Chapter 1

UNIT VI: Reproduction in Plants

Asexual and Sexual Reproduction in Plants

Learning Objectives

The learner will be able to

- Recall various types of reproduction in lower and higher organisms.
- Discuss different methods of vegetative reproduction in plants.
- Recognise modern methods of reproduction.
- Recall the parts of a flower.
- Recognise the structure of mature anther.
- Describe the structure and types of ovules.
- Discuss the structure of embryo sac.
- Recognise different types of pollination.
- Identify the types of endosperms.
- Differentiate the structure of Dicot and Monocot seed.

Chapter outline

1.1 Asexual reproduction
1.2 Vegetative reproduction
1.3 Sexual Reproduction
1.4 Pre-fertilization structure and events
1.5 Fertilization
1.6 Post fertilization structure and events
1.7 Apomixis
1.8 Polyembryony
1.9 Parthenocarpy

4ATHKN

One of the essential features of all living things on the earth is reproduction. Reproduction is a vital process for the existence of a species and it also brings suitable changes through variation in the offsprings for their survival on earth. Plant reproduction is important not only for its own survival but also for the continuation and existence of all other organisms since the latter directly or indirectly depend on plants. Reproduction also plays an important role in evolution.

In this unit let us learn in detail about reproduction in plants.

Basically reproduction occurring in organisms fall under two major categories

1. Asexual reproduction
2. Sexual reproduction.

Panchanan Maheswari (1904-1966)

Professor P. Maheswari was an eminent Botanist who specialised in plant embryology, morphology and anatomy. In 1934, he became the Fellow of Indian Academy of Science. He published the book titled "An introduction to the Embryology of Angiosperms"in 1950. He established the International Society for Plant Morphologists, in 1951.

1.1 Asexual Reproduction

The reproduction method which helps to perpetuate its own species without the involvement of gametes is referred to as asexual reproduction. From Unit I of Class XI we know that reproduction is one of the attributes

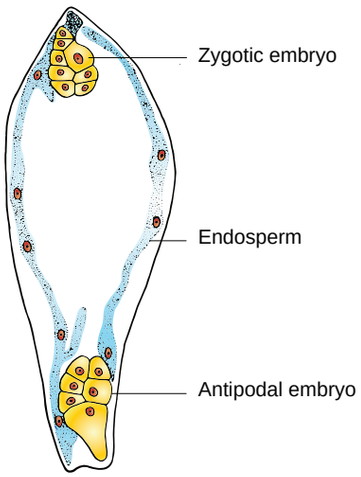

Figure 1.24 : Polyembryony – Embryo sac of *Ulmus glabra* showing zygotic and antipodal embryo

a. **Cleavage polyembryony** (Example: Orchids)

b. **Formation of embryo by cells of the Embryo sac other than egg** (Synergids – *Aristolochia*; antipodals – *Ulmus* and endosperm – *Balanophora*)

c. **Development of more than one Embryo sac within the same ovule.** (Derivatives of same MMC, derivatives of two or more MMC – *Casuarina*)

d. **Activation of some sporophytic cells of the ovule** (Nucellus/ integuments-*Citrus and Syzygium*).

Practical applications

The seedlings formed from the nucellar tissue in *Citrus* are found better clones for Orchards. Embryos derived through polyembryony are found virus free.

1.9 Parthenocarpy

As mentioned earlier, the ovary becomes the fruit and the ovule becomes the seed after fertilization. However in a number of cases, fruit like structures may develop from the ovary without the act of fertilization. Such fruits are called **parthenocarpic fruits**. Invariably they will not have true seeds. Many commercial fruits are made seedless. Examples: Banana, Grapes and Papaya.

Significance

- The seedless fruits have great significance in horticulture.
- The seedless fruits have great commercial importance.
- Seedless fruits are useful for the preparation of jams, jellies, sauces, fruit drinks etc.
- High proportion of edible part is available in parthenocarpic fruits due to the absence of seeds.

Summary

Reproduction is one of the attributes of living things. Lower plants, microbes and animals reproduce by different methods (fragmentation, gemma, binary fission, budding, regeneration). Organisms reproduce through asexual and sexual methods. Asexual methods in angiosperms occur through natural or artificial methods. The natural methods take place through vegetative propagules or diaspores. Artificial method of reproduction involves cutting, layering and grafting. Micropropagation is a modern method used to raise new plants.

Sexual reproduction includes gametogenesis and fertilization. External fertilization occurs in lower plants like algae but in higher plants internal fertilization takes place. A flower is a modified shoot meant for reproduction. Stamen is the male reproductive part and produces pollen grains. The development of microspore is called microsporogenesis. The microspore mother cell undergoes meiotic division to produce four haploid microspores. In majority of Angiosperms the anther is dithecous and are tetrasporangiate. It possesses epidermis, endothecium, middle layers and tapetum. The hygroscopic nature of endothecial cell along with thin walled stomium helps in the dehiscence of anther. Tapetum nourishes the microspores and also contributes to the wall materials of the pollen grain. Pollen grain is

derived from the microspore and possesses thin inner intine and thick outer exine. Sporopollenin is present in exine and is resistant to physiological and biological decomposition. Microspore is the first cell of male gametophyte. The nucleus of the microspore divides to form a vegetative nucleus and a generative nucleus. The generative nucleus divides to form two male nuclei. Gynoecium is the female reproductive part of a flower and it represents one or more pistils. The ovary bears ovules which are attached to the placenta. There are six major types of ovules. The development of megaspore from megaspore mother cell is called megasporogenesis. A monosporic embryo sac (*Polygonum* type) possesses three antipodals in chalazal end, Three cells in the micropylar end constituting egg apparatus(1 egg and 2 Synergids) and two polar nucleus fused to form secondary nucleus. Thus, a 7 celled 8 nucleated Embryo sac is present.

The transfer of pollen grains to the stigma of a flower is called pollination. Self-pollination and cross-pollination are two types of pollination. Double fertilization and triple fusion are characteristic features of angiosperms. After fertilization the ovary transforms into a fruit and the ovule becomes a seed. Endosperm is triploid in angiosperms and is of three types – Nuclear, cellular, helobial. Reproduction which doesn't involve meiosis and syngamy is called apomixis. Occurrence of more than one embryo in a seed is called polyembryony. Formation of fruit without the act of fertilization is called parthenocarpy.

Evaluation

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1. Choose the correct statement from the following
   a) Gametes are involved in asexual reproduction
   b) Bacteria reproduce asexually by budding
   c) Conidia formation is a method of sexual reproduction
   d) Yeast reproduce by budding
2. An eminent Indian embryologist is
   a) S.R.Kashyap b) P.Maheswari
   c) M.S. Swaminathan d) K.C.Mehta
3. Identify the correctly matched pair
   a) Tuber - *Allium cepa*
   b) Sucker - *Pistia*
   c) Rhizome - *Musa*
   d) Stolon - *Zingiber*
4. Pollen tube was discovered by
   a) J.G.Kolreuter b) G.B.Amici
   c) E.Strasburger d) E.Hanning
5. Size of pollen grain in *Myosotis*
   a) 10 micrometer b) 20 micrometer
   c) 200 micrometer d) 2000 micrometer
6. First cell of male gametophyte in angiosperm is
   a) Microspore b) megaspore
   c) Nucleus d) Primary Endosperm Nucleus
7. Match the following

I) External fertilization	i) pollen grain
II) Androecium	ii)anther wall
III) Male gametophyte	iii)algae
IV) Primary parietal layer	iv)stamens

   a)I-iv;II-i;III-ii;IV-iii
   b)I-iii;II-iv;III-i;IV-ii
   c)I-iii;II-iv;III-ii,IV-i
   d)I-iii;II-i;III-iv;IV-ii
8. Arrange the layers of anther wall from locus to periphery
   a) Epidermis,middle layers, tapetum, endothecium
   b) Tapetum, middle layers, epidermis, endothecium
   c) Endothecium, epidermis, middle layers, tapetum
   d) Tapetum, middle layers endothecium epidermis

Chapter

2

UNIT VII: Genetics

Classical Genetics

Learning Objectives

The Learner will be able to

- Differentiate classical and modern genetics.
- Understand the concepts of principles of inheritance.
- Describe the extensions of Mendelism.
- Explain polygenic inheritance and Pleiotropy.
- Analyze extra chromosomal inheritance in cytoplasmic organelles.

8JADTY

Chapter outline

2.1 Heredity and Variation
2.2 Mendelism
2.3 Laws of Mendelian Inheritance
2.4 Monohybrid, Dihybrid, cross, Backcross and Testcross
2.5 Interaction of Genes -Intragenic and Intergenic Incomplete dominance, Lethal genes, Epistasis
2.6 Polygenic inheritance in Wheat kernel colour, Pleiotropy – *Pisum sativum*
2.7 Extra chromosomal inheritance- Cytoplasmic inheritance in Chloroplast.

Genetics is the study of how living things receive common traits from previous generations. No field of science has changed the world more, in the past 50 years than genetics. The scientific and technological advances in genetics have transformed agriculture, medicine and forensic science etc.

Genetics – The Science of heredity (Inheritance) - "Genetics" is the branch of biological science which deals with the mechanism of transmission of characters from parents to offsprings. The term **Genetics** was introduced by **W. Bateson** in 1906.

