

BIOLOGY

Maximum Marks : 70

Time : 3 Hours

General Instructions :

- (i) All questions are compulsory.
- (ii) The question paper has five sections and 33 questions.
- (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

Q. No. 1 to 12 are multiple choice questions. Only one of the choices is correct. Select and write the correct choice as well as the answer to these questions.

1. A decline in population size will be in the simulation
 - (a) Natality < Mortality
 - (b) Mortality < Natality
 - (c) Immigration = Emigration
 - (d) Emigration < Immigration.
2. Match column I with column II and select the correct option from the given codes.

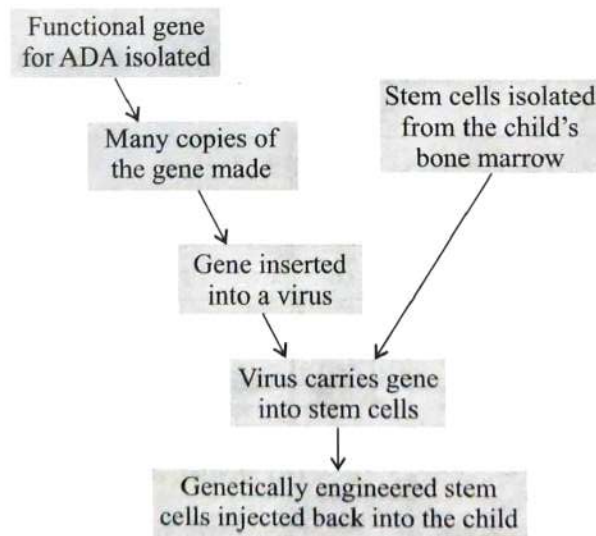
Column I		Column II	
A.	Dihybrid test cross	(i)	9 : 3 : 3 : 1
B.	Law of segregation	(ii)	Dihybrid cross
C.	Law of independent assortment	(iii)	1 : 1 : 1 : 1
D.	ABO blood group in man	(iv)	Purity of gametes
		(v)	Multiple allelism

- (a) A-(iii), B-(iv), C-(ii), D-(v)
 - (b) A-(i), B-(iv), C-(ii), D-(v)
 - (c) A-(iii), B-(ii), C-(iv), D-(v)
 - (d) A-(ii), B-(v), C-(iii), D-(i)
3. Cancer cells do not exhibit the property of
 - (a) generating tumors
 - (b) metastasis
 - (c) contact inhibition
 - (d) less number of mitochondrial cristae.
 4. Mendel's law of independent assortment does not hold true for the genes that are located closely on
 - (a) same chromosome
 - (b) non-homologous chromosomes
 - (c) X-chromosome
 - (d) autosomes.

5. Percentage of photosynthetically active radiation (PAR) that is captured by plants in synthesis of organic matter is
 (a) 50 - 70% (b) 30 - 40% (c) 80 - 100% (d) 2 - 10%.
6. *Monascus purpureus* is a yeast commercially used in the production of
 (a) citric acid
 (b) ethanol
 (c) blood cholesterol lowering statins
 (d) streptokinase for removing clots from blood vessels.
7. Match column I with column II and select the correct option from the given codes.

	Column I		Column II
A.	Sporozoites	(i)	Infectious form of <i>Plasmodium</i>
B.	Filariasis	(ii)	<i>Aedes</i> mosquitoes
C.	Typhoid	(iii)	<i>Wuchereria</i>
D.	Chikungunya	(iv)	Widal test

- (a) A-(iv), B-(ii), C-(i), D-(iii)
 (b) A-(iii), B-(iv), C-(ii), D-(i)
 (c) A-(ii), B-(iii), C-(i), D-(iv)
 (d) A-(i), B-(iii), C-(iv), D-(ii)
8. Children with Severe Combined Immunodeficiency Disorder (SCID) cannot produce many types of white blood cells that fight infections. This is because they do not have the functional gene to make the enzyme Adenosine Deaminase (ADA). Sudha is suffering with SCID have been treated with stem cells as shown in the given flow chart.



Why are stem cells used in this treatment?

