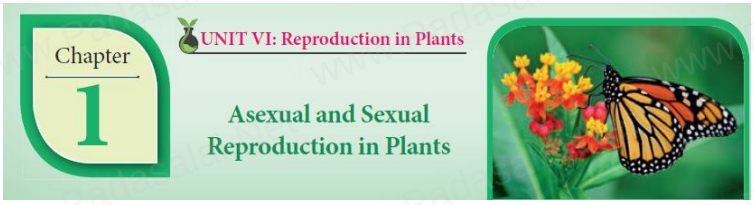
Do You Know Boxes



1.

Scourge of water bodies / Water hyacinth (*Eichhornia crassipes*) is an invasive weed on water bodies like ponds, lakes and reservoirs. It is popularly called "Terror of Bengal". It spreads rapidly through offset all over the water body and depletes the dissolved oxygen and causes death of other aquatic organisms.

2.

Many botanists speak of a third type of tapetum called amoeboid, where the cell wall is not lost. The cells protrude into the anther cavity through an amoeboid movement. This type is often associated with male sterility and should not be confused with periplasmodial type.

3.

Palynology is the study of pollen grains.It helps to identify the distribution of coal and to locate oil fields. Pollen grains reflect the vegetation of an area.

Liquid nitrogen (-196^{0}C) is used to preserve pollen in viable condition for prolonged duration. This technique is called **cryopreservation** and is used to store pollen grains (pollen banks) of economically important crops for breeding programmes..

4.

Bee pollen is a natural substance and contains high protein, carbohydrate, trace amount of minerals and vitamins. Therefore, it is used as dietary supplement and is sold as pollen tablets and syrups. Further , it increases the performance of athletes, race horses and also heals the wounds caused by burns . The study of honey pollen is called Mellitopalynology.

5.

Pollen calendar shows the production of pollen by plants during different seasons. This benefits the allergic persons. Pollen grains cause allergic reactions like asthma, bronchitis, hay fever, allergic rhinitis etc.,

Parthenium hysterophorus L. (Family-Asteraceae) is commonly called Carrot grass is a native of tropical America and was introduced into India as a contaminant along with cereal wheat. The pollen of this plant cause Allergy.

6.

Pollination – A composite event

Pollination provides information about evolution, ecology, animal learning and foraging behaviour. Flowers not only supply nectar but also provide microclimate, site and shelter for egg laying insects. The association of insects benefits the flower by getting pollinated and ensures the propagation of its own progeny. The floral parts are well modified in shape, size to attract the pollinators to accomplish pollination .

The relationship between *Yucca* and moth (*Tegeticula yuccasella*) is an example for obligate mutualism. The moth bores a hole in the ovary of the flower and lays eggs in it. Then it collects pollen and pushes it in the form of balls down the hollow end of the stigma. Fertilization takes place and seeds develop. Larvae feed on developing seeds. Some seeds remain unconsumed for the propagation of the plant species. It is interesting that the moth cannot survive without *Yucca* flowers and the plant fails to reproduce sexually without the moth.

Bee Orchid

Similarly in *Amorphophallus*, flowers apart from providing floral rewards, also forms safe site for laying eggs. Many visitors consume pollen and nectar and do not help in pollination. They are called pollen / nectar robbers.

In Bee orchid (*Ophyrus*) the morphology of the flower mimics that of female wasp (*Colpa*). The male wasp mistakes the flowers for a female wasp and tries to copulate. This act of pseudocopulation helps in polli nation.

The pollination in Fig (*Ficus carica*) by the Wasp (*Blastophaga psenes*) is also an example for similar Plant – insect interaction.

7.

Obturator may originate from different regions of the ovule (Placenta – Euphorbiaceae, Funiculus-Anacardiaceae, Style–*Thymelaeaceae* and Ovary wall – *Ottelia alismoides*)

8.

Aleurone tissue consists of highly specialised cells of one or few layers which are found around the endosperm of cereals (barley and maize). Aleurone grain contains sphaerosomes. During seed germination cells secrete certain hydrolytic enzymes like amylases, proteases which digest reserved food material present in the endosperm cells.

9.

Coconut milk is a basic nutrient medium which induces the differentiation of embryo (embryoids) and plantlets from various plant tissues. Coconut water from tender coconut is free-nuclear endosperm and white kernel part is cellular.

10.

Fresh weight of an orchid seed may be 20.33 microgram and that of double coconut (*Lodoicea maldivica*) is about 6 kg.

Chapter 2

UNIT VII: Genetics

Classical Genetics

In Chapter-2 there is no do you know boxes

Chapter 3

UNIT VII: Genetics

Chromosomal Basis of Inheritance

1. DO YOU KNOW?

Fossil Genes: Some of the junk DNA is made up of pseudo genes, the sequences presence in that was once working genes. They lost their ability to make proteins. They tell the story of evolution through fossilized parts.

2. DO YOU KNOW?

Does environment play a role on sex determination in plants?

Yes. Horsetail plant (***Equisetum***) grown under good conditions develop as female and those grown under stress condition develop into males.

3. DO YOU KNOW?

Plants are sessile. How do they protect themselves from the exposure of sunlight throughout the day?

Plants have effective DNA repair mechanism to prevent UV damage from sunlight. They produce an enzyme called photolyase, which can repair the thymine dimers and restore the structure of DNA.

4. DO YOU KNOW?

Internal methylation

Apart from capping, the internal nucleotides in mRNA are also methylated. Methylated sites are present in translated, untranslated regions, introns and exons.

Chapter 4

UNIT VIII: Biotechnology

Principles and Processes of Biotechnology

1. DO YOU KNOW?

Barcode: You might have seen in all books barcoding and also in items you buy in supermarket. This will reveal the identity of the book or item as well the details like prize. Similarily, Barcode in genetic term refer to the identify of the taxon based on its genetic makeup. In practice, it is an optical, machine-readable representation of data which describes about the characters of any plants or any objects.

Chapter 5

UNIT VIII: Biotechnology

Plant Tissue Culture

In Chapter-5 there is no do you know boxes

Chapter 6

UNIT IX: Plant Ecology

Principles of Ecology

1. **Applied ecology or environmental technology :** Application of the Science of ecology is otherwise called as **Applied ecology or Environmental technology.** It helps us to manage and conserve natural resources, particularly ecosystems, forest and wild life conservative and management. Environmental management involves Bio-diversity conservation, Ecosystem restoration, Habitat management, Invasive species management, Protected areas management and also help us plan landscapes and environmental impact designing for the futuristic ecology.

2. Flowers of poppy, chicory, dog rose and many other plants, blossom before the break of dawn (4 – 5 am), evening primrose open up with the onset of dusk (5 – 6 pm) due to diurnal rhythm.

3. **Palaeoclimatology**–Helps to reconstruct past climates of our planet and flora, fauna and ecosystem in which they lived. Example: Air bubbles trapped in ice for tens of thousands of years with fossilized pollen, coral, plant and animal debris.

4. **Evergreen forests** – Found where heavy rainfall occurs throughout the year.

Sclerophyllous forests – Found where heavy rainfall occurs during winter and low rainfall during summer.

6. **Proto Cooperation**

An interaction between organisms of different species in which both organisms benefit but neither is dependent on the relationship. Example: Soil bacteria / fungi and plants growing in the soil.

5. **Green House Effect**
Albedo Effect

Gases let out to atmosphere causes climatic change. Emission of dust and aerosols (small solids or liquid particles in suspension in the atmosphere) from industries, automobiles, forest fire, So_2 and DMS (dimethyl sulphur) play an important role in disturbing the temperature level of any region. Aerosols with small particles is reflecting the solar radiation entering the atmosphere. This is known as **Albedo effect**. So it reduces the temperature (cooling) limits, photosynthesis and respiration. The sulphur compounds are responsible for **acid rain** due to acidification of rain water and destroy the ozone.

