

Biology Delhi (Set 1)

General Instructions:

Read the following instructions very carefully and strictly follow them:

- (i) Question paper comprises **five** sections – A, B, C, D and E.
- (ii) There are **27** questions in the question paper. **All** questions are compulsory.
- (iii) Section **A** question number **1** to **5** are multiple choice questions, carrying **one** mark each.
- (iv) Section **B** question number **6** to **12** are short answer questions type-I, carrying **two** marks each.
- (v) Section **C** question number **13** to **21** are short answer questions type-II, carrying **three** marks each.
- (vi) Section **D** question number **22** to **24** are short answer questions type-III, carrying **three** marks each.
- (vii) Section **E** question number **25** to **27** are long answer questions, carrying **five** marks each.
- (viii) Answer should be brief and to the point also the above word limit be adhered to as far as possible.
- (ix) There is no overall choice in the question paper. However, an internal choice has been provided in two questions of **1** mark, one question of **2** marks, two questions of **3** marks and three questions of **5** marks questions. Only **one** of the choices in such questions have to be attempted.
- (x) The diagram drawn should be neat proportionate and properly labelled, wherever necessary.
- (xi) In addition to this, separate instructions are given with each section and question, wherever necessary.

Question 1

Which one of the following part of the plant when put into the soil is likely to produce new offspring?

- (a) Part of an internode
- (b) A stem cutting with a node
- (c) Part of a primary root
- (d) A flower

Solution:

The new plantlet grows from the nodes present in the stem of the flowering plants.

Hence, the correct answer is option B.

Question 2

In a bacterium when RNA-polymerase binds to the promoter on a transcription unit during transcription, it

- (a) terminates the process
- (b) helps remove introns
- (c) initiates the process
- (d) inactivates the exons

Solution:

RNA polymerase is the key enzyme for the process of transcription. This enzyme recognizes the promoter region and initiates the transcription process. This leads to the formation of RNA (or mRNA) from the template DNA.

Hence, the correct answer is option C.

Question 3

The hypothesis that "Life originated from pre-existing non-living organic molecules was proposed by

- (a) Oparin and Haldane
- (b) Louis Pasteur
- (c) S.L. Miller
- (d) Hugo de Vries

Solution:

The hypothesis that "Life originated from pre-existing non-living organic molecules was proposed by Oparin and Haldane.

Hence, the correct answer is option A.

Question 4

Mating of a superior male of a breed of a cattle to a superior female of another breed is called

- (a) in breeding
- (b) out crossing
- (c) out breeding
- (d) cross breeding

OR

Large-holes in 'Swiss-Cheese' are due to

- (a) *Propionibacterium sharmanii*
- (b) *Saccharomyces cerevisiae*
- (c) *Penicillium chrysogenum*
- (d) *Acetobacter aceti*

Solution:

Mating of superior male of one breed and superior female of another breed to obtain the desirable qualities of two breeds can be combined by the process of cross breeding. e.g., Hisardale is a new breed of sheep developed in Punjab by crossing Bikaneri ewes and Marino rams.

Hence, the correct answer is option D.

OR

The large holes in 'Swiss cheese' are due to the production of a large amount of CO₂ by a bacterium called *Propionibacterium sharmanii*.

Hence, the correct answer is option A.

Question 5

Increased concentration of DDT in fish-eating birds is due to

- (a) eutrophication
- (b) bio-magnification
- (c) cultural eutrophication
- (d) accelerated eutrophication

OR

Species-Area relationship is represented on a log scale as

- (a) hyperbola
- (b) rectangular hyperbola
- (c) linear
- (d) inverted

Solution:

Biomagnification is the increase in the concentration of non biodegradable material at each trophic level of the food chain. e.g., Biomagnification of DDT in the food chain.

Hence, the correct answer is option B.

OR

The species-area relationship, when represented on a logarithmic scale, shows a typical linear curve.

Hence, the correct answer is option C.

Question 6

State two advantages of an apomictic seed to a farmer.

Solution:

Apomictic seeds are advantageous over the hybrid seeds in the following ways:

- (i) They reduce the cost of hybrid breeding programmes.
- (ii) Desired traits can be maintained without losing superiority of hybrids over parents (hybrid vigour), and farmers can replant these seeds year after year.

Question 7

Explain when is a genetic code said to be

- (a) Degenerate
- (b) Universal

Solution:

(a) The genetic code is said to be degenerate when two or more codons specify a particular amino acid.

(b) The genetic code is said to be universal when its coded information specifies the same amino acid across different species.

Question 8

Differentiate between opioids and cannabinoids on the basis of their

- (a) specific receptor site in human body.
- (b) mode of action in human body.

Solution:

The differences between opioids and cannabinoids on the basis of given parameters are as follows:

(a) Specific receptor site in the human body: The receptors for opioids are located in the gastrointestinal tract and central nervous system. The cannabinoid receptors, on the other hand, are principally located in the brain only.

(b) Mode of action in the human body: Opioids primarily act as a depressant and slows down the body functions. Cannabinoids, on the other hand, primarily affect the cardiovascular system of the body.

Question 9

(a) Name the two techniques employed to meet the increasing demand of fish in the world.

(b) Name any two fresh water fishes.

