

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	3(3)	—	—	1*	3(3)	14
2.		Human Reproduction	1(1)	—	1(3)	1(5)	3(9)	
3.		Reproductive Health	—	1(2)	—	—	1(2)	
4.	Unit-VII	Principles of Inheritance and Variation	3(6)	1(2)	1(3)	1*	5(11)	18
5.		Molecular Basis of Inheritance	2+1*(2)	—	—	1(5)	3(7)	
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)	3+2*(6)	—	—	5(8)	12
9.		Biotechnology and Its Applications	1(1)	—	1(3)	—	2(4)	
10.	Unit-X	Organisms and Populations	2(5)	1(2)	1+1*(3)	—	4(10)	12
11.		Biodiversity and Conservation	2(2)	—	—	—	2(2)	
		Total	16(22)	9(18)	5(15)	3(15)	33(70)	

*It is a choice based question.

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. Name the substance from which exine is made up of.
2. Define parthenocarpy.
3. Hybrid seeds have to be produced year after year. Give reason.
4. Write the function of the seminal vesicle.
5. A garden pea plant (A) produced inflated yellow pod and another plant (B) of the same species produced constricted green pods. Identify the dominant traits.
6. Name the stage of cell division where segregation of an independent pair of chromosomes occurs.
7. Name the negatively charged and positively charged components of a nucleosome.
8. Name the animal source for production of insulin.
9. What is the cell that receives a recombinant gene called?
10. Write the importance of cryopreservation in conservation of biodiversity.
11. **Assertion :** DNA is considered to be better genetic material than RNA for most organisms.
Reason : 2' - OH group present in DNA makes it labile and less reactive.
 - (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 : *tRNA* recognises its corresponding codon in *mRNA*.

Reason : For each codon, there is an individual *tRNA*.

- (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 : Genetic engineering can overcome the drawbacks of traditional hybridisation.

Reason : Genetic engineering can create desired DNA sequences to meet specific requirements.

- (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 : Species with low genetic variability are generally at greater risk of extinction than the species with more genetic variability.

Reason : Species with low genetic variability are more vulnerable to diseases, predators or other environmental challenges.

- (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 : At high altitude a person, from plain areas, may experience altitude sickness.

Reason : At high altitudes atmospheric pressure is generally high leading to symptoms like nausea, fatigue, 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.

15. Read the following and answer any four questions from 15(i) to 15(v) given below:

Malarial pathogen *Plasmodium* depends on human for reproduction. Malarial parasite lives inside the host body and is an intracellular endoparasite. *Plasmodium* reproduces in liver cells, bursting the cells and releasing into the blood. Further reproduce in red blood cells and causing cycles of fever and other symptoms to human.

- (i) The interaction of human and *Plasmodium* is
 - (a) intraspecific (b) interspecific (c) intergeneric (d) intrageneric.
- (ii) The interaction between two are relationship in which
 - (a) one species is harmed and other is benefitted
 - (b) one species is harmed and other is unaffected
 - (c) one species is benefitted and other is unaffected
 - (d) both the species are harmed.
- (iii) The interaction between two represents
 - (a) commensalism (b) amensalism (c) parasitism (d) symbiosis.
- (iv) Which of the following interaction could be another example of the given interaction?
 - (a) Interaction between Flavi virus and human
 - (b) Interaction between suckerfish and shark
 - (c) Interaction between alga and fungus
 - (d) Interaction between sea anemone and clown fish

(v) Assertion : *Plasmodium* live in the body of the host.

