CBSE 2019
Biology Paper

Section A

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

(1 Mark)

Solution

In haplontic life cycle, the haploid stage is multicellular, and the diploid stage is a single cell, meiosis is "zygotic". In their life cycle, meiosis produces haploid cells that germinate to produce new organism.

2. Write the number of chromosomes body cell of honey bee workers and drones have.

(1 Mark)

Solution

In honeybees, female workers and queens have 32, 16 are contributed by the queen's eggs and 16 come from the drones sperm. Since drones' hatch from unfertilized eggs, they only have the 16 chromosomes that were in the egg. Drones are haploid because they only have one set of chromosomes.

3. What are 'flocs', formed during secondary treatment or sewage?

(1 Mark)

Solution

Flocs are essentially groups of bacteria which are in a sludge structure and is held together with the use of slime. Flocs are helpful in increasing the decomposition rate and are put in the aeration tank while the secondary sewage treatment process is in effect.

OR

Write any two places where methanogens can be found.

(1 Mark)

Solution

Methanogens are found in:

- Deep layers of sediments and wet lands
- In guts of ruminant animals like cow

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

(1 Mark)

Solution

The stratosphere or "good" ozone layer extends upward from about 6 to 30 miles and protects life on Earth from the sun's harmful ultraviolet (UV) rays.

OR

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

(1 Mark)

Solution

The relationship between a forest tree and an orchid is an example of commensalisms, where one species gets benefited while the other remains unaffected.

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.

(1 Mark)

Solution

A Punnett square can be used to predict genotypes (allele combinations) and phenotypes (observable traits) of offspring from genetic crosses.

Section B

6. It is said apomixis is a type of asexual reproduction. Justify.

(2 Marks)

Solution

In apomixis, there is no fertilization involved. Since, it does not involve fertilization, it is used as asexual means or vegetative propagation method. Though it is asexual, it still uses the sexual organs of the plant– the ovary and the ovules.

7. Mention four significant services that a healthy forest ecosystem provides.

(2 Marks)

Solution

The benefits provided by forest ecosystems include:

- Goods such as timber, food, fuel and bioproducts.
- Ecological functions such as carbon storage, nutrient cycling, water and air purification.
- Maintenance of wildlife habitat.
- Social and cultural benefits such as recreation, traditional resource uses and spirituality.

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.

(2 Marks)

Solution

(i) Orchids in the genus *Ophrys* are the best known of the plants whose flowers closely resemble females of particular insect species. One of the petals (or labellum) is modified to resemble a female insect. The labellum serves as a landing platform for the male insect. In fact, the resemblance is so close that male attempts to pseudocopulate with the flowers perceiving it to be a female insect. Since the mating is unsuccessful, the male looks out for another female which is likely to be another orchid flower. The male insect does not receive any kind of reward, but pollen has been transferred from one plant to another. In this case, the flower should co-evolve with the female insect otherwise the chances of successful pollination will be reduced.

(ii) Co-extinction is one of the 'Evil Quartet' in which organisms with obligatory relationship like plant pollinator mutualism will result in extinction of one partner if other is eliminated in nature. Seeds of

Sideroxyglon grandiflorum, an exclusive tree in Mauritius, germinate when they pass through the abrasive gut of dodo (*Ruphus cucullatus*), a bird. These birds became extinct in 17th century and only a few old trees survive now. Insects are good pollinators, hence flowering plants and insects are interdependent. In such cases, when one species becomes extinct, the other species associated or dependent on it also becomes extinct.

8. Write the steps in sequence as carried in multiple ovulation embryo transfer technology.

(2 Marks)

Solution

Multiple Ovulation Embryo Transfer (MOET) Technology is used for herd development. Steps involved in MOET programme are:

(i) Oestrous cycle is controlled in donor and surrogate animals.

(ii) The donor animal is administered with hormones that have FSH-like activity to induce follicular maturation and superovulation.

(iii) The donor produces 6–8 eggs instead of one egg produced normally.

(iv) Mating is done either with an elite male or artificial insemination is carried out.

(v) When the fertilized eggs attain 8–32 celled stage, they are non-surgically removed and transferred to a surrogate mother.

(vi) The genetic mother can be again superovulated now.

9. What is an origin of replication in a chromosome? State its function.

(2 Marks)

Solution

The onset of genomic DNA synthesis requires precise interactions of specialized initiator proteins with DNA at sites where the replication machinery can be loaded. These sites, defined as replication origins, are found at a few unique locations in all chromosomes. Close examination of bacterial and archaeal replication origins reveals an array of DNA sequence motifs that position individual initiator protein molecules and promote initiator oligomerization on origin DNA. Conversely, the need for specific recognition sequences in eukaryotic replication origins is relaxed.

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

(2 Marks)

Solution

Some of the potential applications of genetically modified plants in agricultural biotechnology are:

(i) GMO crops have better nutritional quality such as vitamin A-enriched rice

(ii) They are diseases resistant and are more tolerant to abiotic stresses.

(iii) They have pest resistant and hence have reduced the dependency on the chemical pesticides.

(iv) They are better nitrogen fixers.

