

SAMPLE QUESTION PAPER

SQP
4

BLUEPRINT

Time Allowed : 3 hours

Maximum Marks : 70

S. No.	Chapter	MCQs, A & R (1 mark)	SA-I (2 marks)	SA-II (3 marks)	Case Based (4 marks)	LA (5 marks)	Total
1.	Unit-VI Sexual Reproduction in Flowering Plants	1(1)	–	2(6)*	–	–	3(7)
2.		Human Reproduction	1(1)	–	–	1(5)*	2(6)
3.		Reproductive Health	1(1)	1(2)*	–	–	2(3)
4.	Unit-VII Principles of Inheritance and Variation	2(2)	–	1(3)	–	1(5)*	4(10)
5.		Molecular Basis of Inheritance	–	–	1(3)	1(4)*	2(7)
6.		Evolution	1(1)	1(2)	–	–	2(3)
7.	Unit-VIII Human Health and Diseases	2(2)	1(2)	1(3)	–	–	4(7)
8.		Microbes in Human Welfare	1(1)	–	–	1(4)*	2(5)
9.	Unit-IX Biotechnology : Principles and Processes	1(1)	1(2)	–	–	1(5)*	3(8)
10.		Biotechnology and Its Applications	1(1)	–	1(3)	–	2(4)
11.	Unit-X Organisms and Populations	2(2)	–	1(3)	–	–	3(5)
12.		Ecosystem	2(2)	1(2)	–	–	3(4)
13.		Biodiversity and Conservation	1(1)	–	–	–	1(1)
	Total	16(16)	5(10)	7(21)	2(8)	3(15)	33(70)

*It is a choice based question.

BIOLOGY

*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. 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.

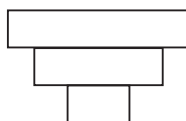
	Column I		Column II
A.	Chromosomal aberration	(i)	An additional sex chromosome
B.	Down's syndrome	(ii)	Inversion
C.	Klinefelter's syndrome	(iii)	Presence of an extra chromosome
D.	Turner's syndrome	(iv)	Absence of sex chromosome

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

14. **Assertion :** Although geitonogamy is functionally cross-pollination involving a pollinating agent, genetically it is similar to autogamy.
Reason : 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 :** The female external genitalia includes mons pubis, labia majora and labia minora.
Reason : The glandular tissue of each breast is divided into 5-10 mammary lobes.
16. **Assertion :** Hardy-Weinberg principle explains the variations occurring in population and species over a number of generations.
Reason : Hardy-Weinberg principle is applicable in absence of genetic drift and gene flow.

SECTION - B

17. Identify the type of the given ecological pyramid and give one example each of pyramid of number and pyramid of biomass in such cases.



18. Write the basis of naming the restriction endonuclease *EcoRI*.
19. Write the Oparin and Haldane's hypothesis about the origin of life on Earth. How does meteorite analysis favour this hypothesis?
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?

OR

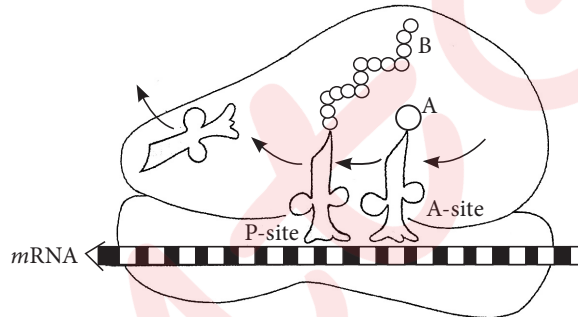
Draw a well labelled diagram of L.S. of embryo of grass.

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. (a) Why is there a fear amongst the guardians that their adolescent wards may get trapped in drug/alcohol abuse?
(b) Explain 'addiction' and 'dependence' in respect of drug/alcohol abuse in youth.

SECTION - D

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

29. Observe the given figure and answer the following questions.

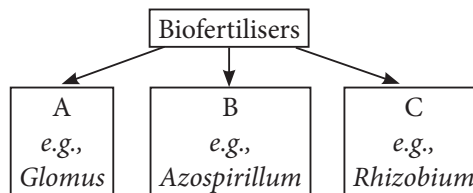


- (a) Identify A and B in the given figure.

OR

Write the two specific codons that a translational unit of mRNA is flanked by one on either sides.

- (b) State the functions of amino acyl (A) site and peptidyl transfer (P) site.
(c) How does elongation of B occur?
30. Study the given flow chart and answer the following questions.



