

CBSE 2014
Biology

Time: 3 hrs

Total Marks: 70

General Instructions:

1. There are total **26** questions and five sections in the question paper. All questions are compulsory.
 2. Section A contains questions number **1 to 5**; very short answer type questions of **1** mark each.
 3. Section B contains questions number **6 to 10**, short-answer type **I** questions of **2** marks each.
 4. Section C contains questions number **11 to 22**, short answer type **II** questions of **3** marks each.
 5. Section D contains question number **23**, value based question of **4** marks.
 6. Section E contains questions number **24 to 26**, long-answer type questions of **5** marks each.
 7. There is no overall choice in the question paper; however, an internal choice is provided in one question of **2** marks, one question of **3** marks and all the three questions of **5** marks. In these questions, an examinee is to attempt any of the two given alternatives.
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SECTION A

1. Why is *Gambusia* introduced into drains and ponds?

Solution

Gambusia is a fish which feeds on larvae of mosquitoes. Its feeding on mosquitoes help in limiting the spread of mosquitoes in ponds. Thus, restricting diseases that spread mosquitoes.

2. State Gause's competitive exclusion principle.

Solution

Gause's competitive exclusion principle can be stated in terms of niches as follows: No two species can occupy exactly the same niche indefinitely. Certainly, species can and do coexist while competing for the same resources. One way for co-existence is through resource partitioning.

3. Name the enzyme that are used for the isolation of DNA from bacterial and fungal cells for recombinant DNA technology?

Solution

DNA is isolated from bacterial cell using the enzyme Lysozyme. Lysozyme digests the polymeric compounds that make the cell walls rigid.

The enzyme used in fungi for breaking the cell wall is chitinase.

4. State the role of C peptide in human insulin?

Solution

C peptide is found in pro-insulin. Removal of C peptide chain converts proinsulin into insulin. It has no-function. It keeps chain A and chain B apart. So that, on its removal the formation of disulphide bonds between the A and B chain components occurs at the right position.

5. Why is it not possible for an alien DNA to become part of a chromosome anywhere along its length and replicate normally?

Solution

An alien DNA cannot become part of a chromosome anywhere along its length because to insert into DNA of the host cell it must have:

- (a) Recognition sites: Sites where restriction endonuclease cuts DNA to ligate alien DNA with the DNA of host.
- (b) Origin of Replication: Site where replication initiates on binding of DNA polymerase.

6. Why is secondary immune response more intense than primary immune response in humans?

Solution

The presence of memory cells makes the secondary response much faster than the primary response. In the secondary response, as in the primary response, IgM is produced before IgG. However, IgM is produced in smaller quantities over a shorter period, and IgG is produced sooner and in much larger quantities than in the primary response. Thus, the secondary response is characterized by a rapid increase in antibodies, most of which are IgG.

7. Why are analogous structures a result of convergent evolution?

Solution

Analogous structures indicate convergent evolution. It explains that in a similar habitat, similar structures can develop for similar function but these structures are not identical. These similar adaptive functional structures are present due to adaptations in organisms having different ancestors and have evolved over a period of time. Such an evolution is known as convergent evolution.

8. Name the vegetative propagules in the following:

- (a) Agave
- (b) Bryophyllum

Solution

- (a) Agave uses bulbil for vegetative propagation.
- (b) Bryophyllum uses its leaves for vegetative propagation.

Section-B

9. List the symptoms of Ascariasis. How does a healthy person acquire this infection?

Solution

Ascariasis is caused by *Ascaris lumbricoides*. It is the largest nematode (round worm) affecting the human alimentary canal. the main symptoms of the disease are:

- Internal bleeding
- Muscular and stomach pain
- Vomiting
- Anemia
- Blockage of intestinal passage
- Bloody sputum and passage of worms in stool

It is transmitted through contaminated food and specially water.

10. Write the scientific name of the fruit-fly. Why did Morgan prefer to work with fruit-flies for his experiments? State any three reasons.

Solution

Drosophila melanogaster, known as the fruit fly to most people, is an excellent organism for geneticists to study for the following reasons:

- (a) Fruit flies are easy to breed, and their life cycles are short. A single female can lay several hundred eggs, which develop into adults in about two weeks. Therefore, a geneticist can study multiple generations of flies within a few months.
- (b) Fruit flies are easy to maintain and take up little room in the laboratory. Populations of flies can be kept in small containers with easily prepared media.

- (c) Fruit flies exhibit variations in certain inherited traits such as eye color and wing formation that are easy to see under a dissecting microscope. The geneticist can easily anesthetize the population, study the flies, and place them back in the bottle before they revive.
- (d) Fruit flies have only four pairs of chromosomes. Experiments can often be simpler using organisms with few chromosomes rather than organisms with a large number of chromosomes.

OR

10. Linkage and crossing over of genes are alternatives of each other. Justify with the help of an example.

Solution

Crossing over takes place between non-homologous chromosome and is a process by which linked genes are separated. In case of complete linkage, no crossing over occurs so offspring comprise only parental types. While, in case of in complete linkage, no crossing over occurs and the offspring comprise more than 25% parental types and less than 25% recombinant types to bring recombinants along with parental types.

