Biology
Question Paper
2019 (Set-2)

General Instructions :

(i) There are total **27** *questions and* **four** *sections in the question paper.* **All** *questions are compulsory.*

(ii) Section **A** *contains questions number* **1** *to* **5***, very short answer type questions of* **one** *mark each.*

(iii) Section **B** *contains questions number* **6** *to* **12***, short answer type* **I** *questions of* **two** *marks each.*

(iv) Section **C** *contains questions number* **13** *to* **24***, short answer type* **II** *questions of* **three** *marks each.*

(v) Section **D** *contains question number* **25 to 27***, long answer type questions of* **five** *marks each.*

(vii) There is no overall choice in the question paper, however, an internal choice is provided in **two** *questions of* **one** *mark,* **two** *questions of* **two** *marks, four questions of* **three** *marks and all the* **three** *questions of* **five** *marks. In these questions, an examinee is to attempt any* **one** *of the* **two** *given alternatives.*

(vii) Wherever necessary, the diagram drawn should be neat and properly labelled.

Question 1

What are 'flocs', formed during secondary treatment of sewage?

OR

Write any two places where methanogens can be found.

SOLUTION:

Flocs are masses of bacteria embedded in fungal filaments to form a mesh-like structure. These flocs consume organic matter in waste water and reduce the B.O.D. levels in water. The flocs form a part of activated sludge, a small part of which is pumped back into aeration tank to help as inoculums.

OR

Methanogens are found in cattle dung (gobar) and in rumen of cattle.

Question 2

How did Charles Darwin express 'fitness'?

SOLUTION:

Charles Darwin expressed 'fitness' as characteristics which enable some organisms to survive better in natural conditions (climate, food, physical factors, etc.) which would outbreed others that are less-endowed to survive under such natural conditions. Another word used is the fitness of the individual or population.

Question 3

At what stage does the meiosis occur in an organism exhibiting haploidic life cycle and mention the fate of the products thus produced.

SOLUTION:

Meiosis occurs at the zygote stage in an organism exhibiting haploidic life cycle. Thus, the product formed will be haploid spores.

Question 4

Name the layer of the atmosphere that is associated with 'good ozone'.

OR

Mention the term used to describe a population interaction between an orchid growing on a forest tree.

SOLUTION:

"Good Ozone" which is chiefly responsible for absorbing the harmful ultraviolet radiation of sun is present in stratosphere.

OR

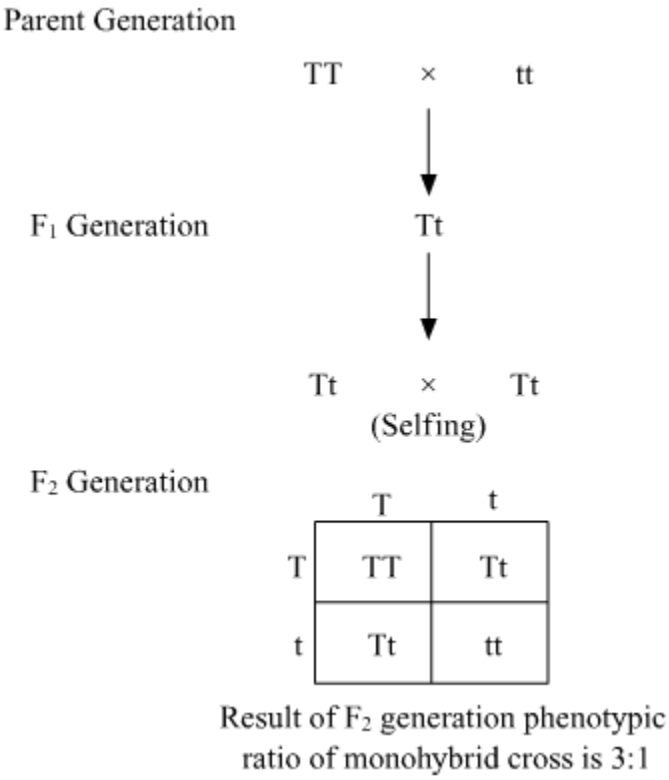
An orchid growing on a forest tree simply uses the tree as a substratum to hold itself and does not harm the host tree in any way. Hence it is a simple case of commensalism.

Question 5

British geneticist R.C. Punnett developed a graphical representation of a genetic cross called "Punnett Square". Mention the possible result this representation predicts of the genetic cross carried.

SOLUTION:

Punnett Square for Mendelian monohybrid cross between pure line tall and dwarf plant will appear as following:



Result of F_2 generation phenotypic ratio of monohybrid cross is 3:1

Question 6

Express the process of pollination in *Vallisneria*.

SOLUTION:

Vallisneria grows in fresh water and is pollinated by water. It is a type of pollination known as hydrophily. The female flowers reach the surface of water by a long stalk while the pollen grains are released on the surface of water. These are passively carried by water currents to reach the stigma of the female flowers. Pollen grains of such plants are covered by mucilage which protect them from wetting.

Question 7

Differentiate between the roles of B-lymphocytes and T-lymphocytes in generating immune responses.

OR

Principle of vaccination is based on the property of "memory" of the immune system. Taking one suitable example, justify the statement.

SOLUTION:

T lymphocytes	B lymphocytes
Originate in the bone marrow and mature in the thymus.	They are born and also mature in bone marrow.
T cells multiply and differentiate into helper, regulatory, or cytotoxic T cells or become memory T cells.	B lymphocyte differentiates into a plasma cell, which secretes immunoglobulin.
T cells are involved in cell-mediated immunity.	B cells are primarily responsible for humoral immunity (relating to antibodies).

