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 causes, process and types of plant succession
- Classify vegetation types of India and Tamil Nadu

Chapter outline

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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 in the water bodies which are all together form an **ecosystem**. Further, we all know that plants and animals are prominent living components in the environment. They interact with nonliving components such as air, water, soil, sunlight, etc. For example, you have studied in class XI, one of the life processes, photosynthesis which utilize 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 nonliving 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

7.1 Structure of ecosystem

Ecosystem comprises of two major components. They are:

i) **Abiotic (non-living) components**: It includes climatic factors (air, water, sunlight, rainfall, temperature and humidity), edaphic factors (soil air, soil water and pH of soil),topography (latitude, altitude), organic components (carbohydrates, proteins, lipids and humic substances) and inorganic substances (C, H, O, N and P). Abiotic components play vital role in any ecosystem and hence the total inorganic substances present in any ecosystem at a given time is called **standing quality** (or) **standing state**.

ii) **Biotic (living) components**: It **i**ncludes all living organisms like plants, animals, fungi and bacteria. They form the trophic structures of any ecosystem. On the basis of nutritional relationships, trophic levels of an ecosystem has two components. (1) autotrophic components and (2) heterotrophic components.

(1) Autotrophic components: Autotrophs are organisms which can manufacture the organic compounds from simple inorganic components through a process called photosynthesis. In most of the ecosystems, green plants are the autotrophs and are also called **producers**.

(2) Heterotrophic components: Those organisms which consume the producers are called **consumers** and can be recognized into macro and micro consumers. **Macroconsumers** refer to herbivores, carnivores and omnivores (primary, secondary and tertiary consumers). **Microconsumers** are called decomposers. Decomposers are organisms that decompose the dead plants and animals to release organic and inorganic nutrients into the environment which are again reused by plants. Example: Bacteria, Actinomycetes and Fungi.

The amount of living materials present in a population at any given time is known as **standing crop**, which may be expressed in terms of number or biomass per unit area. **Biomass** can be measured as fresh weight or dry weight or carbon weight of organisms. Biotic components are essential to construct the food chain, food web and ecological pyramids.

7.2 Functions of ecosystem

The function of ecosystem include to energy creation, sharing of energy and cycling of materials between the living and nonliving component of an ecosystem.

Before studying the productivity in any ecosystem, We should understand the essential role of sunlight used by producers of the first trophic level. The quantity of sunlight is directly proportional to the production of energy by plants.

7.2.1 Photosynthetically Active Radiation (PAR)

The amount of light available for photosynthesis of plants is called **P**hotosynthetically **A**ctive **R**adiation (PAR) which is between the range of 400-700 nm wave length. It is essential for photosynthesis and plant growth. PAR is not always constant because of clouds, tree shades, air, dust particles, seasons, latitudes and length of the daylight availability. Generally plants absorb more blue and red light for efficient photosynthesis.

Of the total sunlight, 34 percent that reaching the atmosphere is reflected back into the atmosphere, moreover 10% is held by ozone, water vapours and atmospheric gases and the remaining 56% reaches the earth's surface. Out of this 56%, only 2 – 10% of the solar energy is used by green plants for photosynthesis while the remaining portion is dissipated as heat.

PAR is generally reported as millimoles / square meter / second by using silicon photo

voltic detectors which detect only 400 – 700 nm wavelength of light. PAR values range from 0 to 3000 millimoles /square meter / second. At night PAR is zero and during midday in the summer, PAR often reaches 2000 – 3000 millimoles /square meter/second.

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.

7.2.2 Productivity of an ecosystem

The rate of biomass production per unit area in a unit time is called productivity. It can be expressed in terms of gm /m^2/year or Kcal/m^2/ year. It is classified as given bellow.

1. Primary productivity
2. Secondary productivity
3. Community productivity

1. Primary productivity:

The chemical energy or organic matter generated by autotrophs during the process of photosynthesis and chemosynthesis is called **primary productivity**. It is the source of energy for all organisms, from bacteria to human.

a. Gross Primary Productivity (GPP)

The total amount of food energy or organic matter or biomass produced in an ecosystem by autotrophs through the process of photosynthesis is called **gross primary productivity**

b. Net Primary Productivity (NPP)

The proportion of energy which remains after respiration loss in the plant is called **net primary productivity**. It is also called as apparent photosynthesis. Thus the difference between GPP and respiration is known as NPP.

$$NPP = GPP - Respiration$$

NPP of whole biosphere is estimated to be about 170 billion tons (dry weight) per year. Out of which NPP of oceanic producers is only 55 billion tons per year in unit time.

2. Secondary productivity

The amount of energy stored in the tissues of heterotrophs or consumers is called **secondary productivity**.

a. Gross secondary productivity

It is equivalent to the total amount of plant material is ingested by the herbivores minus the materials lost as faeces.

b. Net secondary productivity

Storage of energy or biomass by consumers per unit area per unit time, after respiratory loss is called **net secondary productivity**.

3. Community productivity

The rate of net synthesis of organic matter (biomass) by a group of plants per unit area per unit time is known as **community productivity**.

Factors affecting primary productivity

Primary productivity depends upon the plant species of an area, their photosynthetic capacity, availability of nutrients, solar radiation, precipitation, soil type, topographic factors (altitude, latitude, direction), and other environmental factors. It varies in different types of ecosystems.

Productivity of different Ecosystems

The primary productivity of an ecosystem is not determined by size and number of population, but by the rate of total fixation of radiant energy.

Generally, the average world net primary productivities of open ocean and tropical rain forest are the maximum among aquatic and terrestrial ecosystems respectively.

The following graph represents net primary productivity of various ecosystems.

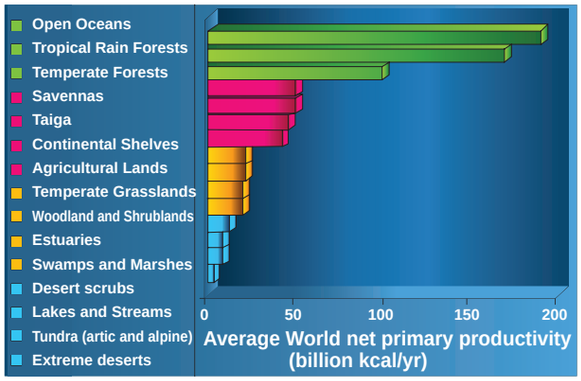


Figure 7.1: Average world net primary production of various ecosystems.

7.2.3 Concept of trophic level in an ecosystem

(Greek word ' trophic' = to food or feeding)

A trophic level refers to the position of an organism in the food chain. The number of trophic levels is equal to the number of steps in the food chain. The green plants (producers) occupying the first trophic level (T_1) are called **producers**. The energy produced by the producers is utilized by the plant eaters (herbivores) they are called **primary consumers** and occupies the second trophic level (T_2).

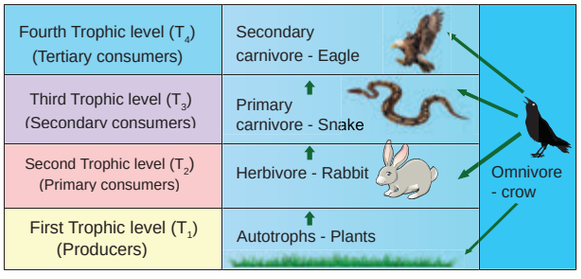


Figure 7.2: Diagrammatic representation of trophic levels

Herbivores are eaten by carnivores, which occupy the third trophic level (T_3). They are also called **secondary consumers** or **primary carnivores**. Carnivores are eaten by the other carnivores, which occupy the fourth trophic level (T_4). They are called the **tertiary consumers or secondary carnivores**. Some organisms which eat both plants and animals are called as **omnivores** (Crow). Such organisms may occupy more than one trophic level in the food chain.

7.2.4 Energy flow

The transfer of energy in an ecosystem between trophic levels can be termed as energy flow. It is the key function in an ecosystem. Part of the energy obtained from the sun by producer is transferred to consumers and decomposers through the each trophic level, while some amount of energy is dissipated in the form of heat. Energy flow is always unidirectional in an ecosystem.

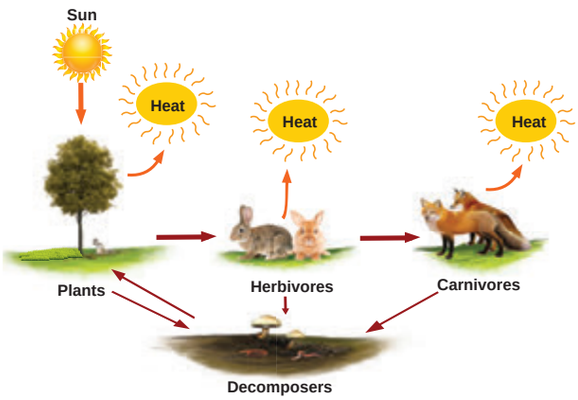


Figure 7.3: Diagrammatic representation of energy flow

Laws of thermodynamics

The storage and loss of energy in an ecosystem is based on two basic laws of thermo-dynamics.

i. First law of thermodynamics

It states that energy can be transmitted from one system to another in various forms. Energy cannot be destroyed or created. But it can be transformed from one form to another. As a result, the quantity of energy present in the universe is constant.

Example:

In photosynthesis, the product of starch (chemical energy) is formed by the combination of reactants (chlorophyll, H_2O, CO_2). The energy stored in starch is acquired from the external sources (light energy) and so there is

no gain or loss in total energy. Here light energy is converted into chemical energy.

$$6\,CO_2 + 6\,H_20 \xrightarrow[\text{Chlorophyll}]{\text{light}} C_6H_{12}0_6 + 6\,O_2$$

Light energy ⟶ chemical energy

ii. Second law of thermodynamics

It states that energy transformation results in the reduction of the free energy of the system. Usually energy transformation cannot be 100% efficient. As energy is transferred from one organism to another in the form of food, a portion of it is stored as energy in living tissue, whereas a large part of energy is dissipated as heat through respiration. The transfer of energy is irreversible natural process. Example: Ten percent law

Ten percent law

This law was proposed by Lindeman (1942). It states that during transfer of food energy from one trophic level to other, only about 10% stored at every level and rest of them (90%) is lost in respiration, decomposition and in the form of heat. Hence, the law is called **ten percent law.**

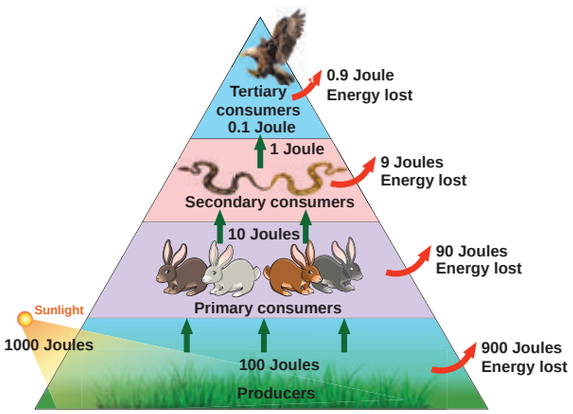


Figure 7.4: Ten percent law

Example: It is shown that of the 1000 Joules of Solar energy trapped by producers. 100 Joules of energy is stored as chemical energy through photosynthesis. The remaining 900 Joules would be lost in the environment. In the next trophic level herbivores, which feed on producers get only 10 Joules of energy and the remaining 90 Joules is lost in the environment. Likewise, in the next trophic level, carnivores, which eat herbivores store only 1 Joule of energy and the remaining 9 Joules is dissipated. Finally, the carnivores are eaten by tertiary consumers which store only 0.1 Joule of energy and the remaining 0.9 Joule is lost in the environment. Thus, at the successive trophic level, only ten percent energy is stored.

7.2.5 Food chain

The movement of energy from producers upto top carnivores is known as **food chain**, i.e., in any food chain, energy flows from producers to primary consumers, then from primary consumers to secondary consumers, and finally secondary consumers to tertiary consumers. Hence, it shows linear network links. Generally, there are two types of food chain, (1) Grazing food chain and (2) Detritus food chain.

1. Grazing food chain

Main source of energy for the grazing food chain is the **Sun**. It begins with the first link, producers (plants). The second link in the food chain is primary consumers (mouse) which get their food from producers. The third link in the food chain is secondary consumers (snake) which get their food from primary consumers. Fourth link in the food chain is tertiary consumers (eagle) which get their food from secondary consumers.

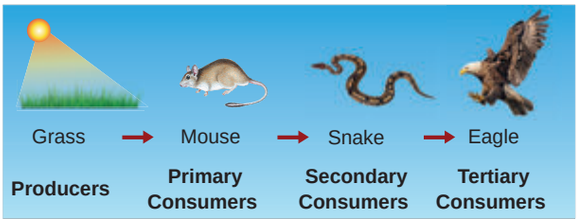


Figure 7.5: Diagrammatic representation of Grazing food chain

2. Detritus food chain:

This type of food chain begins with **dead organic matter** which is an important source of energy. A large amount of organic matter is derived from the dead plants, animals and their excreta. This type of food chain is present in all ecosystems.

The transfer of energy from the dead organic matter, is transferred through a series of organisms called detritus consumers (detritivores)- small carnivores - large (top) carnivores with repeated eating and being eaten respectively. This is called the detritus food chain.

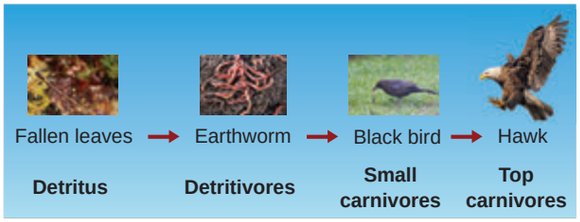


Figure 7.6: Diagrammatic representation of Detritus food chain.

7.2.6 Food Web

The inter-locking pattern of a number of food chain form a web like arrangement called **food web**. It is the basic unit of an ecosystem, to maintain its stability in nature. It is called homeostasis.

Example: In a grazing food chain of a grass land, in the absence of a rabbit, a mouse may also eat food grains. The mouse in turn may be eaten directly by a hawk or by a snake and the snake may be directly eaten by hawks.

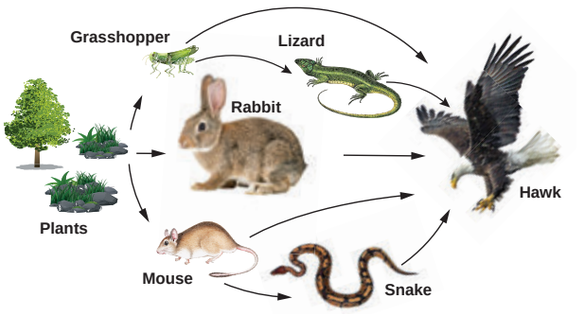


Figure 7.7: Diagrammatic representation of Food web in a grassland ecosystem

Hence, this interlocking pattern of food chains is the food web and the species of an ecosystem may remain balanced to each other by some sort of natural check.

Significance of food web

- Food web is constructed to describe species interaction called direct interaction.
- It can be used to illustrate indirect interactions among different species.
- It can be used to study bottom-up or top-down control of community structure.
- It can be used to reveal different patterns of energy transfer in terrestrial and aquatic ecosystems.

7.2.7 Ecological pyramids

Graphic representation of the trophic structure and function at successive trophic levels of an ecosystem is called **ecological pyramids**. The concept of ecological pyramids was introduced by **Charles Elton (1927)**. Thus they are also called as **Eltonian pyramids**.

There are three types: (1) pyramid of number (2) pyramid of biomass (3) pyramid of energy.

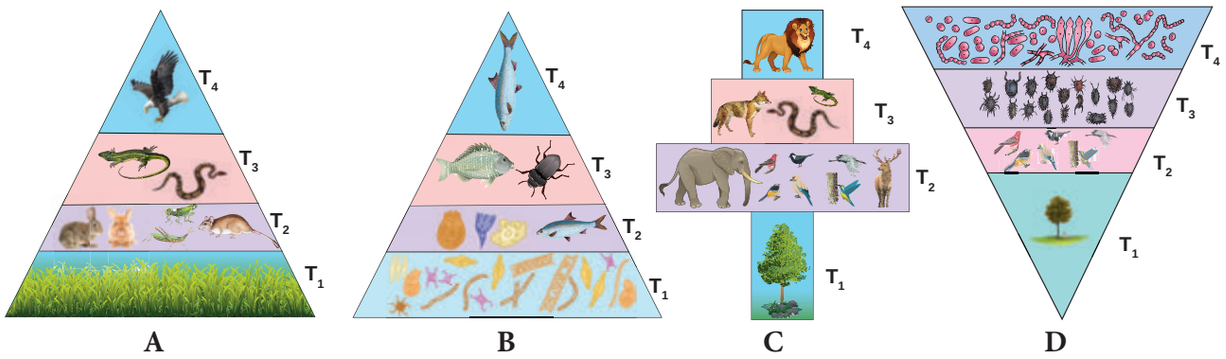
1. Pyramid of number

A graphical representation of the number of organisms present at each successive trophic level in an ecosystem is called **pyramids of number.** There are three different shapes of pyramids upright, spindle and inverted.

There is a gradual decrease in the number of organisms in each trophic level from producers to primary consumers and then to secondary consumers, and finally to tertiary consumers. Therefore, pyramids of number in **grassland** and **pond ecosystem** are always **upright**.

In a **forest ecosystem** the pyramid of number is somewhat different in shape, it is because the base (T_1) of the pyramid occupies large sized trees (Producer) which are lesser in number. Herbivores (T_2) (Fruit eating birds, elephant, deer) occupying second trophic level, are more in number than the producers. In final trophic level (T_4), tertiary consumers (lion) are lesser in number than the secondary consumer (T_3) (fox and snake). Therefore, the pyramid of number in forest ecosystem looks **spindle shaped**.

The pyramid of number in a **parasite ecosystem** is always **inverted**, because it



T_1 - Producers | T_2 - Herbivores | T_3 - Secondary consumers | T_4 - Tertiary consumers

Figure 7.8: Pyramids of numbers (individuals per unit area) in different types of ecosystems. **Upright**-A) Grassland ecosystem B) Pond ecosystem , **Spindle shaped** -C) Forest ecosystem, **Inverted**-D) Parasite ecosystem

starts with a single tree. Therefore there is gradual increase in the number of organisms in successive tropic levels from producer to tertiary consumers.

2 Pyramid of biomass

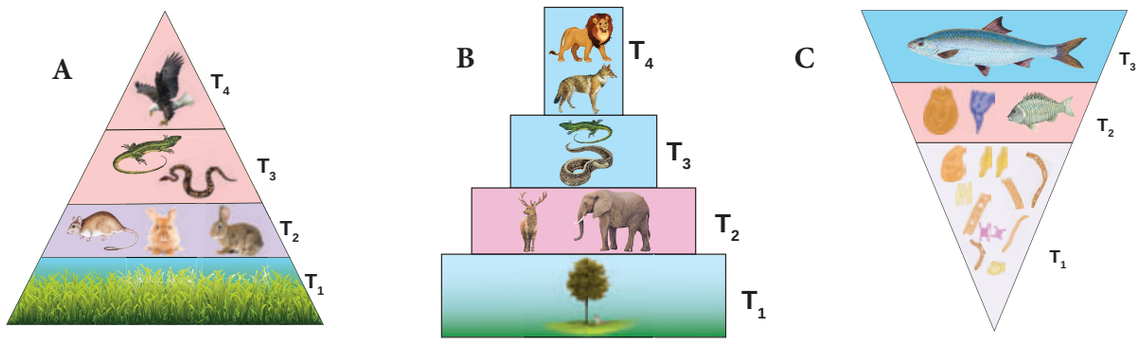
A graphical representation of the amount of organic material (biomass) present at each successive trophic level in an ecosystem is called **pyramid of biomass**.

In **grassland** and **forest ecosystems**, there is a gradual decrease in biomass of organisms at successive trophic levels from producers to top carnivores (Tertiary consumer). Therefore, these two ecosystems show pyramids as **upright** pyramids of biomass.

However, in **pond ecosystem**, the bottom of the pyramid is occupied by the producers, which comprise very small organisms possessing the least biomass and so, the value gradually increases towards the tip of the pyramid. Therefore, the pyramid of biomass is always **inverted** in shape.

3. Pyramid of energy

A graphical representation of energy flow at each successive trophic level in an ecosystem is called **pyramids of energy.** The bottom of the pyramid of energy is occupied by the producers. There is a gradual decrease in energy transfer at successive tropic levels from producers to the upper levels. Therefore, the pyramid of energy is **always upright**.



T_1 - Producers | T_2 - Herbivores | T_3 - Secondary consumers | T_4 - Tertiary consumers

Figure 7.9: Pyramids of biomass (dry weight per unit area)in different types of ecosystems. **Upright**-A) Grassland ecosystem B) Forest ecosystem, **Inverted**- C)Pond ecosystem

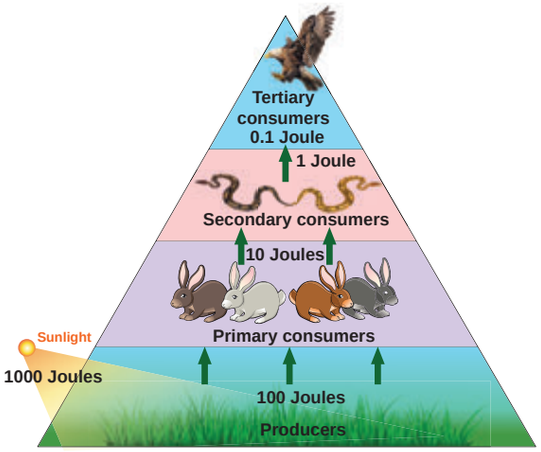


Figure 7.10: Pyramids of energy(Kcal/unit area/unit time) in any ecosystem

7.2.8 Decomposition:

Decomposition is a process in which the detritus (dead plants, animals and their excreta) are breakdown in to simple organic matter by the decomposers. It is an essential process for recycling and balancing the nutrient pool in an ecosystem.

Nature of decomposition

The process of decomposition varies based on the nature of the organic compounds, i.e., some of the compounds like carbohydrate, fat and protein are decomposed rapidly than the cellulose, lignin, chitin, hair and bone.

Mechanism of decomposition

Decomposition is a step wise process of degradation mediated by enzymatic reactions. Detritus acts as a raw material for decomposition. It occurs in the following steps.

a. Fragmentation - The breaking down of detritus into smaller particles by detritivores like bacteria, fungi and earth worm is known as **fragmentation**. These detritivores secrete certain substances to enhance the fragmentation process and increase the surface area of detritus particles.

b. Catabolism - The decomposers produce some extracellular enzymes in their surroundings to break down complex organic and inorganic compounds in to simpler ones. This is called **catabolism**

c. Leaching or Eluviation - The movement of decomposed, water soluble organic and inorganic compounds from the surface to the lower layer of soil or the carrying away

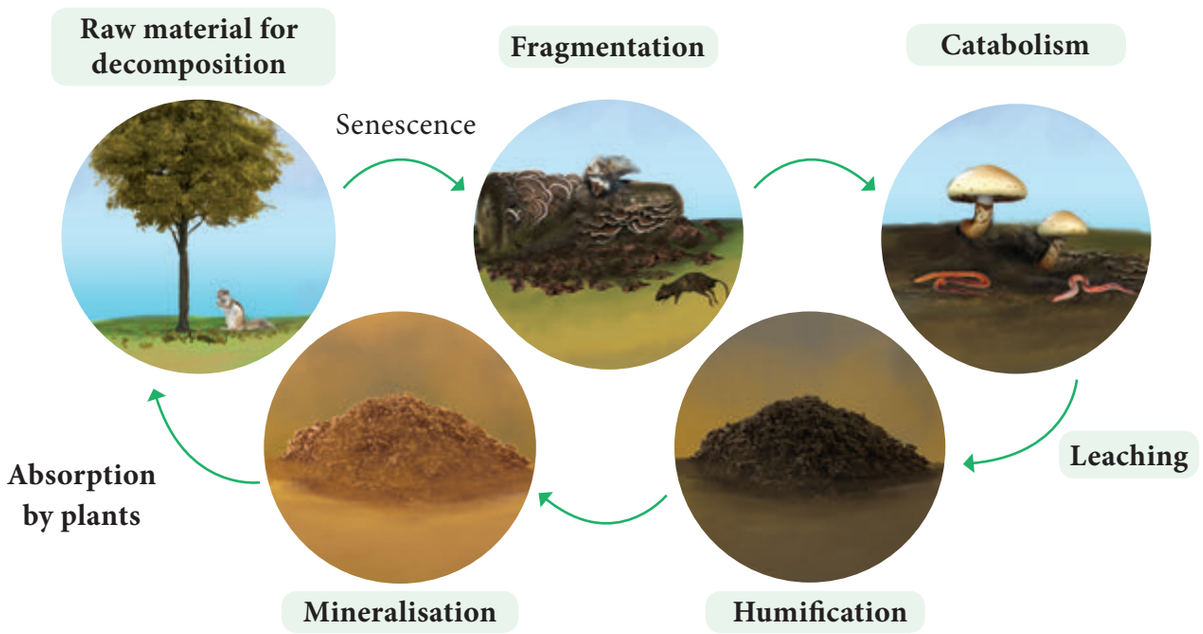


Figure 7.11: Diagrammatic representation – Process of decomposition and cycling of nutrients.

of the same by water is called **leaching** or **eluviation**.

d. **Humification** - It is a process by which simplified detritus is changed into dark coloured amorphous substance called **humus**. It is highly resistant to microbial action, therefore decomposition is very slow. It is the reservoir of nutrients.

e. **Mineralisation** - Some microbes are involved in the release of inorganic nutrients from the humus of the soil, such process is called **mineralisation**.

Factors affecting decomposition

Decomposition is affected by climatic factors like temperature, soil moisture, soil pH ,oxygen and also the chemical quality of detritus.

7.2.9 Biogeochemical cycle (Nutrient cycle)

Exchange of nutrients between organisms and their environment is one of the essential aspects of an ecosystem. All organisms require nutrients for their growth, development, maintenance and reproduction. Circulation of nutrients within the ecosystem or biosphere is known as **biogeochemical cycles** and also called as 'cycling of materials.' There are two basic types,

1. **Gaseous cycle** – It includes atmospheric Oxygen, Carbon and Nitrogen cycles.
2. **Sedimentary cycle** – It includes the cycles of Phosphorus, Sulphur and Calcium - Which are present as sediments of earth.

Many of the cycles mentioned above are studied by you in previous classes. Therefore, in this chapter, only the carbon and phosphorous cycles are explained.

Carbon cycle

The circulation of carbon between organisms and environment is known as the **carbon cycle**. Carbon is an inevitable part of all biomolecules and is substantially impacted by the change in global climate. Cycling of carbon between organisms and atmosphere is a consequence of two reciprocal processes of photosynthesis and respiration. The relesing of carbon in the atmosphere increases due to burning of fossile fules, deforestration, forest fire, volcanic eruption and decomposition of dead organic matters. The details of carbon cycle are given in the figure.

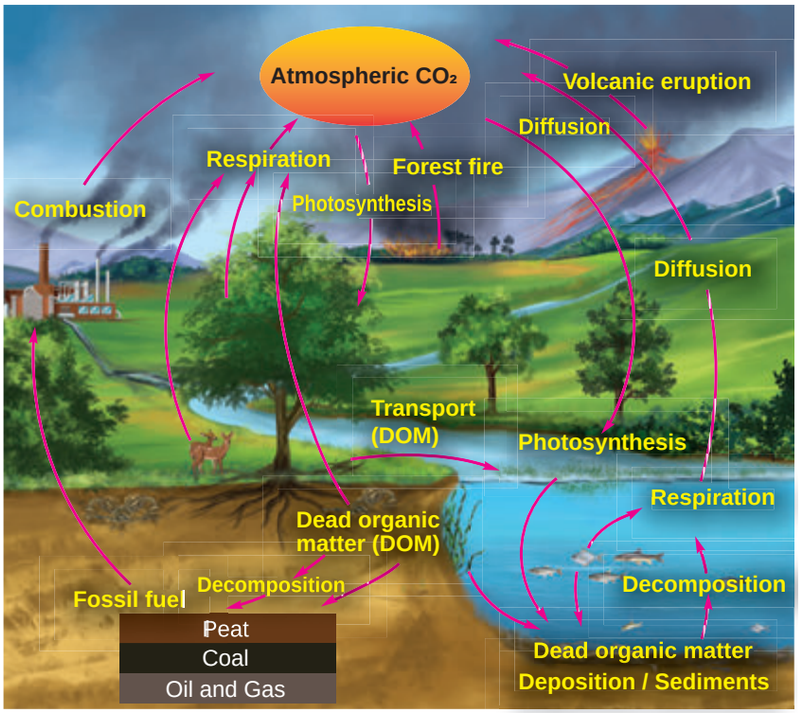


Figure 7.12: Diagrammatic Sketch showing Carbon cycle

Phosphorus cycle

It is a type of sedimentary cycle. Already we know that phosphorus is found in the biomolecules like DNA, RNA, ATP, NADP and phospholipid molecules of living organisms. Phosphorus is not abundant in the biosphere, whereas a bulk quantity of phosphorus is present in rock deposits, marine sediments and guano. It is released from these deposits by weathering

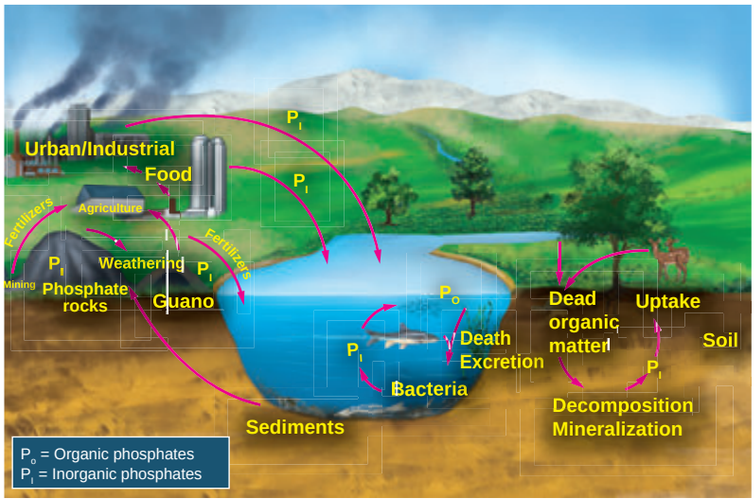


Figure 7.13: Diagrammatic sketch showing Phosphorous cycle

process. After that, it circulates in lithosphere as well as hydrosphere. The producers absorb phosphorus in the form of phosphate ions, and then it is transferred to each trophic level of food chain through food. Again death of the organisms and degradation by the action of decomposers, the phosphorus is released back into the lithosphere and hydrosphere to maintain phosphorus cycle.

7.2.10 Types of ecosystem

Biosphere consists of different types of ecosystems, which are as follows:

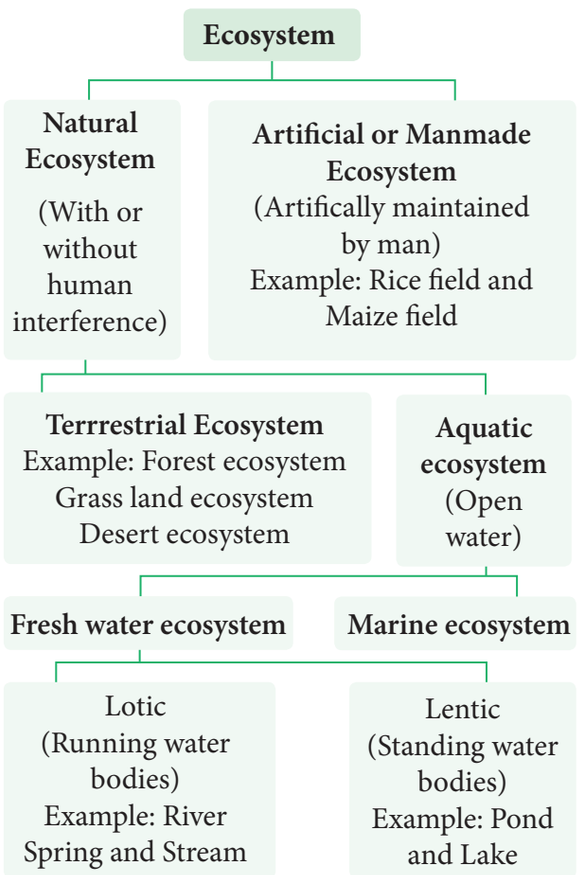


Figure 7.14: Types of Ecosystem

Though there are many types of ecosystems as charted above. Only the pond ecosystem is detailed below.

Structure of Pond ecosystem

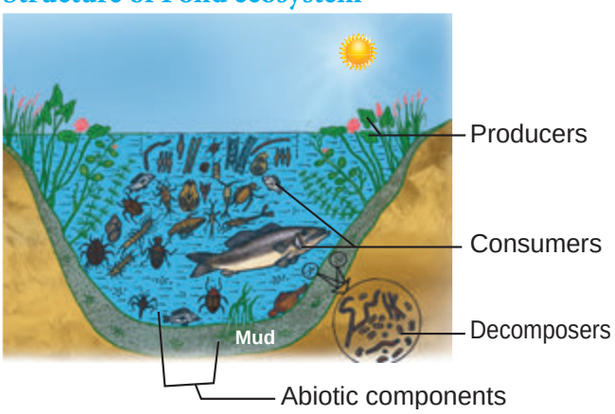


Figure 7.15: Diagram shows structure of pond ecosystem with abiotic and biotic components.

It is a classical example for natural, aquatic, freshwater, lentic type of ecosystem. It helps us to understand the structure and function of an ecosystem. When rain water gathers in a shallow area, gradually over a period of time, different kinds of organisms (microbes, plants, animals) become part of this ecosystem. This pond ecosystem is a self sustaining and self regulatory fresh water ecosystem, which shows a complex interaction between the abiotic and biotic components in it.

Activity

Collect few living and nonliving components from any water body found near by.

Abiotic components

A pond ecosystem consists of dissolved inorganic (CO_2, O_2, Ca, N, Phosphate) and organic substances (amino acids and humic acid) formed from the dead organic matter. The function of pond ecosystem is regulated by few factors like the amount of light, temperature, pH value of water and other climatic conditions.

Biotic components

They constitute the producers, variety of consumers and decomposers (microorganisms).

a. Producers

A variety of phytoplanktons like *Oscillatoria, Anabaena, Eudorina, Volvox* and *Diatoms.* Filamentous algae such as *Ulothrix, Spirogyra, Cladophora* and *Oedogonium;* floating plants *Azolla, Salvia, Pistia, Wolffia* and *Eichhornia*; sub-merged plants *Potamogeton* and *Phragmitis*; rooted floating plants *Nymphaea* and *Nelumbo*; macrophytes like *Typha* and *Ipomoea,* constitute the major producers of a pond ecosystem.

b. Consumers

The animals represent the consumers of a pond ecosystem include zooplanktons like *Paramoecium* and *Daphnia* (primary consumers); benthos (bottom living animals) like mollusces and annelids; secondary consumers like water beetles and frogs; and tertiary consumers (carnivores) like duck , crane and some top carnivores which include large fish, hawk ,man, etc.

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.

c. Decomposers

They are also called as microconsumers. They help to recycle the nutrients in the ecosystem. These are present in mud water and bottom of the ponds. Example: Bacteria and Fungi. Decomposers perform the process of decomposition in order to enrich the nutrients in the pond ecosystem.

The cycling of nutrients between abiotic and biotic components is evident in the pond ecosystem, making itself self sufficient and self regulating.

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.

Stratification of pond ecosystem

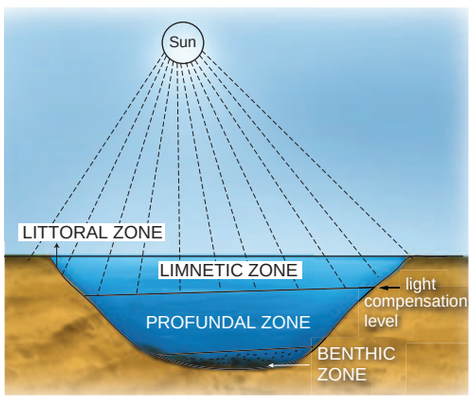


Figure 7.16: Diagrammatic sketch shows stratification of Pond ecosystem

Based on the factors like distance from the shore, penetration of light, depth of water, types of plants and animals, there may be three zones, littoral, limnetic and profundal. The littoral zone, which is closest to the shore with shallow water region, allows easy penetration of light. It is warm and occupied by rooted plant

species. The limnetic zone refers the open water of the pond with an effective penetration of light and domination of planktons. The deeper region of a pond below the limnetic zone is called profundal zone with no effective light penetration and predominance of heterotrophs. The bottom zone of a pond is termed benthic and is occupied by a community of organisms called benthos (usually decomposers).The primary productivity through photosynthesis of littoral and limnetic zone is more due to greater penetration of light than the profundal zone.

7.2.11 Ecosystem services (Benefits)

Ecosystem services are defined as the benefits that people derive from nature. Robert Constanza et al (1927) stated "Ecosystem services are the benefits provided to human, through the transformation of resources (or Environmental assets including land, water, vegetation and atmosphere) into a flow of essential goods and services".

Study on ecosystem services acts as an effective tool for gaining knowledge on ecosystem benefits and their sustained use. Without such knowledge gain, the fate of any ecosystem will be at stake and the benefits they provide to us in future will become bleak.

DO YOU KNOW?

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.

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.

The varieties of benefits obtained from the ecosystem are generally categorized into the following four types

Ecosystem services

Provisoning services
- Food, fiber and fuel
- Genetic resources
- Bio-chemicals
- Fresh water
- Medicines

Cultural services
- Spiritual and religious values
- Knowledge system
- Education and inspiration
- Recreation and aesthetic values
- Ecotourism

Supporting services
- Primary production
- Provision of habitat
- Nutrient cycling
- Soil formation and retention
- Production of atmospherc oxygen
- Water cycling

Regulating services
- Invasion resistance
- Herbivory pollination
- Seed dispersal
- Climate regulation
- Pest regulation
- Disease regulation
- Erosion regulation
- Water purification
- Natural hazard protection

Figure 7.17: Types of Ecosystem services

How do anthropogenic activities affect ecosystem services?

Now, we all exploit the ecosystem more than that of our needs. The **Millennium Ecosystem Assessment (2005)** found that "over the past 50 years, humans have changed the ecosystem more rapidly and extensively than in any comparable period of time in human history, largely to meet rapidly growing demands for food, fresh water, medicine, timber, fiber and fuel."

Generally the following human activities disturb or re-engineer an ecosystem every day.

- Habitat destruction
- Deforestation and over grazing
- Erosion of soils
- Introduction of non-native species
- Over harvesting of plant material
- Pollution of land, water and air
- Run off pesticides, fertilizers and animal wastes

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.

How to protect the ecosystem?

It is a practice of protecting ecosystem at individual, organisational and governmental levels for the benefits of both nature and humans. Threats to ecosystems are many, like adverse human activities, global warming, pollution, etc. Hence, if we change our everyday life style, we can help to protect the planet and its ecosystem.

"If we fail to protect environment, we will fail to save posterity".

Therefore, we have to practice the following in our day today life:

- Buy and use only ecofriendly products and recycle them.
- Grow more trees
- Choose sustained farm products (vegetables, fruits, greens, etc.)
- Reduce the use of natural resources.
- Recycle the waste and reduce the amount of waste you produce.
- Reduce consumption of water and electricity.
- Reduce or eliminate the use of house-hold chemicals and pesticides.
- Maintain your cars and vehicles properly. (In order to reduce carbon emission)
- Create awareness and educate about ecosystem protection among your friends and family members and ask them to find out solution to minimise this problem.

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"

7.2.12 Ecosystem Management

It is a process that integrates ecological, socio economic and institutional factors into a comprehensive strategy in order to sustain and enhance the quality of the ecosystem to meet current and future needs.

Ecosystem management emphasis on human role in judicious use of ecosystem and for sustained benefits through minimal human impacts on ecosystems. Environmental degradation and biodiversity loss will result in depletion of natural resources, ultimately affecting the existence of human

"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

Strategy of ecosystem management

- It is used to maintain biodiversity of ecosystems.
- It helps in indicating the damaged ecosystem (Some species indicate the health of the ecosystem: such species are called a **flagship species**).
- It is used to recognize the inevitability of ecosystem change and plan accordingly.
- It is one of the tools used for achieving sustainability of ecosystem through sustainable development programme (or projects).
- It is also helpful in identifying ecosystems which are in need of rehabilitation.

LAP2JU

- It involves collaborative management with government agencies, local population, communities and NGO's.
- It is used to build the capacity of local institutions and community groups to assume responsibility for long term implementation of ecosystem management activities even after the completion of the project.

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.

Adayar Poonga

7.3 Plant Succession

We very often see that forests and lands in our areas are drastically affected by natural calamities (Flood, earthquake) and anthropogenic activities (Fire, over grazing, cutting of trees). Due to these reasons all plants of an area are destroyed and the areas become nude. When we observe this area, over a period of a time we can see that it will be gradually covered by plant community again and become fertile. Such 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 area are called **pioneers**. On the other hand, a series of transitional developments of plant communities one after another in a given area are called **seral communities**. At the end a final stage and a final plant community gets established which are called as climax and climax community respectively.

7.3.1 Causes of Succession

Ever since the onset of origin of life, organic evolution and ecological succession are taking place parallelly. Ecological succession is a complex process. There are three types of causes for any ecological succession. They are

a. **Initiating causes** - Activity of abiotic (light, temperature, water, fire, soil erosion and wind) and biotic factors (competition among organisms) leads to formation of a barren area or destruction of the existing community of an area, initiating primary or secondary succession respectively.

b. **Continuing causes** - The processes of migration, aggregation, competition, reaction etc, are the continuing causes which lead to change the plant communities and nature of the soil in an area.

c. **Stabilizing causes** - The stabilization of the plant community in an area is primarly controlled by climatic factors rather than other factors.

7.3.2 Characteristics of ecological succession

- It is a systematic process which causes changes in specific structure of plant community.
- It is resultant of changes of abiotic and biotic factors.
- It transforms unstable community into a stable community.
- Gradual progression in species diversity, total biomass, niche specialisation, and humus content of soil takes place.
- It progresses from simple food chain to complex food web.
- It modifies the lower and simple life form to the higher life forms.
- It creates inter-dependence of plants and animals.

7.3.3 Types of succession

The various types of succession have been classified in different ways on the basis of different aspects. These are as follows:

1. Primary succession - The development of plant community in a barren area where no community existed before is called primary succession. The plants which colonize first in a barren area is called **pioneer species** or **primary community** or **primary colonies**. Generally, Primary succession takes a very long time for the occurrence in any region.

Example: Microbes, Lichen, Mosses.

2. Secondary succession - The development of a plant community in an area where an already developed community has been destroyed by some natural disturbance (Fire, flood, human activity) is known as **secondary succession**. Generally, This succession takes less time than the time taken for primary succession.

Example: The forest destroyed by fire and excessive lumbering may be re-occupied by herbs over period of times.

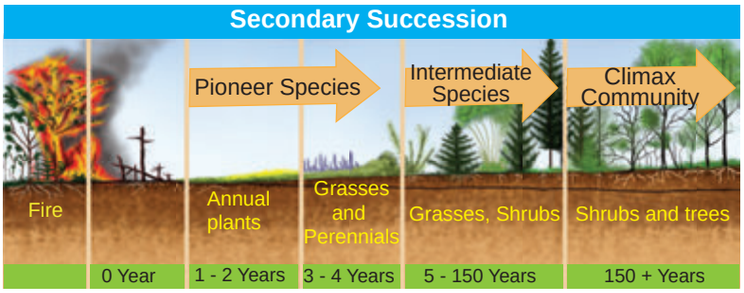


Figure 7.18: Diagrammatic representation of secondary succession

	Primary succession	Secondary succession
1	Developing in an barren area	Developing in disturbed area
2	Initiated due to a biological or any other external factors	Starts due to external factors only
3	No soil, while primary succession starts	It starts where soil covers is already present
4	Pioneer species come from outside environment	Pioneer species develop from existing environment
5	It takes more time to complete	It takes comparatively less time to complete

Table 1: Differences between primary and secondary succession

3. Autogenic succession

Autogenic succession occurs as a result of biotic factors. The vegetation reacts with its environment and modifies its own environment causing its own replacement by new communities. This is known as **autogenic succession**.

Example: In forest ecosystem, the larger trees produce broader leaves providing shade to the forest floor area. It affects the shrubs and herbs which require more light (heliophytes) but supports the shade tolerant species (sciophytes) to grow well.