OR

Describe the contributions of Alexander Fleming, Ernest Chain and Howard Florey in the field of microbiology.

Solution:

a) The two techniques employed to meet the increasing demand of fish in the world are:

- Pisciculture- It is the rearing of fish for food in enclosures such as fish ponds or tanks.
- Inland Fisheries- Inland fisheries are the commercial fishing operations that takes place in freshwater. It includes capture fishery, where the fish living naturally in a body of water are harvested. The other type of inland fishery is the fish farm, where fish are raised in tanks or ponds, generally for human consumption.

b) Rohu, Common Carp

OR

Alexander Fleming while working on *Staphylococci* bacteria, once observed a mould growing in one of his unwashed culture plates around which *Staphylococci* could not grow. He found out that it was due to a chemical produced by the mould and he named it Penicillin after the mould *Penicillium notatum*.

However, its full potential as an effective antibiotic was established much later by Ernest Chain and Howard Florey. This antibiotic was extensively used to treat American soldiers wounded in World War II. Fleming, Chain, and Florey were awarded the Nobel Prize in 1945, for this discovery.

Question 10

All cloning vectors do have a 'selectable marker'. Describe its role in recombinant DNA-technology.

Solution:

The role of selectable marker is to identify and distinguish the bacterial cells that have taken up the recombinant vector during the transformation process.

Question 11

Mention how have plants developed mechanical and chemical defence against herbivores to protect themselves with the help of one example of each.

Solution:

The plants exhibit mechanical and chemical defence to protect themselves against herbivores. These have been enlisted as follows:

The chemical defence includes certain secondary metabolites produced by the plants. They do not participate in the metabolism of the plant and act by impeding certain biochemical pathways in herbivores. Example: alkaloids present in plants produce noxious smell and taste to keep the herbivores away.

Structures such as thorns and spines constitute the mechanical defence of the plant. These structures are the modifications of various plant parts, like thorn-modified branches and spines-modified leaves. They cause physical damage to the herbivores such as rashes and cuts.

Question 12

Name and explain the processes earthworm and bacteria carry on detritus.

Solution:

Earthworm and bacteria carry out the following processes on detritus:

1. Fragmentation: In this process, detritivores (such as the earthworm) breakdown the detritus into smaller fragments.
2. Catabolism: In catabolism, smaller inorganic compounds are produced from detritus because of the enzymes secreted by fungi and bacteria.
3. Mineralisation: In mineralisation, humus is acted upon by microbes (such as bacteria) and converted into inorganic molecules.

Question 13

Explain three different modes of pollination that can occur in chasmogamous flower.

OR

Explain the formation of placenta after implantation in a human female.

Solution:

(i) **Autogamy** – It is the transfer of pollen grains from the anther to the stigma of the same flower. Autogamy requires the anther and the stigma to lie close. It also requires synchrony in the pollen release and stigma receptivity. Plants like Viola, Oxalis, etc. produce two kinds of flowers—chasmogamous (with an exposed anther and stigma) and cleistogamous (which do not open at all, only autogamy occurs).

(ii) **Geitonogamy** – It is the transfer of pollen from the anther of one flower to the stigma of another flower in the same plant. Genetically, it is similar to autogamy but requires pollinating agents.

(iii) **Xenogamy** – It is the transfer of pollen grains from the anther to the stigma of a different plant. Xenogamy causes genetically different types of pollens to be brought to a plant.

OR

The formation of placenta occurs after 12 weeks of pregnancy, when the finger like projection called chorionic villi appears on the trophoblast, penetrate the endometrium lining of uterine tissue.

This chorionic villi and uterine tissue interdigitate to form the structural and functional unit between developing embryo and maternal body called placenta, which help the embryo to obtain nutrients and oxygen and remove the metabolic waste and carbon dioxide.

Question 14

State Mendel's law of dominance. How did he deduce the law? Explain with the help of a suitable example.

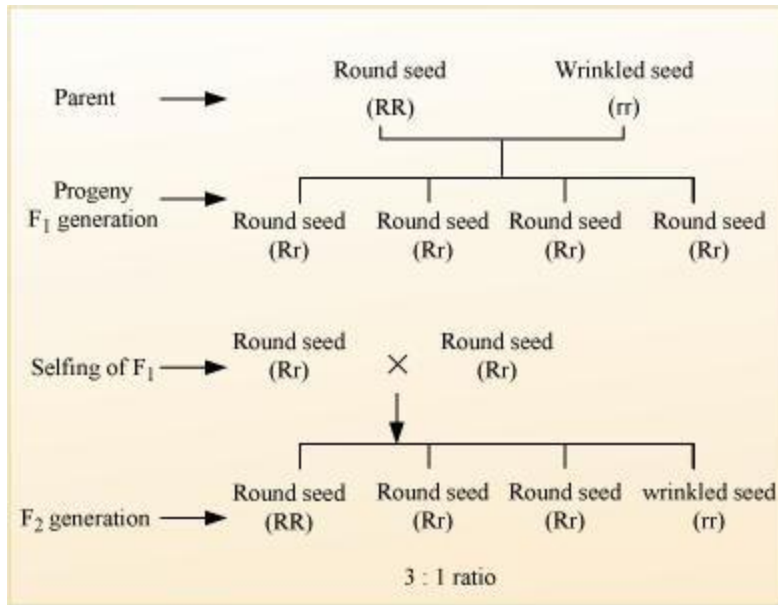
Solution:

According to the law of Dominance, characters are controlled by discrete units called factors, which occur in pairs with one member of the pair dominating over the other in a dissimilar pair. This law explains the expression of only one of the parental characters in the F_1 generation and expression of both in the F_2 generation.