The four major subdisciplines of genetics are

1. **Transmission Genetics / Classical Genetics** – Deals with the transmission of genes from parents to offsprings. The foundation of classical genetics came from the study of hereditary behaviour of seven genes by Gregor Mendel.
2. **Molecular Genetics** – Deals with the structure and function of a gene at molecular level.
3. **Population Genetics** – Deals with heredity in groups of individuals for traits which is determined by a few genes.
4. **Quantitative Genetics** – Deals with heredity of traits in groups of individuals where the traits are governed by many genes simultaneously.

What is the reason for similarities, differences of appearance and skipping of generations?

Genes – Functional Units of inheritance: The basic unit of heredity (biological information) which transmits biochemical, anatomical and behavioural traits from parents to offsprings.

for these are found in mitochondrion. There are also restores of fertility (Rf) genes. Even though these genes are nuclear genes, they are distinct from genetic male sterility genes of other plants. Because the Rf genes do not have any expression of their own, unless the sterile cytoplasm is present. Rf genes are required to restore fertility in S cytoplasm which is responsible for sterility.

So the combination of N cytoplasm with rfrf and S cytoplasm with RfRf produces plants with fertile pollens, while S cytoplasm with rfrf produces only male sterile plants.

Atavism

Atavism is a modification of a biological structure whereby an ancestral trait reappears after having been lost through reemergence of sexual reproduction in the flowering plant *Hieracium pilosella* is the best example for Atavism in plants.

Summary

Gregor Johann Mendel, father of Genetics unraveled the mystery of heredity through his experiments on garden peas. Mendel's laws, analytical and empirical reasoning endure till now guiding geneticists to study variation. The monohybrid cross of Mendel proved his particulate theory of inheritance. In F_2 the alternative traits were expressed in the ratio of 3 dominant and 1 recessive. The characteristic 3 : 1 segregation is referred to as Mendelian ratio. Parents transmit discrete information about the traits to their offspring which Mendel called it as "factors". To test his experimental results Mendel devised a powerful procedure called the test cross. Test cross is used to determine the genotype of an individual when two genes are involved. In Mendel's dihyrbid cross, the two pairs of factors were inherited independently. From the results of dihybrid cross Mendel gave the Law of Independent Assortment. Mendel's dihybrid ratio of 9 : 3 : 3 : 1 with the representation of two new recombinations appeared in the progeny, i.e. round green peas or wrinkled yellow peas. Molecular explanation of Mendel's gene for monohybrid cross, dihybrid cross were explained. Extension of Mendelian Genetics was dealt with examples for interaction among genes. Incomplete dominance is not an example for blending inheritance. Incomplete dominance exhibits a phenotypic heterozygote intermediate between the two homozygous. In plants codominance can be demonstrated by the methods of electrophoresis or chromatography for protein or flavonoid substances. Lethal genes with an example are explained. Pleiotropy a single gene which affects multiple traits was explained with an example of Pisum sativum. Dominant epistatis in summer squash with 12 : 3 : 1 ratio was discussed. Polygenic inheritance is an example for inheritance of continuous traits which is compatible with Mendel's laws. The inheritance of mitochondrial and chloroplast genes were explained with examples which does not follow the rules of nuclear genes.

Evaluation

1. Extra nuclear inheritance is a consequence of presence of genes in
   a) Mitochondria and chloroplasts
   b) Endoplasmic reticulum and mitochondria
   c) Ribosomes and chloroplast
   d) Lysososmes and ribosomes
2. In order to find out the different types of gametes produced by a pea plant having the genotype AaBb, it should be crossed to a plant with the genotype
   a) aaBB b) AaBB
   c) AABB d) aabb
3. How many different kinds of gametes will be produced by a plant having the genotype AABbCC?
   a) Three b) Four
   c) Nine d) Two

4. Which one of the following is an example of polygenic inheritance?
   a) Flower colour in *Mirabilis Jalapa*
   b) Production of male honey bee
   c) Pod shape in garden pea
   d) Skin Colour in humans

5. In Mendel's experiments with garden pea, round seed shape (RR) was dominant over wrinkled seeds (rr), yellow cotyledon (YY) was dominant over green cotyledon (yy). What are the expected phenotypes in the F_2 generation of the cross RRYY x rryy?
   a) Only round seeds with green cotyledons
   b) Only wrinkled seeds with yellow cotyledons
   c) Only wrinkled seeds with green cotyledons
   d) Round seeds with yellow cotyledons an wrinkled seeds with yellow cotyledons

6. Test cross involves
   a) Crossing between two genotypes with recessive trait
   b) Crossing between two F_1 hybrids
   c) Crossing the F_1 hybrid with a double recessive genotype
   d) Crossing between two genotypes with dominant trait

7. In pea plants, yellow seeds are dominant to green. If a heterozygous yellow seed pant is crossed with a green seeded plant, what ratio of yellow and green seeded plants would you expect in F_1 generation?
   a) 9:1 b) 1:3
   b) 3:1 d) 50:50

8. The genotype of a plant showing the dominant phenotype can be determined by
   a) Back cross b) Test cross
   c) Dihybrid corss d) Pedigree analysis

9. Select the correct statement from the ones given below with respect to dihydrid cross
   a) Tightly linked genes on the same chromosomes show very few combinations
   b) Tightly linked genes on the same chromosomes show higher combinations
   c) Genes far apart on the same chromosomes show very few recombinations
   d) Genes loosely linked on the same chromosomes show similar recombinations as the tightly linked ones

10. Which Mendelian idea is depicted by a cross in which the F_1 generation resembles both the parents
    a) Incomplete dominance
    b) Law of dominance
    c) Inheritance of one gene
    d) Co-dominance

11. Fruit colour in squash is an example of
    a) Recessive epistatsis
    b) Dominant epistasis
    c) Complementary genes
    d) Inhibitory genes

12. In his classic experiments on Pea plants, Mendel did not use
    a) Flowering position b) Seed colour
    c) Pod length d) Seed shape

13. The epistatic effect, in which the dihybrid cross 9:3:3:1 between AaBb Aabb is modified as
    a) Dominance of one allele on another allele of both loci
    b) Interaction between two alleles of different loci
    c) Dominance of one allele to another alleles of same loci
    d) Interaction between two alleles of some loci

Chapter

3

UNIT VII: Genetics

Chromosomal Basis of Inheritance

Learning Objectives

The Learner will be able to

- Understand chromosomal theory of inheritance.
- Analyze the three-point test crosses and appreciate results in linkage map construction.
- Differentiate mutation types with examples.

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Chapter outline

3.1 Chromosomal theory of Inheritance

3.2 Linkage - Eye colour in *Drosophila* and Seed colour in Maize

3.3 Crossing over, Recombination and Gene mapping

3.4 Multiple alleles

3.5 Mutation-types, mutagenic agents and their significance.

In the previous chapter you have learned about Mendelian genetics, now you are going to be study with deviations of concepts related to Mendelian genetics and chromosomal theory of inheritance. You must recall the structure of chromosome and cell division from eleventh standard.

3.1 Chromosomal Theory of Inheritance

G. J. Mendel (1865) studied the inheritance of well-defined characters of pea plant but for several reasons it was unrecognized till 1900. Three scientists (de Vries, Correns and Tschermak) independently rediscovered Mendel's results on the inheritance of characters. Various cytologists also observed cell division due to advancements in microscopy. This led to the discovery of structures inside nucleus. In eukaryotic cells, worm-shaped structures formed during cell division are called **chromosomes** (colored bodies, visualized by staining). An organism which possesses two complete basic sets of chromosomes are known as diploid. A chromosome consists of long, continuous coiled piece of DNA in which genes are arranged in linear order. Each gene has a definite position (locus) on a chromosome. These genes are hereditary units. Chromosomal theory of inheritance states that Mendelian factors (genes) have specific locus (position) on chromosomes and they carry information from one generation to the next generation.

3.1.1 Historical development of chromosome theory

The important cytological findings related to the chromosome theory of inheritance are given below.

- **Wilhelm Roux (1883)** postulated that the chromosomes of a cell are responsible for transferring heredity.
- **Montgomery (1901)** was first to suggest occurrence of distinct pairs of chromosomes and he also concluded that maternal chromosomes pair with paternal chromosomes only during meiosis.