- (a) Stem cells are capable of dividing for long periods to generate replacements for cells that are unable to produce ADA.
 (b) The stem cells used here belong to the child and there will be no triggering of immune response.
 (c) Stem cells are unspecialised and can differentiate to specialised cell types such as white blood cells to fight infection.
 (d) All of these

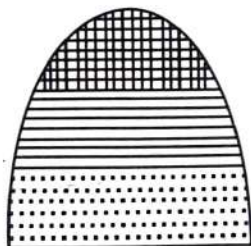
9. Identify the disease, that can affect both the male and the female genitals.
 (a) Cholera (b) Pneumonia (c) Gonorrhoea (d) amoebiasis.
10. What is the criterion for DNA fragments movement on agarose gel during gel electrophoresis?
 (a) The smaller the fragment size, the farther it moves.
 (b) Positively charged fragments move to farther end.
 (c) Negatively charged fragments do not move.
 (d) The larger the fragment size, the farther it moves.
11. Population growth-curve is sigmoid, if the growth pattern is
 (a) logistic (b) geometric (c) exponential (d) accretionary.
12. Red List contains data or information on
 (a) all economically important plants (b) plants whose products are in international trade
 (c) threatened species (d) marine vertebrates only.

Question No. 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 and 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)** : Oceans are a low productivity ecosystems despite occupying about 70% of the earth's surface.
Reason (R) : In aquatic ecosystems, productivity is limited by light which decreases with increasing water depth.
14. **Assertion (A)** : Although geitonogamy is functionally cross-pollination involving a pollinating agent, genetically it is similar to autogamy.
Reason (R) : In geitonogamy, pollen grains from the anthers of one flower are transferred to the stigma of another flower borne on the same plant.
15. **Assertion (A)** : The female external genitalia includes mons pubis, labia majora and labia minora.
Reason (R) : The glandular tissue of each breast is divided into 5-10 mammary lobes.
16. **Assertion (A)** : Hardy-Weinberg principle explains the variations occurring in population and species over a number of generations.
Reason (R) : Hardy-Weinberg principle is applicable in absence of genetic drift and gene flow.

SECTION - B

17. What does the given age pyramid signify about the status of a population? (The bar at the base represents pre-reproductive individuals.)



18. How is a restriction endonuclease named? Explain with the help of a suitable example.

OR

'Insertional inactivation' is a method to detect recombinant DNA. Explain the method.

19. Write the Oparin and Haldane's hypothesis about the origin of life on Earth. How does meteorite analysis favour this hypothesis?

OR

How would the gene flow or genetic drift affect the population in which either of them happen to take place?

20. Retroviruses have no DNA. However, the DNA of the infected host cell does possess viral DNA. How is it possible?

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

OR

List any two reasons other than physical and congenital disorders for causing infertility in couples.

SECTION - C

22. (a) Differentiate between geitonogamy and xenogamy.

(b) Write the difference in the characteristics of the progeny produced as a result of the two processes.

23. (a) Differentiate between a template strand and coding strand of DNA.

(b) Mention the contribution of genetic maps in human genome project.

24. (a) Why are transgenic animals so called?

(b) Explain the role of transgenic animals in (i) vaccine safety and (ii) biological products with the help of an example each.

25. Explain the genetic basis of blood groups in human population.

26. (a) How many number of nuclei are present in a fully developed male gametophyte of angiospermic plants?

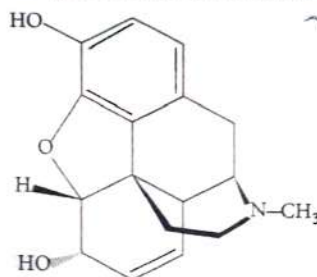
(b) How many meiotic divisions are required for the formation of 400 pollen grains?

27. (a) Name the two growth models that represent population growth and draw the respective growth curves they represent.

(b) State the basis for the difference in the shape of these curves.

(c) Which one of the curves represent the human population growth at present? Do you think such a curve is sustainable? Give reason in support of your answer.

28. Refer to the given structure and answer the questions based on it.

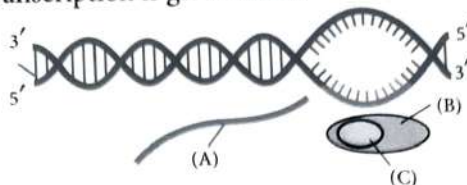


(a) Identify the drug from the given structure.