Mendel selected true breeding plants as pairs having one character, which is then cross-pollinated to obtain first filial generation, F_1 . The offspring of F_1 generation is then self-pollinated to produce the second filial F_1 generation.

For example, when pea plants with round seeds (RR) are crossed with plants with wrinkled seeds (rr), all seeds in F_1 generation were found to be round (Rr).

When these round seeds were self-fertilized, both the round and wrinkled seeds appeared in F_2 generation in 3: 1 ratio. Hence, in F_1 generation, the dominant character (round seeds) appeared and the recessive character (wrinkled seeds) got suppressed, which reappeared in F_2 generation.



A monohybrid cross between round and wrinkled pea seeds

Question 15

What are 'SNPs'? Where are they located in a human cell ? State' any two ways the discovery of SNPs can be of importance to humans.

Solution:

SNP refers to Single Nucleotide Polymorphism. It refers to the variation in the genome of organisms within a particular species because of changes in the sequence of a single nucleotide.

SNPs are located within the chromosomes in certain discrete locations. The discovery of SNPs can prove useful to humans in the following manner:

1. SNPs can be used to specifically identify genetic regions associated with certain genetic disorders.
2. SNPs can also be used in forensic sciences.

Question 16

- (a) State what does the study of Fossils indicate.
- (b) Rearrange the following group of plants according to their evolution from Palaeozoic to Cenozoic periods :
- Rhynia; Arborescent Lycopods; Conifers; Dicotyledon.

Solution:

(a) Fossils are the remains or impressions of organisms that lived in the ancient times. Fossils provide the evidence that the present animals have originated from previously

existing ones through the process of continuous evolution. The study of fossils indicate towards:

- (1) life appeared in sea and in simple form(marine invertebrates)
- (2) an idea of the time in history when different species were formed or became extinct
- (3) an idea of the disparity between the present and the past form of life
- (4) the evolutionary history/ancestors of some animals

(b) Arrangement of the plants from Palaeozoic to Cenozoic period is as follows:

Rhynia(Palaeozoic Era) > Arborescent Lycopods(Palaeozoic Era) > Conifers(Mesozoic Era) > Dicotyledon(Mesozoic Era)

Question 17

- (a) Explain the mode of action of Cu^{++} releasing IUDs as a good contraceptive. How is hormone releasing IUD different from it?
- (b) Why is "Saheli" a preferred contraceptive by women (any two reasons)?

Solution:

- (a) Cu^{++} releasing IUDs such as CuT exert their effects in two ways:
 - They can trigger phagocytosis of sperms within the uterus.
 - They can also affect the fertilizing ability of sperms and suppress their motility.

In contrast to Cu^{++} releasing IUDs, hormone-releasing IUDs alter the uterus through hormonal actions such that implantation does not occur.

- (b) Saheli is a preferred contraceptive because of the following reasons:
 1. Minimal side effects
 2. High contraceptive value

Question 18

- (a) Explain why bee-hives are setup on the farms for some of our crop-species. Name any two such crop species.
- (b) List any three important steps to be kept in mind for successful bee keeping.

Solution:

- (a) Beehives kept in crop fields during the flowering period, increase the pollination efficiency. This increases the yield of crop and honey.

Also, bees can easily collect huge amounts of nectar from the flowers of the crop in a close reach without much foraging. This increases honey production. This technique is

practiced in apple and watermelon fields.

(b) Apiculture or bee keeping refers to the maintenance of hives of honeybees for the production of honey. For successful bee keeping, the following steps are necessary:

- i. Accurate knowledge of nature and habit of bees
- ii. Selection of a suitable location for maintaining beehives
- iii. Management of beehives during different seasons

Question 19

Why GMOs are so called? List the different ways in which GMO plants have benefitted and have become useful to humans.

Solution:

The organisms whose genetic material has been altered using biotechnology techniques are known as genetically modified organisms i.e. GMO. Thus, GMOs have altered genetic makeup.

The different ways in which GMO plants have benefitted and have become useful to humans are:

1. Nutritional enhancement: GMOs have higher vitamin content and more healthful fatty acid profiles.
2. Stress tolerance: GMOs can tolerate high-stress levels of temperature and climatic conditions.
3. Disease resistance: For example, orange trees resistant to citrus greening disease or American chestnut trees resistant to fungal blight. GMOs thus are disease resistant and enhances the crop output.
4. Biofuels: Plants with altered cell wall composition for more efficient conversion to ethanol.
5. Phytoremediations: GMOs extract and concentrate contaminants like heavy metals from polluted sites.

Question 20

Differentiate between "Pioneer-species"; "Climax-community" and "Seres".

OR

Explain any three ways other than zoological parks, botanical gardens and wildlife safaris, by which threatened species of plants and animals are being conserved 'ex situ'.