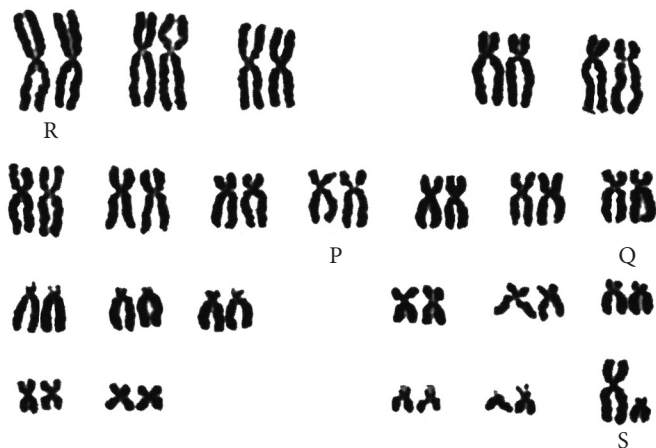
Reason : *Plasmodium* infect host by swallowing it's cyst.

- (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.

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

Phenylketonuria is an inborn, metabolic disorder in which the individual lacks the enzyme phenylalanine hydroxylase that converts the amino acid phenylalanine into tyrosine in liver. Lack of this enzyme is due to the abnormal gene on chromosome 12. This is due to substitution.

- (i) Phenylketonuria is a/an _____ disease.
 - (a) X-linked
 - (b) autosomal dominant
 - (c) autosomal recessive
 - (d) Y-linked
- (ii) If both parents have phenylketonuria, then there is _____ of the child having phenylketonuria.
 - (a) 25% risk
 - (b) 50% risk
 - (c) 75% risk
 - (d) 100% risk
- (iii) If both parents are carrier of phenylketonuria, then there is _____ of the child having phenylketonuria.
 - (a) 25% risk
 - (b) 50% risk
 - (c) 75% risk
 - (d) No risk
- (iv) If one parent has phenylketonuria and the other is carrier of phenylketonuria, there is _____ that their children will have phenylketonuria and _____ that their children will be carrier of phenylketonuria.
 - (a) 25% risk, 75% risk
 - (b) 50% risk, 50% risk
 - (c) 75% risk, 25% risk
 - (d) No risk
- (v) Study the given karyotype.

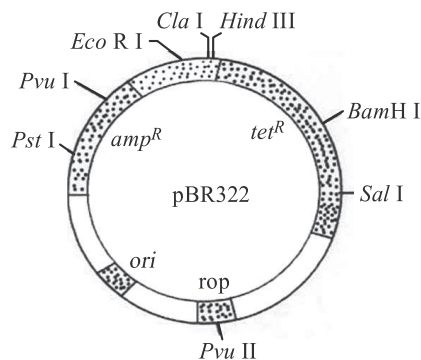


Which of the following chromosomes carries abnormal gene for phenylketonuria?

- (a) P
- (b) Q
- (c) R
- (d) S

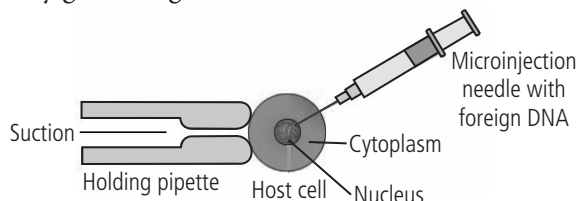
SECTION - B

- 17. (a) How copper ions released by copper-T (Cu-T) work as contraception?
(b) How does failure of testes to descend into the scrotum produce sterility?
- 18. In a cross between two tall pea plants some of the offsprings produced were dwarf. Show with the help of Punnett square how this is possible.
- 19. Name a genus of baculovirus. Why are they considered good biocontrol agents?
- 20. Explain the importance of (i) *ori*, (ii) *amp^R* and (iii) *rop* in the *E.coli* vector shown below.



OR

Briefly describe the process shown by given diagram.

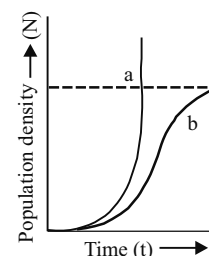


21. Write the basis of naming the restriction endonuclease *EcoRI*.
 22. Name the source of the DNA polymerase used in PCR technique. Mention why it is used.
- OR
- Name two commonly used bioreactors. State the importance of using a bioreactor.
23. Why is *Rhizobium* categorised as a 'symbiotic bacterium'? How does it act as a biofertiliser?
 24. Mention the importance of lactic acid bacteria to humans other than setting milk into curd.
 25. Mention the term used to describe a population interaction between an orchid growing on a forest tree.