11. State the difference between the structural genes in a transcription unit of Prokaryotes and Eukaryotes.

Solution

The structural genes in prokaryotes are found continuously without any non-coding regions. While, the structural genes in eukaryotes are divided into coding regions of DNA called exons and non-coding regions of DNA called introns.

12. In snapdragon, a cross between true-breeding red flowered (*RR*) plants and true-breeding white flowered (*rr*) plants showed a progeny of plants with all pink flowers.

- (a) The appearance of pink flowers is not known as blending. Why?
(b) What is this phenomenon known as?

Solution

(a) The red flowered plants have genotype *RR* and the white flowered plants have genotype *rr*. All the offspring are with pink flowers (*Rr*). It means that neither the red nor the white color trait is dominant, and offspring has mixture of these two colours.

(b) When the heterozygote F_1 has a phenotype that is intermediate between its the two homozygous parents. This is called incomplete dominance or partial dominance.

13. Write the location and function of the following in human testes:

- (a) Sertoli cells
(b) Leydig cells

Solution

(a) Sertoli cells are present inside the seminiferous tubules and are involves in formation of sperms, providing nutrition in supporting spermatogenesis, secretion of androgen binding protein (ABP), secretion of inhibin to check the effects of testosterone and FSH.

(b) Leydig cells are present in the spaces between adjacent seminiferous tubules, and are involved in secretion of testosterone.

14. Construct an age pyramid which reflects an expanding growth status of human population.

Solution

Age pyramid of humans:

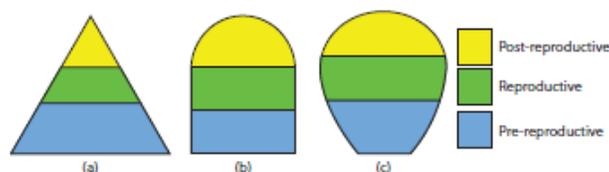


FIGURE 13.11 Age pyramids. (a) Expanding, (b) stable population and (c) declining populations.

15. Describe the mutual relationship between fig tree and wasp and comment on the phenomenon that operates in their relationship.

Solution

The relation between figs (plants in the genus *Ficus*) and fig wasps (members of the family Agaonidae) reflects obligate mutualism in which the lives of a plant and its pollinator have become interdependent. The fig tree can be pollinated only by partner wasp species. The female wasp lays egg in the fig fruit (oviposition) and the developing larvae use the seed as source of nutrients. The plant is benefitted as its inflorescence is pollinated by the wasp while it is scanning it for suitable egg laying site. In turn, the wasp is benefitted as its developing larvae can use fig seed as food.

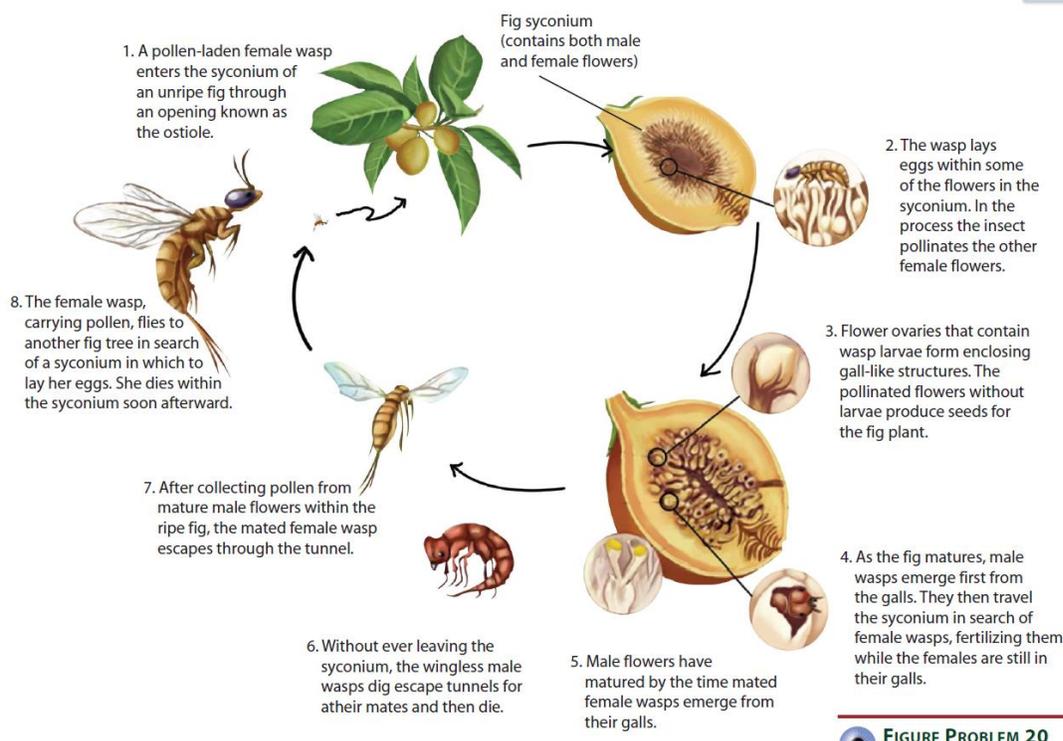


FIGURE PROBLEM 20

16. How have transgenic animals proved to be beneficial in:

- (a) Production of biological products
- (b) Chemical safety testing

Solution

(a) Production of biological products: Transgenic animals that produce useful biological products can be created by introduction of genes coding for a specific product. Some examples have been discussed above with specific transgenic animals and some more are listed as follows:

1. Tracy, the first transgenic farm mammal contained a human gene for α -1-antitrypsin, deficiency of which can lead to a rare form of emphysema in humans. Similarly diseases like phenylketonuria and cystic fibrosis may be treated.

