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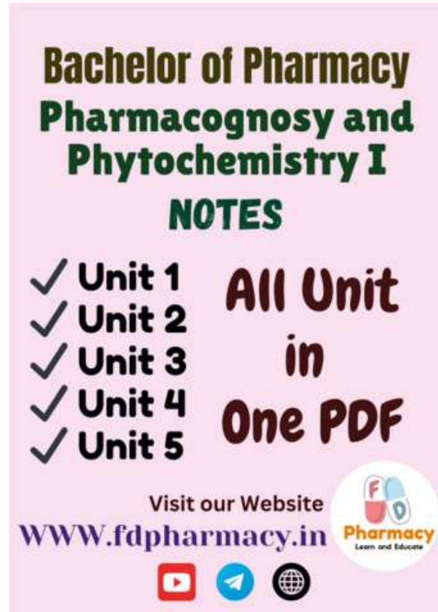
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PHARMACOGNOSY AND PHYTOCHEMISTRY – I

UNIT 2

TOPIC :

- **Cultivation, Collection, Processing and storage of drugs of natural origin :**

  Cultivation and Collection of drugs of natural origin

  Factors influencing cultivation of medicinal plants.

  Plant hormones and their applications.

  Polyploidy, mutation and hybridization with reference to medicinal plants

  Conservation of medicinal plants

Crude Drugs

- Crude drugs are natural substances of plant, animal, mineral, or microbial origin that have undergone minimal or no processing.
- They are used directly or after simple processing for medicinal, pharmaceutical, or therapeutic purposes.

Stages of Crude Drug Production

To become pharmaceutically useful, crude drugs pass through several stages:

1. **Cultivation** – Scientific growing of medicinal plants.
2. **Collection** – Harvesting of the drug at the proper stage of growth.
3. **Drying** – Removing moisture to prevent microbial growth and enzymatic spoilage.
4. **Dressing** – Cleaning, size reduction, and separation of unwanted parts.
5. **Packaging** – Safe packing to protect against environmental damage.
6. **Storage** – Preserving in controlled conditions to maintain stability.

Cultivation of Medicinal Plants

Cultivation of crude drugs refers to the systematic and scientific growing and harvesting of medicinal plants to obtain raw materials that contain bioactive compounds of therapeutic value.

Advantages of Cultivation

1. Ensures quality, purity, and authenticity of crude drugs.
2. Provides better yield and therapeutic value compared to wild plants.
3. Ensures regular and reliable supply of crude drugs.
4. Produces disease-free plants.
5. Promotes industrialization and standardization.
6. Helps in the conservation of medicinal plants by reducing dependence on wild sources.

Methods of Plant Propagation

Medicinal plants can be propagated by two methods:

1. **Sexual Propagation (Seed Propagation)**
2. **Asexual Propagation (Vegetative Propagation)**

1. Sexual Propagation (Seed Propagation)

- Plants are raised from seeds, called seedlings.
- Seeds must be of good quality, viable, and disease-free.
- Common methods:

(a) Broadcasting

- Seeds are scattered freely on well-prepared soil.
- Simple but less controlled method.
- **Examples:** Isapgol, Linseed, Sesame.

(b) Dibbling

- Seeds are placed in individual holes at specific depths and intervals.
- Ensures proper spacing and uniform growth.
- **Examples:** Castor, Cotton.

(c) Miscellaneous (Nursery Beds)

- Seeds are first sown in nursery beds and later transplanted into the field.
- Useful for delicate or expensive seeds.
- **Examples:** Cinchona, Cardamom, Clove.

2. Asexual Propagation (Vegetative Propagation)

- Defined as the formation of a new plant from vegetative parts of the parent plant (stem, root, leaf, or tissue).
- Useful for plants that do not produce viable seeds or have a long growth period.

Methods

1. **Cutting** – Parts of the plant (stem, root, or leaf) are cut and planted to form new plants.
    - **Examples:** Sugarcane, Rose.
2. **Layering** – A stem/branch of the parent plant develops roots while still attached; later separated to grow independently.
    - **Examples:** Jasmine, Black Pepper.
3. **Grafting** – Joining parts of two plants:
    - **Scion** (shoot part of one plant) is joined to Stock (rooted shoot of another).
    - **Examples:** Rose, Citrus, Rubber.
4. **Micropropagation (Tissue Culture)** – Growing cells, tissues, or organs in sterile nutrient medium under controlled conditions.
    - Produces disease-free plants with rapid multiplication.
    - **Examples:** Cinchona, Orchids, Aloe.