SECTION - C

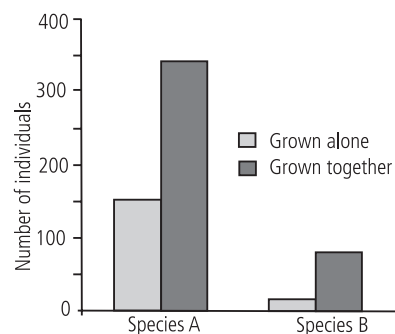
26. (a) Draw labelled diagram of a human sperm.
(b) Which part of the sperm provides energy for its movement?
27. Classify the following into Mendelian and chromosomal disorders:

(i) Phenylketonuria	(ii) Myelogenous leukemia
(iii) Tay-Sach's disease	(iv) Cri-du-chat syndrome
(v) Alzheimer's disease	(vi) Huntington's disease
28. Name the source of cyclosporin- A. How does this bioactive molecule function in our body ?
29. Name the source and the type of *cry* genes isolated from *Bacillus thuringiensis* for incorporation into crops by biotechnologists. Explain how have these genes brought beneficial changes in the genetically modified crops.
30. Study the given graph and answer the questions that follow:
 - (i) Write the status of food and space in the curves (a) and (b).
 - (ii) In the absence of predators, if available food resources are abundant for prey then which one of the two curves would appropriately depict the prey population?
 - (iii) Time has been shown on X-axis and there is a parallel dotted line above it. Give the significance of this dotted line.



OR

Two insect species were used in a laboratory experiment. For one treatment, both species were grown by themselves (in separate chambers) on a suitable food source. For the second treatment, the two species were grown together (in the same chamber) on the same type and amount of food as in the first treatment. The given graph shows the results (the number of individuals of each species in the two treatments) at the end of the experiment.

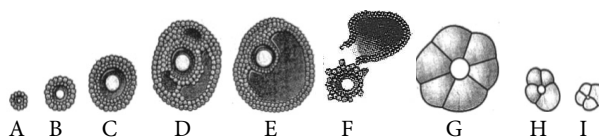


Carefully study the graph and answer the following questions :

- Which type of interaction is shown by species A and species B? Explain briefly.
- Explain any one more type of interaction studied in organisms.

SECTION - D

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

- Draw a longitudinal section of a pistil of an angiosperm showing the growth of the pollen tube up to the micropyle of the ovule. Label (i) stigma, (ii) embryo sac, (iii) pollen tube (iv) micropyle.
- Explain the events that occur, upto fertilisation, when the compatible pollen grain lands on the stigma.

32. Explain the process of protein synthesis.

OR

State three principles of Mendel’s law of inheritance. Using Punnett square demonstrate the law of independent assortment in a dihybrid cross involving two heterozygous parents.

33. (a) Name the hosts where the sexual and the asexual reproduction of malarial parasites occur respectively.
- (b) Name the toxin responsible for the appearance of symptoms of malaria in humans. Why do these symptoms occur periodically?
- (c) Describe the prophylactic measures with regard to the following diseases:
- Diphtheria
 - Cholera

OR

Under polio prevention programme, infants in India were given polio vaccines on a large scale at regular intervals to eradicate polio from the country.

- What is a vaccine? Explain how does it impart immunity to the child against the disease.
- With the help of an example each, differentiate between active and passive immunity.