7. **Kairomone** released from *Pieris rapae* caterpillar exposed to wild Radish gets the capacity to transmit defence induced by predator to progeny of wild radish. Transmission capacity of defence induced by predator to progeny of wild radish.

8. Out of three districts of Tamil Nadu (Nagapattinam, Thanjavur and Thiruvarur), Muthupet (Thiruvarur district) was less damaged by Gaja cyclone (November 2018) due to the presence of mangrove forest.

Chapter 7

UNIT IX: Plant Ecology

Ecosystem

1.

Types of Carbon

Green carbon – carbon stored in the biosphere (by the process of photosynthesis).

Grey carbon – carbon stored in fossil fuel (coal, oil and biogas deposits in the lithosphere).

Blue carbon – carbon stored in the atmosphere and oceans.

Brown carbon – carbon stored in industrialized forests (wood used in making commercial articles)

Black carbon – carbon emitted from gas, diesel engine and coal fired power plants.

2.

Limnology

It is the study of biological, chemical, physical and geological components of inland fresh water aquatic ecosystems (ponds, lakes, etc.).

Oceanography – It is the study of biological, chemical, physical and geological components of ocean.

3.

Sea grasses and mangroves of Estuarine and coastal ecosystems are the most efficient in carbon sequestration. Hence, these ecosystems are called as " **Blue carbon ecosystems**". They are not properly utilized and maintained all over the world although they have rich bioresources potential.

4.

Robert Constanza and his colleagues estimated the value of global ecosystem services based on various parameters. According to them in 1997, the average global value of ecosystems services estimated was US $ 33 trillion a year. The updated estimate for the total global ecosystem services in 2011 is US $ 125 trillion / year, indicating a four-fold increase in ecosystem services from 1997 to 2011.

5.

Ecosystem resilience

Ecosystem is damaged by disturbances from fire, flood, predation, infection, drought, etc., removing a great amount of biomasss. However, ecosystem is endowed with the ability to resist the damage and recover quickly. This ability of ecosystem is called ecosystem resilience or ecosystem robustness.

6.

Go green

It refers to the changing of one's lifestyle for the safety and benefits of the environments (Reduce, Reuse, Recycle)

Way to go green and save green

- Close the tap when not in use.
- Switch off the electrical gadgets when not in use.
- Never use plastics and replace them with biodegradable products
- Always use ecofriendly technology and products.

"USE ECOSYSTEM BUT DON'T LOSE ECOSYSTEM; MAKE IT SUSTAINABLE"

7.

"By 2025, at least 3.5 billion people, nearly 50% of the world's population are projected to face water scarcity." – IUCN.

"Forests house approximately 50% of global bio-diversity and at least 300 million people are dependent on forest's goods and services to sustain their livelihood." – IUCN

8.

Grasslands created and maintained by human are called anthropogenic grasslands.

9.

Existence of two climax communities under the influence of same climatic conditions are found in higher mountain hill tops, above 7000 feet MSL (Mean sea level) of Nilgiris. Example: Sholas and grasslands.

Chapter 8

Unit IX - Plant Ecology

Environmental Issues

1. DO YOU KNOW?

Clouds and Dust particles can also produce Green House effect. That is why clouds, dusts and humid nights are warmer than clear dust free dry nights.

2. DO YOU KNOW?

- Nitrates from fertilizers interact with the haemoglobin to form methyl haemoglobin. This reduces oxygen uptake, results in Blue baby syndrome (cyanosis) and hypoxia. Nitrates vasodilate and reduce blood pressure.
- **Bio-magnification:** Pollutants, toxic substances increase in water move from one food chain to many and finally reach human being and this process of bio-amplification or increase in concentration is called bio-magnification.

Chapter 9

Unit X: Economic Botany

Plant Breeding

1. DO YOU KNOW?

Indian Plant Breeders

a. **Dr. M. S. Swaminathan** – He is pioneer mutation breeder.

b. **Sir. T.S. Venkataraman** – An eminent sugarcane breeder.

c. **Dr. B.P. Pal** – Famous wheat breeder, developed superior disease resistant varieties of wheat.

d. **Dr. K. Ramiah** – Eminent rice breeder, developed several high yielding varieties of rice.

e. **N.G.P. Rao** – An eminent sorghum breeder, developed world's first hybrid of Sorghum (CSH-1).

f. **C.T. Patel** – Who developed world's first cotton hybrid.

g. **Choudhary Ram Dhan** – Wheat breeder, who is famous for C-591 variety of wheat, which is made Punjab as wheat granary of India.

2. DO YOU KNOW?

National Bureau of plant Genetic Resources (NBPGR) The Bureau is responsible for introduction and maintenance of germ plasm of various agricultural and horticultural station in our country. It is also responsible for maintenance of plant materials of botanical and medicinal interest. It is located at Rangpuri, New Delhi and has four regional plant quarantine stations at Amristsar, Kolkata, Mumbai and Chennai at Meenambakkam

3. DO YOU KNOW?

Gamma Garden or Atomic Garden: Is a form of mutation breeding where plants are exposed to radioactive sources typically cobalt-60 or caesium-137 in order to generate desirable mutation in crop plants. The first Gamma garden in India is Bose Research Institute at Calcutta in 1959 and the second is IARI in 1960 which produced large variation in short type.

4. DO YOU KNOW?

NORIN 10 – The cultivars found that Norin 10 dwarfing genes have high photosynthetic rate per unit leaf area and increase respiratory activity. Gonjiro Inazuka selected the semi-dwarf wheat variety that became Norin 10. He would have never thought that the semi dwarf genes would not only revolutionize the world of wheat but also helped to save more than one billion lives from hunger and starvation.

5. DO YOU KNOW?

Nanotechnology in Agriculture:
Currently nanotechnology provides different nano devices and nano material that have a unique role in agriculture. For example Nano biosensors to detect moisture content and nutrient status in the soil. Nanotechnology can offer Nano-fertilizers for efficient nutrient management, Nano-herbicides for selective weed control in crop field, Nanonutrient particles to increase seed vigor, Nano-pesticides for efficient pest management. Hence, nanotechnology have greater role in crop production with environmental safety, ecological sustainability and economic stability.

Chapter 10

Unit X: Economic Botany

Economically Useful Plants and Entrepreneurial Botany

1.

International Rice Research Institute (IRRI)

DO YOU KNOW?

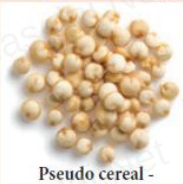
International Rice Research Institute (IRRI) is located in Los Banos, Manila the capital city of Philippines. This is the only institute in the world which exclusively carries out research as on rice. IRRI aims to improve livelihoods and nutrition, abolishing poverty, hunger, and malnutrition. Whatever IR rice varieties available in the world are developed through rice breeding programme and released by IRRI. Till date IRRI has produced 843 rice varieties that have been released in 77 countries. IR8 is a high-yielding semi-dwarf rice variety developed by IRRI in the early 1960s and it is called as miracle rice, much celebrated for fighting famine. Another variety to mention is IR36 which is a semi-dwarf variety that proved highly resistant to a number of insect pests and diseases that raised farmers' rice yields and brought down the prices of the staple food in Asian families. The International Rice Gene bank of IRRI has a collection of more than 117 000 types of rice, comprising of modern and traditional varieties including wild relatives of Paddy.

2.

DO YOU KNOW?

PSEUDO-CEREAL

The term pseudo-cereal is used to describe foods that are prepared and eaten as a whole grain, but are botanical outliers from grasses. Example: **quinoa**. It is actually a seed from the *Chenopodium quinoa* plant belongs to the family Amaranthaceae. It is a gluten-free, whole-grain carbohydrate, as well as a whole protein (meaning it contains all nine essential amino acids) and have been eaten for 6,000 years in Andes hill region.



Pseudo cereal - Chenopodium quinoa

3.

Why do popcorn pops?

