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Botanical Aspects of Medicinal and Aromatic Plants

1. Botany and Medicinal Plants
2. Plant Morphology/Anatomy
 - 2.1 Plant organs utilized for obtaining culinary herbs
3. Plant systematics
 - 3.1 Biological diversity of MAPs
4. Plant physiology
5. Taxonomy and Plant classification
6. Genetics (Heredity and Variability)
7. Variability of active principle accumulation
 - 7.1 Ecological variability
 - 7.2 Life-cycle related variability of MAPs
 - 7.3 Diurnal variations



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Introduction

Utilization of plant kingdom:

- **40000** species used for ethnomedicinal purposes
- **Wild-crafting:** collection/gathering of plants from the wild

What is Botany ?

Botany, also called **plant science(s)** or **plant biology**, is the science of plant life, a branch of biology

- < 18th century: mostly description of plants and classification
- Modern Botany: multidisciplinary study of plants with inputs from numerous science and technology



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Pharmacobotany / Medical Botany

covers all pharmaceutical aspects of botany, including

- cytology,
- histology,
- morphology and
- taxonomy of plants
used in the pharmacological practice,
*i.e. it deals with the botanical aspects of plants affecting
man's health*



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MAPs are specialized and diverse

The differentiating characters of MAPs are studied by 5 main branches of botany:

- morphology/anatomy,
- systematics (taxonomy),
- physiology,
- Genetics,
- ecology.



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Plant Morphology/Anatomy

- **Biologically active substances:** responsible for the medicinal properties
- **Active substances syn. Active principles:** produced and frequently also accumulated in the tissues of organs: leaves, roots, barks, fruits, seeds, flowers, etc.
- Due to **translocation** between organs, one part of the plant could be toxic while another organ of the same plant could be harmless (e.g.: *Taxus baccata*)



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Pharmacognosy (the knowledge of herbs)

- Based on the **morpho-anatomic characteristics**, i.e. on the diverse presence or absence of morphological traits
- Well identifiable morphological/structural traits are used:
 - = to determine the identity of crude drugs,
 - = to eliminate **adulterations**
- Dried forms of these plant organs are called (**crude**) **drugs**
- **Crude drugs** are denominated by the binominal Latin name of plants (e.g.: Flores tiliae)



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Most frequently collected and used plant organs

Bark	Leaf/Leaves
Bulb	Roots/Rhizomes
Flowers	Seeds
Fruits	Tubers
Gum	Wood

- **Essential oils (Volatile oils):** generally extracted from plants by steam distillation (Soxhlet apparatus)
- **Fatty oils:** generally pressed from seeds or fruits and insoluble in water

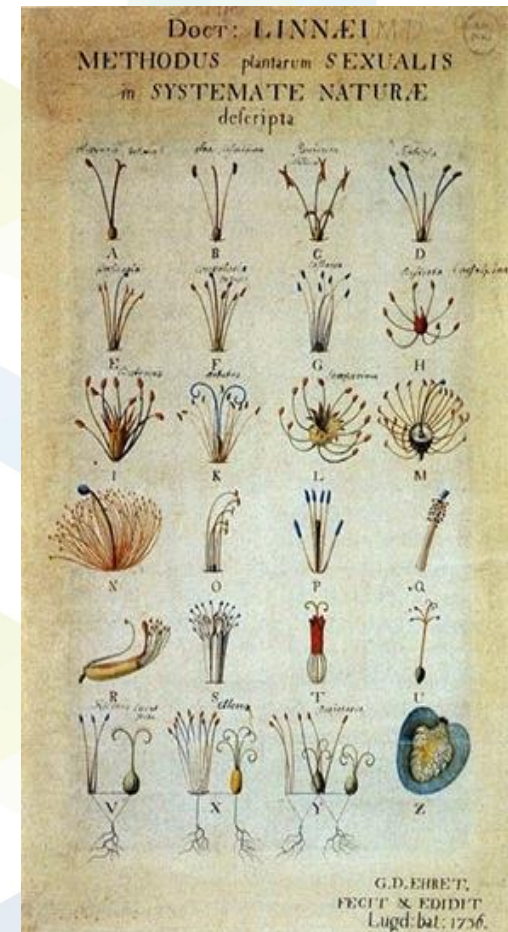


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Plant systematics

- MAPs belong to various plant families
- Artificial systems (e.g.: by Linnaeus, 1758)
 - = only a few characters are considered
 - = members are not similar in hereditary pattern
 - = stable classification
 - = plant are not related phylogenetically





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Biological diversity of MAPs

- Over ninety percent of the traditionally used MAPs are gathered
- Natural resources (natural diversity) are limited
- Biological equilibrium is impaired by irrational exploitation
- Over-exploitation of natural resources is endangering the survival of species
- **Chiang Mai Declaration** (1988): alarm over the consequences in the loss of diversity



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„Save Plants to Save Lives”

- Urgent need for the conservation of MAPs
- Need to coordinate *in situ* and *ex situ* strategies

Ex situ conservation it is the process of protecting endangered plant species **outside** its natural habitat, e.g.: seed bank, gene bank.

In situ conservation, as an opposite, means the process of protecting an endangered plant species **in their natural habitats**.