SOLUTIONS

1. The hard outer layer of pollen grain called exine is made up of sporopollenin.
2. Parthenocarpy is the production and development of seedless fruits without pollination and fertilisation.
3. Hybrid seeds have to be produced year after year because seeds collected from hybrid plants, if sown subsequently, do not maintain hybrid characters due to segregation of traits.
4. Seminal vesicle produces an alkaline secretion that helps to neutralise the acidic environment of the male urethra as well as that of female reproductive tract.
5. Inflated and green colour pod are dominant traits over constricted and yellow colour pod which are recessive traits.
6. During anaphase of meiosis I, segregation of an independent pair of chromosomes occur.
7. The negatively charged and positively charged components of a nucleosome are DNA and histones respectively.
8. The animal source of insulin earlier used for diabetes was pancreas of slaughtered cattles and pigs.
9. The cell that receives a recombinant gene is known as genetically modified cell or recombinant cell.
10. Cryopreservation is *ex-situ* conservation technique in which tissues, organs, embryos, seeds, etc. are stored at very low temperature of -196°C . In order to prevent extinction, endangered organisms are being cryopreserved so that they can be revived to help in conservation.
11. (c) : 2'-OH group present at every nucleotide in RNA is a reactive group and makes RNA labile and easily degradable.

OR

(c) : *t*RNA has an anticodon loop which has 7 bases, out of which three bases form anticodon for recognising and attaching to the codon of *m*RNA. Since there are 61 codons specifying amino acids, the cell should contain 61 different *t*RNA molecules, each with a different anticodon. Actually, however, the number of *t*RNA molecule types discovered is much less than 61. This implies that the anticodons of some *t*RNAs read more than one codon on *m*RNA.

12. (a) : Traditional hybridisation procedures involve mating of organisms to be modified with another individual of the same species having desired characters and screening the progeny for expression of desired set of characters. These procedures, very often lead to inclusion and multiplication of undesirable genes alongwith desired genes. Besides inter-specific hybridisation are generally not very successful. Genetic engineering can overcome all these drawbacks because use of recombinant DNA technology, gene cloning and gene transfer allow us to isolate and introduce only one or a set of desirable genes without introducing undesirable genes into the target organism that too from any distant organism.

13. (a)

14. (c) : At high altitude, a person may experienced altitude sickness. Its symptoms include nausea, fatigue and heart palpitations. It is due to the low atmospheric pressure of high altitudes that the body does not get enough oxygen.

15. (i) (b)

(ii) (a) : In the interaction between *Plasmodium* and human, *Plasmodium* is benefitted whereas human is harmed.

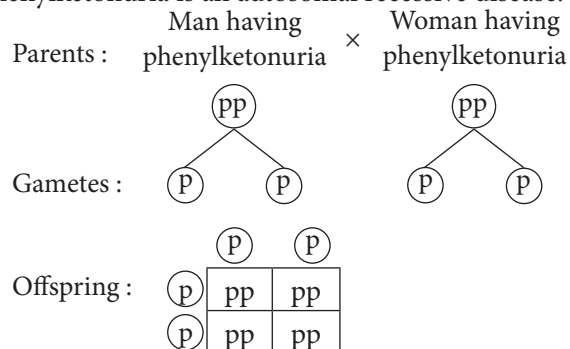
(iii) (c)

(iv) (a) : Interaction between *Plasmodium* of Flavi virus and human is parasitic. The interaction between suckerfish and shark is commensalism. Interaction between alga and fungus is symbiosis. Interaction between sea anemone and clown fish is commensalism.

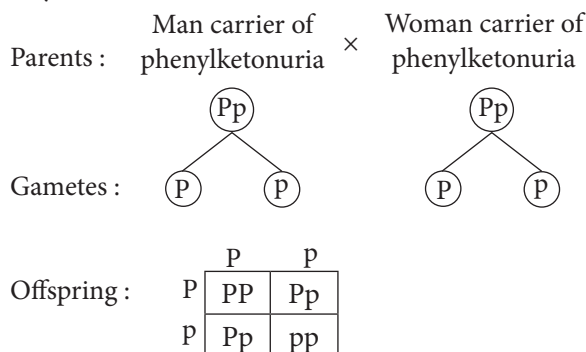
(v) (c) : *Plasmodium* infect human by vector, i.e., through female *Anopheles* mosquito.