Solution:

The differences between pioneer species, climax community and seres can be summarised as follows:

Pioneer species: A pioneer species is a species that is first to colonize a bare area. A typical example of pioneer species is lichen which firstly colonizes a bare rock during primary succession.

Climax community: A climax community is that community which arises during the final stages of succession and remain unchanged for a long period of time (as long as the environment remains stable). A typical example includes a forest community.

Seres: Sere refers to the overall sequence of communities that arise during the course of ecological succession. Each community that exists during ecological succession is called a seral community.

OR

In addition to zoological parks, botanical garden and wildlife safaris, the following methods are being employed for the ex-situ conservation of plants and animals:

1. **Seed banks:** In this method, viable seeds from different plants are preserved in a temperature and moisture controlled environment. These seeds are then stored for extended periods of time.
2. **Gene banks:** This method is preferred for animals. In gene banks, embryos, sperms or eggs of endangered animals are stored in the low-temperature environments.
3. **Cryopreservation:** In this method, pollens, embryos or tissues can be preserved in liquid nitrogen at a temperature of -196°C .

Question 21

Explain 'Integrated organic' farming as successfully practiced by Ramesh C. Dagar, a farmer in Sonapat (Haryana).

Solution:

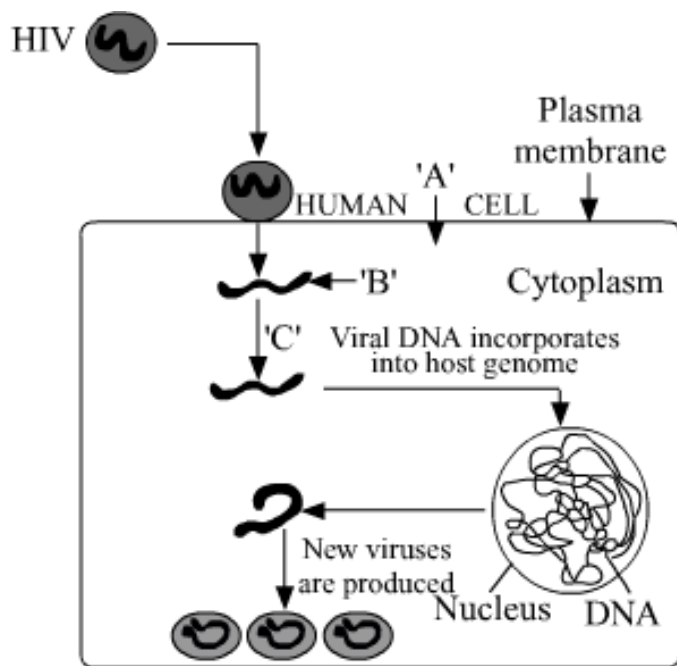
"Integrated Organic farming" is an agricultural technique that relies on crop rotation, green manure, biological pest control and compost. In this kind of farming, the waste from one process is utilised in another process, and hence it is zero waste process. It

limits the use of synthetic fertilizers and pesticides.

Ramesh Chander Dagar, an organic farmer, followed integrated organic farming and has been proven to be successful. It comprises of many practices like bee keeping, dairy management, water harvesting, composting and agriculture, which support each other and allow economic, sustainable and environment friendly venture. Cow dung is used a manure, and the plant wastes are used as compost in this practice.

Question 22

Study the diagram showing the entry of HIV into the human body and the processes that are followed :



- Name the human cell 'A' HIV enters into.
- Mention the genetic material 'B' HIV releases into the cell.
- Identify enzyme 'C'.

Solution:

- HIV which is the causative agent of AIDS specifically attacks helper T-cells. So, 'A' is helper T-cells.
- Viral RNA is introduced into the cell. So, 'B' is RNA.
- Enzyme 'C' is reverse transcriptase.

Question 23

Following a road accident four injured persons were brought to a nearby clinic. The doctor immediately injected them with tetanus antitoxin.

- (a) What is tetanus antitoxin ?
- (b) Why were the injured immediately injected with this antitoxin?
- (c) Name the kind of immunity this injection provided.

Solution:

(a) Tetanus antitoxin is solution of preformed antibodies.

(b) *Clostridium tetani*, a bacterium enters the body through cut & wounds and obstructs nerve signalling. This antitoxin neutralises the effect of tetanus toxin in the body. As the injured persons required immediate immunization in this case, so pre-formed antibodies(tetanus antitoxin) were delivered to the patients.

(c) Passive immunity would be provided in this case.

Question 24

"The population of a metro city experiences fluctuations in its population density over a period of time."

- (a) When does the population in a metro city tend to increase?
- (b) When does the population in metro city tend to decline?
- (c) If 'N' is the population density at the time 't', write the population density at the time 't + 1'.

Solution:

(a) The population in a metro city will tend to increase when natality and immigration will be higher.

(b) The population in metro city will tend to decline when mortality and emigration will be higher.

(c) The equation $N_{t+1} = N_t + [(B + I) - (D + E)]$ represents the population density at time t + 1. The components of the equation are

- N_{t+1} : Population density at time t + 1.
- N_t : Population density at time t.