OR

The principle of vaccination is based on the property of 'memory' of the immune system. In vaccination, a preparation of antigenic proteins of the pathogen or attenuated (inactivated/weakened) pathogen is introduced in the body. The antibodies produced in the body against these pathogens will neutralize the pathogenic agents during actual infection. The vaccine also generates memory B-cells and T-cells that recognize the pathogen quickly on subsequent exposure. For example, vaccination against polio prevents the actual pathogen from resulting in infection.

Question 8

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

SOLUTION:

Gene Flow occurs due to emigration or immigration resulting in the change in the frequency of alleles of a gene within the gene pool of a population. A population with active gene flow will not obey the Hardy-Weinberg principle.

Genetic Drift is a sudden change in the frequency of genes and their alleles within a gene pool of a population over a very short duration of time. A population experiencing

such a phenomenon will also not obey Hardy-Weinberg principle. Genetic drift can occur due to natural or artificial selection alike.

Question 9

Why is crossbreeding in animals practiced? How is a breed Hisardale developed?

SOLUTION:

Cross-breeding is practiced in animals because it allows the desirable qualities of two different breeds to be combined. The progeny hybrid animals may themselves be used for commercial production. *Hisardale* is a new breed of sheep developed in Punjab by crossing Bikaneri ewes and Marino rams.

Question 10

β galactosidase enzyme is considered a better selectable marker. Justify the statement.

SOLUTION:

Selective marker is used in the selection of recombinants on the basis of ability to produce colour in the presence of chromogenic substrate. *β*-galactosidase is an enzyme that converts galactose into lactose. In this, a recombinant DNA is inserted within the coding sequence of enzyme, *β*-galactosidase, which result into inactivation of enzyme referred to as "insertional inactivation". Coding sequence for the enzyme *β*-galactosidase is preferred over antibiotic resistance genes because recombinants can be easily visualised.

Question 11

Mention **four** significant services that a healthy forest ecosystem provide.
OR
Substantiate with the help of one example that in an ecosystem mutualists (i) tend to co-evolve and (ii) are also one of the major causes of biodiversity loss.

SOLUTION:

Ecosystem services are the products of ecosystem processes. Healthy forest ecosystem provides the following ecosystem services:

- Purification of air and water
- Cycling of nutrients
- Generation of fertile soil
- Provision of habitat to wildlife

OR

Mutualists are pairs of organism that benefit from the interactions between them.

(i) Mutualism between a flower and its pollinator follows co-evolution as the interaction should be safe from "cheating". A Fig species is pollinated by a particular species of wasp. While the wasp uses the fruit for oviposition and source of nourishment for its larvae, the fig is pollinated by the wasp.

(ii) Since both the participants in the mutualism are linked, a change, anthropogenic or otherwise, affecting one species will consequently also reduce the population of the other species. Plant-Pollinator interaction is an example of the same. Extinction of the pollinator will reduce the diversity of plant species which is dependent on it. Reduction in bees population is posing a threat to the diversity of crops.

Question 12

List any **four** ways by which GMO's have been useful for enhanced crop output.

SOLUTION:

The four ways by which GMO's have been useful for enhanced crop output are -

- Genetically modified crops are more tolerant to abiotic stress, which can be in the form of cold, drought, heat or salt.
- Crops that are made pest-resistant through genetic modification have reduced dependence on chemical pesticides.
- Genetic modification of crops has reduced post-harvest losses.
- Genetic modification has helped in increasing efficiency of mineral usage by plants. It has helped in maintaining the fertility of the soil for a longer duration.

Question 13

(a) Differentiate between geitonogamy and xenogamy.

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

SOLUTION:

(a)

Xenogamy	Geitonogamy
Xenogamy is the transfer of pollen grains from the anther to the stigma of a different plant.	Geitonogamy is the transfer of pollen from the anther of one flower to the stigma of another flower in the same plant.
This is the only type of pollination which during pollination brings genetically different types of pollen grains to the stigma. It is also known as allogamy.	Genetically, it is similar to autogamy, since the pollen grains come from the same plant. But it requires pollinating agents that help to transfer the pollen from another flower on the same plant.
It is cross-pollination.	It is self-pollination.

(b) As Geitenogamy is a type of self-pollination the progeny is genetically similar to the parent. Whereas, in the case of Xenogamy the progeny is genetically different from either of the parent. Thus, known as cross-pollination.

Question 14

(a) Write **two** differences between *Homo erectus* and *Homo habilis*.
(b) Rearrange the following from early to late geologic periods :
Carboniferous, Silurian, Jurassic.

SOLUTION:

(a)

Homo habilis		*Homo erectus*	
(1)	This creature probably lived in East African grassland around two mya.	(1)	This creature lived about 15 mya and its fossils were discovered in Java in 1891.
(2)	Brain capacity of this creature was 650–800cc.	(2)	Brain capacity was around 900cc.
(3)	They did not eat meat.	(3)	They probably ate meat.

(b) Silurian, Carboniferous, Jurassic.

Question 15

Explain the mechanism of DNA replication with the help of a replication fork. What role does the enzyme DNA-ligase play in a DNA replication fork?