Endosperm in corn consists of two type namely soft and hard. In popcorn soft endosperm constitutes most part of the grain surrounded by thin layer of hard endosperm. When heated, the internal starch and protein are converted into gelatinous substances and when pressure mount further, the soft endosperm expands and explodes reversing the grain and the gelatinous starch are converted into foam, which readily solidifies outside and convert into crispy, tasty popcorn.

4.

DO YOU KNOW?

Capsaicin is responsible for the pungency or spicy taste of chillies. Pungency of Chillies is measured in Scoville Heat Units (SHU). World's hottest chilli, Carolina reaper pepper measures 2,200,000 SHU. Naga viper chilli is the hottest in India that measures 1,349,000 SHU. Commonly used cayenne pepper measures 30,000 to 50,000 SHU.

5.

DO YOU KNOW?

Sambar – The World Inside

When we see the bowl of sambar, we can see the world inside. Mustard, Cumin and Coriander from Mediterranean, pepper from Western Ghats of India, turmeric from Southern Asia, chilly from South America, onion from Afganisthan, tamarind from Tropical Africa, tomato from South America, potato from Peru and Bolivia, lady's-finger from Africa, and redgram from South India make the Sambar as a global dish.

6.

DO YOU KNOW?

Rubber – Vulcanization

Charles Goodyear invented vulcanization in 1839. He found that the defects in rubber articles could be overcome by heating rubber with sulphur under pressure at 150^0 C. The process was called vulcanization. The name was given from the Roman God of Fire, Vulcan. Because of this, solid rubber tyres were used for first time in 1867. That is why we smoothly travel on road.

7.

DO YOU KNOW?

Purified dissolving pulp is used as a basic material in the manufacture of rayon or artificial silk, fabrics, transparent films (cellophane, cellulose acetate films), plastics. The viscose process of making rayon is the most common process.

8.

DO YOU KNOW?

Champaran Satyagraha

Indigofera is a very important cash crop among plants cultivated in India during the British regime. Farmers were forced to cultivate *Indigofera* instead of food crops. Gandhi started satyagraha at Champaran, a village in Bihar in support of farmers. This was the first satyagraha in India by Gandhi. Government accepted 'champaran farmers bill'. Gandhi's first satyagraha in India achieved a great success.

9.

Madurai Malli

'Madurai Malli' is the pride of Madurai has a distinct reputation universally because of its uniqueness and has been given the Geographical Indications (GI) mark by the Geographical indication Registry of India. Madurai malli has thick petals with long stalk equal to that of petals and the distinct fragrance is due to the presence of chemicals such as jasmine and alpha terpineol. This makes it easy to distinguish Madurai Malli from other places. This is the second GI tag for Jasmine after 'Mysore Malli'.

10.

Patenting Of Turmeric

University of Mississippi medical center, USA was granted a patent for wound healing property of Turmeric in 1995. The patent was granted both for oral and topical applications and provides an exclusive right to sell and distribute. Since the use of turmeric to heal wounds is a common domain knowledge in India, the Government of India has decided to fight against the patent through the Indian Council for Scientific and Industrial Research (CSIR). CSIR collected documentary evidences from various literature to prove that the knowledge on wound healing property of turmeric existed in India for a long time and provided the evidences to the United States Patent and Trade mark Office (USPTO). Based on the evidences the patent was revoked by USPTO. Hence the traditional knowledge (TK) on turmeric was safeguarded from Bio piracy.

11.

Narcotics Control Bureau (NCB)

Drugs come in various forms and can be taken in numerous ways. Some are legal and others are not. Drug abuse and misuse can cause numerous health problems and in serious cases death can occur.

The Narcotics Control Bureau (NCB) is the nodal drug law enforcement and intelligence agency of India and is responsible for fighting drug trafficking and the abuse of illegal substances.

12.

National Medicinal Plants Board (NMPB)

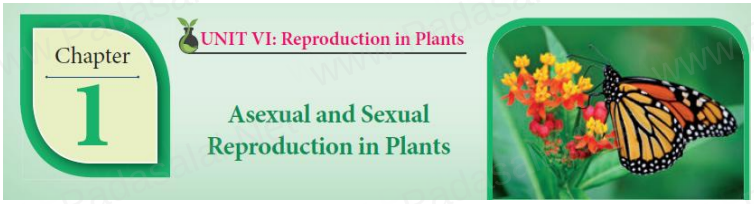
Government of India has set up National Medicinal Plants Board (NMPB) on 24th November 2000. Currently this board is working under AYUSH Government of India. Developing an apt mechanism for coordination of various ministries and implementation of policies for overall growth of medicinal plant sector both at central / state and international level is the primary mandate of NMPB. It focusses on in-situ and ex-situ conservation and enhancing local medicinal plants and aromatic species of medicinal significance to meet the growing demand.

13.

CSIR Aroma Mission of India

The Council of Scientific and Industrial Research (CSIR) has Catalyzing Rural Empowerment through Cultivation, Processing, Value Addition and Marketing of Aromatic Plants". This program has contributed significantly in the development, nurturing and positioning of essential oil-based aroma industry in the country. This has led to creation of an ecosystem benefitting the industry, farmers and next generation entrepreneurs. The activities are pursued in a synergistic mode with the organization in public and private set ups. This program has also paved way for developing entrepreneurship in different parts of the country through cultivation and commercial utilization of aromatic crops.

Box Item



1.

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.

2.

Parts before fertilization	Transformation after fertilization
Sepals, petals, stamens, style and stigma	Usually wither and fall off
Ovary	Fruit
Ovule	Seed
Egg	Zygote
Funicle	Stalk of the seed
Micropyle (ovule)	Micropyle of the seed(facilitates O_2 and water uptake)
Nucellus	Perisperm
Outer integument of ovule	Testa (outer seed coat)
Inner integument	Tegmen (inner seed coat)
Synergid cells	Degenerate
Secondary nucleus	Endosperm
Antipodal cells	Degenerate

3.

More to Know

- The receptacle becomes fleshy and edible around the fruit enclosing the seeds as in *Pyrus malus* (apple)
- The calyx may persist and enlarge (*Solanum melongena*) or may cover the fruit (*Physalis minima*)

Physalis - Persistent calyx

- The flower stalk or axis below the gynoecium enlarges into a juicy pear shaped body which is edible (*Anacardium occidentale*). The Perianth becomes fleshy as in Jack fruit.

Anacardium - pedicel (edible)

- The cells present at the tip of the outer integument around the micropyle develop into a fleshy structure called **caruncle**. (*Ricinus communis*).

Ricinus - Caruncle

- The funiculus develops into a fleshy structure which is often very colourful and called **aril**. (*Myristica and Pithecellobium*)

Aril

Myristica *Pithecellobium*

- The nucellar tissue is either absorbed completely by the developing embryo sac and embryo or small portion may remain as storage tissue. Thus the remnant of nucellar tissue in the seed is called **perisperm**. Example: Black pepper and beet root

1. 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.

2. Can you identify Mendel's gene for **regulating white colour** in peas? Let us find the **molecular answer** to understand the gene function. Now the **genetic mystery of Mendel's white flowers is solved.**

It is quite fascinating to trace the Mendel's genes. In 2010, the gene responsible for regulating flower colour in peas were identified by an international team of researchers. It was called **Pea Gene A** which encodes a **protein** that functions as a transcription factor which is responsible for the production of **anthocyanin pigment**. So the flowers are purple. Pea plants with white flowers do not have anthocyanin, even though they have the gene that encodes the enzyme involved in anthocyanin synthesis.

Figure 2.5: Purple flower of Pea with Pea Gene A and White flower of Pea

Researchers delivered normal copies of gene A into the cells of the petals of white flowers by the gene gun method. When Gene A entered in a small percentage of cells of white flowers it is expressed in those particular cells, accumulated anthocyanin pigments and became purple.

In white flowers the gene A sequence showed a single-nucleotide change that makes the transcription factor inactive. So the mutant form of gene A do not accumulate anthocyanin and hence they are white.

3. **Why Mendel's pea plants are tall and dwarf? Find out the molecular explanation.**

Molecular characterization of Mendel's gene for plant height.