4. Allogenic succession

Allogeneic succession occurs as a result of abiotic factors. The replacement of existing community is caused by other external factors (soil erosion, leaching, etc.,) and not by existing organisms.

Example: In a forest ecosystem soil erosion and leaching alter the nutrient value of the soil leading to the change of vegetation in that area.

5. Autotrophic succession

If the autotrophic organisms like green plants are dominant during the early stages of succession it is called **autotrophic succession**, this occurs in the habitat which is rich in inorganic substances. Since, green plants dominate in the beginning of this succession, there is a gradual increase in organic matter and subsequently the energy flow in the ecosystem.

6. Heterotrophic succession

If heterotrophic organisms like bacteria, fungi, actinomycetes, and animals are dominant during the early stages of succession it is called **heterotrophic succession**. Such a succession takes place in organic habitats. Since heterotrophs dominate in the beginning of such succession, there will be a gradual decrease in the energy content.

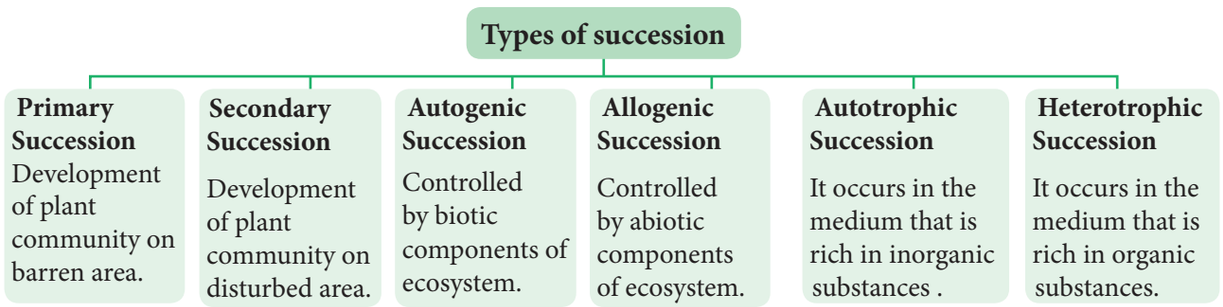


Figure 7.19: Types of succession

7.3.4 Process of succession

There are a number of sequential processes in primary autotrophic succession. They are (1) Nudation, (2) Invasion (migration) (3) Ecesis, (4) Aggregation, (5) Competition, (6) Reaction (7) Stabilization (climax).

1. Nudation - This is the development of a barren area without any form of life. The barren area may be developed due to topographic (soil erosion, wind action), climatic (hails, storm, fire), and biotic (human activities, epidemics, etc.,) factors.

2. Invasion - If species invade or reach a barren area from any other area it is called invasion. When the seeds, spores or other propagules of plant species reach the barren area, by air, water and various other agent, it is known as migration.

3. Ecesis (Establishment) - After reaching a new area (invasion), the successful establishment of the species, as a result of adjustment with the conditions prevailing in the area, is known as **ecesis.** If the establishment is complete, the plant will be able to reproduce sexually in that particular area.

4. **Aggregation** - The successful establishment of species, as a result of reproduction and increase in population of the species than the earlier stage is called aggregation.

5. **Competition** - It refers to the aggregation of a particular species in an area which leads to inter specific and intraspecific competition among the individuals for water, nutrient, radiant energy, CO_2, O_2 and space, etc.

6. **Reaction** - The species occupying a habitat gradually modify the environmental condition, where the existing species community is displaced or replaced by another. This is called reaction. The community which is replaced by another community is called **seral community**.

7. Stabilization (Climax stage) - The final establishment of plant community is called stabilization. This establishment of a plant community which maintains itself in equilibrium with climax of the area and not replaced by others is known as **climax community** and the stage is climax stage.

7.3.5 Classification of plant succession

Detailed study of Hydrosere and Lithosere are discussed below:

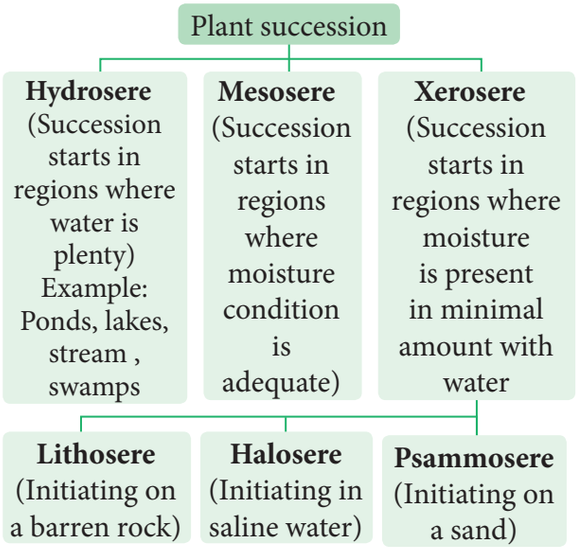


Figure 7.20: Classification of plant succession

Hydrosere

The succession in a freshwater ecosystem is also referred to as hydrosere. Succession in a pond, begins with colonization of the pioneers like phytoplankton and finally ends with the formation of climax community like forest stage. It includes the following stages Fig 7.21.

1. Phytoplankton stage - It is the first stage of succession consisting of the pioneer community like blue green algae, green algae, diatoms, bacteria, etc., The colonization of these organisms enrich the amount of organic matter and nutrients of pond due to their life activities and death. This favors the development of the next seral stages.

2. Submerged plant stage - As the result of death and decomposition of planktons, silt brought from land by rain water, lead to a loose mud formation at the bottom of the pond.

Hence, the rooted submerged hydrophytes begin to appear on the new substratum. Example: *Chara, Utricularia, Vallisneria* and *Hydrilla* etc. The death and decay of these plants will build up the substratum of pond to become shallow. Therefore, this habitat now replaces another group of plants which are of floating type.

3. Submerged free floating stage - During this stage, the depth of the pond will become almost 2-5 feet. Hence, the rooted hydrophytic plants and with floating large leaves start colonising the pond. Example: Rooted floating plants like *Nelumbo, Nymphaea* and *Trapa*. Some free floating species like *Azolla, Lemna, Wolffia* and *Pistia* are also present in this stage. By death and decomposition of these plants, further the pond becomes more shallow. Due to this reason, floating plant species is gradually replaced by another species which makes new seral stage.

4. Reed-swamp stage - It is also called an amphibious stage. During this stage, rooted floating plants are replaced by plants which can live successfully in aquatic as well as aerial environment. Example: *Typha, Phragmites, Sagittaria* and *Scirpus* etc. At the end of this stage, water level is very much reduced, making it unsuitable for the continuous growth of amphibious plants.

5. Marsh meadow stage - When the pond becomes swallowed due to decreasing water level, species of Cyperaceae and Poaceae such as *Carex, Juncus, Cyperus* and *Eleocharis* colonise the area. They form a mat-like vegetation with the help of their much branched root system. This leads to an absorption and loss of large quantity of water. At the end of this stage, the soil becomes dry and the marshy vegetation disappears gradually and leads to shurb stage.

6. Shrub stage - As the disappearance of marshy vegetation continues, soil becomes dry. Hence, these areas are now invaded

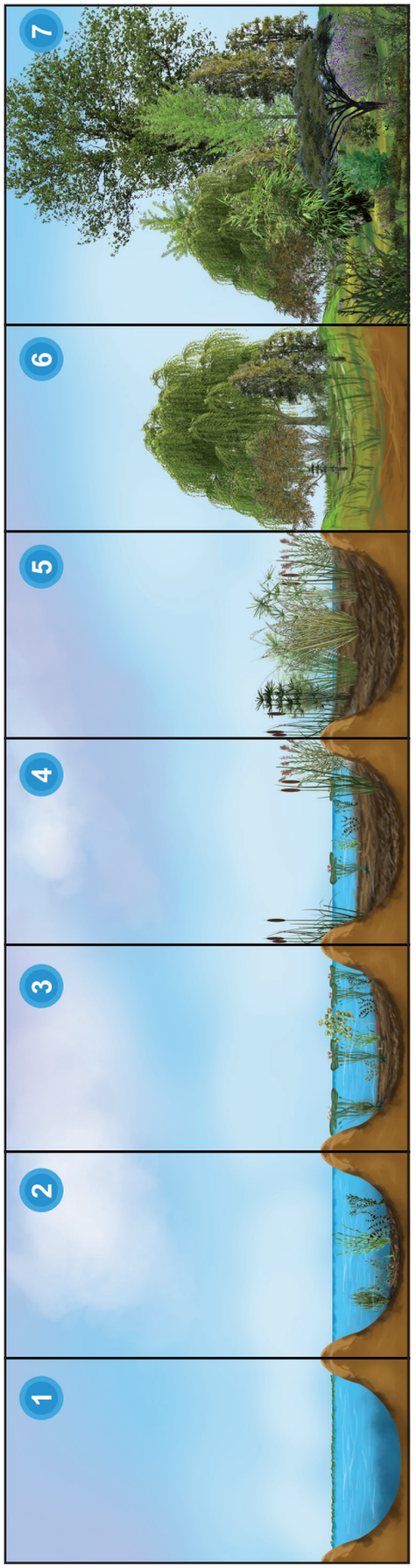


Figure 7.21: Diagrammatic representation shows different stages of hydrosere.

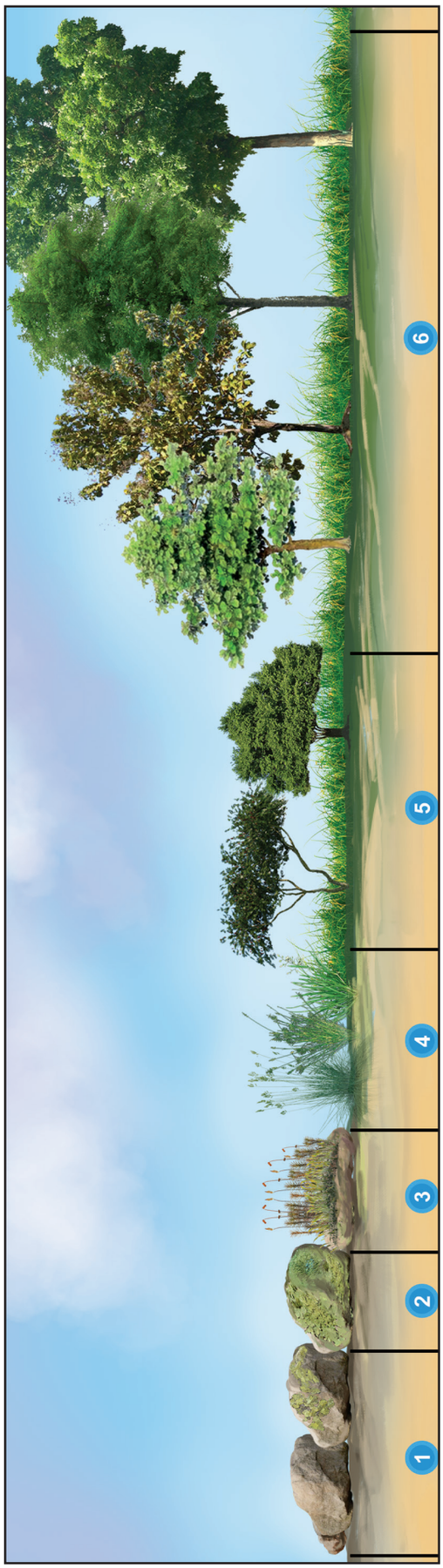


Figure 7.22: Diagrammatic representation shows different stages of lithosere

by terrestrial plants like shrubs (*Salix* and *Cornus*) and trees (*Populus* and *Alnus*). These plants absorb large quantity of water and make the habitat dry. Further, the accumulation of humus with a rich flora of microorganisms produce minerals in the soil, ultimately favouring the arrival of new tree species in the area.

7. Forest stage - It is the climax community of hydrosere. A variety of trees invade the area and develop any one of the diverse type of vegetation. Example:Temperate mixed forest (*Ulmus,Acer* and *Quercus*), Tropical rain forest (*Artocarpus* and *Cinnamomum*) and Tropical deciduous forest (*Bamboo* and *Tectona*).

In the 7 stages of hydrosere succession, stage1 is occupied by pioneer community, while the stage 7 is occupied by the climax community. The stages 2 to 6 are occupied by seral communities.

Lithosere

Lithosere is a type of xerosere initiating on a barren rock surface. The barren rock is devoid of water and organic matter. A barren rock surface gets mineral deposits due to weathering. This results in the colonization of pioneer organisms like crustose lichens. Through a series of successive seral stages, forest stage (Climax community) is achieved finally. These series of stages are given below Fig 7.22.

1. Crustose lichen stage - The pioneers like crustose lichens (*Rhizocarpon* and *Lecanora*) secrete some acids which enhance the weathering of rock. Due to this continuous process, small particles of rocks are formed, which together with decaying lichen make the first thin layer of soil on rock surface. However, this process is very slow. At the end, this habitats become less fit for existing plants and is gradually replaced by another type of lichens called foliose lichen.

2. Foliose lichen stage - Gradually crustose lichens are replaced by foliose lichen like

Parmelia and *Dermatocarpon* etc. These plants have leaf like structures. They also secrete some acids which further loosen the rocks into small soil particles. This process enhances water retaining capacity of the habitat and causes further accumulation of soil particles and humus. Gradual changes make the area less favourable for existing foliose lichen.

3. Moss stage - When the habitat is changed, the existing foliose lichen starts disappearing and favours the growth of some xerophytic moss like *Polytrichum, Tortula* and *Grimmia*. The luxurious growth of moss competes with lichens. Due to the death and decay of mosses, further addition of humus and moisture to the habitat takes place. Therefore, the next seral community tries to replace the moss community.

4. Herb stage - With the gradual disappearance of moss stage, herbaceous plant communities like *Aristida, Festuca* and *Poa,* etc., invade the habitat. The extensive growth of these herbs alter the habitat. The decaying leaves, stems, root and other parts of these plants get deposited on the soil surface in the form of humus. It further increases the water holding capacity of soil. These conditions become more suitable for shrubs.

5. Shrub stage - The habitat change results in the invasion of shrubs like *Rhus, Zizyphus, Capparis* and dominated by herbaceous plants. The death and decaying of shrubs further enrich the habitat with soil and humus. Therefore, the shrubs are replaced by trees which constitute the climax community.

6. Forest stage - The trees capable of growing in xerophytic condition try to invade the area which was occupied previously by shrubs. Further increasing the humus content of the soil favours the arrival of more trees and vegetation finally become mesophytes. As the trees are deeply rooted and much branched, they absorb more quantity of water and nutrients. After a long interval, a complete harmony is established among the plant communities. The climax stage remains unchanged unless some major environmental changes disturb it

Of the 6 stages of lithosere succession, stage 1 is occupied by pioneer community and the stage 6 is occupied by climax community. The stages 2 to 5 are occupied by seral communities. Seral stages occurring on the same rock surfaces.

7.3.6 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.

LQ7WL6

- Forests and vegetation that we come across all over the world are the result of plant succession.

7.4 Vegetation

Vegetation refers to the plant cover of an area. Geographically, India is a tropical country and also has strong monsoon climate and differs from other tropical regions of the World. India has four major climatic regions such as wet zone, intermediate zone, dry zone and arid zone, These regions are characterized by different types of natural vegetation. Nature of vegetation is also determined by several factors like altitude, types of plants, animals, climate, soil type, etc. Vegetation in Indian sub-continent is influenced by biotic factors and the existing human culture for a long time. The influence of man on plant formation and distribution is called anthropogenic effect on vegetation.

Tamil Nadu has a rich biodiversity right from the Gulf of Mannar to Western Ghats. Tamil Nadu shares the Western Ghats with states of Kerala, Karnataka, Goa, Maharashtra, Gujarat while Eastern Ghats is shared with the State of Andhra Pradesh. Of the 10 geographic zones in India, Coramandel (or) East Coast and Western Ghats are from Tamil Nadu.

7.4.1 Vegetation types of India and Tamil Nadu

Vegetation of India and Tamil Nadu consists of variety of plant communities and also possesses rich bio-diversity. It is classified in to the following four types, Which are explained with reference to their unique characteristics and distribution in India and Tamil Nadu:

Forest vegetation
Grassland vegetation
Riparian vegetation
Aquatic and semi aquatic vegetation

Forest Vegetation

Champion and Seth (1968) recognized a total of 16 forest types in India, Whereas 9 types of them in Tamil Nadu.

I) Moist Tropical Forests

It is in the warmer plains. It is characterised by very dense, multi-storeyed diverse trees, shrubs, lianas and scrub jungles. These areas experience a high rainfall and dry climate. These are further classified into the following types on the basis of wetness.

1. **Tropical wet evergreen forests**

This type is found at an altitude of nearly 1500 m on the slopes of hills and mountains .These are also called tropical rain forests or tropical wet evergreen forests, where annual rainfall is more than 250 cm.. Vegetation consists of luxuriantly growing huge trees of more than 45 m in height, shrubs, lianas and abundant epiphytes. The common plants are *Dipterocarpus, Artocarpus, Mangifera, Emblica* and *Ixora.* These forests occur in Andaman and Nicobar Islands, Western Coasts, Anamalai hills and Assam. This type is also found in western ghats of Thirunelveli, Kanyakumari, Anamalai Hills of Tamil Nadu

2. **Tropical semi-evergreen forests**

This type occurs on the slopes of hills and mountain usually up to 1000 m altitude.The annual rainfall in these forests is between 200 to 250 cm. Vegetation consists of luxuriantly growing evergreen species of giant trees and shrubs. The common tree species are *Terminalia, Bambusa, Ixora, Artocarpus, Michelia, Eugenia,* and *Shorea.* Orchids, ferns, some grasses,and herbs are also dominant. These forest are found in Western Coasts, Eastern Orissa and Upper Assam. This type is also present in Coimbatore, Thirunvelveli and Kanyakumar District of Tamil Nadu

3. **Tropical moist deciduous forests**

The annual rainfall of these forests is 100 to 200 cm with short dry periods. These are spread over an extensive part of the country. Many of the plants shed their leaves in hot summer. Some are ever green and semi-evergreen. The common plant species are *Terminalia, Grewia, Adina,*

FOREST TYPES OF INDIA
Champion and Seth (1968)

I. Moist Tropical Forests

01. Tropical wet evergreen forests
02. Tropical semi-evergreen forests
03. Tropical moist deciduous forests
04. Littoral and swamp forests

II. Dry Tropical Forests

05. Tropical dry deciduous forests
06. Tropical thorn forests
07. Tropical dry evergreen forests

III. Montane Sub-Tropical Forests

08. Sub-tropical broad leaved hill forests
09. Sub-tropical pine forests
10. Sub-tropical dry evergreen forests

IV. Montane Temperate Forests

11. Montane Wet temperate forests
12. Himalayan moist temperate forests
13. Himalayan dry temperate forests

V. Sub-Alpine Forests

14. Sub alpine forests

VI. Alpine Scrub

15. Moist alpine scrub
16. Dry alpine scrub

Figure 7.23: Map showing forest types of India. Champion and Seth (1968)

Melia, Albizzia, Dalbergia and *Shorea.* The most dominant plants are *Tectona* and *Sal.* These are found in Kerala, Karnataka, South Madhya Pradesh, northern parts of Uttar Pradesh, Bihar, Bengal, Orissa and Assam. This type is also present in Kanyakumari, Theni, Gudalur, Dindigul, Madurai and Nilgiris of Tamil Nadu.

4. **Littoral and swamp forests**

These include beach forests, tidal forests, mangrove forests and fresh water swamp forests.

a. **Beach forests**

These are found all along the sea coasts and river deltas. These areas have sandy soil which consists of large amount of lime and salts but poor in nitrogen and other mineral nutrients. The rainfall varies from 75 cm to 500 cm with moderate temperature. The common tree species are *Casuarina, Borassus, Phoenix, Pandanus , Morinda* and *Thespesia* with many twiners and climbers.

b. Tidal or mangrove forests

Tidal forests grow near the estuaries,

FOREST TYPES IN TAMIL NADU
Champion and Seth (1968)

I. Moist tropical Forests
1. Tropical wet evergreen forests
2. Tropical semi evergreen forests
3. Tropical moist deciduous forests
4. Littoral and swamp forests

II. Dry tropical Forests
5. Tropical dry deciduous forests
6. Tropical thorn forests
7. Tropical dry evergreen forests

III. Montane Sub-Tropical Forests
8. Sub-tropical broad leaved hill forests

IV. Montane Temperate Forests

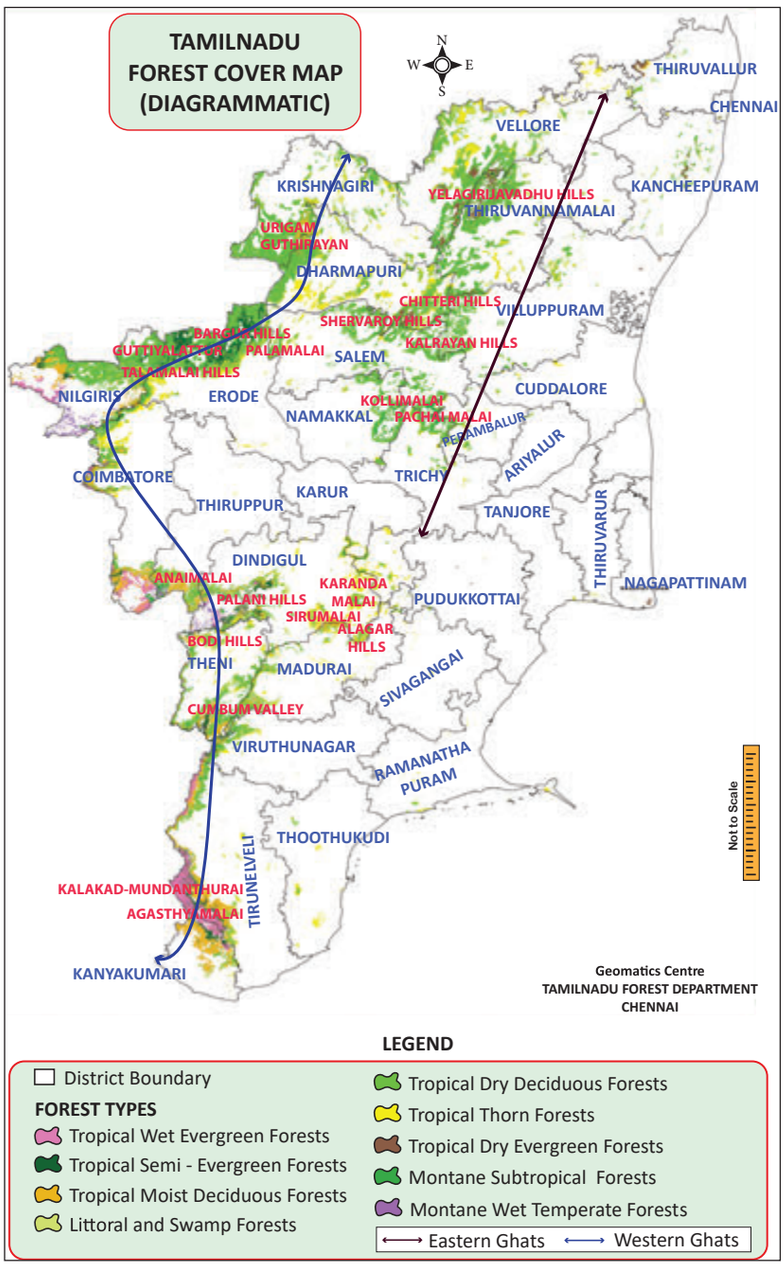


Figure 7.24: Map showing forest types of Tamil Nadu.

swampy margins of islands and along sea coasts. The plants are halophytes characterized by the presence of stilt roots, pneumatophores and viviparous germinations of seed. The common plants are *Rhizophora, Avicennia,* and *Sonneratia*. These are found near sea coast,Gujarat, Ganges, delta regions of Mahanadhi, Godavari, Krishna, Sundarbans and Pulicat, Pichavaram, Ramanathapuram of Tamil Nadu.

c. Fresh water swamp forests

These forests grow in low lying land areas where rain or river water gets collected for some time. So the water table is closer to the earth surface. The common plants are *Salix, Acer, Ficus* and all varieties of grasses and sedges. These forests are found in wetlands of Kanchipuram, Kanniyakumari of Tamil Nadu.

II. Dry Tropical Forests

These are classified into three types: Tropical dry deciduous forests, tropical thorn forests and tropical dry evergreen forests

5. **Tropical dry deciduous forests**

These forests are found at about 400 to 800 m MSL .These forests are found in the areas where annual rainfall is usually low, ranging between 70 and 100 cm. The largest forest area of the country is occupied by tropical dry deciduous forest. The dry season is long and most of the trees remain leafless during this season. The forest trees are not dense, and grow up to 10 to 15 m in height. The common plant species are *Dalbergia, Diospyros, Terminalia, Acacia, Chloroxylon, Bauhinia* and *Zizyphus.* Some common Climbers are *Combretum, Hiptage*: herbs like *Abutilon, Achyranthes* and *Tribulus.* These are found in Andhra Pradesh, Punjab, Uttar Pradesh, Bihar, Orissa, Madhya Pradesh and also found in all districts of Tamil Nadu at lower elevations.

6. **Tropical thorn forests**

These forests extend from plains upto 400 M . Occur in the areas where annual rainfall is between 20 and 70 cm. The dry season is hot and very long. The vegetation is of open type consisting of small trees (8 to 10 m length) and thorny or spiny shrubs with a stunted growth. The plants remain leafless for most of the year and many species have latex.. In rainy season, there is a luxuriant growth of ephemeral herbs and grass. The most common plant species are *Acacia, Cassia, Calotropis, Albizzia, Zizyphus, Dichrostachys, Euphorbia, Capparis,* and including unpalatable species. They are found in Karnataka, Andhra Pradesh, Maharashtra, South Punjab, most parts of Rajasthan and part of Gujarat and Thirunelveli in Tamil Nadu.

7. **Tropical dry evergreen forests**

This type of vegetation is found in areas where annual rainfall is in plenty but the dry season is comparatively longer. The trees are dense, evergreen, short and about 10 to 15 meter height. The common plant species are *Manilkara , Walsura, Diospyros and Memexylon* These types of forests are found in the eastern parts of Tamil Nadu, East coat of Andhra pradesh. They are also found in all coastal districts in Tamil Nadu from Thiruvallur to Nagapatinum districts.

III. Montane Subtropical Forests

This type of vegetation occurs in the areas with fairly high rainfall but where the climate is cooler than the tropical and warmer than the temperate forests. They are found in the altitude between 1000 m and 2000 m. The common plants are *Eugenia, Syzygium* and *Toona* are mostly evergreens. Many epiphytes including orchids and ferns are present. These are found in Nilgiri, Mahabaleswar, Assam and Manipur. In Eastern Ghats,it is found in the upper slopes and plateau of shervaroys, Kollimalai and Pachamalai of Tamil Nadu

These are further classified into

8. Sub-tropical broad leaved hill forests (Tamil Nadu,Kerala,Karnataka and Assam).

9. Sub-tropical pine forests (Punjab, U.P and a part of Sikkim)

10. Sub-tropical dry evergreen forests (Shivaliks and foot hills of western Himalayas).

IV. Montane Temperate Forests

This type of vegetation occurs where humidity and temperature are comparatively low. These forests are very dense with an extensive growth of grass and evergreen trees of 15 – 45 meters tall. The common plants are *Artocarpus, Balanocarpus, Pterocarpus, Myristica* and woody climbers besides ferns and epiphytes. It is also called mountain wet temperate forests. They are found in mountains of Himalayas. These are further classified into

11. Montane wet temperate forests.

12. Himalayan moist temperate forests.

13. Himalayan dry temperate forests.

In Tamil Nadu montane forest is mostly

confined to moist and sheltered valleys, glens and hollows as in the Anamalis, Nilgiri and Palani hills tops at above 1000 m. They are known in Tamil as 'Sholas'. The common vegetation of sholas are *Ilex, Syzygium, Michelia, Eurya* and *Rhododendron*.

V Sub-Alpine Forests

14 Sub-Alpine Forests

This type of vegetation is found in the altitude ranging between 2900 m to 3500 m, where snow fall occurs for several weeks in a year with less than 65 cm annual rainfall. Hence, strong winds and below 0^0 C temperature prevail for greater part of the year. The common tree species are *Abies, Pinus, Betula, Quercus, Salix, Rhododendron* with plenty of epiphytic orchids ,mosses and lichens. They occur in Himalayas from Ladakh in the West to Arunachal in the East Bengal, Uttar Pradesh, Assam, Jammu and Kashmir.

VI Alpine - Scrub

This type of vegetation is found in the Himalayas at an altitude ranging from 3600 m to 4900 m. The height of the trees decreases with increasing altitudes. The common plants are small sized plants such as *Sedum, Primula, Saxifraga, Rhododendron* , *Juniperus* and with many types of lichens. These are further classified into

15. Moist alpine scrubs

16. Dry alpine scrubs.

2. Grass land vegetation

Grassland refer to the vegetation community predominated by graminoids (i.e. grass and grass like plants). These are found in the altitude ranging from 150 to 2000 m and above mean sea level. The major plant families of the plants are Poaceae, Cyperaceae, Fabaceae , Gentianaceae and Asteraceae are common in this type of vegetation. The grass land not only comprises plants but also serves as habitats to a variety of micro and macro fauna. Based on the range of altitude, grasslands are categorized into: low altitude grasslands and high altitude grasslands.

Grasslands created and maintained by human are called anthropogenic grasslands.

a. Low altitude grasslands

This type of grasslands are found at an altitude upto 1000 m. The common plant species are *Halopyrum,* Wild *Saccharum, Arundinella, Heteropogon* and *Chrysopogon.* These types of grasslands are spread over coastal areas, riverline and alluvial areas of Deccan plateau, Chota Nagpur plateau, Gangetic, Brahmaputra valley and Eastern Ghats.

In Tamil Nadu, these are found in the Eastern Ghats .These are scattered and intermixed with local forests. They are exposed to considerable biotic interference. Fire is common during dry months.

b. Higher altitude grasslands

This type of grasslands are found in altitude above 1000 m.The common plants species are *Chrysopogon, Arundinella, Andropogon, Heteropogon, Cymbopogon, Imperata, Festuca,* and *Agrostis.*. It is spread over the southern slopes of Himalayas, sub-Himalayan ranges, Nagaland, Himachal Pradesh and Western ghats.

Figure 7.25: Higher altitude grassland

In Tamil Nadu ,these grasslands are found in higher regions of western ghats and are found between the sholas forest patches that occur in the depressions and furrows created by water courses flowing in these rolling downs are called as **rolling grassland** and also called **shola grassland**. It shows different types of vegetation like grasses, herbs, few shrubs and stunted trees.

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.

3. Riparian Vegetation

This type of vegetation is located along streams and rivers. The most common species are, *Terminalia, Diospyros,Salix,Ficus* and grasses. They are found on the banks of Godavari, Krishna, Ganga, Brahmaputria, Narmadha Yamuna and riverbeds of Cauvery and Thamirabharani in Tamil Nadu.

Activity

Visit nearby forest and water bodies, observe the species found, describe and then identify the various types of vegetation

4. Aquatic And Semi-Aquatic Vegetation

This type of vegetation is found in lakes, ponds, puddles and marshy places. The common plant species are *Nelumbo, Nymphaea, Bacopa, Typha, Pandanus, Cyperus, Aeschynomene, Hydrilla, Aponogeton* and *Potomogeton*. It is found in various parts of Tamil Nadu.

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, autogenic succession, allogeneic succession, autotrophic succession and heterotrophic 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.

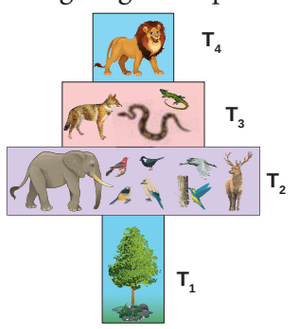
Vegetation refers to the plant cover of an area. Geographically, India and Tamil Nadu show tropical climate. Hence it has rich vegetation (Forest vegetation, Grassland vegetation, Riparian vegetation, Aquatic and semi aquatic vegetation). According to Champion and Seth (1968), forest vegetation of India and Tamil Nadu has been classified in to 16 and 9 types respectively.

Evaluation

M5QRMH

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. Write some plants are found in sub alpine forest.
19. What will happen if all producers are removed from ecosystem?
20. Construct the food chain with the following data.

    Hawk, plants, frog, snake, grasshopper.
21. Name of the food chain which is generally present in all type of ecosystem. Explain and write their significance.
22. Shape of pyramid in a particular ecosystem is always different in shape. Explain with example.
23. Generally human activities are against to the ecosystem, where as you a student how will you help to protect ecosystem?
24. Generally in summer the forest are affected by natural fire. Over a period of time it recovers itself by the process of successions . Find out the types of succession and explain.
25. Draw a pyramid from following details and explain in brief.

    Quantities of organisms are given-Hawks-50, plants-1000.rabbit and mouse-250 +250, pythons and lizard- 100 + 50 respectively.
26. Various stages of succession are given bellow. From that rearrange them accordingly. Find out the type of succession and explain in detail.

    Reed-swamp stage, phytoplankton stage, shrub stage, submerged plant stage, forest stage, submerged free floating stage, marsh medow stage.

Glossary

Ecosystem: Study of interaction between living and non-living components

Standing quality: Total inorganic substances presents in any ecosystem at a given time and given area

Standing crops: Amount of living material present in a population at any time.

Biomass: Can be measured as fresh weight or dry weight of organisms

Benthic: Bottom zone of the pond

Trophic: Refers to the position of organisms in food chain

Omnivores: Those eats both plants and animals

Food chain: Refers movement of energy from producers up to top carnivores

Food web: Interlocking pattern of food chain

Pyramid of number: Refers number of organisms in a successive trophic level

Pyramid of biomass: Refers to quantitative relationship of the standing crops

Pyramid of energy: Refers transformation of energy at successive trophic levels

Ten per cent law: refers only 10 per cent of energy is stored in each successive trophic levels

Bio geo chemical cycle: Exchange of nutrients between organisms and environments

Carbon cycle: Circulation of carbon among organisms and environments

Guano: It is a accumulated excrement of sea birds and bats.

Phosphorus cycle: Circulation of Phosphorus among organisms and environments

Succession: Successive replacement of one type of plant communities by other on barren or disturbed area.

Pioneers: Invaded plants on barren area

Primary succession: Plants colonising on barren area

Secondary succession: Plants colonising on disturbed area.

Climax communities: Final establishment of plant communities which are not replaced by others.

ICT Corner

ECO SYSTEM

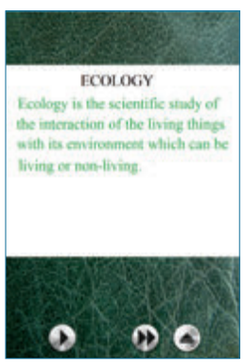
B266_12_BOT_EM

Let us know about the **Ecosystem** in detail through this activity.

Steps

- Type the URL or scan the QR code to open the activity page then Introduction page will open.
- Click on the Learn icon in the introduction page to know in detail.
- Click on the Flashcards icon in the introduction page to know about the topics easily.
- Click on the Test icon to write a quiz test finally it displays the marks we scored.

Step 1



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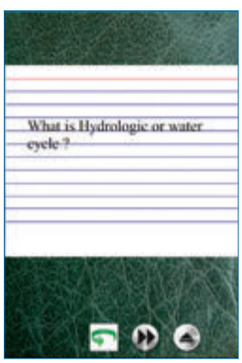

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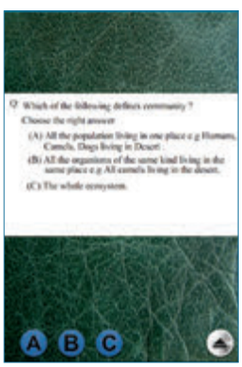

Step 4

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* Pictures are indicative only

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

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

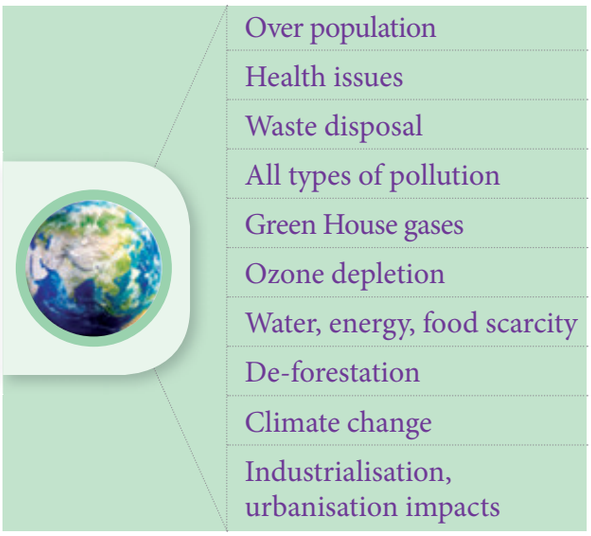


Figure 8.1: Environmental issues

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.

Countries of the whole world agree that something needs to be done about these important environmental issues. Many global summits, conferences and conventions are regularly conducted by the United Nations and many steps are taken to minimise human-induced issues by signing agreements with around 150 countries.

Activity 1

Students may form 'ECOGROUPS' and discuss eco-issues of their premises and find solutions to the existing problems like, litter disposal, water stagnation, health and hygiene, greening the campus and its maintenance.

Drastic increase in population resulted in demand for more productivity of food materials, fibres, fuels which led to many environmental issues in agriculture, land use modifications resulting in loss of biodiversity, land degradation, reduction in fresh water availability and also resulting in man-made global warming by green house gases even altering climatic conditions.

8.1 Green House effect and Global Warming

Green House Effect is a process by which radiant heat from the sun is captured by gases in the atmosphere that increase the temperature of the earth ultimately. The gases that capture heat are called **Green House Gases** which include carbon dioxide (CO_2), methane (CH_4), Nitrous Oxide (N_2O) and a variety of manufactured chemicals like chlorofluorocarbon (CFC). Increase in greenhouse gases lead to irreversible changes in major ecosystems and climate patterns. For example, coral ecosystem is affected by increase in temperature, especially **coral bleaching** observed in Gulf of Mannar, Tamil Nadu.

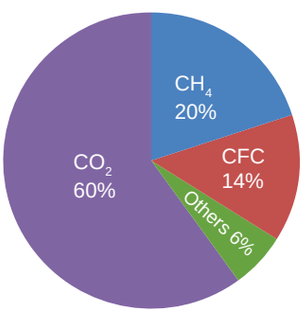


Figure 8.2: Relative contribution of green house gases

Human activities lead to produce the green house effect by

- Burning fossil fuels, which releases CO_2 and CH_4
- Way of Agriculture and animal husbandry practices
- Electrical gadgets like refrigerator and air conditioners release chloro fluoro carbons
- The fertilizers used in Agriculture which release N_2O
- The emissions from automobiles.

The increase in mean global temperature (highest in 4000 years) due to increased concentration of green house gases is called **global warming.**

One of the reasons for this is over population which creates growing need for food, fibre and fuel and considered to be the major cause of global warming.

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.

8.1.1. Effects of Global Warming

- Rise in global temperature which causes sea levels to rise as polar ice caps and glaciers begin to melt causing submergence of many coastal cities in many parts of the world.
- There will be a drastic change in weather patterns bringing more floods or droughts in some areas.
- Biological diversity may get modified, some species ranges get redefined. Tropics and sub-tropics may face the problem of decreased food production.

8.1.2. Sources of Green House Gases Emission (Natural and Anthropogenic)

CO_2 (Carbon dioxide)

- Coal based power plants, by the burning of fossil fuels for electricity generation.
- Combustion of fuels in the engines of automobiles, commercial vehicles and air planes contribute the most of global warming.
- Agricultural practices like stubble burning result in emission of CO_2.
- Natural from organic matter, volcanoes, warm oceans and sediments.

Methane

Methane is 20 times as effective as CO_2 at trapping heat in the atomosphere. Its sources are attributed paddy cultivation, cattle rearing, bacteria in water bodies, fossil fuel production, ocean, non-wetland soils and forest / wild fires.

N_2O (Nitrous oxide)

It is naturally produced in Oceans from biological sources of soil and water due to microbial actions and rainforests. Man-made sources include nylon and nitric acid production, use of fertilizers in agriculture, manures cars with catalytic converter and burning of organic matter.

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

8.1.3 Strategies to deal with Global Warming

- Increasing the vegetation cover, grow more trees
- Reducing the use of fossil fuels and green house gases
- Developing alternate renewable sources of energy
- Minimising uses of nitrogeneous fertilizers, and aerosols.

8.1.4. Ozone depletion

Ozone layer is a region of Earth's stratosphere that absorbs most of the Sun's ultra violet radiation. The ozone layer is also called as the **ozone shield** and it acts as a protective shield, cutting the ultra-violet radiation emitted by the sun.

Just above the atmosphere there are two layers namely troposphere (the lower layer) and stratosphere (the upper layer). The ozone layer of the troposphere is called **bad ozone** and the ozone layer of stratosphere is known as **good ozone** because this layer acts as a shield for absorbing the UV radiations coming from the sun which is harmful for living organisms

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.

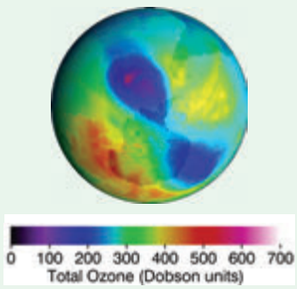


Figure 8.3: The false colour view of total ozone

causing DNA damage. The thickness of the ozone column of air from the ground to the top of the atmosphere is measured in terms of **Dobson Units**.

The ozone shield is being damaged by chemicals released on the Earth's surface notably the chlorofluorocarbons widely used in refrigeration, aerosols, chemicals used as cleaners in many industries. The decline in the thickness of the ozone layer over restricted area is called **Ozone hole.**

September 16 is WORLD OZONE DAY

Ozone depletion in the stratosphere results in more UV radiations especially UV B radiations (shortwaves). UV B radiation destroys biomolecules (skin ageing) and damages living tissues. UV – C is the most damaging type of UV radiation, but it is completely filtered by the atmosphere (ozone layer). UV – a contribute 95% of UV radiation which causes tanning burning of skin and enhancing skin cancer. Hence the uniform ozone layer is critical for the wellbeing of life on earth.

During 1970's research findings indicated that man-made chlorofluorocarbons (CFC) reduce and convert ozone molecules in the atmosphere. The threats associated with reduced ozone pushed the issue to the forefront of global climate issues and gained promotion through organisation such as World Meterological Organisation and the United Nations. The Vienna Convention was agreed upon at the Vienna conference of 1985 but entered into force in 1988 provided the frameworks necessary to create regulative measures in the form of the Montreal protocol. The International treaty called the **Montreal Protocol** (1987) was held in Canada on **substances that deplete ozone layer** and the main goal of it is gradually eliminating the production and consumption of ozone depleting substances and to limit their damage on the Earth's ozone layer.

Clean Development Mechanism (CDM) is defined in the **Kyoto protocol** (2007) which provides project based mechanisms with two objectives to prevent dangerous climate change and to reduce green house gas emissions. CDM projects helps the countries to reduce or limit emission and stimulate sustainable development.

An example for CDM project activity, is replacement of conventional electrification projects with solar panels or other energy efficient boilers. Such projects can earn Certified Emission Reduction (CER) with credits / scores, each equivalent to one tonne of CO_2, which can be counted towards meeting Kyoto targets.

Plant indicators

The presence or absence of certain plants indicate the state of environment by their response. The plant species or plant community acts as a measure of environmental conditions, it is referred as biological indicators or phytoindicators or plant indicators.

Examples

	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

8.1.5 Effects of Ozone depletion

The main ozone depletion effects are:

- Increases the incidence of cataract, throat and lung irritation and aggravation of asthma or emphysema, skin cancer and diminishing the functioning of immune system in human beings.
- Juvenile mortality of animals.
- Increased incidence of mutations.

- In plants, photosynthetic chemicals will be affected and therefore photosynthesis will be inhibited. Decreased photosynthesis will result in increased atmospheric CO_2 resulting in global warming and also shortage of food leading to food crisis.
- Increase in temperature changes the climate and rainfall pattern which may result in flood / drought, sea water rise, imbalance in ecosystems affecting flora and fauna.