11. How is a continuous culture system maintained in bioreactors and why?

(2 Marks)

Solution

The cells can be multiplied by continuous culture techniques, making use of a fermenter, from which samples can be continuously drawn off, providing a non-stop supply of the product. The fresh medium is added continuously. This ensures that the cells are active and maintained in their log phase of growth. Since the cells can multiply under conducive conditions, a large amount of biomass is obtained and hence the protein. In this bioreactor, nutrients are replaced as soon as they are utilized and products are removed as soon as they are produced.

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

(2 Marks)

Solution

Genetic drift refers to the alteration in the frequencies of alleles in the gene pool of a finite population due to chance events. It takes place in one or over a few generations. If the change in the allele frequencies is very drastic, then new species are formed. If the population is finite or limited, a random selection of alleles occurs and in such a scenario, the frequencies of alleles in a sample may not be the same as the frequencies of alleles in the total population. This is known as sampling error.

Section C

13. How does a bisexual flowering plant ensures cross pollination? Explain.

(3 Marks)

Solution

In bisexual flowering plant, cross pollination is favored by number of methods:

- Dichogamy: In such cases, the male and female parts of a bisexual flower mature at different times and xenogamy is favored. If the stamens mature before the pistil, the condition is known as protandry (e.g., sunflower, *Salvia*) while if the carpels mature before stamens, the condition is known as protogyny (e.g., banyan, *Plantago*, *Mirabilis jalapa*).
- Self-sterility or self-incompatibility: In some plants, the pollen grains of a flower are not effective on the stigma of the same flower or that of flower of the same plant (e.g., tea, tobacco, etc.). In such cases, there is genetic incompatibility and xenogamy is favored.
- Heterostyly: In this, length of filaments and styles in a flower are different. If the styles are of different lengths, it is called heterostyly while if the stamens are of different lengths, it is called heteroanthy.
- Herkogamy: It is a condition in which a physical barrier is present between the anther and the style. They are arranged in such manner that the pollen grain does not fall on stigma of the same flower. For example, in orchids, pollen grains are present in special structures called pollinia and insects are required for pollination. In members of the family Caryophyllaceae, the stigma is present at a higher level than the anther.

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14. 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.

(3 Marks)

Solution

Apis indica (Indian bee) is the most common species of bee reared in India. The other important species that can also be reared are: *Apis mellifera* (Italian bee), *Apis dorsata* (rock bee) and *Apis florea* (little bee). The rearing of bees can be done in any area with plantation such as orchards, farms, etc., where sufficient pollen and nectar are available. Such places are called apiary sites.

The following points should be taken care of:

(i) Since pollen and nectar are available only in flowering season so seasonal management is very important. This season is known as honey flow season. In this season the pollination efficiency as well as honey production, both get increased. The nectar collected by the bees is passed through the pre-oral cavity and tongue to ripen it. Honey is then deposited in the cells. Hence, more space for storage of honey should be provided during this season.

(ii) During summer season, adequate shade and water should be provided by artificial constructions or by keeping the beehives under the trees. Proper ventilation should also be provided. Sugar syrup and pollen supplement are provided as food source.

(iii) During winter season, disease-free colonies should be maintained. The hives should be provided with new queens.

(iv) During rainy season, dampness should be avoided and since bees cannot go out to collect pollen and nectar, sugar syrup should be provided as food. Knowledge of hiving the swarms.

(v) Proper handling of beehives and collection of honey and beeswax. One should wear protective clothing while handling the honey bees. Smokers are also used by the bee-keepers to keep them calm while handling them.

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?

(3 Marks)

Solution

The entire process of DNA replication involves following steps.

(a) Recognition of the initiation point: First, DNA helix unwinds by the enzyme helicase which use the energy of ATP and replication of DNA begin at a specific point, called initiation point or origin where replication fork begins.

(b) Unwinding of DNA: The unwinding proteins bind to the nicked strand of the duplex and separate the two strands at DNA duplex. Topoisomerase helps in unwinding of DNA.

(c) Single stranded binding protein (SSBP): These proteins help in keeping DNA in single stranded position and also known as helix destabilising protein (HDP).

(d) RNA priming: The DNA directed RNA polymerase now synthesises the primer strands of RNA (RNA primer). The priming RNA strands are complementary to the two strands of DNA and are formed of 50 to 100 nucleotides.

(e) Formation of DNA on RNA primers: The new strands of DNA are formed in the 5′ → 3′ direction from the 3′→ 5′ template DNA by the addition of deoxyribonucleotides to the 3′ end of primer RNA. Addition of nucleotide is done by DNA polymerase III. The leading strand of DNA is synthesized continuously in 5′→3′ direction as one piece. The lagging strand of DNA is synthesized discontinuously in its opposite direction in short segments. These segments are called Okazaki fragments.
(f) Excision of RNA primers: Once a small segment of an Okazaki fragment has been formed. The RNA primers are removed from the 5′ by the action of 5′→3′ exonuclease activity of DNA polymerase I.
(g) Joining of Okazaki fragments: The gaps left between Okazaki fragments are filled with complimentary deoxyribonucleotide residues by DNA polymerase I. Finally, the adjacent 5′ and 3′ ends are joined by DNA ligase.