The plant height is controlled by a single gene with two alleles. The reason for this difference in plant height is due to the following facts: (i) the cells of the pea plant have the ability to convert a precursor molecule of gibberellins into an active form (GA1) (ii) Tall pea plants have one allele (Le) that codes for a protein (functional enzyme) which functions normally in the gibberellin-synthesis pathway and catalyzes the formation of gibberellins (GA1). The allele is dominant even if it is two (Le Le) or single (Le le), it produces gibberellins and the pea plants are tall. Dwarf pea plants have two recessive alleles (le le) which code for non-functional protein, hence they are dwarf.

Gene for plant height in Peas

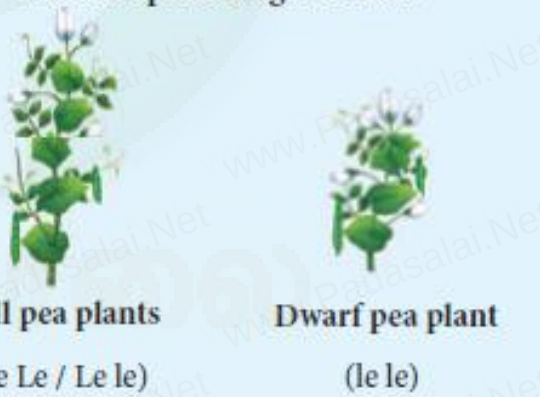
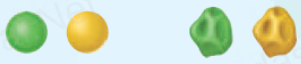


Figure 2.8: Gene for plant height in Peas

4. **How does the wrinkled gene make Mendel's peas wrinkled? Find out the molecular explanation.**

The protein called starch branching enzyme (SBEI) is encoded by the wild-type allele of the gene (RR) which is dominant. When the seed matures, this enzyme SBEI catalyzes the formation of highly branched starch molecules. Normal gene (R) has become interrupted by the insertion of extra piece of DNA (0.8 kb) into the gene, resulting in r allele. In the homozygous mutant form of the gene (rr) which is recessive, the activity of the enzyme SBEI is lost resulting in wrinkled peas. The wrinkled seed accumulates more sucrose and high water content. Hence the osmotic pressure inside the seed rises. As a result, the seed absorbs more water and when it matures it loses water as it dries. So it becomes wrinkled at maturation. When the seed has atleast one copy of normal dominant gene heterozygous, the dominant allele helps to synthesize starch, amylopectin an insoluble carbohydrate, with the osmotic balance which minimises the loss of water resulting in smooth structured round seed.

The wrinkled gene make Mendel's peas wrinkled



Round Peas & Wrinkled Peas

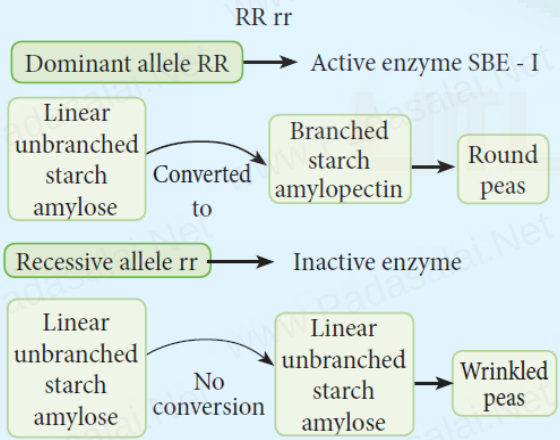


Figure 2.11: Molecular explanation of round and wrinkled peas.

5. **How are we going to interpret the lack of dominance and give explanation to the intermediate heterozygote phenotype?**

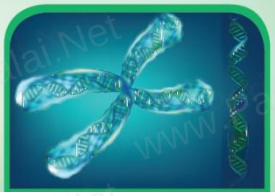
How will you explain incomplete dominance at the molecular level?

Gene expression is explained in a quantitative way. Wild-type allele which is a functional allele when present in two copies (R^1 R^1) produces an functional enzyme which synthesizes red pigments. The mutant allele which is a defective allele in two copies (R^2 R^2) produces an enzyme which cannot synthesize necessary red pigments. The white flower is due to the mutation causing complete loss of function. The F_1 intermediate phenotype heterozygote (R^1R^2) has one copy of the allele R^1. R^1 produces 50% of the functional protein resulting in half of the pigment of red flowered plant and so it is pink. The intermediate phenotype pink heterogyzote with 50% of functional protein is not enough to create the red phenotype homozygous, which makes 100% of the functional protein.

Chapter 3

UNIT VII: Genetics

Chromosomal Basis of Inheritance



1.

Mendelian factors	Chromosomes behaviour
1. Alleles of a factor occur in pair	Chromosomes occur in pairs
2. Similar or dissimilar alleles of a factor separate during the gamete formation	The homologous chromosomes separate during meiosis
3. Mendelian factors can assort independently	The paired chromosomes can separate independently during meiosis but the linked genes in the same chromosome normally do not assort independently.

2.

Organism	Number of chromosomes (2n)
Adder's tongue fern (*Ophioglossum*)	1262
Horsetail *(Equisetum)*	216
Giant sequoia	22
Arabidopsis	10
Sugarcane	80
Apple	34
Rice	24
Potato	48
Maize	20
Onion	16
Haplopappus gracilis	4

3.

Thomas Hunt Morgan (1933) received Nobel Prize in Physiology or Medicine for his discoveries concerning the role played by chromosomes in heredity.

4.

Name of organism	Linkage groups
Mucor	2
Drosophila	4
Sweet pea	7
Neurospora	7
Maize	10

5.

Linkage	Crossing over
1. The genes present on chromosome stay close together	It leads to separation of linked genes
2. It involves same chromosome of homologous chromosome	It involves exchange of segments between non-sister chromatids of homologous chromosome.
3. It reduces new gene combinations	It increases variability by forming new gene combinations. lead to formation of new organism

6.

Mustard gas (Dichloro ethyl sulphide) used as chemical weapon in world war I.

H J Muller (1928) first time used X rays to induce mutations in fruit fly.

L J Stadler reported induced mutations in plants by using X rays and gamma rays.

Chemical mutagenesis was first reported by C. Auerback (1944).

7.

Colchicine , an alkaloid is extracted from root and corms of ***Colchicum autumnale***, when applied in low concentration to the growing tips of the plants it will induce polyploidy. Surprisingly it does not affect the source plant *Colchicum*, due to presence of anticolchicine.

8.

DNA Polymerase β does not play any role in the replication of normal DNA. Function - Removing incorrect bases from damaged DNA. It is involved in Base excision repair.

Chapter 4

UNIT VIII: Biotechnology

Principles and Processes of Biotechnology

1. **PCR**: Polymerase Chain Reaction is a common laboratory technique used to make copies (millions) of a particular region of DNA.

2. **Walking Genes** - Gene walking involves the complete sequencing of large more than 1 kb stretches of DNA.

3. **Cosmid**

Cosmids are plasmids containing the 'cos' - Cohesive Terminus, the sequence having cohesive ends. They are hybrid vectors derived from plasmids having a fragment of lambda phage DNA with its Cos site and a bacterial plasmid.

4. **Bacteriophage Vectors**

Bacteriophages are viruses that infect bacteria. The most commonly used *E. coli* phages are l phage (Lambda phage) and M13 phage. Phage vectors are more efficient than plasmids - DNA upto 25 Kb can be inserted into phage vector.

Lambda genome: Lambda phage is a temperate bacteriophage that infects Escherichia coli. The genome of lambda-Phage is 48502 bp long, i.e. 49Kb and has 50 genes.

5. **Phagemid Vectors**

Phagemids are reconstructed plasmid vectors, which contain their own origin - 'ori' gene and also contain origin of replication from a phage. pBluescript SK (+/–) is an example of phagemid vector.