8.2 Forestry

8.2.1 Agro forestry

Agroforestry is an integration of trees, crops and livestock on the same plot of land. The main objective is on the interaction among them . Example: intercropping of two or more crops between different species of trees and shrubs, which results in higher yielding and reducing the operation costs. This intentional combination of agriculture and forestry has varied benefits including increased bio-diversity and reduced erosion.

Some of the major species cultivated in commercial Agroforestry include *Casuarina, Eucalyptus*, Malai Vembu, Teak and Kadambu trees which were among the 20 species identified as commercial timber. They are of great importance to wood-based industries.

Benefits of agroforestry

- It is an answer to the problem of soil and water conservation and also to stabilise the soil (salinity and water table) reduce landslide and water run-off problem.
- Nutrient cycling between species improves and organic matter is maintained.
- Trees provide micro climate for crops and maintain O_2 – CO_2 balanced, atmospheric temperature and relative humidity.
- Suitable for dry land where rainfall is minimum and hence it is a good system for alternate land use pattern.
- Multipurpose tree varieties like *Acacia* are used for wood pulp, tanning, paper and firewood industries.
- Agro-forestry is recommended for the following purposes. It can be used as Farm Forestry for the extension of forests, mixed forestry, shelter belts and linear strip plantation.

Rehabilitation of degraded forests and recreation forestry

The production of woody plants combined with pasture is referred to **silvopasture** system. The trees and shrubs may be used primarily to produce fodder for livestock or they may be grown for timber, fuel wood and fruit or to improve the soil.

This system is classified into following categories.

i. **Protein Bank:** In this various multipurpose trees are planted in and around farm lands and range lands mainly for fodder production.

   Example: *Acacia nilotica, Albizzia lebbek, Azadirachta indica, Gliricidia sepium, Sesbania grandiflora.*

ii. **Livefence of fodder trees and hedges:** Various fodder trees and hedges are planted as live fence to protect the property from stray animals or other biotic influences.

   Example: *Gliricidia sepium, Sesbania grandiflora, Erythrina* spp., *Acacia* spp..

8.2.2 Social forestry

It refers to the sustainable management of forests by local communities with a goal of climate carbon sequestration, change mitigation, depollution, deforestation, forest restoration and providing indirect employment opportunity for the youth. Social forestry refers to the **management of forests and afforestation on barren lands** with the purpose of helping the environmental, social and rural development and benefits. Forestry programme is done for the benefit of people and participation of

the people. Trees grown outside forests by government and public organisation reduce the pressure on forests.

In order to encourage tree cultivation outside forests, **Tree cultivation in Private Lands** was implemented in the state from 2007-08 to 2011-12. It was implemented by carrying out block planting and inter-crop planting with profitable tree species like Teak, *Casuarina, Ailanthus*, Silver Oak, etc. in the farming lands and by a free supply of profitable tree species for planting in the bunds. The **Tank foreshore plantations** have been a major source of firewood in Tamil Nadu. The 32 **Forestry extension centres** provide technical support for tree growing in rural areas in Tamil Nadu. These centres provide quality tree seedlings like thorn / thornless bamboo, *casuarinas*, teak, neem, *Melia dubia*, grafted tamarind and nelli, etc. in private lands and creating awareness among students by training / camps.

8.2.3. Major activities of forestry extension centres

- Training on tree growing methods
- Publicity and propaganda regarding tree growing
- Formation of demonstration plots
- Raising and supply of seedlings on subsidy
- Awareness creation among school children and youth about the importance of forests through training and camps.

8.3 Deforestation

Deforestation is one of the major contributors to enhance green house effect and global warming. The conversion of forested area into a non-forested area is known as deforestation. Forests provide us many benefits including goods such as timber, paper, medicine and industrial products. The causes are

- The conversion of forests into agricultural plantation and livestock ranching is a major cause of deforestation.
- Logging for timber
- Developmental activities like road construction, electric tower lines and dams.
- Over population, Industrialisation, urbanisation and increased global needs.

Effects of deforestation

- Burning of forest wood release stored carbon, a negative impact just opposite of carbon sequestration.
- Trees and plants bind the soil particles. The removal of forest cover increases soil erosion and decreases soil fertility. Deforestation in dry areas leads to the formation of deserts.
- The amount of runoff water increases soil erosion and also creates flash flooding, thus reducing moisture and humidity.
- The alteration of local precipitation patterns leading to drought conditions in many regions. It triggers adverse climatic conditions and alters water cycle in ecosystem.
- It decreases the bio-diversity significantly as their habitats are disturbed and disruption of natural cycles.
- Loss of livelihood for forest dwellers and rural people.
- Increased global warming and account for one-third of total CO_2 emission.
- Loss of life support resources, fuel, medicinal herbs and wild edible fruits.

8.4 Afforestation

Afforestation is planting of trees where there was no previous tree coverage and the conversion of non-forested lands into forests by planting suitable trees to retrieve the vegetation. Example: Slopes of dams afforested to reduce water run-off, erosion and siltation. It can also provide a range of environmental services including carbon sequestration, water retention.

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.

Afforestation Objectives

- To increase forest cover, planting more trees, increases O_2 production and air quality.
- Rehabilitation of degraded forests to increase carbon fixation and reducing CO_2 from atmosphere.
- Raising bamboo plantations.
- Mixed plantations of minor forest produce and medicinal plants.
- Regeneration of indigenous herbs / shrubs.
- Awareness creation, monitoring and evaluation.
- To increase the level and availability of water table or ground water and also to reduce nitrogen leaching in soil and nitrogen contamination of drinking water, thus making it pure not polluted with nitrogen.
- Nature aided artificial regeneration.

Achievements

- Degraded forests were restored
- Community assets like overhead tanks bore-wells, hand pumps, community halls, libraries, etc were established
- Environmental and ecological stability was maintained.
- Conserved bio-diversity, wildlife and genetic resources.
- Involvement of community especially women in forest management.

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

8.5 Agrochemicals and their effects

An agro-chemical is useful in managing agriculture or in farming area which is one of the major issues of the environment. Agro-

chemicals includes **fertilizers, liming and acidifying agents, soil conditioners, pesticides and chemicals** used in animal husbandry, such as antibiotics and hormones.

Excessive use of fertilizers and pesticides leads to the contamination of groundwater and makes it nonpotable, ultimately affecting the soil fertility. Most of the chemical fertilizers contain varying amounts of nitrogen, phosphorous, potassium and nutrients that plants need to grow. Soil acidity influences C and N cycles by affecting soil microbes, also green house gas flux in soils and affect bio availability of N, P, S like major nutrients. This makes the soil too acidic or alkaline so that it becomes difficult for the plants to survive. These residues and synthetic chemicals like DDT (dichloro diphenyl trichloro ethane) and PCBs (polychlorinated biphenyls) cause nutrient and pH imbalance and quality reduction of agricultural produce. This problem can be minimised by sustainable agriculture.

Pesticides increase incidence of brain, blood cancer and neurotoxicity, Parkinson like symptoms, infertility, birth defects, reproductive and behavioural disorders.

- 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.

8.6 Alien invasive species

Invasion of alien or introduced species disrupts ecosystem processes, threaten biodiversity, reduce native herbs, thus reducing the ecosystem services (benefits). During eradication of these species, the chemicals used increases greenhouse gases. Slowly they alter ecosystem, micro climate and nature of soil and make it unsuitable for native species and create human health problems like allergy, thus resulting in local environmental degradation and loss of important local species.

According to World Conservation Union invasive alien species are the second most significant threat to bio-diversity after habitat loss.

What is invasive species?

A non-native species to the ecosystem or country under consideration that spreads naturally, interferes with the biology and existence of native species, poses a serious threat to the ecosystem and causes economic loss.

It is established that a number of invasive species are accidental introduction through ports via air or sea. Some research organisations import germplasm of wild varieties through which also it gets introduced. Alien species with edible fruits are usually spread by birds.

Invasive species are fast growing and are more adapted. They alter the soil system by changing litter quality thereby affecting the soil community, soil fauna and the ecosystem processes.

It has a negative impact on decomposition in the soils by causing stress to the neighbouring native species. Some of the alien species which cause environmental issues are discussed below

Eichhornia crassipes

Figure 8.5:
Eichhornia crassipes

It is an invasive weed native to South America. It was introduced as aquatic ornamental plant, which grows faster throughout the year. Its widespread

growth is a major cause of biodiversity loss worldwide. It affects the growth of phytoplanktons and finally changing the aquatic ecosystem.

It also decreases the oxygen content of the waterbodies which leads to eutrophication. It poses a threat to human health because it creates a breeding habitat for disease causing mosquitoes (particularly *Anopheles*) and snails with its free floating dense roots and semi submerged leaves. It also blocks sunlight entering deep and the waterways hampering agriculture, fisheries, recreation and hydropower.

Lantana camara

Figure 8.6: *Lantana camara*

Identified as one of the worst invasive species by Global Invasive Species Database. It is also an invasive weed native to South America introduced as ornamental plant. It occupies a widely adaptable range of habitats.

This species is spread by birds It exerts allelopathic effect, which reduces the growth of surrounding plants by inhibiting germination and root elongation. Root removal and bio-control are the best methods to control. Now tribes are trained to use the stem as fibre for making household materials like baskets, furniture and even cots.

Parthenium hysterophorus

Parthenium hysterophorus native to South America introduced accidently into many regions of the world along with imported food grains. It is a harmful weed in the forest which suppresses the growth of native species and reduces the availability of fodder for animals

Figure 8.7: *Parthenium hysterophorus*

It infests pastures and farmland causing often loss of yield. The plant produces allelopathic chemicals that suppress crop and native plants and its pollen causes allergic rhinitis and asthma, dermatitis in humanbeing.

Prosopis juliflora

Figure 8.8: *Prosopis juliflora*

Prosopis juliflora is an invasive species native to Mexico and South America. It was first introduced in Gujarat to counter desertification and later on in Andhra Pradesh, Tamil Nadu as a source of firewood. It is an aggressive coloniser and as a consequence the habitats are rapidly covered by this species. Its invasion reduced the cover of native medicinal herbaceous species. It is used to arrest wind erosion and stabilize sand dunes on coastal and desert areas. It can absorb hazardous chemicals from soil and it is the main source of charcoal.

8.7 Conservation

India due to its topography, geology and climate patterns has diverse life forms. Now this huge diversity is under threat due to many environmental issues for this conservation becomes an important tool by which we can reduce many species getting lost from our native land. By employing conservation management strategies like germplasm conservation, in situ, ex-situ, in-vitro methods, the endemic as well as threatened species can be protected

In-situ conservation

It means conservation and management of genetic resources in their natural habitats. Here the plant or animal species are protected within the existing habitat. Forest trees, medicinal and aromatic plants under threat are conserved by this method. This is carried out by the

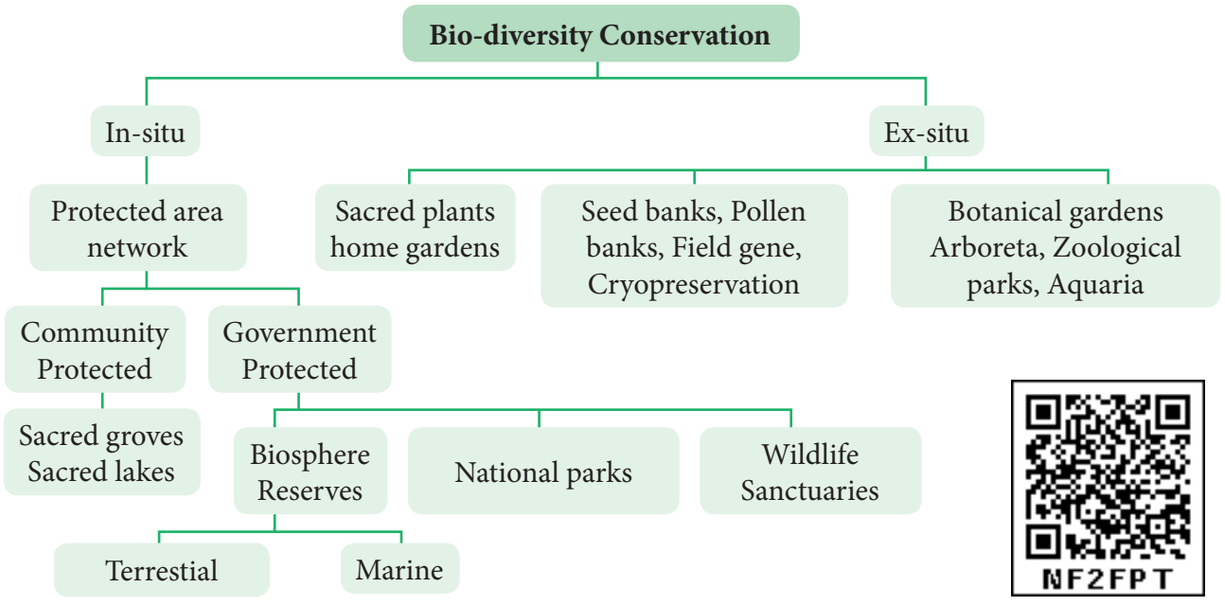


Figure 8.9: Flow chart on biodiversity conservation

community or by the State conservation which include wildlife, National park and Biosphere reserve. The ecologically unique and biodiversity rich regions are legally protected as wildlife sanctuaries, National parks and Biosphere reserves. Megamalai, Sathyamangalam wildlife, Guindy and Periyar National park, and Western ghats, Nilgiris, Agasthyamalai and Gulf of Mannar are the biosphere reserves of Tamil Nadu.

Sacred groves

These are the patches or grove of cultivated trees which are community protected and are based on strong religious belief systems which usually have a significant religious connotation for protecting community. Each grove is an abode of a deity mostly village God Or Goddesses like Aiyanar or Amman. 448 grooves were documented throughout Tamil Nadu, of which 6 groves (Banagudi shola, Thirukurungudi and Udaiyankudikadu, Sittannnavasal, Puthupet and Devadanam) were taken up for detailed floristic and faunistic studies. These groves provide a number of ecosystem services to the neighbourhood like protecting watershed, fodder, medicinal plants and micro climate control.

Ex-situ conservation

It is a method of conservation where species are protected outside their natural environment. This includes establishment of botanical gardens, zoological parks, conservation strategies such as gene, pollen, seed, in-vitro conservation, cryo preservation, seedling, tissue culture and DNA banks. These facilities not only provide housing and care for endangered species, but also have educational and recreational values for the society

8.7.1 International Union for Conservation of Nature (IUCN)

Founded in 1948, the International Union for Conservation of Nature (IUCN) is the world's oldest environmental organisation with its headquarters at Gland, Switzerland. It is a neutral forum for Governments, NGO's, Scientists, business and local communities with the aim of developing solution and implementing policies related to the conservation of environment and sustainable development.

IUCN Red List

IUCN Red List categories help us to evaluate the degree of threat and conservation priorities to the flora and fauna It is also a powerful tool for

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.

persuading governments to protect threatened species and for most of the plant and animal species world-wide. IUCN has developed protected areas and developed criteria for threatened species. The criteria are as follows .

A - Population reduction
B - Geographic range
C - Small population size and decline
D - Very small or restricted population
E - Quantitative analysis

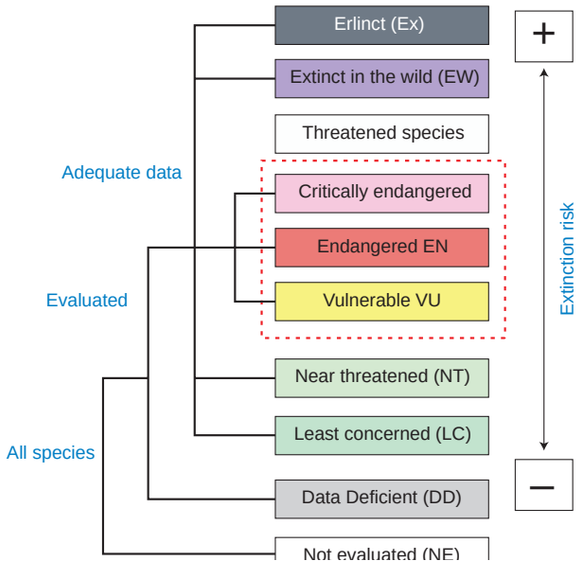


Figure 8.10: IUCN Red List categories

IUCN Red List categories

Extint (EX)

A taxon is Extinct when there is no reasonable doubt on the death of the last individual. A taxon is presumed Extinct when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Example: *Neuracanthus neesianus*.

Extinct in the wild (EW)

A taxon is Extinct in the Wild when it is known only to survive in cultivation, in captivity or as a naturalised population (or populations) well outside the past range. Example: *Ginkgo biloba*

Critically endangered (CR)

A taxon is Critically Endangered when the best available evidence indicates that it meets any of the criteria A to E for Critically Endangered, and it is therefore considered to be facing an extremely high risk of extinctions in the wild. Example: *Euphorbia santapaui, Piper barberi, Syzygium gambelianum.*

Endangered (EN)

A taxon is Endangered when the best available evidence indicates that it meets any of the criteria A to E for Endangered, and it is therefore considered to be facing a very high risk of extinction in the wild. Example: *Elaeocarpus venustus, Pogostemon nilagricus, Eugenia singampattiana.*

Vulnerable (VU)

A taxon is Vulnerable when the best available evidence indicates that it meets any other criteria A to E for Vulnerable, and it is therefore considered to be facing a high risk of extinction in the wild. Example: *Dalbergia latifolia, Santalum album, Chloroxylon sweitenia*

Near threatened (NT)

A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for threatened category in the near future.

Least concerned (LC)

A taxon is Least Concerned when it has been evaluated against the criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened, Widespread and abundant taxa are included in this category.

Data deficient (DD)

A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of the risk of extinction based on its distribution and/or population status.

Not evaluated (NE)

A taxon is Not Evaluated when it has not yet been evaluated against the criteria.

P9U9QT

8.7.2 Endemic Centres and Endemic Plants

Endemic species are plants and animals that exist only in one geographic region. Species can be endemic to large or small areas of the earth. Some are endemic to a particular continent, some to a part of a continent and others to a single island.

Any species found restricted to a specified geographical area is referred to as ENDEMIC.. It may be due to various reasons such as isolation, interspecific interactions, seeds dispersal problems, site specificity and many other environmental and ecological problems. There are 3 Megacentres of endemism and 27 microendemic centres in India. Approximately one third of Indian flora have been identified as endemic and found restricted and distributed in three major phytogeographical regions of india, that is Indian Himalayas, Peninsular India and Andaman nicobar islands. Peninsular India, especially Western Ghats has high concentration of endemic plants. *Hardwickia binata* and *Bentinckia condapanna* are good examples for endemic plants. A large percentage of Endemic species are herbs and belong to families such as Poaceae. Apiaceae, Asteraceae and Orchidaceae.

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

Table 1: Endemic plants

Majority of endemic species are threatened due to their narrow specific habitat, reduced seed production, low dispersal rate, less viable nature and human intereferences.. Serious efforts need to be undertaken for their conservation, otherwise these species may become globally extinct.

Figure 8.11: Endemic Plants

a. *Bentinckia condapanna* **b.** *Baccaurea courtallensis*

8.8 Carbon Capture and Storage (CCS)

Carbon capture and storage is a technology of capturing carbondioxide and injects it deep into the underground rocks into a depth of 1 km or more and it is an approach to mitigate global warming by capturing CO_2 from large point sources such as industries and power plants and subsequently storing it instead of releasing it into the atmosphere. Various safe sites have been selected for permanent storage in various deep geological formations, liquid storage in the Ocean and solid storage by reduction of CO_2 with metal oxide to produce stable carbonates. It is also known as Geological sequestration which involves injecting CO_2 directly into the underground geological formations (such as declining oil fields, gas fields saline aquifers and unmineable coal have been suggested as storage sites).

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.

Carbon Sequestration

Carbon sequestration is the process of capturing and storing CO2 which reduces the amount of CO2 in the atmosphere with a goal of reducing global climate change.

Carbon sequestration occurs naturally by plants and in ocean. Terrestrial sequestration is typically accomplished through forest and soil conservation practices that enhance the storage carbon.

As an example microalgae such as species of *Chlorella*, *Scenedesmus*, *Chroococcus* and *Chlamydomonas* are used globally for CO_2 sequestration. Trees like *Eugenia caryophyllata*, *Tecomastans*, *Cinnamomum verum* have high capacity and noted to sequester carbon macroalgae and marine grasses and mangroves are also have ability to mitigate carbon-di-oxide.

Carbon Foot Print (CFP)

Every human activity leaves a mark just like our footprint. This **Carbon foot print** is the

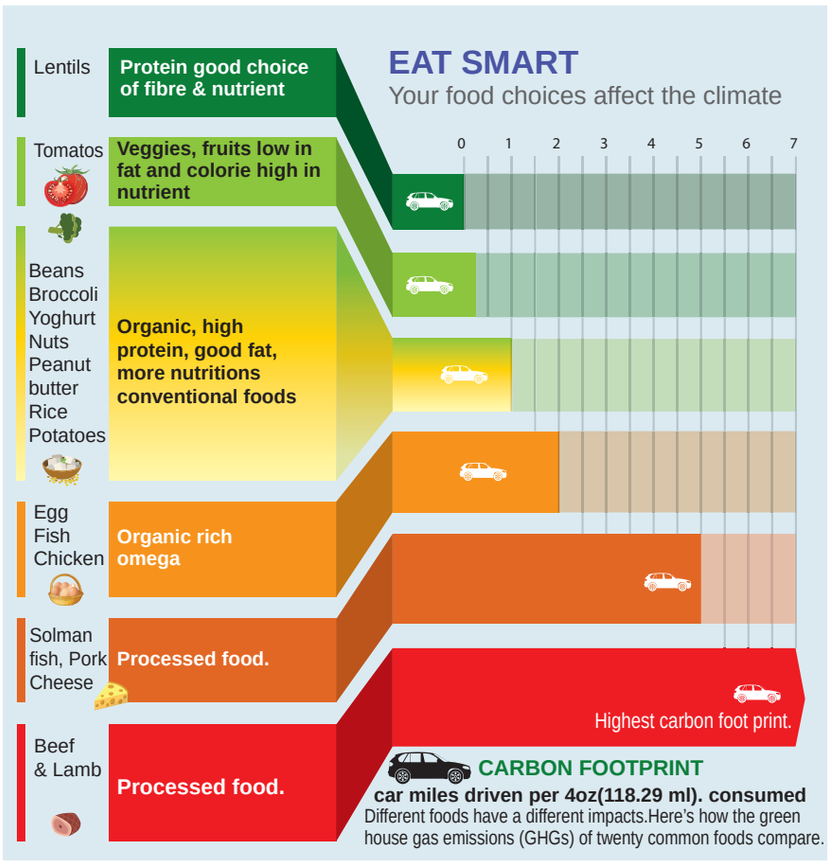


Figure 8.12: Carbon foot print

total amount of green house gases produced by human activities such as agriculture, industries, deforestation, waste disposal, buring fossil fuels directly or indirectly. It can be measured for an individual, family, organisation like industries, state level or national level. It is usually estimated and expressed in equivalent tons of CO_2 per year. The burning of fossil fuels releases $CO_2$and other green house gases. In turn these emissions trap solar energy and thus increase the global temperature resulting in ice melting, submerging of low lying areas and inbalance in nature like cyclones, tsunamis and extreme weather conditions. To reduce the carbon foot print we can follow some practices like (i) Eating indigenous fruits and products (ii) Reduce use of your electronic devices (iii) Reduce travelling (iv) Do not buy fast and preserved, processed, packed foods. (v) Plant a garden (vi) Less consumption of meat and sea food. Poultry requires little space, nutrients and less pollution comparing cattle farming. (vii) reduce use of Laptops (when used for 8 hours, it releases nearly 2 kg. of CO_2 annually) (viii) Line dry your clothes. (Example: If you buy imported fruit like kiwi, indirectly it increases CFP. How? The fruit has travelled a long distance in shipping or airliner thus emitting tons of CO_2)

Biochar

Biochar is another long term method to store carbon. To increase plants ability to store more carbon, plants are partly burnt such as crop waste, waste woods to become carbon rich slow decomposing substances of material called Biochar. It is a kind of charcoal used as a soil amendment. Biochar is a stable solid, rich in carbon and can endure in soil for thousands of years. Like most charcoal, biochar is made from biomass via pyrolysis. (Heating biomas in low oxygen environment) which arrests wood from complete burning. Biochar thus has the potential to help mitigate climate change via carbon sequestration. Independently, biochar when added to soil can increase soil fertility of acidic soils, increase agricultural productivity, and provide protection against some foliar and soil borne diseases. It is a good method of preventing waste woods and logs getting decayed instead we can convert them into biochar thus converting them to carbon storage material.

8.9 Rain water harvesting – RWH (Solution to water crisis – A ecological problem)

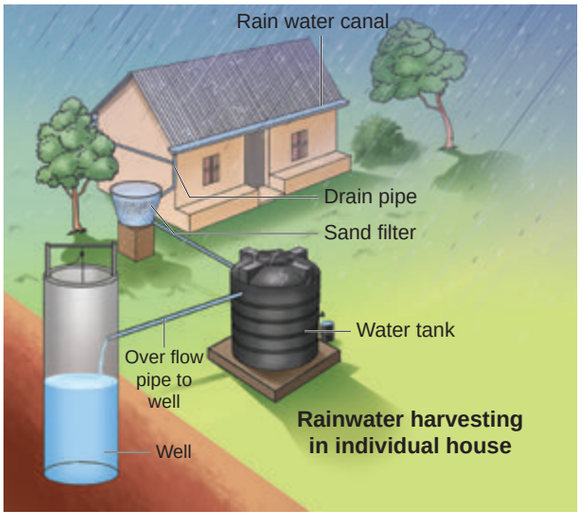


Figure 8.13: Pictures of Rain Water Harvesting Structures in Ooraniers

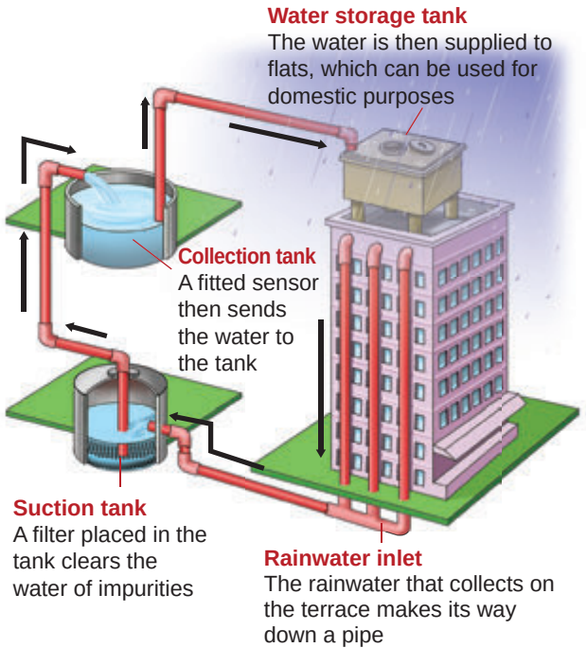


Figure 8.14: Rain Water Harvesting Structures in Water Supply sources

Rainwater harvesting is the accumulation and storage of rain water for reuse in-site rather than allowing it to run off. Rainwater can be collected from rivers, roof tops and the water collected is directed to a deep pit. The water percolates and gets stored in the pit. RWH is a sustainable water management practice implemented not only in urban area but also in agricultural fields, which is an important economical cost effective method for the future.

8.9.1 Environmental benefits of Rain Water Harvesting:

- Promotes adequacy of underground water and water conservation.
- Mitigates the effect of drought.
- Reduces soil erosion as surface run-off is reduced.
- Reduces flood hazards.
- Improves groundwater quality and water table / decreases salinity.
- No land is wasted for storage purpose and no population displacement is involved.
- Storing water underground is an eco-friendly measure and a part of sustainable water storage strategy for local communities.

8.9.2 Importance of Lakes

Water bodies like lakes, ponds not only provide us a number of environmental benefits but they strengthen our economy as well as our quality of life like health. Lakes as a storage of rain water provides drinking water, improves ground water level and preserve the fresh water bio-diversity and habitat of the area where in occurs.

In terms of services lakes offer sustainable solutions to key issues of water management and climatic influences and benefits like nutrient retention, influencing local rainfall, removal of pollutants, phosphorous and nitrogen and carbon sequestration.

Important lakes in Tamil Nadu

Lakes are man-made surface water harvesting systems. They are useful for irrigation, drinking, fishing and recreation purposes. It is the responsibility of the individuals as well as communities collectively to maintain and manage water bodies. Understanding catchment areas help us to halt the degradation of water bodies and protecting it from getting polluted.

Sholavaram Lake : It is located in Ponneri Taluk of Thiruvallur District. It is one of the rain fed reservoir from where water is drawn for supply to Chennai city. The full capacity of the lake is 65.5 ft. Built in the British era this lake is responsible for treating the guests to water sports too. This lake is rich in varied species of flora and fauna.

Chembarampakkam Lake: It is located about 25 km. from Chennai. This lake is 500 yrs old. This lake is a rain fed water body which aids the Chennai City in its water supply. A river named Adyar also incepts from this lake which acts as the primary outflow for this reservoir. This lake is spread over an area of 15 square km.

Figure 8.15: Chembarampakkam Lake

Maduranthakam Lake: It is located in Kancheepuram district and it is a man-made creation. An ideal spot for an evening picnic, the widespread pristine waters of the lake are an exceptionally calming sight. The full capacity of the reservoir is 23.3ft. Kiliyar is a small river that originates from Madhuranthagam reservoir. It spreads to an area of 2908 acres and was built by Uttama Chola and the boundaries (stretched upto 12960 feet) are strengthened by Britishers with a storing capacity of 690 million cu.feet. Rain water from Cheyyar, Thiruvannamalai and Vandavasi reaches this lake.

8.10 Sewage disposal

Sewage disposal treatment helps to transform raw sewage into an easier manageable waste and to retrieve and reuse treated residual sewage materials. Greenhouse gases like carbon-dioxide, methane, nitrous oxide are produced during sewage treatment which apart from causing the impact on the atmosphere, it also affect the urban ecosystem, aquatic ecosystems. By making use of advanced disposal treatment plants, climate change and pollution can be minimised.

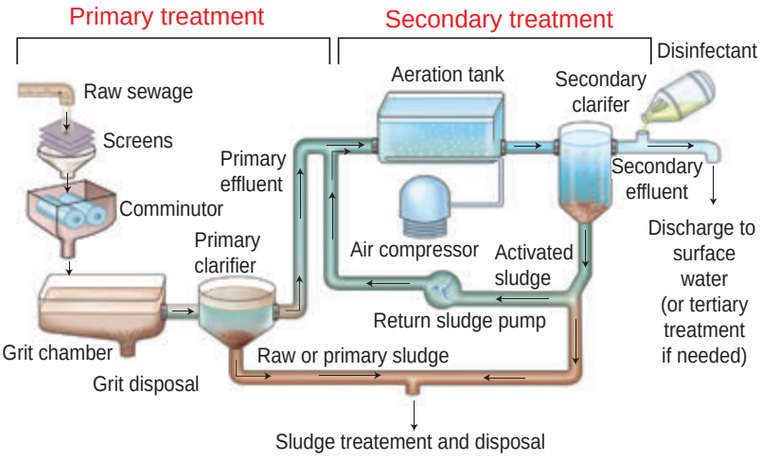


Figure 8.16: Sewage treatment plant process flow diagram

Sewage is waste matter such as faeces or used dirty water from homes and factories, which flows away through sewers. Sewage treatment is the process of removing contaminants from waste water, primarily from household sewage. Physical, chemical and biological processes are used to remove contaminants and produce treated waste water, that is safer for the environment. Sewage contains large amounts of organic matter and microbes. This cannot be discharged into natural water bodies like rivers and streams directly. Hence sewage is treated in sewage treatment plants (STPs) to make it less polluting.

Sewage treatment generally involves three stages, called primary, secondary and tertiary treatment.

Solid waste management

Solid waste refers to all non liquid wastes which causes health problems and unpleasant living environment leading to pollution. Solid waste management is a term that is used to refer to the process of collecting and treating solid wastes. It is all about how it can be changed and recycled as a valuable resource.

Methods of solid waste management includes Landfill, incineration, recovery, recycling, composting, and pyrolysis.

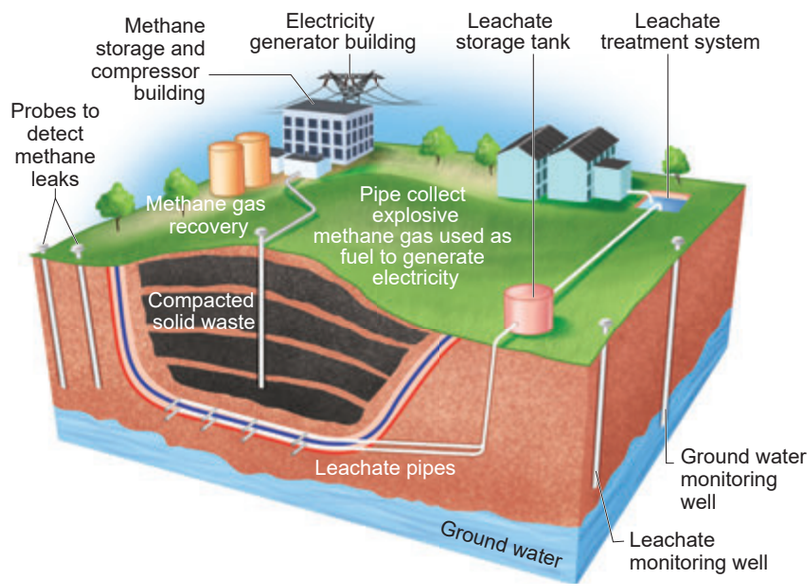


Figure 8.17: Sanitary landfill

- Technological advancement for processing treatment and disposal of solid waste helps in converting it into renewable energy and organic manure.
- Electronic waste contains toxic materials and are found to be non-biodegradable which causes threat to human health and the smoke during recycling and leaching causes great threat to water bodies. Agricultural landfills method stands a good method to reduce these problems.

Liquid Waste Management

Liquid waste includes point source and non-point source discharges such as storm water and waste water. Examples of liquid waste include wash water from homes, liquids, used for cleaning in industries and waste detergents.

Grey water is the one from municipal waste which contains harmful pathogens. Water coming from domestic equipments other than toilets (bathtub, showers, sinks, and washing machine) is also referred as grey water. Municipal wastes can be detoxified biologically and then recycled. Domestic waste water can be recycled and used for gardening.

8.11 Environmental Impact Assessment (EIA)

Environmental Impact Assessment is an environmental management tool. It helps to regulate and recommend optimal use of natural resources with minimum impact on ecosystem and biotic communities. It is used to predict the environmental consequences of future proposed developmental projects (example: river projects, dams, highway projects) taking into account inter-related socio-economic, cultural and human-health impacts. It reduces environmental stress thus helping to shape the projects that may suit local environment by ensuring optimal utilization of natural resources and disposal of wastes to avoid environmental degradation.

The benefits of EIA to society

- A healthier environment
- Maintenance of biodiversity
- Decreased resource usage
- Reduction in gas emission and environment damage

8.11.1 Biodiversity Impact Assessment (BIA)

Biodiversity Impact Assessment can be defined as a decision supporting tool to help biodiversity inclusive of development, planning and implementation. It aims at ensuring development proposals which integrate bio-diversity considerations. They are legally compliant and include mechanisms for the conservation of bio-diversity resources and provide fair and equitable sharing of the benefits arising from the use of bio-diversity.

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.

Figure 8.18: Agricultural drone

Bio-diversity impacts can be assessed by

- Change in land use and cover
- Fragmentation and isolation
- Extraction
- External inputs such as emissions, effluents and chemicals
- Introduction of invasive, alien or genetically modified species
- Impact on endemic and threatened flora and fauna.

8.12. Geographic Information System

GIS is a computer system for capturing, storing, checking and displaying data related to positions

on Earth's surface. Also to manipulate, analyse, manage and present spacial or geographic data.

GPS is a satellite navigation system used to determine the ground position of an object. It is a **constellation** of approximately 30 well spaced satellites that orbit the earth and make it possible for the people with ground receivers to pinpoint their geographic location. Some applications in which GPS is currently being used for around the world include Mining, Aviation, Surveying Agricultural and Marine ecosystem.

Importance of GIS

- Environmental impact assessment
- Disaster management
- Zoning of landslide hazard
- 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 (100th 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. Agrochemicals like fertilizers, pesticides and runoff from fields cause soil infertility and in turn depletes the growth of plants. Help the government to retrieve the vegetation. 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. IUCN is the oldest environmental organisation which protects endemic and threatened species. 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. The lake which was built in British era and is near the Indian Army Base
    a) Veeranam lake
    b) Maduranthagam lake
    c) Sholavaram lake
    d) Chembrambakkam lake

11. 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

12. The invasive species introduced in India from Philippines
    a) Lantana b) Prosopis
    c) Parthenium d) Kappaphycus

13. Cash crops like sesame and pearl millet are inhibited by the invasive plant
    a) Kappaphycus b) Parthenium
    c) Lantana d) Prosopis
14. 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
15. IUCN red list categories has developed criteria for threatened species. The criteria 'C' refers to
    a) Geographic range
    b) Quantitiative analysis
    c) Small population size and decline
    d) population reduction
16. What is ozone hole?
17. Give four examples of plants cultivated in commercial agroforestry.
18. What are agrochemicals?
19. Expand CCS.
20. How do forests help in maintaining the climate?
21. How do sacred groves help in the conservation of biodiversity?
22. Which one gas is most abundant out of the four commonest greenhouse gases? Discuss the effect of this gas on the growth of plants?
23. Distinguish between endangered, vulnerable and rare species.
24. Suggest a solution to water crisis and explain its advantages.
25. Explain afforestation with case studies.
26. 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.

Biodegradable waste: Organic waste, typically coming from a plant or animal sources, which other living organisms can break done.

Biosphere: The portion of earth and its atmosphere that can support life.

Effluent: Liquid waste such as sewage and liquid waste from industries.

Landfill: A site that is specially designed to dispose of waste and operates with a license granted by the Environmental Protection Agency (EPA).

Oil spill: The harmful release of oil into the environment, usually through water, which is very difficult to clean up and often kills, birds, fish and other wildlife.

Radiation: A form of energy that is transmitted in waves, rays or particles from a natural source such as the sun and the ground or an artificial source such as an X-ray machine.

Radioactive: A materials is said to be radioactive if it emits radiation.

Recycle:To break waste items done into their raw materials, which are then used to remake the original item or to make new items.

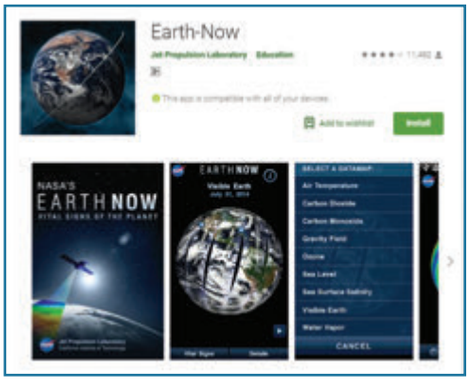
Sewage: Liquid waste from communities which may be a mixture of domestic effluent from homes, and liquid waste from industries.

Sustainable development: Development using hand of energy sources in a way that meets the needs of people today without reducing the ability in future generation to meet their own needs.

ICT Corner

Environmental Issues

Let us know about the Environmental issues using the **EARTH NOW** app through this activity.

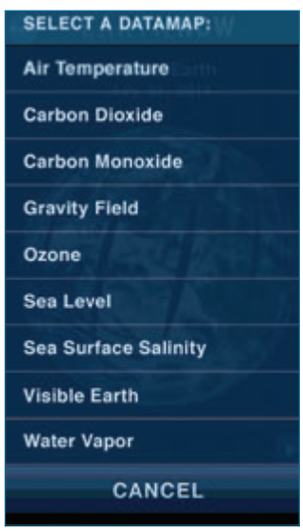


Steps

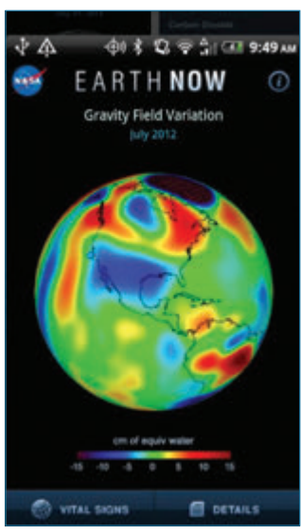
- Type the URL or scan the QR code to open the activity page.
- Click on the satellite it displays the shape and activities of the satellite.
- Click on the Vital Signs to see the global Climate data including surface air temperature, Carbondioxide, Ozone, etc.,

Step 1

Step 2



Step 3



Step 4

URL:

https://play.google.com/store/apps/details?id=gov.nasa.jpl.earthnow.activity

* Pictures are indicative only

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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.
- Realize the importance of seed protection and seed storage.
- Compare the traditional methods of seed storage with modern methods.

Chapter outline

Q4VYTG

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.
- Increased size of fruits and seeds.
- Change from a perennial to annual habit.
- Change in breeding system.
- Increased yield.
- Increased resistance for disease and pest.
- Developing seedless parthenocarpic fruit.
- Enhancing colour, appearance, palatability and nutritional composition.

9.3 Origin of Agriculture

Archeological evidence for earliest record of agriculture is found in the fertile crescent region in and around Tigris and Euphrates river valleys, approximately about 12,000 years ago.

The earlier Greek and Roman naturalists like Theophrastus, Dioscorides, Pliny the elder and Galen laid down the scientific foundation in understanding origin and domestication of cultivated plants.

9.4 History of Agriculture

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

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

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.

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 has given the centre of diversity of a crop species which may be the centre of origin for that species.

Vavilov initially proposed eight main geographic centres of origin originally in 1926. Later (1935) he 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.

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.

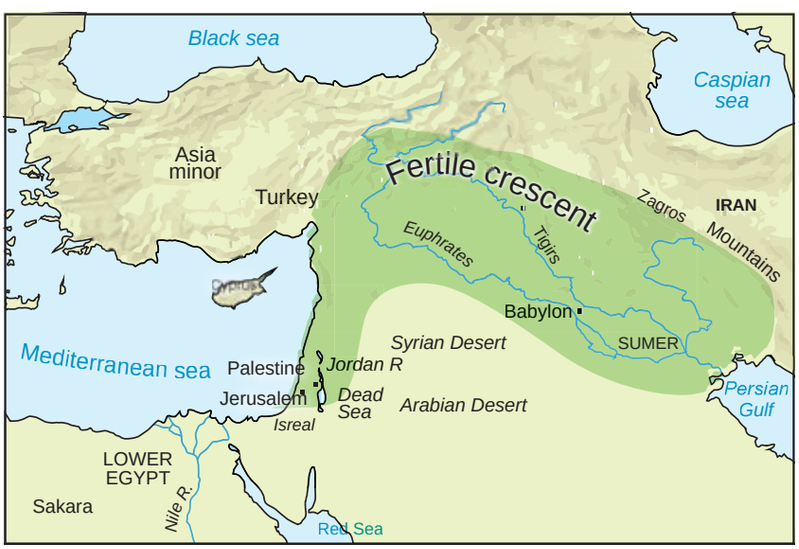


Figure 9.1: Map shows Fertile crescent region

1971 According to 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.

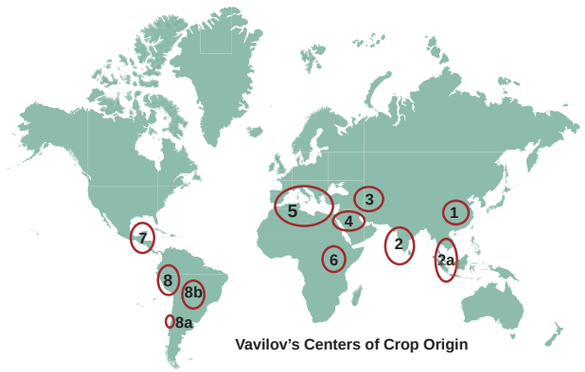


Figure 9.2: Vavilov's centres of crop origin and crops domesticated

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.

9.5 Organic Agriculture

Organic farming is an alternative agricultural system which originated early in the twentieth century in reaction to rapidly changing farming practices. It is a production system that sustains the health of the soils, ecosystems and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions rather than the use of inputs with adverse effects.

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.