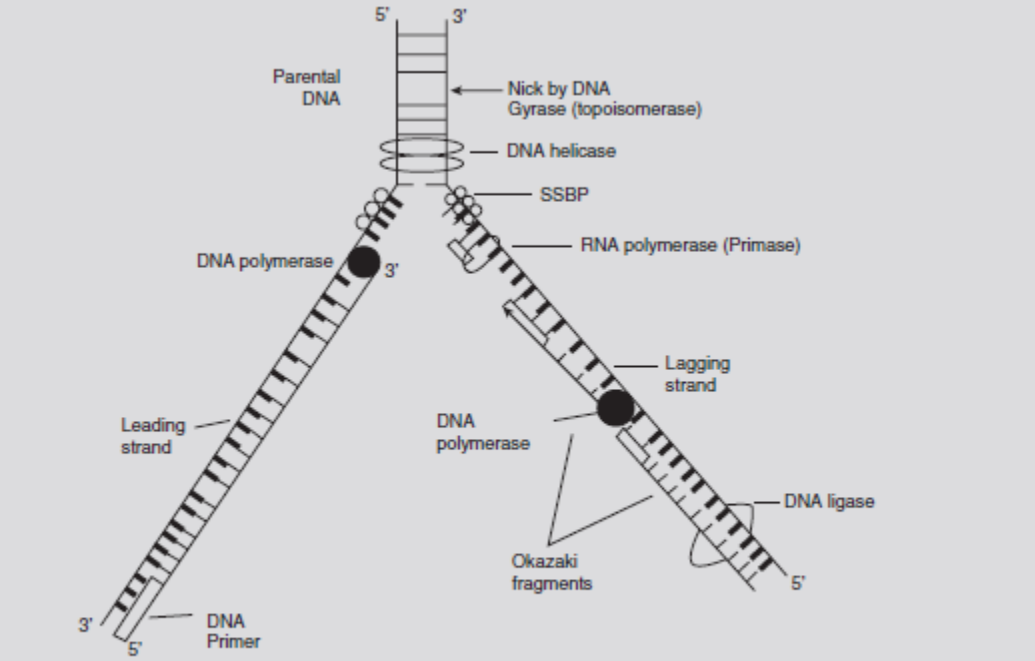
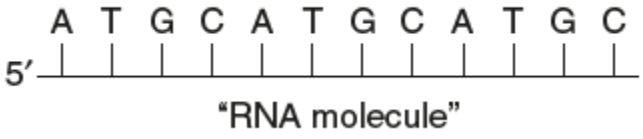


Fig. Replication of DNA

OR

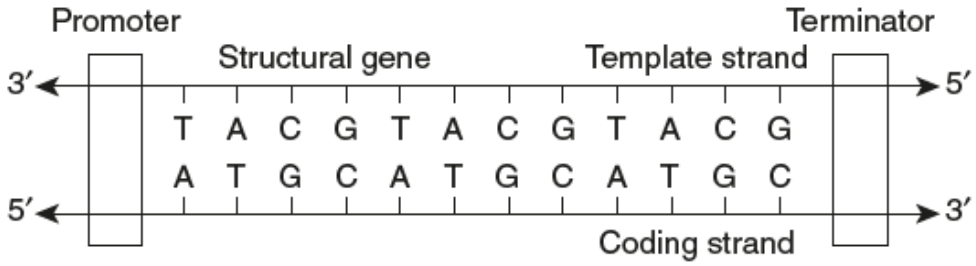
Construct and label a transcription unit from which the RNA segment given below has been transcribed. Write the complete name of the enzyme that transcribed this RNA.



(3 Marks)

Solution

Formation of mRNA from DNA is called as transcription. It is heterocatalytic function of DNA. Template of DNA called sense strand (Master Strand) is involved. The segment of DNA involved in transcriptions is cistron, which has a promoter region where initiation starts and terminator region where transcription ends. Transcription is catalyzed by DNA dependent RNA polymerase. As RNA have uracil at the place of thymine. For given RNA the transcription unit will be



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

(3 Marks)

Solution

(a) *Homo erectus* was the fossil that had evolved from *Homo habilis*.

Homo habilis	*Homo erectus*
Its fossils were found in Africa about 1.5–2 mya.	It has also been found in Europe and Africa. It existed about 1.5 mya.
Their brain was large and was about 650–800 cc.	The brain of *Homo erectus* was large (about 900 cc).
They also shaped stones into tools and used them for chopping, pounding, cutting, etc.	The stone tools were more advanced than those by *Homo habilis*.

(b) The correct sequence from early to late geological period is:
Silurian period → Carboniferous period → Jurassic period

17. List six advantages of "*ex-situ*" approach to conservation of biodiversity.

(3 Marks)

Solution

Ex-situ conservation involves the conservation of genetic resources of species away from their area of origin or development. The various ways in which it can be achieved, and their advantages include:
(i) The best method of maximizing a species chance of survival is by relocating part of the population to a less threatened location. Collecting wild and domesticated organisms in botanical gardens, nurseries, aquaria and zoos, etc., are examples of off-site collection.
(ii) Organism are completely protected from predation and poached. They can be monitored and given medical assistance as required.

(iii) Field gene banks are used to conserve genes of perennials, recalcitrant species, vegetatively propagated species, etc., by planting them in an artificial ecosystem requiring more land, adequate soil, suitable weather conditions, etc. For example, orchards, plantations and botanical gardens
(iv) In laboratories (*in vitro* preservation), tissue culture is used to propagate plants by developing callus, embryoids, pollen grains, shoot tips, etc. Rapid multiplication of endangered plants is possible with this method.
(v) Shoot tip culture maintains virus free plants.
(vi) The gametes, embryos, cells, etc., are preserved at very low temperatures, generally −196°C by cryopreservation, thawed and reused whenever needed.