(b) What is the source of this drug? State its effects.

SECTION - D

29. The process of copying genetic information from template strand of DNA into RNA is called transcription. It is mediated by RNA polymerase. Transcription takes place in the nucleus of eukaryotic cells. In transcription, only a segment of DNA and only one of the strands is copied into RNA. Transcription mainly consists of three steps. One of the steps of transcription is given below.

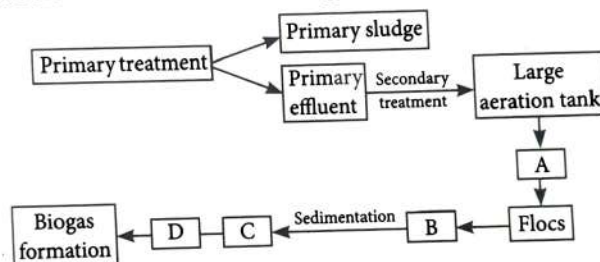


- (a) Identify the given step and name the labels B and C.

OR

What will happen if C is not available in the above process?

- (b) What changes will take place in A after the completion of above process in eukaryotes?
 (c) Briefly explain the previous step of given figure taking place in prokaryotes.
30. Refer to the flow chart given below that shows the sewage treatment.



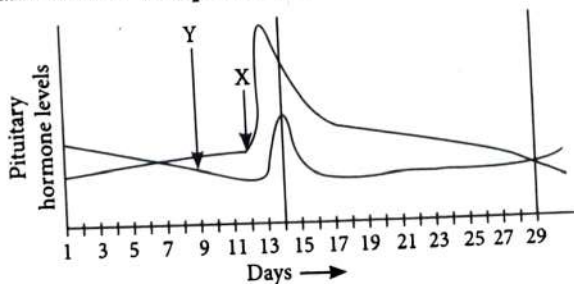
- (a) With reference to the flow chart explain the role of step A in the given process.

OR

- (a) Identify A, B, C and D in the given process.
 (b) Explain the process at step D.
 (c) What is the significance of low B in the given process and how does it forms C?

SECTION - E

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



- (i) Name the hormones 'X' and 'Y'.
 (ii) Identify the ovarian phases during given days of menstrual cycle.
 (a) 6th-13th day of the cycle.
 (b) 14th day of the cycle.
 (c) 15th-28th day of the cycle.
 (iii) Explain the ovarian phases (a), (b) and (c) under the influence of hormones 'X' and 'Y'.

OR

- (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 follicular antrum and secondary oocyte.
32. In pea plantlet, symbol Y represent dominant yellow; symbol y, the recessive green; symbol R, the round seed shape and symbol r, the wrinkle seed shape. A typical Mendelian dihybrid cross was carried out in pea plants.
- (a) Write the genotypes of
- homozygous dominant and recessive parents
 - gametes produced by both the parents
 - F₁ offspring
 - gametes produced by F₁ offspring
- (b) Write the Mendelian F₂ phenotypic ratio in a dihybrid cross. State the law that he proposed on the basis of this ratio. How is this law different from the law of segregation?

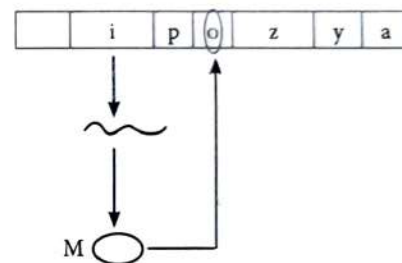
OR

Refer to given figure showing regulation of gene expression in *E.coli* and answer the following questions.

- (a) Name the molecule 'M' that binds with the operator.
- (b) Mention the result of such binding.
- (c) What will prevent the binding of the molecule 'M' with the operator gene? Mention the event that follows.
33. (a) List the key tools used in recombinant DNA technology.
- (b) Explain the role of Ti plasmids in biotechnology.

OR

- (a) Describe the different steps in one complete cycle of PCR.
- (b) State the purpose of such an amplified DNA sequence.