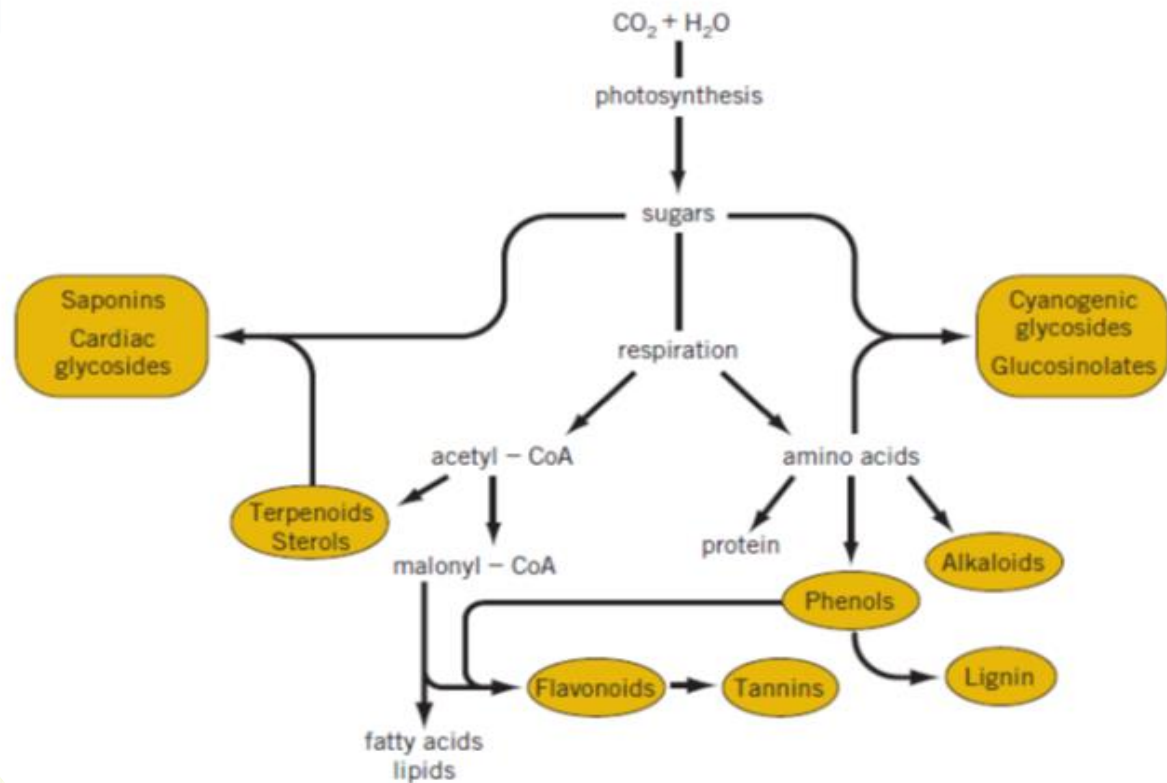


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Primary and secondary metabolism



Hopkins and Norman, 2009)



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Interrelated Primary and Secondary Metabolism

- Primary metabolism takes place in most cells,
- Secondary metabolic processes are frequently related to specialized cells and tissues.

In MAPs it is mainly the secondary metabolites that we utilize.

Yield of active principles is determined by:

- = **Biomass** of the plant (generally expressed as dry mass) and
- = **Amount** of active principles (substances) accumulated



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Role of secondary substances in plants

- Protect against being eaten by predators, herbivores/pathogens,
- Serve as attractants (smell/color/taste),
- Allelopathic agents in plant-plant competition,
- Used by plants for nutrition, maintenance, reproduction, *etc.*



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Taxonomy and Plant classification

- Basic taxonomic unit : ***species*** (sp.),
- Related species constitute: ***genus***
- ***subspecies*** (subsp.), ***variety*** (var.) and ***form*** (f.) are used to differentiate among dissimilar populations of wild-growing species.
- ***infraspecific varieties*** (Terpó, 1992) within both natural and cultivated species,
- ***Cultivars or varieties*** are differentiated according to their features valued by human societies.



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Special feature of MAPs

- A number of characteristic
 - = chemical,
 - = cytological,
 - = morphological, and occasionally even
 - = ecological propertiesneeded for their correct identification (description).
- Species represents either
 - = a homogenous taxon of plants with little variation from one specimen to another, or
 - = includes various varieties or **chemical races** with distinctive features (e.g.: *Ocimum* spp.)



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Genetics (Heredity and Variability)

- **Chemical taxa** = result of biochemical and metabolic processes, mostly under genetic control
- **Polychemism** = infra-specific chemical modifications caused by ecological and/or geographical conditions
- **Chemical characters** serve as a real biological base for breeding
- Recent research trends reveal DNA and biosynthetic causes of chemo-differentiation → new perspectives for the breeding of new, highly powerful chemo-cultivars.



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Variability in active principle accumulation

- **Ecological variability:** growth/development/synthesis of metabolites affected by the environment (physical and biotic-factors)
- **Life-cycle related variability:** synthesis, accumulation or translocation undergoes changes in the course of the plant life cycle (from seed to seed). Consequently, their presence and/or optimal concentrations must be determined specifically
- **Diurnal variations:** changes during one single day (e.g. due to ecological factors and/or translocation of metabolites between organs)



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Factors influencing biomass/active principle yields