- **B**: This represents natality. Natality refers to the number of births during a given period in the population.
- **I**: It refers to immigration. It is the number of individuals of the same species that have come into habitat from elsewhere during the considered time period.
- **D**: This represents mortality. Mortality is the number of deaths in the population during a given period.
- **E**: It refers to emigration. It is the number of individuals of the population who left the habitat and went elsewhere during the considered time period.

Question 25

- Describe the process of megasporogenesis, in an angiosperm.
- Draw a diagram of a mature embryo sac of angiosperm, label its any six parts.

OR

- Where and how in the testes process of spermatogenesis occur in humans.
- Draw diagram of human sperm and label four parts.

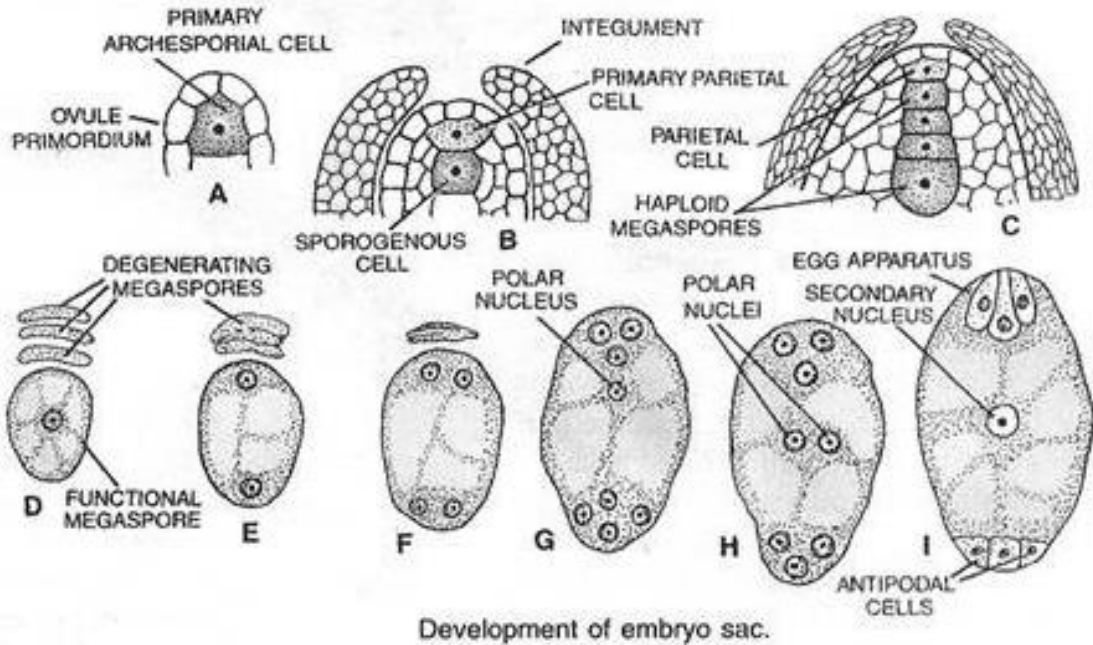
Solution:

a) Megasporogenesis is the process of formation of megaspores in the angiosperms. The megaspore mother cell (MMC) gets converted into megaspores by the process of megasporogenesis.

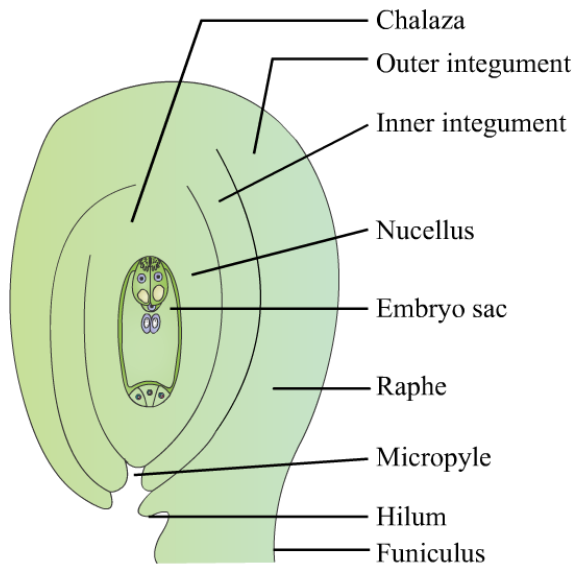
The MMC is large and contains a dense cytoplasm and a prominent nucleus. It undergoes meiosis to produce four megaspores.

In most flowering plants, only one megaspore is functional while the other three degenerate.