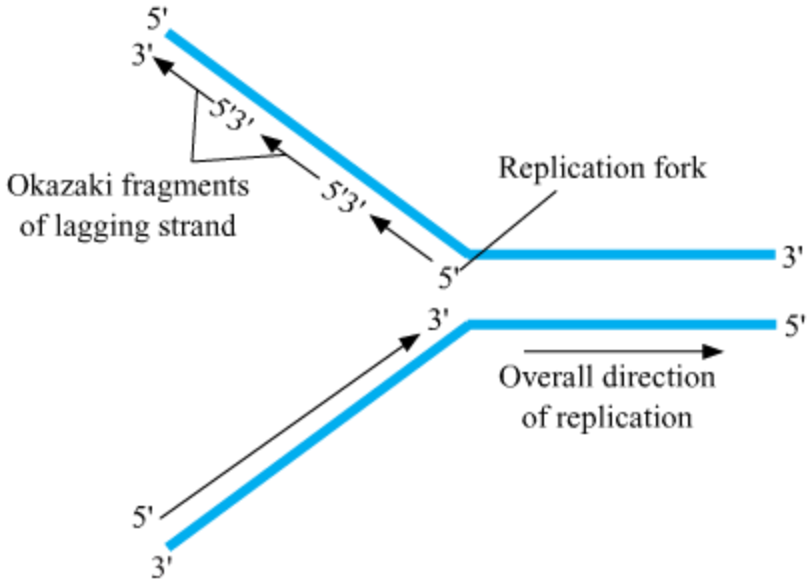
OR

Construct and label a transcription unit from which the RNA segment given below has been transcribed. Write the complete name of the enzyme that transcribed this RNA.

SOLUTION:

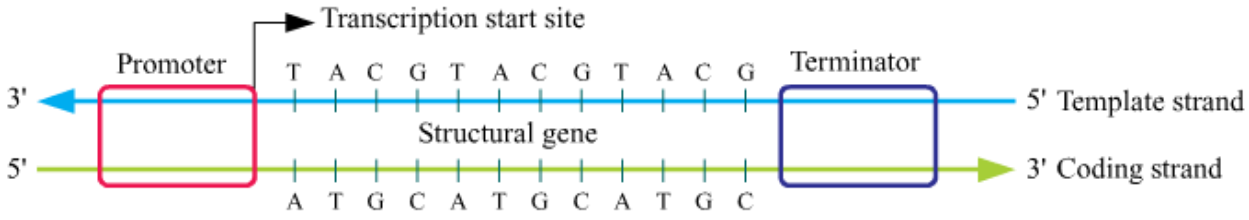
- DNA replication occurs in small replication forks. It does not occur in its entire length in one time as DNA is a very large molecule and only that part of DNA opens up which is being replicated. The opening of the whole DNA molecule would be an energetically more expensive process.
- The main enzyme involved in DNA replication is the DNA-dependent DNA polymerase. This enzyme catalyzes the polymerization of deoxynucleotides along the 5' → 3' direction, and hence, replication is continuous along the 3' → 5' strand (leading strand) and discontinuous along the template, i.e., the 5' → 3' direction (lagging strand).
- Okazaki fragments are short DNA segments on the lagging strand, formed in the 5’ – 3’ direction, starting from RNA primers. A separate RNA primer is needed for the synthesis of each Okazaki fragment. These discontinuously synthesized fragments are later joined by the enzyme DNA ligase.
- Ori stands for Origin of replication. This site has the highly conserved sequence of DNA among various species. The replication of DNA starts here because this site attracts some proteins which help in the opening and unwinding of DNA and this leads to the initiation of replication.

The function of DNA Ligase is to join the two nucleotides. During the DNA replication process, it joins the Okazaki fragments of the daughter DNA to form the complete DNA molecule on the lagging strand.



As per the question, the RNA strand given is having Thymine which is not possible. Hence, the question is wrong.

Taking U (Uracil) instead of T (Thymine) in the given strand the possible solution shall be
RNA Polymerase is the enzyme which is used during transcription.



Schematic Structure of a transcription unit

Question 16

Compare in any three ways the chromosomal theory of inheritance as proposed by Sutton and Bovery with that of experimental results on pea plant presented by Mendel.
OR
(a) Explain linkage and recombination as put forth by T.H. Morgan based on his observations with *Drosophila melanogaster* crossing experiment.
(b) Write the basis on which Alfred Sturtevant explained gene mapping.

SOLUTION:

Gregor Mendel, through his work on pea plants, discovered the fundamental laws of inheritance. He deduced that genes come in pairs and are inherited as distinct units, one from each parent. Mendel tracked the segregation of parental genes and their

appearance in the offspring as dominant or recessive traits. He recognized the mathematical patterns of inheritance from one generation to the next.
Mendel did not investigate how characteristics are sorted and combined on cellular level. Sutton and Boveri , working independently, suggested that chromosomes could be shown to bear the materials of heredity.
They noted that the behaviour of chromosomes was parallel to the behaviour of the gene and used chromosomes movement to explain Mendel's laws.
Sutton and Boveri argued that the pairing and separation of pair of chromosomes would lead to segregation of a pair of factors they carry. Sutton united the knowledge of chromosomal segregation with Mendelian principle and called it " chromosomal theory of inheritance".

OR

(a) The linkage is a term that describes the tendency of certain loci or alleles to be inherited together. Genetic loci on the same chromosome are physically close to one another and tend to stay together during meiosis, thus are genetically linked. Genetic recombination is the formation of new combinations of alleles in offspring as a result of the exchange of DNA sequences between chromosomes. It occurs naturally, as in sexual reproduction during meiosis or artificially, as a result of experiments on genetic engineering.

Thomas Hunt Morgan and his colleagues used fruitfly, or *Drosophila melanogaster* to study linkage. They showed how sexual reproduction gave rise to variations. Similar to Mendel’s dihybrid cross in peas, Morgan conducted dihybrid cross between yellow-bodied, white-eyed females and brown-bodied, red-eyed males. Shockingly, the self-crossing of F1 generation did not give a ratio of 9:3:3:1 in the F2 generation. The result showed a deviation from Mendel’s dihybrid cross.
Morgan observed that while crossing a set of characteristics, two genes did not segregate as per Mendel’s law. If two genes were present on the same chromosome, the probability of getting a parental combination was much higher in the next generation as compared to the non-parental combination. This physical association of genes was termed as linkage.
In addition, they noted that the probability recombination is dependent on how strong the linkage is. In other words, though there is a link between two genes on chromosomes, genes may or may not be tightly linked. Some genes have strong linkage giving less chance of recombination while another linkage of genes is weak (loosely linked) giving a higher chance of recombination.