1. (a) : Natality and immigration lead to increase in population size whereas mortality and emigration result in population decline.
2. (a)
3. (c) : Normal cells have the property of contact inhibition. Due to this property, they contact with other cells and inhibit their uncontrolled growth. Cancer cells seem to have lost this property and thus, undergo uncontrolled growth.
4. (a) : As per linkage experiments carried out by Morgan, the two linked genes do not always segregate independently of each other and F_2 ratio deviated very significantly from 9:3:3:1 ratio (expected when two genes are independent). Hence, if linkage was known at the time of Mendel, he would not have been able to explain law of independent assortment.
5. (d) : About 1-5% of incident solar energy or 2-10% of PAR is captured by the photosynthetic organisms for the synthesis of organic matter (Gross primary productivity).
6. (c) : Statins are products of fermentation produced by yeast *Monascus purpureus* which resemble mevalonate and are competitive inhibitors of β -hydroxy- β -methylglutaryl or HMG CoA reductase. This inhibits cholesterol synthesis. Statins are, therefore, used in lowering blood cholesterol, e.g., lovastatin, pravastatin, simvastatin.
7. (d) 8. (d)
9. (c) : Gonorrhoea is a sexually transmitted disease, caused by the bacterium *Neisseria gonorrhoeae*, that affects the genital mucous membranes of either sex. Symptoms develop about a week after infection and include pain on passing urine and discharge of pus (known as gleet) from the penis (in men) or vagina (in women); some infected women, however, experience no symptoms. If a pregnant woman has gonorrhoea, her baby's eyes may become infected during passage through the birth canal.
10. (a) : Gel electrophoresis is a technique used for the separation of substances of different ionic properties. Since, DNA fragments are negatively charged molecules, they can be separated by allowing them to move towards the anode. DNA fragments move towards the anode according to their molecule size through the pores of agarose gel. Thus, the smaller fragments move farther away as compared to larger fragments.
11. (a) : Unlimited resources result in exponential growth. In nature, a given habitat has limited resources to support only a certain number of individuals of a population, beyond which no further growth is possible. This limit is called as nature's carrying capacity (K) for that species in that habitat. Thus, a population growing in a natural habitat with limited resources shows initially a lag phase, followed by phases of increase and decrease and finally the population density reaches the carrying capacity. This type of growth results in sigmoid growth curve and is called logistic growth. Since, resources for growth for most animal populations become limiting sooner or later, the logistic growth model is more realistic. It is also called S or sigmoid growth form.
12. (c) : A Red Data Book or Red List is a catalogue of taxa facing risk of extinction. Red Data Book or Red List was initiated in 1963.
13. (a) : Productivity levels of an ecosystem depend upon plant species inhabiting a particular area, their photosynthetic capacity, availability of nutrients, sunlight, moisture and a variety of other environmental factors. The annual net primary productivity of the whole biosphere is approx. 170 billion tons (dry weight) of organic matter. Of this, despite occupying about 70% of earth's surface, oceans contribute only 32% of the total productivity (55 billion tons out of 170 billion tons). Thus, oceans are a low productivity ecosystems. It is because in oceans, productivity is limited by light which decreases with increasing water depth.
14. (a) : Geitonogamy is a type of pollination in which pollen grains of one flower are transferred to the stigma of another flower belonging to either the same plant or genetically similar plant. It usually occurs in plants which show monoecious condition (unisexual male and female flowers are borne on the same plant). Thus, geitonogamy is functionally cross pollination as it involves the pollinating agent to carry out pollination, but genetically it is similar to autogamy (self-pollination) since the pollen grains come from the genetically same plant.
15. (c) : The female external genitalia include mons pubis, labia majora, labia minora, hymen and clitoris. The mammary glands are paired structures (breasts) that contain glandular tissue and variable amount of fat. The glandular tissue of each breast is divided

into 15-20 mammary lobes containing clusters of cells called alveoli.

16. (d) : The relative frequencies of various kinds of genes in a large and randomly mating, sexual panmictic population tend to remain constant from generation to generation in the absence of mutation, selection and gene flow. This is called Hardy-Weinberg principle or Hardy-Weinberg equilibrium. Genetic drift can cause elimination of certain alleles or fixation of the other in the population leading to a change in the population of alleles in the gene pool. So, genetic drift must not occur to maintain the equilibrium.

