**Ministry of Higher Education**
**Salahaddin University**
**College of Agricultural Engineering Sciencies**
**Plant Protection Department**

**Weeds and Weed Control**
**Fourth Grade**
**Spring Semester (2021-2022)**
**Instructor: Saber Wasman (PhD)**
**Lecture 5**

# What is natural product?

- A natural product is a chemical compound or substance produced by a living organism
- They may be extracted from tissues of plants, marine organism or micro - organism fermentation
- Any biological molecule is a natural product
- In general, the term is reserved for secondary metabolites (carotenoids, saponines, phenolic compounds, alkaloids, terpenes etc.), produced by an organism
- They are not essential for normal growth, development or reproduction and its survival

# History of plant natural products

- The history of the extraction of natural products dates back to Mesopotamian and Egyptian times, where production of perfumes or pharmaceutically - active oils and waxes was a major business.
- In archaeological excavations 250 km south of Baghdad extraction pots from about 3500 BC were found, made from a hard, sandy material presumably air - dried brick earth.
- Several Sumerian texts also confirm that a sophisticated pharmaceutical and chemical technology existed

# History of plant natural products

- Natural extracts were subjected to separation into component compounds, which were then purified and analyzed.
- In the late 1800's, synthetic methods were being developed for some of these natural compounds.
- It was discovered that natural extracts had more complex compositions and properties than salts and minerals.

**Natural products are often divided into two major classes:**

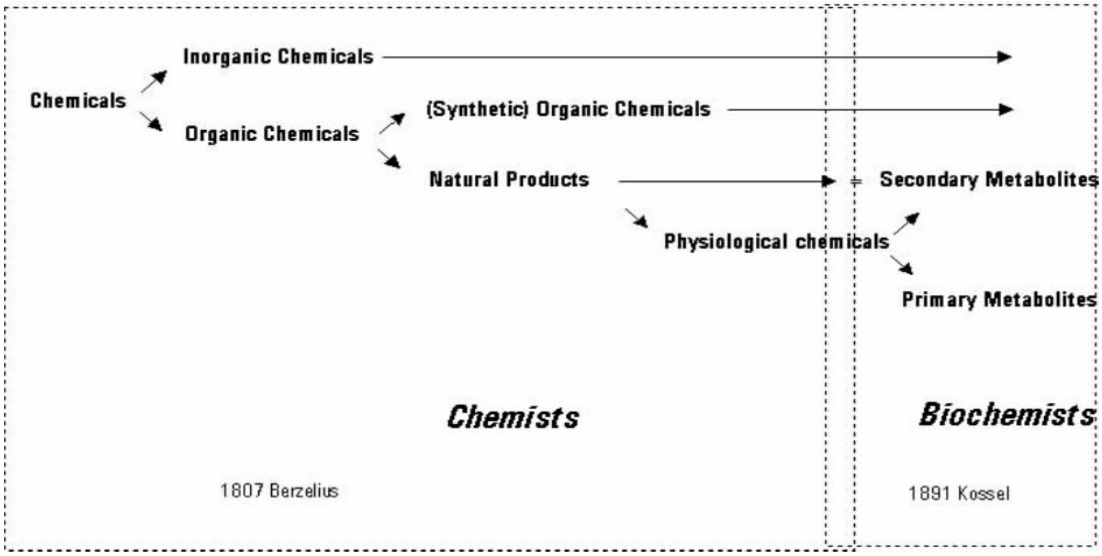
1. Primary metabolites
2. Secondary metabolites


## Primary metabolites

- Organic molecules that have an intrinsic function that is essential to the survival of the organism that produces them (i.e. the organism would die without these metabolites).
- Examples of primary metabolites include the core building block molecules (nucleic acids, amino acids, sugars, and fatty acids) required to make the major macromolecules (DNA, RNA, proteins, carbohydrates, and lipids) responsible for sustaining life.

# Secondary metabolites

- Organic molecules that typically have an extrinsic function that mainly affects other organisms outside of the producer.
- Secondary metabolites are not essential to survival but do increase the competitiveness of the organism within its environment.
- Secondary metabolites, in contrast to primary metabolites are dispensable and not absolutely required for survival.



# The study of natural products is multidisciplinary

| Biology ← → Chemistry |
| --- |
| Taxonomy . Botany — Organic synthesis |
| Agriculture . Pharmacology . Pharmaceutical Science . Organic analytical chemistry |
| Entomology . Microbiology . Biotechnology/Molecular Biology . Biochemistry |
| Genomics . Proteomics |
| Metabolonomics |

# Where do we find natural products?

- Natural products may be extracted from the cells, tissues, and secretions of microorganisms, plants and animals.
- A crude (unfractionated) extract from any one of these sources will contain a range of structurally diverse and often novel chemical compounds.
- Chemical diversity in nature is based on biological diversity, so researchers travel around the world obtaining samples to analyze and evaluate in drug discovery screens or bioassays.
- This effort to search for natural products is known as bioprospecting.