The single functional megaspore develops into the female gametophyte.



b) Diagram of a mature embryo sac of an angiosperm-

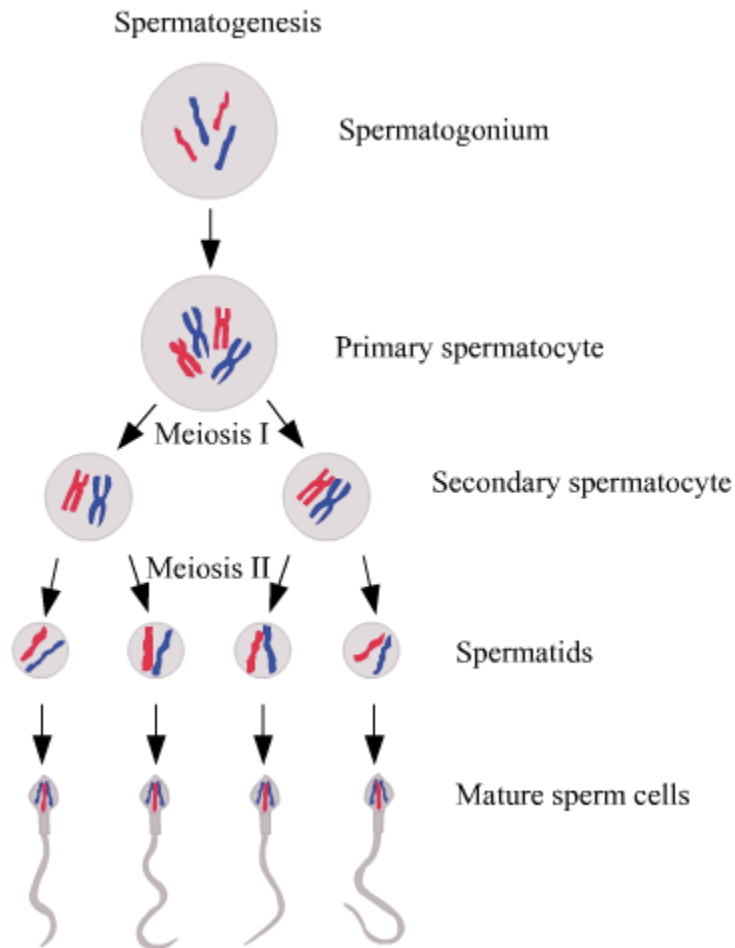


OR

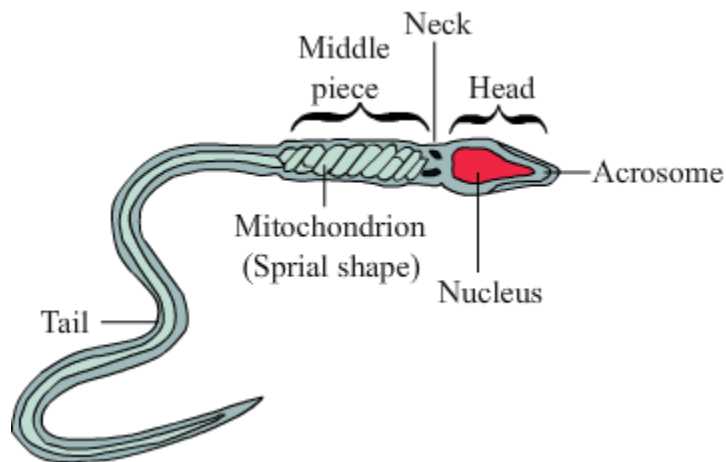
(a) Spermatogenesis is the process of the production of sperms from the immature germ cells in males. It takes place in seminiferous tubules present inside the testes. During spermatogenesis, a diploid spermatogonium (male germ cell) increases its size to form a diploid primary spermatocyte via mitosis.

This diploid primary spermatocyte undergoes the first meiotic division (meiosis I), which is a reductional division to form two equal haploid secondary spermatocytes. Each secondary spermatocyte then undergoes second meiotic division (meiosis II) to form

two equal haploid spermatids. Hence, a diploid spermatogonium produces four haploid spermatids. These spermatids are transformed into spermatozoa(sperm) by the process called spermiogenesis.



(b)



Question 26

- (a) Why did T.H. Morgan select *Drosophila melanogaster* for his experiments?
- (b) How did he disprove Mendelian dihybrid F₂ phenotypic ratio of 9 : 3 : 3 : 1? Explain giving reasons.

OR

- (a) List any four major goals of Human Genome project.
- (b) Write any four ways the knowledge from HGP is of significance for humans.
- (c) Expand BAC and mention its importance.

Solution:

a) T. H. Morgan selected *Drosophila melanogaster* as the model organism for his genetic studies because of the following reasons:

(i) *Drosophila* is easy and suitably grown on cheap synthetic medium under laboratory conditions in all seasons.

(ii) *Drosophila* has a short life cycle of two weeks only.

(iii) High number of progenies are generated per generation making it easy to observe variation.

(iv) Male and female flies can be easily distinguished from each other.