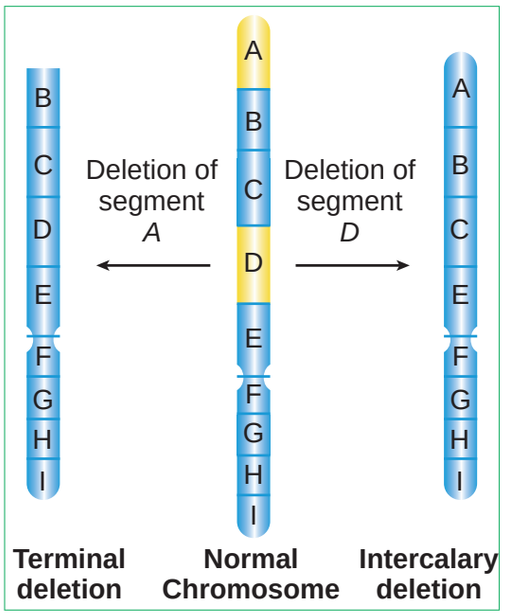

Figure 3.24 Deletion

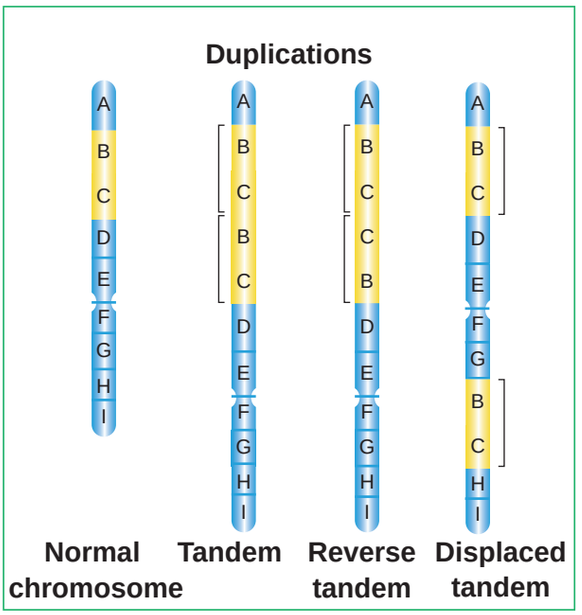

Figure 3.25 Duplication

Summary

Chromosomal theory of inheritance states that Mendelian factors have specific locus on chromosomes and they carry information from one generation to the next generation. Genes located close together on the same chromosome and inherited together are called linked genes the phenomenon is called Linkage. Two types of linkage are complete linkage and incomplete linkage. The groups of linearly arranged linked genes are called Linkage groups. Crossing over is a biological process that produces new combination of genes by inter-changing the corresponding segments between non-sister chromatids of homologous pair of chromosomes. In this segments of DNA are broken and recombined to produce new combinations of alleles a process is called Recombination. The diagrammatic representation of distances between the adjacent genes which is directly proportional to the frequency of recombination between them is called genetic mapping. When any of the three or more allelic forms of a gene occupy the same locus in a given pair of homologous chromosomes, they are said to be multiple alleles. They are m, M1 and M2 of a single gene. Mutational events that take place within individual genes are called gene mutations or point mutation, whereas the changes that occur in structure and number of chromosomes are called chromosomal mutation. The agents which are responsible for mutation is called mutagens.

Evaluation

B3WQYL

1. An allohexaploidy contains
   a) Six different genomes
   b) Six copies of three different genomes
   c) Two copies of three different genomes
   d) Six copies of one genome
2. The A and B genes are 10 cM apart on a chromosome. If an AB/ab heterozygote is testcrossed to ab/ab, how many of each progeny class would you expect out of 100 total progeny?
   a) 25 AB, 25 ab, 25 Ab, 25 aB
   b) 10 AB, 10 ab
   c) 45 AB, 45 ab
   d) 45 AB, 45 ab, 5 Ab, 5aB

3. Match list I with list II

List I	List II
A. A pair of chromosomes extra with diploid	i) monosomy
B. One chromosome extra to the diploid	ii) tetrasomy
C. One chromosome loses from diploid	iii) trisomy
D. Two individual chromosomes lose from diploid	iv) double monosomy

a) A-i, B-iii, C-ii, D-iv b) A-ii, B-iii, C-iv, D-i
c) A-ii, B-iii, C-i, D-iv d) A-iii, B-ii, C-i, D-iv

4. Which of the following sentences are correct?
   1. The offspring exhibit only parental combinations due to incomplete linkage
   2. The linked genes exhibit some crossing over in complete linkage
   3. The separation of two linked genes are possible in incomplete linkage
   4. Crossing over is absent in complete linkage

   a) 1 and 2 b) 2 and 3
   c) 3 and 4 d) 1 and 4

5. Accurate mapping of genes can be done by three point test cross because increases
   a) Possibility of single cross over
   b) Possibility of double cross over
   c) Possibility of multiple cross over
   d) Possibility of recombination frequency

6. Due to incomplete linkage in maize, the ratio of parental and recombinants are
   a) 50:50 b) 7:1:1:7 c) 96.4: 3.6 d) 1:7:7:1

7. Genes **G S L H** are located on same chromosome. The recombination percentage is between L and G is 15%, S and L is 50%, H and S are 20%. The correct order of genes is
   a) GHSL b) SHGL c) SGHL d) HSLG

8. The point mutation sequence for transition, transition, transversion and transversion in DNA are
   a) A to T, T to A, C to G and G to C
   b) A to G, C to T, C to G and T to A
   c) C to G, A to G, T to A and G to A
   d) G to C, A to T, T to A and C to G

9. If haploid number in a cell is 18. The double monosomic and trisomic number will be
   a) 35 and 37 b) 34 and 35
   c) 37 and 35 d) 17 and 19

10. Changing the codon AGC to AGA represents
    a) missense mutation b) nonsense mutation
    c) frameshift mutation d) deletion mutation

11. **Assertion (A):** Gamma rays are generally use to induce mutation in wheat varieties.
    Reason (R): Because they carry lower energy to non-ionize electrons from atom
    a) A is correct. R is correct explanation of A
    b) A is correct. R is not correct explanation of A
    c) A is correct. R is wrong explanation of A
    d) A and R is wrong

12. How many map units separate two alleles A and B if the recombination frequency is 0.09?
    a) 900 cM b) 90 cM c) 9 cM d) 0.9 cM

13. When two different genes came from same parent they tend to remain together.
    i) What is the name of this phenomenon?
    ii) Draw the cross with suitable example.
    iii) Write the observed phenotypic ratio.

14. If you cross dominant genotype PV/PV male *Drosophila* with double recessive female and obtain F_1 hybrid. Now you cross

Chapter

4

UNIT VIII: Biotechnology

Principles and Processes of Biotechnology

Learning Objectives

The learner will be able to

- Apply the knowledge of traditional and modern biotechnology in day to day life.
- Appreciate the uses of fermentation process.
- Acquire the knowledge on the process of genetic engineering
- Analyse the uses and limitations of genetically modified plants
- Cognize the terms of bio prospecting and bio piracy.

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Chapter outline

4.1 Development of Biotechnology
4.2 Methods of Biotechnology
4.2 Advancements in Modern Biotechnology
4.4 Tools for Genetic Engineering
4.5 Methods of Gene transfer
4.6 Screening for Recombiants
4.7 Transgenic Plants / Genetically Modified Crops
4.8 Applications of Biotechnology.

Karl Ereky

Biotechnology is the science of applied biological processes. In other words it is science of development and utilization of biological processes, forms and systems for the benefit of mankind and other life forms. The term biotechnology was coined by Karl Ereky, a Hungarian Engineer in 1919 and has been extended to include any process in which organisms, tissues, cells, organelles or isolated molecules such as enzymes are used to convert biological or other raw materials to products of greater value.

4.1 Development of Biotechnology

Biotechnology has developed by leaps and bounds during the past century and its development can be well understood under two main heads namely **conventional or traditional biotechnology** and **modern biotechnology**

1. Conventional or traditional biotechnology: This is the kitchen technology developed by our ancestors, and it is as old as human civilization. It uses bacteria and other microbes in the daily usage for preparation of dairy products like curd, ghee, cheese and in preparation of foods like idli, dosa, nan, bread and pizza. This conventional biotechnology also extends to preparation of alcoholic beverages like beer, wine, etc.

With the advancement of the science and technology during the 18th century, these kitchen technologies gained scientific validation.

the path of Indian Basmati rice exports to the foreign countries. The Patent Office ordered the patent name to be changed to 'Rice lines 867'.

4.9 Applications of Biotechnology

- Biotechnology is one of the most important applied interdisciplinary sciences of the **21st century**. It is the trusted area that enables us to find the beneficial way of life.
- Biotechnology has wide applications in various sectors like agriculture, medicine, environment and commercial industries.
- This science has an invaluable outcome like **transgenic varieties** of plants e.g. transgenic cotton (Bt-cotton), rice, tomato, tobacco, cauliflower, potato and banana.
- The development of transgenics as pesticide resistant, stress resistant and disease resistant varieties of agricultural crops is the immense outcome of biotechnology.
- The synthesis of **human insulin** and blood protein in *E.coli* and utilized for insulin deficiency disorder in human is a breakthrough in biotech industries in medicine.
- The synthesis of vaccines, enzymes, antibiotics, dairy products and beverages are the products of biotech industries.
- **Biochip** based biological computer is one of the successes of biotechnology.
- Genetic engineering involves genetic manipulation, tissue culture involves aseptic cultivation of totipotent plant cell into plant clones under controlled atmospheric conditions.
- **Single cell protein** from *Spirulina* is utilized in food industries.
- Production of **secondary metabolites**, biofertilizers, biopesticides and enzymes.
- Biomass energy, biofuel, Bioremediation, phytoremediation for environmental biotechnology.

Summary

Biotechnology is the science of applied biological process in which there is a controlled use of biological agents such as microorganisms or cellular components for beneficial use. A Hungarian Engineer, Karl Ereky (1919) coined the term biotechnology. Biotechnology broadly categorized into traditional practices and modern practices. Traditional biotechnology includes our ancient practices such as fermentation. Single Cell Protein (SCP) organisms are grown in large quantities to produce goods rich in protein, minerals, fats, carbohydrates and vitamins. The modern biotechnology embraces all the genetic manipulations. The recombinant DNA technology is a technique of modern biotechnology in which transfer of DNA coding for a specific gene from one organism is introduced into another organism using specific agents like vectors or using instruments like electroporation, gene gun, liposome mediated, chemical mediated and micro injection. Other tools are enzymes and host organisms. The enzyme restriction endonuclease is a molecular scissor that cleaves DNA into fragments at or near specific recognition sites with the molecule known as restriction sites. Other enzymes are DNA ligase and alkaline phosphatase. DNA ligase enzyme joins the sugar and phosphate molecules of double stranded DNA. Alkaline phosphatase is an enzyme which adds or removes specific phosphate group of double stranded DNA.