6. **Bacterial Artificial Chromosome (BAC) Vector**

BAC is a shuttle plasmid vector, created for cloning large-sized foreign DNA. BAC vector is one of the most useful cloning vector in r-DNA technology they can clone DNA inserts of upto 300 Kb and they are stable and more user-friendly.

7. **Yeast Artificial chromosome (YAC vector)**

YAC plasmid vector behaves like a yeast chromosome, which occurs in two forms, i.e. circular and linear. The circular YAC multiplies in Bacteria and linear YAC multiplies in Yeast Cells.

8. **Shuttle Vectors**

The shuttle vectors are plasmids designed to replicate in cells of two different species. These vectors are created by recombinant techniques. The shuttle vectors can propagate in one host and then move into another host without any extra manipulation. Most of the Eukaryotic vectors are Shuttle Vectors.

9. Agricultural diagnostics refers to a variety of tests that are used for detection of pathogens in plant tissues. Two of the most efficient methods are

1. ELISA (Enzyme Linked Immumo Sorbent Assay)

Elisa is a diagnostic tool for identification of pathogen species by using antibodies and diagnostic agents. Use of ELISA in plant pathology especially for weeding out virus infected plants from large scale planting is well known.

2. DNA Probes

DNA Probes, isotopic and non-isotopic (Northern and Southern blotting) are popular tools for identification of viruses and other pathogens

10. **Genome sequencing:** The location of genes on the entire diploid chromosome of an organism.

11. **Transfection**: Introduction of foreign nucleic acids into cells by non-viral methods.

12. **Transgenic plants** contain a novel DNA introduced into its genome.

Chapter 5

UNIT VIII: Biotechnology

Plant Tissue Culture

1. **Explant:** The tissue taken from a selected plant transferred to a culture medium often to establish a new plant.

2. **Agar:** A complex mucilaginous polysaccharide obtained from marine algae (sea weeds) used as solidifying agent in media preparation.

3. **Somaclonal variations:** Somatic variations found in plants regenerated in vitro (i.e. variations found in leaf, stem, root, tuber or propagule)
Gametoclonal variations: Gametophytic variations found in plants regenerated in vitro gametic origin (i.e. variations found in gametes and gametophytes)

Chapter 6

UNIT IX: Plant Ecology

Principles of Ecology

1. **Alexander von Humbolt** - Father of Ecology
Eugene P. Odum - Father of morden Ecology
R. Misra - Father of Indian Ecology

2. **Latitude:** Latitude is an angle which ranges from 0^0 at the equator to 90^0 at the poles.

Altitude: How high a place is located above the sea level is called the altitude of the place.

3. **Timber line / Tree line** : It is an imaginary line in a mountain or higher areas of land that marks the level above which trees do not grow. The altitudinal limit of normal tree growth is about **3000** to **4000m.**

4. **Indicators of fire** – *Pteris* (fern) and *Pyronema* (fungus) indicates the burnt up and fire disturbed areas. So they are called indicators of fire.

5. **Fire break** – It is a gap made in the vegetation that acts as a barrier to slow down or stop the progress of fire.

A **natural fire break** may occur when there is a lack of vegetation such as River, lake and canyon found in between vegetation may act as a natural fire break.

6. **Rhytidome:** It is the structural defense by plants against fire .The outer bark of trees which extends to the last formed periderm is called Rhytidome. It is composed of multiple layers of suberized periderm, cortical and phloem tissues. It protects the stem against fire , water loss, invasion of insects and prevents infections by microorganisms.

7. **Loamy soil is ideal soil for cultivation.** It consists of 70% sand and 30% clay or silt or both. It ensures good retention and proper drainage of water. The porosity of soil provides adequate aeration and allows the penetration of roots.

8.
1. **Halophytes:** Plants living in saline soils
2. **Psammophytes:** Plants living in sandy soils
3. **Lithophytes:** Plants living on rocky surface
4. **Chasmophytes**: Plants living in rocky crevices
5. **Cryptophytes**: Plants living below the soil surface
6. **Cryophytes**: Plants living in ice surface
7. **Oxylophytes**: Plants living in acidic soil
8. **Calciphytes**: Plants living in calcium rich alkaline soil.

9. **Hollard** –Total soil water content
Chresard –Water available to plants
Echard – Water not available to plants

10. **Ecotone** - The transition zone between two ecosystems. Example: The border between forest and grassland.

Edge effect – Those species are found in the ecotone areas are due to the effect of environment of the two habitats. This is called edge effect. Example: Owl in the ecotone area between forest and grassland.

11. Lotus seeds showing highest longevity in plant kingdom.

12. **Hygrophytes:** The plants which can grow in moist damp and shady places are called hygrophytes. Examples: *Habenaria* (Orchid), Mosses (Bryophytes), etc.

13 In Xerophytic plants with the leaves and stem are covered with hairs are called **trichophyllous plants** . Example: *Cucurbits* (*Melothria and Mukia*)

14. **Tropophytes** are plants which behave as xerophytes at summer and behave as mesophytes (or) hydrophytes during rainy season.

15.

Xerophytes

The plants which are living in dry or xericcondition are known as **Xerophytes**.

Mesophytes

The plants which are living in moderate conditions (neither too wet nor too dry) are known as **mesophytes**. These are common land plants. Example: Maize and *Hibiscus*.

Epiphytes

Epiphytes are plants which grow perched on other plants (Supporting plants). They use the supporting plants only as shelter and not for water or food supply. These epiphytes

Halophytes

There are special type of **Halophytic plants** which grow on soils with high concentration of salts. Examples: *Rhizophora, Sonneratia* and *Avicennia*.

16.

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

Chapter 7

UNIT IX: Plant Ecology

Ecosystem

1. **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

2. **Mangrove ecosystem services**

- Offers habitat and act as nursery for aquatic plants and animals
- Provides medicine, fuel wood and timber.
- Act as bridge between sea and rivers by balancing sedimentation and soil erosion.
- Help to reduce water force during cyclones, tsunamis and high tide periods.
- Help in wind break, O_2 production, carbon sequestration and prevents salt spray from waves.

3. **Urban ecosystem restoration model**

Adayar Poonga is located in Chennai and covers an area around a total of 358 acres of Adayar creek and estuary, of which 58 acres were taken up for eco restoration under the auspices of Government of Tamil Nadu. It is maintained by Chennai Rivers Restoration Trust (CRRT).This was a dumping site previously.

Presently it has 6 species of mangroves, about 170 species of littoral and tropical dry evergreen forests (TDF) which have successfully established as a sustainable ecosystem. Restoration of plants species has brought other associated fauna such as butterflies, birds, reptiles, amphibians and other mammals of the ecosystem.

Currently Adayar Poonga functions as an environmental education Centre for school and college students and the public. The entire area stands as one of the best examples for urban eco restoration in the state of Tamil Nadu.

Chapter 8

Unit IX - Plant Ecology

Environmental Issues

1. **Global Warming Effects on Plants**
   - Low agricultural productivity in tropics
   - Frequent heat waves (Weeds, pests, fungi need warmer temperature)
   - Increase of vectors and epidemics
   - Strong storms and intense flood damage
   - Water crisis and decreased irrigation
   - Change in flowering seasons and pollinators
   - Change in Species distributional ranges
   - Species extinction

2. Ozone is a colourless gas, reacts readily with air pollutants and cause rubber to crack, hurt plant life, damages lung tissues. But ozone absorbs harmful ultra violet β (uv-β) and UV – α radiation from sunlight.

   What is Dobson Unit? DU is the unit of measurement for total ozone. One DU (0.001 atm. cm) is the number of molecules of ozone that would be required to create a layer of pure ozone 0.01 millimetre thick at a temperature of 0° C and a pressure of 1 atmosphere (atm = the air pressure at the surface of earth). Total ozone layer over the earth surface is 0.3 centrimetres (3 mm) thick and is written as 300 DU.

   The false colour view of total ozone - The purple and blue colours are where there is the least ozone, and the yellows and reds are where there is more ozone.