9.5.1. Biofertilizers

Biofertilizers are defined as preparations containing living cells or latent cells of efficient strains of microorganisms that help crop plants uptake of nutrients by their interactions in the rhizosphere when applied through seed or soil. Biofertilizers could be also called as microbial cultures, bioinoculants, bacterial inoculants or bacterial fertilizers.

They are efficient in fixing nitrogen, solubilising phosphate and decomposing cellulose. They are designed to improve the soil fertility, plant growth, and also the number and biological activity of beneficial microorganisms in the soil. They are eco-friendly organic agro inputs and are more efficient and cost effective than chemical fertilizers.

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*

Figure 9.3: Classification of Biofertilizers

Rhizobium

Bio-fertilisers containing rhizobium bacteria are called rhizobium bio-fertilizer culture. Symbiotic bacteria that reside inside the root nodules convert the atmospheric nitrogen into a bio available form to the plants. This nitrogen fixing bacterium when applied to the soil undergoes multiplication in billions and fixes the atmospheric nitrogen in the soil. Rhizobium is best suited for the paddy fields which increase the yield by 15 – 40%.

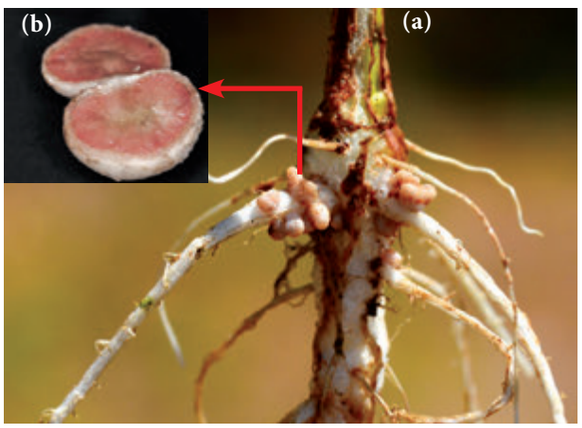


Figure 9.4 (a) : Root nodules occur on root
(b) C.S. of Root nodule

Azolla

Azolla is a free-floating water fern that fixes the atmospheric nitrogen in association with nitrogen fixing blue green alga *Anabaena azolla*. It is used as a bio-fertilizer for wetland rice cultivation and is known to contribute 40 – 60 kg/ha/crop. The agronomic potential of Azolla is quite significant particularly for increasing the yield of rice crop, as it quickly decompose in soil.

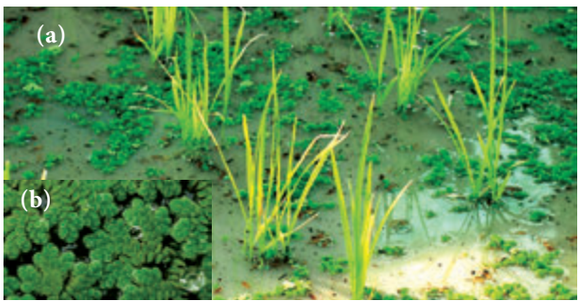


Figure 9.5: (a) *Azolla* in paddy field
(b) *Azolla*

Arbuscular mycorrhizae

Arbuscular mycorrhizae (AM) is formed by the symbiotic association between certain phycomycetous fungi and angiosperm roots. They have the ability to dissolve the phosphates found in abundance in the soil.

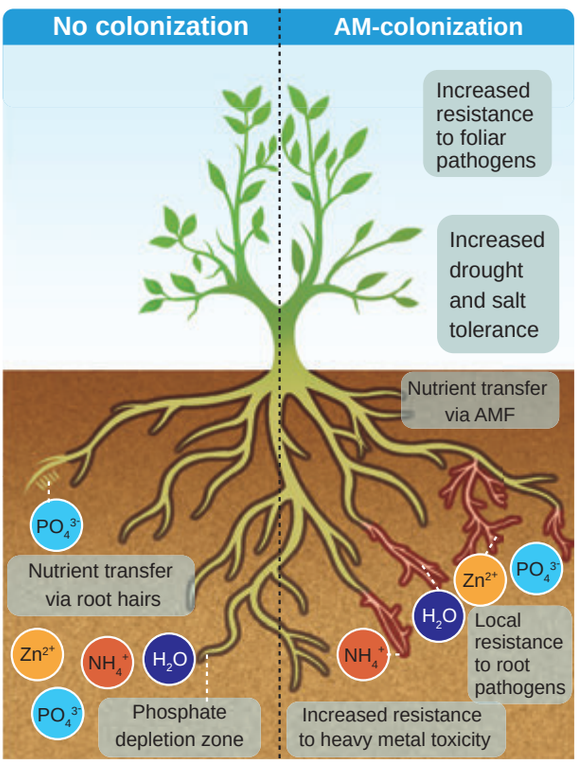


Figure 9.6 Benefits of AM colonisation

Apart from increasing the availability of phosphorus, AM provides necessary strength to resist disease, germs and unfavourable weather conditions. It also assures water availability.

Seaweed Liquid Fertilizer

Seaweed liquid fertilizer (SLF) contains cytokinin, gibberellins and auxin apart from macro and micro nutrients. Most seaweed based fertilizers are made from kelp (brown algae) which grows to length of 150 metres. Liquid seaweed fertilizer is not only organic but also eco-friendly. The alginates in the seaweed that reacts with metals in the soil and form long, cross-linked polymers in the soil. These polymers improve the crumbing in the soil, swell up when they get wet and retain moisture for a long time. They are especially useful in organic gardening which provides carbohydrates for plants. Seaweed has more than 70 minerals, vitamins and enzymes. It promotes vigorous growth. Improves resistance of plants to frost and disease. Seeds soaked in seaweed extract germinate much rapidly and develop a better root system.

Figure 9.7 : Seaweed – Kelp

Bio-Pesticides

Bio-pesticides are biologically based agents used for the control of plant pests. They are in high use due to their non-toxic, cheaper and eco-friendly characteristics as compared to chemical or synthetic pesticides. Bio-pesticides have become an integral component of pest management in terms of the environmental and health issues attributed to the use of chemicals in agriculture.

Trichoderma species are free-living fungi that are common in soil and root ecosystem. They have been recognized as bio-control agent for (1) the control of plant disease (2) ability to enhance root growth development (3) crop productivity (4) resistance to abiotic stress and (5) uptake and use of nutrients.

Figure 9.8:
(a) *Trichoderma* fungi

Figure 9.8:
(b) Biopesticide

Beauveria species is an entomo-pathogenic fungus that grows naturally in soils throughout the world. It acts as a parasite on various arthropod species causing white muscardine disease without affecting the plant health and growth. It also controls damping off of tomato caused by *Rhizoctonia solani*.

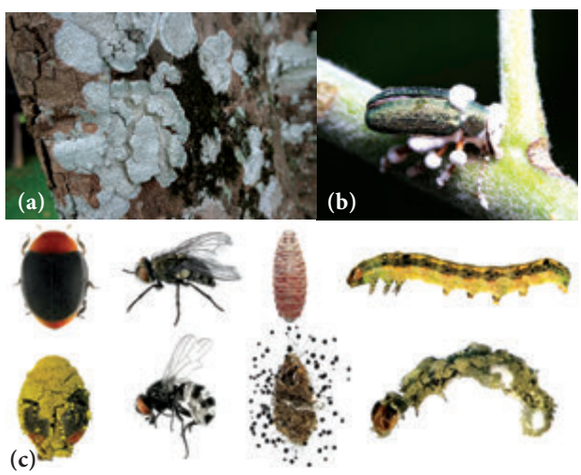


Figure 9.9 : (a) *Beauveria* Fungi
(b) *Beauveria* sps infected insect on green plant
(c)Entomopathogenic fungi on insets

Green Manuring

Green manuring is defined as the growing of green manure crops and use of these crops directly in the field by ploughing. One of the main objectives of the green manuring is to increase the content of nitrogen in the soil. Also it helps in improving the structure and physical properties of the soil. The most important green manure crops are *Crotalaria juncea, Tephrosia purpurea, Indigofera tinctoria*

The green manuring can be practised as Green in-situ manuring or Green leaf manuring. Green in-situ manuring refers to the growing of green manuring crops in the border rows or as intercrops along with the main crops. Example: Sun hemp, Cowpea, Green gram etc. whereas green leaf manuring is the application of green leaves and twigs of trees, shrubs, plants growing in wastelands and field bunds. The important plant species useful for green leaf manure are *Cassia fistula*, *Sesbania grandiflora, Azadirachta indica, Delonix regia, Pongamia pinnata* etc.,

9.6 Plant Breeding

Plant breeding is the science of improvement of crop varieties with higher yield, better quality, resistance to diseases and shorter durations which are suitable to particular environment. In other words, it is a purposeful manipulation of plant species in order to create desired genotype and phenotype for the benefit of humans. In early days, plant breeding activities were based mainly on skills and ability of person involved. But as the principles of genetics and cytogenetics have elucidated breeding methods such as selection, introduction, hybridization, ploidy, mutation, tissue culture and biotechnology techniques were designed to develop improved crop varieties.

9.6.1. Objectives of Plant Breeding

- To increase yield, vigour and fertility of the crop
- To increase tolerance to environmental condition, salinity, temperature and drought.
- To prevent the premature falling of buds, fruits etc.
- To improve synchronous maturity.
- To develop resistance to pathogens and pests.
- To develop photosensitive and thermos-sensitive varieties.

QYNSUG

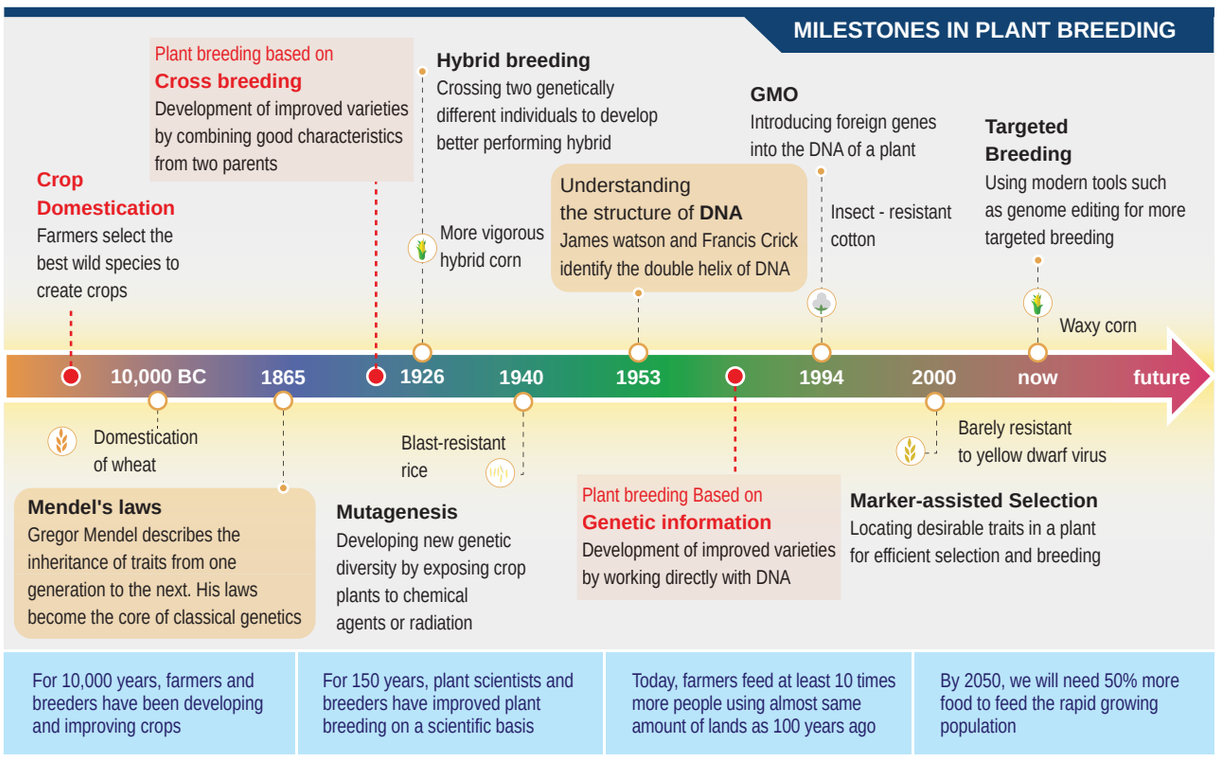


Figure 9.10 : Milestones in Plant Breeding

9.6.2. Steps in Plant Breeding

The main steps in plant breeding are given below

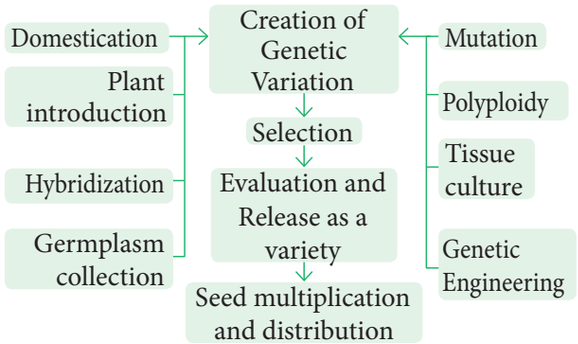


Figure 9.11 : Steps in Plant Breeding

9.7 Conventional Plant Breeding Methods

Conventional plant breeding methods resulting in hybrid varieties had a tremendous impact on agricultural productivity over the last decades. It develops new plant varieties by the process of selection and seeks to achieve expression of genetic material which is already present within the species. In this chapter we will discuss about some of the conventional methods of plant breeding.

9.7.1. Plant Introduction

Plant introduction may be defined as the introduction of genotypes from a place where it is normally grown to a new place or environment. Rice variety of IR8 introduced from Philippines and Wheat varieties of Sonora 63, Sonora 64 from Mexico.

The newly introduced plant has to adapt itself to the new environment. This adjustment or adaptation of the introduced plant in the changed environment is called **acclimatization.** All the introductions must be free from presence of weeds, insects and disease causing organisms. This has to be carefully examined by the process called **quarantine**, a strict isolation imposed to prevent the spread of disease.

Introduction may be classified as Primary introduction and Secondary introduction

(1) **Primary introduction** - When the introduced variety is well adapted to the new environment without any alternation to the original genotype.

(2) **Secondary introduction** - When the introduced variety is subjected to selection to isolate a superior variety and hybridized with a local variety to transfer one or a few characters to them. The botanical garden in different parts of the world also played a significant role in plant introduction. Example : Tea varieties collected from China and North East India initially grown in Botanical Garden of Kolkata from which appropriate clones have selected and introduced to different parts of India.

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

9.7.2. Selection

Selection is the choice of certain individuals from a mixed population for a one or more desirable traits. Selection is the oldest and basic method of plant breeding. There are two main types of Selection.

i. **Natural Selection:** This is a rule in the nature and results in evolution reflected in the Darwinian principle "survival of the fittest". It takes longer time in bringing about desired variation.

ii. **Artificial Selection:** It is a human involved process in having better crop from a mixed population where the individuals differ in character. The following are the three main types of artificial selection.

a. **Mass Selection:** In mass selection a large number of plants of similar phenotype or morphological characters are selected and their seeds are mixed together to constitute a new variety. The population obtained

from the selected plants would be more uniform than the original population and are not individually tested. After repeated selection for about five to six years, selected seeds are multiplied and distributed to the farmers. The only disadvantage of mass selection is that it is difficult to distinguish the hereditary variation from environmental variation.

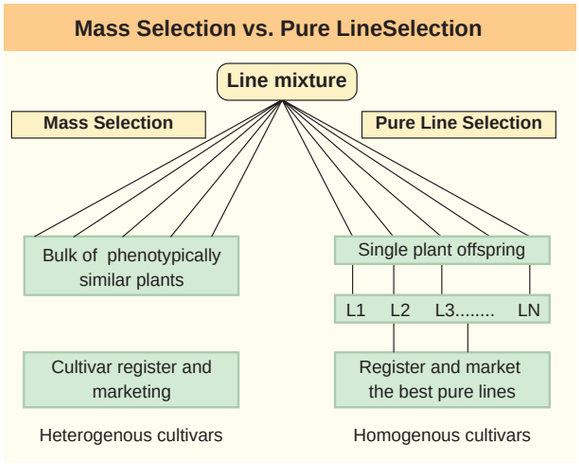


Figure 9.12 : Mass selection vs Pureline selection

b. Pureline selection: Johannsen in 1903 coined the word pureline. It is a collection of plants obtained as a result of repeated self-pollination from a single homozygous individual. Hence, a variety formed by this method shows more homozygosity with respect to all genes. The disadvantage of this type is that the new genotypes are never created and they are less adaptable and less stable to the environmental fluctuations.

c. Clonal Selection: In asexually propagated crop, progenies derived from a plant resemble in genetic constitution with the parent plant as they are mitotically divided. Based on their phenotypic appearance, clonal selection is employed to select improved variety from a mixed population (clones). The selected plants are multiplied through vegetative propagation to give rise to a clone. The genotype of a clone remains unchanged for a long period of time.

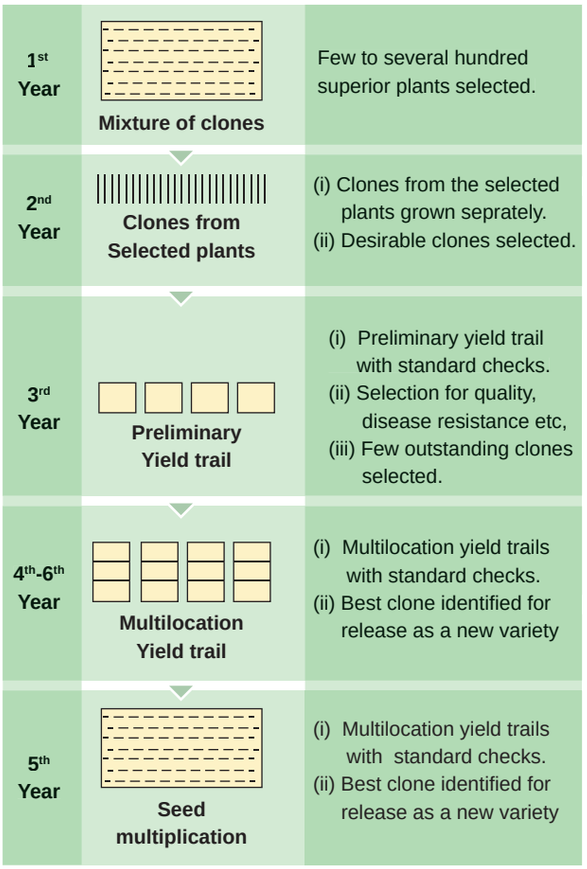


Figure 9.13 Clonal Selection

9.7.3. Hybridization

Hybridization is the method of producing new crop varieties in which two or more plants of unlike genetically constitution is crossed together that result in a progeny called hybrid. Hybridization offers improvement in crop and is the only effective means of combining together the desirable characters of two or more varieties or species. The first natural hybridization was observed by Cotton Mather in maize.

Steps in Hybridization

Steps involved in hybridization are as follows.

1. **Selection of Parents:** Male and female plants of the desired characters are selected. It should be tested for their homozygosity.
2. **Emasculation:** It is a process of removal of anthers to prevent self pollination before anthesis (period of opening of a flower)
3. **Bagging:** The stigma of the flower is protected against any undesirable pollen grains, by covering it with a bag .

Figure 9.14 a & b: Emasculation and Bagging (Wheat)

4. **Crossing:** Transfer of pollen grains from selected male flower to the stigma of the female emasculated flower.
5. **Harvesting seeds and raising plants**: The pollination leads to fertilization and finally seed formation takes place. The seeds are grown into new generation which are called hybrid.

Types of Hybridization

According to the relationship between plants, the hybridization is divided into.

i. **Intravarietal hybridization** - The cross between the plants of same variety. Such crosses are useful only in the self-pollinated crops.

ii. **Intervarietal hybridization** - The cross between the plants belonging to two different varieties of the same species and is also known as intraspecific hybridization. This technique has been the basis of improving self-pollinated as well as cross pollinated crops

iii. **Interspecific hybridization** - The cross between the plants belonging to different species belonging to the same genus is also called intragenic hybridization. It is commonly used for transferring the genes of disease, insect, pest and drought resistance from one species to another. **Example:** Gossypium hirsutum x Gossypium arboreum – Deviraj.

Figure 9.15 Flower -
(a) *G. hirsutum* (b) *G. arboreum*

iv. **Intergeneric hybridization** – The crosses are made between the plants belonging to two different genera. The disadvantages are hybrid sterility, time consuming and expensive procedure. **Example:** Raphanobrassica, Triticale. (Refer chapter 4 for detail illustration)

9.7.4. Heterosis

Heterosis (hetero- different; sis - condition) G.H. Shull was the first scientist to use the term heterosis in 1912. The superiority of the F1 hybrid in performance over its parents is called heterosis or hybrid vigour. Vigour refers to increase in growth, yield, greater adaptability of resistance to diseases, pest and drought. Vegetative propagation is the best suited measure for maintaining hybrid vigour, since the desired characters are not lost and can persist over a period of time. Many breeders believe that its magnitude of heterosis is directly related to the degree of genetic diversity between the two parents. Depending on the nature, origin, adaptability and reproducing ability heterosis can be classified as:

i. Euheterosis- This is the true heterosis which is inherited and is further classified as:

a. Mutational Euheterosis - Simplest type of euheterosis and results from the sheltering or eliminating of the deleterious, unfavourable often lethal, recessive, mutant genes by their adaptively superior dominant alleles in cross pollinated crops.

b. Balanced Euheterosis – Well balanced gene combinations which is more adaptive to environmental conditions and agricultural usefulness.

ii. Psuedoheterosis – Also termed as luxuriance. Progeny possess superiority over parents in vegetative growth but not in yield and adaptation, usually sterile or poorly fertile.

9.7.5. Mutation Breeding

Muller and Stadler (1927- 1928) coined the term mutation breeding. It represents a new method of conventional breeding procedures as they have the advantage of improving the defect without losing agronomic and quality character in agriculture and crop improvement. Mutation means the sudden heritable changes in the genotype or phenotype of an organism. Gene mutations are of considerable importance in plant breeding as they provide essential inputs for evolution as well as for re-combination and selection. It is the only method for improving seedless crops.

Radiation such as UV short wave, X-ray, Alpha (α), Beta (β), Gamma waves and many chemicals such as cesium, EMS (ethyl methane sulfonate), nitromethyl, urea induces mutation to develop new variety of crops. **Example:** Triple gene dwarf wheat with increase in yield and height. Atomita 2 - rice with saline tolerance and pest resistance.

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.

9.7.6. Polyploid Breeding

Majority of flowering plants are diploid (2n). The plants which possess more than two sets of chromosome are called polyploids. Polyploidy is a major force in the evolution of both wild and cultivated plants. Polyploidy often exhibit increased hybrid vigour increased heterozygosity, increase the tolerance to both biotic and abiotic stresses, buffering of deleterious mutations. In addition, polyploidy often results in reduced fertility due to meiotic error allowing the production of seedless varieties.

When chromosome number is doubled by itself in the same plant, is called autopolyploidy. Example: A triploid condition in sugarbeets, apples and pear has resulted in the increase in vigour and fruit size, large root size, large leaves, flower, more seeds and sugar content in them. It also resulted in seedless tomato, apple, watermelon and orange. Polyploidy can be induced by the use of colchicine to double the chromosome number. Allopolyploids are produced by multiplication of chromosome sets that are initially derived from two different species. Example: Triticale (Triticum durum x secale cereale) Raphanobrassica (Brassica oleraceae x Raphanus sativus).

9.7.7. Green Revolution

Green revolution the term was coined by William S.Gaud in (1968). It is defined as the cumulative result of a series of research, development, innovation and technology transfer initiatives. Agricultural production (especially wheat and rice) manifolds worldwide particularly in the developing countries between the 1940's and the late 1960's.

The Green revolution or third Agricultural Revolution is the intensive plan of 1960's to increase crop yield in developing countries by introducing the high yielding, resistant varieties, increased irrigation facilities, fertilizer application and better agricultural management. The scheme began in Mexico in 1940's and was successfully introduced in parts of India, Asia, Middle East and Latin America. Dr.B.P Pal the Director of IARI, requested M.S.Swaminathan to arrange for Dr.NE Borlaug visit to India and for obtaining a wide range of dwarf wheat possessing the Norin 10 dwarfing genes from Mexico.

In 1963 semi-dwarf wheat of Mexico was introduced from which India got five prolonged strategies for breeding a wide range of high varieties like Sonora 64, Sonalika and Kalyansona possessing a broad spectrum of resistance to major biotic and abiotic condition. Same as wheat M.S.Swaminathan produced the first semi-dwarf fertiliser responsive hybrid variety of rice_TNI (Taichung Native-1) in 1956 from Taiwan. The derivatives were introduced in 1966. Later better yielding semi dwarf varieties of rice Jaya and Ratna developed in India.

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.

Plant Breeding for Developing Resistance to diseases

Some crop varieties bred by hybridization and selection, for disease resistance to fungi, bacteria and viral diseases are released (Table 9.1).

Crop	Variety	Resistance to diseases
Wheat	Himgiri	Leaf and Stripe rust, hill bunt
Brassica	Pusa swarnim (Kara rai)	White rust
Cauliflower	Pusa Shubhra, Pusa snowball K-1	Black rot and curl blight black rot
Cowpea	Pusa Komal	Bacterial blight
Chilli	Pusa Sadabahar	Chilly mosaic virus, Tobacco mosaic virus and Leaf curl.

Table 9.1 Disease resistance varieties

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.

Biofortification – breeding crops with higher levels of vitamins and minerals or higher protein and healthier fats – is the most practical means to improve public health.

Breeding for improved nutritional quality is undertaken with the objectives of improving

- Protein content and quality
- Oil content and quality
- Vitamin content and
- Micronutrient and mineral content

In 2000, maize hybrids that had twice the amount of amino acids, lysine and tryptophan, compared to existing maize hybrids were developed. Wheat variety, Atlas 66 having a high protein content, has been used a donor for improving cultivated wheat. It has been possible to develop an iron fortified rice variety containing over five times as much iron as in commonly consumed varieties.

The Indian Agricultural Research Institute, New Delhi has also released several vegetable crops that are rich in vitamins and minerals, example: vitamin A enriched carrots, spinach, pumpkin; vitamin C enriched bitter gourd, bathua, mustard, tomato; iron and calcium enriched spinach and bathura; and protein enriched beans – broad, lablab, French and garden peas.

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.

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

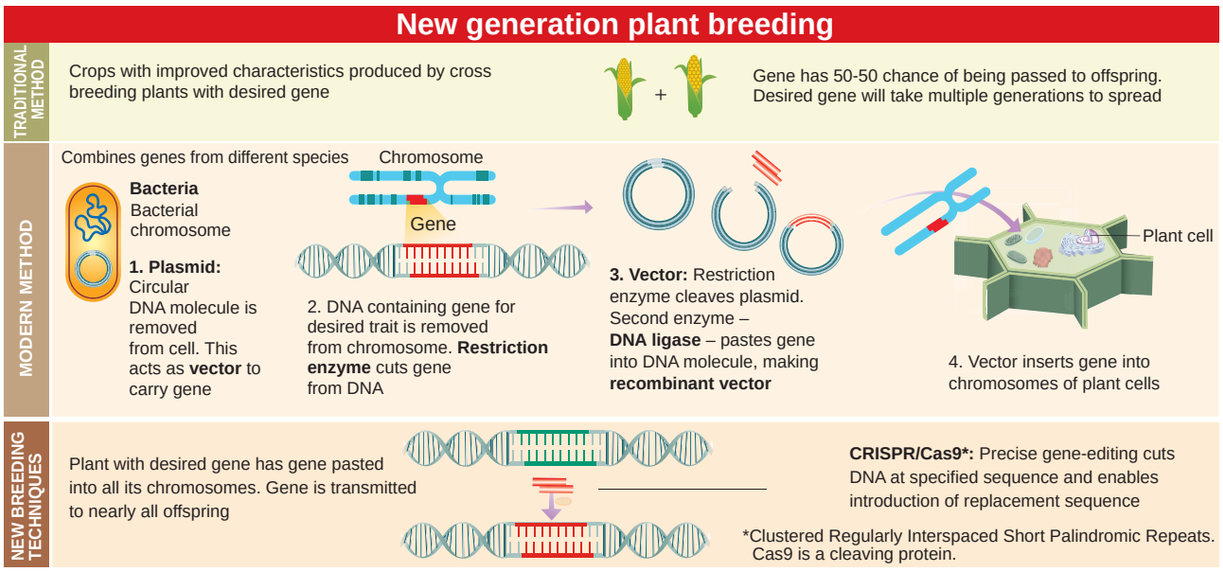


Figure 9.16 Sequential development of plant breeding techniques

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).

RE7MVS

9.9 Seed Protection

Seed is one of the most crucial elements in the livelihoods of agricultural communities. It is the repository of the genetic information of crop species and their varieties resulting from the continuous improvement and selection over the time. The potential benefits of seed to crop productivity and food security can be enormous. Crop protection products can be applied during the growth of the crop or added to the seed. Seed protection play a significant role in improving the establishment of healthy crops. Protection and storage of seeds can be done by traditional and modern methods.

9.9.1. Traditional methods of Seed Protection

- In traditional method seeds are coated with fine red soil, Guntur Chilli Powder, Neem leaf Powder, Powder of Bittergourd, Drumstick extract, Pongamia leaf extract and stored for short duration.
- Paddy Seeds are immersed in salt water in the ratio of 1:10 to remove the floating chaffy seed and then dried in shade for one -two years of storage.
- Sorghum seeds were treated with lime water (1 kg of lime in 10 litres of H_20) for 10 days and then the seeds are dried and stored.
- Chickpea were treated with citronella leaf oil, cotton seed oil, soya bean oil, castor seed oil (500 ml of oil for 100 kg of seed).
- Sunflower seeds were kept inside the dried fruit of sponge gourd after removing the seeds. These fruits were kept in an airtight container.

9.9.2. Modern Methods of Seed Protection

The various modern methods of seed protection are as follows:

1. Seed Treatment

In agriculture and horticulture, seed treatment or seed dressing is a chemical, typically antimicrobial or antifungal, with which seeds are treated (or dressed) prior to planting.

Benefits of seed treatment

- Prevents spread of plant disease.
- Protects seed from seedling blights.
- Improves germination.
- Provides protection from storage insects.
- Controls soil insects.

2. Seed Hardening

Seed hardening is a physiological preconditioning of the seed by soaking of seed in water or chemical solution for definite duration in proper ratio (Seed : Solution) and shade drying to bring back the seed to original moisture content.

Benefits:

- It increases the yield, root growth and vigour of seed germination
- The uniformity of seedling emergence.
- Flowering occurs 2-3 days earlier
- Uniform seed set and maturity
- Exposes the seed to drought tolerance.

3. Seed Pelleting

The process of enclosing seed in a filter inert material using an adhesive with bioactive chemicals. Seed pelleting increases the weight, size and shape of seeds by allowing percale maturing and spacing of seed in the field.

4. Seed coating

Seed coating is a thicker form of covering of seed and may contain fertilizer, growth promoters, rhizobium inoculum, nutritional elements and repulsive agents. Chemical, pesticides added to the seed by adhesive agents cause increased seed performance and seed germination.

5. Bio Priming of Seeds

Bio-Priming is a process of biological seed treatment that refers to combination of seed hydration (physiological aspect of disease control) and inoculation (biological aspect of disease control) of seed with beneficial organism to protect seed. It is an ecological approach using selected fungal antagonists against the soil and seed borne pathogens. This seed treatments may provide an alternative to chemical control.

9.10 Seed Storage

Storage starts in the mother plant itself when it attains physiological maturity. Storage may be defined as the preservation of viable seeds from the time of collection until they are required for sowing. After harvesting the seeds are either stored in ware houses or in transit or in retail shop.

9.10.1. Classification of seeds based on storage

SEED STORAGE
Roberts (1973) classified seeds based on physiological behaviour during storing

ORTHODOX SEED	RECALCITRANT SEED
Seeds dried to low moisture of 5% (wet basis) and stored at low or Sub-freezing temperature for long period. Example:Cereals, pulses and oil seeds.	Seeds dried to high moisture of 20 - 50% (wet basis) and which cannot be successfully stored for long period. Example: Mango, Jack fruit, Coconut etc

SEED STORAGE
Ewart (1908) classified seeds into 3 categories based on life span or longitivity

Micro biotic:
Seed life span not exceeding 3 years.
Mesobiotic:
Seed life span not exceeding from 3 to 15 years.
Macrobiotic:
Seed life span not exceeding from 15 years to over 1000 years.

9.10.2. Methods of Seed Storage

i. Conventional Methods of Seed Storage

Conventional storage includes storage in Bamboo structure, mud and earthen structure, wooden structure and underground structure. In village level storage is done in large level in concrete/ cement silos, Metal or plastic drums and metal silos. Improved rural level storage structure includes storage in coal tar drum, udaipur bin, bamboo bin, pusa bin and metal bins.

ii. Modern Methods of Seed Storage

a. Seed storage in cryopreservation: It is the technique of germplasm conservation (storage of cells, tissue, embryo or seeds) by ultra-low temperature in liquid nitrogen at -196oC. It is not practical for commercial seed storage purpose, but is useful to store the valuable germplasm for use in future which cannot be preserved by conventional methods.

b. Seed storage in gene bank: In gene bank, seed storage is the preservation of seed under controlled environmental condition which will prolong the viability of the seeds for long periods. The temperature, relative humidity and seed moisture content. Containers and distribution arrangement vary for each and every type of seed.

c. Svalbard seed bank:

The seeds are stored in four ply sealed envelopes, and then placed into plastic tote containers on metal shelving racks. The storage rooms are kept at -18°C. The low temperature and limited access to O_2 will ensure low metabolic activity and delayed seed ageing. The permafrost surrounding will help to maintain low temperature of the seed when the electricity supply fails.

Figure 9.17 Svalbard seed bank

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.

9.10.3. Seed Certification

Seed certification is a legally sanctioned system for quality control of seed multiplication and production. The purpose of this certification is to maintain the seeds and make them available to the public. Through certification, high quality seeds and propagating materials of notified kind and variety are grown and distributed to ensure genetic identity and purity.

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 is 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.

Seed is an important part of the plant as it gives the food for future generation, so it should be carefully protected and stored. Seed hardening, seed treatment, seed pelleting, seed coating and bio priming of seeds are the modern methods of seed protection. Seeds are stored in bamboo structure, mud or earthen structure in conventional method of storage. In villages, the farmers store the entire seeds in concrete / cement silos or metal or plastic drums. In modern methods of storage we have cryo preservation, gene bank and Svalbard seed bank for long time seed storage.

Evaluation

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

15. A wheat variety, Atlas 66 which has been used as a donor for improving cultivated wheat, which is rich in
    a) iron b) carbohydrates
    c) proteins d) vitamins

16. Which one of the following crop varieties correct matches with its resistance to a disease?

Variety	Resistance to disease
a) Pusa Komal	Bacterial blight
b) Pusa Sadabahar	White rust
c) Pusa Shubhra	Chilli mosaic virus
d) Brassica	Pusa swarnim

17. Which of the following is incorrectly paired?
    a) Wheat - Himgiri
    b) Milch breed - Sahiwal
    c) Rice - Ratna
    d) Pusa Komal - Brassica

18. Match list I with list II

List I	**List II**
Biofertilizer	**Organisms**
i) Free living N2	a) *Aspergillus*
ii) Symbiotic N2	b) *Amanita*
iii) P Solubilizing	c) *Anabaena azollae*
iv) P Mobilizing	d) *Azotobactor*

    a. ic, iia, iiib, ivd b. id, iic, iiia, ivb.
    c. ia, iic, iiib, ivd c. ib, iia, iiid, ivc.

19. List the ways by which seeds can be stored for longer duration.

20. Differentiate primary introduction from secondary introduction.

21. How are microbial innoculants used to increase the soil fertility?

22. Discuss the importance of neem in seed storage?

23. What are the different types of hybridization?

24. Explain the best suited type followed by plant breeders at present?

25. Write a note on heterosis.

26. List out the new breeding techniques involved in developing new traits in plant breeding.

Glossary

Acclimatization : The adaptation of an individual to a changed climate or the adjustment of a species or a population to a changed environment over a number of generations.

Agronomy : Science of farming

Anthesis : Period of opening of flower.

Certified seed : Seed produced from the foundation or certified seed under the regulation of a legally constituted agency.

Germplasm Collection : The entire collection (of plants / seeds) having all the diverse alleles for all genes in a given crop is called **germplasm collection.**

Non recurrent parent : The parent of a hybrid that is not again used as a parent in backcrossing

Pure-Line: Progeny of a single self-fertilised homozygous individual.

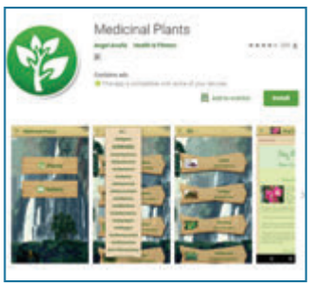
Quarantine : Strict isolation imposed to prevent the spread of disease

Strain : A group of similar individuals from a common origin.

ICT Corner

Plant Breeding

Let us know about the details of Medicinal Plants in detail.



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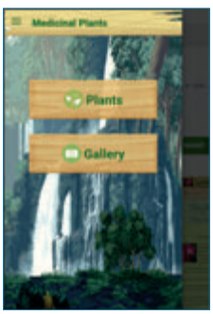
Steps

- Type the URL or scan the QR code to open the activity page then Introduction page will open.
- Click on 'Plants' it will display list of Medicinal Plants.
- Click on each plants individually on the next screen it displays the description, harvesting and properties of the plants.
- Click the option on the top left side of the front page to see the preparation of oils, Powder etc.,



Step 1

Step 2

Step 3

Step 4

* Pictures are indicative only

URL:
https://play.google.com/store/apps/details?id=com.dssoft.plantasmedicinales

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.
- Develop skill of mushroom cultivation, knowledge of SCP production and sea weed liquid fertilizers
- Gains knowledge of organic farming- bio fertilisers and bio pest repellants.
- Learn to make terrarium and bonsai
- Acquires knowledge of cultivation of medicinal plants.

Chapter outline

SNIBY4

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:

i. Greater adaptability and successful colonisation on every type of habitat.

ii. The relative ease of cultivation

iii. Tillering property that produce more branches which results in higher yield per unit area.

iv. Compact and dry grains that they can be easily handled, transported and stored without undergoing spoilage.

v. High caloric value that provides energy.

The nutrients provided by cereals include carbohydrates, proteins, fibres and a wide range of vitamins and minerals. Cereals can be classified into two different types based on their size namely Major Cereals and Minor Cereals.

Major Cereals

Rice / Paddy

Botanical name : *Oryza sativa*

Paddy is a semi-aquatic crop and is grown in standing water. It is an important food crop of the world, occupying the second position in terms of area under cultivation and production, next to wheat. Rice is the chief source of carbohydrate.

Origin and Area of cultivation

South East Asia is considered as the center of origin of rice. Earliest evidences of rice cultivation have been found in China, India and Thailand. It is mainly cultivated in Delta and irrigated regions of Tamil Nadu.

Uses

Rice is the easily digestible calorie rich cereal food which is used as a staple food in Southern and North East India. Various rice products such as **Flaked rice** (Aval), **Puffed rice / parched rice** (Pori) are used as breakfast cereal or as snack food in different parts of India.

Rice bran oil obtained from the rice bran is used in culinary and industrial purposes.

Husks are used as fuel, and in the manufacture of packing material and fertilizer.

International Rice Research Institute (IRRI)

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.


Rice


Wheat


Maize

Figure 10.1: Major Cereals

Wheat

Botanical name : *Triticum aestivum*

Origin and Area of cultivation

Earliest evidence for wheat cultivation comes from Fertile Crescent region. The common cultivated wheat, *Triticum aestivum* is cultivated for about 7,500 years. Wheat is mostly cultivated in the North Indian states such as Uttar Pradesh, Punjab, Haryana, Rajasthan, Madhya Pradesh and Bihar.

Uses

Wheat is the staple food in Northern India. Wheat flour is suitable to make bread and other bakery products. Processed wheat flour, that has little fibre, is called Maida which is used extensively in making parota, naan and bakery products. Malted wheat is a major raw material for producing alcoholic beverages and nutritive drinks.

Maize / Corn

Botanical name : *Zea mays*

Origin and Area of Cultivation

Maize is the only cereal that has originated and domesticated from the New World. Madhya Pradesh, Himachal Pradesh and Punjab are the major maize producing states of India. Whereas Perambalur, Ariyalur, Cuddalore, Dindigul and Tirupur are the major maize growing belts in Tamil Nadu.

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.

PSEUDO-CEREAL

Pseudo cereal - Chenopodium quinoa

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.

Uses

Most of the corn produced is used as fodder than food. Corn syrup is used in the manufacture of infant foods. Corn is a raw material in the industrial production of alcohol and alcoholic beverages.

10.1.2 Millets (Siru Thaniyangal)

The term millet is applied to a variety of very small seeds originally cultivated by ancient people in Africa and Asia. They are gluten free and have less glycemic index.

Pearl Millet

Botanical name: *Pennisetum americanum*

It is one of the millets introduced in India and Africa. Pearl Millet is rich in fibre, iron and minerals, stable food grain in many parts of India, especially in Gujarat and Rajasthan.

Uses

It is commonly used to make flat bread, gluten free cereal based products, porridge (Kambang koozh), biscuits, pasta and non-dairy probiotic beverages.


Pearl Millet


Finger Millet


Sorghum

Figure 10.2: Millets

Finger Millet – Ragi

Botanical name : *Eleusine coracana*

Finger millet is the crop of early introduction from East Africa into India. Ragi is rich in calcium.

Uses

It is used as a staple food in many southern hilly regions of India. Ragi grains are made into porridge and gruel. Ragi malt is the popular nutrient drink. It is used as a source of fermented beverages.

Sorghum

Botanical name : *Sorghum vulgare*

Sorghum is native to Africa. It is one of the major millets in the world and is rich in calcium and iron.

Uses

It is fed to poultry, birds, pigs and cattle and a source of fermented alcoholic beverage

10.1.3 Minor Millets

Little Millet

Botanical name- *Panicum sumatrense*

This is one of the oldest millets and is native to India. The species name is based on a specimen collected from Sumatra. It is rich in iron and fibre than rice that makes it best for diabetes.

Uses

It is cooked like rice and also milled and baked. It cures anaemic condition, constipation and other gastrological problems.

Foxtail Millet

Botanical name : *Setaria italica*

This is one of the oldest millet used traditionally in India. Which is domesticated first in China about 6000 years. Rich in protein, carbohydrate, vitamin B and C, Potassium and Calcium.

Uses

It supports in strengthening of heart and improves eye sight. Thinai porridge is given to lactating mother.

Kodo Millet

Botanical name : *Paspalum scrobiculatum*

Kodo millet is originated from West Africa, which is rich in fibre, protein and minerals.

Uses

Kodo millet is ground into flour and used to make pudding. Good diuretic and cures constipation. Helps to reduce obesity, blood sugar and blood pressure.

10.1.4 Pulses

The word Pulse is derived from the Latin words 'puls' or 'pultis' meaning "thick soup". Pulses are the edible seeds that are harvested from the fruits of Fabaceae. They provide vital source of plant-based protein, vitamins and minerals for people around the globe.

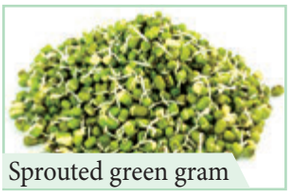

Little Millet

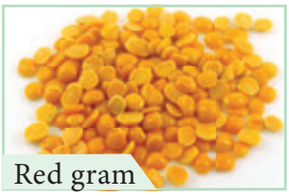

Foxtail Millet


Kodo Millet

Figure 10.3: Minor Millets


Black gram


Sprouted green gram


Red gram


Chick pea

Figure 10.4: Pulses

Black gram

Botanical name : *Vigna mungo*

Origin and Area of cultivation

Black gram is native to India. Earliest archeobotanical evidences record the presence of black gram about 3,500 years ago. It is cultivated as a rain fed crop in drier parts of India. India contributes to 80% of the global production of black gram. Important states growing black gram in India are Uttar Pradesh, Chattisgarh and Karnataka.

Uses

Black gram is eaten whole or split, boiled or roasted or ground into flour. Black gram batter is a major ingredients for the preparation of popular Southern Indian breakfast dishes. Split pulse is used in seasoning Indian curries.