(b) Alfred Sturtevant was a student of Morgan. He discovered the position of linked genes on a chromosome by calculating their frequency of genetic recombination by the process of gene mapping. This method of generating linkage map was extensively used during Human Genome Project.

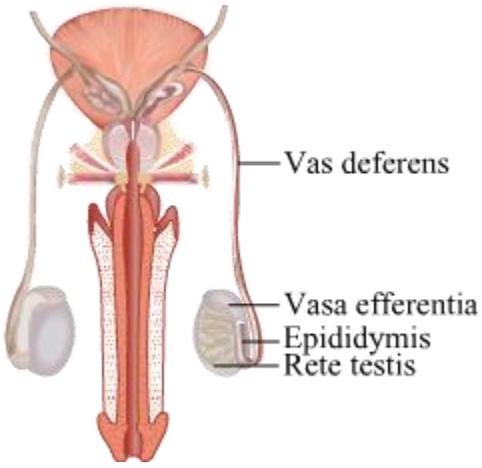
Question 17

Draw a labelled diagram to show interrelationship of four accessory ducts in a human male reproductive system.

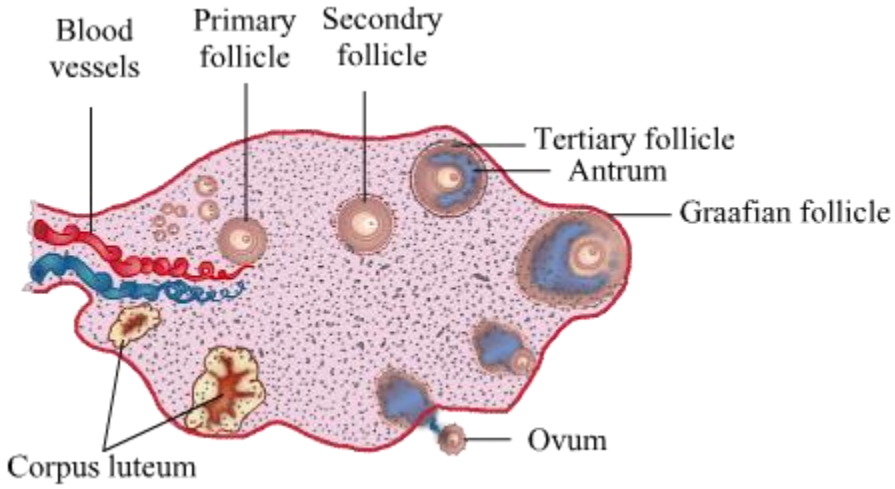
OR

Draw a sectional view of the human ovary showing the different stages of developing follicles, corpus luteum and ovulation.

SOLUTION:



OR



Question 18

How does the activity of each one of the following help in organic farming?

(a) *Mycorrhiza*

(b) *Cyanobacteria*

(c) *Rhizobium*

SOLUTION:

(a) Fungi are known to form symbiotic associations with plants, this association is called mycorrhiza. The fungal symbiont in these associations absorbs phosphorus from soil and passes it to the plant. This association help the plant to absorb phosphorus in a natural way thus help in Organic farming

(b) Cyanobacteria are free-living or symbiotic blue-green algae which are capable of converting atmospheric molecular nitrogen into the soluble form like nitrites or nitrates. This is called nitrogen fixation. The cyanobacteria carry out this process when free-living in the soil or plant roots and enrich the nitrogen content of the soil acting as a natural fertilizer.

(c) Rhizobium bacteria live in the root nodules of the leguminous plants. Rhizobium converts the atmospheric nitrogen into a soluble form such as nitrate and nitrite so that plants can take them up from the soil. Thus is enriches the soil and makes it fertile thereby helping the farmers.

Question 19

Two children, A and B aged 4 and 5 years respectively visited a hospital with a similar genetic disorder. The girl A was provided enzyme-replacement therapy and was advised to revisit periodically for further treatment. The girl, B was, however, given a therapy that did not require revisit for further treatment.
(a) Name the ailments the two girls were suffering from ?
(b) Why did the treatment provided to girl A required repeated visits ?
(c) How was the girl B cured permanently ?

SOLUTION:

a) ADA (adenosine deaminase) deficiency is a form of SCID (severe combined immunodeficiency)- a type of disorder that affects the immune system. The disease is caused by a mutation in a gene on chromosome 20. The gene codes for the enzyme adenosine deaminase (ADA). Without this enzyme, the body is unable to break down a toxic substance called deoxyadenosine. The toxin builds up and destroys infection-fighting immune cells called T and B lymphocytes.

b) Girl A was given Enzyme replacement therapy in which lymphocytes isolated from patient's blood are cultured in-vitro. Functional ADA cDNA are then introduced into the cultured lymphocytes. These lymphocytes are returned back to the patient's body. Lymphocytes are not immortal. Therefore, repeated infusion of genetically engineered lymphocytes is required and hence it is not a permanent treatment and the patient have to revisit periodically in the future.

c) Girl B was treated with gene therapy through the gene isolated from bone marrow cells producing ADA is introduced into cells at early embryonic stages which is a permanent cure so the patient is cured permanently.