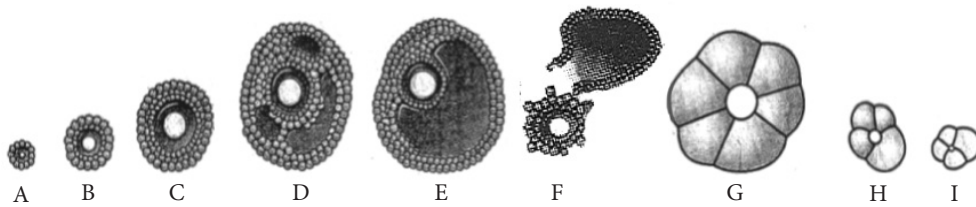
- (a) Identify A, B and C in the given flow chart.
(b) Give one another example of biofertiliser B.
(c) How does the application of the fungal genus, *Glomus*, to the agricultural farm increase the farm output?

OR

Why is *Rhizobium* act as a biofertiliser?

SECTION - E

31. The following is the illustration of the sequence of ovarian events “A” to “I” in a human female.



- Identify the figure that illustrates ovulation and mention the stage of oogenesis it represents.
- Name the ovarian hormone and the pituitary hormone that have caused the above mentioned event.
- Explain the changes that occur in the uterus simultaneously in anticipation.
- Write the difference between ‘C’ and ‘H’.
- Draw a labelled sketch of the structure of a human ovum prior to fertilisation.

OR

- Explain the menstrual phase in a human female. State the levels of ovarian and pituitary hormones during this phase.
- Why is follicular phase in the menstrual cycle also referred as proliferative phase? Explain.
- Explain the events that occur in a Graafian follicle at the time of ovulation and thereafter.
- 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.

- Write the genotypes of
 - homozygous dominant and recessive parents
 - gametes produced by both the parents
 - F₁ offspring
 - gametes produced by F₁ offspring
- 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

How are the following formed and involved in DNA packaging in a nucleus of a cell?

- Histone octamer
- Nucleosome
- Chromatin

33. (a) List the key tools used in recombinant DNA technology.
(b) Explain the role of Ti plasmids in biotechnology.

OR

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

Self Evaluation Sheet

Once you complete **SQP-4**, check your answers with the given solutions and fill your marks in the marks obtained column according to the marking scheme. Performance Analysis Table given at the bottom will help you to check your readiness.



Q. No.	Chapter	Marks Per Question	Marks Obtained
1	Organisms and Populations	1	
2	Principles of Inheritance and Variation	1	
3	Human Health and Diseases	1	
4	Principles of Inheritance and Variation	1	
5	Ecosystem	1	
6	Microbes in Human Welfare	1	
7	Human Health and Diseases	1	
8	Biotechnology and its Applications	1	
9	Reproductive Health	1	
10	Biotechnology : Principles and Processes	1	
11	Organisms and Populations	1	
12	Biodiversity and Conservation	1	
13	Ecosystem	1	
14	Sexual Reproduction in Flowering Plants	1	
15	Human Reproduction	1	
16	Evolution	1	
17	Ecosystem	2	
18	Biotechnology : Principles and Processes	2	
19	Evolution	2	
20	Human Health and Diseases	2	
21	Reproductive Health/ Reproductive Health	2	
22	Sexual Reproduction in Flowering Plants	3	
23	Molecular Basis of Inheritance	3	
24	Biotechnology and its Applications	3	
25	Principles of Inheritance and Variation	3	
26	Sexual Reproduction in Flowering Plants/ Sexual Reproduction in Flowering Plants	3	
27	Organisms and Populations	3	
28	Human Health and Diseases	3	
29	Molecular Basis of Inheritance	4	
30	Microbes in Human Welfare	4	
31	Human Reproduction/ Human Reproduction	5	
32	Principles of Inheritance and Variation/ Molecular Basis of Inheritance	5	
33	Biotechnology : Principles and Processes/ Biotechnology : Principles and Processes	5	
Total		70
		Percentage%

Performance Analysis Table

If your marks is



> 90% TREMENDOUS!

➤ You are done! Keep on revising to maintain the position.



81-90% EXCELLENT!

➤ You have to take only one more step to reach the top of the ladder. Practise more.



71-80% VERY GOOD!

➤ A little bit of more effort is required to reach the 'Excellent' bench mark.



61-70% GOOD!

➤ Revise thoroughly and strengthen your concepts.



51-60% FAIR PERFORMANCE!

➤ Need to work hard to get through this stage.



40-50% AVERAGE!

➤ Try hard to boost your average score.

1. (a) : Natality and immigration lead to increase in population size whereas mortality and emigration result in population decline.
2. (c)
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 by yeast *Monascus purpureus* which resemble mevalovate 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. (c) : Product P represents polypeptide chain C which is removed prior to insulin formation.
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 the 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. (c) : There are two types of food chains: grazing food chain and detritus food chain. Detritus food chains are those which start from the dead bodies of animals or fallen leaves etc. In terrestrial ecosystems, detritus food chain is the major conduit of energy flow, while in aquatic ecosystems, grazing food chain is the major conduit of energy flow. As the detritus food chains depend upon the dead organic matter hence, these are not directly dependent upon solar energy.
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

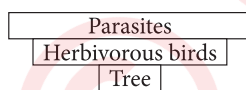
to autogamy (self-pollination) since the pollen grains come from the genetically same plant.