A vector is a small DNA molecule capable of self replication and used as a carrier of DNA inserted in the host cell. Few examples of vectors are plasmid – pBR 322, cosmid – Lambda phage, M13, Phagmid , BAC, YAC, transposon, shuttle vector and expression vector.

After production of recombinant DNA molecule has been generated is introduced into a suitable host cell. Type of host cell depends upon the cloning experiment. E.coli is the most widely used host organism. There are two kinds of gene transfer methods in plants. They are direct or vectorless gene transfer and indirect or vector

mediated gene transfer. Direct gene transfer includes chemical mediated gene transfer, micro injection, electroporation. Gene gun method and Liposome mediated method of gene transfer. Indirect or vector mediated gene transfer is a method of gene transfer with the help of a plasmid vector. In this method Ti-plasmid from *Agrobactirum tumefeciens* has been used extensively for vector mediated gene transfer.

After the introduction of rDNA into a host cell, it is essential to identify those cells which have received the rDNA molecule. This process is called screening. One of the method of recombinant screening is blue white selection method Replica plating technique in which the pattern of colonies growing on a culture plate is copied. Electrophoresis is a separating technique used to separate different biomolecules.

Blotting techniques are widely used tools for identification of desired DNA or RNA fragments from larger number of molecules. Some of the genetically modified crops are herbicide tolerant – Basta, Dhara mustard, insects resistance – Bt crops, flavrSavr – Tomato, Golden rice. Biopolymers are polyhydroxybutyrate (PHB), polylactic acid (PLA) and green fluorescent protein (GFP) is used to make biosensors. Other applications are biopharming, bioprospecting, biomedication and biofuel, etc.

Evaluation

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1. Restriction enzymes are
   a. Not always required in genetic engineering
   b. Essential tools in genetic engineering
   c. Nucleases that cleave DNA at specific sites
   d. both b and c

2. Plasmids are
   a. circular protein molecules
   b. required by bacteria
   c. tiny bacteria
   d. confer resistance to antibiotics

3. EcoRI cleaves DNA at
   a. AGGGTT b. GTATATC
   c. GAATTC d. TATAGC

4. Genetic engineering is
   a. making artificial genes.
   b. hybridization of DNA of one organism to that of the others.
   c. production of alcohol by using micro organisms.
   d. making artificial limbs, diagnostic instruments such as ECG, EEG etc.,

5. Consider the following statements:
   I. Recombinant DNA technology is popularly known as genetic engineering is a stream of biotechnology which deals with the manipulation of genetic materials by man invitro
   II. pBR322 is the first artificial cloning vector developed in 1977 by Boliver and Rodriguez from E.coli plasmid
   III. Restriction enzymes belongs to a class of enzymes called nucleases.

   Choose the correct option regarding above statements
   a. I & II b. I & III
   c. II & III d. I,II & III

6. The process of recombinant DNA technology has the following steps
   I. amplication of the gene
   II. Insertion of recombinant DNA into the host cells
   III. Cutting of DNA at specific location using restriction enzyme .
   IV. Isolation of genetic material (DNA)

   Pick out the correct sequence of step for recombinant DNA technology.
   a. II, III, IV, I b. IV, II, III, I
   c. I, II, III, IV d. IV, III, I, II

7. Which one of the following palindromic base sequence in DNA can be easily cut at about the middle by some particular restriction enzymes?
   a. 5` CGTTCG 3` 3` ATCGTA 5`

Chapter

5

UNIT VIII: Biotechnology

Plant Tissue Culture

Learning Objectives

The learner will be able to

- Perceive the concepts of tissue culture.
- Cognize the steps of tissue culture techniques and its types.
- Understand the protoplast culture in detail.
- Elicit the list of secondary metabolites obtained through cell suspension culture.
- Learn plant regeneration pathway.
- Appreciate the uses of micro propagation, somatic hybridization, shoot meristem culture and germplasm conservation.
- Acquire the knowledge of patenting Biosafety and Bioethics.

Chapter outline

5.1 Basic concepts in plant disuse culture
5.2 Plant tissue culture techniques and types
5.3 Plant regeneration pathway
5.4 Applications of plant tissue culture
5.5 Conservation of plant genetic resources
5.6 Intellectual rights of property (IPR), Biosafety and Bioethics
5.7 Future Biotechnology

FRWH98

Gottlieb Haberlandt

Growing plant protoplasts, cells, tissues or organs away from their natural or normal environment, under artificial condition, is known as Tissue Culture. It is also known as *in vitro* (*In vitro* is a Latin word, it means that - in glass or in test-tube) growth of plant protoplasts, cells, tissues and organs. A single explant can be multiplied into several thousand plants in a short duration and space under controlled conditions.

Tissue culture techniques are often used for commercial production of plants as well as for plant research. Plant tissue culture serves as an indispensable tool for regeneration of transgenic plants. Apart from this some of the main applications of Plant tissue culture are clonal propagation of elite varieties, conservation of endangered plants, production of virus-free plants, germplasm preservation, industrial production of secondary metabolites. etc., In this chapter let us discuss the history , techniques, types , applications of plant tissue culture and get awareness on ethical issues.

Gottlieb Haberlandt (1902) the German Botanist proposed the concept **Totipotency** and he was also the first person to culture plant cells in artificial conditions using the mesophyll cells of *Lamium purpureum* in culture medium and obtained cell proliferation. He is regarded as the father of tissue culture.

(ELSI) program was founded in 1990 as an integral part of the Human Genome Project. The mission of the ELSI program was to identify and address issues raised by genomic research that would affect individuals, families, and society. A percentage of the Human Genome Project budget at the National Institutes of Health and the U.S. Department of Energy was devoted to ELSI research.

Genetic Engineering Appraisal Committee (GEAC)

GEAC is an apex body under Ministry of Environment, Forests and Climate change for regulating manufacturing, use, import, export and storage of hazardous microbes or genetically modified organisms (GMOs) and cells in the country. It was established as an apex body to accord approval of activities involving large scale use of hazardous microorganisms and recombinants in research and industrial production. The GEAC is also responsible for approval of proposals relating to release of genetically engineered organisms and products into the environment including experimental field trials.

5.8 Future of Biotechnology

Biotechnology has become a comprehensive scientific venture from the point of academic and commercial angles, within a short time with the sequencing of human genome and genome of some important organisms. The future developments in biotechnology will be exciting. Thus the development in biotechnology will lead to a new scientific revolution that would change the lives and future of people. Like industrial and computer revolution, biotechnological revolution will also promise major changes in many aspects of modern life.

Summary

Tissue culture is the in vitro asceptic culture of cells, tissues or organs into whole plants under controlled nutritional and environmental conditions. A German physiologist Gotllieb Haberlant in 1902 for the first time attempted to culture plant cells in artificial medium, hence he was regarded as father of Tissue culture. Tissue culture mainly based on the concepts totipotency, differentiation, redifferentiation and dedifferentiation. Plant tissue culture technique involves selection of explants, sterilization, media preparation, maintaining culture condition, callus formation, embryogenesis or organgenesis and hardening. Based on the explants chosen the types of tissue culture are organ culture, meristem culture, protoplast culture and cell suspension culture. From the explants, plants can be regenerated by somatic embryogenesis or organgenesis is said to be plant regeneration pathway. Some of the main applications of tissue culture are production of somatic hybrids, artificial seeds, disease resistant and stress resistant plants, germplasm conservation, micropropagation and production of secondary metabolites. Intellectual Property Right (IPR) is primarily aimed at patents, copyrights, trade secret and trademark given to the discoverer / inventor for the commercial production of transformed micro organisms or plants. Biosafety is the prevention mechanism to protect harmful incidents due to biohazards or pathogens. Bioethics dealt with ethical issue emerging from biotechnological advancement. ELSI program addresses issues related to genenomic research. GEAC (Genetic Engineering Appraisal Committee) is a regulatory authority for release of genetically modified products or organisms into the environment.

Evaluation

Choose the correct answer from the given option:

1. Totipotency refers to
   a) capacity to generate genetically identical plants.
   b) capacity to generate a whole plant from any plant cell / explant.

c) capacity to generate hybrid protoplasts.
d) recovery of healthy plants from diseased plants.

2. Micro propagation involves
   a) vegetative multiplication of plants by using micro-organisms.
   b) vegetative multiplication of plants by using small explants.
   c) vegetative multiplication of plants by using microspores.
   d) Non-vegetative multiplication of plants by using microspores and megaspores.

3. Match the following :

Column A	Column B
1) Totipotency	A) Reversion of mature cells into meristerm
2) Dedifferentiation	B) Biochemical and structural changes of cells
3) Explant	C) Properties of living cells develops into entire plant
4) Differentiation	D) Selected plant tissue transferred to culture medium

	1	2	3	4
a)	C	A	D	B
b)	A	C	B	D
c)	B	A	D	C
d)	D	B	C	A

4. The time duration for sterilization process by using autoclave is _____ minutes and the temperature is _____
   a) 10 to 30 minutes and 125° C
   b) 15 to 30 minutes and 121° C
   c) 15 to 20 minutes and 125° C
   d) 10 to 20 minutes and 121° C

5. Which of the following statement is correct
   a) Agar is not extracted from marine algae such as seaweeds.
   b) Callus undergoes differentiation and produces somatic embryoids.
   c) Surface sterilization of explants is done by using mercuric bromide
   d) P^H of the culture medium is 5.0 to 6.0

6. Select the incorrect statement from given statement
   a) A tonic used for cardiac arrest is obtained from Digitalis purpuria
   b) Medicine used to treat Rheumatic pain is extracted from Capsicum annum
   c) An anti malarial drug is isolated from Cinchona officinalis.
   d) Anti-cancinogenic property is not seen in Catharanthus roseus.