2. US patent has been granted for a genetically engineered mouse known as OncoMouse. It carries a gene promoting the development of different types cancers in humans.
3. Transgenic animals are used for the production and secretion of valuable proteins in milk.
4. First two therapeutic agents C1 inhibitor (Ruconest) and antithrombin isolated from the milk of transgenic animals.

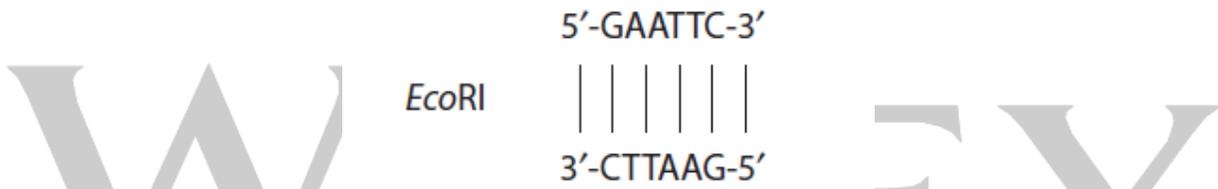
(b) Chemical safety testing: In order to test the safety or toxicity of chemicals, transgenic animals are used. These animals have genes that make them very sensitive to chemicals as compared to non-transgenic animals. This method is comparatively quicker than the traditional methods of toxicity testing of chemicals. Moreover, transgenic animals have been used to grow transplant tissues and human transplant organs (xenotransplantation).

17. How does a restriction nuclease function? Explain.

Solution

The restriction endonucleases function by first inspecting the length of a DNA sequence and finding its specific recognition sequence at which the DNA molecule is to be cut. For example, *PvuI*, a restriction endonuclease from *Proteus vulgaris*, cuts DNA at the hexanucleotide CGATCG. However, *PvuII* from the same bacterium cuts at a different hexanucleotide (CAGCTG).

Almost all the recognition sequences are palindromes, that is, they are groups of letters forming words that read the same in each direction. For example,



After recognition of the specific sequence, the restriction endonuclease binds to the DNA and cuts each of the two strands of the double helix at specific points in their sugar-phosphate backbones. They cut the DNA strand a little away from the center of palindrome sites, but between the same two bases on the opposite sides. As a result of the cut, single stranded portion of the helix are left at the ends. The different types of cuts are described next.

18. Explain the significant role of genus Nucleopolyhedrovirus in an ecological sensitive area.

Solution

Nucleopolyhedrovirus encloses either single or multiple nucleocapsids per envelope. Several species of baculoviruses belong to the Nucleopolyhedrovirus genera are excellent candidates for species-specific interaction (narrow spectrum) and attack moth larvae, boll worm, Asiatic rice borer, cotton leaf worm, etc. Hence, they can play an important role in organic farming. The advantages of baculoviruses as biocontrol agents are:

- (a) They are harmless to non-target organisms.
- (b) They are as effective as chemical pesticides.
- (c) They are non-toxic to humans and hence safe to use.
- (d) They help in conserving insects for overall integrated pest management (IPM) programs.
- (e) They help in treating ecologically sensitive areas.

Section-C

19. Identify 'a', 'b', 'c', 'd', 'e' and 'f' in the table given below:

No.	Syndrome	Cause	Characteristics of affected individuals	Sex Male/Female/Both
1.	Down's	Trisomy of 21	'a' (i)	'b'

			(ii)	
2.	'c'	XXY	Overall masculine development	'd'
3.	Turner's	45 with XO	'e' (i) (ii)	'f'

Solution

No.	Syndrome	Cause	Characteristics of affected individuals	Sex Male/Female/Both
1.	Down's	Trisomy of 21	(i) Short stocky build (ii) Mental impairment	Both
2.	Klinefelter	XXY	Overall masculine development	Males
3.	Turner's	45 with XO	(i) Female is sterile. (ii) Develops webbed neck and a broad chest	Females

20. Why is pedigree analysis done in the study of human genetics? State the conclusion that can be drawn from it.

Solution

A pedigree analysis is done to determine whether a trait is sex linked or autosomal. It can be done by following steps:

Step 1: Notice whether the trait is expressed more frequently in males than in females. If so, the trait may be a sex-linked trait. If the trait is expressed equally in both males and females, it is most likely an autosomal trait (whether dominant or recessive).

Step 2: To determine whether a trait is dominant or recessive, notice whether each person expressing the trait has a parent who expressed the trait. For example, if color blindness is dominant to normal color vision, then each color-blind person will have a color-blind parent.

However, if the trait is recessive, persons expressing the trait can have parents who are heterozygous (carry the mutant allele), but who do not express the trait. If each parent passes on the recessive gene to a child, the child is then homozygous recessive and the trait will be expressed.

In sex-linked traits, however, males receiving the recessive trait from their mothers on their only X-chromosome will express the trait.