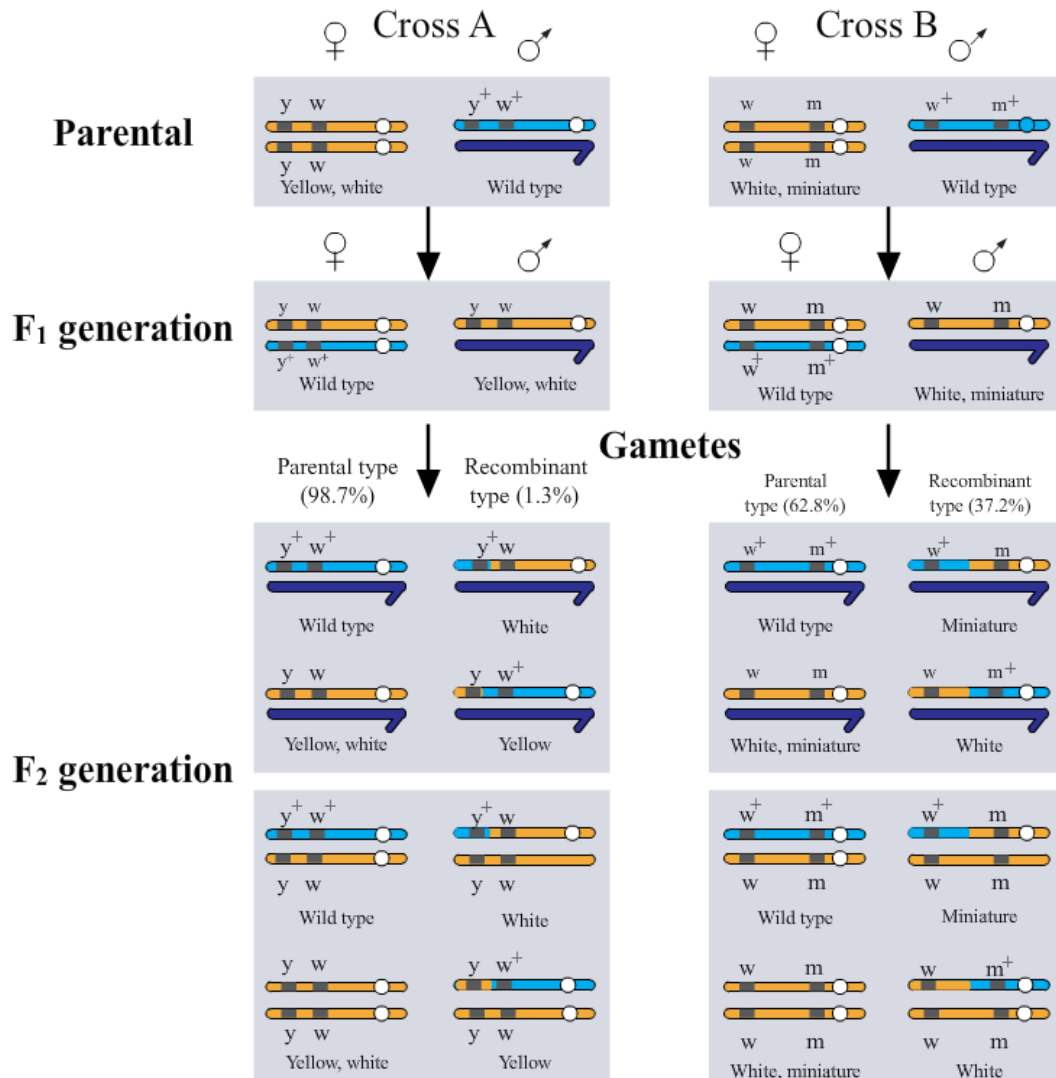
(v) Observable genetic variations can be easily noticed using a low power microscope or a hand lens.

(vi) Four pair of chromosomes in diploid organisms makes *Drosophila* a fairly simple model for genetic studies.

b) Morgan observed that for many genetic characters observed in case of *Drosophila*, the typical mendelian dihybrid cross ratio of 9:3:3:1 is not observed. This was proved by test cross of F₁ generation flies of dihybrid cross.

If the two genes involved in the dihybrid cross are assorting independently then the test cross of the F₁ generation individuals will result in off springs with 50% parental genetic combination and 50% recombinants, but that is not the case as observed by Morgan in case of *Drosophila*.

This can be demonstrated as follows:



OR

a) Main goals of Human genome project (HGP) are:

To identify all the genes (approximately 20,000-25,000) present in the human DNA.
 To determine the accurate sequence of 3 billion chemical base pairs which make up the human genome

To store the above information in the form of databases.

To improve the tools available for data analysis

(b) The four important advantages of the Human genome project (HGP) are:

1. HGP has led to better understanding of Human Biology and Genetics in general.
2. HGP has paved the way for personalised medicine in future based on one's own

genome.

3. HGP has shed a lot of light on human evolution and phylogenetics.

4. HGP has provided greater insights into the field of genetic disorders and their cures.

c) BAC stands for Bacterial Artificial Chromosome. It is an artificially constructed vector containing the origin of replication & selectable marker for identification.

It is capable of carrying large DNA fragments and can replicate easily inside a bacterial cell.

These vectors are used in the human genome project for cloning large chunks of fragmented human genome with ease.

Question 27

(a) Name the insect that attacks cotton crops and causes lot of damage to the crop. How has Bt cotton plants overcome this problem and saved the crop? Explain.

(b) Write the role of gene Cry IAb.

OR

(a) Explain the different steps carried out in Polymerase Chain Reaction, and the specific roles of the enzymes used.

(b) Mention application of PCR in the field of

(i) Biotechnology

(ii) Diagnostics

Solution:

a) Cotton Bollworm is a lepidopteran larvae which is notoriously known as the major pest of cotton plants. Bt cotton plants are GMOs containing the active Cry gene from *Bacillus thuringiensis* which leads to a production of inactive insecticidal protein, which becomes active and functional due to the alkaline pH in the gut of the lepidopteran larvae.