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.

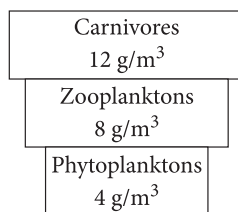
16. (d) : The relative frequencies of various kinds of genes in a large and randomly mating, sexual panmictic population tend to remain constant from generation to generation in the absence of mutation, selection and gene flow. This is called Hardy- Weinberg principle or Hardy-Weinberg equilibrium. Genetic 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 given ecological pyramid is inverted - shaped pyramid.

Pyramid of number is inverted in parasitic food chain. Here, a single large sized producer like tree provides nourishment to several herbivores (e.g., fruit-eating birds) and each herbivore in turn may support a still larger population of parasites. Thus, from the producer towards consumers, the number of organisms gradually shows an increase, making the pyramid inverted in shape.



In a pond ecosystem, the pyramid of biomass is generally inverted in shape. As the producers are small organisms, their biomass is least, and this value gradually shows an increase towards the apex of the pyramid, thus making the pyramid inverted in shape.



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).

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.

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.

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 :

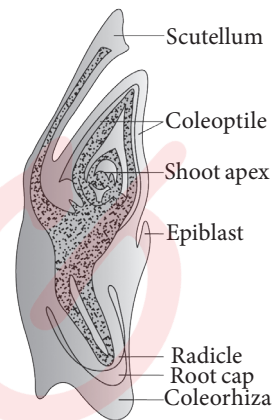
Blood group	Genotypes (possible)
A	$I^A I^A$ or $I^A i$
B	$I^B I^B$ or $I^B i$
AB	$I^A I^B$
O	<i>ii</i>

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.

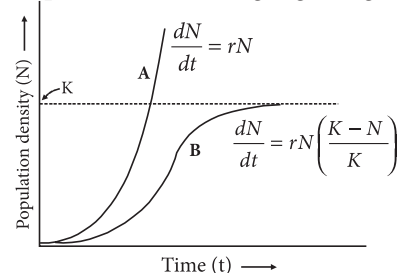
OR

The well labelled diagram of L.S. of embryo of grass is as follows:



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) Guardians fear that their adolescent wards may get trapped in drug/alcohol abuse because it has been observed that use of drugs has increased especially among youth. Adolescence (age group 12-18 years) is the period which is accompanied by several biological and behavioural changes. This is also a very vulnerable phase of mental and psychological development of an individual. Curiosity, need for adventure and excitement, experimentation and exposure to media

are some common causes that motivate the youngsters towards drug and alcohol abuse. Stress (to excel in academics or examination) has played major role in persuading youngsters to try alcohol and drugs.

(b) The prolonged use of drugs/alcohol may lead to the dependence of body upon them. Addiction is the habitual, physiological and psychological dependence on substance or practice which is beyond voluntary control. Addiction is a chronic, progressive and sometimes fatal disorder with both genetic and environmental roots. It manifests as a compulsion that drives an individual to continue to behave in a way that is harmful to self and loved ones, despite an intense desire to halt that behaviour. Medically, addiction is of three types: tobacco addiction, alcohol addiction and drug addiction.

Dependence is the tendency of the body to manifest a characteristic and unpleasant withdrawal syndrome if regular dose of drug or alcohol is abruptly discontinued.

29. (a) In the given figure, 'A' is amino acid and 'B' is peptide chain.

OR

The two specific codons are initiation codon on one side (AUG or GUG) and termination codon (UAA, UAG or UGA) on the other side of *mRNA*.

(b) A-site or aminoacyl or acceptor site is situated on the larger subunit of ribosome. It faces the tunnel between the two subunits. P-site or peptidyl transfer or donor site is jointly contributed by the two ribosomal subunits.

(c) An aminoacyl *tRNA* complex reaches the A-site and attaches to *mRNA* codon next to initiation codon with the help of its anticodon. This step requires GTP and elongation factor. A peptide bond (–CO–NH–) is established between the carboxyl group of amino acid attached to *tRNA* at P-site and amino group of amino acid attached to *tRNA* at A-site. In the process, the connection between *tRNA* and the amino acid at the P-site breaks. The free *tRNA* of the P-site slips to E-site and from there to the outside of ribosome with the help of G-factor. The A-site carries peptidyl *tRNA* complex. After the establishment of first peptide linkage and slipping of the freed *tRNA*, the ribosome rotates slightly, as a result the A-site codon alongwith peptidyl-*tRNA* complex reaches the P-site. A new codon is exposed at the A-site. The process of bond formation and translocation is repeated.