Question 20

While on a visit to a pond in the city-neighbourhood, the visitors were delighted to find large expanse of water covered with colourful algal mass.
(a) As a student of biology, do you agree with their delight? Give reasons in support of your answer.
(b) Explain the cause of such algal growth.

SOLUTION:

(a) What the villagers saw and are delighted about is algal bloom over a stationary water body. This algal bloom will cut off the supply of light and oxygen to the submerged flora and fauna of the water body. It will outcompete the water bodies flora and fauna for nutrients and will rapidly grow and deplete other organisms in the given water body ecosystem of necessary nutrients. This will quickly lead to the death, decay, and destruction of the already existing water body ecosystem.

(b) The flushed out and washed nutrients from the excess fertilizers of the nearby fields had accumulated and promoted the sudden burst in the growth of algal bloom on the water body. This phenomenon is often termed as Cultural or Accelerated Eutrophication.

Question 21

(a) Match the microbes listed under Column-A with the products mentioned under Column-B.

Column –A	Column –B
(H) Penicillium notatum	(i) Statin
(I) Trichoderma polysporum	(ii) ethanol
(J) Monascus purpures	(iii) antibiotic
(K) Saccharomyces cerevisiae	(iv) Cyclosporin-A

(b) Why does 'Swiss Cheese' develop large holes?

SOLUTION:

(a)
(H) *Penicillium notatum* - (iii) antibiotic
(I) *Trichoderma polysporum* - (iv) Cyclosporin -A
(J) *Monascus pupurea* - (i) Statin
(K) *Saccharomyces cerevisiae* - (ii) ethanol

(b) Swiss cheese develops large holes because of the large amount of carbon dioxide produced by the bacterium *Propionibacterium shermanii*.

Question 22

Bee keeping practice is a good income generating industry. Write the different points to be kept in mind for successful bee keeping. Write the scientific name of the most common Indian species used for the purpose.

SOLUTION:

The important points for successful bee keeping are as follows.
(i) Knowledge about habits and nature of bees
(ii) Selection of suitable location for placing beehives
(iii) Catching and hiving of group of bees
(iv) Management of beehives during various seasons

The scientific name of the most common Indian species used for apiculture is *Apis indica*.

Question 23

Mention the special adaptations evolved in parasites and why?

SOLUTION:

The survival of a parasite in the body of the host depends upon its ability to adapt to the surrounding environment at the site of its infection. Certain morphological, anatomical and physiological changes occur because of which the parasite survives in the host. These are as follows:
(i) Body shape and size of the parasite depends upon the space available at the site of infection. e.g., Intracellular parasites are very small in size – *Plasmodium*.
(ii) Locomotory structures almost absent in the parasitic forms, as they need not move in search of food.
(iii) In the case of intestinal parasites, there is every possibility, that they are either harmed, injured or digested by the gastrointestinal secretions of the host.
(iv) To protect from the harmful effects of digestive enzymes, the parasite's body surface is covered with cuticle (Nematodes – *Ascaris lumbricoides*).

Question 24

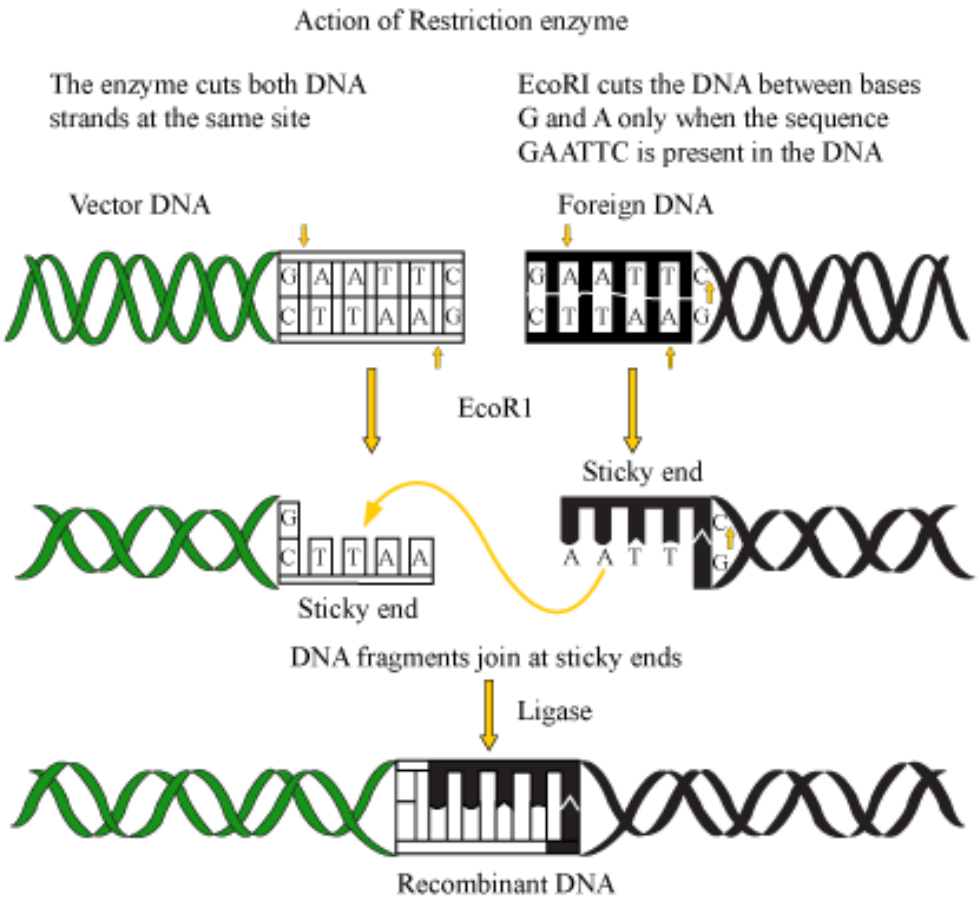
Describe the formation of recombinant DNA by the action of EcoRI.