# Natural products as a bioherbicide

- Many secondary plant natural products are linked with bioherbicidal influences.
- Some secondary plant metabolites, such as phenolics and alkaloids, play an essential role in natural plant activities such as germination and early growth.
- Certain crop species can be used as bioherbicide and their allelochemical extracts can be used to advantage to suppress and reduce negative effects of weeds on crop production

# Allelopathy

- The phenomenon of plants affecting other neighbouring plants through releasing chemicals was originally mentioned as early as 370 BC by Theophrastus
- The term Allelopathy was first mentioned by Molisch in 1937
- It is a Greek hybrid word, "Allelon", which means "of each other" and "pathos" meaning "suffer"

# What is Allelopathy?

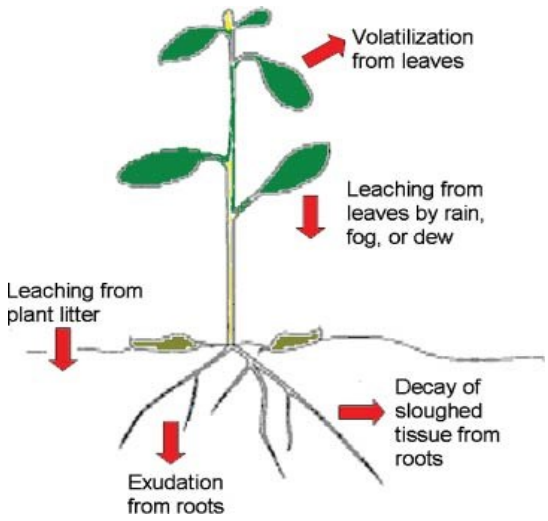
- Any direct or indirect harmful or beneficial effect of one plant or a microorganism on other plants by releasing chemicals termed allelochemicals to the environment

- According to the International Allelopathy Society (International Allelopathy Society, 1996), allelopathy is

"any process involving secondary metabolites produced by plants, algae, bacteria and fungi that influences the growth and development of agricultural and biological systems

- Plants which have allelopathic potential must produce allelochemicals, which must be released into the environment and must be available for transport to the target plant to be taken up

- Allelochemicals are released to neighbouring plants by different mechanisms involving
- Root exudation,
- Leaching,
- Volatilization and
- Decomposition of plant residue




# Field Crop Production

- Certain crop species can be used as allelopathic plants and their allelochemical extracts can be used to advantage to suppress and reduce negative effects of weeds
- It could help to avoid environmental pollution soil contamination
- Crop allelopathy could be achieved by using such crops as cover crops, companion crops as well as components of the crop rotation system

- Selecting crops to release allelochemicals may minimize the intensity not only of weeds, but also pests, diseases and nematodes

- Crop Allelopathy may play an essential role in the development of biological herbicides

- Some weeds have been shown to have allelopathic properties against some crop plants

# Weed Management

- Weeds are defined as plants growing in unwanted locations which compete with other plants for resources such as water, nutrients, and light, reduce the yield and quality of crops and may contaminate produce with weed seeds

- About 7000 weed species have been identified
- Nearly 200-300 of them are problems for farmers .
- Using herbicides to minimize the negative impact of weeds on crop yield has many risks.

- Using chemical herbicides to suppress weeds, poses risks to environment, health, water contamination, and soil microorganisms
- There are more than 470 biotypes of weeds that are resistant to chemical herbicides
- Plants that have allelopathic activity can be used as bioherbicides for weed suppression
- Allelopathy may be considered as a possible tool to minimize weeds and enhance crop production

## Soil and Allelopathy

- Soil is a system which gives a living biological environment for living microorganisms such as fungi, bacteria, algae, protozoa and actinomycetes
- Soil is the environment where allelopathic activities happen
- Soil type significantly affects the allelopathic potential of allelochemicals

- Allelopathic activity of several allelochemicals can be reduced by organic matter, ion exchange capacity, inorganic ions, and mineral reactive surfaces
- Allelochemicals incorporated into soil may be transformed when movement happens and they are metabolized by soil microbes
- Soil pH affects availability of soil nutrients and hence plant growth
- Phenolic compounds may reduce soil pH due to soil acidification

# What are Allelochemicals?

- The allelopathic compounds present in some plants are mostly secondary metabolites, including phenolics, terpenoids, and alkaloids
- There are many plants that produce allelochemicals during their growth, such as sorghum, wheat, alfalfa, barley, corn, asparagus, coffee, tea, tobacco, and sunflower
- These allelopathic crops can produce allelochemicals during decomposition of their plant residues, such as roots and leaves

# Phenolic acids as allelochemicals

- Phenolic acids are a class of most important common secondary metabolites which are found in plants and act as allelochemicals in natural ecosystems
- Phenolic acids originate from the shikimic acid and acetic acid metabolic pathways in plants
- Phenolic acids consist of a hydroxyl group bonded to an aromatic hydrocarbon group

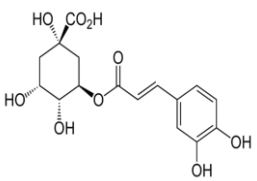
- Phenolic compounds are one of the big groups of plant metabolites which have numerous important functions in some plant species

- The primary structures of phenolic acids are benzoic acids and derivatives of cinnamic acids
- Most of the phenolic acids which have already been identified as allelochemicals are extracted from plant parts, such as shoots and roots

- Many years ago, de Candolle (1830) noticed suppressive effects of root exudates on the neighbouring plants
- It was difficult to determine if phenolic compounds were involved in this effect and if so, which ones.
- After 1980s there was a revolution: numerous methods such as column chromatography on silica, ion exchange chromatography were developed which enabled phenolics to be found and extracted from plants

# 1. Chlorogrnic acid

- Chlorogenic acid is produced by a combination of caffeic acid and quinic acid and usually appears in high concentration in comparison with other phenolic acids in many fruits, vegetable, and field crop plants.
- Chlorogenic acid plays an essential role as a dietary antioxidant and it is the main polyphenolic acid.
- Example: *Imperata cylindrica*



# 2. Caffeic acid

- Caffeic acid is a well-known important phenolic substance found from plants and belongs to hydroxycinnamic acid derivatives
- Caffeic acid plays an essential role in inhibiting seed germination and seedling growth of some plants
- Example: Sunflower plants