Factors Affecting Cultivation of Crude Drugs

Cultivation is influenced by environmental, biological, and economic factors:

1. Climate and Weather Conditions

- **Temperature** – Each plant has an optimum temperature range; extreme heat/cold affects growth.
- **Rainfall** – Amount and distribution influence plant health (e.g., rice thrives in wet regions).
- **Sunlight** – Essential for photosynthesis; affects growth and production of active compounds.

2. Soil Quality

- **Soil Type** – Sandy, loamy, or clay-rich soils affect plant health.
- **Nutrient Content** – Adequate nitrogen, phosphorus, potassium, etc., are essential for growth.

3. Water Availability

- **Irrigation Systems** – Regular supply of clean water ensures growth.
- **Drainage** – Poor drainage may cause root rot and fungal infections.

4. Pests and Diseases

- **Insect pests** – e.g., caterpillars, beetles.
- **Fungal & bacterial diseases** – e.g., blight, root rot.

5. Genetics and Plant Variety

- **Seed Quality** – Good quality seeds ensure higher yield.
- **Varieties** – Different varieties may differ in active compound content.

6. Atmospheric Factors

- **Altitude** – Some plants grow best at specific heights.
    - Tea, Cinchona, and Eucalyptus → 1000–2000 m.
- **Humidity** – High/low humidity influences plant metabolism and oil/resin content.

7. Pollution and Environmental Factors

- **Air Quality** – Pollution reduces plant growth and lowers active compound quality.
- **Soil Contamination** – Heavy metals, chemicals, and pollutants reduce safety and therapeutic value.

Collection of Crude Drugs

Collection refers to the process of gathering useful parts of medicinal plants (leaves, roots, flowers, seeds, bark, etc.) at the appropriate stage of growth for therapeutic use.

Importance of Collection

- Ensures maximum concentration of bioactive compounds (alkaloids, glycosides, tannins, volatile oils, etc.).
- Collection at the right growth stage enhances medicinal value.
- Proper handling prevents contamination by soil, insects, or microbes.
- Protects natural resources and allows for sustainable use of medicinal plants.

Right Time of Collection (Based on Plant Part)

- **Leaves** → Collected when fully grown but still green and fresh.
- **Flowers** → Collected just before or during full bloom (for best aroma and chemical content).
- **Roots & Rhizomes** → Dug up at the end of the growing season or during plant dormancy.
- **Fruits & Seeds** → Collected when fully mature and ripe.
- **Bark** → Collected when it separates easily from the stem or trunk.

Techniques of Collection

1. Use clean and sterilized tools to avoid contamination.
2. Avoid exposure to direct sunlight, as heat/light can degrade active compounds.
3. Handle delicate parts (like flowers) gently.
4. Keep different plant parts separate since they require different drying and storage conditions.

Factors Affecting Collection

- **Season** → The amount of active constituents varies with seasons.
- **Weather** → Avoid rainy or humid conditions to reduce spoilage risk.
- **Time of Day** → Early morning or late evening is ideal (to preserve volatile oils in leaves/flowers).
- **Growth Stage** → Too early or too late collection reduces potency.

Drying of Crude Drugs

Drying is the process of removing moisture from freshly collected crude drugs (leaves, roots, bark, flowers, etc.) to:

- Prevent microbial (bacterial, fungal) growth.
- Preserve stability and potency of active constituents.
- Reduce weight and volume for easier storage and transport.

Objectives of Drying

1. Prevent spoilage due to enzymes, microbes, and pests.
2. Fix the chemical composition of the drug.
3. Make the drug lightweight for packaging and transport.

Dressing of Crude Drugs

Dressing is the process of cleaning, grading, and preparing crude drugs after drying.

Purpose

- Remove unwanted parts, dirt, and foreign matter.
- Cut, sort, or powder crude drugs into uniform size.
- Enhance appearance, quality, and market value.
- Prepare the drug for further processing or direct use.