OR

Describe the process of amplification of "gene of interest" using PCR technique.

SOLUTION:

Restriction endonuclease enzyme EcoRI is used in the molecular biology to cut the foreign DNA and vector DNA to form overhangs (called sticky ends). These sticky ends then form hydrogen bonds with their complementary counterparts. The segments with the help of DNA ligases are joined to produce recombinant DNA.



OR

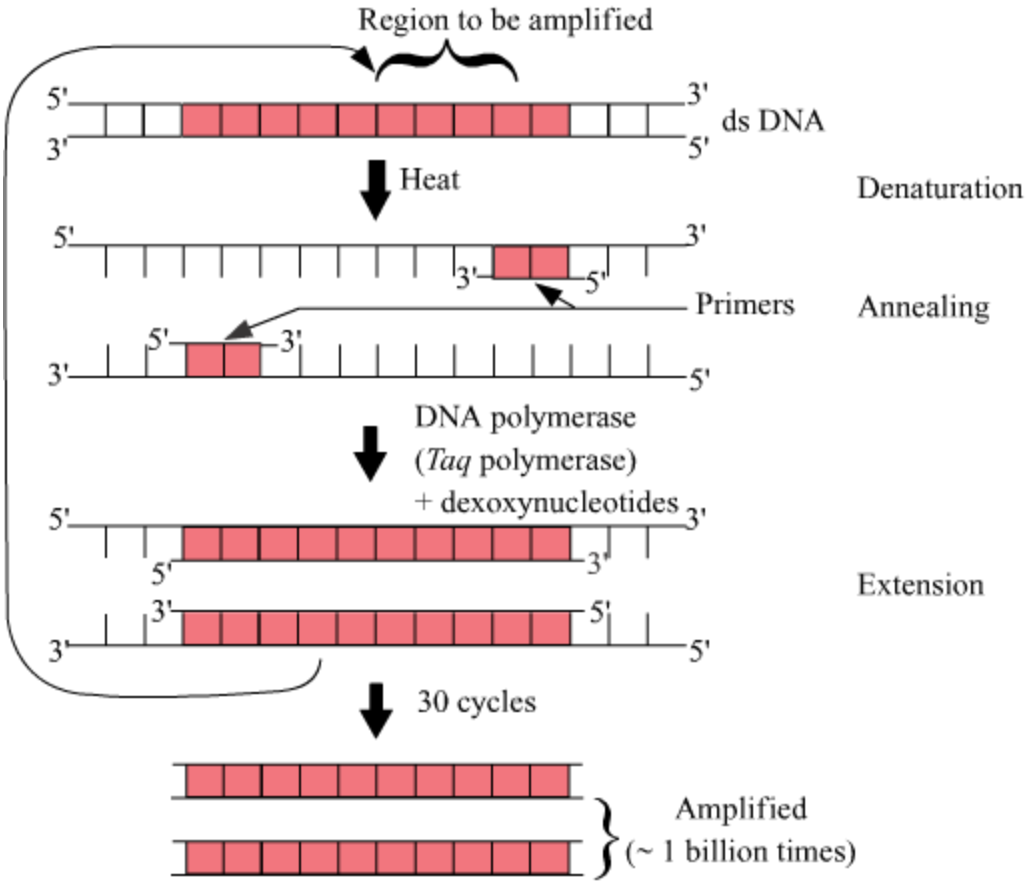
To amplify the gene segment of the interest we should know the sequence of the gene of interest. Primers are designed for amplifying the gene of interest. Two sets of primers (chemically synthesized oligonucleotide stretches) that are complementary to the gene of interest, DNA polymerase enzyme, and deoxynucleotides are added. PCR can then be carried out for its amplification.

PCR consists of 3 steps:

• **Denaturation** – Double-helical DNA is denatured by providing high temperature(95-degree Celsius). DNA polymerase does not get degraded in such high temperatures. The DNA polymerase used in this reaction is thermostable and is isolated from the thermophilic bacteria, *Thermus aquaticus* (*Taq*).

• **Annealing-** It is the step in which primers are annealed to single-stranded DNA templates. Two sets of primers are used. The temperature of the 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.

Question 25

Where does the process of megasporogenis start in an angiosperm? Describe the process upto the formation of embryo sac.

OR

(a) Explain the process of fertilization in human.