17. The figure is a bell-shaped age pyramid which signifies that the population is stable. Such age pyramid is formed when the number of pre-reproductive and reproductive individuals is almost equal and the post-reproductive individuals are comparatively fewer. It implies that the population is neither decreasing nor increasing, instead is maintained at a stable level.

18. Restriction enzymes are named for the bacterium from which they have been isolated. The first letter used for the enzyme is the first letter of the bacterium's genus (in italics). Then comes the first two letters of the species (in italics).

For example, *EcoRI* is obtained from bacterium *Escherichia coli* RY13. The capital letter 'E' comes from genus *Escherichia*. The letter 'co' are from species *coli*. The letter 'R' is from RY13 (strain). The roman number 'I' indicates that it was the first enzyme isolated from bacterium *E.coli* RY13.

OR

Insertional inactivation refers to the process where insertion of *rDNA* within the coding sequence of an enzyme 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.

19. Oparin and Haldane proposed that life originates from pre-existing, non-living organic molecules, such as RNA, proteins, etc., and formation of life was preceded by chemical evolution. Meteorite analysis confirmed presence of similar compounds elsewhere in space, maintaining that, life had reached earth in the form of spores from other heavenly bodies.

OR

Gene flow or gene migration refers to the movement of alleles from one population to another as a result

of interbreeding between members of the two populations. It causes continual interchange of alleles between organisms in a population. Genetic drift refers to a change in the population of alleles in the gene pool. It occurs by eliminating or fixing certain alleles in the population randomly and by chance. These affect population by changing the allelic frequency in both old and new population that become a different species.

20. Retroviruses have RNA as their genome. RNA genome of virus replicates in host cell to form viral DNA with the help of reverse transcriptase enzyme.

21. '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

The reasons for causing infertility in couples other than physical and congenital are drugs and diseases (immunological or psychological). Sometimes, alcohol addiction among males causes defective spermatogenesis and leads to infertility.

22. (a) Differences between geitonogamy and xenogamy are as follows:

	Geitonogamy	Xenogamy
(i)	It is pollination between two flowers of the same plant.	It is pollination between two flowers of different plants.
(ii)	The flowers are genetically similar.	The flowers are genetically different.
(iii)	It is genetically self pollination.	It is genetically cross pollination.

(b) In geitonogamy, pollination between the neighbouring flowers of the same plant takes place. Ecologically, it is a cross-pollination as it requires pollinating agents. But genetically, it is self pollination as there is no mingling of genes.

On the other hand in xenogamy, pollination between two flowers of different plants takes place and therefore, a mingling of two sets of parental characteristics takes place resulting in healthier progeny. So, the progeny obtained from the process of xenogamy give higher yield with better varieties and advanced characters than that of the progeny obtained by geitonogamy.

23. (a) Differences between template strand and coding strand are as follows :

	Template strand	Coding strand
(i)	Strand of DNA having 3' → 5' polarity.	Strand of DNA having 5' → 3' polarity.
(ii)	Participates in transcription.	Do not take part in transcription.

(b) Genetic maps have helped in gene sequencing, DNA fingerprinting, tracing human history, etc.

24. (a) Transgenic animals are those animals which contain in their genome, a foreign gene introduced by recombinant DNA technology. Such gene is called transgene. Examples of transgenic animals are transgenic mice and transgenic rabbit, etc.

(b) (i) Genetically modified organisms such as mice are being formed for use in testing the safety of vaccines before they are used on human beings. Transgenic mice are being used to test the safety of the polio vaccine.

(ii) Transgenic animals that produce useful biological products can be created by the introduction of the DNA segment (or gene) which code for a particular product such as human protein (α -1-antitrypsin) used to treat emphysema. Similar attempts are being made for treatment of phenylketonuria (PKU) and cystic fibrosis.

25. ABO blood groups are controlled by gene *I*. The gene *I* has three alleles I^A , I^B and *i*. This phenomenon is known as multiple allelism.