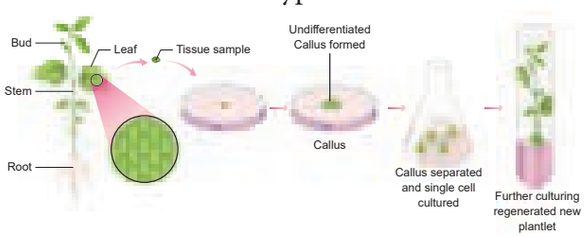
7. Virus free plants are developed from
   a) Organ culture
   b) Meristem culture
   c) Protoplast culture
   d) Cell suspension culture

8. The prevention of large scale loss of biological interity
   a) Biopatent b) Bioethics
   c) Biosafety d) Biofuel

9. Cryopreservation means it is a process to preserve plant cells, tissues or organs
   a) at very low temperature by using ether.
   b) at very high temperature by using liquid nitrogen
   c) at very low temperature of -196 by using liquid nitrogen
   d) at very low temperature by using liquid nitrogen

10. Solidifying agent used in plant tissue culture is
    a) Nicotinic acid b) Cobaltous chloride
    c) EDTA d) Agar

11. What is the name of the process given below? Write its 4 types.



12. How will you avoid the growing of microbes in nutrient medium during culture process? What are the techniques used to remove the

Chapter 6

Principles of Ecology

Learning Objectives

The learner will be able to

- Understand the interaction between organisms and their environment.
- Describe biotic and abiotic factors that influence the dynamics of populations.
- Describe how organisms adapt themselves to environmental changes.
- Learn the structure of various fruits and seeds related to their dispersal mechanism.

IBIUDV

Chapter outline

6.1 Ecology
6.2 Ecological factors
6.3 Ecological adaptations
6.4 Dispersal of seeds and fruits

Ecology is a division of biology which deals with the study of environment in relation to organisms. It can be studied by considering individual organisms, population, community, biome or biosphere and their environment. While observing our different environments, one can ask questions like

- Why do plants or animals vary with places?
- What are the causes for variation in biological diversity of different places?
- How soil, climate and other physical features affect the flora and fauna or vice versa?

These questions can be better answered with the study of ecology.

Ecology is essentially a practical science involving experiments, continuous observations to predict how organisms react to particular environmental circumstances and understanding the principles involved in ecology.

6.1 Ecology

R. Misra

The term "ecology" (**oekologie**) is derived from two Greek words – **oikos** (meaning house or dwelling place and **logos** meaning study) It was first proposed by **Reiter** (1868). However, the most widely accepted definition of ecology was given by **Ernest Haeckel** (1869).

Alexander von Humbolt - Father of Ecology
Eugene P. Odum - Father of modern Ecology
R. Misra - Father of Indian Ecology

6.1.1 Definitions of ecology

"The study of living organisms, both plants and animals, in their natural habitats or homes."

- Reiter (1885)

"Ecology is the study of the reciprocal relationship between living organisms and their environment." **- Earnest Haeckel (1889)**

Example: *Ecballium elatrium* (Squirting cucumber) *Gyrocarpus* and *Dipterocarpus.*

Figure 6.34: *Ecballium*

Figure 6.35: *Impatents*

Human aided seed dispersal

Figure 6.36: Seed ball

Seed Ball : Seed ball is an ancient Japanese technique of encasing seeds in a mixture of clay and soil humus (also in cow dung) and scattering them on to suitable ground, not planting of trees manually. This method is suitable for barren and degraded lands for tree regeneration and vegetation before monsoon period where the suitable dispersal agents become rare.

Guess? what is atelochory or Achory?

Ecologically important days
March 21 - World forest day
April 22 - Earth day
May 22 - World bio diversity day
June 05 - World environment day
July 07 - Van Mohostav day
September 16 - International Ozone day

Advantages of seed dispersal:

- Seeds escape from mortality near the parent plants due to predation by animals or getting diseases and also avoiding competition.
- Dispersal also gives a chance to occupy favourable sites for growth.
- It is an important process in the movement of plant genes particularly this is the only method available for self-fertilized flowers and maternally transmitted genes in outcrossing plants.
- Seed dispersal by animals help in conservation of many species even in human altered ecosystems.
- Understanding of fruits and seed dispersal acts as a key for proper functioning and establishment of many ecosystems from deserts to evergreen forests and also for the maintenance of biodiversity conservation and restoration of ecosystems.

Summary

Ecology is a division of biology and deals with the study of environment in relation to organisms. Ecology is mainly divided into two branches Autecology and Synecology. The environment (surrounding) includes physical, chemical and biological components. These factors can be classified into living (biotic) and non-living (abiotic), which make the environment of an organism. The ecological factors are meaningfully grouped into four classes, which are as follows: 1. Climatic factors 2. Edaphic factors 3. Topographic factors 4. Biotic factors.

Climate is one of the important natural factors controlling the plant life. The climatic factors includes light, temperature, water, wind, fire, etc. Edaphic factors, the abiotic factors related to soil, include the physical and chemical composition of the soil formed in a particular area. The surface features of earth are called topography. Topographic influence on the climate of any area is determined by the interaction of solar radiation, temperature, humidity ,rainfall, latitude and altitude. The interactions among living organisms, the plants and animals are called biotic factors, which may cause marked effects upon vegetation.

The modifications in the structure of organisms to survive successfully in an environment are called adaptations of organisms. Based on the habitats and the corresponding adaptations of plants, they are classified into 1) Hydrophytes 2) Xerophytes 3) Mesophytes 4) Epiphytes and 5) Halophytes.

The dissemination of seeds and fruits to various distances from the parent plant is called **seed and fruit dispersa**l. It takes place with the help of ecological factors such as wind, water and animals.

Evaluation

1. Arrange the correct sequence of ecological hierarchy starting from lower to higher level.
   a) Individual organism → Population Landscape → Ecosystem
   b) Landscape → Ecosystem → Biome → Biosphere
   c) community → Ecosystem → Landscape → Biome
   d) Population → organism → Biome → Landscape

2. Ecology is the study of an individual species is called
   i) Community ecology ii) Autecology
   iii) Species ecology iv) Synecology
   a) i only b) ii only
   c) i and iv only d) ii and iii only

3. A specific place in an ecosystem, where an organism lives and performs its functions is
   a) habitat b) niche
   c) landscape d) biome

4. Read the given statements and select the correct option.
   i) Hydrophytes possess aerenchyma to support themselves in water.
   ii) Seeds of *Viscum* are positively photoblastic as they germinate only in presence of light.
   iii) Hygroscopic water is the only soil water available to roots of plant growing in soil as it is present inside the micropores.
   iv) High temperature reduces use of water and solute absorption by roots.
   a) i, ii, and iii only b) ii, iii and iv
   c) ii and iii only d) i and ii only

5. Which of the given plant produces cardiac glycosides?
   a) Calotropis b) *Acacia*
   c) *Nepenthes* d) *Utricularia*

6. Read the given statements and select the correct option.
   i) Loamy soil is best suited for plant growth as it contains a mixture of silt, sand and clay.
   ii) The process of humification is slow in case of organic remains containing a large amount of lignin and cellulose**.**
   iii) Capillary water is the only water available to plant roots as it is present inside the micropores.
   iv) Leaves of shade plant have more total chlorophyll per reaction centre, low ratio of chl *a* and chl *b* are usually thinner leaves.
   a) i, ii and iii only b) ii, iii and iv only
   c) i, ii and iv only d) ii and iii only

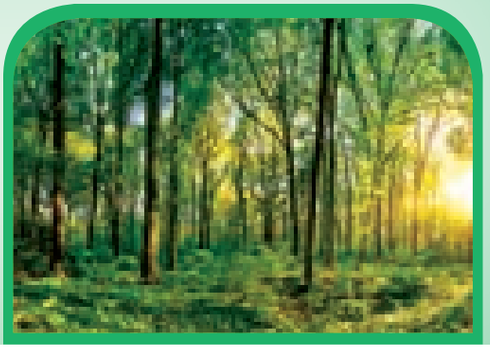
7. Read the given statements and select the correct option.
   Statement A : Cattle do not graze on weeds of *Calotropis*.
   Statement B : *Calotropis* have thorns and spines, as defense against herbivores.
   a) Both statements A and B are incorrect.
   b) Statement A is correct but statement B is incorrect.
   c) Both statements A and B are correct but statement B is not the correct explanation of statement A.
   d) Both statements A and B are correct and statement B is the correct explanation of statement A.