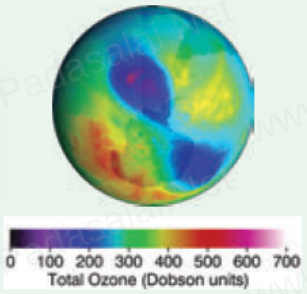


Figure 8.3: The false colour view of total ozone

3. September 16 is WORLD OZONE DAY

4.

	Plants	Indicator for
1	*Lichens, Ficus, Pinus,* Rose	SO_2 pollution
2.	*Petunia, Chrysanthemum*	Nitrate
3.	*Gladiolus*	Flouride pollution
4.	*Robinia pseudoacacia (Black locust tree)*	Indicator of heavy metal contamination

5.

Endemic plants	Habit	Name of endemic centre
Baccaurea courtallensis	Tree	Southern Western Ghats
Agasthiyamalaia pauciflora	Tree	Peninsular india
Hardwickia binata	Tree	Peninsular and northern India
Bentinckia condappana	Tree	Western ghats of Tamil Nadu and kerala
Nepenthes khasiyana	Liana	Khasi hills, Meghalaya

6. **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

7. **The Man who Single Handedly Created a Dense Forest**

Jadav "Molai" Payeng (born 1963) is an environmental activist has single-handedly planted a forest in the middle of a barren wasteland. This Forest Man of India has transformed the world's largest river island, Majuli, located on one of India's major rivers, the Brahmaputra, into a dense forest, home to rhinos, deers, elephants, tigers and birds. And today his forest is larger than Central Park.

Former vice-chancellor of Jawahar Lal Nehru University, Sudhir Kumar Sopory named Jadav Payeng as **Forest Man of India**, in the month of October 2013. He was honoured at the Indian Institute of Forest Management during their annual event 'Coalescence'. In 2015, he was honoured with Padma Shri, the fourth highest civilian award in India. He received honorary doctorate degree from Assam Agricultural University and Kaziranga University for his contributions.

9. Case study

Tamil Nadu Afforestation Project (TAP)

With an aim of ecological restoration and biological up-gradation of degraded forests and other lands, the government of Tamil Nadu launched the project in 2 phases Tap I (1997-2005). It aimed to uplift the quality and life of villagers abutting forest areas and to resolve the degraded forests in Tamil Nadu. This is a massive Joint Forest Management Programme. TAP II (2005-2013) had 2 main objectives.

- To restore the ecological equilibrium of the forests, watersheds and adjacent villages of Tamil Nadu.
- To improve the quality of the life of inhabitants through reforestation, water conservation and sustained community action.

Figure 8.4: Constructions under TAP
A. Check Dam B. Percolation pond

8. **Conservation movement**

A community level participation can help in preservation and conservation of our environment. Our environment is a common treasure for all the living organisms on earth. Every individual should be aware of this and participate actively in the programs meant for the conservation of the local environment. Indian history has witnessed many people movements for the protection of environment.

Chipko Movement

The tribal women of Himalayas protested against the exploitation of forests in 1972. Later on it transformed into **Chipko Movement** by **Sundarlal Bahuguna** in Mandal village of Chamoli district in 1974. People protested by hugging trees together which were felled by a sports goods company. Main features of Chipko movement were,

- This movement remained non political
- It was a voluntary movement based on Gandhian thought.
- It was concerned with the ecological balance of nature
- Main aim of Chipko movement was to give a slogan of five F's – Food, Fodder, Fuel, Fibre and Fertilizer, to make the communities self sufficient in all their basic needs.

Appiko Movement

The famous Chipko Andolen of Uttarakhand in the Himalayas inspired the villagers of Uttar Karnataka to launch a similar movement to save their forests. This movement started in Gubbi Gadde a small village near Sirsi in Karnataka by Panduranga Hegde. This movement started to protest against felling of trees, monoculture, forest policy and deforestation.

10. **Biomonitoring**

The act of observing and assessing the current state and ongoing changes in ecosystem, biodiversity components, landscape including natural habitats, populations and species.

An agricultural drone is an unmanned aerial vehicle applied to farming in order to help increased crop production and monitor crop growth. Agricultural drones let farmers see their fields from the sky. This bird's eye-view can reveal many issues such as irrigation problems, soil variation and pest and fungal infestations. It is also used for cost effective safe method of spraying pesticides and fertilizers, which proves very easy and non-harmful.

11. **Carbon Sink**

Any system having the capacity to accumulate more atmospheric carbon during a given time interval than releasing CO_2. Example: forest, soil, ocean are natural sinks. Landfills are artificial sinks.

Chapter 9

Unit X: Economic Botany

Plant Breeding

1.

Vavilov's Centre of Crop Origin		Crops domesticated
1	China	Foxtail millet, soybean, bamboo, onion, crucifers.
2	India	Rice, sugarcane, mango, orange, eggplant, sesame.
2 a	South East Asia	Rice, banana, coconut, clove , hemp.
3	Central East	Wheat, pea, hemp, cotton etc.
4	The Near East	Wheat, rye, many subtropical and tropical fruits.
5	Mediterranean	Olive, vegetables, oil yielding plants, wheats
6	Ethiopia (Abyssinian)	Wheat, barley, sesame, castor, coffee.
7	Mesoamerica (South Mexican & Central American Centre)	Maize, bean, sweet potato, papaya, guava, tobacco.
8	South America	Tomato, pine-apple
8 a	The Chiloe Centre	Potato
8 b	The Brazilian –Paraguayan Centre	Groundnut, cashew nut, pine apple, peppers, rubber.

2.

S.N	Groups		Examples
A	**N_2 fixing Biofertilize**		
	1.	Free-living	*Azotobacter, Clostridium, Anabaena, Nostoc,*
		Symbiotic	*Rhizobium, Anabaena azollae*
	3.	Associative Symbiotic	*Azospirillum*
B	**P Solubilizing Biofertilizer**		
	1.	Bacteria	*Bacillus subtilis, Pseudomonas striata*
	2.	Fungi	*Penicillium, Aspergillus.*
C	**P Mobilizing Biofertilizers**		
	1.	Arbuscular Mycorrhiza	*Glomus, Scutellospora.*
	2.	Ectomycorrhiza	*Amanita.*
D	**Biofertilizer for Micro nutrients**		
	1.	Silicate and Zinc solubilizers	*Bacillus.*
E	**Plant Growth Promoting Rhizobacteria**		
	2.	Pseudomonas	*Pseudomonas fluorescence*

3.

Norman E. Borlaug: The plant pathologist plant breeder devoted his life at the International Maize and Wheat improvement centre at Sonord in Mexico. He developed a new high yielding, rust resistant, non-lodging dwarf wheat varieties like Norin-10, Sonora-64, Lerma rojo-64, etc. which are now being cultivated in many countries. This formed the base for 'green revolution'. He was awarded a Nobel prize for Peace in 1970.

Dr. M. S. Swaminathan: He is pioneer mutation breeder. He has produced Sharbati Sonora, is the amber grain coloured variety of wheat by mutation, which is responsible for green revolution in India. Dr. Swaminathan is called "Father of green revolution in India".

Nel Jayaraman: Mr. Jayaraman, hails from Adirangam village in Tiruvarur district. He was a disciple of Dr.Nammalvar and state co-ordinator of 'Save our rice campaign, Tamil Nadu. He strived hard for conservation of traditional rice varieties. He had trained a team of farmers and regularly update them on the current issues that affect them. In 2005, he organized a first ever traditional paddy seed festival in his farm as an individual. The seed festival in May 2016 at Adhirangam was 10th in a row and in which 156 different traditional varieties were distributed to more than 7000 farmers across Tamil Nadu. He was invited by the Philippines Government to give a talk at the International Rice Research Institute (IRRI) on his work and mission. In 2011, he received the State Award for best organic farmer for his contribution to organic farming, and in the year 2015, he received the National Award for best Genome Savior.