Red gram / Pigeon pea

Botanical name : *Cajanus cajan*

Origin and Area of cultivation: It is the only pulse native to Southern India. It is mainly grown in the states of Maharashtra, Andhra Pradesh, Madhya Pradesh, Karnataka and Gujarat.

Uses

Red gram is a major ingredient of sambar, a characteristic dish of Southern India. Roasted seeds are consumed either salted or unsalted as a popular snack. Young pods are cooked and consumed.

Green gram

Botanical name : *Vigna radiata*

Origin and Area of cultivation

Green gram is a native of India and the earliest archaeological evidences are found in the state of Maharashtra. It is cultivated in the states of Madhya Pradesh, Karnataka and Tamil Nadu.

Uses

It can be used as roasted cooked and sprouted pulse. Green gram is one of the ingredients of pongal, a popular breakfast dish in Tamil Nadu. Fried dehulled and broken or whole green gram is used as popular snack. The flour is traditionally used as a cosmetic, especially for the skin.

Chick pea / Bengal gram

Botanical name : *Cicer arietinum*

Origin and Area of cultivation: It has originated in West Asia and was known in cultivation for more than 4,000 years in India. It is mainly grown in the states of Madhya Pradesh, Uttar Pradesh and Rajasthan.

Uses

Chick pea protein is rated high in terms of amino acid content and digestibility. Infant food formulae uses malted chick pea as an ingredient. Chick pea seed flour is a prime constituent of many forms of Indian confectionary. Roasted and salted, whole or split gram forms the popular snacks of middle class.

10.1.5 Vegetables

While walking through a market filled with fresh vegetables like stacks of lady's finger, mountains of potatoes, pyramids of brinjal, tomatoes, cucurbits, we learn to choose the vegetables that is fresh, tender, ripe and those suit the family taste through experience and cultural practices. Why do we need to eat vegetables and what do they provide us?

Vegetables are the important part of healthy eating and provide many nutrients, including potassium, fiber, folic acid and vitamins A, E and C. The nutrients in vegetables are vital for maintenance of our health.

Potato

Botanical name : *Solanum tuberosum*
Family: Solanaceae

Origin and Area of cultivation

Potato has originated from the highlands of Peru and Bolivia. It is cultivated in Uttar Pradesh, West Bengal and Bihar are the major potato cultivating states of India. Nilgiri and Palani hills also contribute to the potato cultivation in Southern Indian hills.

Uses

Potato tubers are used in a variety of ways like boiled, steamed, fried, baked, roasted or as an ingredient in soup, stews, pies and other dishes. It is the major raw material for the chips industry, brewing industry and in the manufacture of products used for microbiological and clinical applications.

Lady's finger / Okra

Botanical name : *Abelmoschus esculentus*
Family: Malvaceae

Origin and Area of cultivation

Lady's finger is a native of the Tropical Africa. Assam, Maharashtra and Gujarat are the important states where Lady's finger is grown in abundance. Coimbatore, Dharmapuri and Vellore are the major cultivating regions of Tamil Nadu.

Uses

The fresh and green tender fruits are used as a vegetable. Often they are sliced and dehydrated to conserve them for later use. It has most important nutrients.

Cucumber

Botanical name : *Cucumis sativus*
Family: Cucurbitaceae

The cucurbits are the vining plants of the family Cucurbitaceae, which include cucumbers, squash, pumpkins, melons and gourds.

Origin and Area of Cultivation

The cucumber is an important summer vegetable in all parts of India. It is originated in India. It has been cultivated for at least three thousand years. Cucumber is commonly cultivated throughout India.

Uses

Depending on the species immature or mature fruit are consumed as fresh or cooked vegetables. It is used in the preparation of salad and pickle. Oil obtained from cucumber seed is good for the brain and the body and the kernels are used in confectionaries.

10.1.6 Fruits

Edible fruits are fleshy structures with a pleasant aroma and flavours. Fruits are sources of many nutrients including potassium, dietary fiber, folic acid and vitamins.Depending on the climatic region in which fruit crops grow, they can be classified into temperate(apple, pear, plum) and tropical fruits (mango, jack, banana). In this chapter we will study some examples of tropical fruits.

Mango (National fruit of India)

Botanical name : *Mangifera indica*
Family: Anacardiaceae

Origin and Area of cultivation

Figure 10.5: Mango

The mango is the native to Southern Asia, especially Burma and Eastern India. It is the National fruit of India. Major mango producing States are Andhra Pradesh, Bihar, Gujarat and Karnataka. Salem, Krishnagiri, Dharmapuri are the major mango producing districts of Tamil Nadu. Some of the major cultivars of mango in India are Alphonsa, Banganapalli, neelam and malgova.

Uses

Mango is the major table fruit of India, which is rich in beta carotenes. It is utilized in many ways, as dessert, canned, dried and preserves in Indian cuisine. Sour, unripe mangoes are used in chutneys, pickles, side dishes, or may be eaten raw with salt and chili. Mango pulp is

made into jelly. Aerated and non-aerated fruit juice is a popular soft drink.

Banana

Botanical name : *Musa* x *paradisiaca*
Family: Musaceae

Origin and Area of cultivation

Figure 10.6: Banana

Bananas were domesticated in South East Asia. Tamil Nadu is the world's No. 1 banana producer. Theni, Trichy, Erode, Thoothukudi, Coimbatore, Kanyakumari, Thanjavur and Dindigul are the prominent regions in Tamil Nadu where the crop is being cultivated. Major cultivars of banana are Chevazhai, Nentheran, Karpooravalli, Poovan and Peyan.

Uses

The banana fruit is loaded with potassium and essential vitamins, which can be eaten raw or cooked (deep fried, dehydrated, baked or steamed). The fruit can be processed into flour and can be fermented for the production of beverages such as banana juice, beer, vinegar and vine.

Jack fruit (State fruit of Tamil Nadu)

Botanical name : *Artocarpus heterophyllus*
Family: Moraceae

Origin and Area of cultivation

The jackfruit has originated in the Western Ghats of India and it is the state fruit of Tamil Nadu. The major Jack fruit cultivating areas of Tamil Nadu are Cuddalore, Kanyakumari, Dindigul, Pudukottai, Namakkal, Tirunelveli and Nilgiris. Panruti and Coimbatore districts are the major marketing centres.

Figure 10.7: Jackfruit

Uses

The fruit can be eaten raw or cooked. Unripe flake slices are deep-fried to make crispy chips. The seeds are either boiled or roasted and eaten. Unripe fruits are used as vegetables.

10.1.7 Nuts

Nuts are simple dry fruits composed of a hard shell and an edible kernel. They are packed with a good source of healthy fats, fibre, protein, vitamins, minerals and antioxidants. Some of the important nuts are discussed below.

Cashew nut

Botanical name : *Anacardium occidentale*
Family: Anacardiaceae

Origin and Area of cultivation

Cashew has originated in Brazil and made its way to India in the 16th century through Portuguese sailors. Cashew is grown in Kerala, Karnataka, Goa, Maharashtra, Tamil Nadu, and Orissa.

Uses

Cashews are commonly used for garnishing sweets or curries, or ground into a paste that forms a base of sauces for curries or some sweets. Roasted and raw kernels are used as snacks.

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

Figure 10.8: Nuts

Almond

Botanical name : *Prunus dulcis*
Family: Rosaceae

Origin and Area of cultivation

Almond is a tree native to Mediterranean regions of the Middle East. Almond is cultivated in Kashmir, Himachal Pradesh and Uttar Pradesh.

Uses

Almonds are often eaten raw or roasted and are available as whole, sliced (flaked), and as flour. Almond oil is made into almond butter or almond milk, which are used in sweet and savoury dishes. Almond helps in promoting HDL (High Density Lipids)

10.1.8 Sugars

We experienced sweetness while eating the stems of sugarcane, roots of sugar beet, fruits of apple and while drinking palmyra sap. This is due to the different proportions of sugars found in it. Sugar is the generic name for sweet tasting soluble carbohydrate, which are used in foods and beverages. Sugars found in sugarcane and palmyra make them ideal for efficient extraction to make commercial sugar.

Sugarcane

Botanical name : *Saccharum officinarum*
Family : Poaceae

Origin and Area of cultivation

The cultivated *Saccharum officinarum* has evolved by repeated back crossing of *S.officinarum* of New Guinea with wild *S.spontaneum* of India to improve the quality. All districts except Kanyakumari and Nilgiris of Tamil Nadu cultivate Sugarcane.

Uses

Sugar cane is the raw material for extracting white sugar. Sugarcane supports large number of industries like sugar mills producing refined sugars, distilleries producing liquor grade ethanol and millions of jaggery manufacturing units. Fresh sugarcane juice is a refreshing drink. Molasses is the raw material for the production of ethyl alcohol.

Stevia /Sweet leaf

Botanical name : *Stevia rebaudiana*
Family: Asteraceae

Stevia is a sweetener and a sugar substitute, extracted from the leaves of *Stevia rebaudiana.* It has no calories and is 200 times sweeter than sugar. The Steveocide is the chemical that is responsible for sweetness in Stevia.

Origin and Area of cultivation

Stevia is a native to Brazil and Paraguay. It is cultivated in the states of Himachal Pradesh, Gujarat and Tamil Nadu.

Uses

This is the most popular natural sweetener and is a substitute for white sugar, hence it is extensively used by diabetic patients and health conscious people.

Figure 10.9: Sugars

Palmyra (State tree of Tamil Nadu)

Botanical name : *Borassus flabellifer*

Family: Arecaceae

Origin and Area of cultivation

Palmyra is native to tropical regions of Africa, Asia and New Guinea. Palmyra grows all over Tamil Nadu, especially in coastal districts.

Uses

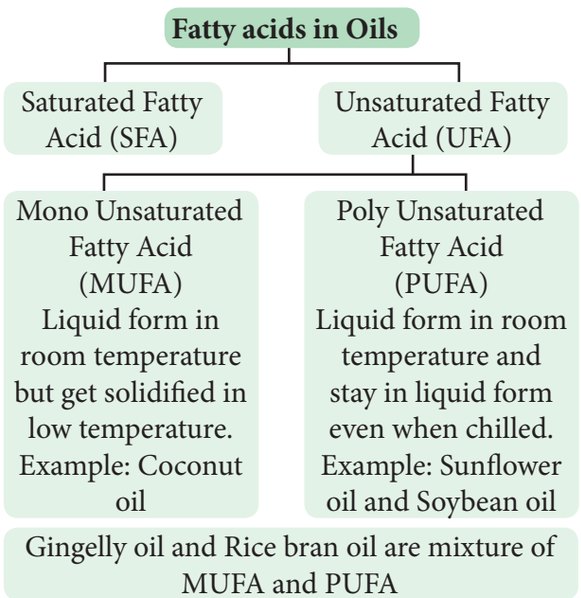
Exudate from inflorescence axis is collected for preparing palm sugar. Inflorescence is tapped for its sap which is used as health drink. Sap is processed to get palm jaggery or fermented to give **toddy**.

Endosperm is used as a refreshing summer food. Germinated seeds have an elongated embryo surrounded by fleshy scale leaf which is edible.

10.1.9 Oil Seeds

Why fried foods are tastier than boiled foods?

There are two kinds of oils namely, essential oils and vegetable oils or fatty oils. The essential oils or volatile oils which possess aroma evaporate or volatilize in contact with air. Any organ of a plant may be the source of essential oil. For example, flowers of Jasmine, fruits of orange and roots of ginger. The vegetable oils or non-volatile oils or fixed oils that do not evaporate. Whole seeds or endosperm form the sources of vegetable oils.



Let us know about few oil seeds

Groundnut / Peanut

Botanical name : *Arachis hypogaea*

Family : Fabaceae

Origin and Area of Cultivation:

Groundnut is native of Brazil. Portuguese introduced groundnut into Africa. The Spanish took it to the South East Asia and India via Philippines. In India Gujarat, Andhra Pradesh and Rajasthan are top producers.

Uses

Nuts contain about 45% oil. The kernels are also rich sources of phosphorous and vitamins, particularly thiamine, riboflavin and niacin. It is premium cooking oil because it does not smoke. Lower grade oil is used in manufacture of soaps and lubricants.

Sesame / Gingelly

Botanical name : *Sesamum indicum*

Family : Pedaliaceae

Origin and Area of cultivation: *Sesamum indicum* has originated from Africa.. Sesame is cultivated as a dry land crop. West Bengal and Madhya Pradesh are the top producers in India during 2017-18. It is considered as a healthy oil in Southern Indian culture.

Uses

Sesame oil is used for mostly culinary purposes in India. Lower grades are used in manufacture of soaps, in paint industries, as a lubricant and as an illuminant. In India, the oil is the basis of most of the scented oils used in perfumes. Sesame seed snacks are popular throughout India.

Coconut

Botanical name : *Cocos nucifera*

Family : Arecaceae

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Origin and Area of cultivation: The origin of coconut is Pacific island region. Kerala and Tamil Nadu are the leading producers in India.


Groundnut


Sesame


Coconut

Figure 10.10: Oil Seeds

Uses

Coconut oil is classified as edible-industrial oil. Soaps obtained from coconut oil lathers well in soft and hard water. It is used in manufacture of rubber, synthetic resins, lubricants, brake fluids for aeroplanes and detergents. It is used as major hair oil and a base for applying medicinal powders.

10.1.10 Beverages

How about a cup of coffee or tea? We always entertain our guests with this offer. Children exchange chocolates during their birthdays.

All non-alcoholic beverages contain alkaloids that stimulate central nervous system and also possess mild diuretic properties. In this part of chapter, we learn about three popular non-alcoholic beverages namely tea, coffee and cocoa.

Tea

Botanical name : *Camellia sinensis*

Family : Theaceae

Origin and Area of cultivation: Tea is native of China.Assam is the top tea producer in India, followed by Kerala and Tamil Nadu.

Uses

Tea is the most popular beverage among all sections of people in India. Regular consumption of green tea is believed to lowers the bad cholesterol and increases the good cholesterol.

Coffee

Botanical name : *Coffea arabica*

Family : Rubiaceae

Why does a student or a driver prefer tea or coffee during night work?

Origin and Area of cultivation: *Coffea arabica* is the prime source of commercial coffee which is native to the tropical Ethiopia An Indian Muslim saint, Baba Budan introduced coffee from Yemen to Mysore.Karnataka is the largest coffee producing state in India followed by Tamil Nadu and Kerala. Tamil Nadu is the largest consumer of coffee in India.

Uses

Drinking coffee in moderation provides the following health benefits:

Caffeine enhances release of acetylcholine in brain, which in turn enhances efficiency. It can lower the incidence of fatty liver diseases, cirrhosis and cancer. It may reduce the risk of type 2 diabetes.

Cocoa

Botanical name: *Theobroma cacao*

Family : Malvaceae

Origin and Area of cultivation: Cocoa is native of Tropical American region. The word Theobroma (Theos means god, broma means food) means 'food of the Gods'. Kerala is the largest producer of Cocoa in India followed by Karnataka.

Uses

Cocoa is mainly used in confectionaries and forms an important ingredient in nutritive drinks. Cocoa products are rich in fibres, minerals and antioxidants, thus preventing cancer, cardiovascular diseases, premature ageing.


Tea plantation


Coffee


Cocoa

Figure 10.11: Beverages

10.2 Spices and Condiments

"Aroma attracts everyone"

History:

Spices were used extensively throughout the world for several thousands of years. Records of use of garlic and onion dates back 2500 years.

Majority of the spices are native to Mediterranean region, India and South East Asian countries. Spices, especially pepper triggered the search for sea route to India and paved way for the exploratory voyages by Spanish and Portuguese.

Spices are accessory foods mainly used for flavouring during food preparation to improve their palatability. Spices are aromatic plant products and are characterized by sweet or bitter taste. Spices are added in minimal quantities during the cooking process. For example black pepper.

Condiments, on the other hand, are flavouring substances having a sharp taste and are usually added to food after cooking. For example, curry leaves.

The following spices and condiment are discussed in detail.

Spices

Cardamom

Botanical name : *Elettaria cardamomum*

Family : Zingiberaceae

Origin and Area of cultivation: It is indigenous to Southern India and Sri Lanka. Cardamom is called as "Queen of Spices". In India it is one of the main cash crops cultivated in the Western Ghats, and North Eastern India

Uses

The seeds have a pleasing aroma and a characteristic warm, slightly pungent taste. It is used for flavouring confectionaries, bakery products and beverages. The seeds are used in the preparation of curry powder, pickles and cakes. Medicinally, it is employed as a stimulant and carminative. It is also chewed as a mouth freshener.

Black Pepper

Botanical name : *Piper nigrum*

Family : Piperaceae

Origin and Area of cultivation: It is indigenous to Western Ghats of India. Pepper is one of the most important Indian spices referred to as the "King of Spices" and also termed as "Black Gold of India". Kerala, Karnataka and Tamil Nadu are the top producers in India.

The characteristic pungency of the pepper is due to the presence of alkaloid Piperine. There are two types of pepper available in the market namely black and white pepper.

Uses

It is used for flavouring in the preparation of sauces, soups, curry powder and pickles. It is used in medicine as an aromatic stimulant for enhancing salivary and gastric secretions and also as a stomachic. Pepper also enhances the bio-absorption of medicines.

Turmeric

Botanical name : *Curcuma longa*

Family : Zingiberaceae

Origin and Area of cultivation: It is indigenous to Southern Asia India is the largest producer, consumer and exporter of


Cardamom


Black Pepper


Turmeric


Chillies

Figure 10.12: Spices

turmeric. Erode in Tamil Nadu is the World's largest wholesale turmeric market.

Uses

Turmeric is one of the most important and ancient Indian spices and used traditionally over thousands of years for culinary, cosmetic, dyeing and for medicinal purposes. It is an important constituent of curry powders. Turmeric is used as a colouring agent in pharmacy, confectionery and food industry. Rice coloured with turmeric (yellow) is considered sacred and auspicious which is used in ceremonies. It is also used for dyeing leather, fibre, paper and toys.

Curcumin extracted from turmeric is responsible for the yellow colour. Curcumin is a very good anti-oxidant which may help fight various kinds of cancer. It has anti-inflammatory, anti-diabetic, anti-bacterial, anti-fungal and anti-viral activities. It stops platelets from clotting in arteries, which leads to heart attack.

Chillies / Red Pepper

Botanical name : *Capsicum annuum, C. frutescens*.

Family : Solanaceae

Origin and Area of cultivation: Capsicum is native to South America and is popularly known as chillies or red pepper in English. India is leading producer and exporter. *C. annuum* and *C. frutescens* are important cultivated species of chillies.

Uses

The fruits of *C.annuum* are less pungent than the fruits of *C.frutescens*. *C.annum* includes large, sweet bell peppers. Long fruit cultivars of this species are commercially known as 'Cayenne pepper' which are crushed, powdered and used as condiment. Chillies are used in manufacture of sauces, curry powders and preparation of pickles. Capsaicin is an active component of chillies. It has pain relieving properties and used in pain relieving balms. Chillies are a good source of Vitamin C, A and E.

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.

Condiment

Tamarind

Botanical name :*Tamarindus indica*

Family : Fabaceae-Caesalpinioideae

Origin and Area of cultivation: Tamarind is native of tropical African region and was introduced into India several thousand years before. It is cultivated in India, Myanmar, south asian countries and several African and Central American countries.

Figure 10.13 : Tamarind

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

Tamarind has long been used in Africa and in Southern Asia. The name tamarindus is of Arabian origin, which means "dates of India". (tamar – dates; Indus – India).

Uses

It is used in flavouring sauces in the United States and Mexico. In India, the fruit pulp is major ingredients for many culinary preparations. Sweet tamarinds are sold as table fruits in India imported from Thailand and Malaysia.

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.

10.3 Fibres

Botanically a fiber is a long narrow and thick-walled cell. Plant fibres are classified according to their use (Table 10.3)

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.

Cotton

Botanical name : *Gossypium* spp.

Family : Malvaceae

Cotton is the world's most important non-food commercial crop.

Origin and Area of cultivation: It is one of the oldest cultivated crops of the world. It has been cultivated for about 8000 years both in new world and in old world. Commercial cotton comes from four cotton species: two from the new world and two from the old world. (1) *G. hirsutum* (2) *G.barbadense* are the New world species and (3) *G. arboretum* (4) *G. herbaceum* are the old world species. In India cotton is cultivated in Gujarat, Maharashtra, Andhra Pradesh and Tamil Nadu.

Uses

It is mainly used in the manufacturing of various textile, hosiery products, toys and is also used in hospitals.

Jute

Botanical name : *Corchorus* spp.

Family : Malvaceae

Origin and Area of cultivation: Jute is derived from the two cultivated species (1) *Corchorus capsularis* and (2) *C.olitorius* is of African origin whereas *C. capsularis,* is believed to be Indo-Burmese origin. It is an important cultivated commercial crop in Gangetic plains of India and Bangladesh.

Uses

It is one of the largest exported fibre material of India. The jute industry occupies an important place in the national economy of India. Jute is used for 'safe' packaging in view of being natural, renewable, bio-degradable and eco-friendly product. It is used in bagging and wrapping textile. About 75% of the jute produced is used for manufacturing sacks and bags. It is also used in manufacture of blankets, rags, curtains etc. It is also being used as a textile fibre in recent years.


Cotton plant


Jute products


Coconut coir

Figure 10.14: Fibres

Coconut / Coir

Botanical name : *Cocos nucifera*

Family : Arecaceae

Commercial coir is obtained from the mesocarp of coconut. The fibre is known for its light mass, elasticity, high resistance to sea water and for its insulating capacity.

Origin and Area of cultivation: We have already studied the origin of Coconut under the oil crops. India and Sri Lanka are the top producers since 2001. Kerala and Tamil Nadu are the top producers in India.

Uses

It is used in manufacture of mats, cushion seats, bags, packaging material, water-proof and sound proof boards and thermal insulation. Using coir peat in horticulture also made demand for coir. It is also used for manufacturing ecofriendly horticultural products such as biodegradable planting pots.

10.4 Timber

The basic need of shelter is obtained from the timber trees. In this lesson we learn about few timber plants.

Teak

Botanical name : *Tectona grandis*

Family: Lamiaceae


Teak wood carving


Rosewood

Figure 10.15: Timber

Origin and Area of cultivation: This is native to South east Asia. It is observed wild in Assam. But cultivated in Bengal, Assam, Kerala, Tamil Nadu and North-West India.

Uses

It is one of best timbers of the world. The heartwood is golden yellow to golden brown when freshly sawn, turning darker when exposed to light. Known for its durability as it is immune to the attack of termites and fungi.

The wood does not split or crack and is a carpenter friendly wood. It was the chief railway carriage and wagon wood in India. Ship building and bridge-building depends on teakwood. It is also used in making boats, toys, plywood, door frames and doors.

Rosewood

Botanical name : *Dalbergia latifolia*

Family: Fabaceae

Origin and Area of cultivation: Rose wood is native to India It is cultivated in Uttar Pradesh, Bihar, Odisha, Central, Western and Southern India.

Uses

Indian rosewood has yellowish sapwood and dull brown to almost purple coloured heartwood. The wood is characterised by fragrant, heavy, narrowly interlocked grained and medium coarse textured. It is a durable and heavy wood and is suitable for under water use. Wood is used for making furniture, army wagons, temple chariots, cabinets, railway sleepers, musical instruments, hammer handles, shoe heels and tobacco pipes.

Ebony

Botanical name : *Diospyros ebenum*

Family: Ebenaceae

Origin and Area of cultivation: It is commonly found in tropical forests Southern India and Srilanka. Ebony is distributed in forests of Karnataka, Kerala and Tamil Nadu.

Uses

The heartwood is jet black with a metallic lustre when smoothened and is resistant to attack by insects and fungi. The wood is difficult to season and hence cut into small pieces before seasoning It is used mainly for making piano keys, handles of cutlery, musical instruments, making sticks, umbrella handles, whips and furniture.

10.5 Latex

Rubber

Botanical name : *Hevea brasiliensis*

Family : Euphorbiaceae

Origin and Area of cultivation: It is a native of Brazil and was introduced outside its native range during the colonial period and has become an important cash crop. Asia contributed 90% of the world production. Kerala is the largest producer in India followed by Tamil Nadu.

Figure 10.16 : Rubber Tree

Uses

Tyre and other automobile parts manufacturing industries consume 70% of the rubber production. Rubber is used in manufacturing footwear, wire and cable insulations, rain-coats, household and hospital goods, shock absorbers, belts, sports goods, erasers, adhesives, and rubber-bands Hard rubber is used in the electrical and radio engineering industries Concentrated latex is used for making gloves, balloons and condoms. Foamed latex is used in the manufacture of cushions, pillows and life-belts.

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.

10.6 Pulp Wood

The term paper is derived from the word 'papyrus' a plant (*Cyperus papyrus*) that was used by Egyptians to make paper-like materials. Paper production is a Chinese invention. The Chinese discovered the paper that was prepared from the inner bark of paper mulberry in 105 A.D. For a long time, the art of paper making remained a monopoly of the Chinese until Arabs learned the technique and improved it around 750 A.D. Invention of printing increased the demand for paper.

Manufacture of Wood pulp: Wood is converted into pulp by mechanical, and chemical processes. Wood of Melia azadirachta, *Neolamarkia chinensis*, *Casuarina* spp, *Eucalyptus* spp are used for making paper pulp.

Figure 10.17 : Wood pulp

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.

10.7 Dyes

The ability to perceive colour is a wonderful aspect of human eyes and dyes add colour to the goods we use. They have been in use since the ancient times.

The earliest authentic records of dyeing were found in the tomb painting of ancient Egypt. Colourings on mummy cements (wrapping) included saffron and indigo. They can also be seen in rock paintings in India.

Indigo

Botanical name : *Indigofera*

Family : Fabaceae

Origin and Area of cultivation: Indigofera tinctoria is native to India. It was grown in many states in India. Now it is grown limited states mainly in Tamil Nadu and Andhra Pradesh.

Uses

A brilliant dark blue dye 'indigo' was extracted from the leaves of several species of Indigofera. The people of Asia, especially India have known the dye for over 4,000 years. It is also used in painting of murals. Indigofera have long been used in Southern India in temple arts and folk arts, popularly known as Kalamkari. Indigo used for dyeing and printing cotton, rayon and wool.

Henna

Botanical name : *Lawsonia inermis*

Family : Lythraceae

Origin and Area of cultivation: It is indigenous to North Africa and South-west Asia. It is grown mostly throughout India, especially in Gujarat, Madya Pradesh and Rajasthan.

Uses

An orange dye 'Henna' is obtained from the leaves and young shoots of *Lawsonia inermis*. The principal colouring matter of leaves 'lacosone" is harmless and causes no irritation to the skin. This dye has long been used to dye skin, hair and finger nails. It is used for colouring leather, for the tails of horses and in hair-dyes.

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.

10.8 Cosmetics

Traditionally in Southern India, people have been using turmeric, green gram powder, henna, sigaikai and usilai for their skin and hair care. These were mostly home prepared products that are used for grooming. Today, cosmetics have a high commercial value and have become chemical based industrial products. Providing personal care services has become a major industry. In recent years, people have realized the hazards of chemical-based cosmetics and are turning back to

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Figure 10.18: Naturals Dyes

natural products. In this chapter one of the major plants namely Aloe which is used in the cosmetic industries is discussed.

Aloe

Botanical name : *Aloe vera*

Family: Asphodelaceae (formerly Liliaceae)

Origin and Area of cultivation: It is a native of Sudan. It is cultivated on a large scale in Rajasthan, Gujarat, Maharashtra, Andhra Pradesh and Tamil Nadu.

Uses

'Aloin' (a mixture of glucosides) and its gel are used as skin tonic. It has a cooling effect and moisturizing characteristics and hence used in preparation of creams, lotions, shampoos, shaving creams, after shave lotions and allied products. It is used in gerontological applications for rejuvenation of aging skin. Products prepared from aloe leaves have multiple properties such as emollient, antibacterial, antioxidant, antifungal and antiseptic. Aloe vera gel is used in skin care cosmetics.

Figure 10.19: *Aloe vera*

10.8.1 Perfumes

The word **perfume** is derived from the Latin word **Per** (through) and **fumus** (to smoke), meaning **through smoke**. It refers to the age-old tradition of burning scented woods at religious ceremonies.In early days, when people were less conscious of personal hygiene, essential oils not only masked offensive odours, but also may have acted as antiseptics. Perfumes are added to baths and used for anointing the body.

Perfumes are manufactured from essential oil which are **volatile** and **aromatic**. Essential oils are found at different parts of the plant such as leaves, (curry leaf, mint), flowers (rose, jasmine), fruits (citrus, straw berry) and wood (sandal, eucalyptus).

Jasmine

Botanical name : *Jasminum grandiflorum*

Family: Oleaceae

Jasmine, as a floral perfume, ranks next to the rose oil. Major species cultivated on the commercial scale is Jasminum grandiflorum, a native of the north-western Himalayas. In Tamil Nadu, the major jasmine cultivation centres are Madurai and Thovalai of Kanyakumari District. The essential oil is present in the epidermal cells of the inner and outer surfaces of both the sepals and petals. One ton of Jasmine blossom yields about 2.5 to 3 kg of essential oil, comprising 0.25 to 3% of the weight of the fresh flower.

Uses

Jasmine flowers have been used since ancient times in India for worship, ceremonial purposes, incense and fumigants, as well as for making perfumed hair oils, cosmetics and soaps. Jasmine oil is an essential oil that is valued for its soothing, relaxing, antidepressant qualities.

Jasmine blends well with other perfumes. It is much used in modern perfumery and cosmetics and has become popular in air freshners, anti-perspirants, talcum powders, shampoos and deodorants.

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'.


Jasmine


Rose


Sandal

Figure 10.20: Perfumes

Rose

Botanical name : *Rosa X damascena*

Family: Rosaceae

Origin and Area of cultivation: R.X damascena, has its origin from the Middle East. Major scented rose cultivating states include Rajasthan, Delhi, Haryana, Maharashtra, West Bengal, Karnataka, Andhra Pradesh and Tamil Nadu. Rose oil is one of the oldest and most expensive of perfume oils. The oil is concentrated in the epidermal cells on the inner surface of the petals.The average oil yield is a little less than 0.5 g. from 1000 g. of flowers.

Uses

Rose oil is largely used in perfumes, scenting soaps, flavouring soft drinks, liqueurs and certain types of tobacco, particularly snuff of chewing tobacco.

Rose water (panneer) containing much of phenylethyl alcohol and other compounds in dissolved confectioneries syrups and soft drinks. In India, the water is much used in eye lotions and eye-washes. In addition, it is sprinkled on guests as a ceremonial welcome.

Sandalwood

Botanical name : *Santalum album*

Family: Santalaceae

Origin and Area of cultivation: Sandal tree is native of South East Asia. Karnataka and Tamil Nadu are states that possess large natural populations of Santalum album in India. The heart-wood is scented due to the presence of santalol, from which oil is extracted. The oil yield from a wood chips, varies from 4-5% being the highest when distilled from roots (10% of the dry weight).

Uses

Sandalwood oil is a valuable fixative for other fragrances due to the excellent blending properties. More than 90% of the oil is used in the manufacture of scented soaps, talcum powder, face powder, creams, hair oils, hand lotions as well as in perfumery and pharmaceutical industries.

10.9 Traditional Systems of Medicines

India has a rich medicinal heritage. A number of Traditional Systems of Medicine (TSM) are practiced in India some of which come from outside India. TSM in India can be broadly classified into **institutionalized** or documented and **non-institutionalized** or oral traditions. Institutionalized Indian systems include Siddha and Ayurveda which are practiced for about two thousand years. These systems have prescribed texts in which the symptoms, disease diagnosis, drugs to cure, preparation of drugs, dosage and diet regimes, daily and seasonal regimens. Non- institutional systems, whereas, do not have such records and or practiced by rural and tribal peoples across India. The knowledge is mostly held in oral form. The TSM focus on healthy lifestyle and healthy diet for maintaining good health and disease reversal.

Siddha system of medicine

Siddha is the most popular, widely practiced and culturally accepted system in Tamil Nadu. It is based on the texts written by 18

Siddhars. There are different opinions on the constitution of 18 Siddhars. The Siddhars are not only from Tamil Nadu, but have also come from other countries. The entire knowledge is documented in the form of poems in Tamil. Siddha is principally based on the **Pancabūta** philosophy. According to this system three humors namely **Vātam, Pittam** and **Kapam** that are responsible for the health of human beings and any disturbance in the equilibrium of these humors result in ill health. The drug sources of Siddha include plants, animal parts, marine products and minerals. This system specializes in using minerals for preparing drugs with the long shelf-life. This system uses about 800 herbs as source of drugs. Great stress is laid on disease prevention, health promotion, rejuvenation and cure.

Ayurveda system of medicine

Ayurveda supposed to have originated from Brahma. The core knowledge is documented by **Charaka, Sushruta** and **Vagbhata** in compendiums written by them. This system is also based on three humor principles namely, Vatha, Pitha and Kapha which would exist in equilibrium for a healthy living. This system Uses more of herbs and few animal parts as drug sources. Plant sources include a good proportion of Himalayan plants. The **Ayurvedic Pharmacopoeia** of India lists about 500 plants used as source of drugs.

Folk system of medicine

Folk systems survive as an oral tradition among innumerable rural and tribal communities of India. A consolidated study to document the plants used by ethnic communities was launched by the Ministry of Environment and Forests, Government of India in the form of All India Coordinated Research Project on Ethnobiology. As a result about 8000 plant species have been documented which are used for medicinal purposes. The efforts to document in several under-explored and unexplored pockets of India still continue. Major tribal communities in Tamil Nadu who are known for their medicinal knowledge include **Irulas, Malayalis, Kurumbas, Paliyans** and **Kaanis**. Some of the important medicinal plants are discussed below.

10.10 Medicinal Plants

India is a treasure house of medicinal plants. They are linked to local heritage as well as to global-trade. All institutional systems in India primarily use medicinal plants as drug sources. At present, 90% collection of medicinal plants is from the non-cultivated sources. Growing demand for herbal products has led to quantum jump in volume of plant materials traded within and across the countries. Increasing demand exerts a heavy strain on the existing resources. Now efforts are being made to introduce cultivation techniques of medicinal plants to the farmers.

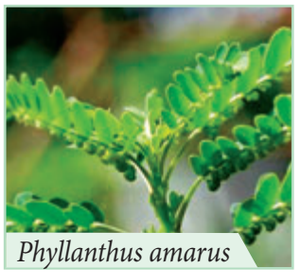
Medicinal plants play a significant role in providing primary health care services to rural and tribal people. They serve as therapeutic agents as well as important raw materials for the manufacture of traditional and modern medicines. Medicinally useful molecules obtained from plants that are marketed as drugs are called Biomedicines. Medicinal plants which are marketed as powders or in other modified forms are known as Botanical medicines. In this chapter you will be learning about a few medicinal plants that are commonly used in Tamil Nadu. All these plants are commonly available in and around dwelling places and can be easily cultivated in home gardens.

Keezhanelli

Botanical name : *Phyllanthus amarus*

Family : Euphorbiaceae (Now in Phyllanthaceae)

Origin and Area of cultivation: The plant is a native of Tropical American region and is naturalised in India and other tropical countries. It is not cultivated and is collected from moist


Phyllanthus amarus


Justicia adhatoda


Andrographis paniculata


Curcuma longa

Figure 10.21: Medicinal Plants

places in plains. *Phyllanthus maderspatensis* is also commonly sold in the medicinal plant markets collected from non-forest are as keezhanelli.

Active principle: Phyllanthin is the major chemical component.

Medicinal importance

Phyllanthus is a well-known hepato-protective plant generally used in Tamil Nadu for the treatment of Jaundice. Research carried out by Dr. S P Thyagarajan and his team from University of Madras has scientifically proved that the extract of *P. amarus* is effective against hepatitis B virus.

Adathodai

Botanical name : *Justicia adhatoda*

Family: Acanthaceae

Origin and Area of cultivation: It is native to India and Srilanka. This species is not known in wild in Tamil Nadu but widely cultivated as a live fence and around temples.

Active principle: Vascin

Uses

Adhatoda possess **broncho dilating** property. The decoction is used in treating many bronchial disorders such as cough,cold and asthma. It is also used in treating fevers. The extract forms an ingredient of cough syrups.

Nilavembu

Botanical name : *Andrographis paniculata*

Family : Acanthaceae

Andrographis paniculata, known as the **King of Bitters** is traditionally used in Indian systems of medicines.

Active principle: Andrographolides.

Medicinal importance:

Andrographis is a **potent hepatoprotective** and is widely used to treat liver disorders.

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.

Concoction of *Andrographis paniculata* and eight other herbs (Nilavembu Kudineer) is effectively used to treat malaria and dengue.

Turmeric

Botanical name : *Curcuma longa*

Family: Zingiberaceae

Origin and Area of Cultivation: You have already studied the details under the spices.

Active principle: Curcumin.

Medicinal importance:

Curcumin (the yellow colouring principle is the major pharmacologically active compound of turmeric) is well known for its medicinal properties.

It is used to treat **Alzheimer's** disease due to its property to cross over blood brain barrier. It has a very powerful anti-oxidant, anti-cancerous, anti-inflammatory, anti-diabetic, anti-bacterial, anti-fungal and anti-viral properties. It is one of the traditional medicines used for wound healing.

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.

Psychoactive Drugs

In the above chapter you have learnt about plants that are used medicinally to treat various diseases. Phytochemicals / drugs from some of the plants alter an individual's perceptions of mind by producing hallucination are known as psychoactive drugs. These drugs are used in all ancient culture especially by Shamans and by traditional healers. Here we focus on two such plants namely Poppy and Marijuana.

Opium poppy

Botanical name : *Papaver somniferum*

Family: Papaveraceae

Origin and Area of cultivation: *Opium poppy* is native to South Eastern Europe and Western Asia. Madhya Pradesh, Rajasthan and Uttar Pradesh are the licenced states to cultivate opium poppy.

Opium is derived from the exudates of fruits of poppy plants. It was traditionally used to induce sleep and for relieving pain. Opium yields **Morphine**, a strong analgesic which is used in surgery. However, opium is an addiction forming drug.

Cannabis / Marijuana

Botanical name : *Cannabis sativa*

Family: Cannabiaceae

Origin and Area of Cultivation: Marijuana is native to China. States such as Gujarat, Himachal Pradesh, Uttarkand, Uttarpradesh and Madhaya Pradesh have legally permitted to cultivate industrial hemp/Marijuana

The active principle in Marijuana is **trans-tetrahydrocanabinal** (THC). It possess a number of medicinal properties. It is an effective pain reliever and reduces hypertension. THC is used in treating **Glaucoma** a condition in which pressure develops in the eyes. THC is also used in

reducing nausea of cancer patients undergoing radiation and chemotherapy. THC provides relief to bronchial disorders, especially asthma as it dilates bronchial vessels. Because of these medicinal properties, cultivation of cannabis is legalized in some countries. However, prolonged use causes addiction and has an effect on individual's health and society. Hence most of the countries have banned its cultivation and use.

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.

10.11 Entrepreneurial Botany

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. An **entrepreneur** is someone who has an idea and who works to create a product or service that people will buy, by building an organization to support the sales. **Entrepreneurship** is now a popular topic for higher secondary students, with a focus on developing ideas to create new ventures among the young people.

Vast opportunities are there for the students of Botany. In the present scenario students should acquire ability to merge skills and knowledge in a meaningful way. Converting botanical knowledge into a business idea that can be put into practice for earning a livelihood is the much-needed training for the students.

This part of chapter is aimed to help the students to acquire such skills with practical knowledge to start a few activities of entrepreneurship.

10.11.1 Mushroom cultivation

Malnutrition caused by the lack of adequate protein and other nutrients in daily diet of people is becoming a major health hazard in developing countries. Under such circumstances, mushroom being a rich source of protein and other nutrients can be a part and parcel of every day's food.

Mushrooms are the **fruiting body** of edible fungi and is the most priced commodity among vegetables, not only because of its nutritive value but also for its characteristic aroma and flavor. Mushrooms are also called **white vegetable**. Mushroom cultivation has great scope in India and in other developing countries. Mushroom cultivation activities can play an important role in supporting the local economy. Selling mushroom in a local market form a source of additional income to the family.

Figure 10.22: Mushroom Cultivation

Steps involved in mushroom cultivation

- The straw used for composting should be ripe and golden-yellow in colour. It should be cut into 2-4 inches and properly sterilized.
- The culture space should be clean and the ventilators and windows should be covered with fine wire mesh to prevent the entry of flies and birds.

- The culture space should be sprayed with 0.1% Nuvan and 5% Formalin, two days prior to spawning and transferring to bags to cropping rooms.
- The spawn used for mushroom should be free from contaminations. Bags should be filled with 8 kg of wet straw.
- During spawning running temperature and relative humidity should be maintained 20^0C to 30^0C, 75 to 85% respectively.
- Proper watering should be done when the growth coverings are removed. There should not be dry patches on blocks. Excess watering must be avoided.
- About 20 cm gap should be maintained in between two bags or blocks.
- Picking must be done as their caps become 10 – 12 cm by twisting.

Two kinds of mushrooms are cultivated namely **button** and **oyster**.

10.11.2 Single Cell Protein (SCP) Production

Single-cell proteins are the dried cells of microorganism, which are used as protein supplement in human foods or animal feeds. Microorganisms that can be used for the production of SCP have the capacity to synthesize proteins rapidly than higher living organisms. Microorganisms like algae, fungi, yeast and bacteria are used for this purpose. Here you will learn about the production of SCP from an algae, *Spirulina*.

Figure 10.23: Production of *Spirulina*

Small scale biomass production of *Spirulina*.

It requires an aquarium, air pump, nutrients and *Spirulina* mother culture.

- Take a 30 litre capacity aquarium and fill half of it with water.
- Check if any heavy metal concentration or fluorine or calcium carbonate in water.
- Fill the tank with water and add nutrients preferably **zarrouk medium**. (Add half of the required nutrients first and add another half later).
- To aerate the culture, fix the air pump (avoid centrifugal pump) after adding nutrients.
- Add the mother culture to the aquarium. For every 1 liter of water add 4 gm. mother culture.
- Place it in sunlight for 10-12 hrs. every day.
- After a week check the culture and add more water leave it for one more week, till the biomass becomes dark green.
- Use a very fine cloth and harvest the algae.
- Water can be reused in aquarium.
- Dry the algae for later use.

Single cell protein has a high nutritive value due to higher protein, vitamin, essential amino acids and lipid content. Hence it can form a good protein supplement. However it cannot completely replace the conventional protein sources due to their high nucleic acid content and slower in digestibility. They may result in allergic reactions.

10.11.3 Seaweed Liquid Fertilizer

Seaweed is rich in trace elements and potassium, which makes it ideal to add to compost in its raw state, to work in as a mulch, or to create a liquid fertilizer. This is easy to do. Seaweed fertilizer releases about 60 nutrients from which plants can benefit.

- Collect the seaweed that is not too stinky.
- Rinse the seaweed to remove the excess salt.
- Fill a bucket to three quarters way with

water. Add as much seaweed as will fit and leave to soak.

- Stir the seaweed mix every two to four days.
- Allow to soak for several weeks to months. So that the fertilizer grows stronger and stronger over time. (Make sure to keep the brew somewhere so that its odour will not affect the daily household.)
- It is ready for use once it no longer carries a smell of ammonium.
- When it is ready, use as a fertilizer for plants and garden beds (soil). (It should be diluted with water at a minimum of three parts to one).

Liquid seaweed extract enhances healthy growth of plants, flowers and vegetables. Regular use will help plants to withstand environmental stress, pests and disease attack. It can be used as a foliar spray for fruit, flower, vegetable crops as well as for shrubs and trees. It stimulates healthy growth for all plants.

10.11.4 Organic farming

Organic farming is an alternative agricultural system in which plants/crops are cultivated in natural ways by using biological inputs to maintain soil fertility and ecological balance thereby minimizing pollution and wastage. Indians were organic farmers by default until the green revolution came into practice.

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 10.24: Preparation of organic pesticide

Use of biofertilizers is one of the important components of integrated organic farm management, as they are cost effective and renewable source of plant nutrients to supplement the chemical fertilizers for sustainable agriculture. Several microorganisms and their association with crop plants are being exploited in the production of biofertilizers. Organic farming is thus considered as the movement directed towards the philosophy of **Back to Nature.**

I. Organic Pesticide

Pest like aphids, spider and mites can cause serious damage to flowers, fruits, and vegetables. These creatures attack the garden in swarms, and drain the life of the crop and often invite disease in the process. Many chemical pesticides prove unsafe for human and the environment. It turns fruits and vegetables unsafe for consumption. Thankfully, there are many homemade, organic options to turn to war against pests.