18. Effluent from the primary treatment of sewage is passed for secondary treatment. Explain the process till the water is ready to be released into natural water bodies.

(3 Marks)

Solution
Sewage is municipal waste water released from household, commercial and industrial establishments. It carries many organisms most of which are pathogenic, organic matter and other household waste including human excreta, detergents, greases, heavy metals, plastics, etc. It consists of about 99.9% water and about 0.1% solid or dissolved wastes. The treatment of sewage is done using heterotrophic microbes mainly consists of three steps:
(i) In primary treatment, solid wastes are removed by physical means, such as filtration and sedimentation.
(ii) In secondary treatment, liquid effluent solid wastes that remain after primary treatment are treated by biological means (actions of decomposers). An activated sludge is generated by aeration of sewage which consists of organic material containing large number of microorganisms consisting of bacteria (Coliform *Clostridium*, *Pseudomonas*, etc.) and fungi that form a filamentous mesh-like filter and are called floc.
(iii) In tertiary treatment, an effluent of water pure enough to drink is produced by chemical and physical means.

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?

(3 Marks)

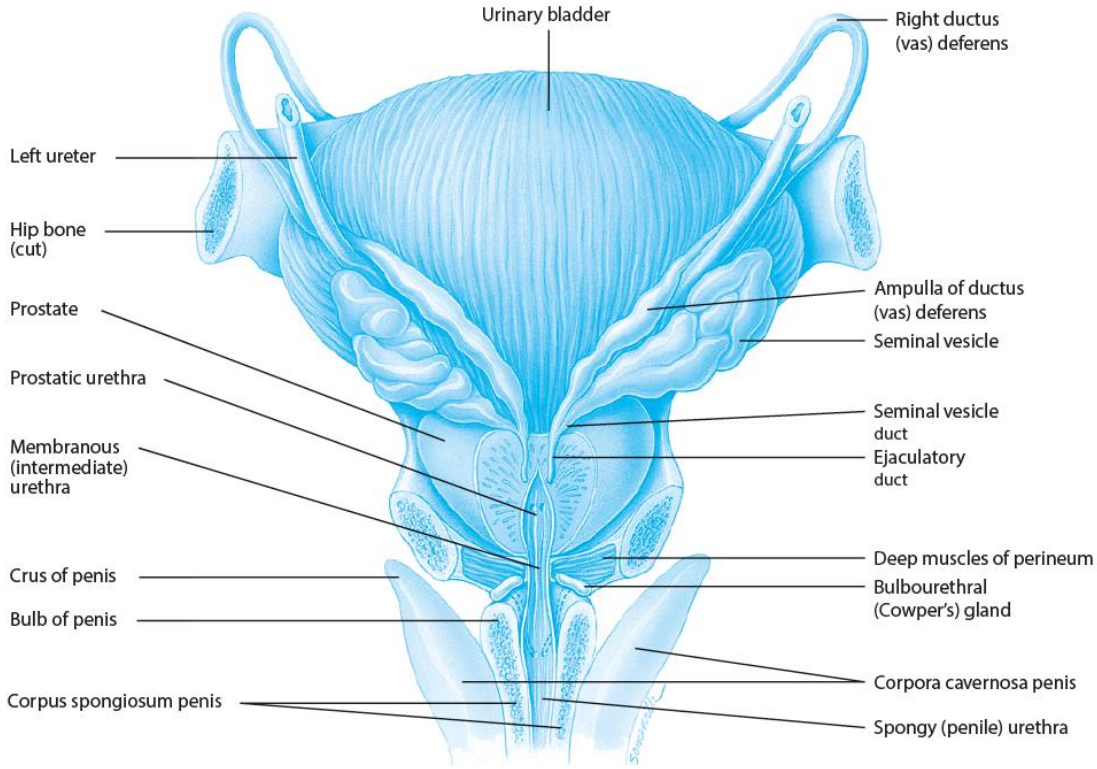
Solution
(a) Both the girls A and B are suffering from rare genetic disorder of adenosine deaminase deficient severe combined immunodeficiency disease (ADA–SCID). In the absence of this enzyme, toxic levels of the phosphorylated form of its substrate, deoxyadenosine, accumulates in T lymphocytes (white blood cells essential to an immune response) and kill them

(b) ADA deficiency can be treated either by bone marrow transplantation or by enzyme replacement therapy (ERT) by giving an intravenous injection of ADA. However, both approaches are not completely curative as these lymphocytes are not immortal and require repeated treatment. Girl A must have been treated with one of these therapies.
(c) Girl B must have been treated using gene-therapy where the gene isolate from marrow cells producing ADA was introduced into cells at an early embryonic stage for a possible permanent cure.