Step 3: Determine which individuals are carriers of gene responsible for that trait. For example, a color-blind male always contributes an X chromosome with the defective allele to his daughters; it is the only X he can contribute. His sons, however, get a Y chromosome from him and an X chromosome from their mother. A color-blind female can contribute only a chromosome with the defective allele to her children because both her X chromosomes carry the mutant allele. Women who are carriers of the trait, however, may contribute either a normal or a defective X to her children.

21. A woman has certain queries as listed below, before starting with contraceptive pills. Answer them.

- What do contraceptive pills contain and how do they act as contraceptive?
- What schedule should be followed for taking these pills?

Solution

(a) Oral contraceptives (the pill) are tablets that contain hormones (either progestogens or progestogen-estrogen combinations) designed to prevent pregnancy. Some, called combined oral contraceptives

(COCs), contain both progestin (hormone with actions similar to progesterone) and estrogens. They act in the following manner:

- (i) The primary action of COCs is to inhibit ovulation by suppressing the gonadotropins FSH and LH.
 - (ii) The low levels of FSH and LH usually prevent the development of a dominant follicle in the ovary.
 - (iii) As a result, levels of estrogens do not rise, the mid-cycle LH surge does not occur and ovulation does not take place.
 - (iv) Even if ovulation does occur, as it does in some cases, COCs may also block implantation in the uterus and inhibit the transport of ova and sperm in the fallopian tubes.
- (b) These pills should be taken daily for 21 days starting within the first five days of menstruation. A gap of 7 days should be given during which menstruation takes place. After that, it should be repeated again as long as pregnancy is not desired.

22. Make a list of any three outbreeding devices that flowering plants have developed and explain how they help to encourage cross-pollination.

Solution

Xenogamy or cross-pollination is encouraged in plants using following adaptations:

1. Unisexuality or dicliny: In such cases, flowers are unisexual. If a plant bears both male and female flowers on the same plant, it is called monoecious (e.g., cucurbits, maize, castor). In such cases, autogamy is prevented but geitonogamy can take place. If male and female flowers are borne on different plants, it is known as dioecious (e.g., Vallisneria, mulberry, papaya). In such cases both autogamy and geitonogamy can be prevented and xenogamy is favored.
2. Dichogamy (dikho = apart; gamous = marriage): 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).
3. 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. Thus, self-pollination is prevented despite occurrence of fully viable pollen grains and ovules. Also, as germination of pollen grains does not occur on stigma, it prevents fusion of the gametes and development of the embryo. Hence, no seed formation takes place.

OR

22. Why angiosperm anthers are called ditheous? Describe the structure of its microsporangium.

Solution

The angiosperm anther is bilobed and the two lobes are connected by sterile connective tissue. In a bilobed anther, each lobe has two theca, hence it is called ditheous.

When cut transversely, the microsporangium is generally circular in shape. It is surrounded by four wall layers:

1. *Epidermis*: It is the outermost wall and is one-cell layer thick. It protects and helps in dehiscence of anther to release pollen.
2. *Endothecium*: Located below the epidermis, it consists of a single layer of radially elongated cells. Like epidermis, its function is protection as well as helping in anther dehiscence. Some cells have fibrous thickenings or fibrous layer of cellulose on inner and radial walls that help in dehiscence. Some cells without thickening are also present and are collectively known as stomium.
3. *Middle layers*: It is present below the endothecium. It consists of few layers of thin-walled cells. Like epidermis and endothecium, their function is protection as well as helping in anther dehiscence.

4. *Tapetum*: It is the innermost layer of cells. These cells are generally polyploid, multinucleate and possess dense cytoplasm. In tapetal cells, the nucleus divides but cytokinesis does not take place so same cell contains two or more nuclei.

23. Since the origin of life on earth, there were five episodes of mass extinction of species. (i) How is the 'Sixth Extinction' presently in progress, different from the previous episodes?

(ii) Who is mainly responsible for the 'Sixth Extinction'?

(iii) List any four points that can help to overcome this disaster.

Solution

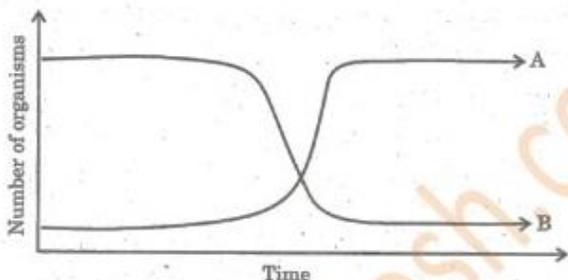
(i) The current extinction rates (i.e., for the sixth extinction event) are different from the previous episodes as they are estimated to be 100 to 1000 times faster than those in the pre-human period. The Earth may lose 50% species by the end of the 21st century, if the current rate of extinction continues.

(ii) Major human activities such as habitat loss and fragmentation, over exploitation, pollution, intensive agriculture, alien species invasions and co-extinctions are responsible for the accelerated rates of species extinction. They are referred to as evil quartet.

(iii) This disaster can be overcome by:

1. Stopping deforestation and planting more and more trees.
2. Conserving endangered species in biosphere reserves.
3. Bringing awareness among people for biodiversity.
4. Reserving non-renewable resources by using more of renewable resources.