Preparation of Organic Pesticide

UDCV2R

Refer figure: 10.24

II. Bio-pest repellent

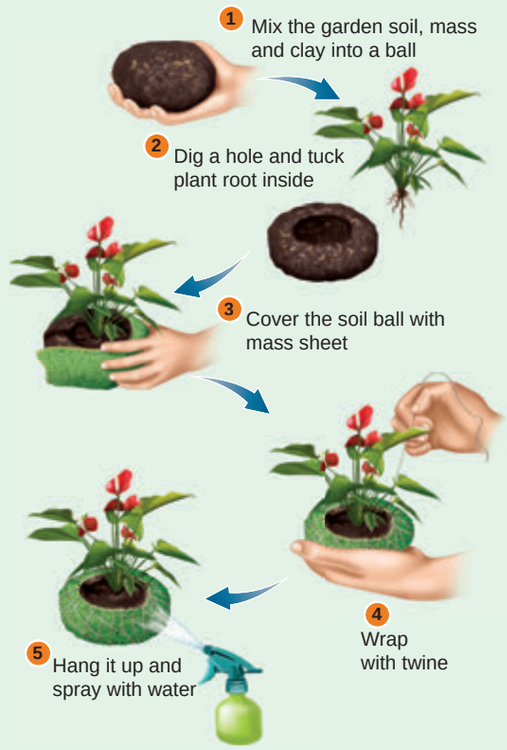
Botanical pest repellent and insecticide made with the dried leaves of *Azadirachta indica*

Preparation of Bio-pest repellent

- Pluck leaves from the neem tree and chop the leaves finely.
- The chopped up leaves were put in a 50-liter container and fill to half with water; put the lid on and leave it for 3 days to brew.
- Using another container, strain the mixture which has brewed for 3 days to remove the leaves, through fine mesh sieve. The filtrate can be sprayed on the plants to repel pests.
- To make sure that the pest repellent sticks to 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).
- The stewed leaves from the mixture can be used in the compost heap or around the base of the plants.

Activity

Hanging Garden



10.11.5 Terrarium

Can portable miniature indoor greenery be commercially sold?

A terrarium is a collection of small plants growing in a transparent, sealed container. Terrariums are easy to make, low maintenance gardens, and it can survie indefinitely with minimal water.

How to make a terrarium?

Prepare the Container: Collect whatever interesting glassware you have or source your container from a store and clean it thoroughly. Plan how to arrange the plants inside the glassware.

Add Drainage Layers: To create a false drainage layer, fill the bottom with pebbles so that water can settle and does not flood. The depth of the pebbles depends on the size of the container.

Add the Activated Charcoal: Cover the pebbles with charcoal to improve the quality of the terraria by reducing bacteria, fungi and odors.

Add Soil: Add enough soil so that the plant roots will have enough space to fit and grow.


Plants and ornates


Moss dried


Coal


Coloured glass


Pebbles


Sand

Plant: Select the desired plant such as, *Caralluma spp, Asperagus spp, Portulaca spp, Begonia spp,* and *Chlorophytum spp*; trim the roots if they are too long. Dig a pit using a stick, and place the plants' roots in it. Add more soil around the top and compact the soil down around the base of the plant. Place little plants in the container and try to keep them away from the edges of the container, so that the leaves do not touch the sides. After planting add accessories like a layer of moss (dried or living), little figurines (old toys, glass beads, stones) or a layer of miniature rocks. This is the little green world

Cleaning and Watering: Wipe if there is any dirt along the sides of the container. Give the terrarium a little bit of water and enjoy the beautiful miniature living world on your table or in your living room.

Ready made terrariums can fetch a good price as indoor garden objects or as gift articles.

Figure 10.25: Terrarium

BONSAI

Bonsai is a Japanese art form using miniature trees grown in containers that mimic the shape and scale of full size trees.

How do you make a Bonsai tree?

Visualize the finished product of bonsai while selecting a plant species and the pot.

1 Plug out the sapling and clean and prune the roots.

2 Prepare the pot and position the tree in it

3 After re-potting leave the plant in a semi shaded area until the roots have re-established.

COMMON BONSAI STYLES


Formal Upright


Informal upright


Broom style


Slant


Cascade - Overflowing potential of growth


Semi Cascade

10.11.6 Cultivation of Medicinal and Aromatic Plants

Globalization has brought opportunities and challenges in all business sectors. Government of India has identified medicinal and aromatic plants as one of the sectors that can make India a global leader in the 21st century owing to the treasure of about **8,000** medicinal and **2,500** aromatic plants that can provide large number of consumer products with national and international demand. Medicinal plants synthesize a number of secondary metabolites with pharmacological properties through secondary metabolism. The chemicals isolated from medicinal plants are used in traditional and biomedicine systems to treat diseases of both humans and animals. But most of the medicinal and aromatic plants are still wild collecting.

Central Institute of Medicinal and Aromatic Plants (CIMAP) has developed a number of high yielding varieties and processing technologies to promote cultivation of medicinal and aromatic plants. Profitable cultivation of medicinal plants can be practiced by the entrepreneurs along with traditional agriculture horticulture crops. They can be profitably intercropped in plantations. Cultivation of medicinal/aromatic plants offers following advantages:

- Generate employment through development of ancillary industries.
- Foreign exchange earnings through exports.
- Crops are not damaged by domestic animals or by birds.
- Technologies are farmer and eco-friendly.

I. Cultivation of Medicinal Plant - *Gloriosa superba*

Economically useful part – Seed, Rhizome.

Major constituents - Colchicine (0.5-0.7%) and Colchicoside

Uses - Cures gout, anti-inflammatory, anticancer.

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.

Figure 10.26: *Gloriosa superba*

Soil and Climate: Red loamy soils are well suited for cultivation. Glory lily is cultivated in Tamil Nadu mainly in the parts of Tirupur, Dindigul, Karur and Salem districts covering an area of 2000 hectare.

Planting: Planting is distributed from June – July. **P**lough the field 2 -3 times and add 10 tons of Farmyard Manure during last ploughing. Trenches of 30 cm depth are formed and tubers are planted at 30 – 45 cm spacing. The vines are trained over support.

Irrigation: Irrigation should be given immediately after planting. Subsequent irrigation is given at 5 days intervals of time.

Harvest: Pods are harvested at 160 – 180 days.

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.

II. Cultivation of Aromatic plant - *Cymbopogon citratus*(Lemongrass)

Lemongrass is a tropical herb packed with strong citrus flavor. The lemon taste is prized in Asian cooking, as well as in tea, sauces, and soups.

Figure 10.27: Lemon grass

Economic part: Stem base and leaves.

Major constituents: Citronella, geraniol and citronellol.

Uses: The aromatic oil has flavouring properties and is used in perfumery, cosmetics, confectionary, beverages, mosquito repellents and toilet cleaners.

Soil and Climate: Lemongrass grow well in full sun, with plenty of water, in a rich, well-draining soil.

Planting: This plant can thrive well all through the year. Fill planting holes with composted manure to improve fertility and enhance the soil's ability to hold water. If you're adding several lemongrass plants to planting beds, space plants 60 cm apart.

Irrigation: Water requirements for this plant will vary dependent upon the type of soil they grow. Sandy, loose soils require more frequent watering than silty loam.

Harvest: Start harvesting as soon as plants are 30 cm tall and stem bases are at least 1.5 cm thick. Cut stalks at ground level.

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, fodder 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, sesame, sunflower, coconut and mustard. The oils are used in cooking, making soaps and other purposes. Beverages contain alkaloids that stimulate central nervous system. Non alcoholic beverages are coffee, tea and cocoa. 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. It is classified based on uses: textile fibres, brush fibres, plaiting fibres and

filling fibres. Cotton, Jute and Coconut are fibre yielding plants. Teak, Rosewood, and Ebony are woods 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. Indigo was extracted from the leaves of Indigofera. The orange dye henna is from the leaves of Lawsonia. Cosmetics have a high commercial value and have become chemical based industrial products. 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. Thus plantsplay a vital role in the lives of people throughout the world.

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. Mushrooms are the fruiting body of edible fungi and is the most priced commodity among vegetables.

Single-cell proteins are the dried cells of microorganism, which are used as protein supplement in human foods or animal feeds. Microorganisms like algae, fungi, yeast and bacteria are used for this purpose.

A terrarium is a collection of small plants growing in a transparent, sealed container. Bonsai is the art and science of dwarfing and shaping of a tree. Specialty materials like essential oils and pharmaceuticals, are obtained from plants. Many species of medicinal and aromatic plants (MAPs) are cultivated for such industrial uses, but most are still wild collected.

Evaluation

V85P3R

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.
   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. This is an example of brush fibre yielding plant
   a) Cyperus b) Neem
   c) Cotton d) Palm

6. *Tectona grandis* is coming under family
   a) Lamiaceae b) Fabaceae
   c) Dipterocaipaceae e) Ebenaceae

7. *Tamarindus indica* is indigenous to
   a) Tropical African region
   b) South India, Sri Lanka
   c) South America, Greece
   d) India alone

8. New world species of cotton
   a) Gossipium arboretum
   b) G.herbaceum
   c) Both a and b
   d) G.barbadense

9. 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

10. Find out the correctly matched pair.
    a) Rubber – *Shorea robusta*
    b) Dye – *Indigofera annecta*
    c) Timber – *Cyperus papyrus*
    d) Pulp – *Hevea brasiliensis*

11. Find out the wrongly paired one
    a) Burma teak – *Tectona grandis*
    b) Rosewood – *Dalbergia* sp.
    c) Ebony – *Diaspyros eberum*
    d) Henna – *Shorea robusta*

12. 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 different parts of the plants.
    a) Statement I is correct
    b) Statement II is correct
    c) Both statements are correct
    d) Both statements are wrong

13. Observe the following statements and pick out the right option from the following:
    Statement I: The drug sources of Siddha include plants, animal parts, ores and minerals.
    Statement II: Minerals are used for preparing drugs with long shelf-life.
    a) Statement I is correct
    b) Statement II is correct
    c) Both statements are correct
    d) Both statements are wrong

14. Select the mismatch.
    a) Andrographis – hepato protective
    b) Adhatada – broncho dialator
    c) Phyllanthus – anti-diabetic
    d) Curcumin – anti-oxidant

15. The active principle trans-tetra hydro canabial is present in
    a) Opium b) Curcuma
    c) Marijuana d) Andrographis

16. Which one of the following matches is correct?
    a) Palmyra - Native of Brazil
    b) Saccharun - Abundant in Kanyakumari
    c) Steveocide - Natural sweetener
    d) Palmyra sap - Fermented to give ethanol

17. The only cereal that has originated and domesticated from the New world.
    a) *Oryza sativa* b) *Triticum asetumn*
    c) *Triticum duram* d) *Zea mays*

18. Which of the following statement(s) is/are correct?
    i. Mushrooms are the fruiting body of edible fungi.
    ii. Single-cell proteins are the dried cells of macro organism.
    iii. Regular use of liquid seaweed fertilizer will help plants to withstand environmental stress.
    iv. SCP can completely replace the conventional protein sources.
    A. (i) and (ii), B. (i) and (iii),
    C. (i) and (iv), D. (i) alone

19. Select the incorrect pair/pairs of statements about single cell protein

    i. Chemical pesticides - Safe for human and the environment
    ii. Mushrooms - White vegetable
    iii. Zarrouk medium- Culture medium
    iv. Seaweed - Rich in potassium

    A. (i) and (ii), B. (i) and (iv),
    C. (i) and (iii), D. (i) alone

20. Match the following pairs about mushroom cultivation.

A. Straw size	(i) 75-85%
B. Distant between blocks	(ii) 20 cm
C. Cap size at harvesting	(iii) 2-4 inch
D. Relative humidity	(iv) 10-12 cm

    A. A-(ii), B-(iii), C-(iv), D-(i)
    B. A-(iii), B-(ii), C-(iv), D-(i)
    C. A-(ii), B-(iii), C-(iv), D-(i)
    D. A-(i), B-(ii), C-(iii), D-(iv)

21. Assertion: In *Spirulina* culture, half of the required nutrie nts added first and the rest in later.

    Reason: If all the nutrients are added first, it will affect the culture growth.

    (a) Both A and R are true and R is the correct explanation of A.
    (b) Both A and R are true but R is not the correct explanation of A.
    (c) A is true but R is false.
    (d) Both A and R are false.

22. Write the cosmetic uses of *Aloe*.
23. What is pseudo cereal? Give an example.
24. What are cucurbits? Why it is considered as an important summer vegetable?
25. Which fruit is rich in potassium? Mention its economic importance.
26. Discuss which wood is better for making furniture.
27. A person got irritation while applying chemical dye. What would be your suggestion for alternative?
28. Name the humors that are responsible for the health of human beings.
29. Give definitions for organic farming?
30. Define bonsai?
31. What is terrarium?
32. Which is called as the "King of Bitters"? Mention their medicinal importance.
33. Differentiate bio-medicines and botanical medicines.
34. Write the origin and area of cultivation of green gram and red gram.
35. What are millets? What are its types? Give example for each type.
36. Write the economic importance of *Lycopersicon esculentum*.
37. If a person drinks a cup of coffee daily it will help him for his health. Is this correct? If it is correct, list out the benefits.
38. Enumerate the uses of turmeric.
39. What is TSM? How does it classified and what does it focuses on?
40. What are the advantages of cultivation of aromatic plants?
41. How will you make a Bonsai tree
42. What is NMPB?
43. Write the uses of nuts you have studied.
44. Give an account on the role of *Jasminum* and *Rosa* in perfuming.
45. Give an account of active principle and medicinal values of any two plants you have studied.
46. Write the economic importance of rice.
47. Which TSM is widely practiced and culturally accepted in Tamil Nadu? - explain.
48. What are psychoactive drugs? Add a note *Marijuana* and *Opium*
49. Describe the types of fibres.
50. What are the King and Queen of spices? Explain about them and their uses.

51. How will you prepare an organic pesticide for your home garden with the vegetables available from your kitchen?
52. What will you do if you want to make a portable indoor greenery?
53. Give an account on cultivation of *Gloriosa superba* / *Cymbopogon citrates*

Glossary

Term: Description

Lubricant: Oily substance reduces friction.

Odour: Smell (pleasant or unpleasant).

Diuretic: Substance that promote urine production

Cirrhosis: A chronic liver disease typically caused by alcoholism or hepatitis.

Antioxidant: A substance that scavenges free radicals.

Carminative: A drug causing expulsion of gas from the stomach or bowel.

Malnutrition: Deficiencies, excesses or imbalances in a person's intake of energy and / or nutrients

Spawn: Mycelium especially prepared for propagating mushrooms

Aromatic crops: Plants that produce aromatic oils.

Perfumery: The art or process of making perfume

Cosmetics: substances or products used foe personal grooming.

confectionary: a place where confections/ sweets are kept or made

Anti-inflammatory: the property of a substance or treatment that reduces swelling.

Alzheimer's disease: A type of dementia that causes problems with memory, thinking and behavior

Ethnobiology: Ethnobiology is the study of relationships between peoples and plants.

Pharmacopoeia: Is a book containing directions for the identification of compound medicines, and published by the authority of a government or a medical or pharmaceutical society.

Fixative: A substance used to reduce the evaporation rate and improve stability when added to more volatile components.

Antiperspirant: Products whose primary function is to inhibit perspiration / sweat

Seasoning: The processing of food with spices and condiments to enhance the flavour.

ICT Corner

Economically Useful Plants

Let us know about the agriculture in detail through this activity

B266_12_BOT_EM

Steps

- Type the URL or scan the QR code to open the activity page then Introduction page will open.
- Select Package of Practices to know the various methods of agricultural crops breeding system.
- Click on Chat with expert helps the farmers to clarify their doubts.
- Click on Videos to know about the agricultural methods visually through videos.


Step 1


Step 2


Step 3


Step 4

URL: **https://play.google.com/store/apps/details?id=com.criyagen**

Let us know about the Agri book in detail through this activity.

B266_12_BOT_EM

Steps

- Type the URL or scan the QR code to open the activity page then Introduction page will open.
- Click on Agriculture it will display the approaches to cultivate the planted paddy, cotton and sugarcane.
- Click on Horticulture it will display the approaches to cultivate the agricultural crops like tea, coffee.
- Click on Organic Farming it will explain the Traditional method of farming and Traditional Fertilizers.
- Click on Forestry it will explain the gardening methods about plants.

Step 1


Step 2


Step 3


Step 4

URL: **https://play.google.com/store/apps/details?id=com.agribook.venkatmc.agri**

* Pictures are indicative only

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English – Tamil Terminology

Unit VI – Reproduction in plants

Apomixis	கருவுறா இனப்பெருக்கம்
Apospory	கருவுறா வித்து
Archesporium	முன்வித்து திசு
Cleistogamous flower	மூடிய பூ
Cryopreservation	குளிர்பாதுகாப்பு
Embryo sac	கருப்பை
Floral primordium	மலர் தோற்றுவி
Funiculus	சூல் காம்பு
Microsporogenesis	நுண் வித்துருவாக்கம்
Polyembryony	பல்கருநிலை
Scion	ஒட்டுத் தண்டு
Stock	வேர்கட்டை

Unit VII - Genetics

Allele	அல்லீல்
Allopolyploidy	அயல்பன்மடியம்
Alternative splicing	மாற்று இயைத்தல்
Anticodons	எதிர் குறியன்கள்
Autopolyploidy	தன்பன்மடியம்
Backcross	பிற்கலப்பு
Blending inheritance	கலப்பு பாரம்பரியம்
Branch migration	கிளைவழி இடம்பெயர்தல்
Capping	நுனி மூடுதல்
Coding strand	குறியீட்டு இழை
Codominance	இணைஓங்குத்தன்மை
Complete linkage	முழுமையான பிணைப்பு
Complementation test	நிரப்பு சோதனை
Coupling	இணைப்பு
Crossing over	குறுக்கேற்றம்
DNA metabolism	DNA வளர்சிதை மாற்றம்
Dominance	ஓங்குத்தன்மை
Duplication	இரட்டிப்பாதல்
F_1 generation (first filial generation)	முதல் மகவுச்சந்ததி

Frame shift mutation	கட்ட நகர்வு சடுதி மாற்றம்
Gene interaction	மரபணு இடைச்செயல்
Gene mapping	மரபணு வரைபடம்
Genome	மரபணுத்தொகையம்
Genotype	மரபணுவகையம்
Haploidy	ஒருமடியம் (பன்மம்)
Heredity	பாரம்பரியம்
Heterozygous	மாறுபட்டபண்பிணைவு
Homologous chromosome	ஒத்த அமைவிட குரோமோசோம்
Incomplete dominance	முழுமைபெறா ஓங்குத்தன்மை
Incomplete linkage	முழுமையற்ற பிணைப்பு
Independent assortment	சாராஒதுங்கு விதி
Internal methylation	அக மெத்திலாக்கம்
Inversion	தலைகீழ் திருப்பம்
Jumping genes	தாவும் மரபணுக்கள்
Linkage group	பிணைப்புத் தொகுதி
Locus	நிலையிடம்
Map unit	வரைபட அலகு
Mis-sense mutation	தவறாக வெளிப்பாட்டடையும் சடுதிமாற்றம்
Monohybrid	ஒரு பண்புக்கலப்புயிரி
Multiple alleles	பல்கூட்டு அல்லீல்கள்
Mutagen	சடுதிமாற்றக் காரணி
Mutation	சடுதிமாற்றம்
Non-sense mutation	வெளிப்பாடடையாத சடுதி மாற்றம்
Palindrome	முன்பின்ஒத்தவரிசை
Phenotype	புறத்தோற்றவகையம்
Purity of gametes	இனச்செல்கலப்பற்றது
Recessive	ஒடுங்குத்தன்மை
Repulsion	விலகல்
Restriction enzymes	தடைக்கட்டு நொதிகள்
RNA Splicing	RNA இயைத்தல்
Saltation	திடீர் மாற்றம்
Segregation	தனித்தொதுங்குதல்
Sequence	தொடர்வரிசை
Sex linkage	பால் பிணைப்பு
Silent mutation	அமைதி சடுதிமாற்றம்
Split genes	பிளவுறு மரபணு
Start codon	தொடக்கக் குறியன்
Synaptonemal complex	இணைப்பிணைப்புக் கூட்டமைப்பு
Synopsis	இணைச் சேர்தல்
Tailing	வாலாக்கம்
Tassel seed	கதிர் குஞ்சவிதை
Template strand	வார்ப்பு இழை
Test cross	சோதனைக்கலப்பு
Tetrad stage	நான்மய நிலை
Three point test cross	முப்புள்ளி சோதனைக் கலப்பு
Translocation	இடம்பெயர்தல்

UNIT VIII - Biotechnology

Artificial seeds	செயற்கை விதைகள்
Aseptic condition	நுண்ணுயிர் அற்ற நிலை
Autoradiography	கதிரியக்க படமெடுப்பு
Biochip	உயிரி சில்லு
Biomass	உயிரி கூளம்
Biopharming	உயிரி மருந்தாக்கம்
Biopiracy	உயிரிபொருள் கொள்ளை
Bioreactor / Fermentor	உயிரி வினைகலன் / நொதிகலன்
Biosynthesis	உயிரி உற்பத்தி
Buffer	தாங்கல் கரைசல்
Carriers	கடத்தி
Cloned Plants	நகலொத்த தாவரங்கள்
Cloning	நகல்பெருக்கம்
Cloning Site	நகலாக்க களம்
Cryoconservation	உறைகுளிர் வெப்பநிலை பேணல்
Cybrids	கலப்பின பிளாஸ்மிட்கள்

Dedifferentiation	வேறுபாடு இழத்தல்
Differentiation	வேறபாடுறுதல்
DNA Bank	DNA வங்கி
Downstream Process	கீழ்காற் பதப்படுத்தம்
Embryogenesis	கரு உருவாக்கம்
Embryoids	சிறுகருக்கள்
Explant	பிரிகூறு
Fermentation	நொதித்தல்
Gel Electrophoresis	இழும மின்னாற் பிரித்தல்
Gene	மரபணு
Gene Bank	மரபணு வங்கி
Gene Gun	மரபணு துப்பாக்கி
Gene Manipulation Technique	மரபணு கையாளும் தொழில்நுட்பம்
Genetically modified plants	மரபணு மாற்றப்பட்ட தாவரங்கள்
Genome	மரபணு தொகையம்
Green Fluorescence Protein	பசுமை ஒளிர் புரதம்
Hardening	வன்மையாக்குதல்
Human Genome Sequence	மனித மரபணு தொகைய தொடர் வரிசை
Inoculation	உள்நுழைத்தல்
Insert	செருகி
invitro culture	ஆய்வுகூட சோதனை வளர்ப்பு
Isolation	தனிமைபடுத்துதல்
Laminar air flow chamber	சீரடுக்கு காற்று பாய்வு அறை
Liquid medium/ liquid culture	திரவ ஊடகம் / திரவ வளர்ப்பு
Marker	அடையாளக்குறி
Microinjection	நுண்செலுத்துதல்
Micropropagation	நுண்பெருக்கம்
Mycoremediation	பூஞ்சை சீரமைப்பாக்கம்
Nutritional medium	ஊட்ட ஊடகம்
Organogenesis	உறுப்புகளாக்கம்
Palindrome Sequence	முன்பின் ஒத்த வரிசை
Phytoremediation	தாவர சீரமைப்பாக்கம்

Pollen Bank	மகரந்த வங்கி
Probe	துருவி
Recombinant DNA	மறுகூட்டிணைவு DNA
Recombinant	மறுகூட்டிணைவு
Redifferentiation	மறுவேறுபாடுறுதல்
Regeneration	மீள் உருவாக்கம்
Replica Blotting Technique	நகல் முலாம் தொழில்நுட்பம்
Restriction Enzyme	தடை கட்டு நொதி
Somatic Embryoids	உடல் கருவுருக்கள்
Sterile condition	நுண்ணுயிர் நீக்கிய நிலை
Sterilization	நுண்ணுயிர் நீக்கம்
Tissue culture	திசு வளர்ப்பு
Totipotency	முழு ஆக்குத்திறன் பெற்றவை
Transfection	தொற்றுதல்
Transposon	இடமாற்றிக் கூறுகள்
Upstream Process	மேல்காற் பதப்படுத்தம்
Vector	தாங்கி கடத்தி
Virus free plants	வைரஸ் அற்றத் தாவரங்கள்
Walking Genes	நடக்கும் மரபணுக்கள்

UNIT IX – Plant Ecology

Agroforestry	வேளாண்காடுகள்
Alien Invasive species	அயல் ஊடுருவும் சிற்றினங்கள்
Allelopathic chemicals	வேதியத்தடைப் பொருட்கள்
Altitude	குத்துயரம்
Autecology	சுய சூழ்நிலையில்
Benthic	ஆழ்மிகு மண்டலம்
Benthos	ஆழ் உயிரிகள்
Biochar	உயிரித்தொகுப்பு
Biome	உயிர்மம்
Biotope	உயிரி நில அமைவு

Carbon foot print	கார்பன் தடம்
Carbon sequestration	கார்பன் ஒதுக்கமடைதல்
Carbon sink	கார்பன் தேக்கி
Co-evolution	கூட்டுப் பரிணாமம்
Decomposers	சிதைப்பவைகள்
Ecological hierarchy	சூழ்நிலைப்படிகள்
Ecotone	இடைச்சூழலமைப்பு
Ecotope	சூழல் நில அமைவு
Furgivores	பழ உண்ணிகள்
Gnano	கடல் அருகு வாழ் பறவைகளின் எச்சம்
Habitat	புவி வாழிடம்
Humus	மட்கு
Latitude	விரிவகலம்
Mimicry	பாவனை செயல்கள்
Niche	செயல் வாழிடம்
Ozone depletion	ஓசோன் குறைதல்
Photosyntheicaly active radioactive	ஒளிச்சேர்க்கை சார் செயலூக்கக் கதிர்வீச்சு
Plant Ecology	தாவர சூழ்நிலையியல்
Predation	கொன்றுண்ணும் வாழ்க்கை முறை
Sacred groves	கோயில் காடுகள்
Seedball	விதைப்பந்து
Social forestry	சமூகக்காடுகள்
Soil profile	மண்ணின் நெடுக்குவெட்டு விவரம்
Standing crops	நிலைப்பயிர்
Standing quality	நிலைத்தரம்
Succession	வழிமுறை வளர்ச்சி
Synecology	கூட்டுச் சூழ்நிலையில்
Topographic factors	நிலப்பரப்பு வடிவமைப்பு காரணிகள்
Trophic level	ஊட்டஞ்சார் மட்டம்

UNIT X - Economic Botany

Acclimatization	புதிய தட்பவெப்ப நிலைக்கு பழகுதல்
Archeological records	தொல்லியல் பதிவுகள்
Aromatic plant	நறுமண தாவரம்
Bio medicine	உயிரிமூலக்கூறு மருந்து
Biofertilizers	உயிரி உரம்
Culinary	சமையல்
Decoction	வடிநீர்
Domestification	வளர்ப்புச் சூழலுக்கு உட்படுத்துதல்
Emasculation	மகரந்தத்தாள் நீக்கம்
Entrepreneur	தொழில் முனைவோர்
Essential oil	நறுமண எண்ணெய்
Fruiting body	கனி உடலம்
Gluten	பசையம்
Green manuring	தழை உரம்
Kelp	பழுப்பு பாசி
Organic agriculture	இயற்கை வேளாண்மை
Pelleting	சிற்றுருண்டைகள் ஆக்குதல்
Plant pathology	தாவர நோயியல்
Pseudo cereal	பொய் தானியம்
Pungent	நெடி (அல்லது) காரம்
Resin	பிசின்
Sapwood	மென்கட்டை
Saturated fatty acids	நிறைவுற்ற கொழுப்பு அமிலம்
Seed treatment / seed dressing	விதை நேர்த்தி
Spawn	பூஞ்சை வித்து
Stimulant	தூண்டி
Tillering	புல் கிளைத்தல்
Unsaturated fatty acids	நிறைவுறா கொழுப்பு அமிலம்
Vigour	வீரியம்
Volatile oil	எளிதில் ஆவியாகும் எண்ணெய்

Competitive Examination Questions

UNIT VI – Reproduction in plants

1. Which of the following plant reproduces by leaf (DPMT 2003)
   a) *Agave* b) ***Bryophyllum***
   c) *Gladiolus* d) Potato

2. Advantage of cleistogamy (NEET 2013)
   a) Higher genetic variability
   b) More vigorous offspring
   c) **No dependence on pollinators**
   d) Vivipary

3. An example for edible underground stem is (NEET 2014)
   a) Carrot b) Groundnut
   c) Sweet potato d) **Potato**

4. Pollen tablets are available in the market for (NEET 2014)
   a) *invitro* fertilization
   b) Breeding programmes
   c) **supplementing food**
   d) *ex situ* conservation

5. Geitonogamy involves (NEET 2014)
   a) **Fertilization of a flower by pollen from another flower of a same plant**
   b) Fertilization of a flower by pollen of the same flower
   c) Fertilization of a flower by pollen from a flower of another plant in a same population
   d) Fertilization of a flower by the pollen from a flower of another plant belongs to distant population.

6. Which one of the following generates new genetic combinations leading to variations? (NEET 2016)
   a) vegetative reproduction
   b) parthenogenesis
   c) **Sexual reproduction**
   d) Nucellar polyembryony

7. Functional megaspore in angiosperm develops into an (NEET 2017)
   a) endosperm b) **Embryo sac**
   c) embryo d) ovule

8. Which of the statement is not true. (NEET 2016)
   a) Pollen grain of many species cause severe allergies
   b) Stored pollen in liquid nitrogen can be used in crop breeding programmes
   c) **Tapetum helps in the dehiscence of anther**
   d) Exine of pollen grains is made up of sporopollenin

9) When a diploid female plant is crossed with a tetraploid male, the ploidy of endosperm cells in the resulting seed is (AIPMT 2004)
   a) pentaploidy b) diploidy
   c) triploidy d) **tetraploidy**

10) Which one of the following pairs of plant structures has haploid number of chromosomes? (AIPMT 2008)
   a) Egg nucleus and secondary nucleus
   b) Megaspore mother cell and antipodal cells
   c) **Egg cell and and antipodal cells**
   d) Nucellus and antipodal cells

11) The arrangement of nuclei in a normal embryo sac in the dicot plant is (AIPMT 2006)
   a) 2 + 4 + 2 b) **3 + 2 + 3**
   c) 2 + 3 + 3 d) 3 + 3 + 2

12) Wind pollinated flowers are (AIPMT PRE 2010)
   a) Small, producing nectar and dry pollen
   b) small, brightly colored, producing large number of pollen grains
   c) **small, producing large number of pollen grains**
   d) large, producing abundant nectar and pollen

13) Function of filiform apparatus is to (AIPMT 2014)
a) recognize the suitable pollen at stigma
b) stimulate division of generative cell
c) produce nectar
d) **guide the entry of pollen tube**

14) The coconut water from tender coconut represents (NEET 2016)
a) endocarp
b) fleshy mesocarp
c) free nuclear proembryo
d) **free nuclear endosperm**

15) Pollination in water hyacinth and water lily is brought about by the agency of (NEET 2016)
a) **insects or wind** b) birds
c) bats d) water

16) Perisperm differs from endosperm in (NEET 2013)
a) being haploid tissue
b) having no reserve food
c) **being a diploid tissue**
d) its formation by fusion of secondary nucleus with several sperms

17) Male gametes in angiosperms are formed by the division of (AIPMT 2007)
a) microspore mother cell b) microspore
c) **generative cell** d) vegetative cell

18) In a type of apomixes known as adventive polyembryony,embryo develop directly from the (AIPMT 2005)
a) synergids or antipodals in an embryo sac
b) **nucellus or integuments**
c) zygote
d) accessory embryo sac in the ovule

19) In a cereal grain the single cotyledon of the embryo is represented by (AIPMT 2006)
a) coleorhizae b) **scutellum**
c) prophyll d) coleoptiles

20) An ovule which becomes curved so that the nucellus and embryo sac lie at right angles to the funicle is (AIPMT 2004)
a) camylotropous b) anatropous
c) orthotropous d) **hemianatropous**

21) Endosperm is formed during the double fertilization by (AIPMT 2000)
a) **two polar nuclei and one male gamete**
b) one polar nuclei and one male gamete
c) ovum and male gametes
d) two polar nuclei and two male gametes

UNIT VII – Genetics

1. Genes for cytoplasmic male sterility in plants are generally located in (AIPMT 2005)
a) **Mitrochondrial genome** b) Cytosol
c) Chloroplast genome d) Nuclear genome

2. In which mode of inheritance do you expect more maternal influence among the off spring (AIPMT 2006)
a) Autosomal b) **Cytoplasmic**
c) Y-linked d) X-linked

3. Which one of the following cannot be explained on the basis of Mendel's Law of Dominance? (AIPMT 2010)
a) Factors occur in pairs
b) The discrete unit controlling a particular character is called a factor
c) Out of one pair of factors one is dominant and the other is recessive
d) Alleles does not show any blending and both the characters recover as such in F_2 generation

4. F_2 generation in a Mendelian cross shows that both genotypic and phenotypic ratios are same as 1:2:1. It represents a case of (AIPMT 2012)
a) Monohybrid crosses with incomplete dominance
b) Co-dominance c) Dihybrid cross
d) Monohybrid cross with complete dominance

5. A Pleiotropic gene
(AIPMT 2015 – Re-exam)
a) Controls multiple traits in an individual
b) Is expressed only in primitive plants
c) Is a gene evolved during Pliocene
d) Controls a trait only in combination with another L gene

6. A true breeding plant is
(NEET Phase II 2016)
a) Near homozygous and produces offspring of its own kind
b) Always homozygous recessive in its genetic construction
c) One that is able to breed on its own
d) Produced due to cross pollination among unrelated plants

7. Mendel obtained wrinkled seeds in pea due to the deposition of sugars instead of starch. It was due to which enzyme?
(AIPMT 2001)
a) Amylase b) Invertase c) Diastase
d) **Absence of starch branching enzyme**

8. Ratio of complementary gene is
(AIPMT 2001)
a) 9:3:4 b) 12:3:1 c) 9:3:3:4 d) **9:7**

9. If there are 999 bases in an RNA that codes for a protein with 333 amino acid and the base at position 901 is deleted such that the length of the RNA becomes 998 bases, how many codons will be altered?
(NEET 2017)
a) 1 b) 11 c) 33 d) **333**

10. If a homozygous red flowered plant is crossed with a homozygous white flowered plant, then the off-springs will be
(AIIMS 1999, 2002, 2007)
a) Half-white flowered b) Half-red flowered
c) All white flowered d) **All red flowered**

11. The ratio in a dihyrbid test cross between two individuals is given by (AIIMS 2001)
a) 2:1 b) 1:2:1 c) 3:1 d) **1:1:1:1**

12. Pure line breed refers to
(AIIMS 2002, AIIMS 2007)
a) Heterozygosity only
b) Heterozygosity and linkage
c) **Homozygosity only**
d) Homozygosity and self assortment

13. How many different types of gametes can be formed by F_1 progeny, resulting from the following cross AABBCC x aabbcc
(AIIMS 2004)
a) 3 b) **8** c) 27 d) 64

14. Which of the following conditions represents a case of co-dominant genes?
(AIIMS 2009)
a) A gene expresses itself, suppressing the phenotypic effect of its alleles
b) Genes that are similar in phenotypic effect when present separately, but when together interact to produce a different trait
c) Alleles both of which interact to produce a trait which may or may not resemble either of the parental type
d) Alleles, each of which produces an independent effect in a heterozygous condition.

15. If 'A' represents the dominant gene and 'a' represents its recessive allele, which of the following would be most likely result in the first generation off spring when Aa is crossed with aa? (AIIMS 2016)
a) All will exhibit dominant phenotype
b) All will exhibit recessive phenotype
c) **Dominant and recessive phenotypes will be 50% each**
d) Dominant phenotype will be 75%

16. In *Pisum Sativum*, there are 14 chromosomes. How many types of homologous pairs can be prepared? (JIPMER 2010)
a) 14 **b) 7** c) 2^{14} d) 2^{10}

17. The year 1900 AD is highly significant for geneticists due to (JIPMER 2013)
    a) Discovery of genes
    b) Principle of linkage
    c) Chromosomal theory of heredity
    d) **Rediscovery of Mendelism**

18. The phenotypic ratio of trihybrid cross in F_2 generation is (JIPMER 2016)
    a) **27:9:9:9:3:3:3:1** b) 9:3:3:1
    c) 1:4:6:4:1 d) 27:9:3:3:9:1:2:1

19. In a mutational event when adenine is replaced by guanine, it is the case of (AIPMT 2004)
    a) Frameshift mutatin b) Transcription
    c) **Transition** d) Transversion

20. Mutations can be induced with (AIPMT 2011)
    a) **Gamma radiations** b) Infrared radiations
    c) IAA d) Ethylene

21. The mechanism that causes a gene to move from one linkage group to another is called (AIPMT 2015, NEET (Phase – II) 2016)
    a) **Translocation** b) Crossing over
    c) Inversion d) Duplication

22. A point mutation comprising the substitution of a purine by pyrimidine is called (AIIMS 2002)
    a) Transition b) Translocation
    c) Deletion d) **Transversion**

23. Frameshift mutation occurs when (AIPMT 2008)
    a) Base is substituted
    b) **base is deleted or added**
    c) Anticodons are absent
    d) None of these

24. The distance between two genes in a chromosome is measured in cross-over units which represent (AIIMS 2008)
    a) Ratio of crossing over between them
    b) **Percentage of crossing over between them**
    c) Number of crossing over between them
    d) None of these

25. When a cluster of genes show linkage behaviour they (AIPMT 2003)
    a) do not show a chromosome map
    b) show recombination during meiosis
    c) **do not show independent assortment**
    d) induce cell division

26. Genetic map is one that (AIPMT 2003)
    a) **Establish sites of the genes on a chromosome**
    b) Establishes the various stages in gene evolution
    c) Shows the stages during the cell division
    d) Shows the distribution of various species in a region

27. After a mutation at a genetic locus of the character of an organism changes due to the change in (AIPMT 2004)
    a) DNA replication
    b) Protein synthesis pattern
    c) RNA transcription pattern
    d) **Protein structure**

28. In a hexaploidy wheat, the haploid (n) and basic (x) numbers of chromosomes are (AIPMT 2007)
    a) **n =21 and x =7** b) n =7 and x =21
    c) n =21 and x =21 d) n =21 and x =14

29. Point mutation involves (AIPMT 2009)
    a) Deletion b) Insertion
    c) **Change in single base pair**
    d) duplication

30. Which one of the following is a wrong statement regarding mutations**?** (AIPMT 2012)
    a) UV and Gamma rays are mutagens
    b) **Change in a single base pair of DNA does not cause mutation**
    c) Deletion and insertion of base pairs cause frame shift mutations.
    d) Cancer cells commonly show chromosomal aberrations.

31. Which of the following statement is not true of two genes that show 50% recombination frequency? (NEET 2013)
    a) The genes may be on different chromosomes
    b) **The genes are tightly linked**
    c) The genes show independent assortment
    d) If the genes are present on the same chromosome, they undergo more than one crossover in every meiosis.

32. Haploids are more suitable for mutation studies than the diploids. This is because (AIPMT 2008)
    a) **All mutations, whether dominant or recessive are expressed in haploids**
    b) Haploids are reproductively more stable than diploids
    c) Mutagens penetrate in haploids more effectively than diploids
    d) Haploids are more abundant in nature than diploids

33. Crossing over that results in genetic recombination in higher organisms occurs between (AIPMT 2004)
    a) **Non-sister chromatids of a bivalent**
    b) Two daughter nuclei
    c) Two different bivalents
    d) Sister chromatids of bivalents

34. Removal of introns and joining the exons in a defined order in a transcription unit is called (AIPMT 2009, AIPMT Pre 2012)
    a) Tailing b) Transformation
    c) Capping d) **Splicing**

35. Selection the correct option (AIPMT 2014)\

	Direction of RNA synthesis	**Direction of reading of the template DNA strand**
a)	**5' – 3'**	**3' – 5'**
b)	3' – 5'	5' – 3'
c)	5' – 3'	5' – 3'
d)	3' – 5'	3 ' – 5'

36. Peptide synthesis inside a cell takes place in (AIPMT 2011)
    a) **Ribosomes** b) Chloroplast
    c) Mitrochondria d) Chloroplast

37. During protein synthesis in a organism at one point the process comes to a halt. Select the group of the three codons from the following from which any one of the three could bring about this halt. (AIIMS 2006)
    a) UUU, UCC, UAU b) UUUC, UUA, UAC
    c) **UAG, UGA, UAA** d) UUG, UCA, UCG

38. The binding site of tRNA with mRNA and amino acids respectively are (AIIMS 2009)
    a) mRNA with DHU loop and amino acid with CCA end
    b) mRNA with CCA end and amino acid with anticodon loop
    c) mRNA with anticodon loop and amino acid with DHU loop
    d) **mRNA with anticodon loop and amino acid with CCA end**

39. Which of the following is correct regarding genetic code? (AIIMS 2010)
    a) UUU is the initiation codon which also codes for phenylalanine
    b) **There are 64 triplet codons and only 20 amino acids**
    c) Three random nitrogen bases specify the placement of one amino acid
    d) UAA is the nonsense codon which also codes for methionine

40. Which of the following set of options is used in translation? (AIIMS 2015)
    a) hnRNA, tRNA, rRNA
    b) **mRNA, tRNA, rRNA**
    c) mRNA, tRNA, hnRNA
    d) hnRNA, rRNA, lRNA

41. Sequence of DNA (non-coding) is known as (JIPMER 2006)
    a) exon b) **intron**
    b) cistron d) none of these

42. During transcription holoenzyme RNA polymerase binds to a DNA sequence and the DNA assumes a saddle like structure at that point. What is that sequence called (JIPMER 2007)
a) CAAT box b) GGTT box
c) AAAT box d) **TATA box**

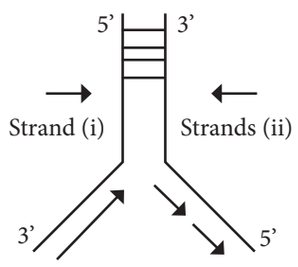
43. The successive nucleotides of RNA are covalently linked through (JIPMER 2001)
a) Hydrogen bonds
b) **Phosphodiester bonds**
c) Glycosidic bonds d) None of these

44. The Okazaki fragments in DNA chain growth (AIPMT 2007, JIPMER 2004)
a) Polymerize in the 3' - to 5' direction and forms replication fork
b) Prove semi conservative nature of DNA replication
c) **Polymerize in the 5' to 3' direction and explains 3' – to – 5' DNA replication**
d) Result in transcription

45. Taylor conducted the experiment to prove semiconservative mode of chromosome replication on (NEET (Phase II) 2016)
a) Drosophila melanogaster b) e-coli
c) Vinca rosea d) **vicia faba**

46. The new strand synthesized in small pieces and then joined together during DNA replication is called (AIIMS 1994)
a) Dead strand b) **Lagging strand**
c) Leading strand d) All of these

47. What is incorrect about the following figure representing DNA replication (AIIMS 2009)



a) The direction of DNA replication in strand (i)
b) The direction of DNA replication in strand (ii)
c) **Discontinuous replication of strand (i)**
d) Discontinuous replication of strand (ii)

48. DNA multiplication is called (JIPMER 2009)
a) Translation b) **Replication**
c) Transduction d) Transcription

49. The complete set of chromosome inherited as a single unit from one parent is known as (AIIMS 1994)
a) **Genome** b) Linkage
c) Gene pool d) Genotype

50. The mobile genetic element is (JIPMER 2014)
a) **Transposon** b) Mutation
c) Endonuclease d) Variation

UNIT VIII – Biotechnology

1. What is the criterion for DNA fragments movement on agarose gel during gel electrophoresis? (NEET 2017)
a) **The smaller the fragment size, the farther it moves.**
b) Positively charged fragments move to farther end.
c) Negatively charged fragments do not move.
d) The larger the fragment size, the farther it moves.

2. Stirred-tank bioreactors have been designed for (NEET – II 2016)
a) Purification of product.
b) Addition of preservatives to the product
c) **Availability of oxygen throughout the process**
d) Ensuring anaerobic conditions in the culture vessel.