16. (i) (c)

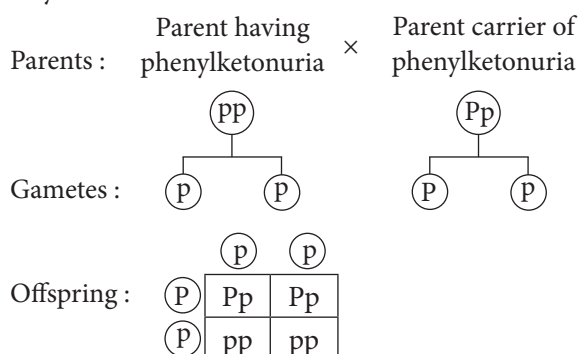
(ii) (d) : If both parents have phenylketonuria, then there is 100% risk of child having phenylketonuria. Phenylketonuria is an autosomal recessive disease.



(iii) (a) : If both parents are carrier of phenylketonuria, then there is 25% risk of the child having phenylketonuria.



(iv) (b) : If the one parent has phenylketonuria and the other is carrier of phenylketonuria, there is 50% chances that their children will have phenylketonuria and 50% risk that their children will be carrier of phenylketonuria.



(v) (b) : The labelled parts P, Q, R, S are 9, 12, 1 and XY chromosomes respectively. The 12th chromosomes carry abnormal genes for phenylketonuria.

17. (a) Copper ions (Cu^{++}) released by Cu-T suppress sperm motility and fertilising capacity of the sperms, thus help in contraception.

(b) Sterility results in this case because spermatogenesis requires a temperature 2-2.5°C that is lower than the internal body temperature, which is provided by scrotum.

18. Tall plants may either have genotype TT or Tt. Two tall pea plants that produce some dwarf plants among their progenies must be heterozygous with the genotype Tt; because TT plants cannot produce dwarf offsprings as they lack the allele for dwarfness (t) and hence cannot transfer it to the progeny. Besides, both of them should have a 't' allele as dwarfness is expressed in homozygous (tt) condition only. It can be expressed using Punnett square as follows:

	Tt ♂	T	t
Tt ♀	TT (Tall)	Tt (Tall)	tt (Dwarf)
T	TT (Tall)	Tt (Tall)	tt (Dwarf)
t	Tt (Tall)	tt (Dwarf)	tt (Dwarf)

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. (i) *ori* : It is the origin of replication. This is a sequence from where replication starts and any piece of DNA when linked to this sequence can be made to replicate within host cells. It controls the copy number of the linked DNA.

(ii) *amp^R* : Gene for ampicillin resistance which helps in selecting the transformants.

(iii) *rop* : It codes for the proteins involved in the replication of the plasmid.

OR

The given diagram represents microinjection method of gene transfer. It is a direct or vectorless method of gene transfer in which foreign DNA is directly injected into the nucleus of animal cell or plant cell by using micro-needles or micro-pipettes.

21. Type II 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.

22. *Taq* DNA polymerase is isolated from thermophilic bacterium *Thermus aquaticus*. It is used to synthesise the segment of DNA between the primers (extension) in polymerase chain reaction at high temperatures.

OR

Two commonly used bioreactors are :

- (i) Simple stirred-tank bioreactor
- (ii) Sparged stirred-tank bioreactor

Bioreactors are used for large scale production of biological products.

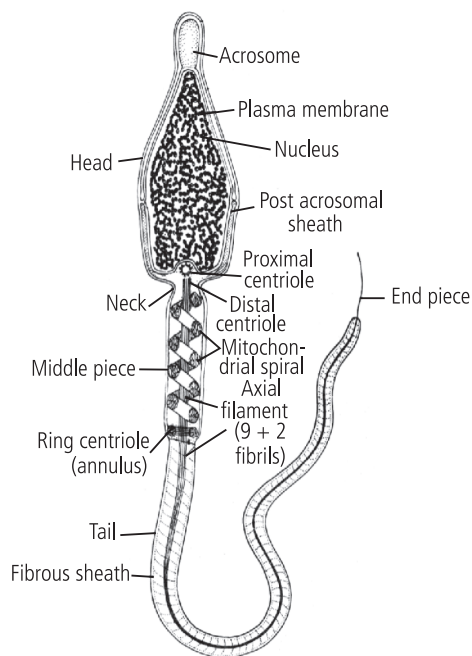
23. *Rhizobium* is a soil bacterium which either lives freely in soil or lives in symbiotic association with roots of leguminous plants. The bacterium forms nodules on roots of leguminous plants where it lie in groups. When it occurs freely in soil, it cannot fix nitrogen. Nitrogen fixing ability develops 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.