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

(3 Marks)

Solution

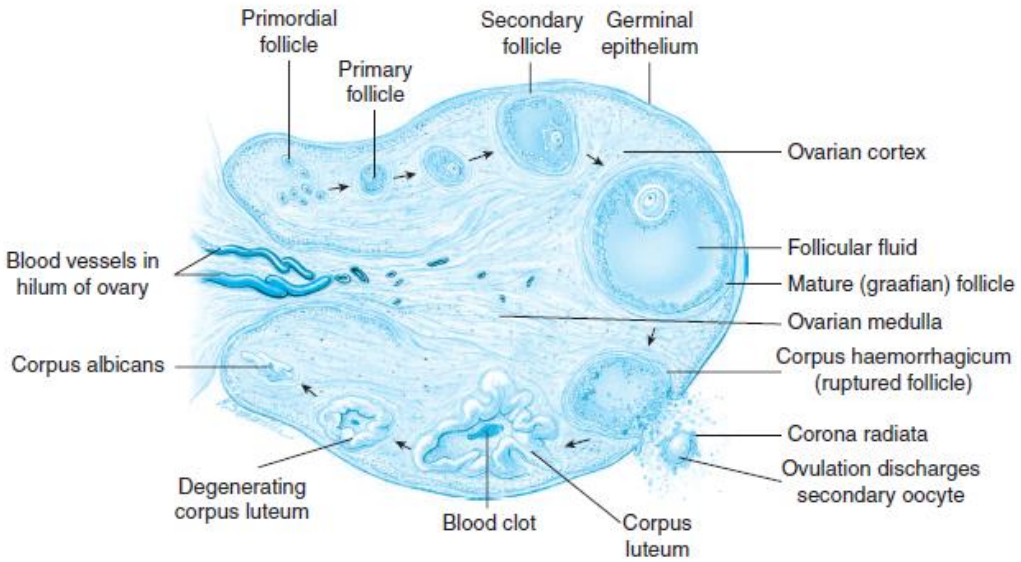


OR

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

(3 Marks)

Solution



21. 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.

(3 Marks)

Solution

The chromosome theory of inheritance states that the genes (Mendel's factors) are located on specific location on the chromosomes called locus, and the chromosomes follow Mendel's laws of segregation and independent assortment during meiosis and recombine at the time of fertilization in the zygote. Walter Sutton along with Theodore Boveri, noted that there was marked resemblance between chromosomes and Mendel's factors called genes. They found the following similarities:

(i) Chromosomes exist in pairs and segregate during meiosis, as did Mendel's factors.

(ii) Behavior of chromosomes during the meiotic process paralleled the behavior of the hereditary factors (genes).

(iii) On studying chromosomes, several of Mendel's findings could be explained by Sutton, such as

- gametes could contain only one allelomorphic part (allele) of each gene;
- gametes containing either of the two alleles are in equal proportion; and
- two gametes fertilize to produce a zygote having two alleles for each trait.

OR

(a) Explain linkage and recombination as put forth by T.H. Morgan based his observations with *Drosophila melanogaster* crossing experiment.

(b) Write the basis on which Alfred Sturtevant explained gene mapping.

(3 Marks)

Solution

(a) Thomas Hunt Morgan explained the mechanism of linkage through his studies on the fruit fly *Drosophila melanogaster*. He studied X-linked genes in Drosophila and saw that when the two genes in a dihybrid cross were situated on the same chromosome, the proportion of parental gene combinations were

much higher than the non-parental type. Morgan and Castle in 1911 proposed Chromosome Theory of Linkage that states:

(i) Genes that are physically attached to the same chromosome should travel as a unit through meiosis. This implies that genes present on the same chromosome should act as if they are linked to each other, that is, they are part of the same linkage group. The physical evidence for this was found in sweet peas plant in which genes for two traits—flower color and pollen shape—were linked.

(ii) Genes are attached to one another like beads on a string in a linear organization.

(iii) Genes present on the same chromosome could be separated during meiosis and new combinations of genes could be formed. This phenomenon is called recombination of genes.

(iv) During meiosis, when homologous chromosomes paired, the separated and recombined genes physically exchange of material at a crossover point called chiasma. This phenomena of exchange between paired chromosomes at the chiasma is called crossing over. Except for crossing over, the genes stay in their parental combination.

(v) The distance between the linked genes indicates the strength of linkage. Closely spaced genes have stronger linkage than those far apart. Likelihood of crossing over increases with increasing distance.

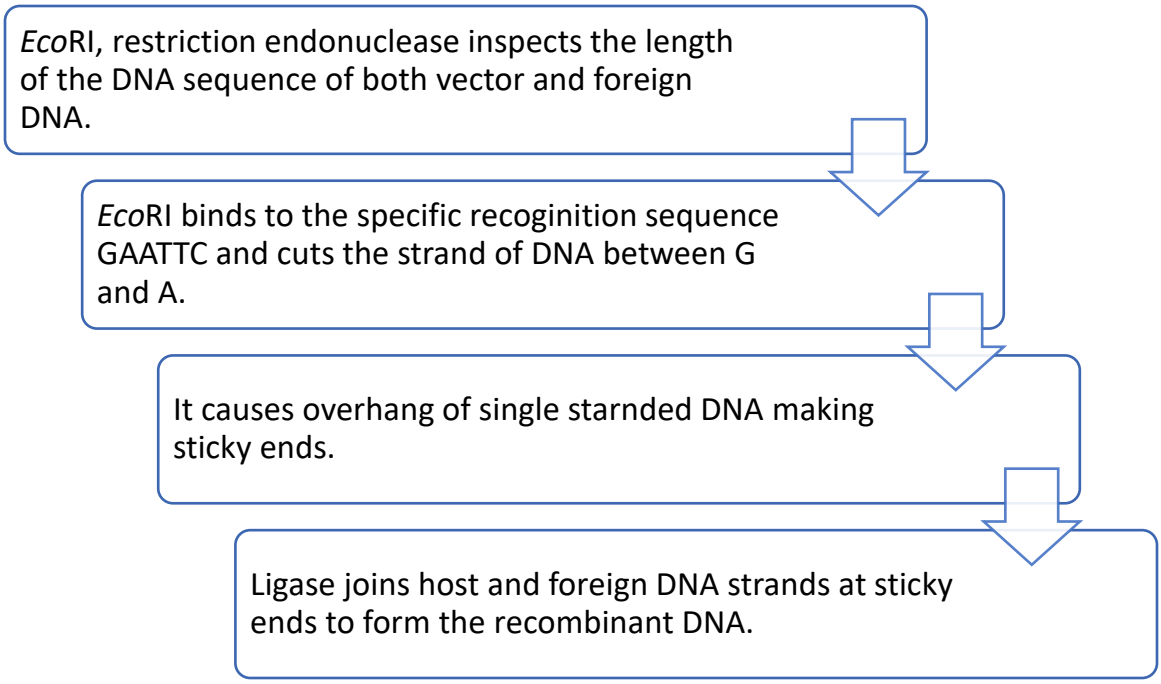
(vi) For any two genes present on different chromosomes, the recombination frequency never exceeds 50%. This implies that the genes are assorted independently.