8. In soil water available for plants is
   a) gravitational water
   b) chemically bound water
   c) capillary water
   d) hygroscopic water

Chapter 7

UNIT IX: Plant Ecology

Ecosystem



Learning Objectives

Learning objectives

The learner will be able to,

- Describe the Structure, functions and types of ecosystems
- Draw ecological pyramids by means of number, biomass and energy
- Interpret carbon and phosphorus cycle
- Recognise pond ecosystem as a self-sufficient and self-regulating system
- Analyse ecosystem services and its management
- Discuss about the importance and conservation of ecosystem
- Explain the types of plant succession

Chapter outline

7.1 Structure of ecosystem

7.2 Functions of ecosystem

7.3 Plant succession

KFW8IU

Have you seen lakes, ponds and pools in your surroundings? They are all called water bodies with many components in them. Can you list out the things which are found in water bodies? Mud, nutrients, clay, dissolved gases, planktons, microorganisms, plants like algae, *Hydrilla, Nelumbo, Nymphaea* and animals like snake, small fish, large fish, frog, tortoise and crane are the components of the water bodies which constitutes **ecosystem**. Further, we all know that plants and animals are prominent living components in the environment. They interact with space components such as air, water, soil, sunlight, etc. For example, you have studied in class XI, one of the life processes, photosynthesis which utilizes sunlight , water, carbondioxide, nutrients from the soil and release oxygen to the atmosphere. From this, we understand that the exchange of materials takes place between living and space components. Likewise, you can study the structure, function and types of ecosystem in this chapter. The term **'ecosystem'** was proposed by A.G. Tansley (1935), who defined it as '**the system resulting from the integration of all the living and nonliving factors of the environment'**. Whereas, Odum (1962) defined ecosystem **'as the structural and functional unit of ecology'.**

Parallel terms for ecosystem coined by various ecologists

- Biocoenosis – Karl Mobius
- Microcosm – S.A. Forbes
- Geobiocoenosis – V. V. Dokuchaev, G.F. Morozov
- Holocoen - Friederichs
- Biosystem – Thienemann
- Bioenert body – Vernadsky

7.3.4 Significance of Plant Succession

- Succession is a dynamic process. Hence an ecologist can access and study the seral stages of a plant community found in a particular area.
- The knowledge of ecological succession helps to understand the controlled growth of one or more species in a forest.
- Utilizing the knowledge of succession, even dams can be protected by preventing siltation.
- It gives information about the techniques to be used during reforestation and afforestation.
- It helps in the maintenance of pastures.
- Plant succession helps to maintain species diversity in an ecosystem.
- Patterns of diversity during succession are influenced by resource availability and disturbance by various factors.
- Primary succession involves the colonization of habitat of an area devoid of life.
- Secondary succession involves the reestablishment of a plant community in disturbed area or habitat.
- Forests and vegetation that we come across all over the world are the result of plant succession.

Summary

The interaction between biotic and abiotic components in an environment is called ecosystem. Autotrophs and heterotrophs are the producers and consumers respectively. The function of ecosystem refers to creation of energy, flow of energy and cycling of nutrients. The amount of light available for photosynthesis is called Photo synthetically Active Radiation . It is essential for increase in the productivity of ecosystem. The rate of biomass production per unit area /time is called productivity. It is classified as primary productivity, secondary productivity and community productivity. The transfer of energy in an ecosystem can be termed as energy flow. It is explained through the food chain, food web, ecological pyramids (pyramid of number, biomass and energy) and biogeochemical cycle. Cycling of nutrients between abiotic and biotic components is evident in the pond ecosystem, making itself self sufficient and self regulating Ecosystem protected for the welfare of posterity is called ecosystem management.

Successive replacement of one type of plant community by the other of the same area/ place is known as plant succession. The first invaded plants in a barren (nude) area are called pioneers (pioneers communities). On the other hand, a series of transitional developments of plant communities one after another in a given area are called seral communities. Succession is classified as primary succession, secondary succession, allogeneic succession and autotrophic succession. Plant succession is classified in to hydrosere (Initiating on a water bodies) ,Mesosere and xerosere. Further xerosere is subdivided in to Lithosere (Initiating on a barren rock), Halosere and Pasmmosere.

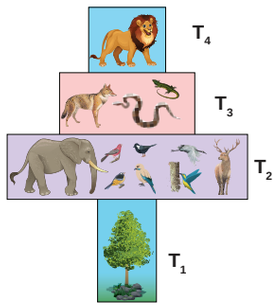
Evaluation

I Choose the most suitable answer from the given four alternatives and write the option code and the corresponding answer.

1. Which of the following is not a abiotic component of the ecosystem?
   a) Bacteria
   b) Humus
   c) Organic compounds
   d) Inorganic compounds
2. Which of the following is / are not a natural ecosystem?
   a) Forest ecosystem b) Rice field
   c) Grassland ecosystem d) Desert ecosystem
3. Pond is a type of
   a) forest ecosystem

b) grassland ecosystem
c) marine ecosystem
d) fresh water ecosystem

4. Pond ecosystem is
   a) not self sufficient and self regulating
   b) partially self sufficient and self regulating
   c) self sufficient and not self regulating
   d) self sufficient and self regulating
5. Profundal zone is predominated by heterotrophs in a pond ecosystem, because of
   a) with effective light penetration
   b) no effective light penetration
   c) complete absence of light
   d) a and b
6. Solar energy used by green plants for photosynthesis is only
   a) 2 – 8% b) 2 – 10%
   c) 3 – 10% d) 2 – 9%
7. Which of the following ecosystem has the highest primary productivity?
   a) Pond ecosystem
   b) Lake ecosystem
   c) Grassland ecosystem
   d) Forest ecosystem
8. Ecosystem consists of
   a) decomposers b) producers
   c) consumers d) all of the above
9. Which one is in descending order of a food chain
   a) Producers → Secondary consumers → Primary consumers → Tertiary consumers
   b) Tertiary consumers → Primary consumers → Secondary consumers → Producers
   c) Tertiary consumers → Secondary consumers → Primary consumers → Producers
   d) Tertiary consumers → Producers → Primary consumers → Secondary consumers
10. Significance of food web is / are
    a) it does not maintain stability in nature
    b) it shows patterns of energy transfer
    c) it explains species interaction
    d) b and c
11. The following diagram represents



    a) pyramid of number in a grassland ecosystem
    b) pyramid of number in a pond ecosystem
    c) pyramid of number in a forest ecosystem
    d) pyramid of biomass in a pond ecosystem
12. Which of the following is / are not the mechanism of decomposition
    a) Eluviation b) Catabolism
    c) Anabolism d) Fragmentation
13. Which of the following is not a sedimentary cycle
    a) Nitrogen cycle b) Phosphorous cycle
    c) Sulphur cycle d) Calcium cycle
14. Which of the following are not regulating services of ecosystem services
    i) Genetic resources
    ii) Recreation and aesthetic values
    iii) Invasion resistance
    iv) Climatic regulation
    a) i and iii b) ii and iv
    c) i and ii d) i and iv
15. Productivity of profundal zone will be low. Why?
16. Discuss the gross primary productivity is more efficient than net primary productivity.
17. Pyramid of energy is always upright. Give reasons
18. What will happen if all producers are removed from ecosystem?

Chapter

8

Unit IX - Plant Ecology

Environmental Issues

Learning Objectives

Learning objectives

The learner will be able to,

- Understand the importance of growing more plants to mitigate the environmental problems.
- Distinguish between the importance and conservation of endemic and endangered species.
- Appreciate the use of technologies for agriculture and forestry.
- Participate in community activities to improve environmental conditions.
- Develop methods in conservation of water and plants for sustainable development.
- Get acquainted with satellite technology and utilising it in our daily life needs

Chapter outline

8.1 Green house effect, ozone depletion
8.2 Forestry
8.3 Deforestation
8.4 Afforestation
8.5 Alien invasive species
8.6 Conservation
8.7 Carbon Capture and Storage (CCS)
8.8 Rain water harvesting
8.9 Environmental Impact Assessment (EIA)
8.10 Geographic Information System

MZIKNH

After understanding the structure and functions of major ecosystems of the world, now student community should observe and understand environmental problems of their surroundings at local, national and international level.

Now we are going to understand some of the environmental issues such as

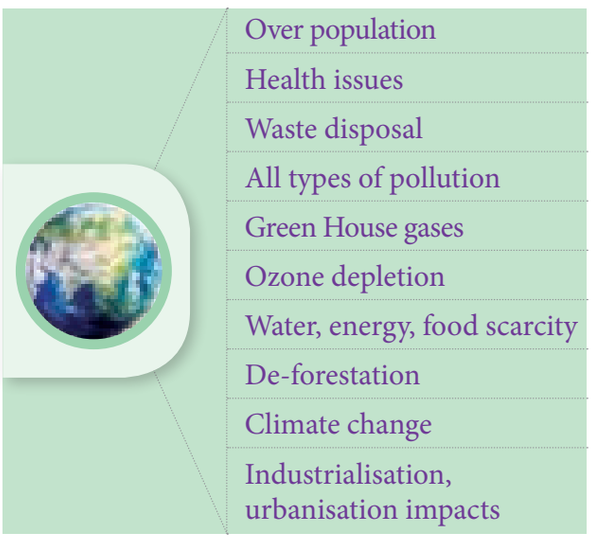


Figure 8.1: Environmental issues

Environmental issues are the problems and harmful effects created by human's unmindful activity and over utilisation of valuable resources obtained from the nature (environment). Student should understand not only the environmental issues we are facing now, but also find solutions to rectify or reduce these problems.

- Determination of land cover and land use
- Estimation of flood damage
- Management of natural resources
- Soil mapping
- Wetland mapping
- Irrigation management and identification of volcanic hazard
- Vegetation studies and mapping of threatened and endemic species.

Remote Sensing is the process of detecting and monitoring the physical characteristics of an area by measuring its reflected and emitted radiation at a distance from the targeted area. It is an tool used in conservation practices by giving exact picture and data on identification of even a single tree to large area of vegetation and wild life for classification of land use patterns and studies, identification of biodiversity rich or less areas for futuristic works on conservation and maintenance of various species including commercial crop, medicinal plants and threatened plants.