24. Two types of aquatic organisms in a lake show specific growth patterns as shown below, in a brief period of time. The lake is adjacent to an agricultural land extensively supplied with fertilizers.



Answer the questions based on the facts given above:

(i) Name the organism depicting the patterns A and B.

(ii) State the reason for the growth patterns seen in A.

(iii) Write the effects of the growth patterns seen above.

Solution

(i) Pattern A is depicted by herbivores animals such as zooplankton. Pattern B is depicted by producers such as phytoplankton's and algae.

(ii) Pattern A shows growth pattern of a herbivores animal. they show such growth as they utilize, produce and increase their number.

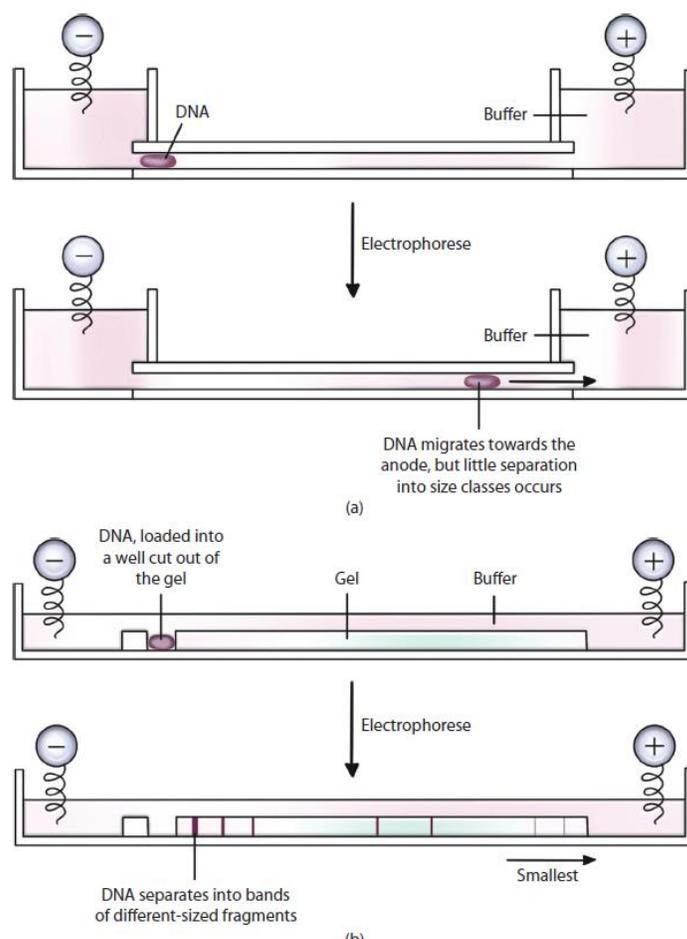
(iii) Pattern B is the result of pattern A (increase in the number of herbivores), the amount of natural resources are reduced and later it acts as limiting factors for growing population of herbivores.

25. Name and describe the techniques that helps in separating DNA fragments formed by the use of restriction endonuclease.

Solution

The cutting of the DNA using restriction endonucleases (also called restriction digest) results in a number of DNA fragments. DNA molecules are of the same shape and similar charge-to-mass ratios, the fragments of different sizes are separated by gel electrophoresis. The gel is made up of up of agarose

(from sea weed) or polyacrylamide or a mixture of two. It has a complex network of pores provides sieving effect and allows the DNA molecules to travel and reach the positive electrode. The smaller the DNA molecule, faster is the migration. So the DNA band that is the farthest from the well where it was loaded, is the smallest in size.



26. Explain giving three reasons, why tropics show greatest levels of species diversity.

Solution

There are three reasons that facilitate higher level of biodiversity in tropics compared to temperate regions:

1. The tropical region harbors more number of species as this area remained stable for millions of years. Hence, species in tropics got a long time for speciation and evolutionary diversification. Unlike the tropical regions, the temperate regions were subjected to frequent glaciations in the past.
2. Tropical environment is less seasonal, more constant and predictable than temperate regions.
3. In general, higher productivity (capacity of an area to support growth) contributes to more number of species. Gross primary productivity is the solar energy that is captured and converted into carbon compounds in an ecosystem. In tropics, the amount of solar energy available is more, which in turn leads to higher productivity.

27. Community service department of your school plans a visit to a slum area near the school with an objective to educate the slum dwellers with respect to health and hygiene.

(i) Why is there a need to organize such visits?

(ii) Write the steps you will highlight, as a member of department, in your interactions with them to enable them to lead a healthy life.

Solution

(i) Slums are commonly that area of a state where there is illegal construction of houses. Most of the colonies in such areas are unauthorized and invaded. There are no public facilities in such colonies. They don't get water to drink. People living there have very low standard of living. They live in unhygienic conditions and are at high risk of epidemics. Thus, it is necessary to aware them of epidemics and encourage them for sanitation.