(b) Alfred Sturtevant used the recombination frequency between gene pairs as a measure of physical distance between genes and 'mapped' their position on the chromosome. This process of mapping the gene positions was termed as gene mapping, which are used today for genome sequencing projects as in Human Genome Project.

22. Describe the formation of recombinant DNA by the action of *Eco*RI.

(3 Marks)

Solution



OR

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

(3 Marks)

Solution

The sequence of steps that take place in a PCR are listed as follows.

(i) The target DNA is mixed with Taq polymerase, the two oligonucleotide primers and nucleotides. Very small amount of target DNA (just a single molecule) is sufficient as PCR is extremely sensitive.

(ii) When the mixture is heated to a temperature >90°C, the DNA molecule denatures. The hydrogen bonds that hold together the two polynucleotides of the double helix are broken, so the target DNA becomes denatured to single stranded molecules.

(iii) The mixture is then cooled down to 50–60 °C where the primers anneal to the DNA molecules at specific positions. The two strands of DNA can also rejoin at this temperature.

(iv) When the temperature is again raised above 70°C, the DNA polymerase enzyme attaches to one end of each primer and synthesizes new strands of DNA, complementary to the template DNA molecules.

(v) Now there are four strands of DNA (two original and two new). This process is called extension by which the enzyme extends the primers using the nucleotides provided in the reaction and the genomic DNA as template. When the temperature is then increased back to >90°C, the double-stranded DNA molecules (each of which consists of one strand of the original molecule and one new strand of DNA) denature into single strands.

(vi) The second cycle of denaturation-annealing-synthesis, at the end of which there are eight DNA strands. This means that after 30 cycles, there will be over 1 billion products derived from each starting molecule.

At the end of a PCR, a sample of the reaction mixture is usually analyzed by agarose gel electrophoresis. The DNA produced should be sufficient for the amplified fragment to be visible as a discrete band after staining with EtBr.

23. (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 purpurea*	(iii) antibiotic
(K) *Saccharomyces cerevisiae*	(iv) Cyclosporin-A

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

(3 Marks)

Solution

(a) (H)–(iii); (I)–(iv); (J)–(i); (K)–(ii)

- *Penicillium* mould contaminating a culture of Staphylococcus bacteria had prevented growth of bacteria close to itself. He was the first to recognize the potential for countering infections. The bacteria could not grow because of the substance produced by the mould. Fleming named the substance as penicillin after the mould *Penicillium notatum*.
- Cyclosporin A is produced by the fungus *Trichoderma polysporum* and *Cylindrocarpon lucidum*. It is used as an immunosuppressive agent that prevents rejection in patients who have had transplants of kidney, bone marrow, liver, pancreas, etc.
- Statins are produced by the yeast *Monascus purpureus*. They are used as agents that lower the blood-cholesterol.
- Ethanol (ethyl alcohol) is produced by the fermentation of substrate such as grains, fruit juice, vegetables and other ingredients. The yeasts used in brewing for preparing juices or alcoholic drinks are called brewer's yeast. For example, yeast *Saccharomyces cerevisiae* is used in the fermentation of juices or cereals.

(b) In Swiss cheese, the bacterium *Propionibacterium shermanii* ferments lactic acid and produces propionic acid, acetic acid and carbon dioxide. The acids provide flavor to the cheese and the carbon dioxide, which becomes trapped in the curd, produces the characteristic holes in the cheese.

24. Explain any two most important levels of biological organization showing biodiversity with the help of an example each.

(3 Marks)

Solution

(i) Genetic biodiversity enables a population to adapt to its environment and to respond to natural selection. Genetic diversity within a species increases with environmental variability which results in the formation of polymorphs, races and subspecies in geographically isolated populations. Therefore, it provides the raw material for adaptation and evolution of new life forms (speciation). The different varieties of a given plant may differ in the concentration and activity of an important chemical compound that the plant may be

producing (e.g., reserpine in *Rauwolfia vomitoria*). Similarly, the genetic diversity of rice in India is reflected in having more than 50,000 strains and in having more than 1000 varieties of mango.
(ii) Species biodiversity refers to the variety of species within a region. Species diversity has three qualities: (a) Species richness (the total number of species), (b) Species evenness (the relative abundance of species) and (c) species dominance (the most abundant species). Species diversity is the sum total of relative chance of seeing species as well as the actual number of species present.
(iii) Ecological biodiversity describes the number of niches, trophic levels and various ecological processes that sustain energy flow, food webs and the recycling of nutrients. Ecological biodiversity helps in producing more productive and stable ecosystems which can tolerate various stresses like prolonged drought.