30. (a) In the given flow chart A represents mycorrhiza, B represents free living nitrogen fixing bacteria and C represents symbiotic nitrogen fixing bacteria.

(b) *Azotobacter* is free living nitrogen fixing bacteria.

(c) Many members of the genus *Glomus* form symbiotic associations with plants to form mycorrhiza. *Glomus* helps to absorb phosphorus from soil and passes it to the plant. Plants having such associations show other benefits also, such as resistance to root-borne pathogens, tolerance to salinity and drought and an overall increase in plant growth and development. Therefore, *Glomus* increases the farm yield.

OR

Rhizobium is a soil bacterium which either lives freely in soil or lives in symbiotic association with roots of leguminous plants. The bacterium forms nodules on roots of leguminous plants where it lie in groups. When it occurs freely in soil, it cannot fix nitrogen. Nitrogen fixing ability develops only when it is present inside root nodules. Hence, *Rhizobium* is categorised as symbiotic bacterium. It acts as a biofertiliser as it helps plants in obtaining their nitrogen nutrition.

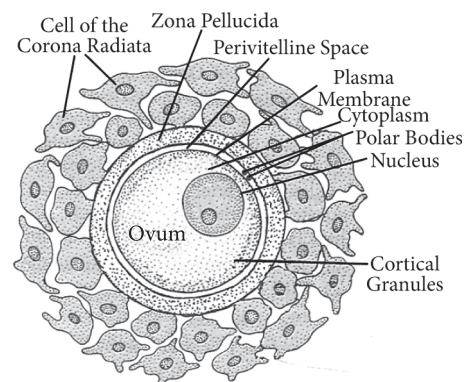
31. (a) 'F' illustrates ovulation. It represents secondary oocyte.

(b) Estrogen (ovarian hormone) and LH (pituitary hormone).

(c) Endometrium becomes thicker by rapid cell multiplication which is accompanied by an increase of uterine glands and blood vessels.

(d) 'C' is developing follicle under the influence of FSH. 'H' is regressing corpus luteum under the influence of reduction of LH.

(e) The labelled structure of a human ovum prior to fertilisation is as follows:



OR

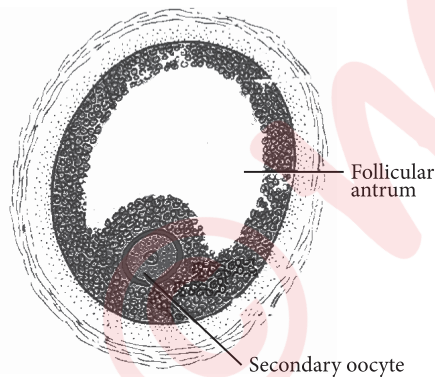
(a) In a 28 day menstrual cycle, the menses takes place on days 3-5. The production of LH from the anterior

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

(i) Histone octamer : Histones are positively charged proteins, rich in basic amino acid residues lysines and arginines. These amino acids carry positive charges on their side chains. There are five types of histone proteins : H_1 , H_2A , H_2B , H_3 and H_4 . Four of them (H_2A , H_2B , H_3 and H_4) are organised in pairs to form a unit of eight molecules called histone octamer, nu body or core of nucleosome. Negatively charged DNA wraps around this octamer to form nucleosome.

(ii) Nucleosome : It is the compaction unit. The positively charged ends of histone octamer attract the negatively charged strands of DNA. The DNA is thus wrapped around the positively charged histone octamer to form a structure called nucleosome. Around 200 bp of DNA is wrapped around the nu body or histone octamer for $1\frac{3}{4}$ turns. DNA connecting two adjacent nucleosomes is called linker DNA which bears H_1 histone protein. Nucleosome and linker DNA together constitute chromatosome. Nucleosome chain gives a bead on string appearance under electron microscope.

(iii) Chromatin : The nucleosomal organisation has approximately 10 nm thickness, which further gets condensed and coiled to produce a solenoid (having 6 nucleosomes per turn) of 30 nm diameter. This solenoid structure further undergoes coiling to produce a chromatin fibre of 30-80 nm thickness. These chromatin fibres are further coiled and condensed to form chromatid which further forms chromosome at metaphase stage of cell division.

The packaging can be summarised as follows :

DNA → Nucleosome → Solenoid → Chromatin fibre
 (2nm diameter) (10 nm diameter) (30 nm diameter) (30-80 nm diameter)
 ↓
 Chromatid
 (700 nm diameter)
 ↓
 Chromosome
 (1400 nm diameter)

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.