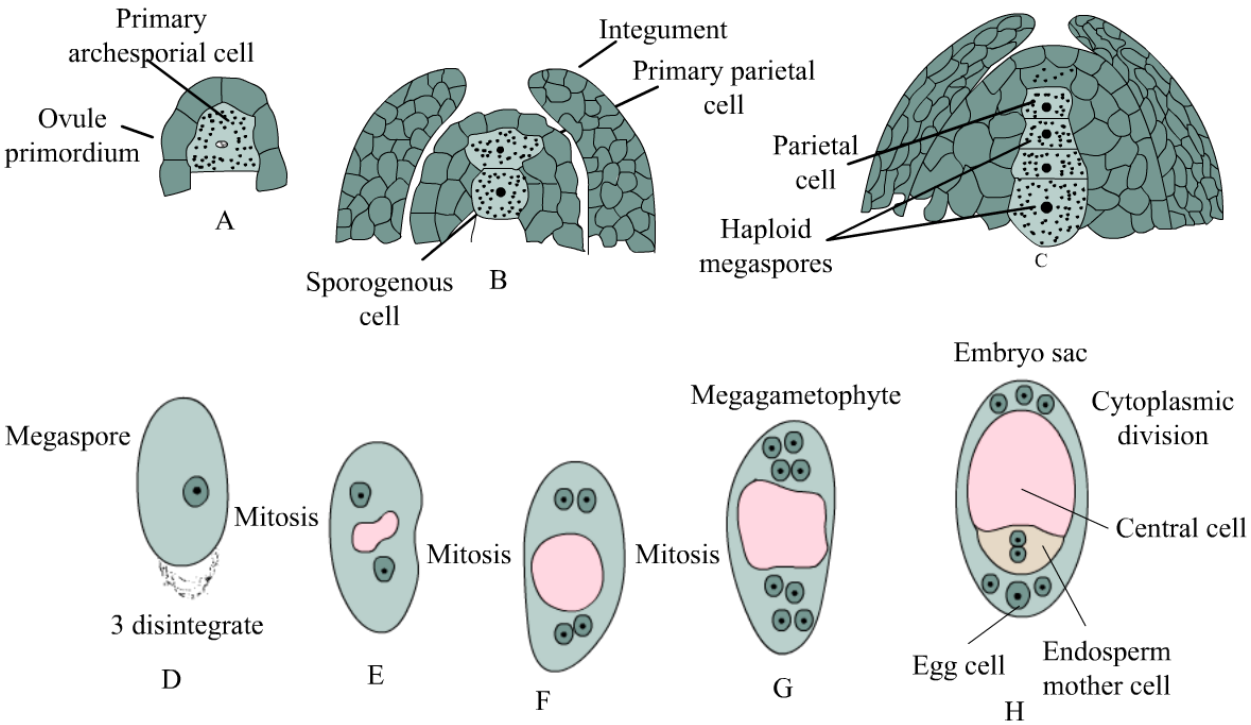
(b) Name the embryonic stage that gets implanted in human females. Explain the process of implantation.

SOLUTION:

Megasporogenesis is the process of formation of megaspores from megaspore mother cells (MMC). The megaspore mother cell (MMC) undergoes meiosis and forms a linear tetrad of 4 haploid megaspores. The process of meiotic formation of haploid megaspores from diploid megaspore mother cell is called megasporogenesis. Commonly the chalazal megaspore remains functional while the other 3 degenerate.

The functional megaspore is the first cell of the female gametophyte. The cell enlarges

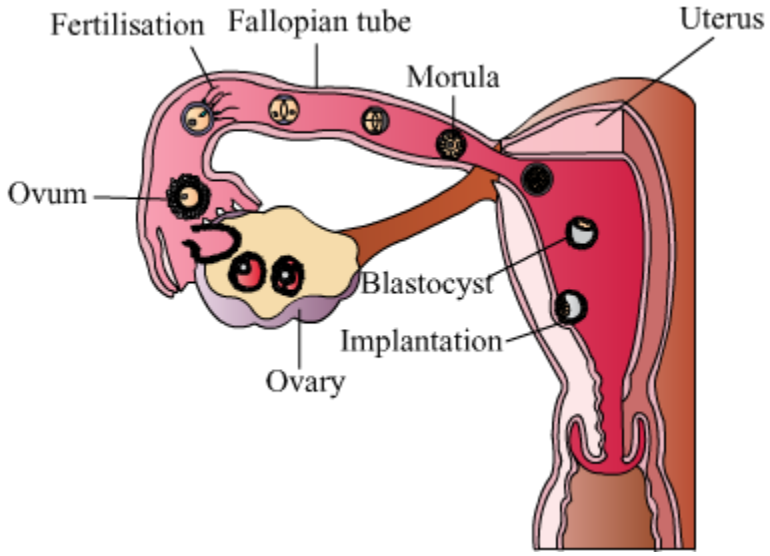
and undergoes three free nuclear mitotic divisions. The first division produces two nucleate embryo sac. The two nuclei shift to the two ends and divide there twice forming four nucleate and then eight nucleate structure.
One nucleus from each side moves to the middle. They are called polar nuclei. The remaining three nuclei form cells at the two ends, 3 celled egg apparatus at the micropylar end and three antipodal cells at the chalazal end.
The middle bi-nucleate part organises itself into a central cell. Embryo sac developed from a single megaspore is called monosporic.



(a) Fertilization involves the fusion of the male and the female gamete. The male and the female gametes are released from the male and the female reproductive organs. Sperms or male gametes are released from the male reproductive organ i.e., the penis. These sperms then enter the female body through the vagina. They travel through the fallopian tubes where they fuse with the eggs in the fallopian tube. Hence, the process of fertilization takes place in the fallopian tubes.
During fertilization, the haploid nucleus of the sperm and that of the ovum fuse with each other to form the zygote. This zygote divides to form an embryo which in turn develops into a foetus.

(b) A blastocyst is an embryonic stage that gets implanted in the uterus of the female. Implantation involves the attachment of the blastocysts to the uterine epithelium. The process of implantation begins at the end of week 1, it requires the newly hatched blastocyst loosely adhered to the endometrial epithelium layer within the uterus. The blastocyst is arranged into an outer layer called the trophoblast and an inner cell mass. It is the trophoblast cells that proliferate rapidly and differentiate into an inner layer of cytotrophoblast and an outer multinucleated cell layer, the syncytiotrophoblast. The

projections of cytotrophoblast and syncytiotrophoblast bring the embryo into the endometrium so that it will fully be covered by endometrium epithelium.



Question 26

(a) What is "population" according to you as a biology student?
(b) "The size of a population for any species is not a static parameter." Justify the statement with specific reference to fluctuations in the population density of a region in a given period of time.