Section D

25. (a) Differentiate between spermatogenesis and Oogenesis on the basis of
(i) Time of initiation of the process
(ii) Site of completion of the process
(iii) Nature of meiotic division undergone by gamete mother cells
(b) Name the hormones and state their role involved in controlling spermatogenesis in humans.

(5 Marks)

Solution

	Spermatogenesis	**Oogenesis**
(i) Time of initiation of the process	It starts in males at the age of puberty.	It starts in females during embryonic development stage before their birth.
(ii) Site of completion of the process	It is the formation of mature sperms and occurs in the testes.	It is the formation of mature female gametes in the ovaries.
	It involves developmental changes and differentiation of spermatogonia into primary spermatocytes, which divide to form two secondary spermatocytes.	It involves the development of oogonia into primary oocytes,
	Each secondary spermatocyte divides to form two spermatids. which divide to form one secondary oocyte and one polar body.	Each secondary oocyte divides to form one ootid and one polar body.
	It is completed in the testes and the mature sperms are released from the testes.	It is completed in the female reproductive tract or in water because oocytes are released from the ovaries.
(iii) Nature of meiotic division undergone by gamete mother cells	It involves equal cytoplasmic divisions.	It involves unequal cytoplasmic divisions.

(b) Spermatogenesis is initiated due to increase in gonadotropin-releasing hormone (GnRH) by hypothalamus. This hormone stimulates anterior pituitary to secrete two gonadotropins: luteinizing

hormone (LH) and follicle stimulating hormone (FSH). LH acts on the Leydig's cells of the testes and stimulates them to synthesize and secrete androgens (testosterone) which in turn stimulate spermatogenesis. FSH acts on Sertoli cells of seminiferous tubules of the testes and stimulate them to secrete an androgen binding protein (ABP) and inhibin. ABP binds to testosterone, keeping its concentration high, thus stimulating the final steps of spermatogenesis in the seminiferous tubules. Once the degree of spermatogenesis required for male reproductive functions has been achieved, Sertoli cells release inhibin, a protein hormone named for its role in inhibiting FSH secretion by the anterior pituitary.

OR

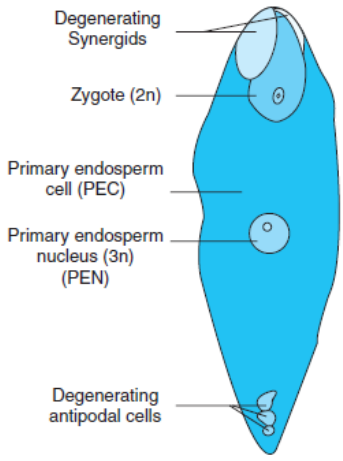
Explain the process of double fertilization in angiosperms. Why does the development of endosperm precedes that of embryo? List the parts of a typical dicot embryo.

(5 Marks)

Solution

Double fertilization is observed only in angiosperms. It involves two types of fusions in the embryo sac:
(i) Fusion of sperm cell (male gamete) with egg cell (female gamete) to form a diploid zygote. This process is known as syngamy or generative fertilization.
(ii) Fusion of the other sperm cell with two polar nuclei to form primary endosperm cell containing triploid nucleus also known as primary endosperm nucleus (PEN). This process is known as triple fusion as it involves fusion of three haploid nuclei.
The zygote gradually develops into an embryo and central cell becomes primary endosperm cell (PEC) and eventually develops into endosperm.

- Double fertilization gives stimulus to other cells of embryo sac to resume their growth and form nutritive tissue to ensure that developing embryo gets proper nutrition for formation of viable seed.
- Since formation of endosperm takes place after zygote formation, angiosperms ensures that energy used in formation of endosperm is not wasted if fertilization fails. Hence, angiosperms are more advanced and economical as compared to gymnosperms where large nutritive female gametophyte develops much before fertilization and if fertilization does not occur all the energy used in formation of nutritive tissue is wasted.
- Triploid nature of endosperm makes it more vigorous. It shows high physiological activity, grows faster and accumulates nutrients.



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.

(5 Marks)

Solution

(a) A population is a group of individuals of the same species living in the same area or interbreeding and sharing genetic information.

(b) Population density is the number of individuals of a species per unit area/ space at a given time. Various processes affecting population density are:

(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 is the number of deaths in the population during a given period.

(iii) Immigration: It is the number of individuals of the same species that have come into the habitat from elsewhere during the time period.

(iv) Emigration: It is the number of individuals of the population who left the habitat and gone elsewhere during the time period.

If N is the population density at time t, then its density at time $t + 1$ is

$N_{t+1} = N_t + [(B + I) – (D + E)]$

where, B = natality, D = mortality, E = emigration and I = immigration.

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 depends in secondary hydrarch succession. Why is the rate of this succession faster than that of primary succession?