(ii) I will highlight following steps to enable them to lead a healthy life:

- Interact with all people
- Try to understand their needs
- Ask about availability of funds
- Try to communicate with all concerned authorities
- Make tangible plan of development

Section-D

28 Describe the Hershey and chase experiment. Write the conclusion drawn by the scientists after their experiment.

Solution

Hershey and Chase experiment was based on the fact that DNA contains phosphorus but no sulphur, whereas proteins contain sulphur but no phosphorus. This led them to specifically label:

1. The phage DNA by growth in a medium containing the radioactive isotope of phosphorus, ^{32}P , in place of the normal isotope, ^{31}P ; and
2. The phage protein coats by growth in a medium containing radioactive sulphur, ^{35}S , in place of the normal isotope, ^{32}S .

Experiment I with ^{32}P -labeled phage

1. T2 phage particles in which the DNA was labeled with ^{32}P were mixed with *E. coli* cells for a few minutes.
2. The phage-infected cells were agitated in a blender.
3. The phage protein capsules or coats were separated from the infected cells by low-speed centrifugation.
4. The cells were found as pellets while leaving phage particles suspended.
5. All the radioactivity was found inside the cells as when the phage-infected cells were blended, the DNA could not be removed by shearing in a blender.

Experiment II with ^{35}S -labeled phage

6. T2 phage particles in which protein coat was labeled with ^{35}S were mixed with *E. coli* cells for a few minutes.
7. The phage-infected cells were agitated in a blender.
8. Most of the radioactivity (and thus the proteins) could be removed from the cells without affecting progeny phage production.

These results of Hershey-Chase experiment indicated that:

1. The DNA of the virus enters the host cell, whereas the protein coat remains outside the cell.
2. Since progeny viruses are produced inside the cell, the genetic information for the synthesis of the DNA molecules and the protein coats of the progeny viruses must be present in the parental DNA.
3. The progeny particles were shown to contain some of the ^{32}P (present in DNA), but none of the ^{35}S (present in protein coat), of the parental phage.

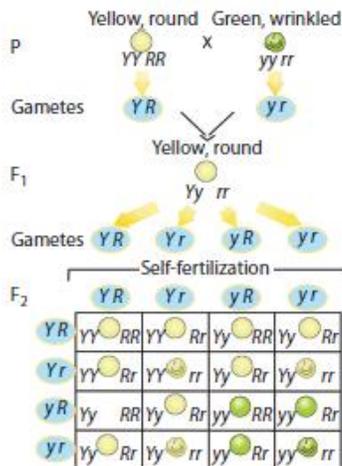
OR

28. Work out a typical Mendelian dihybrid cross and state the law that he derived from it.

Solution

Consider the dihybrid cross shown below. From Fig., we have from law of segregation that the alleles Yy , Rr would segregate independent of each other during gamete formation. Thus, after segregation each gamete will contain one allele from every pair of alleles. The possible combinations of gametes are YR , Yr , yR , yr and these will be in equal proportions 1:1:1:1. Based on the dihybrid cross of the pea plant, Mendel made some more conclusions:

1. The two pairs of alleles present in F_1 generation for two contrasting traits (yellow and green; round and wrinkled seeds) segregate from each other in the F_2 generation.
2. The alleles of one pair (i.e., Y and y) seeds behave independent to the alleles of another pair (R and r) to give recombination along with parental combinations.



Thus, Mendel's law of independent assortment states that for alleles of different genes present on different chromosomes assort independently of each other.

29. With advancements in genetics, molecular biology and tissue culture, new traits have been incorporated into crop plants. Explain the main steps in breeding a new genetic variety of a crop.

Solution

The following are the important steps taken into consideration in several plant breeding programs:

1. *Germplasm collection*: The sum total of all the genes present in a crop and its related species is called germplasm. It is important to collect all the genetic varieties by cultivating and preserving the wild varieties and relatives of the cultivated species
2. *Evaluation and selection of individuals for the cross*: Once the germplasm has been collected, the individuals are assessed for desirable traits. The plants with undesirable characteristics are eliminated and seeds of plants with desirable traits are replanted. The process is repeated till the plants with desirable traits are obtained in large numbers for hybridization.
3. *Cross-hybridization*: Hybridization is a process of crossing different species/ varieties of plants to create a hybrid. Two main objectives of hybridization are to produce a single variety having combination of good characters and increase and generate the variations through recombination.
4. *Selection and testing of superior recombinants*: The offspring are screened for desirable combination. They are evaluated particularly for the characters that are expected to contribute to the breeding program.
5. *Testing, release and commercialization of new cultivars*: Intensive testing is done for the selected lines before they are commercialized. For this, they are grown in research fields where adequate management practices including application of fertilizers and proper irrigation facilities are provided. Once the results are approved, these lines are grown in farmers' fields in various parts of the country under different climatic conditions for at least three growing seasons. It is also tested against the most suitable local cultivar called check or reference cultivar. Once the crop passes these tests, it is commercialized.

OR

29.

- (i) State the objective of animal breeding.
- (ii) List the importance and limitations of inbreeding. How can the limitations be overcome?
- (iii) Give an example of a new breed each of cattle and poultry.

Solution

(i) Animal breeding is defined as the application of animal genetics to improve the quantity, quality, efficiency and aesthetic value of animals. Its two important objectives are:

1. Genetic analysis: This helps in studying the genetic constitution of the animals.
2. Increasing productivity: Increasing productivity and efficiency is done by breeding and selection of good breeds with desired characteristics.

