

cells at early embryonic stages, it could be a permanent cure. Steps of gene therapy can be summarised in the given diagram.



30. The bell-shaped age pyramid reflects a stable growth status of human population. It can be represented as follows:

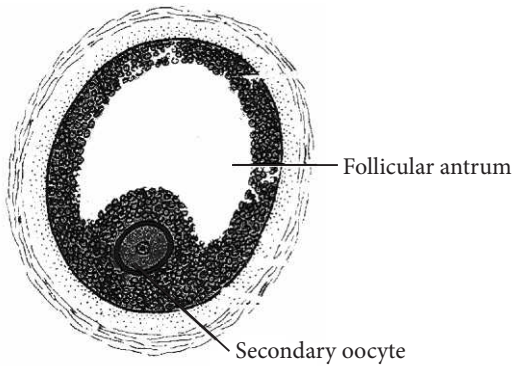


31. (a) In a 28 day menstrual cycle, the menses takes place on days 3-5. The production of LH from the anterior lobe of the pituitary gland is considerably reduced. The withdrawal of this hormone causes degeneration of the corpus luteum and, therefore, progesterone production from the ovary is reduced. Production of estrogens from the ovary is also reduced in this phase. The endometrium of the uterus breaks down and menstruation begins. The cells of endometrium secretions, blood and the unfertilised ovum constitute the menstrual flow.

(b) During follicular phase, follicle stimulating hormone (FSH) stimulates the ovarian follicle to secrete estrogens, which in turn stimulate the proliferation of the endometrium of the uterine wall. As a result, endometrium becomes thicker by rapid cell multiplication and is accompanied by an increase of uterine gland and blood vessels. Hence, this phase is also referred as proliferative phase.

(c) At the time of ovulation, rapid secretion of LH induces rupturing of Graafian follicle, thereby releasing ovum. After ovulation has taken place, LH stimulates cells of ovarian follicle to develop corpus luteum. Corpus luteum secretes large amount of progesterone.

(d) The structure of a mature Graafian follicle is as follows:



OR

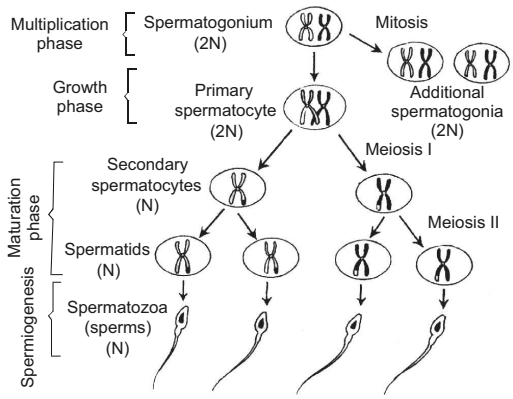
(a) In humans, follicle stimulating hormone (FSH) initiates the process of spermatogenesis.

Spermatogenesis is the process of formation of haploid spermatozoa from diploid spermatogonia inside the testes of the male. It includes following three phases :

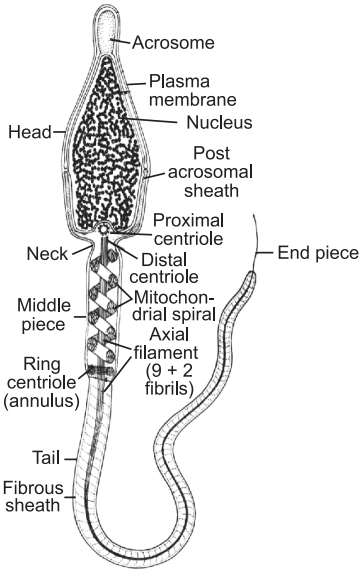
(i) Multiplication phase – At sexual maturity, the undifferentiated primordial germ cells divide several times by mitosis to produce a large number of spermatogonia or sperm mother cells. Spermatogonia (2N) are of two types : type A spermatogonia and type B spermatogonia. Type A spermatogonia serve as the stem cells which divide to form second type of spermatogonia whenever required. Type B spermatogonia are progenitor cells which function as precursors of spermatozoa.

(ii) Growth phase - Each type B spermatogonium actively grows to a larger primary spermatocyte by obtaining nourishment from the nursing cells.