4. **Sugar cane:** *Saccharum bareri* was originally grown in North India, but had poor sugar content and yield. Tropical canes grown in South India *Saccharum officinarum* had thicker stems and higher sugar content but did not grow well in North India. These two species were successfully crossed to get sugar cane varieties combining the desirable qualities of high yield, thick stems, high sugar and ability to grow in the sugarcane areas of North India.

5.

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

Chapter 10

Unit X: Economic Botany

Economically Useful Plants and Entrepreneurial Botany

1.

Table 10.1 : Other common fruits

S.No	Common Name	Tamil Name	Botanical name	Family	Edible part
1	Guava	கொய்யா	*Psidium guajava*	Myrtaceae	Mesocarp and Endocarp
2	Papaya	பப்பாளி	*Carica papaya*	Caricaceae	Mesocarp
3	Pomegranate	மாதுளை	*Punica granatum*	Punicaceae	Aril
4	Fig	அத்தி	*Ficus carica*	Moraceae	Fleshy receptacle
5	Date Palm	பேரீச்சம்	*Phoenix dactylifera*	Arecaceae	Pericarp

2.

Table 10.2 : Other common spices and condiments

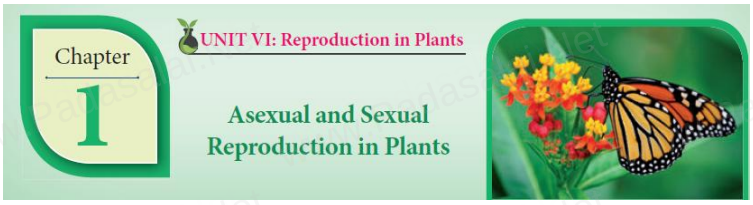
S. No	Common Name	Tamil Name	Botanical Name	Family
1	Coriander	கொத்துமல்லி	*Coriandrum sativum*. L	Apiaceae
2	Cumin	சீரகம்	*Cuminum cyminum*. L	Apiaceae
3	Fenugreek	வெந்தயம்	*Trigonella foenum graecum*. L	Fabaceae
4	Cloves	இலவங்கம்	*Eugenia aromaticum*	Myrtaceae
5	Asafoetidia	பெருங்காயம்	*Ferula asafoetida*.L	Umbelliferae (Apiaceae)
6	Onion	வெங்காயம்	*Allium cepa*	Amarillidaceae

3.

Table 4: Other commo Medicinal plants						
S. No	Common Name	Tamil Name	Botanical Name	Family	Plant part used	Medicinal Uses
1	Holy basil	துளசி	*Ocimum sanctum*	Lamiaceae	Leaves and Roots	The leaves are stimulant, antiseptic, anti-hypertensive and anti-bacterial and expectorant used in bronchitis. Decoction of roots is given as a diaphoretic in malarial fevel.
2	Indian gooseberry	நெல்லி	*Phyllanthus emblica*	Phyllanthaceae	Fruit	It is a potent rejuvenator and immune modulator. It has a anti-ageing properties. It helps to promote longevity, enhance digestion, treat constipation and reduce fever and cough.
3	Indian Acalypha	குப்பைமேனி	*Acalypha indica*	Euphorbiaceae	Leaves	Used to cure skin diseases caused by ringworms. Powdered leaves are used to cure bedsores and infected wounds.
4	Vilvam	வில்வம்	*Aegle marmelos*	Rutaceae	Fruit	The unripe fruit is used to treat problems of stomach indigestion. It kills intestinal parasites.
5	Veldt grape	பிரண்டை	*Cissus quadrangularis*	Vitaceae	Stem and root	Paste obtained from the powdered stem and root of this plant is used in bone fractures. Whole plant is useful to treat asthma and stomach troubles.

4.

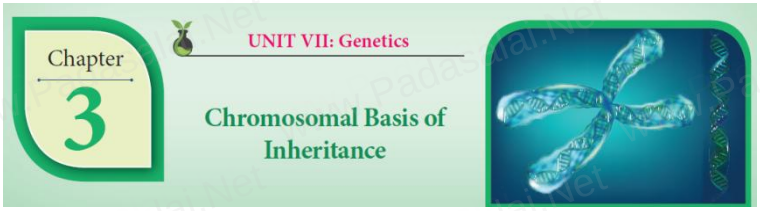
Table 10.3 Classification of fibres			
S. No	Types of fibre	Uses	Example
1	Textile fibre	Manufacture of fabrics, netting and cordage.	Cotton, hemp, jute.
2	Brush fibre	Making brushes and brooms.	Palm fibres and brooms.
3	Plaiting fibre	Making hats, baskets, furniture.	Cane, Vitex and Lantana.
4	Filling fibre	Stuffing pillows, cushions and beds.	Silk cotton, Calotropis.



Milestones

1. 1682 - Nehemiah Grew mentioned stamens as the male organ of a fl ower.
2. 1694 - R.J.Camerarius described the structure of a fl ower, anther, pollen and ovule
3. 1761 - J.G. Kolreuter gave a detailed account on the importance of insects in pollination
4. 1824 - G.B.Amici discovered the pollen tube.
5. 1848 - Hofmeister described the structure of pollen tetrad
6. 1870 - Hanstein described the development of embryo in *Capsella* and *Alisma*
7. 1878 - E.Strasburger reported polyembryony
8. 1884 - E.Strasburger discovered the process of Syngamy.
9. 1898 - S.G.Nawaschin and L. Guignard independently discovered Double fertilization
10. 1904 – E.Hanning initiated embryo culture.
11. 1950 - D.A. Johansen proposed classifi cation for embryo development
12. 1964 - S.Guha and S.C.Maheswari raised haploids from *Datura* pollen grains
13. 1991 - E.S.Coen and E. M. Meyerowitz proposed the ABC model to describe the genetics of initiation and development of fl oral parts
14. 2015 - K.V.Krishnamurthy summarized the molecular aspects of pre and post fertilization Reproductive development in fl owering plants

In Chapter-2 there is no Milestones



Milestones

1. 1883 - Wilhelm Roux - postulated that the chromosomes of a cell are responsible for transferring heredity.

2. 1901 – Montgomery - was first to suggest occurrence of distinct pairs of chromosomes and he also concluded that maternal chromosomes pair with paternal chromosomes only during meiosis.

3. 1902 - T.Boveri - supported theidea that the chromosomes containgenetic determiners, and he waslargely responsible for developing thechromosomal theory of inheritance.

4. 1902 - W.S. Sutton - a young Americanstudent independently recognized aparallelism (similarity) between thebehaviour of chromosomes and Mendelian factors during gamete formation.

5. 1903 - Sutton and Boveri independentlyproposed the chromosome theory of inheritance. Sutton united the knowledge of chromosomal segregation with Mendelian principles And called it chromosomal theory of inheritance.

Milestones

1. 6000 BC – 3000 BC – Bread making, fermentation of fruit juices and plant exudates to produce alcoholic beverages using yeast.

2. 1770 – Antoine Lavoisier gave chemical basis of alcoholic fermentation.

3. 1798 – Edward Jenner uses fi rst viral vaccine to inoculate a child from smallpox.

4. 1838 – Protein discovered, named and recorded by Gerardus Johannes Mulder and Jons Jacob Berzelius.

5. 1871 – Ernst Hoppe, Seyler discovered enzyme invertase, which is still used for making Artificial sweeteners.

6. 1876 – Louis Pasteur identifi ed role of microorganisms in fermentation.

7. 1919 – The term biotechnology was coined by Karl Ereky

8. 1928 – Discovery of Penicillin by Alexander Fleming

9. 1941 – Experiment with *Neurospora crassa* resulting in one gene one enzyme hypothesis by George Beadle and Edward Tatum.

10. 1944 – Identifi cation of DNA as the genetic material Avery–MacLeod–McCarty

11. 1953 – Discovery of double helix structure of DNA by James Watson and Francis Crick.

12. 1972 – Discovery of Restriction enzymes by Arber, Smith and Nathans.