(ii) Inbreeding is the best strategy to increase homozygous, however, the main disadvantage of continuous or close inbreeding is inbreeding depression. It lowers the performance such as fertility, disease resistance, growth rate, productivity and survivability. To overcome this situation and to restore fertility and productivity, the animals should be mated with unrelated superior animals of the same breed

(iii) New breed of cattle: Karan Swiss and Karan Fries

New breed of poultry: Lohmann Dual, Black Rock

30.

- (a) Where does fertilization occur in humans? Explain the events that occur during this process.
- (b) A couple where both husband and wife are producing functional gametes, but the wife is still unable to conceive is seeking medical aid. Describe any one method that you can suggest to this couple to become happy parents.

Solution

(a) In humans, sperms swim from the vagina to fallopian tube (where fertilization takes place) by the whip-like movements of their tails. The steps involved in fertilization are as follows:

1. *Penetration of sperm cell*: The sperm cell first penetrates two layers: (1) the corona radiata, the granulosa cells that surround the secondary oocyte, and (2) the zona pellucida, the clear glycoprotein layer between the corona radiata and the oocyte's plasma membrane
2. *Acrosomal reactions*: The acrosome, a helmet-like structure that covers the head of a sperm, contains several enzymes. Acrosomal enzymes, such as sperm lysins, and strong tail movements by the sperm help it to penetrate the cells of the corona radiata and come in contact with the zona pellucida. It then reaches to the oocyte's plasma membrane and fuses with the oocyte.
3. *Fusion of sperm cell and depolarization of plasma membrane*: The fusion of a sperm cell with a secondary oocyte depolarizes the plasma membrane of the oocyte, which prevents polyspermy (fertilization by more than one sperm cell) as a depolarized oocyte cannot fuse with another sperm.
4. *Formation of fertilization cone*: Once a sperm cell enters a secondary oocyte, the oocyte engulfs the sperm forming a fertilization or reception cone.
5. *Karyogamy or Amphimixis*: The oocyte now must complete meiosis II. It divides into a larger ovum (mature egg) and a smaller second polar body that fragments and disintegrates. The nucleus in the head of the sperm develops into the male pronucleus, and the nucleus of the fertilized ovum develops into the female pronucleus. After the male and female pronuclei form, they fuse, producing a single diploid nucleus, a process known as syngamy. Thus, the fusion of the haploid (n) pronuclei restores the diploid number (2n) of 46 chromosomes. The fertilized ovum now is called a zygote.

(b) This couple can go for *In Vitro* Fertilization. It means fertilization outside of the body of woman. The woman is administered hormone to produce multiple eggs. These eggs are removed once they mature and are fertilized with sperms and are induced to form zygotes under simulated laboratory conditions.

The zygote having up to 8 blastomeres are implanted in the woman's fallopian tube by a process known as zygote intra fallopian transfer (ZIFT). If it has more than 8 blastomeres, it is transferred to the uterus by a process known as intra uterine transfer (IUT).

OR

30.

- (a) Explain the different ways apomictic seeds can develop. Give an example of each.
- (b) Mention the advantages of apomictic seeds to farmers.
- (c) Draw a labelled mature stage of a dicotyledons embryo.

Solution

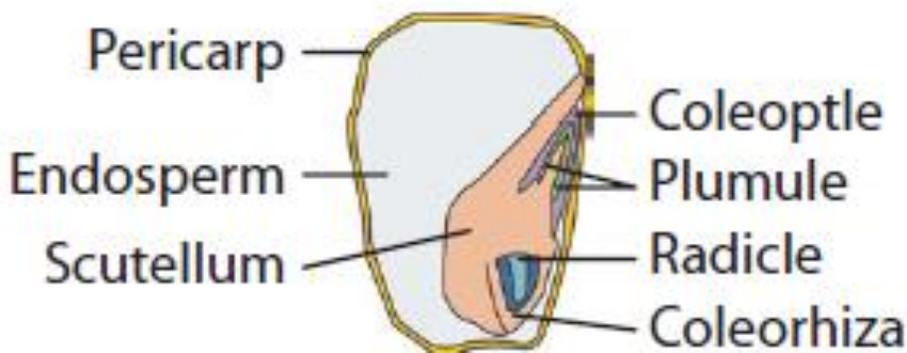
(a) Apomixis is a type of asexual reproduction that resembles sexual reproduction. In this, seeds are produced without fertilization. Hence, all the individuals produced apomictically are genetically similar to the parent producing them. It is of following types in flowering plants:

1. *Non-recurrent apomixis*: In this, megaspore mother cell undergoes the usual meiotic divisions and the embryo sac that is formed is haploid. The embryo develops either from the egg (haploid parthenogenesis) or from other cells of the gametophyte (haploid apogamy). This process gives rise to haploid plants which are generally sterile. For example, *Solanum nigrum*.

2. *Recurrent apomixis*: In this, the embryo sac generally develops from archesporial cell (generative apospory; e.g., *Parthenium argentatum*) or from some other part of nucellus (somatic apospory; e.g., *Hierarcium flagellare*). The cells are diploid as meiotic division does not take place. The embryo develops either from egg or diploid megaspore mother cell (diploid parthenogenesis) or from some other cell of gametophyte (diploid apogamy).

(b) Apomixis led to production of better and desirable varieties of fruits, vegetables and grains for farmers.