OR

(a) What is hydrarch succession?
(b) Compare the pioneer species and climax communities of hydrarch and xerarch succession respectively.
(c) List the factors upon which the type of invading pioneer species depend in secondary hydrarch succession. Why is the rate of this succession faster than that of primary succession?

SOLUTION:

(a) The term 'Population' refers to the group of individuals of a species living together in a group in a well-defined geographical area, sharing or competing for resources and potentially interbreeding. Although the term interbreeding implies sexual reproduction, a group of individuals resulting from even asexual reproduction is also considered a population.

(b) The size of a population of any species is not a static parameter. It keeps changing in time, depending on various factors including food availability, predation pressures, and weather. The population density in a given period can fluctuate due to the following four factors:
(i) Natality: It refers to the number of births during a given period in the population that are added to the initial density.
(ii) Mortality: It refers to the number of deaths during a given period that reduced the

size.
(iii) Immigration: It is the number of individuals of the same species that have come into the habitat from elsewhere during the given period.
(iv) Emigration: It is the number of individuals who left the habitat and have gone elsewhere.

OR

(a) Succession that occurs in wetter areas and the successional series progress from hydric to the mesic condition is called the hydrarch succession.

(b) The species that invade a bare area are called the pioneer species while the climax community is established over the process of succession and it is in near equilibrium with the environment. The pioneer species of hydrarch succession are phytoplankton and the climax community is the xerophytic forest. The pioneer species of xerarch succession are lichens and the climax community is the mesophytic forest.

(c) In secondary succession the species that invade depend on the condition of the soil, availability of water, the environment and the seeds and propagules already present. Since the soil is in existence already, the rate of secondary succession is faster than the primary succession, in which the soil is gradually produced.

Question 27

Differentiate between incomplete dominance and co-dominance. Substantiate your answer with one example of each.

OR

(a) Write the contributions of the following scientists in deciphering the genetic code.

George Gamow ; Hargobind Khorana ; Marshall Nirenberg ; Severo Ochoa

(b) State the importance of a Genetic code in protein biosynthesis.

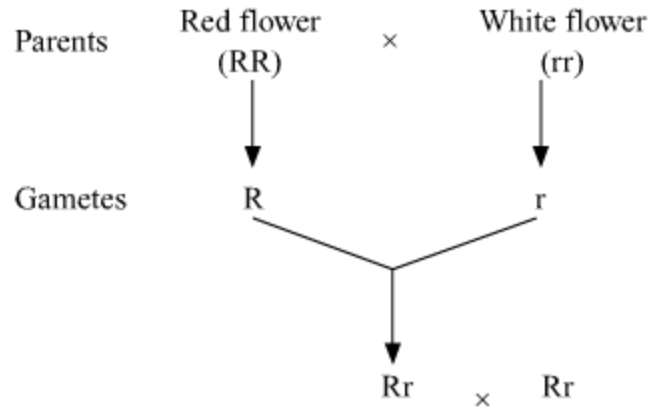
SOLUTION:

Co-dominance is the phenomenon in which both the alleles of a contrasting character are expressed in the heterozygous condition. Both the alleles of a gene are equally dominant. ABO blood group in human beings is an example of co-dominance. The blood group character is controlled by three sets of alleles, namely, I^A, I^B, and i. The alleles, I^A and I^B, are equally dominant and are said to be co-dominant as they are expressed in the AB blood group. Both these alleles do not interfere with the expression of each other and produce their respective antigens. Hence, the AB blood group is an example of co-dominance.

Allele from Parent 1	Allele from Parent 2	Genotype of offspring	Blood type of offspring
I^A	I^A	I^A I^A	A

I^A	I^B	I^AI^B	AB
I^A	i	I^A i	A
I^B	I^A	I^A I^B	AB
I^B	I^B	I^BI^B	B
I^B	i	I^B i	B
i	i	i i	O

Incomplete dominance is a phenomenon in which one allele shows incomplete dominance over the other member of the allelic pair for a character. For example, a monohybrid cross between the plants having red flowers and white flowers in *Antirrhinum* species will result in all pink flower plants in the F_1 generation. The progeny obtained in F_1 generation does not resemble either of the parents and exhibits intermediate characteristics. This is because the dominant allele, R, is partially dominant over the other allele, r. Therefore, the recessive allele, r, also gets expressed in the F_1 generation resulting in the production of intermediate pink flowering progenies with Rr genotype.



F_2 Generation

♀/♂	R	r
R	RR red	Rr pink
r	Rr pink	rr white

Phenotypic ratio = Red : Pink : White
1 : 2 : 1

Genotype ratio = Rr : Rr : rr
1 : 2 : 1

OR

(a) **George Gamow** proposed that if 20 amino acids are to be coded by 4 bases, then the code should be made up of three nucleotides.
43 = 64 (42 = 16), which is less than 20; so, the codon was proposed to be a triplet.
Har Gobind Khorana developed a chemical method to synthesise RNA molecules with defined combination of bases.
Marshall Nirenberg developed cell-free systems for protein synthesis, which helped the code to be deciphered.
Severo Ochoa discovered an enzyme (polynucleotide phosphorylase) which helped in the synthesis of RNA with defined sequences in a template-independent manner.

(b) The genetic code is a set of three different nucleotides taken at a time which code for a specific amino acid.

1. A codon is a triplet. $4^3 = 64$ (61 codons code for amino acids while 3 are stop codons)
2. One codon codes for a single specific amino acid. Codons are unambiguous.
3. Codons are degenerate since some amino acids are coded by more than one codon.
4. The genetic code is universal. 1 codon codes for the same amino acid in all species.
5. Codons are read continuous. They lack punctuations.
6. AUG has dual functions – Codes for Methionine and acts as a start codon

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