Packaging of Crude Drugs

Packaging is the process of enclosing crude drugs in suitable containers to protect them from damage, contamination, and deterioration during storage and transport.

Objectives of Packaging

- Prevent exposure to moisture, light, air, and pests.
- Maintain potency, purity, and safety of crude drugs.
- Facilitate easy handling, labeling, and distribution.
- Ensure long shelf life of the drug.

Storage of Crude Drugs

Storage is the process of keeping packaged crude drugs under suitable environmental conditions to preserve their quality, potency, and shelf life.

Objectives of Storage

- Protect drugs from moisture, heat, and sunlight.
- Prevent microbial growth, insect attack, and contamination.
- Maintain stability of chemical constituents.

Ideal Storage Conditions

- Cool, dry, well-ventilated place.
- Use of airtight, light-resistant containers.
- Regular inspection to avoid spoilage.
- Proper labeling with name, source, collection date, and batch number.

Plant Hormones (Phytohormones)

- Plant hormones, also called phytohormones, are organic compounds produced in small quantities within plants.
- They regulate growth, development, and physiological processes, and coordinate plant responses to internal signals and external stimuli (like light, gravity, stress, etc.).

Types of Plant Hormones

Plant hormones are classified into two broad categories:

1. Plant Growth Promoters

- Stimulate growth and development.
- Examples:
    - **Auxins**
    - **Cytokinins**
    - **Gibberellins**

2. Plant Growth Inhibitors

- Inhibit or slow down plant growth.
- Examples:
    - **Abscisic Acid (ABA)**
    - **Ethylene**

1. Plant Growth Promoters

1. Auxins

- The word *Auxin* is derived from the Greek word *auxein* = "to grow".
- Found mainly in shoot tips, young leaves, and seeds.
- Two types:
  - **Natural Auxins** → e.g., Indole-3-acetic acid (IAA), Phenyl acetic acid.
  - **Synthetic Auxins** → e.g., 2,4-D (2,4-dichlorophenoxyacetic acid), NAA (Naphthalene acetic acid).

Functions of Auxins

1. Stimulate cell elongation (by loosening cell walls).
2. Promote root initiation and growth.
3. Induce fruit development (e.g., parthenocarpic fruit like seedless tomato).
4. Delay leaf abscission (falling).
5. Used in weed control (synthetic auxins act as herbicides).

2. Cytokinins

- Discovered in herring sperm DNA, later identified in plants.
- Purine derivatives, mainly found in **roots** and transported upward.
- Examples: Zeatin, Kinetin.

Functions of Cytokinins

1. Stimulate cell division (cytokinesis).
2. Work with auxins to maintain balanced root and shoot development.
3. Delay leaf senescence (aging).
4. Promote nutrient mobilization.

3. Gibberellins

- Acidic plant hormones; over 130 gibberellins (GAs) identified.
- Found in roots, shoots, young leaves, seeds, and fruits.
- Example: Gibberellic acid (GA_3).

Functions of Gibberellins

1. Stimulate stem and leaf elongation.
2. Break seed dormancy and promote germination.
3. Induce flowering in long-day plants.
4. Increase fruit size and development.
5. Used in malting of barley for beer production.

2. Plant Growth Inhibitors

1. Abscisic Acid (ABA)

- Also called **stress hormone**.
- A naturally occurring **sesquiterpenoid (C_{15} compound)** synthesized via the mevalonic acid pathway.
- Found in **mature leaves, roots, and seeds**.

Functions of ABA

1. Promotes leaf abscission (falling) and seed dormancy.
2. Inhibits shoot growth.
3. Regulates stomatal closure during water stress.
4. Acts as a plant growth inhibitor under unfavorable conditions.

2. Ethylene

- A simple, gaseous plant hormone.
- Present in ripening fruits, flowers, seeds, and leaves.
- First reported by Gane (1934) as a natural product of plants.

Functions of Ethylene

1. Promotes fruit ripening (e.g., bananas, tomatoes, mangoes).
2. Induces leaf and fruit abscission.
3. Stimulates flowering in some plants (e.g., pineapple).
4. Enhances seed germination in some species.

Polyploidy

Polyploidy is a genetic condition in which the cells of an organism contain more than two complete sets of chromosomes.

- "Poly" = many,
- "Ploidy" = number of chromosome sets.