(c) Longitudinal section of dicotyledons embryo.



Questions from other sets

30.

- (i) Describe the various steps of Griffith's experiment that led to the conclusion of the 'Transforming Principle'.
- (ii) How did the chemical nature of the 'Transforming Principle' get established?

Solution

(i) The experiment was conducted using bacterium *Streptococcus pneumoniae* that causes pneumonia and since mice are quite sensitive to pneumococci, they are used as test animals. Pneumococci with capsules produce smooth (S), shining colonies as they have mucous (polysaccharide coat), while those lacking capsules produce rough (R) colonies with a coarse appearance. Only the encapsulated *S. pneumoniae* (S strain) caused pneumonia as it was virulent.

The various steps in the experiment are as follows:

1. One group of mice was injected with heat-killed S strain of *S. pneumoniae*. The mice did not develop pneumonia and survived.
2. The second group was injected with live S strain of *S. pneumoniae*. The mice that received live smooth pneumococci developed pneumonia and died.
3. The third group was injected with live R strain of *S. pneumoniae*. The mice did not develop pneumonia and survived.
4. The fourth group was injected with a mixture of live R strain and heat-killed S strain of pneumococci, neither of which is lethal by itself. The mice which received the mixture also died of pneumonia. The live S strain as well as R strain bacteria were recovered from the dead mice.

Based on these observations, Griffith concluded that some cells had been transformed from R strain to S strain when some transforming principle was transferred from the heat-killed S strain to live R strain. This made R strain to synthesize capsules and become virulent. This phenomenon is called Griffith effect or transformation.

(ii) The transforming principle was initially considered to be proteins. Oswald Avery, Colin MacLeod and Maclyn McCarty conducted a series of experiments to determine the exact biochemical nature of transforming principle.

1. They removed the nucleic acids from bacteria (heat-killed S cells) and purified the proteins, RNA and DNA from the extract to test which of these caused transformation.
2. The highly purified DNA from S cells was treated with the following enzymes:
 - (a) Deoxyribonuclease (DNase) which degrades DNA,
 - (b) Ribonuclease (RNase), which degrades RNA, or
 - (c) Proteases, which degrade proteins.
3. The DNA was then tested for its ability to transform R cells to S cells.
4. It was found that only DNA was responsible for transformation because when DNA was treated with DNase (which degraded DNA), transformation was not possible.

OR

9 If implementation of better techniques and new strategies are required to provide more efficient care and assistance to people, then why is there a statutory ban on amniocentesis? Write the use of this technique and give reason to justify the ban.

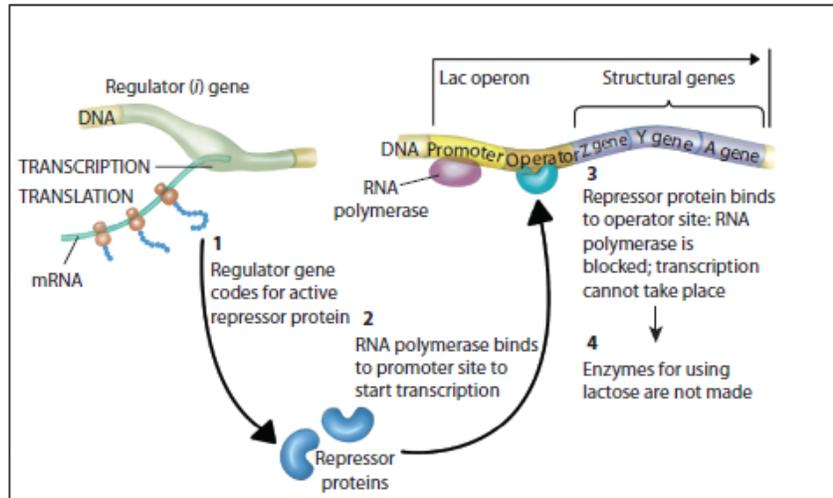
Solution Amniocentesis is a test that is used in assessing foetal well-being. It involves withdrawing some of the amniotic fluid and analyzing it. It is used to test to detect for the presence of certain genetic disorders. It is used to help determine survivability of the foetus. It can be used for sex determination also. In some parts of the world, preference is given to male child over female child. If during amniocentesis, it is determined that the baby is a girl child, then the parents may go in for abortion leading to female foeticide. It is ethically incorrect. In the long run, it may have disastrous effect on the mankind leading to a skewed ratio between males and females. Therefore, a ban has been imposed on amniocentesis for sex determination.

30. Describe how the lac operon operates, both in presence and absence of an inducer in *E.coli*.

Solution The lac operon is an example of an inducible operon which induces transcription of structural genes in the presence of lactose or allolactose and hence it is called an inducer.

A. In the absence of lactose:

1. The regulator *i* gene codes for active repressor protein and produces it all the time.
2. The repressor protein binds to the lac operator.
3. This binding prevents RNA polymerase from catalyzing the transcription of the three structural genes.
4. The enzymes for using lactose are not produced.



B. In the presence of lactose:

1. The regulator *i* gene codes for active repressor protein but lactose or allolactose binds to the repressor protein and inactivates it thereby preventing it from binding to the lac operator.
2. RNA polymerase can now access the promoter and transcribe the structural genes.
3. Enzymes needed for using lactose are made.