24. Lactic acid bacteria is beneficial to us in the following ways other than helping in curdling of milk:

- (i) Increases nutritional quality of curd by increasing vitamin B₁₂ content.
- (ii) Checks the growth of disease-causing microbes in the gut.

25. The population interaction is commensalism between an orchid growing on a forest tree in which orchid is benefitted and forest tree remains unaffected.

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



(b) The mitochondrial spiral present in middle piece of the sperm provides energy for its movement.

27. Mendelian disorders: Phenylketonuria, Tay-Sach's disease, Alzheimer's disease, Huntington's disease. Chromosomal disorders: Myelogenous leukemia, Cri-du-chat syndrome.

28. *Trichoderma polysporum* produces a bioactive molecule known as cyclosporin-A which has antifungal, anti-inflammatory and immunosuppressive properties. It inhibits activation of T-cells and therefore, prevents rejection reactions in organ transplantation.

29. Two genes *cryIAC* and *cryIIAb* control cotton bollworms. These two genes were isolated from *Bacillus thuringiensis* and incorporated into cotton plant. The genetically modified plant is called Bt cotton as it contains Bt toxin genes. The bacterium *Bacillus thuringiensis* produces Bt toxin proteins in mature form. When the insect larvae ingest any plant part, toxin becomes active in the alkaline pH of the gut and kills the insect pests. That is how Bt cotton attains resistance against bollworm.

30. (i) There is ample food and space for the population depicted by the curve (a). When the resources are unlimited, the curve is exponential. There is limiting food and space for the population depicted by the curve (b). When the resources are limiting, the curve becomes sigmoid.

(ii) In the absence of predators, curve (a) would appropriately depict the prey population as the food resources available for prey are abundant.

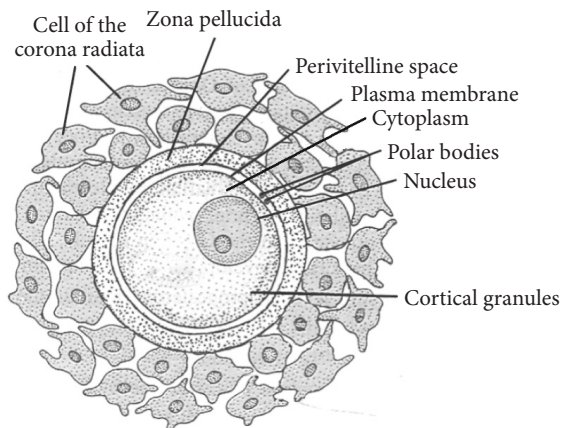
(iii) The dotted line represents the carrying capacity of the environment. The carrying capacity represents the size of population that the environment can hold by providing necessary resources. When a population reaches this line its population size is stabilised by various environmental factors.

OR

(i) The given data shows that the insect species A and B are mutualists. Mutualism is an interaction between two organisms of different species where both the partners are benefitted from each other. Species A when grown alone showed less number of individuals, however, its population increased when grown along with species B. Similar observations were made for species B. Hence, it can be concluded that they exhibit mutualism.