Most eukaryotes are diploid (2n), having two sets of chromosomes (one from each parent). In polyploidy, the chromosome number increases to triploid (3n), tetraploid (4n), hexaploid (6n), etc.

Polyploidy is very common in plants and plays an important role in plant evolution, adaptability, and economic value.

Types of Polyploidy

1. **Autopolyploidy**
    - Occurs due to duplication of chromosome sets within a single species.
    - Example: A diploid plant (2n) → becomes a tetraploid (4n).
    - Results from errors in mitosis/meiosis or induced by chemicals like colchicine.
    - Produces larger vegetative organs (leaves, stems, roots).
2. **Allopolyploidy**
    - Involves combination of chromosome sets from two or more different species.
    - Leads to the formation of new hybrid species.
    - Example: Wheat (Triticum aestivum, hexaploid, 6n) is an allopolyploid formed from hybridization between different wild grasses.

Applications of Polyploidy

- **Plant Breeding & Evolution**
  - Creates new species with improved adaptability.
  - Provides genetic information useful in evolutionary studies.
- **Seedless Fruits**
  - Polyploidy is used to produce seedless fruits (e.g., seedless grapes, bananas, watermelons) which are preferred by consumers.
- **Larger Plant Organs**
  - Leads to increased size of leaves, flowers, fruits, and seeds, improving yield.
- **Medicinal Value**
  - Increases concentration of secondary metabolites and active medicinal compounds in certain plants.
- **Stress Resistance**
  - Polyploid plants show better resistance to diseases, pests, and environmental stress.

Mutation

- A mutation is a sudden, permanent, and heritable change in the genetic material (DNA/RNA) of an organism, including plants.
- Mutations can affect:
    - Single genes (point mutation)
    - Large chromosomal segments (chromosomal mutation)
    - Entire genome (polyploidy)
- In plants, mutations contribute to variation, evolution, and crop improvement.

Types of Mutation in Plants

1. Based on Effect on DNA Sequence

- **Point Mutation**
    - Change in a single nucleotide base in the DNA sequence.
    - Types:
        - **Substitution** → one base replaces another.
        - **Insertion** → addition of an extra base.
        - **Deletion** → loss of a base.
    - Example: Mutations in metabolic pathways affecting enzyme activity.
- **Frameshift Mutation**
    - Insertion or deletion of nucleotides that alters the reading frame of the gene.
    - Often leads to production of non-functional proteins.

2. Based on Effect on Chromosomes

- **Chromosomal Mutations** (large-scale changes)
    - **Deletion** → loss of a chromosomal segment.
    - **Duplication** → repetition of a segment.
    - **Inversion** → segment breaks and reinserts in reverse order.
    - **Translocation** → transfer of a chromosomal segment to another non-homologous chromosome.

- **Polyploidy** (genome mutation)
  - Change in the number of entire chromosome sets.
  - **Autopolyploidy** → duplication of genome within the same species (e.g., 2n → 4n).
  - **Allopolyploidy** → combination of chromosome sets from different species (hybrid polyploids).
  - Example: Wheat, cotton (important polyploid crops).

3. Based on Source of Mutation

- **Spontaneous Mutation**
  - Occurs naturally due to DNA replication errors or environmental influences.
  - Rare but important in natural variation and evolution.
- **Induced Mutation**
  - Caused by **external agents (mutagens)**.
  - **Physical Mutagens** → UV rays (thymine dimers), X-rays, Gamma rays.
  - **Chemical Mutagens** → Colchicine (induces polyploidy by preventing spindle formation), EMS (Ethyl Methane Sulphonate).
  - **Biological Agents** → Viruses, transposable elements.

Applications of Mutation in Plants

- Crop Improvement → Development of improved varieties with high yield, better nutritional value, early maturity.
- Disease Resistance → Resistant rice, wheat, and cotton varieties developed through mutation breeding.
- Stress Tolerance → Enhanced adaptability to drought, salinity, extreme temperature, poor soils.
- Seedless & Improved Fruits → Seedless banana, grapes developed using induced mutation.
- Medicinal Plant Improvement → Increased production of alkaloids, glycosides, terpenoids, etc.