(iii) Maturation phase - Each primary spermatocyte undergoes two successive divisions, called maturation divisions. The first maturation division is reductional or meiotic. Hence, the primary spermatocyte divides into two haploid daughter cells called secondary spermatocytes. Both secondary spermatocytes now undergo second maturation division which is an ordinary mitotic division to form four haploid spermatids, by each primary spermatocyte.



(b) Labelled diagram of a human sperm is as follows:



32. (i) A-Antigen, B-Binding sites, C-Epitopes, D-Antibody

(ii) Each antibody molecule has at least two binding sites (B)that can recognise and attach to the specific epitopes on an antigen.

(iii) After the binding of antigen with antibody, an antigen-antibody complex is formed. This complex is then transported to cellular system where it can be destroyed or deactivated.

(iv) Antigen - A, B and AB

OR

(i) Morphine is obtained from the given plant, *i.e.*, *Papaver somniferum*.

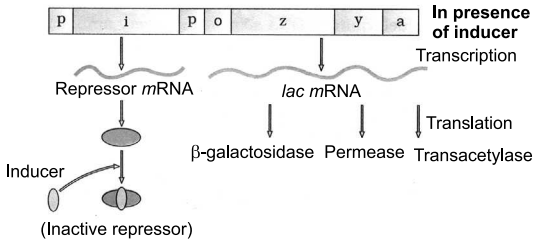
(ii) Morphine is the active principal alkaloid of opium. It is obtained from the latex of *Papaver somniferum*.

(iii) Morphine has strong analgesic effect as it can bind to specific receptors in central nervous system and relieves pain. It also depresses respiratory centre and contributes to the fall in blood pressure. It can cause bradycardia.

(iv) $C_{17}H_{19}NO_3$

33. *Lac* operon is the operon of *E. coli* associated with lactose metabolism. It is an inducible operon that consists of a regulator, a promoter, an operator and three structural genes z, y and a. The structural genes are activated in presence of lactose that acts as an inducer. The structural genes are normally inactivated, as a repressor molecule binds to an operator gene preventing transcription. These genes get activated when lactose binds to the repressor disabling it from binding with operator. Now operator gene becomes free, permitting transcription thus expression of structural genes.

Its expression can be explained with the schematic diagram of *lac* operon in open state as follows:



OR

(a) A polynucleotide chain is formed by the end to end polymerisation of a large number of nucleotides. A nucleotide is a condensation product of three chemicals – a pentose sugar, phosphoric acid and a nitrogenous base.

The nitrogen base combines with the sugar molecule at its carbon atom 1′ in a glycosidic bond (C–N–C) by one of its nitrogen atoms (usually 1 in pyrimidines and 9 in purines).

The phosphate group is connected to carbon 5′ of the sugar residue of its own nucleotide and carbon 3′ of the sugar residue of the next nucleotide by phosphodiester bonds. –H of phosphate and –OH of sugar are eliminated as H_2O during each ester formation.

At the end of the polynucleotide chain, last sugar has its 5–C free while at the other end 3–C of first sugar is free. They are respectively called 5′ and 3′ ends.

(b) Watson and Crick proposed the double helix model for structure of DNA in 1953. Its salient features are as follows:

(i) In a DNA double helix, two polynucleotide chains are coiled to form a helix. Sugar-phosphate forms backbone of this helix while bases project inwards towards each other.

(ii) Complementary bases, pair with each other through hydrogen bonding. Purines (adenine, guanine) always pair with their corresponding pyrimidines (thymine, cytosine). Adenine pairs with thymine through two hydrogen bonds while guanine pairs with cytosine through three hydrogen bonds.

(iii) The helix is right-handed.

(iv) The plane of one base pair stacks over the other in a double helix. This provides stability to the helix along with hydrogen bonding.

(v) The two chains of DNA have antiparallel polarity, 5′ → 3′ in one and 3′ → 5′ in other.

(vi) The pitch of helix is 3.4 nm (34 Å) with roughly 10 base pairs in each turn. The average distance between two adjacent base pairs comes to about 0.34 nm (0.34×10^{-9} m or 3.4 Å).

(vii) DNA is acidic. For its compaction, it requires basic (histone) proteins. The histone proteins are positively charged and occupy the major grooves of DNA at an angle of 30° to helix axis.

☺ ☺ ☺