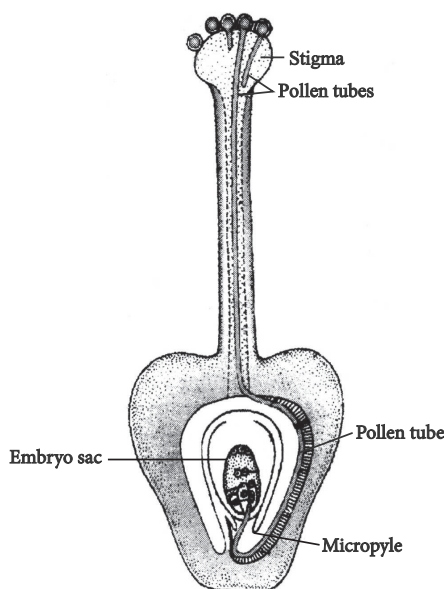
(ii) Another type of interaction studied in organisms is competition. Competition is a sort of rivalry among two or more organisms for obtaining the same resources. The competition among individuals of the same species is called intraspecific competition and among members of different species is called interspecific competition. Intraspecific competition is more severe than interspecific competition due to similar needs.

31. (i) 'F' illustrates ovulation. It represents secondary oocyte.
 (ii) Estrogen (ovarian hormone) and LH (pituitary hormone).
 (iii) Endometrium becomes thicker by rapid cell multiplication which is accompanied by an increase of uterine glands and blood vessels.
 (iv) C is developing follicle under the influence of FSH. H is regressing corpus luteum under the influence of reduction of LH.
 (v) The labelled structure of a human ovum prior to fertilisation is as follows:



OR

- (a) Longitudinal section of pistil showing growth of pollen tube is shown below:



- (b) The compatible pollen grain germinates on the stigma; the intine grows out through one of the germ pores as a pollen tube.
 – The contents of the pollen grain move into the pollen tube.
 – The generative cell divides into two male gametes.

- The pollen tube grows through the stigma and style and reaches the ovary; it enters the ovule through micropyle and then enters the embryo sac guided by the filiform apparatus and discharges the male gametes into one of the synergids.
 – One of the male gametes fuses with the egg cell (syngamy) to form the zygote and the other male gamete fuses with the two polar nuclei (triple fusion) to form the primary endosperm nucleus (PEN).

32. The process of decoding of the message from *mRNA* to protein with the help of *tRNA*, ribosome and enzymes is called protein synthesis or translation. Protein synthesis occurs over ribosomes. The 4 main steps in protein synthesis are: activation, initiation, elongation and termination of polypeptide chain.

The newly synthesised *mRNA* joins the smaller subunit of ribosome at 5' end. *mRNAs* carry the codon and *tRNAs* carry the anticodon for the same codon. Activation of amino acid is catalysed by the enzyme aminoacyl *tRNA* synthetase in the presence of ATP. In presence of ATP an amino acid combines with its specific aminoacyl-*tRNA* synthetase to produce aminoacyl adenylate enzyme complex. This reacts with *tRNA* to form aminoacyl-*tRNA* complex. Activated *tRNA* is taken to ribosome *mRNA* complex for initiation of protein synthesis.

Initiation of protein synthesis is accomplished with the help of 3 initiation factors (IF3, IF2, IF1) in prokaryotes and 9 in eukaryotes (eIF2, eIF3, eIF1, eIF4A, eIF4B, eIF4C, eIF4D, eIF5, eIF6). The ribosome binds to the *mRNA* at the start codon (AUG) that is recognised only by the initiator *tRNA*. A polypeptide chain forms as *tRNAs* deliver amino acids to the ribosome. Large ribosomal subunit binds the initiation complex forming two (A and P) binding sites for *tRNA* molecules. The first site is P site or peptidyl site which is occupied by *tRNA*^{met}. The second site is A or aminoacyl site and is positioned over the second codon. Now, the ribosome proceeds to the elongation phase of protein synthesis. During this stage, complexes composed of an amino acid linked to *tRNA*, sequentially bind to the appropriate codon in *mRNA* by forming complementary base pairs with the *tRNA* anticodon. The ribosome moves from codon to codon along the *mRNA*. Amino acids are added one by one, translated into polypeptide sequences dictated by DNA and represented by *mRNA*. The enzyme peptidyl synthetase catalyses the formation of peptide bond between the carboxylic group of amino acid at P site and amino group of amino acid at A site. Enzyme translocase brings about the movement of *mRNA* by one codon. The termination of protein synthesis occur

when a non-sense codon reaches at A site of ribosome. The chain detaches from the ribosome. A release factor binds to the stop codon, terminating translation and releasing the complete polypeptide from the ribosome. Two subunits of ribosomes dissociate with the help of dissociation factor.