The blood groups and their possible genotypes are given below in the table :

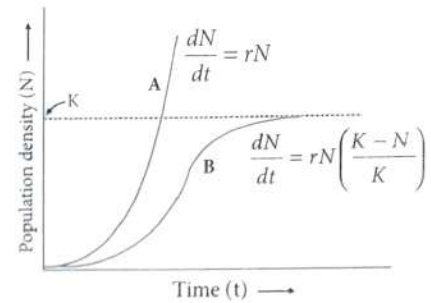
Blood group	Genotypes (possible)
A	$I^A I^A$ or $I^A i$
B	$I^B I^B$ or $I^B i$
AB	$I^A I^B$
O	<i>ii</i>

26. (a) Fully developed male gametophyte is a pollen grain with pollen tube carrying male gametes. It carries 3 nuclei, i.e., one tube nucleus and two nuclei of each male gamete.

(b) 100 meiotic divisions are required to form 400 pollen grains. Each pollen mother cell on meiotic division gives rise to 4 pollen grains.

27. (a) Two growth models of population growth are as follows :

- (i) A : J-shaped curve showing exponential growth
 (ii) B : S-shaped curve showing logistic growth



(b) Difference in shape of curves is due to difference in amount of resources available.

(c) Human population growth represents B (logistic growth form). This curve is sustainable as resources are limited and environment cannot support population beyond carrying capacity.

28. (a) The given structure is of morphine.

(b) Morphine is an opium derivative. Opium or *afeem* is latex from unripe fruits or capsules of poppy plant, *Papaver somniferum*. It is a strong analgesic. It also has sedative and calming effect. The person lacks initiative and is unable to concentrate. Morphine depresses respiratory centre. It contributes to the fall in BP. It can cause bradycardia (slow heart beat). Morphine can release ADH and reduce urine output. Constipation is a prominent feature of morphine action. Morphine causes mild hyperglycaemia. It causes addiction.

29. (a) The given figure represents the termination process during transcription in bacteria. A is *m*RNA transcript, B is RNA polymerase and C is rho factor.

OR

When RNA polymerase reaches to termination region, rho factor finds it and alters its specificity. As a result, the process of transcription terminates if Rho factor is absent, termination will not occur.

(b) After the completion of transcription, in eukaryotes, the newly formed RNA undergoes three processes, namely, splicing, capping and tailing.

(c) With the help of RNA polymerase the adjacent ribonucleotides held over DNA template to form RNA chain. As the RNA chain formation initiates, the sigma (σ) factor of the RNA polymerase separates. RNA polymerase (core enzyme) moves along the DNA template causing elongation of RNA chain at the rate of some 30 nucleotides per second. RNA synthesis stops as soon as polymerase reaches the terminator region.

30. (a) Step A (mechanical agitation) allows the vigorous growth of useful aerobic microbes into flocs.

OR

- A – Mechanical agitation
 B – Reduced BOD

- C - Activated sludge
 D - Anaerobic sludge digesters
- (b) At step D, other kinds of bacteria, which grow anaerobically, digest the bacteria and the fungi in the sludge. During this digestion, bacteria produce a mixture of gases such as methane, hydrogen sulphide and carbon dioxide. These gases form biogas and can be used as source of energy as it is inflammable.
- (c) The low BOD level indicates that water is less polluted. Once the BOD of sewage or wastewater is reduced significantly, the effluent is then passed into a settling tank where the bacterial 'flocs' are allowed to sediment. This sediment is called activated sludge.

31. (i) Hormone 'X' is luteinising hormone (LH) and 'Y' is follicle stimulating hormone (FSH).

- (ii) (a) Follicular phase (proliferative phase)
 (b) Ovulatory phase (release of ovum)
 (c) Luteal phase (secretory phase)
- (iii) (a) Follicular phase-FSH is secreted by the anterior pituitary, that stimulates the ovarian follicle to secrete estrogen, which stimulates the proliferation of the endometrium of the uterine wall.

(b) Ovulatory phase - Both LH and FSH attain a peak level in the middle of cycle (about 14th day). Rapid secretion of LH leading to its maximum level during the mid-cycle is called LH surge. It induces rupture of Graafian follicle and thereby the release of ovum (ovulation).