This happens when the pest larvae feeds on the GMO Bt crop, which produces the inactive toxin as produced by the *Bacillus thuringiensis*. The functional protein inside the larvae gut binds to the surface of midgut epithelial cells leading to formation of pores in them.

Due to this the midgut epithelial cells of the insect larvae swells up and lyse, leading to the death of the larvae itself. This way it leads to control of the major insect pest cotton bollworm.

b) CryIAb gene is responsible for the control of corn borer just like the way CryIAc controls the cotton bollworm.

OR

a) Polymerase Chain Reaction (PCR)- This process is used to amplify specific DNA into million or billion copies in vitro. It was invented in 1983 by Kary Mullis.

Two sets of primers (chemically synthesised oligonucleotide stretches that are complementary to a region of DNA), enzyme DNA polymerase, and deoxynucleotides are used in this process.

- PCR consists of 3 steps:

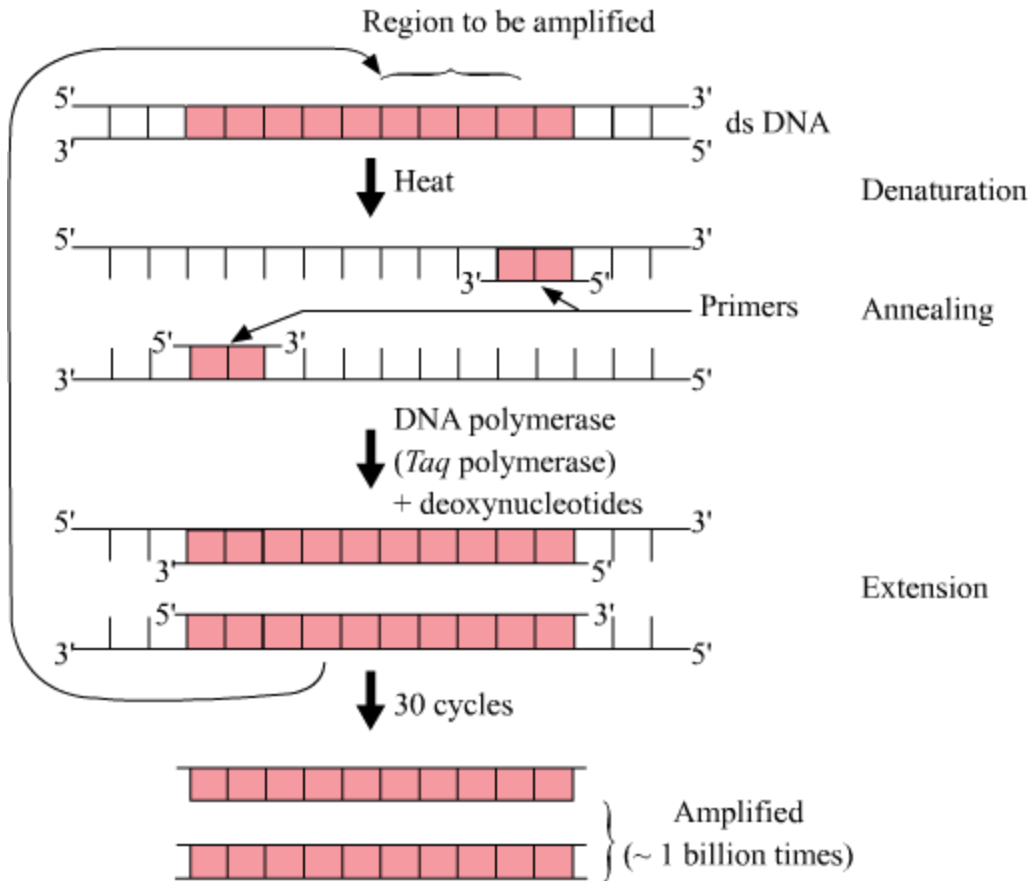
- Denaturation – Double helical DNA is denatured by providing high temperature. DNA polymerase does not get degraded in such high temperatures since the DNA polymerase used in this reaction is thermostable as it is isolated from thermophilic bacteria, *Thermus aquaticus* (Taq).

- Annealing- It is the step in which primers are annealed to single stranded DNA templates. Two sets of primers (small chemically synthesised oligonucleotides that are complementary to the regions of DNA) are used.

The temperature of reaction mixture is lowered to 50- 65°C for some seconds to allow annealing of primers. DNA polymerase extends the primer in 5' to 3' direction.

- Extension – Replication of DNA occurs in vitro.

This cycle is repeated several times to generate up to 1 billion identical copies of the DNA.



The enzymes used in PCR is Taq polymerase which is obtained from the bacterium *Thermus aquaticus*, which yields DNA polymerase.

This enzyme is thermostable and can withstand the high temperature and is used in PCR in recombinant DNA technology.

b) i) In molecular biology to amplify a single or a few copies of a piece of DNA across several orders of magnitude, generating thousands to millions of copies of a particular DNA sequence.

ii) PCR is used in early diagnosis of bacteria and virus in body, when the concentration is extremely low, can be done by PCR since it amplifies the DNA several folds. It is used to detect HIV virus in suspected AIDS patients and mutations in genes in suspected cancer patients.