Specific uses

- Helps predicting favourable climate, for the study of spreading of disease and controlling it.
- Mapping of forest fire and species distribution.
- Tracking the patterns of urban area development and the changes in Farmland or forests over several years
- Mapping ocean bottom and its resources

Applications of Satellites

Name of the Satellites	Year of Launch	Application
SCATSAT – I	Sep. 2016	Weather forecasting, cyclone prediction and tracking services in India
INSAT 3DR	Sep. 2016	Disaster management
CARTOSAT – 2	Jan. 2018	Earth observation
GSAT – 6A	March 2018	Communication
CARTOSAT – 2 (100^{th} Satellite)	Jan. 2018	To watch border surveillance

Summary

Green house effect leads to climate change which results in global warming. Deforestation causes soil erosion, whereas Afforestation helps to restore vegetation and increases ground water table. Regeneration of trees by Agroforestry is possible with the involvement of community and government. Help to conserve the flora and fauna in their natural habitat and man-made environments like zoological parks and national parks. Mitigation of carbon in the atmosphere done in the form of sequestration. Rain water harvesting is done for improving the ground water table. Importance and location of lakes in Tamil Nadu which aids water supply to the city is a measure of conservation of drinking water. Assessment of Environment and Biodiversity helps to study risk analysis and disaster management. Forest cover is monitored through Remote sensing and GIS.

Evaluation

PPD4S5

1. Which of the following would most likely help to slow down the greenhouse effect.
   a) Converting tropical forests into grazing land for cattle.
   b) Ensuring that all excess paper packaging is buried to ashes.
   c) Redesigning landfill dumps to allow methane to be collected.
   d) Promoting the use of private rather than public transport.

2. With respect to *Eichhornia*
   Statement A: It drains off oxygen from water and is seen growing in standing water.
   Statement B: It is an indigenous species of our country.
   a) Statement A is correct and Statement B is wrong.
   b) Both Statements A and B are correct.
   c) Statement A is correct and Statement B is wrong.
   d) Both statements A and B are wrong.

3. Find the wrongly matched pair.
   a) Endemism - Species confined to a region and not found anywhere else.
   b) Hotspots - Western ghats
   c) Ex-situ Conservation - Zoological parks
   d) Sacred groves - Saintri hills of Rajasthan
   e) Alien sp. Of India - Water hyacinth

4. Depletion of which gas in the atmosphere can lead to an increased incidence of skin cancer?
   a) Ammonia b) Methane
   c) Nitrous oxide d) Ozone

5. One green house gas contributes 14% of total global warming and another contributes 6%. These are respectively identified as
   a) N_20 and CO_2 b) CFCs and N_20
   c) CH_4 and CO_2 d) CH_4 and CFCS

6. One of the chief reasons among the following for the depletion in the number of species making endangered is
   a) over hunting and poaching
   b) green house effect
   c) competition and predation
   d) habitat destruction

7. Deforestation means
   a) growing plants and trees in an area where there is no forest
   b) growing plants and trees in an area where the forest is removed
   c) growing plants and trees in a pond
   d) removal of plants and trees

8. Deforestation does not lead to
   a) Quick nutrient cycling
   b) soil erosion
   c) alternation of local weather conditions
   d) Destruction of natural habitat weather conditions

9. The unit for measuring ozone thickness
   a) Joule b) Kilos
   c) Dobson d) Watt

10. People's movement for the protection of environment in Sirsi of Karnataka is
    a) Chipko movement
    b) Amirtha Devi Bishwas movement
    c) Appiko movement
    d) None of the above

11. The plants which are grown in silivpasture system are
    a) Sesbania and Acacia
    b) Solenum and Crotalaria
    c) Clitoria and Begonia
    d) Teak and sandal

12. What is ozone hole?

13. Give four examples of plants cultivated in commercial agroforestry.

14. Expand CCS.

15. How do forests help in maintaining the climate?

16. How do sacred groves help in the conservation of biodiversity?

17. Which one gas is most abundant out of the four commonest greenhouse gases? Discuss the effect of this gas on the growth of plants?

18. Suggest a solution to water crisis and explain its advantages.

19. Explain afforestation with case studies.

20. What are the effects of deforestation and benefits of agroforesty?

Glossary

Algae Blooms: Sudden sprout of algae growth, which can affect the water quality adversely and indicate potentially hazardous changes in local water chemistry.

Atmosphere: A major regional community of plants and animals with similar life forms and environmental conditions.

Chapter

9

Unit X: Economic Botany

Plant Breeding

Learning Objectives

The learner will be able to

- Appreciate the relationship between humans and plants.
- Recognise the origin of agriculture.
- Perceive the importance of organic agriculture.
- Understand the different conventional methods of plant breeding.

Chapter outline

9.1 Relationship between human and plants

9.2 Domestication of plants

9.3 Origin of agriculture

9.4 History of agriculture

9.5 Organic agriculture

9.6 Plant breeding

9.7 Conventional plant breeding methods

9.8 Modern plant breeding Techniques

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Economic botany is the study of the relationship between people and economically important plants. It explores the ways by which humans use plants for food, medicines and other uses. Economic botany intersects many fields including established disciplines such as agronomy, anthropology, archaeology, chemistry, trade and commerce.

9.1 Relationship between humans and plants

From the very early times, human beings have co-existed with plants which played a vital role in their survival. Through a long process of trial and error, our ancestors have selected hundreds of wild plants from the various parts of the world for their specific use. The knowledge of the plants and its applications have led to the development of the humans and their civilization in many ways.

9.2 Domestication of plants

Domestication is the process of bringing a plant species under the control of humans and gradually changing it through careful selection, genetic alteration and handling so that it is more useful to people. The domesticated species are renewable sources that have provided food and other benefits to human.

The possible changes in the plant species due to domestication are listed below;

- Adaptation to a greater diversity of environments and a wider geographical range.
- Simultaneous /uniform flowering and fruiting.
- Lack of shattering or scattering of seeds.

Resistance to yellow mosaic virus in bhindi *(Abelmoschus escullentus)* was transferred from a wild species and resulted in a new variety of *A. Escullentus* called Parbharni kranti.

Plant Breeding for Developing Resistance to Insect Pests

Insect resistance in host crop plants may be due to morphological, biochemical or physiological characteristics. Hairy leaves in several plants are associated with resistance to insect pests. Example: resistance to jassids in cotton and cereal leaf beetle in wheat. In wheat, solid stems lead to non-preference by the stem sawfly and smooth leaves and nectar-less cotton varieties do not attract bollworms. High aspartic acid, low nitrogen and sugar content in maize leads to resistance to maize stem borers.

Crop	Variety	Insect pests
Brassica (rapeseed mustard)	Pusa Gaurav	Aphids
Flat been	Pusa Sem 2 Pusa Sem 3	Jassids, aphids and fruit borer
Okra (Bhindi)	Pusa Sawani Pusa A-4	Shoot and Fruit borer

Table 9.2 Pest resistance varieties

9.8 Modern Plant Breeding

In the milestones of plant breeding methods Genetic Engineering, Plant tissue culture, Protoplasmic fusion or somatic hybridisation, Molecular marking and DNA finger printing are some of the modern plant breeding tools used to improve the crop varieties. We have already discussed about the various techniques and application of the above mentioned concepts in Unit VIII.

New Plant Engineering Techniques / New Breeding Techniques (NBT)

NBT are a collection of methods that could increase and accelerate the development of new traits in plant breeding. These techniques often involve genome editing, to modify DNA at specific locations **within the plants** to produce new traits in crop plants. The various methods of achieving these changes in traits include the following.

- Cutting and modifying the genome during the repair process by tools like CRISPR /Cas.
- Genome editing to introduce changes in few base pairs using a technique called Oligonucleotide-directed mutagenesis (ODM).
- Transferring a gene from an identical or closely related species (cisgenesis)
- Organising processes that alter gene activity without altering the DNA itself (epigenetic methods).

Summary

Economic Botany deals with the relationship between people and economically important plants to fulfill the three basic needs of life such as food, clothing and shelter. Domestication, a term often used for a more intricate process, involves the genetic alteration of plants which did not appear at once, but rather over a substantial period of time, perhaps hundreds of years for some species. In the history of agriculture Vavilov has given the eight main centres of origin of plants were now divided into 12 centres of origin. In Organic agriculture biofertilizers are microbial inoculants which all ecofriendly, more effective even though cost effective than chemical fertilizers. *Rhizobium, Azolla,* VAM and sea weeds are used as fertilizers which increase the crop yield many fold.

Plant breeding is a purposeful manipulation of plant species in order to create desirable genotype and phenotype for the benefit of mankind. Plant introduction, selection, hybridization, heterosis, mutation breeding, polyploidy breeding and green revolution are the different methods of conventional breeding.

Evaluation

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1. **Assertion:** Genetic variation provides the raw material for selection

   Reason: Genetic variations are differences in genotypes of the individuals.

   a) Assertion is right and reason is wrong.
   b) Assertion is wrong and reason is right.
   c) Both reason and assertion is right.
   d) Both reason and assertion is wrong.