Hybridization in Plants

Hybridization in plants is the process of crossing two genetically different plants (varieties, species, or even genera) to produce a new plant called a hybrid, which combines desirable traits from both parents.
It is a powerful tool in plant breeding for developing high-yielding, disease-resistant, and climate-adaptable varieties.

Procedure of Hybridization

The hybridization process generally involves 5 steps:

1. **Selection of Parent Plants**
   - Parents are chosen based on desirable traits such as high yield, resistance to pests/diseases, drought tolerance, or improved nutritional value.
2. **Pollination (Crossing)**
   - Pollen grains from the male parent are transferred to the stigma of the female parent.
   - This can be done naturally (wind, insects) or artificially (manual transfer).
3. **Seed Formation**
   - After successful fertilization, seeds develop that contain genetic material from both parents.
4. **Growth of Hybrid Plants**
   - The hybrid seeds are sown, and the plants show a mixture of characteristics inherited from both parents.
5. **Selection & Testing**
   - The best hybrid plants are selected and tested for stability, adaptability, and performance before being released as a new variety.

Types of Hybridization

1. **Intraspecific (Intervarietal) Hybridization**
    - Crossing between two varieties of the same species.
    - Example: Crossing two rice varieties to combine high yield and **disease resistance**.
2. **Interspecific Hybridization**
    - Crossing between two different species of the same genus.
    - Example: Wheat × Rye = Triticale (a hybrid grain with high productivity and resilience).
3. **Intergeneric Hybridization**
    - Crossing between two different genera.
    - Example: Raphanobrassica (Radish × Cabbage).
4. **Genetic Engineering / Biotechnological Hybridization**
    - Modern methods like tissue culture, protoplast fusion, and genetic modification are used to create hybrids with precise traits.
    - Example: Bt-cotton (genetically modified for pest resistance).

Applications of Hybridization

- Development of high-yielding varieties.
- Production of disease- and pest-resistant plants.
- Creation of plants with better adaptability to different climates and soils.
- Improvement in nutritional quality (protein-rich cereals, vitamin-enriched crops).
- Used in ornamental plants to enhance flower color, size, and fragrance.
- Essential in commercial crop improvement programs.

Conservation of Medicinal Plants

Conservation of medicinal plants refers to the protection, sustainable use, and scientific management of plant species that possess medicinal properties.
These plants are crucial for Ayurveda, Unani, Siddha, Homeopathy, and modern pharmaceuticals, but many are threatened due to overharvesting, deforestation, urbanization, and climate change.

Importance of Conservation

1. **Medicinal Value** – Many plants are sources of alkaloids, glycosides, tannins, volatile oils, etc., used in traditional and modern medicine.
2. **Biodiversity Protection** – Conserving medicinal plants helps maintain ecological balance and sustains natural biodiversity.
3. **Sustainable Resource Use** – Ensures availability of valuable plant species for **future generations**.
4. **Livelihoods & Economy** – Millions of rural and tribal communities depend on medicinal plants for income and survival.
5. **Scientific Research** – Provides raw material for discovery of **new drugs and phytochemicals**.
6. **Environmental Protection** – Helps in maintaining **soil fertility, forest cover, and climate regulation**.

Methods of Conservation

There are two main approaches:

1 In-Situ Conservation ("On-site")

- Conservation of medicinal plants within their natural habitat.
- Allows species to grow, adapt, and evolve naturally without disturbance.

Examples:

- National Parks – Protected areas where deforestation, grazing, and human activity are restricted.
- Biosphere Reserves – Large areas combining conservation with sustainable use.
- Sacred Groves – Community-protected forest patches where cutting plants is prohibited.

Advantages:

- Maintains natural biodiversity.
- Protects interdependent flora and fauna.
- Ensures ecological balance and evolutionary processes.

2 Ex-Situ Conservation ("Off-site")

- Conservation of medicinal plants outside their natural habitats.
- Used for species that are endangered or threatened in the wild.

Examples:

- Botanical Gardens – Cultivation and preservation of medicinal plants.
- Seed Banks & Gene Banks – Storage of seeds and genetic material for future use.
- Tissue Culture Techniques – Micropropagation of rare or endangered species.
- Herbal Gardens – Cultivation of medicinally important plants for research and education.

Advantages:

- Protects species close to extinction.
- Allows controlled breeding and propagation.
- Ensures availability of germplasm for future reintroduction into natural habitats.