3. Which of the following is not a component of downstream processing? (NEET-II 2016)

a) Separation b) Purification
c) Preservation d) **Expression**

4. Which of the following is not a feature of the plasmids? (NEET-I 2016)
a) Transferable **b) Single-stranded**
c) Independent replication
d) Circular structure

5. Which of the following is not required for nay of the techniques of DNA fingerprinting available at present? (NEET-I 2016)
a) Restriction enzymes
b) DNA-DNA hybridization
c) Polymerase chain reaction
d) Zinc finger analysis

6. Which vector can clone only a small fragment of DNA? (AIPMT 2014)
a) Bacterial artificial chromosome
b) Yeast artificial chromosome
c) Plasmid d) Cosmid

7. The colonies of recombinant bacteria appear white in contrast to blue colonies of non-recombinant bacteria because of (NEET 2013)
a) Insertional inactivation of alpha galactosidase in recombinant bacteria.
b) Inactivation of glycosidase enzyme in recombinant bacteria.
c) N**on-recombinant bacteria containing beta galactosidase.**
d) Insertional inactivation of alpha galactosidase in non-recombinant bacteria.

8. During the process of isolation of DNA, chilled ethanol is added to (Karnataka NEET 2013)
a) **Precipitate DNA**
b) Break open the cell to release DNA
c) Facilitate action of restriction enzymes
d) Remove proteins such as histones.

9. For transformation, micro-particles coated with DNA to be bombarded with gene gun are made up of (AIPMT 2012)
a) Silver or platinum b) Platinum or zinc
c) Silicon or platinum **d) Gold or tungsten.**

10. Biolistics (gene-gun) is suitable for (AIPMT Mains 2012)
a) disarming pathogen vectors
b) transformation of plant cells
c) constructing recombinant DNA by joining with vectors
d) DNA fingerprinting.

11. Genetic engineering is possible because (CBSE 1998)
a) phenomenon of transduction in bacteria understood
b) we can see DNA by electron microscope
c) we can cut DNA at specific sites by endonuclease like DNAase I
d) restriction endonuclease purified from bacteria can be used invitro

12. Genetic Engineering is (BHU 2003)
a) Making artificial genes
b) **Hybridisation of DNA of one organism to that of the others**
c) Production of alcohol by using microorganisms
d) Making artificial limbs, diagnostic instruments such as ECG, EFG, etc.

13. Ligase is used for (AMU 2006)
a) **Joining of two DNA fragments**
b) Separating DNA
c) DNA polymerase reaction
d) All of these

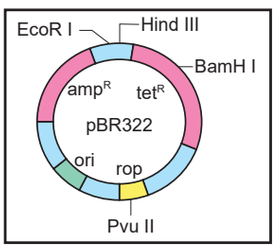
14. In genetic engineering, gene of interest is transferred to the host cell through a vector. Consider the following four agents (1-4) in this regard and select the correct option about which one or more of these can be used as vectors
1. A bacterium 2. Plasmid
3. Plasmodium 4. Bacteriophage
(AIPMT Main 2010)
a) 1 and 4 only b) **2 and 4 only**
c) 1 only d) 1 and 3 only

15. Given below is a sample of a portion of DNA strand giving the base sequence on the opposite strands. What is so special shown in it? (AIPMT 2014)
5'---GAATTC---3' 3'---CTTAAG---5'

a) **Palindromic sequence of base pairs**
b) Replication completed
c) Deletion mutation
d) Start codon at the 5'end

16. There is a restriction endonuclease called EcoRI. What does "co" part in it stand for ? (AIPMT 2011)
a) Coelom b) Colon
c) **Coli** d) Coenzyme

17. The figure below is the diagrammatic representation of the vector pBR322. Which one of the given options correctly identifies its certain components? (AIPMT 2012)



a) Ori-original restriction enzyme
b) rop-reduced osmotic pressure
c) Hind III, EcoRI – selectable markers
d) **ampR, tetR – antibiotic resistance genes**

18. A mixture containing DNA fragments a,b,c,d with molecular weights of a+b=c, a>b and d>c, was subjected to agarose gel electrophoresis. The position of these fragmets from cathode to anode sides of the gel would be (DPMT 2010)
a) **b,a,c,d** b) a,b,c,d
c) c,b,a,d d) b,a,d,c

19. An analysis of chromosomal DNA using the southern hybridisation technique does not use (AIPMT 2014)
a) Electrophoresis
b) Blotting
c) Autoradiography
d) **PCR**

20. The colonies of recombinant bacteria appear white in contrast to blue colonies of non- recombinant bacteria because of (NEET 2013)
a) Non-recombinant bacteria containing beta galactosidase
b) Insertional inactivation of a-galactosidase in non-recombinant bacteria
c) **Insertional inactivation of b-galactosidase in recombinant bacteria**
d) Inactivation of glycosidase enzyme in recombinant bacteria

21. Which one of the following palindromic base sequence in DNA can be easily cut at about the middle by some particular restriction enzyme? (AIPMT 2010)
a) 5'CGTTCG3' 3'ATCGTA 5'
b) 5' GATATG 3' 3' CTACTA 5'
c) **5' GAATTC 3' 3' CTTAAG 5'**
d) 5' CACGTA 3' 3' CTCAGT 5'

22. Silencing of mRNA has been used in producing transgenic plants resistant to (AIPMT, 2011)
a) Boll worms b) **Nematodes**
c) White rusts d) Bacterial blights

23. Some of the characteristics of Bt cotton are (AIPMT,2010)
a) Long fibre and resistant to aphids
b) Medium yield, long fibre and resistant to beetle pests
c) High yield and production of toxic protein crystals which kill dipteran pests
d) **High yield and resistant to boll worms**

24. An improved variety of transgenic basmati rice (AIPMT,2010)
a) Does not require chemical fertilisers and growth hormones
b) **Gives high yield and is rich in vitamin A**

c) Is completely resistant to all insect pests and diseases of paddy
d) Gives high yield but no characteristic aroma

25) Consumption of which one of the following foods prevent the kind of blindness associated with vitamin A deficiency? (AIPMT 2012)

a) Flavr Savr b) Canola
c) **Golden rice** d) Bt brinjal

26. A protoplast is a cell (NEET 2016)
a) undergoing division
b)without cell wall
c) without plasma membrane
d) without nucleus.

27. A technique of micropropagation is (NEET 2015)
a) Protoplast fusion
b) embryo rescue
c) somatic hybridization
d) somatic embryogenesis

28. To obtain virus-free healthy plants from a diseased one by tissue culture technique, which part/parts of the diseased plant will be taken? (AIPMT 2014)
a) Apical meristem only
b) Palisade parenchyma
c) **Both apical and axillary meristems**
d) Epidermis only.

29. Cellular totipotency was demonstrated by (AIPMT 1991)
a) Theodore Schwann
b) A.V. Leeuwenhoek
c) F.C. Steward
d) Robert Hooke

30. Tissue culture technique can produce infinite number of new plants from a small parental tissue. The economic importance of the technique is raising. (Karnataka NEET 2013)
a) **genetically uniform population identical to the original parent.**
b) homozygous diploid plants
c) new species
d) variants through picking up somaclonal variations

31. Which of the following statements is not true about somatic embryogenesis? (Karnataka NEET 2013).
a. The pattern of development of a somatic embryo is comparable to that of a zygotic embryo.
b) **Somatic embryos can develop from microspores.**
c) Somatic embryo is induced usually by an auxin such as 2, 4-D.
d) A somatic embryo develops from a somatic cell.

32. Which one of the following is a case of wrong matching? (AIPMT 2012)
a) Somatic - Fusion of two diverse hybridization cells
b) Vector DNA - Site for tRNA synthesis
c) Micropropagation - *in vitro* production of plants in large numbers
d) Callus - Unorganised mass of cells produced in tissue culture.

33. Polyethylene glycol method is used for (AIPMT 2010)
a) biodiesel production
b) seedless fruit production
c) energy production from sewage
d) gene transfer without a vector.

34. Somaclones are obtained by (AIPMT 2009)
a) Plant breeding
b) Irradiation
c) genetic engineering
d) tissue culture.

35. The technique of obtaining large number of plantlets by tissue culture method is called
a) Plantlet culture (AIPMT 2005)
b) Organ culture
c) Micropropagation
d) Macropropagation

36. Coconut milk is used in tissue culture in which present (AIPMT 2000)
a) cytokinin b) auxin
c) gibberellins d) ethylene.

37. Haploid plants can be obtained by culturing. (AIPMT 1994)
a) pollen grains b) root tips
c) young leaves d) endosperm.

UNIT IX - Plant Ecology

1. Plants which produce characteristic pneumatophores and show vivipary belong to (NEET 2017)
a) **Halophytes** b) psammophytes
c) hydrophytes d) mesophytes

2. Mycorrhizae are the example of (NEET I 2017)
a) amensalism b) antibiosis
c) **mutualism** d) fungistatis

3. If '+' sign is assigned to beneficial interaction, '-' sign to detrimental and '0' sign to neutral interaction, then the population interaction represented by '+' '-' refers to (NEET 2016)
a) mutualism b) amensalism
c) commensalism d) **parasitism**

4. Which of the following is correctly matched? (NEET Phase 2 – 2016)
a) Aerenchyma - *Opuntia*
b) Age pyramid - Biome
c) ***Parthenium hysterophorus*** - **Threat to biodiversity**
d) Stratification - Population

5. An association of individuals of different species living in the same habitat and having functional interactions is (Re-AIPMT 2015)
a) Population b) Ecological niche
c) **Biotic community** d) Ecosystem

6. Roots play in significant role in absorption of water in (Re-AIPMT 2015)
a) Wheat b) Sunflower
c) ***Pistia*** d) Pea

7. If we uncover half of the forest covering the earth, what crisis will be produced at most and the first? (AIPMT 1996)
a. Some species will be extinct
b. Population and ecological imbalance will rise up
c. Energy crisis will occur
d. Rest half forests will maintain this imbalance.

8. Most animals are tree dwellers in a (AIPMT 2015)
a) **Tropical rain forest**
b)Coniferous forest
c) Thorn woodland
d) Temperate deciduous fo

9. *Cuscuta* is an example of (AIPMT Mains 2012)
a) **Ectoparasitism** b) Brood parasitism
c) Predation d) Endoparasitism

10. Large woody vines are more commonly found in (AIPMT Prelims 2011)
a) Alphine forests
b) Temperate forests
c) Mangroves
d) **Tropical rain forests**

11. Niche overlap indicates (AIPMT Prelims 2006)
a) Active co-operation between two species
b) Two different parasites on the same host
c) **Sharing of one or more resources between the two species**
d) Mutualism between two species

12. Which one of the following pairs is **mismatched?** (AIPMT Prelims 2005)
    a) Savanna – Acacia trees
    b) **Prairie – Epiphytes**
    c) Tundra – Permafrost
    d) Coniferous forest – Evergreen trees

13. Which ecosystem has the maximum biomass? (NEET 2017)
    a) Grassland ecosystem
    b) Pond ecosystem
    c) Lake ecosystem
    d) **Forest ecosystem**

14. Which of the following would appear as the pioneer organisms on bare rocks? (NEET 2016)
    a) Mosses b) Green algae
    c) **Lichens** d) Liverworts

15. In which of the following both pairs have correct combination? (NEET 2015)

a)	Gaseous nutrient cycle Sedimentary nutrient cycle	Nitrogen and Sulphur Carbon and Phosphorous
b)	Gaseous nutrient cycle Sedimentary nutrient cycle	Sulphur and Phosphorous Carbon and Nitrogen
c)	**Gaseous nutrient cycle Sedimentary nutrient cycle**	**Carbon and Nitrogen Sulphur and Phosphorous**
d)	Gaseous nutrient cycle Sedimentary nutrient cycle	Carbon and Sulphur Nitrogen and Phosphorous

16. Secondary succession takes place on / in (NEET 2015 cancelled)
    a) newly created pond b) newly cooled lava
    c) bare rock d) **degraded forest**

17. In an ecosystem the rate of production of organic matter during photosynthesis is termed as (NEET 2015 cancelled)
    a) Secondary productivity
    b) net productivity
    c) Net primary productivity
    d) **gross primary productivity**

18. Natural reservoir of phosphorous is (NEET 2013)
    a) **rock** b) fossils
    c) sea water d) animal bones

19. Secondary productivity is rate of formation of new organic matter by (NEET 2013)
    a) **consumers** b) decomposers
    c) producers d) parasites

20. Which one of the following processes during decomposition is correctly described? (NEET 2013)
    a) Catabolism – Last step in the decomposition under fully anaerobic condition
    b) Leaching – Water soluble inorganic nutrient rise to the top layers of soil
    c) **Fragmentation – Carried out by organisms such as earthworms.**
    d) Humification – Leads to the accumulative of a dark coloured substance humus which undergoes microbial action in a very fast rate.

21. Which one of the following is not a functional unit of an ecosystem? (AIPMT 2012)
    a) Energy flow b) decomposition
    c) Productivity d) **stratification**

22. The upright pyramid of number is absent in (AIPMT 2012)
    a) Pond b) **forest**
    c) lake d) grassland

23. The rate of formation of new organic matter by rabbit in a grassland is called (Mains 2012)
    a) net productivity
    b) **secondary productivity**
    c) net primary productivity
    d) gross primary productivity

24. The second stage of hydrosere is occupied by plants like (Mains 2012)
a) *Azolla* b) *Typha*
c) *Salix* d) ***Vallisneria***

25. Which one of the following is a characteristic feature of cropland ecosystem? (NEET 2016)
a) Ecological succession
b) Absence of soil organisms
c) **Least genetic diversity**
d) Absence of weeds

26. Most animals that live in deep oceanic waters are (Re-AIPMT 2015)
a) **Detritivores**
b) Primary consumers
c) Secondary consumers
d) Tertiary consumers

27. During ecological succession (Re-AIPMT 2015)
a) The changes lead to a community that is in near equilibrium with the environment and is called pioneer community.
b) **The gradual and predictable change in species composition occurs in a given area**.
c) The establishment of a new biotic community is very fast in its primary phase.
d) The number and types of animals remain constant.

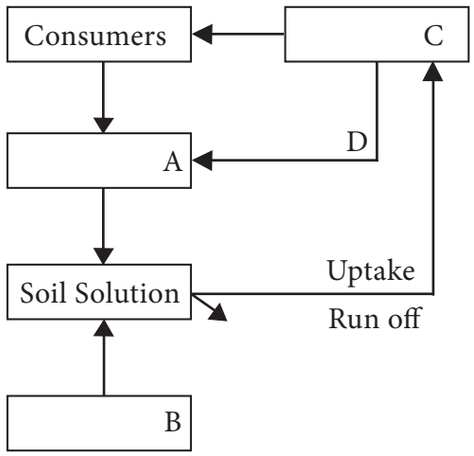
28. The mass of living material at a trophic level at a particular time is called (AIPMT 2015)
a) **Standing crop**
b) Gross primary productivity
c) Standing state
d) Net primary productivity

29. Match the following and select the **correct** option (AIPMT 2014)

Column I	**Column II**
(I) Earthworm	(i) pioneer species
(II) Succession	(ii) Detritivore
(III) Ecosystem service	(iii) Natality
(IV) Population growth	(iv) Pollination

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

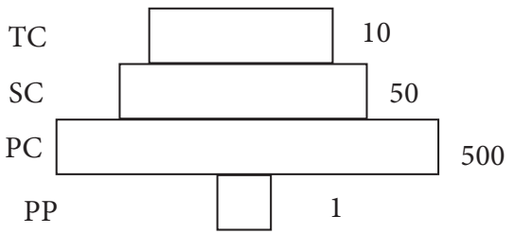
30. Given below is a simplified model of phosphorous cycling in a terrestrial ecosystem with four blanks (A – D. Identify the blanks. (AIPMT 2014)



	A	B	C	D
a)	Rock minerals	Detritus	Litter fall	Producers
b)	Litter fall	Producers	Rock minerals	Detritus
c)	**Detritus**	**Rock minerals**	**Producers**	**Litter fall**
d)	Producers	Litter fall	Rock minerals	Detritus

31. If 20 J of energy is trapped at producer level, then how much energy will be available to peacock as food in the following chain? (AIPMT 2014)
Plant → Mice → Snake → Peacock
a) **0.02 J** b) 0.002 J
c) 0.2 J d) 0.0002 J

32. Given below is an imaginary pyramid of numbers. What could be one of the possibilities about certain organisms at some of the different levels ? (AIPMT Prelims 2012)



a) Level one PP is 'pipal trees' and the level SC is 'sheep'.
b) Level PC is 'rats' and level SC is 'cats'
c) **Level PC is 'insects' and level SC is 'small insectivorous birds'**
d) Level PP is 'phytoplanktons' in sea and 'whale' on top level TC

33. Which one of the following statements for pyramid of energy is incorrect, whereas the remaining three are correct? (AIPMT Prelims 2011)
a) It is upright in shape
b) Its base is broad
c) It shows energy content of different trophic level organisms
d) **It is inverted in shape**

34. Which one of the following animals may occupy more than one trophic levels in the same ecosystem at the same time? (AIPMT Mains 2011)
a) Goat b) Frog
c) **Sparrow** d) Lion

35. Both hydrarch and xerarch successions lead to (AIPMT Mains 2011)
a) Highly dry conditions
b) Excessive wet conditions
c) **Medium water conditions**
d) Xeric conditions

36. Of the total incident solar radiation the proportion of PAR is (AIPMT Prelims 2011)
a) More than 80% b) About 70%
c) About 60% d) **Less than 50%**

37. The breakdown of detritus into smaller particles by earthworm is a process called (AIPMT Mains 2011)
a) Mineralisation b) Catabolism
c) Humification d) **Fragmentation**

38. The biomass available for consumption by the herbivores and the decomposers is called (AIPMT Prelims 2010)
a) Gross primary productivity
b) **Net primary productivity**
c) Secondary productivity
d) Standing crop

39. The correct sequence of plants in a hydrosere is (AIPMT Prelims 2009)
a) ***Volvox*** → ***Hydrilla*** → ***Pistia*** → ***Scirpus*** → ***Lantana*** → **Oak**
b) *Pistia*→*Volvox*→*Scirpus*→*Hydrilla*→Oak → *Lantana*
c) Oak→*Lantana*→*Volvox*→*Hydrilla*→*Pistia* →*Scirpus*
d) Oak→*Lantana*→*Scirpus*→*Pistia*→*Hydrilla* →*Volvox*

40. About 70% of the total global carbon is found in (AIPMT Prelims 2008)
a) Forests b) Grasslands
c) Agro ecosystems d) **Oceans**

41. Consider the following statements concerning food chains
i) Removal of 80% tigers from an area resulted in greatly increased growth of vegetation.
ii) Removal of most of the carnivores resulted in an increased population of deers.
iii) The length of food chains is generally limited to 3 – 4 trophic levels due to energy loss.
iv) The length of food chains may vary from 2 to 8 trophic levels.
Which two of the above statements are correct? (AIPMT Prelims 2008)
a) i and ii b) **ii and iii**
c) iii and iv d) i and iv

42. Which one of the following is not used for construction of ecological pyramids?
(AIPMT Prelims 2006)
a) Dry weight
2) Number of individuals
c) Rate of energy flow
4) **Fresh weight**

43. The UN Conference of Parties on climate change in the year 2012 was held at (NEET 2015)
a. Lima b. Warsaw
c. Durban **d. Doha.**

44. Which of the following are most suitable indicators of SO_2 pollution in the environment? (NEET 2015)
a. Algae b. Fungi
c. Lichens d. Conifers

45. Which of the following is not one of the prime health risks associated with greater UV radiations through the atmosphere due to depletion of stratospheric ozone? (NEET 2015)
a. Damage to eyes
b. Increased liver cancer
c. Increased skin cancerd.
d. Reduced Immune system

46. A location with luxuriant growth of lichens on the trees indicates that the
(AIPMT 2014)
a. trees are very healthy
b. trees are heavily infested
c. location is highly polluted
d. location is not polluted.

47. The ozone of atmosphere in which the ozone layer is present is called
(AIPMT 2014)
a. ionosphere b. mesosphere
c. stratosphere d. troposphere

48. Which one of the following is a wrong statement? (AIPMT 2012)
a. Most of the forests have been lost in tropical areas.
b**. Ozone in upper part of atmosphere is harmful to animals.**
c.Greenhouse effect is a natural phenomenon.
d. Eutrophication is a natural phenomenon in freshwater bodies.

49. Good ozone is found in the (Mains 2011)
a. mesosphere b.troposphere
c. stratosphere d. ionosphere

50. Chipko movement was launched for the protection of (AIPMT 2009)
a. **forests** b. livestock
c.wetlands d.grasslands

51. Identify the correctly matched pair.
(AIPMT 2005)
a. Basal convention - Biodiversity conservation
b.Kyoto protocol -Climatic change
c. Montreal protocol -Global warming
d. Ramsar convention -Ground water pollution

52. Common indicator organism of water pollution is (AIPMT 2004)
a. *Lemna pancicostata*
b. *Eichhornia crassipes*
c. *Escherichia coli*
d. *Entamoeba histolytica*

53. Which country has the greatest contribution for the hole formation in ozone layer? (AIPMT 1996)
a. Russia b. Japan
c. USA d Germany

UNIT X - Economic Botany

1. The name of Dr. Norman Borlaug is associated with (JIPMER 2007)

   a) **Green revolution**
   b) Yellow revolution
   c) White revolution
   d) Blue revolution

2. Which of the following is generally used for induced mutageneis in crop plants (JIPMER 2007)

   a) Alpha b) X-ray
   c) UV ray d) **Gamma ray**

3. A man-made allopolyploid cereal crop is (OJEE 2010)

   a) *Hordeum vulgare* **b) *Triticale***
   c) *Raphanus brassica* d) *Zee mays*

4. Objective of plant breeding is (MP PMT 2001)

   a) better yield
   b) better quality
   c) disease / stress resistance
   d) All of the above

5. Selection is a method of (MP Pmet 2001)

   a) cytology b) plant phycology
   c) plant breeding d) genetics

6. Green revolution in India occurred during (AIPMT 2012)

   a) 1960's b) 1970's
   c) 1980's d) 1950's

7. Jaya and ratna developed for green revolution in India are the varieties of (AIPMT 2011)

   a) maize **b) rice**
   c) sugarcane d) wheat.

9. First man-made cereal triticale is (HPMT 2008)

   a) Octaploid **b) hexaploid**
   c) Both a & b d) diploid

11. In plant breeding programmes, the entire collection (of plants / seeds) having all the diverse alleles for all genes in a given crop is called (NEET 2013)

    a) cross hybridization among the selected parents
    b) evaluation is selection of parents
    c) **germplasm collection**
    d) selection of superior recombinants

16. An example for semi dwarf variety of wheat is (HPPMT 2012)

    a) IR 8 b) **Sonalika**
    c) *Triticum* d) *Saccharum*

17. Himgiri developed by hybridization is selection for disease resistance against rust pathogen is a variety of (AIPMT 2011)

    a) Chilli b) Maize
    c) Sugarcane d) **Wheat**

18. Breeding of crops with high levels of minerals, vitamins and proteins is called (CBSE AIPMT 2010)

    a) somatic hybridization
    b) **biofortification**
    c) bio magnification
    d) micro propagation

19. The reason for vegetatively reproducing crop plants to suit for maintaining hybrid vigour is that (AIPMT 1998)

    a) they are more resistant to disease
    b) **once a desired hybrid produced, no chances of losing it**
    c) they can be easily propagated
    d) they have a longer life span.

20. Wonder wheat is a new wheat variety developed by (AIIMS 2009)

    a) **Mexico's International Wheat and Maize improvement centre**
    b) Indian National Botanical Research Institute
    c) Australian crop Improvement centre
    d) African Crop Improvement centre

HIGHER SECONDARY - SECOND YEAR
BOTANY PRACTICALS

INTRODUCTION

Laboratory is a place where ideas and concepts can be tested through experiments. Laboratory investigations in biology increase the reasoning abilities, brings scientific attitude in a learner and also helps in acquisition of skills of scientific processes. Hence, a biology student too, is obliged to attend practical in laboratory with utmost sincerity, honesty and inquisitiveness. The practical work includes

- ❖ Study of permanent slides
- ❖ Microscopic preparation of slides
- ❖ Study of preserved and fresh specimens
- ❖ Section, cutting and mounting
- ❖ Analysing the problem and solving it
- ❖ Physiological experiments, etc.

GENERAL INSTRUCTIONS

In order to perform experiments successfully, a learner needs to go to the Biology Laboratory well prepared. This includes the following.

VMNJ53

1. Laboratory record book
2. Dissection box
3. Laboratory manual
4. A laboratory coat or apron
5. A hand towel
6. Drawing pencil (HB) and pencil eraser to record various experiments and to draw diagrams
7. Any item more as per the instructions of the teacher

While in the laboratory, a student should be very careful and methodical. One should listen carefully to the instructions given by the teacher / instructor before performing an experiment. Maintain a complete silence and working atmosphere in the laboratory. Record keeping is most important in practical. Diagrams should be correctly drawn and well labelled. Always get the signature of the teacher in the practical note book on each day after the practical class.

However, it is important that every student of Botany / Biology may pay proper attention to the practical work and should try to acquire basic laboratory skills and develop a keen sense of observation and acquire a sound training in the reporting of the work done.

If the material suggested for a particular experiment is not available, a suitable alternate material may be used.

BOTANY PRACTICALS

MODEL QUESTION

I.	Identify the given slide 'A' and give any two reasons. Draw a neat, labelled diagram.
II.	Identify the given fresh / preserved specimen 'B" and give any two reasons.
III.	Identify the given model / photograph / picture 'C' and give any two reasons.
IV.	Analyse the given ecological / genetic problem 'D'. Solve/Construct it by giving appropriate reasons.
V.	Write the aim, procedure, observation and inference of the given experiment 'E'
VI.	Identify the economically important plant / plant product 'F'. Mention its Botanical name, useful part and their uses.

MARKS ALLOTMENT-PRACTICAL EXAMINATION

I.	A	Identification – 1 , Reason (any two) – 1 , Diagram and Labelling – 1	3
II.	B	Identification – 1, Reason (any two) – 1	2
III.	C	Identification – 1, Reason (any two) – 1	2
IV.	D	Identification – 1 , Solve/ Construct– 1, Reason/ Observation and Inference/ Answer – 1	3
V.	E	Aim – 1, Procedure – 1, Table (Observation, Inference) – 1	3
VI.	F	Identification – ½ Botanical name – ½ , Useful part – ½, use – ½.	2
		Total 15 marks	
		Record 3 marks	
		Skill 2 marks	
		Maximum marks 20 marks	

QUESTION No- I (A) - Preparation and Demonstration of Slides	
Note: Teacher has to prepare a temporary slide using fresh specimen for demonstration. (During examination permanent slides can be used if temporary slide preparation is not possible).	
Exercise 1	T.S. of Mature anther
Exercise 2	L.S. of an Angiospermic ovule
Exercise 3	T.S. of *Nerium* leaf
QUESTION No- II (B) - Fresh or preserved specimens	
Exercise 4	Natural methods of vegetative propagation in plants - Rhizome, Sucker, Epiphyllous buds.
Exercise 5	Adaptations of flowers for pollination by different agents – Wind, Insects.
Exercise 6	Structure of Dicotyledonous seed – Gram (*Cicer*).
Exercise 7	Dispersal of seeds by various agents – Wind, Water, Animal.
Exercise 8	Ecological adaptations of plants - Hydrophytic, Xerophytic, Halophytic and Epiphytic.
QUESTION No- III (C)- Models / Photographs / Charts	
Exercise 9	Types of ovules – Anatropous, Orthotropous, Campylotropous
Exercise 10	Picture of a vector (pBR 322)
Exercise 11	Plant tissue culture – Callus with plantlets
Exercise 12	Types of ecological pyramids – Number, Biomass, Energy
QUESTION No- IV (D) - Problems – Genetics and Ecology	
Exercise 13	To verify Mendel's Monohybrid cross
Exercise 14	Analysis of seed sample to study Mendelian Dihybrid Ratio
Exercise 15	Flow of energy and Ten percent law
Exercise 16	Determination of population density and percentage frequency of different plant species of given area by Quadrat method
Exercise 17	Chromosomal aberration – Deletion, Duplication, Inversion
Exercise 18	Genetic / Linkage maps
QUESTION No- V (E) - Experiments	
Exercise 19	Dissect and display the Pollinia of *Calotropis*
Exercise 20	Study of pollen germination on a slide
Exercise 21	Study of pH of different types of soils
Exercise 22	Water holding capacity of garden soil and road side soil
Exercise 23	Isolation of DNA from plant material
QUESTION No- VI (F) -Economic importance of plants	
Exercise 24	Economically important plants and their uses Wheat, Black pepper, Cotton, Keezhanelli, Green gram, Banana
Exercise 25	Economically important plant products and their uses:Sesame / Gingelly oil, Rubber, Aval (Flaked rice), Rose water, Henna powder,Aloe gel

BOTANY PRACTICALS

I - Preparation and Demonstration of Slides

Note: Teacher has to prepare a temporary slide using fresh specimen for demonstration. (During examination permanent slides can be used if temporary slide preparation is not possible)

Exercise 1: T.S of Anther

Aim: To study and identify the given slide – T.S of Anther

Principle: Androecium is made up of stamens. Each stamen possesses an anther and a filament. Anther bears pollen grains which represent the male gametophyte.

Requirements: Anther of *Datura metel*, glycerine, safranin, slide, cover slip, blade, brush, needle to prepare temporary slides, permanent slide of T.S. of mature anther and compound microscope.

Collect buds and opened flowers of *Datura metel*. Dissect the stamens, separate the anthers and take thin sections and observe the structure under the microscope. Record the various stages of anther from your observation.

Diagnostic Features

- A mature anther is bilobed (dithecous) and the two lobes are joined by a connective.
- Each anther lobe has two pollen chambers in which pollen grains are produced.
- A microsporangium or pollen sac is surrounded by four wall layers. They are epidermis , endothecium, middle layers and tapetum.
- Centre of the microsporangium (pollen sac) is filled with haploid pollen grains.

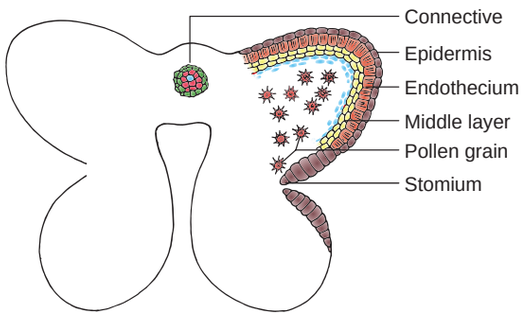


Figure 1: Pollen grain stage of anther

Exercise 2: L.S of an Angiospermic ovule.

Aim: To study and identify the L.S. of an Angiospermic Ovule.

Principle: In female reproductive part of a flower, the basal swollen part is ovary. The ovules are present inside the ovary, later they develops to seed.

Requirement: Permanent slide of L.S. of Ovule, microscope

Diagnostic Features

- Ovule or megasporangium is protected by one / two coverings called integuments.
- The stalk of the ovule is called funicle.
- The point of attachment of funicle to the body of the ovule is known as hilum.
- The body of the ovule is made up of a central mass of parenchymatous tissue called nucellus.
- The integuments form a pore called micropyle and the region opposite to the micropyle is called as chalaza.
- The nucellus has a large, oval, sac like structure towards the micropylar end called embryo sac.
- A mature ovule, has 8 nuclei in its embryo sac.

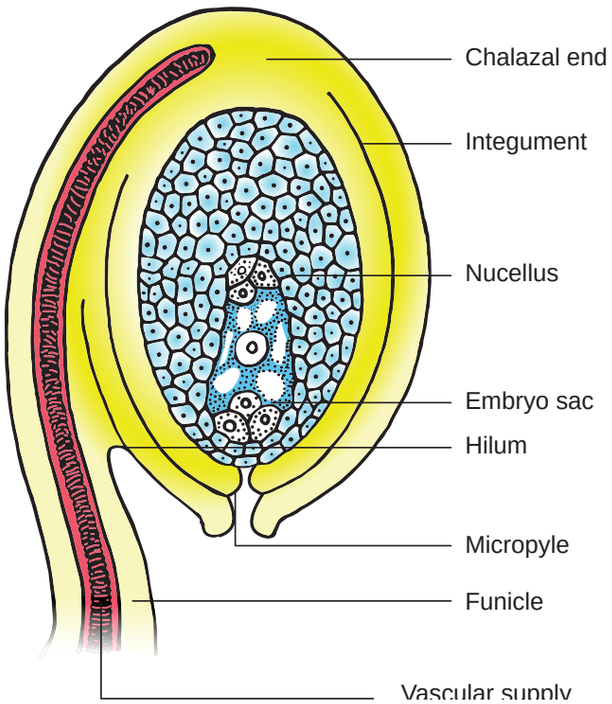


Figure 2: L.S of ovule

Exercise 3: T.S. of *Nerium* Leaf

Aim: To observe and understand the xerophytic adaptations found in *Nerium* leaves for living in dry or xeric habitat.

Principle: The plants which are living in dry or xeric condition are known as Xerophytes.

Requirements: *Nerium* leaf, few pieces of carrot / pith / styrofoam, blade, brush, needle, compound microscope, glycerine, coverslip, wash glass, microslide, saffranin solution, petri dish, etc.

Start cutting transverse sections of *Nerium* leaf placing it in between a piece of carrot. Select the thinnest section of the material with the help of a delicate brush. Take a clean watch glass with water, transfer thin sections of the material. Put a few drops of safranin stain in the watch glass with water. Leave it for 3-5 minutes. Drain off stain and wash with water if necessary. Put the thinnest section in the centre of the slide. Put a drop of glycerine over the material. Cover it with a coverslip with the help of needle. Observe it under a compound microscope.

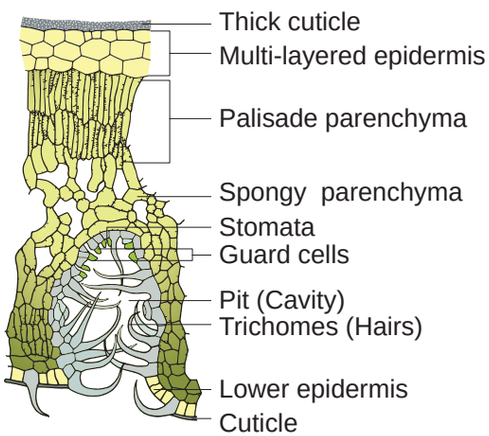


Figure 3: T.S. of Nerium leaf

Diagnostic Features

- Presence of multilayered epidermis with thick cuticle.
- Sunken stomata are present only in the lower epidermis.
- Mesophyll is well differentiated into palisade and spongy parenchyma.
- Mechanical tissues are well developed.

II - Fresh or Preserved Specimens

Exercise 4: Natural methods of Vegetative Propagation in Plants

Aim: To study and identify the types of natural methods of vegetative propagation in plants.

Principle: Natural vegetative reproduction is a form of asexual reproduction in which vegetative bud grows and develops into a new plant.

Requirements: Fresh / preserved specimens of *Zingiber*, *Chrysanthemum*, *Bryophullum*.

Ask the students to visit the nearest vegetable market and classify the vegetable into root, stem or leaf based on their utility and identify how many of them can be propagated through vegetative methods.

4 A. Vegetative Propagation by underground stem – Rhizome

Diagnostic Features

- Ginger is a underground stem which is called as Rhizome.
- Rhizomes are horizontal and swollen due to the storage of food materials.
- The terminal buds turn upwards to produce the aerial flowering shoot and the lateral buds grow out to form new rhizomes.

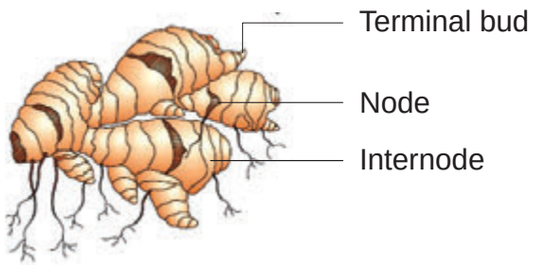


Figure 4a: Rhizome – Ginger

4 B. Vegetative Propagation by sub-aerial stem – Sucker

Diagnostic Features

- The suckers of *Chrysanthemum* are used for propagating plants.
- Suckers grows horizontally under the soil and then emerge out obliquely from the soil and give rise to a new plant or leafy shoot.
- The sucker has nodes and internodes. In the nodal region, it bears axillary buds above and adventitious roots below.

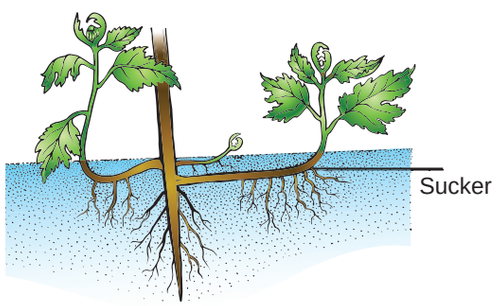


Figure 4b: Sucker - *Chrysanthemum*

4 C. Vegetative Propagation by epiphyllous buds - *Bryophyllum*

Diagnostic Features

- In *Bryophyllum*, adventitious buds arise on the leaf margins. These are called epiphyllous buds.
- When the leaves fall off the epiphyllous buds develop roots into the soil and becomes independent plants.

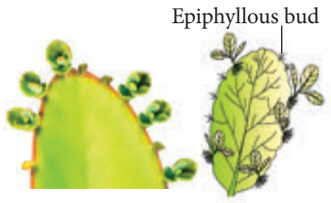


Figure 4a: *Bryophyllum* leaf

Exercise 5: Adaptations of flowers for pollination by different agents.

Aim: To study the adaptations in flowers for pollination by different agents (wind and insects)

Principle: The process of transfer of pollen grains from the anther to stigma of a flower is called **pollination**.

Requirements: Fresh flowers of maize or any other cereal / gram, any insect pollination flowers like *Salvia*, *Calotropis, Ocimum* and Asteraceae flowers.

Place the given flower on a slide and observe it with the help of hand lens. Note down the adaptations of the flowers meant for pollination by the external agents.

5 A. Wind Pollinated Flowers - Anemophily

Diagnostic Features

- The flowers are small, inconspicuous, colourless, odourless and nectarless.
- Anthers and stigmas are commonly exerted.
- Pollen grains are light, small, powdery and produced in large numbers.
- The stigmas are large, sometimes feathery and branched adapted to catch the pollens.

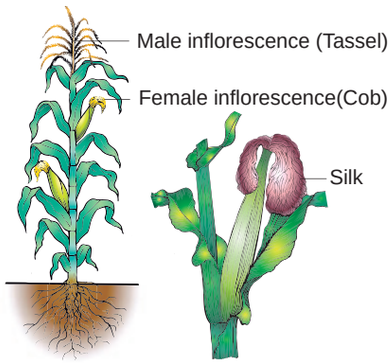


Figure 5a: Maize

5 B. Insect Pollinated Flowers - Entemophily

Diagnostic Features

- The flowers are showy, brightly coloured and scented.
- The flowers produce nectar or edible pollen.
- Anthers and stigmas are commonly inserted.
- Stigmas are usually unbranched and flat or lobed.

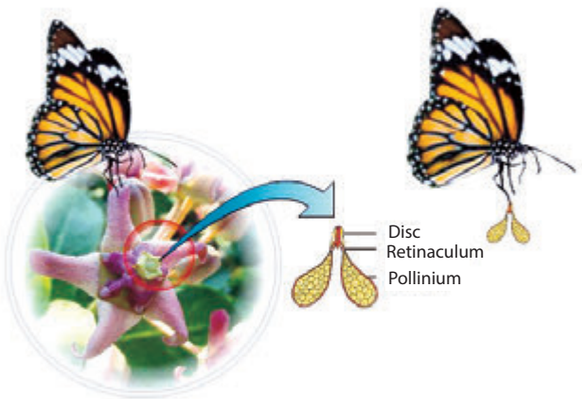


Figure 5b: *Calotropis*

Exercise 6: Dicot seed

Aim: To study and identify the Dicot seed

Principle: The fertilized ovule is called seed and possesses an embryo, endosperm and a protective coat. Seeds may be endospermous or non endospermous.

Requirements: Chick pea, bowl, water

Soak the seeds of chick pea or gram in water for 2 – 3 hours. Drain the water and place the seeds in a moist cotton cloth for 2 – 3 days. Observe for germination. Select some sprouted seeds, observe under a dissection microscope and record the parts.

Diagnostic Features

- Seeds of gram have two cotyledons and an embryonal axis.
- Each seed is covered by two seed coats (a) Testa – outer coat and (b) Tegmen – inner coat.
- The embryonal axis consists of radicle and plumule.
- The portion of the embryonal axis above the level of cotyledons is called epicotyl. It terminates into the plumule.
- The portion of the embryonal axis below the level of cotyledons is called hypocotyl. It terminates into the radicle or root tip.

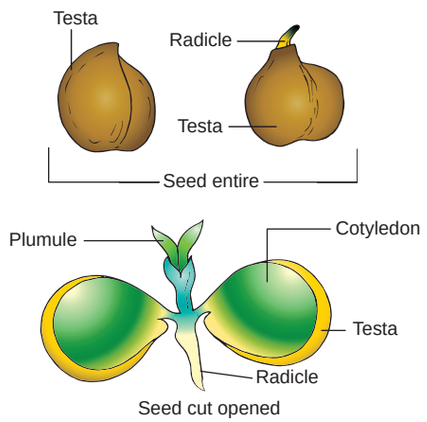


Figure 6: Dicot seed – Gram (*Cicer*)

Exercise 7: Dispersal of seeds by various agents

Aim: To study and understand the agents that help in the dispersal of fruits and seeds.

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

Requirements: Fruits of *Tridax*, Coconut and *Achyranthes*, knife, forceps, petridish, hand-lens etc.

7 A. Dispersal by wind – Anemochory (Example: *Tridax*)

Diagnostic Features

- Fruits are light so that wind may carry them away.
- Fruits are minute, very small and with inflated covering.
- Fruits have feathery appendages (pappus) which greatly increase their buoyancy to disperse in high altitudes.

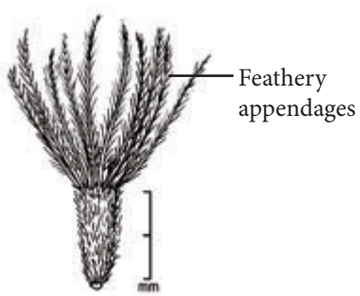


Figure 7a: Fruit of Tridax

7 B. Dispersal by water – Hydrochory (Example: Coconut)

Figure 7b: Coconut

Diagnostic Features

- Fruits have outer coats that are modified to enable them to float.
- The mesocarp of coconut is fibrous, which is easily carried away by water currents.

7 C. Dispersal by animals –Zoochory (Example: *Achyranthes*)

Figure 7c: *Achyranthes*

Diagnostic Features

- Fruits are provided with hooks, spines, bristles, stiff hairs, etc. on their outer coat.
- The sharp pointed fruits of *Achyranthes* stick to the hairs of the animals and clothes and get carried away from one place to another.

Exercise 8: Ecological adaptations of plants found in hydrophytic, xerophytic, halophytic and epiphytic conditions.

Aim: To study plants found in different habitats and comment upon their adaptations.

Principle: The modifications in the structure of organisms to survive successfully in an environment are called adaptations of organisms. Observe different plants existing under various ecological habitats. The corresponding adaptations of plants and their interaction with the environment can be better understood.

Requirements: Fresh or preserved specimens of *Eichhornia*, *Opuntia*, *Avicennia* and *Vanda*.

8 A. Adaptations of Hydrophytes - *Eichhornia* (Water hyacinth)

Eichhornia is a free floating hydrophyte that grows in ponds, lakes and water bodies containing fresh water.

Diagnostic Features

- Root system is poorly developed.
- Root pockets are present.
- The petioles become swollen and spongy, providing buoyancy.
- Cortex is well developed with numerous air chambers. It helps in buoyancy and rapid gaseous exchange.
- Mechanical tissues are generally absent.

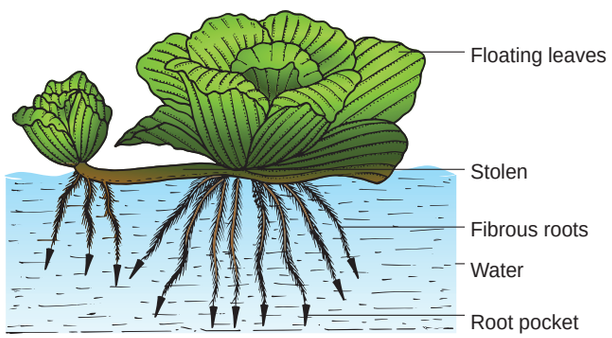


Figure 8a: Free floating hydrophyte – *Eichhornia*

8 B. Adaptations of Xerophytes - *Opuntia*

Opuntia is a succulent or drought resisting xerophyte, which grows wild in arid areas.