2. While studying the history of domestication of various cultivated plants _____ were recognized earlier
   a) Centres of origin
   b) Centres of domestication
   c) Centres of hybrid
   d) Centres of variation

3. Pick out the odd pair.
   a) Mass selection - Morphological characters
   b) Purline selection - Repeated self pollination
   c) Clonal selection - Sexually propagated
   d) Natural selection - Involves nature

4. Match Column I with Column II

Column I	Column II
i) William S. Gaud	I) Heterosis
ii) Shull	II) Mutation breeding
iii) Cotton Mather	III) Green revolution
iv) Muller and Stadler	IV) Natural hybridization

   a) i – I, ii – II, iii – III, iv – IV
   b) i – III, ii – I, iii – IV, iv – II
   c) i – IV, ii – II, iii – I, iv – IV
   d) i – II, ii – IV, iii – III, iv – I

5. The quickest method of plant breeding is
   a) Introduction b) Selection
   c) Hybridization d) Mutation breeding

6. Desired improved variety of economically useful crops are raised by
   a) Natural Selection b) hybridization
   c) mutation d) biofertilisers

7. Plants having similar genotypes produced by plant breeding are called
   a) clone b) haploid
   c) autopolyploid d) genome

8. Importing better varieties and plants from outside and acclimatising them to local environment is called
   a) cloning b) heterosis
   c) selection d) introduction

9. Dwarfing gene of wheat is
   a) pal 1 b) Atomita 1
   c) Norin 10 d) pelita 2

10. Crosses between the plants of the same variety are called
    a) interspecific b) inter varietal
    c) intra varietal d) inter generic

11. Progeny obtained as a result of repeat self pollination a cross pollinated crop to called
    a) pure line b) pedigree line
    c) inbreed line d) heterosis

12. Jaya and Ratna are the semi dwarf varieties of
    a) wheat b) rice
    c) cowpea d) mustard

13. Which one of the following are the species that are crossed to give sugarcane varieties with high sugar, high yield, thick stems and ability to grow in the sugarcane belt of North India?
    a) *Saccharum robustum* and *Saccharum officinarum*
    b) *Saccharum barberi* and *Saccharum officinarum*
    c) *Saccharum sinense* and *Saccharum officinarum*
    d) *Saccharum barberi* and *Saccharum robustum*

14. Match column I (crop) with column II (Corresponding disease resistant variety) and select the correct option from the given codes.

Column I	Column II
I) Cowpea	i) Himgiri
II) Wheat	ii) Pusa komal
III) Chilli	iii) Pusa Sadabahar
IV) Brassica	iv) Pusa Swarnim

	I	II	III	IV
a)	iv	iii	ii	i
b)	ii	i	iii	iv
c)	ii	iv	i	iii
d)	i	iii	iv	ii

Chapter

10

Unit X: Economic Botany

Economically Useful Plants and Entrepreneurial Botany

Learning Objectives

The learner will be able to

- Acquire knowledge about origin, area of cultivation and uses of various food yielding plants.
- Describe the different spices and condiments and their uses.
- Elicit the uses of fibre, timbers, paper and dye yielding plants.
- Acquire knowledge about the active principles, chemical composition and medicinal uses of plants.
- Gains knowledge of organic farming- bio fertilisers and bio pest repellants.

Chapter outline

10.1 Food Plants
10.2 Spices and Condiments
10.3 Fibre
10.4 Timber
10.5 Latex
10.6 Pulp wood
10.7 Dye
10.8 Cosmetics
10.9 Traditional system of medicines
10.10 Medicinal plants
10.11 Entrepreneurial Botany

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The land and water of the earth sustain a vast assemblage of plants upon which all other living forms are directly or indirectly dependent. Pre-historic humans lived on berries, tubers, herbage, and the wild game which they collected and hunted that occupied whole of their time. Domestication of plants and animals has led to the production of surplus food which formed the basis for civilizations. Early civilization in different parts of the world has domesticated different species of plants for various purposes. Based on their utility, the economically useful plants are classified into food plants, fodder plants, fibre plants, timber plants, medicinal plants, and plants used in paper industries, dyes and cosmetics. Selected examples of economically important plants for each category are discussed in this chapter.

10.1 Food plants

Currently about 10,000 food plants are being used of which only around 1,500 species were brought under cultivation. However, food base of majority of the population depends only on three grass species namely rice, wheat and maize.

10.1.1 Cereals

The word cereal is derived from Ceres, which according to the Roman mythology denotes "Goddess of agriculture". All cereals are members of grass family (Poaceae) that are grown for their edible starchy seeds. The prominence of cereals as food plants is due to the following attributes:

Preparation of Organic Pesticide

Mix 120g of hot chillies with 110 g of garlic or onion. Chop them thoroughly. 1

Blend the vegetables together manually or using an electric grinder until it forms a thick paste. 2

Add the vegetable paste to 500 ml of warm water. Give the ingredients a stir to thoroughly mix them together. 3

Pour the solution into a glass container and leave it undisturbed for 24 hours. If possible, keep the container in a sunny location. If not, at least keep the mixture in a warm place. 4

Strain the mixture. Pour the solution through a strainer, remove the vegetables and collect the vegetable-infused water and pour into another container. This filtrate is the pesticide. Either discard the vegetables or use it as a compost. 5

Pour the pesticide into a squirt bottle. Make sure that the spray bottle has first been cleaned with warm water and soap to get rid it of any potential contaminants. Use a funnel to transfer the liquid into the squirt bottle and replace the nozzle. 6

Spray your plants with the pesticide. Treat the infected plants every 4 to 5 days with the solution. After 3 or 4 treatments, the pest will be eliminated. If the area is thoroughly covered with the solution, this pesticide should keep bugs away for the rest of the season. 7

Avoid spraying the plants during the sunny times of the day since it could burn plants. Many other plants possess insect repellent or insecticidal properties. Combinations of these plants can be fermented and used as biopesticide.

Figure 10.20: Preparation of organic pesticide

the plants, add 100 ml of cooking oil and the same amount of soap water. (The role of the soap water is to break down the oil, and the role of the oil is to make it stick to the leaves).

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- The stewed leaves from the mixture can be used in the compost heap or around the base of the plants.

Summary

Early civilization in different parts of the world has domesticated different species of plants for various purposes. Based on their utility, the economically useful plants are classified into food plants, fibre plants, timber plants, medicinal plants, and plants used in paper industries, dyes and cosmetics.

However, food base of majority of the population depends on very few Cereals, Millets, Pulses, Vegetables, Fruits, Nuts, Sugars, Oil seeds, Beverages, Spices and Condiments.

Oils can be classified into two types namely, essential oils and vegetable oils. Fatty acids in oil may be saturated or unsaturated. The oil yielding plants are groundnut and sesame. The oils are used in cooking, making soaps and other purposes. Beverages contain alkaloids that stimulate central nervous

system. Spices were used throughout the world for several years. Cardamom is 'Queen of Spices' used for flavouring confectionaries and beverages. Black pepper is King of Spices.

Botanically a fibre is a long, narrow, thick walled cell. Cotton and Jute are fibre yielding plants. Teak is wood used for making furniture. Rubber is produced from the latex of Hevea brasiliensis. Paper production is a Chinese invention. Dyes have been used since ancient times. The orange dye henna is from the leaves of Lawsonia. Perfumes are volatile and aromatic in nature, manufactured from essential oils which are found at different parts of the plant. Medicinal plants serve as therapeutic agents. Medicinally useful molecules obtained from these plants are marketed as drugs are called Biomedicines. Whereas phytochemicals from some of the plants which alter an individual's perceptions of mind by producing hallucination are known as psychoactive drugs.

Entrepreneurial Botany is the study of how new businesses are created using plant resources as well as the actual process of starting a new business.

Evaluation

1. Consider the following statements and choose the right option.
   i) Cereals are members of grass family.
   ii) Most of the food grains come from monocotyledon.
   a) (i) is correct and (ii) is wrong
   b) Both (i) and (ii) are correct
   c) (i) is wrong and (ii) is correct
   d) Both (i) and (ii) are wrong
2. Assertion: Vegetables are important part of healthy eating.
   Reason: Vegetables are succulent structures of plants with pleasant aroma and flavours.
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   a) Assertion is correct, Reason is wrong
   b) Assertion is wrong, Reason is correct
   c) Both are correct and reason is the correct explanation for assertion.
   d) Both are correct and reason is not the correct explanation for assertion.
3. Groundnut is native of _____
   a) Philippines b) India
   c) North America d) Brazil
4. Statement A: Coffee contains caffeine
   Statement B: Drinking coffee enhances cancer
   a) A is correct, B is wrong
   b) A and B – Both are correct
   c) A is wrong, B is correct
   d) A and B – Both are wrong
5. *Tectona grandis* is coming under family
   a) Lamiaceae b) Fabaceae
   c) Dipterocaipaceae e) Ebenaceae
6. *Tamarindus indica* is indigenous to
   a) Tropical African region
   b) South India, Sri Lanka
   c) South America, Greece
   d) India alone
7. New world species of cotton
   a) Gossipium arboretum
   b) G.herbaceum
   c) Both a and b
   d) G.barbadense
8. Assertion: Turmeric fights various kinds of cancer
   Reason: Curcumin is an anti-oxidant present in turmeric
   a) Assertion is correct, Reason is wrong
   b) Assertion is wrong, Reason is correct
   c) Both are correct
   d) Both are wrong
9. Find out the correctly matched pair.
   a) Rubber *Shorea robusta*
   b) Dye *Lawsonia inermis*
   c) Timber *Cyperus papyrus*
   d) Pulp *Hevea brasiliensis*
10. Observe the following statements and pick out the right option from the following:
    Statement I – Perfumes are manufactured from essential oils.
    Statement II – Essential oils are formed at