Due to these events, this phase is termed as ovulatory phase of menstrual cycle.

(c) Luteal phase - The remaining cells of ovarian follicles are stimulated by the LH to develop corpus luteum. The corpus luteum secretes large amount of progesterone, which is essential for the maintenance of endometrium. This is known as luteal phase.

OR

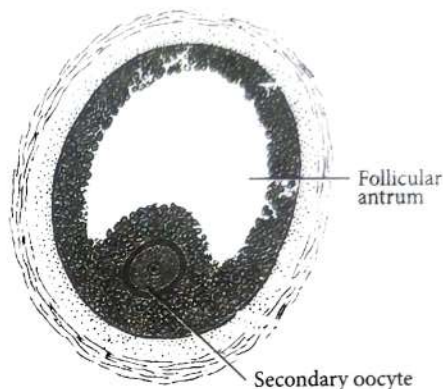
(a) In a 28 day menstrual cycle, the menses takes place on days 3-5. The production of LH from the anterior lobe of the pituitary gland is considerably reduced. The withdrawal of this hormone causes degeneration of the corpus luteum and, therefore, progesterone production from the ovary is reduced. Production 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:



32. (a) (i) Homozygous dominant = YYRR
 Homozygous recessive = yyrr
 (ii) Gametes produced by both the parents = YR and yr
 (iii) $F_1 = YyRr$
 (iv) Gametes produced by F_1 offspring = YR, Yr, yR and yr.

(b) Mendelian F_2 phenotypic ratio in a dihybrid cross is 9:3:3:1. Law proposed by Mendel on the basis of this ratio is law of independent assortment.

It states that in the inheritance of two pairs of contrasting characters, the factors of each pair of characters segregate independently of the factors of the other pair of characters. It is different from law of segregation as law of segregation states that the members of the allelic pair that remained together in the parent, segregate during gamete formation and only one factor enters a gamete.

OR

- (a) M is repressor protein.
 (b) Binding of repressor (M) with operator (O) switches off the lac operon.
 (c) Presence of inducer *i.e.*, lactose will prevent the binding of the molecule M with the operator gene. Inducer will bind to the repressor, change the latter into non-DNA binding state so as to free the operator gene and switch on the lac operon.

33. (a) Biological or key tools used in recombinant DNA technology are :

(i) Enzymes : Different kinds of specific enzymes used in recombinant DNA technology are lysing enzymes (used to open up the cells to get DNA), it includes lysozyme, cellulase and chitinase and cleaving enzymes (enzymes used to break DNA molecules) which includes exonuclease, endonuclease and restriction endonuclease.

(ii) Cloning vectors : These are DNA molecules that can carry foreign DNA segment and replicate inside a host cell. It may be plasmids, a bacteriophage, cosmids, yeast artificial chromosomes (YACs), Bacterial artificial chromosomes (BACs) and viruses.

(iii) Competent host : A competent host is essential for transformation with recombinant DNA. It includes DNA mediated or vector mediated gene transfer and direct or vectorless gene transfer (microinjection, electroporation, chemical mediated gene transfer, biolistic method or gene gun method).

(b) *Agrobacterium tumefaciens* is a soil-inhabiting bacterium that may invade growing plants at the junction of root and stem, where it can cause a cancerous growth known as a crown gall. *A. tumefaciens* contains Ti plasmid which carries gene for tumour formation. For using *Agrobacterium tumefaciens* as a cloning vector researchers deleted the genes which governs auxin and cytokinin production (the oncogene) from T-DNA of Ti plasmid by the process is known as disarming. After disarming, this T-DNA is inserted into chromosomes of the host plant where it produces copies of itself.

OR

(a) 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 :

(i) 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.

(ii) Annealing : During this step, two oligonucleotide primers hybridise to each of single stranded template DNA in presence of excess of synthetic oligonucleotides.

(iii) 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 Mg^{2+} and occurs at 72°C.

(b) Applications of PCR :

- (i) Diagnosis of pathogens
- (ii) Diagnosis of specific mutations
- (iii) DNA fingerprinting
- (iv) In prenatal diagnosis
- (v) In gene therapy.