OR

The three principles of Mendel's law of inheritance are :

- (i) Law of dominance : This law explains that when two individuals of a species, differing in a pair of contrasting forms of a trait are crossed, the form of the trait that appears in the F_1 hybrid is dominant and the alternate form that remains hidden, is called recessive.
- (ii) Law of segregation : This law 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.
- (iii) Law of independent assortment : This law 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.

The principle or law of independent assortment can be studied by means of dihybrid cross between heterozygous parents having YyRr genotype. This can be demonstrated through Punnett square as follows:

Parents:	<div>♀ YyRr Yellow Round</div>	×	<div>♂ YyRr Yellow Round</div>	
<div>♀ YR</div>	YYRR	YYRr	YyRR	YyRr
<div>Yr</div>	YYRr	YYrr	YyRr	Yyrr
<div>yR</div>	YyRR	YyRr	yyRR	yyRr
<div>yr</div>	YyRr	Yyrr	yyRr	yyrr

Phenotypic ratio obtained is:

Yellow : Yellow : Green : Green
round : wrinkled : round : wrinkled
9 : 3 : 3 : 1

Thus, the phenotypic ratio of a dihybrid cross is 9 : 3 : 3 : 1. The occurrence of four types of plants (parental types) in the F_2 generation of dihybrid cross shows that the factors of each of the two characters assort independently of the other as if the other pair of factor are not present.

33. (a) The sexual reproduction of malarial parasite occurs in mosquito and asexual reproduction occurs in human body.

(b) The release of merozoites and toxin haemozoin from the bursting of schizont in RBCs causes chill and high fever. The released merozoites then attack fresh RBCs leading to the formation of trophozoites causing decrease in fever. The trophozoites then grow in size to become schizont that causes increase in temperature. The schizonts again develop merozoites inside themselves thus causing recurrence of fever with the release of merozoites, *e.g.*, at regular intervals of 48 hours in case of vivax malaria.

- (c) (i) To prevent diphtheria, DPT vaccine (to prevent diphtheria, pertussis and tetanus) is given as immunisation within six weeks of birth and then at 10 and 14 weeks followed by two boosters at 15-18 months.
- (ii) Proper sanitation and hygienic conditions are the best methods of prevention of cholera.

OR

- (i) Vaccine is suspension or extract of weakened (attenuated/ dead) pathogens of disease which when injected into healthy person provides it active acquired immunity to the disease.

Vaccination stimulates the antibody production and formation of memory cells without causing the disease. This protects the child by neutralising the pathogenic agents during infection.

In vaccination, a preparation of antigenic proteins of pathogens or weakened pathogen is introduced into the body. These antigens generate the primary immune response and the memory B and T cells. When the vaccinated person is attacked by the same pathogen again, the existing memory T or B cells recognise the antigen quickly and attack the invaders with massive production of lymphocytes and antibodies.

- (ii) The given table shows differences between active and passive immunity:

S.No.	Active immunity	Passive immunity
(i)	It is developed when the person's own cells produce antibodies in response to infection or vaccine.	It is developed when antibodies produced in other organisms are injected into a person to counter act antigen such as snake venom.
(ii)	It provides relief only after long period.	It provides immediate relief.
(iii)	It has no side effects. It is long lasting.	It may cause reaction. It is not long lasting.
(iv)	<i>E.g.</i> , MMR vaccine for measles, mumps, rubella.	<i>E.g.</i> , Colostrum rich in IgA antibodies provides immunity to newborn.