13. 1973 – Fragmentation of DNA-combined with Plasmid DNA, r-DNA technology - Genetic engineering -Modifi ed gene by Stanley Cohen, Annie Chang, Robert Helling and Herbert Boyer.

14. 1975 – Production of Monoclonal antibodies by Kohler and Milstein

15. 1976 – Sanger and Gilbert developed techniques to sequence DNA

16. 1978 – Production of human insulin in E.Coli

17. 1979 – Development of Artifi cial gene – functioning within the living cells by H.G. Khorana

18. 1982 – U.S approved humulin (human insulin) the fi rst pharmaceutical product of rDNA technology, for human use.

19. 1983 – Use of Ti plasmids to genetically transform plants

20. 1986 – Development of Polymerase Chain Reaction (PCR) technology by Kary Mullis.

21. 1987 – Gene transfer by biolistic transformation

22. 1992 – First chromosomes of yeast is sequenced

23. 1994 – U.S approved the first Genetically Modified food: Flavr Savr tomato.

24. 1997 – Ian Wilmet - The first transgenic animal, mammalian sheep, Dolly developed by nuclear cloning

25. 2000 – First plant Genome of *Arabidopsis thaliana* sequenced

26. 2001 – Human genome Project creates a draft of the human genome sequence.

27. 2002 – First crop plant genome sequenced in *Oryza sativa*

28. 2003 – Human genome project is completed, providing information on the locations and sequence of human genes on all 46 chromosomes.

29. 2010 – Sir Robert G. Edwards developed *in vitro* fertilization in animal.

30.2016 – Stem cells injected into stroke patients re- enable patient to walk – Stem cell therapy

31. 2017 – Blood stem cells grown in lab.

32. 2018 – James Allison and TasukuHonjo discovered protein found in immune cells. This found a new role in cancer therapy.

Milestones

1.1902 - Haberlandt - cultured plant cells in artifi cial condition called in vitro (inside glass) in culture medium (Knop's salt solution) containing glucose and peptone and developed callus (unorganized growth of cells and tissue) and proposed the concept Totipotency, it means the development of whole plant from isolated cells or tissue in in vitro condition.

2. 1934 – P.R.White - developed root cultures, used Knop's solution along with three vitamins like pyridoxine, thiamine and nicotinic acid

3. 1984 - F.C. Steward - used coconut water in plant tissue culture work and obtained cell proliferation from carrot explants (Cellular totipotency).

4. 1952-1955 - Morel and Martin - developed virus-free *Dahlia* and potato plants using shoot meristem culture.

5. 1962 - Murashige and Skoog - formulated tissue culture medium, a land mark in plant tissue culture and it is the most frequently used medium for all kinds of tissue culture work.

6. 1962 - Kanta *et al* - produced test-tube fertilization in fl owering plants.

7. 1963 - Yamada *et al* - produced *calli* and free cells in tissue culture of *Tradescantia refl exa.*

8. 1964 - Guha and Maheshwari - developed *in vitro* production of haploid embryos from anthers of *Datura*.

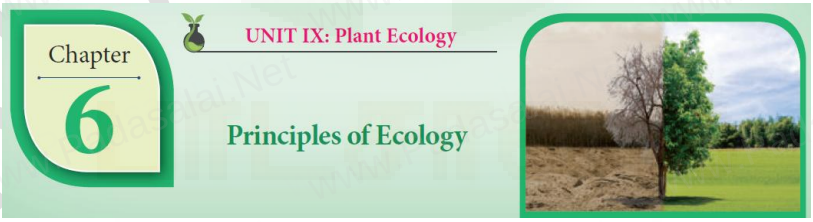
9. 1965 - Vasil and Hildbrandt - achieved diff erentiation of tobacco plants from single, isolated cells in micro propagation.

10. 1971 - Takebe *et al* - regenerated tobacco plants from isolated mesophyll protoplasts. Carlson and co-workers obtained protoplast fusion between *Nicotiana glauca* and *Nicotiana longsdorffii* and developed first interspecifi c somatic hybrid in 1971.

11. 1978 - Melchers and co-workers - developed intergenic hybrid between potato and tomato called pomato.

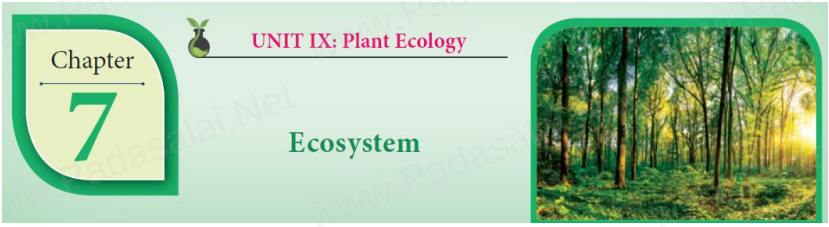
12. 1983 – Chilton - produced transformed tobacco plants from single cell transformation and gene insertion.

13. 1984 - Horsh *et al*-developed transgenic tobacco by Agrobacterium mediated gene transfer



Milestones

1. 1885 – Reiter -The study of living organisms, both plants and animals, in their natural habitats or homes.
2. 1889 - Earnest Haeckel - Ecology is the study of the reciprocal relationship between living organisms and their environment.



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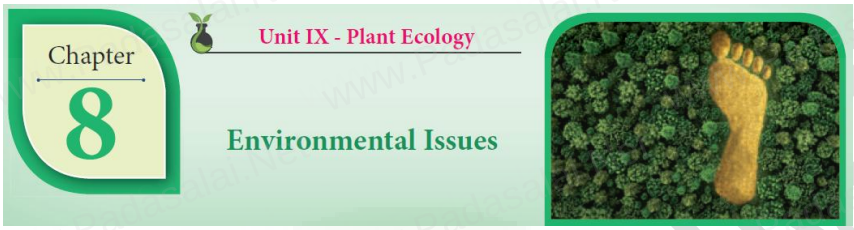

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Milestones

1. 1807 - Alexander Von Humboldt - considered the original sources of most useful plants and their origin is an impenetrable secret.

2. 1868 - Darwin's - evolutionary theory proposed that origin of useful cultivated plants have existed through natural selection and hybridisation.

3. 1883 - De Candolle - in his "Origin of cultivated plants" studied 247 cultivated plant species and attempted to solve the mystery about the ancestral form, region of domestication and history.

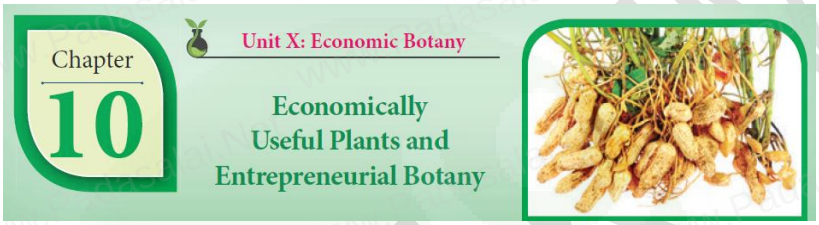
4. 1887-1943 - Nikolai Ivanovich Vavilov - made an inventory of the diverse forms of our most important cultivated plants and their distribution based on variety of facts obtained from morphology, anatomy, cytology, genetics and plant geography. Vavilov hasgiven the centre of diversity of a crop species which may be the centre of origin for that species.

5. 1926 - Vavilov initially proposed eight main geographic centres of origin.

6. 1935 - Vavilov named 11 centres of origin by dividing few centres into two and three centres and added a new centre USA thus making the 8 centres of origin into 12.

7. 1968 - Zhukovsky - put forward the concept of mega gene centre for the origin of cultivated plants. He divided the whole world into 12 mega gene centres.

8. 1971 – Harlan - agriculture originated independently in three different areas in different times or simultaneously. Hence a crop may not have a single centre of origin. Harlan says that the centre of crop plant means the places of agricultural origin of the crop plants. The non-centre denotes the place where agriculture of the crop was introduced and spread. Thus centre and non-centre interact with each other.



In Chapter-10 there is no Milestones

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