Diagnostic Features

- The stem is flattened, green, thick and fleshly called phylloclade
- Mucilage is present which helps to retain the water.
- Leaves are modified into spines

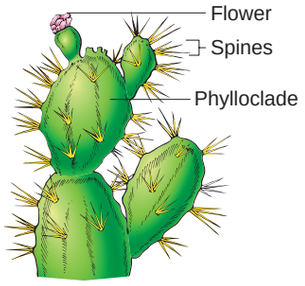


Figure 8a: Succulent xerophyte - *Opuntia*

8 C. Adaptation of Halophytes – Pneumatophores of *Avicennia*

Avicennia is a plant which grows and survives in saline environment like salty lakes and sea shores (mangrove vegetation).

Diagnostic Features

- A special kind of negatively geotropic root called pneumatophores (respiratory roots) are present.
- The leaves excrete salts through the salt glands.

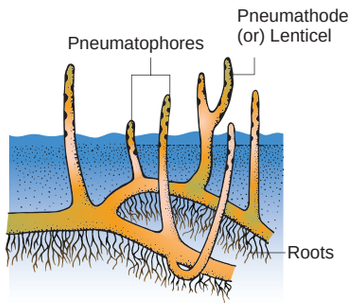


Figure 8c: Pneumatophores of *Avicennia*

8 D. Adaptation of Epiphytes – *Vanda*

Vanda is an epiphytic plant that grows perched on other plants (supporting plants). They use supporting plants only as shelter and not for water or food supply.

Diagnostic Features

- Root system is extensively developed. These roots are of two types (1) clinging roots and (2) aerial roots.
- The clinging roots fix epiphytes firmly on the surface of the supporting plant.
- Aerial roots are green coloured, hang downwardly and absorbs moisture from the atomosphere with the help of spongy tissue called velamen.

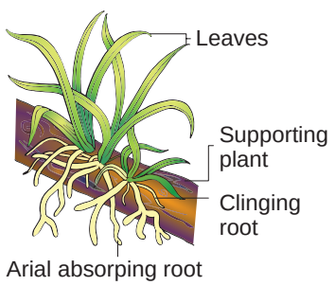


Figure 8d: Epiphytic roots of *Vanda*

III - Models / Photographs / Pictures

Exercise 9: Types of ovules

Aim: To recognize different types of ovules in flowering plants

Principle: To identify ovules based on the orientation, form and position of the micropyle with respect to funicle and chalaza

Requirements: Models / Photographs/ Pictures of different types of ovules.

9 A. Anatropous Ovule

Diagnostic Features

- The body of the ovule becomes completely inverted so that micropyle lies close to the funicle.
- Micropyle and chalaza lie on the same straight line. Example: Asteraceae.

Figure 8a: Anatropous ovule

9 B. Orthotropous Ovule

Diagnostic Features

- In this type of ovule, the micropyle is at the distal end.
- The ovule is erect or straight so that the funicle, chalaza and micropyle lie on the same vertical line. Example: Piperaceae and Polygonaceae.

Figure 8b: Orthotropous ovule

9 C. Campylotropous Ovule

Diagnostic Features

- In this type, the body of the ovule at the micropylar end is curved and more or less bean shaped.
- The embryosac is slightly curved.
- The funicle, micropyle and chalaza are adjacent to one another with the micropyle oriented towards the placenta. Example: Leguminosae.

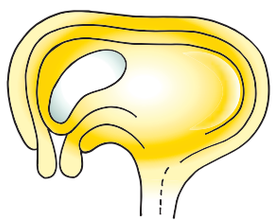


Figure 8c: Campylotropous ovule

Exercise 10: E.coli cloning vector (pBR 322)

Aim: To study and identify the features of cloning vector – pBR 322

Principle: Vectors are used as carriers to deliver the desired foreign DNA into a host cell.

Requirements: Models/ Photographs / Pictures of E.coli Cloning vector pBR 322.

Diagnostic Features

- pBR 322 plasmid is a reconstructed plasmid containing 4361 base pairs and most widely used as cloning vector.
- In pBR, p denotes plasmid and B and R respectively the notes of scientists Boliver and Rodriguez who developed the plasmid. The number 322 is the number of plasmids developed from their laboratory.
- It contains two different antibiotic resistance genes and recognition site for several restriction enzymes (Hind III, Eco R I, Bam H I, Sal I, Pvu II, Pst I, Cla I), Ori and antibiotic resistance genes (amp^R and tet^R). Rop codes for the proteins involved in the replication of the plasmid.

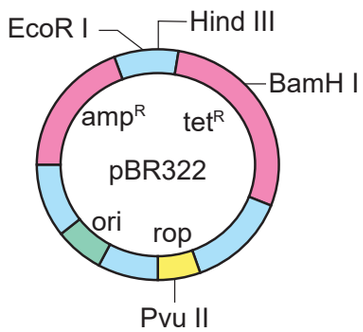


Figure 10: E-coli cloning vector (pBR 322)

Exercise 11: Plant tissue culture – Callus with plantlets

Aim: To study and identify the Callus with plantlets.

Principle: Growing the plant cells, tissues and organs in an artificial, synthetic medium under controlled conditions is called plant tissue culture. The technique of cloning plant is easier than animals because plant cells are simple in structure and most plant cells shows totipotency (i.e) ability to regenerate from cells.

Requirements: Model / Photograph / Picture of callus with plantlets.

Diagnostic Features

- The callus is an unorganized mass of undifferentiated tissue.
- The mechanism of callus formation is that auxin induce cell elongation and cytokinin induces cell division as a result of which masses of cells are formed.
- Roots and shoots are differentiated from the callus.

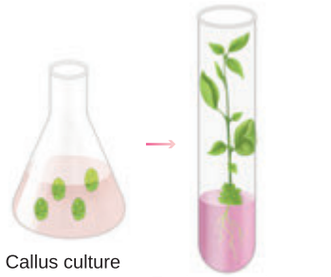


Figure 11: Callus with plantlets

Exercise 12: Types of ecological pyramid

Aim: To study and identify the different types of ecological pyramids

Principle: The relationship between different trophic levels in an ecosystem when shown diagrammatically appear as 'ecological pyramids'. In these ecological pyramids, the successive tiers represent successive trophic levels towards the apex. The base of the pyramid is of producers, the next one above it is of herbivores and the top tiers are of carnivores. The top most or apex represents the tertiary or top level consumers.

Requirements: Models / Photographs / Pictures of different types of ecological pyramid.

12 A. Pyramid of numbers

Diagnostic Features

- The number of organism that are present in successive trophic levels of an ecosystem is shown in the pyramid of numbers of a grassland ecosystem.
- There is a gradual decrease in the number of organisms in each trophic level from producers to primary consumers, then to secondary consumer, and finally to tertiary consumers.
- Therefore, pyramid of number in grassland ecosystem is always upright.

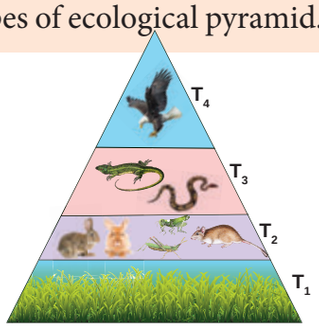


Figure 12 a: Pyramid of numbers in grassland ecosystem

T_1 - Producers | T_2 - Herbivores | T_3 - Secondary consumers | T_4 - Tertiary consumers

12 B. Pyramid of biomass

Diagnostic Features

- Pyramid of biomass represents the total biomass or standing crop (dry weight) of organisms in each trophic level at a particular time.
- In aquatic ecosystem, the bottom of the pyramid is occupied by the producers, which comprises very small organisms (algae and phytoplanktons) possessing the least biomass and so the value gradually increases towards the tip of the pyramid.
- Therefore, here the pyramid of biomass is always inverted in shape.

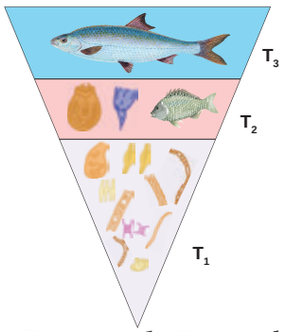


Figure 12 b: Pyramid of biomass in aquatic ecosystem

T_1 - Producers | T_2 - Herbivores | T_3 - Secondary consumers |

12 C. Pyramid of energy

Diagnostic Features

- Pyramid of energy represents the number of joules transferred from one trophic level to next.
- The bottom of the pyramid of energy is occupied by the producers. There is a gradual decrease in energy transfer at successive trophic levels from producers to the upper levels.
- Therefore pyramid of energy is always upright.

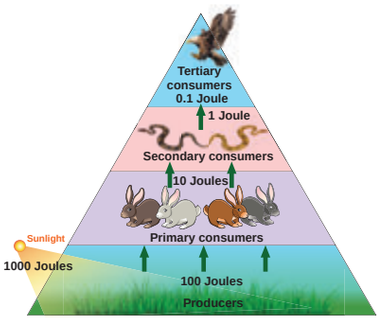


Figure 12 c: Pyramid of Energy

IV - Solving the Problems

Exercise 13: To verify Mendel's Monohybrid cross

NOTE: Student have to work in pairs to perform this experiment and record the data in the observation and record note book with the help of the teacher.

Need not consider this Monohybrid cross experiment for Board Practical Examination.

Aim:

To verify Mendel's Monohybrid cross.

Principle:

When two pure lines with contrasting traits of a particular character (phenotype) are crossed to produce the next generation (F_1 generation), all the members of the progeny are of only one phenotype, i.e. of one of the two parents. The phenotype that appears is called dominant and the one that does not appear is called recessive. When the F_1 plants are selfed, the progeny i.e. the F_2 generation, is in the ratio of 3 dominant : 1 recessive (¾ : ¼ of 75% : 25%). This reappearance of the recessive phenotype in F_2 generation, verifies Mendel's Monohybrid cross.

Requirements:

64 yellow and 64 green plastic beads, all of exactly same shape and size (when beads are not available, pea seeds may be painted and used). Plastic beakers, petri dish and a napkin / hand towel.

Procedure

Make the student to work in pairs to perform the experiment. Follow the steps in given sequence.

1. Put 64 yellow beads in one beaker and 64 green beads in the other to represent male and female gametes respectively. Let the yellow bead be indicated by 'Y' and the green bead by 'y'
2. Take a bead from each container and place them together (it represents fertilization) on the hand towel spread before you on the table.
3. Just like the previous step, continue to pick beads and arrange them in pairs. Thus 64 pairs of beads are obtained representing the 64 heterozygous F_1 progeny.
4. Put 32 F_1 progeny in one petridish and the remaining 32 in another petridish (representing the F_1 males and females).
5. To obtain the F_2 generation, the student should withdraw one bead from one beaker labelled male and one from the other beaker labelled female keeping his / her eyes closed (to ensure randomness) and put them together on the hand towel spread over the table. Continue this process till all the beads are paired. Thus 64 offsprings of F_2 progeny are obtained.
6. Note the genotype (YY or Yy or yy) of each pair and their possible phenotype.
7. Pool all the data and calculate the genotypic and phenotypic ratios.

Observation:

Record the result in the following table:

Generation	Total Number of individuals	Genotypes			Phenotype(s)
		YY	Yy	yy	
F_1					
	Total				
F_2					
	Total				

Phenotypic ratio : in F_1 _____

in F_2 _____

Genotypic ratio : in F_1 _____

in F_2 _____

Inference:

The results are so because when the F_1 individuals are crossed together to raise the F_2 generation, each F_1 individual produces two types of gametes: 50% having dominant allele and the remaining 50% having recessive allele. These gametes undergo random fusion during fertilization to produce the F_2 generation. According to simple probability of mixing of opposite sex gametes, offsprings of three genotypes are likely to appear as follows:

Among these, proportion of dominant phenotype would be YY + Yy = yellow and recessive phenotype yy = green, which occur in 3 : 1 or 75% : 25% ratio.

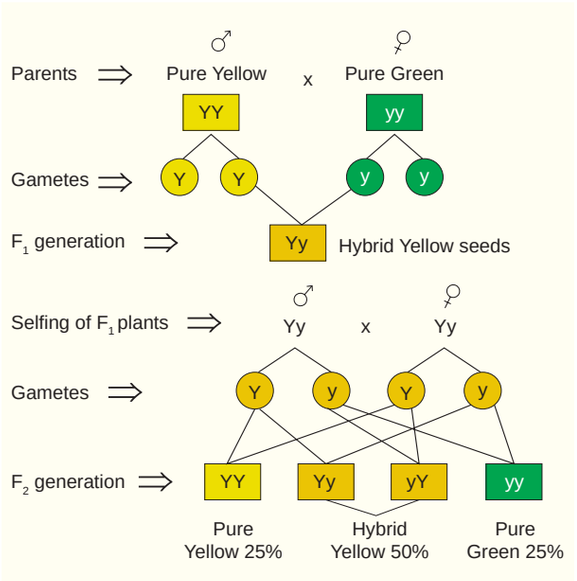


Figure 13 : Monohybrid cross

This ratio of 3 :1 in the F_2 suggests that the hybrids or heterozygotes of F_1 generation have two contrasting factors or alleles of dominant and recessive type. These factors, though remain together for a long time, do not contaminate or mix with each other. They separate or segregate at the time of gamete formation so that a gamete carries only one factor, either dominat or recessive.

Precautions:

1. Take a sufficiently large number of seeds for analysis to minimise the error.
2. Observe the contrasting form of trait carefully.

Exercise 14: Analysis of seed sample to study Mendelian dihybrid ratio

Aim:

To analyse seed sample of pea for Mendelian dihybrid ratio of 9 : 3 : 3 : 1.

Principle:

In a dihyrbid cross, the segregation of one gene pair is independent of the segregation of the other pair. It means that when the factors (genes) for different characters inherited from parents do not remain linked in the offsprings, but their distribution in the gametes and in the progeny of subsequent generations is independent of each other.

Requirement:

Plastic beakers, Pea seed samples or plastic beads, tray, petri dishes, notebook, pencil / pen.

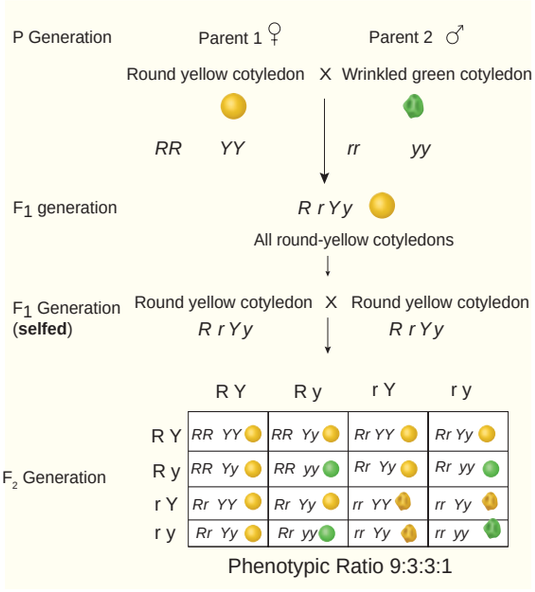


Figure 14 : Dihybrid cross

Teachers should select the Pea seed or plastic beads which represents the four types of traits such as yellow round, yellow wrinkled, green round and green wrinkled in the ratio of 9:3:3:1

Procedure:

1. Take a lot of about 160 Pea seeds or plastic beads in a tray.
2. Separate out yellow round, yellow wrinkled, green round and green wrinkled and put them in separate petridishes.
3. Note down the number of seeds in each plate and find out their approximate ratio.

Observation:

Present your finding in the form of a table.

Total Number of seeds observed	No. of yellow round seeds	No. of yellow wrinkled seeds	No. of green round seeds	No. of green wrinkled seeds	Approximate ratio
160	90	30	30	10	9 : 3:3:1

Inference:

The ratio of yellow round : yellow wrinkled : Green round : green wrinkled is approximately 9 : 3 : 3 : 1 which is exactly the same as obtained by Mendel for a dihybrid cross. This indicates that the contrasting genes for seed colour and seed shape show an independent assortment in the population of pea seeds.

Exercise 15: Flow of energy and Ten percent law

Aim:

To understand the unidirectional flow of energy in an ecosystem and transfer of energy follows the 10% law.

Principle:

The student studies about flow of energy and that only about 10% of energy is made available to the next trophic level. Large amount of energy about 90% is lost at each trophic level in a food chain.

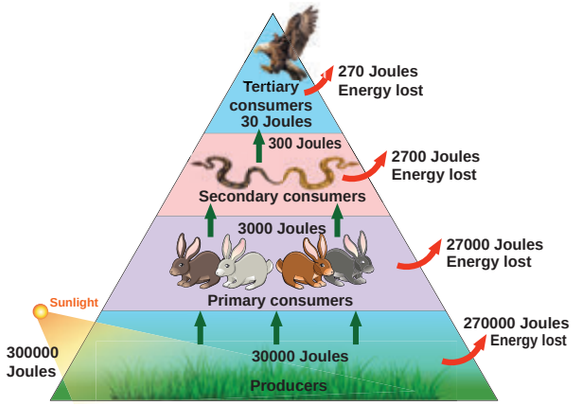


Figure 15: Ten percent law

Requirements:

Problems to be given to students based on different examples with alternating food chain and amount of energy.

> The teacher must train the student by giving them various kinds of food chain with different values.

Problem

Analyse the food chain given below and find out the amount of energy received by the organism in third trophic level.

Sun

↓ Grass receives 30,000. J of energy from sun

Grass ⟶ Rabbit ⟶ Snake ⟶ Eagle

Given: The amount of energy in the producers, i.e. grass = 30,000 J.

Solution:

Grass	⟶	Rabbit	⟶	Snake	⟶	Eagle
T_1		T_2		T_3		T_4
Producer		Primary Consumer		Secondary Consumer		Tertiary Consumer

T_1 – Grass (Producer) = 30,000 J of energy

T_2 – Rabbit (Primary Consumer) = ?

T_3 – Snake (Secondary Consumer) = ?

According to the ten percent law, during the transfer of energy, only about 10% of the energy flows from each trophic level to the next lower trophic level. So 10% of energy from T_1 gets transferred to T_2

So T_2 - Rabbit (primary consumer) receives $30000 \times \frac{10}{100} = 3000$ J

Similarly, 10% of energy from T_2 gets transferred to T_3

So T_3 – Snake (Secondary consumer) receives $3000 \times \frac{10}{100} = 300$ J

Answer:

1. The third tropic level T_3 – (Snake) receives 300 J of energy.

Exercise 16: Determination of Population density and Percentage frequency by Quadrat method.

NOTE: Teachers can take the students to open space and teach them how to construct plot/ quadrats and to record the number of individuals of each plant species occurring in the quadrat. The percentage frequency should be calculated and entered in the practical observation and record note book. Examiner need not consider this experiment for Board Practical Examinations.

Aim:

To study population density and percentage frequency of different plant species of a given area by quadrat method.

Principle:

The number of individuals in a population never remains constant. It may increase or decrease due to many factors like birth rate, death rate, migration, etc. The number of individuals of a species presents per unit area or space of a given time is called population density. The population density and percentage frequency of different plant species can be determined by laying quadrats / segments of suitable size and recording of the number of individuals of each species occurring in the quadrat.

Requirements:

Metre scale, string or cord, hammer, nails, paper, pencil, etc.

Procedure:

1. In the selected site of study, hammer the nails firmly in the soil without damaging the vegetation.
2. Fix four nails to make a square plot.
3. Tie each end of the nails using a thread, to make 1 m X 1 m plot.
4. If the number of plants in the plot is large, the plot can be divided into quadrats.
5. Count the number of individuals of a species "A" present in the first quadrat and record the data in the table.
6. Similarly count the individuals of the species "A" in other quadrats respectively and record the data in the table.
7. Count the number of individuals of a species "B" present in the all quadrats and record the data in the table.
8. Repeat the same procedure for other species and record the data in the table.

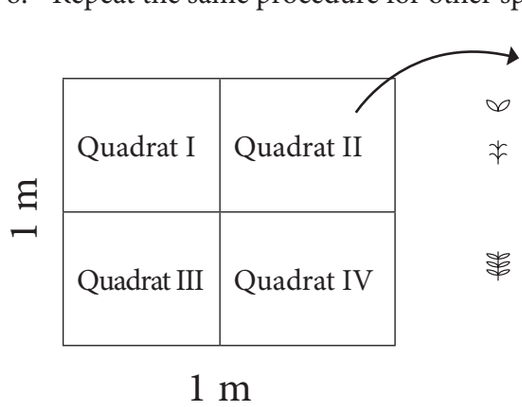


Figure: A plot

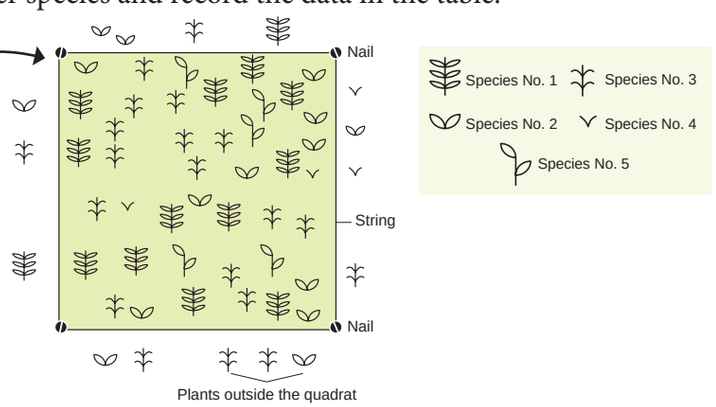


Figure 16: Occurrance of plant species in a quadrat

$$\text{Population Density} = \frac{\text{Total number of individuals in all the quadrats studied}}{\text{Total number of quadrats studied}}$$

$$\text{Percentage frequency} = \frac{\text{Total number of quadrats in which species occurred}}{\text{Total number of quadrats studied}} \text{ X } 100$$

Observation and Inference:

Different plant species, their population density and percentage frequency occurring in a given area.

S. No.	Plant species	No. of individuals per quadrat				Total number of individuals in all the quadrats studied (N)	Total number of quadrats in which each species occurred (A)	Total Number of quadrats studied (B)	Population Density (N/B)	Frequency percentage (A/B) x 100
		I	II	III	IV					
1										
2										
3										
4										
5										

Precautions:

1. The measurement of quadrat should be accurate.
2. The string or cord used should not be very thick.

Exercise 17: Chromosomal aberrations – Deletion, Duplication and Inversion

Problem:

Given below is the representation of a kind of chromosomal aberration such as deletion, duplication and inversion. Identify and give reasons for identification. Also mentions its significance.

Aim:

To understand the abnormality in the chromosomal structure in an organism.

Principle:

To study about the chromosomal aberration which can occur due to ionizing radiations or chemicals. On the basis of breaks and reunions in the chromosomal segment different types of aberrations can be recognized.

Requirements:

Copper wire, Alphabets marked (A to H) yellow colour beads denotes gene, and red colour bead without alphabet denote centromere. Using this materials make different kinds of chromosomal segments with specific gene sequence, that can be given to the students and asked to analyse the aberration involved in it.

Procedure:

1. Make a normal chromosome model using copper wire and yellow beads and place it on the table. In the model chromosome with gene sequence A to H, along with centromere (red bead).
2. For Deletion - Give yellow colour beads without one or more marked alphabets A to H (The lack

of any one or more beads denotes deletion type of chromosomal aberration).

3. For Duplication – Give yellow colour beads with addition of one or more marked alphabets A to H (The repetition of one or more beads denotes duplication type of chromosomal aberration).
4. For Inversion – Give yellow colour beads which marked alphabets from A to H as in normal chromosome. (There is no addition or deletion of beads (A to H) given, so the students can construct the inverted segment of the chromosome using the given beads).

Based on the type of beads given the student has to identify and construct the relevant chromosomal aberration.

17 A. Chromosomal Aberration – Deletion

Reasons:

1. The deletion of the chromosomal segement A and D. (Refer figure 17a)
2. When there is a loss of a segment of the genetic material in a chromosome it is called deletion.

Significance:

Most of the deletions lead to death of an organism.

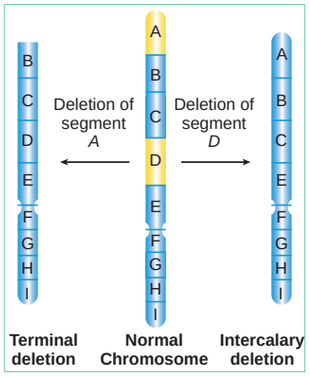


Figure: 17 a: Deletion

17 B. Chromosomal Aberration - Duplication

Reasons:

1. When a segment of a chromosome is present more than once in a chromosome, then it is called duplication (Tandem duplication)
2. The order of the genes in a chromosome is A, B, C, D, E, F, G, H and I. Due to aberration, the genes B and C are duplicated and the sequence of genes becomes A, B, C, B, C, D, E, F, G, H and I. (Refer figure 17b)

Significance:

Some duplications are useful in the evolution of the organism.

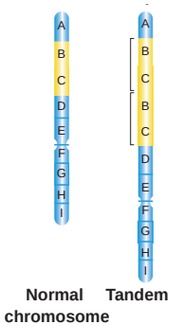


Figure 17 b: Duplication

17 C. Chromosomal Aberration - Inversion

Problem:

Given below is the representation of a kind of chromosomal aberration. Identify it giving reasons for your identification. Also mentions its significance.

Identification:

The given genetic problem is identified as inversion type of chromosomal aberration.

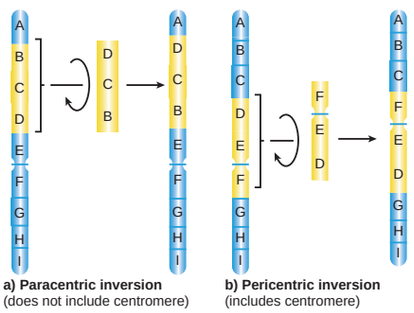


Figure: 17 c: Inversion

Reasons:

1. When the order of genes in a chromosomal segment is reversed due to rotation by an angle of 180°, it is called inversion.
2. The order of genes in a chromosome is A, B, C, D, E, F, G, H and I. Due to aberration, the sequence of genes become A, D, C, B, E, F, G, H and I (Refer figure 17c)

Significance:

Sometimes inversion is responsible for evolution of the organism.

NOTE: Likewise the teacher can give different types of chromosomal aberrations with various gene sequence to students for practise. The external examiner can also use the same technique by giving different gene sequence.

Exercise 18: Genetic / linkage maps

Aim:

To understand the frequency of recombination between the gene pairs on the same chromosome.

Principle:

To analyse the relative distance between the various genes and map their position in the chromosome, which is called genetic or linkage maps.

Requirements:

Different kinds of linkage / genetic maps can be constructed by giving the students the relative distance between the linked genes of a chromosome. A diagrammatic representation can be drawn showing the location and arrangement of genes and their relative distance between them.

Solve the Problem

Problem: There are three linked genes A, B and C in a chromosome. Percentage of crossing over (recombination frequency) between A and B is 20, B and C is 28 and A and C is 8. What is the sequence of genes on the linkage map?

Given: Percentage of crossing over between the 3 linked genes A – B = 20%, B – C = 28% and A – C = 8%.

Solution

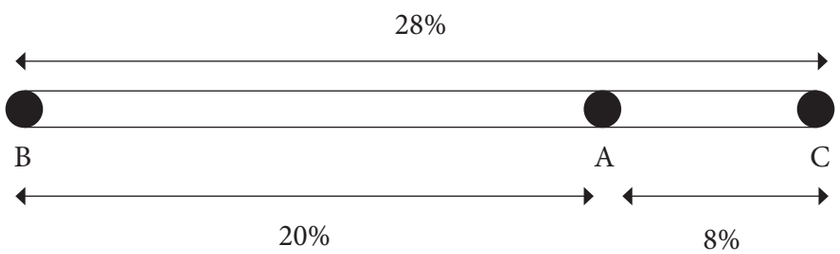


Figure 18: Linkage Map

Reasons:

1. The frequency of crossing over is directly proportional to the relative distance of the genes on the chromosomes.
2. More crossing over = More distance between two genes and
   Less crossing over = Less distance between the two genes.

In the above problem, the sequence of the genes on the linkage map is B, A, C

NOTE: Teachers can give different crossing over percentage between its linked genes in a chromosome and make the students construct the linkage maps. The external examiner can also do the same for the Board Practical Examinations.

IV - Experiments

Exercise 19: To dissect and display the pollinia of *Calotropis*

Aim:

To dissect and observe the structure of pollinia and understand the mechanism of pollination in *Calotropis* flowers. (Translator Mechanism)

Principle:

In *Calotropis* the pollen in each anther lobe of a stamen unites into a mass, forming a pollinium.

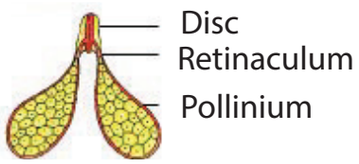


Figure 19: Pollinia of *Calotropis*

Requirements:

Flowers of *Calotropis*, dissection needle, dissection microscope ,slide, blade, glycerine, coverslip, scissors.

Procedure:

Take a mature flower of *Calotropis*. Observe the parts of the flower and remove the calyx and corolla with the help of scissors. Identify the pentangular stigmatic disc. Insert the needle at the angles of the stigma where the pollinia are adhered. Dissect it and place the pollinia on a clean slide. Mount it in glycerine and place a coverslip on it. Observe the pollinia under the dissection microscope and record your observation.

Observation:

The stamens of *Calotropis* produce pollinium. Two pollinia are found attached to a glandular adhesive disc called corpusculum by a thread like structure called retinaculum. The whole structure looks like inverted letter 'Y' and is called translator. The sticky disc gets attached with the legs of pollinator (bees or butterflies) and is carried to the stigma of another flower, thus ensuring pollination.

Inference:

The structure of pollinia of *Calotropis* is well suited to achieve pollination.

Exercise 20: Study of Pollen germination on a slide

NOTE: Pollen germination can be studied by dusting some pollens from common flowers like *Crotalaria*, *Hibiscus*, *Pisum*, etc. on a glass slide containing a drop of 10% sugar solution or tender coconut water or any nutrient medium.

Observe the slide after about 10 – 15 minutes under the low power of compound microscope. You will be able to observe the pollen tubes coming out of the pollen grains.

Aim:

To study the pollen germination on a slide.

Requirements:

Fresh seasonal flowers, cavity slide, cover slip, compound microscope, sucrose, boric acid, distilled water, beakers, etc.

Procedure:

1. Prepare a nutrient solution by dissolving 1 gm. of sucrose / 1 gm. of boric acid in 100 ml. of distilled water.
2. Take a clean cavity slide and put a few drops of nutrient solution in the cavity of the slide.
3. Dust a few pollen grains from the stamen of a mature flower on it.
4. View the slide in the microscope after 5 minutes and then observe it regularly for about half an hour.

Observation:

In nutrient medium, the pollen grains germinate. The tube cell enlarges and comes out of the pollen grain through one of the germ pores to form a pollen tube. The tube nucleus descends to the tip of the pollen tube. The generative cell also passes into it. It soon divides into two male gametes.

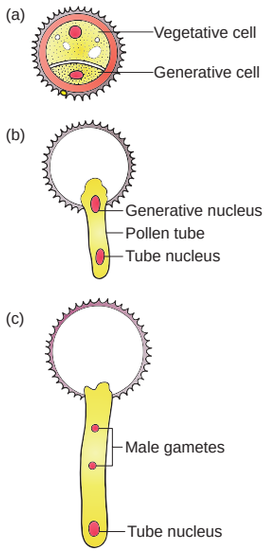


Figure 20: Pollen germination

Inference: Different stages of germinating pollens are observed. Some pollens are in their initial stage of germination while others have quite long pollen tube containing tube nucleus and two male gametes.

Precautions:

1. Flowers should be freshly plucked.
2. Use clean cavity slide to observe the pollen grains.
3. The slides should not be disturbed, otherwise position of pollen grains will get changed.

Exercise 21: Study of pH of different types of soil

Some nutrients become toxic in higher concentration. Therefore pH of the soil is an important chemical property of the soil. Plants thrive well in neutral or slightly acidic soils. The pH of the soil determines the types of soil organisms and also controls the solubility of different nutrients. The pH of soil ranges from 0 - 14.

a. pH level 7 - Neutral soil

b. pH level below 7 - Acidic soil

c. pH level above 7 -Alkaline soil

d. Optimum pH for plant growth ranges from 5.5 to 7.

Most plants thrive best in neutral pH. Slight acidity favours tree growth and forms forests. Slight alkalinity is favourable for grasses and legume crops.

Aim:

To study pH of different types of soil.

Requirements:

Soil samples (from two different sites such as crop soil, garden soil, roadside soil, pond soil, river bank soil), test tubes, funnel, filter papers, pH papers of different range, distilled water, beaker.

Procedure:

Dissolve one tablespoon or 1 gram of soil from each soil sample in 100 ml of distilled water in separate beakers. Stir the solutions well and keep aside for half an hour to settle down the suspended particles. Filter off each solution separately in different test tubes. Dip a small piece of broad range pH paper on each of the solution. Match the colour of the pH paper with the colour scale given on the pH paper booklet. This gives an approximate pH.

Observation:

Record the pH of different soil samples in the observation table.

S. No.	Soil sample	pH Value
1		
2		
3		

Figure 21: Study of pH of different types of soil

Inference:

Thus the pH value of different soil samples required for plant growth can be determined.

Precautions:

1. Wash the glassware thoroughly and get it dried before the experiment.
2. Dry the pH papers before comparing the colour with the colour scale.
3. Match the colour carefully and determine pH accurately.

Exercise 22: Water holding capacity of garden soil and roadside soil

The maximum amount of water retained by soil per unit of its dry weight after the gravitational flow has ceased is called water holding capacity or field capacity of the soil. The water holding capacity varies in different type of soils and depends upon the types of soil particles and porocity of the soil. Sandy soils have poor water holding capacity then the loam and clay soils.

Aim:

To study the water holding capacity of garden soil and roadside soil.

Requirements:

Garden soil, roadside soil, measuring cylinders, funnels, filter papers, beakers, balance, etc.

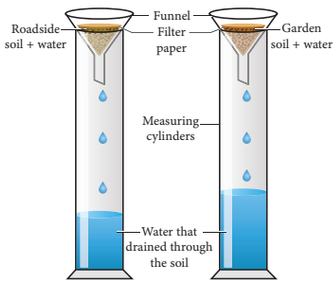


Figure 22: Water holding capacity of soil

Procedure:

Take two funnels and line them with filter paper. Lable them A and B. Place them on measuring cylinders. Take 100 gm dried sample each of the garden soil and roadside soil. Put the garden soil in funnel A and roadside soil in funnel B. Pour 100 ml of water in each funnel. Record the volume of filtered out water in the measuring cylinder when the dripping of water stops from the funnel.

Observation:

Record the observation in the table as follows:

S. No.	Soil types	Weight of soil (X)	Volume of water poured (Y)	Volume of water collected in measuring cylinder (Z)	Volume of water retained by the soil (Y – Z)	Water holding capacity of the soil in percentage (Y – Z) / X × 100
1	Garden soil					
2	Roadside soil					

Inference:

Garden soil has a high water holding capacity than the roadside soil, because roadside soil has larger quantities of sand and silt.

Precautions:

1. Weighing of soil samples should be done accurately.
2. Pour water slowly and gently on the soil in the funnel
3. Record the volume of collected water in the measuring cylinders carefully.

Exercise 23: Isolation of DNA from plant materials

DNA is one of the nucleic acids found in living systems. DNA acts as the genetic material in most of the organisms.

Principle: Recombinant DNA technology has allowed breeders to introduce foreign DNA in other organisms including bacteria, yeast, plants and animals. Such organisms are called Genetically Modified Organisms (GMOs). Thus rDNA technology involves isolation of DNA from a variety of sources and formation of new combination of DNA.

Aim: To isolate DNA from available plant materials such as spinach leaves, fresh green pea seeds, green papaya, etc.

Requirements: Plant materials, mortar and pestle, beakers, test tubes, ethanol, etc.

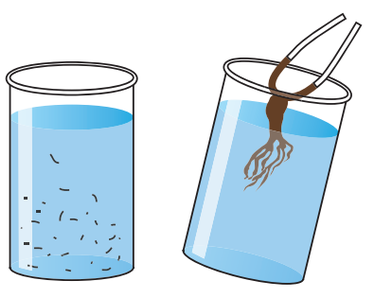


Figure 22: Isolation of DNA

Procedure: Take a small amount of plant material and grind it in a mortar with a little amount of water and sodium chloride. Make it into a solution and filter it. To this filterate, add liquid soap solution or any detergent solution and mix it with a glass rod. Then tilt the test tube and add chilled ethanol and leave it aside in the stand. After half-an-hour we can observe the precipitated DNA as fine threads. DNA that separates can be removed by spooling

Observation: DNA appears as white precipitate of very fine threads on the spool.

Inference: Thus DNA can be isolated from the plant cell nucleus by this technique.

Precautions:

1. All the glasswares must be thoroughly cleaned and dried.
2. The chemicals used for the experiments must be of standard quality.
3. If ordinary ethanol is used, the time duration for obtaining precipitated DNA may extend further.

VI - Economic Importance of Plants

Exercise 24: Economically important plants

S.No	Identification (Plant name)	Botanical Name	Useful parts	Uses
1	Wheat	*Triticum aestivum*	Whole grain	1. Wheat flour is suitable to make bread and bakery products. 2. Malted wheat is a major raw material for producing alcoholic beverages and nutritive drinks.
2	Black pepper	*Piper nigrum*	Seeds	1. It is used as an aromatic stimulant for enhancing salivary and gastric secretion. 2. Pepper also enhances the bio-absorption of medicine.
3	Cotton	*Gossypium barbadense*	Seed coat fibres	1. It is mainly used in the manufacturing of various textile, hosiery products, toys and is also used in hospitals. 2. Cotton fibres are used in stuffing pillows and cushions.
4	Keezhanelli	*Phyllanthus amarus*	Entire shoot system	Extract of the plant is generally used for the treatment of jaundice
5	Green gram	*Vigna radiata*	Seeds	1. Roasted, cooked or sprouted seeds are edible. 2. Fried, dehulled and broken or whole green gram is used as a popular snack and breakfast dish.
6	Banana	*Musa* x *paradisiaca*	Fruit	1. The banana fruit contains potassium and essential vitamins which can be eaten raw or cooked. 2. The fruit can be processed into flour and can be fermented for the production of beverages such as banana juice, vinegar, beer and vine.

Exercise 25: Economically important plant products

S. no	Identification (Product name)	Botanical Name	Useful parts	Uses
1.	Sesame/ Gingelly oil	*Sesamum indicum*	Seeds	1. Sesame oil is mostly used for culinary purposes. 2. Lower grades are used in manufacture of soaps, in paint industries, as a lubricant and as an illuminant.
2.	Rubber	*Hevea brasiliensis*	Latex	1. Rubber is used in the manufacture of footwear, wire and cable insulations, rain coat, sports goods, erasers, adhesives, rubber bands, household and hospital goods and shock absorbers. 2. Concentrated latex is used for making gloves and balloons. 3. Foamed latex is used in the manufacture of cushions, pillows and life-belts.
3.	Flaked Rice (Aval)	*Oryza sativa*	Seeds	1. Flaked rice (aval) is used as breakfast cereal or as snacks.
4.	Rose Water	*Rosa* x *damascena*	Petals	1. Rose water (panneer) is used in confectionaries, syrups and soft drinks. 2. In India, rose water is much used in eye lotions and eye washes.
5.	Henna Powder	*Lawsonia inermis*	Leaves	1. An orange dye "henna" obtained from leaves and young shoots is used to dye skin, hair and fingernails. 2. It is also used for colouring leather, tails of horses and hair.
6.	Aloe Gel	*Aloe vera*	Leaves	1. Aloe gel is used as skin tonic. 2. Because of its cooling effect and moisturizing characteristics, it is used in the preparation of creams, lotions, shampoos, shaving creams and allied products. 3. It is used in gerontological applications for rejuvenation of ageing skin.

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List of Authors and Reviewers

Reviewers

Dr. K. V. Krishnamurthy,
Professor and Head (Retd.)
Bharathidasan University, Trichy

Dr. S. Palaniappan,
Principal (Retd.),
Govt. Arts College for Men (A), Nandanam, Chennai

Domain Experts

Dr. M.N. Abubacker, Associate Professor & Head,
PG and Research Department of Biotechnology,
National College (A), Tiruchy

Dr. S.S. Rathinakumar, Principal (Retd.),
Sri Subramania Swamy Government Arts College , Thiruthani

Dr. D. Narashiman, Professor and Head (Retd.)
Plant Biology & Biotechnology, MCC College
Tambaram, Kancheepuram

Dr. K.P. Girivasan, Associate Professor of Botany,
Govt. Arts & Science College, Nandanam, Chennai

Dr. C.V. Chitti Babu, Associate Professor of Botany,
Presidency College, Chennai

Dr. Renu Edwin, Associate Professor of Botany,
Presidency College, Chennai

Academic Coordinators

K. Manjula,
Lecturer in Botany, DIET, Triplicane, Chennai.

J.Radhamani,
Lecturer in Botany, DIET, Kaliyampoondi, Kancheepuram

V. Kokiladevi,
PGT Botany, GHSS, Sunnambukulan, Thiruvallur.

Art and Design Team

Illustration

A. Jeyaseelan, Art Teacher
GBHSS, Uthangarai, Krishnagiri.
S. Gopu
Gopu Rasuvel
N. Prabhakar

Layout

Santhiyavu Stephen S
Balaji
Prasanth C

In-House

QC - **Arun Kamaraj Palanisamy**
- Rajesh Thangappan

Wrapper Design

Kathir Aarumugam

Co-ordination

Ramesh Munisamy

Typist

S. Chitra, SCERT, Chennai

Authors

P. Saravanakumaran, PG Assistant in Botany,
GHSS, Koduvalarpatti, Theni.

P. Anandhimala, PG Assistant in Botany,
GGHSSS, Pochampalli, Krishnagiri.

M.V. Vasudevan, PG Assistant in Botany,
Adhiyaman GBHSS, Dharmapuri

J. Mani, PG Assistant in Botany,
GHSS, R. Gobinathampatti, Dharmapuri.

G. Muthu, PG Assistant in Botany,
GHSS (ADW), Achampatti, Madurai.

G. Sathiyamoorthy, PG Assistant in Botany,
GHSS, Jayapuram, Tirupattur, Vellore.

T. Ramesh, PG Assistant in Botany,
GBHSS, Vettavalam, Thiruvannamalai

S. Malar Vizhi, PG Assistant in Botany,
GHSS, Chenbagaramanputhoor, Kanyakumari.

G. Bagyalakshmi, PG Assistant in Botany,
GGHSS, Jalagandapuram, Salem.

C. Kishore Kumar, PG Assistant in Botany,
GHSS, Thattaparai, Vellore.

Sathyawathi Sridhar, PG Assistant in Botany,
Sri Sankara Senior Secondary School, Adyar, Chennai.

M. Lakshmi, PG Assistant in Botany,
Sri Sankara Senior Secondary School, Adyar, Chennai.

M. Chamundeswari, PG Assistant in Botany,
Prince MHSS, Nanganallur, Kancheepuram.

D. Padma, PG Assistant in Botany,
Prince MHSS, Madipakkam, Chennai.
(Author, Practical)

Content Readers

Dr. T.S. Subha, Associate Professor in Botany,
Bharathi Womens College, Chennai.

Dr. P.T. Devarajan, Associate Professor in Botany,
Presidency College, Chennai

Dr. N. Pazhanisami, Associate Professor in Botany,
Govt. Arts College, Nandanam, Chennai

Dr. G. Rajalakshmi, Associate Professor in Botany,
Bharathi Womens College, Chennai.

Dr. R. Kavitha, Associate Professor in Botany,
Bharathi Womens College, Chennai

QR Code Management Team

R. Jaganathan, SGT,
PUMS - Ganesapuram, Polur, Thiruvannamalai.

J.F. Paul Edwin Roy, B.T.Assistant,
PUMS -Rakkipatty, Salem.

S. Albert Valavan Babu, B.T.Assistant
G.H.S, Perumal Kovil, Paramakudi, Ramanathapuram

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