(5 Marks)

Solution

(a) Succession of plants in a water body is called hydrarch succession.

(b)

	Hydrarch succession	**Xerarch succession**
Pioneer species	It begins with phytoplanktons such as diatoms, green flagellates, single-celled colonial or filamentous green algae multiply rapidly and with their death and decomposition organic matter is produced.	Crustose lichens (e.g., *Rhizocarpus*, *Graphis*, *Lacanora*, *Rinodina*, etc.) form the pioneer species in xerarch succession. As discussed, the lack of water prevents habitation but lichens can tolerate desiccation. Besides, they can also produce some organic acids that

		can cause rock weathering, thereby releasing the minerals essential for the growth of lichens.
Climax communities	Forest stage represents the final stage of hydrarch succession and includes mixed forest vegetation. This is a climax community called climax forest. Several trees rapidly invade the woodland community of trees and shrubs.	Forests are the climax community. The weathering of rocks and addition of more organic matter due to the death and decay of the plants makes the soil favorable for the growth of large trees.

(c) The series of biotic communities that develop one after the other is called hydrosere. The various successional stages are:
(i) Plankton stage: It is the pioneer stage. This organic matter mixes up with clay and silt at the bottom of the water body to form soft mud favorable for growth of next seral stage.
(ii) Submerged stage: The soft mud supports the growth of submerged plants. They are rooted in the mud and from dense growth. Due to this sand and silt get deposited around the plants and therefore, bottom level rises slowly. The older plants and buried parts of other plants form humus on their death and decay. This enriches the newly built up bottom and makes it favorable for growth of next stage.
(iii) Floating stage: Floating leaved anchored plants appear when water becomes shallow and with their subterranean stems make the water rich in mineral and organic matter. As a result, water becomes suitable for growth of free-floating plants. These plants cover the water and their rapid growth further builds up bottom so that the water becomes shallow on the periphery.
(iv) Reed swamp stage: These are amphibious plants which grow where the water body becomes shallow. These plants transpire large quantity of water and produce abundant organic matter. Their tangled growth accumulates silt.
(v) Sedge or Marsh meadow stage: The plants invade the shores built up by reed swamp stage and transpire rapidly. They also add abundant humus, as a result of which soil is build up to invite next stage.
(vi) Scrub stage: The plants of this stage are rhizome bearing shrubs which can tolerate bright sunlight as well as water logged
conditions. The shrubs invite invasion by trees capable of bearing bright sunlight and water logging. The plants of this stage lower the water table by their transpiration. They also built up more soil and shade loving plants start growing below them.
(vii) Climax forest: The climax forest depends upon the climate, for example, in moist tropical area rain forest is formed, in temperate area mixed coniferous forest or deciduous forest is formed.

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

(5 Marks)

Solution

Co-dominance	Incomplete dominance
The condition in which two alleles are able to express themselves independently when present together, that is, neither allele is dominant, or even partially dominant, over the other.	The condition in which none of the two contrasting alleles or factors is dominant, and the heterozygote F_1 has a phenotype that is intermediate between its the two homozygous parents.
For example, the AB blood group in human beings is characterized by the presence of both antigen A (I^A) and antigen B (I_B) on the surface of RBCs. Another example is sickle cell anemia in which the allele for sickle cell hemoglobin Hb^S is codominant with allele for normal hemoglobin Hb^A.	For example, in plants like four O' Clock (*Mirabilis jalapa*) red and white flowered plants are homozygous for different alleles of a color-determining gene; and when these are crossed, they produce heterozygotes that have pink flowers. If F_1 plants are self-pollinated, the plants of F_2 generation are of three types red, pink and white flowered in the ratio of 1:2:1.

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.

(5 Marks)

Solution

(a)

(i) According to the one of the first models proposed for the genetic code by physicist George Gamow, each amino acid in a polypeptide was encoded by three sequential nucleotides. The code words, or codons, for amino acids were nucleotide triplets.

(ii) In 1968, the Nobel Prize in Physiology or Medicine was awarded jointly to Robert W. Holley, Har Gobind Khorana and Marshall W. Nirenberg for their work on the interpretation of the genetic code and its function in protein synthesis, showing how the order of nucleotides in nucleic acids, which carry the genetic code of the cell, encode the proteins synthesized by the cell . They established the biological language or genetic code common to all living organisms, is spelled out in three-letter words: each set of three nucleotides codes for a specific amino acid.

(iii) Nirenberg and Mathaei used a synthetic poly (U) RNA and deciphered the genetic code by translating this as polyphenylalanine.

(iv) Over the course of several years, Marshall Nirenberg, Har Khorana and Severo Ochoa and their colleagues elucidated the genetic code - showing how nucleic acids with their 4-letter alphabet determine the order of the 20 kinds of amino acids in proteins. In 1959, Nobel Prize for the discovery of RNA polymerase was given to Ochoa.

(b) The genetic code is the set of rules by which information encoded in genetic material (DNA or RNA sequences) is translated into proteins (amino acid sequences) by living cells.

- They are unambiguous means that one codon specifies only one amino acid and not any other.
- They are universal means that the genetic code is applicable universally, i.e., a codon specifies the same amino acid from a virus to a tree or human being.

- They are degenerate means some amino acids often have more than one codon. Only methionine and tryptophan have singlet triplet codons. All other amino acids are specified by two to six codons.