



Introduction to Natural Products Chemistry



Introduction to Natural Products Chemistry

- Cells of organisms - plants, fungi, bacteria, lichens, insects, animals - produce a large variety of organic compounds.
- Many substances were obtained anciently, e.g. foodstuffs, building materials, dyes, medicinals, and other extracts from nature.

Natural Products
(secondary metabolites)

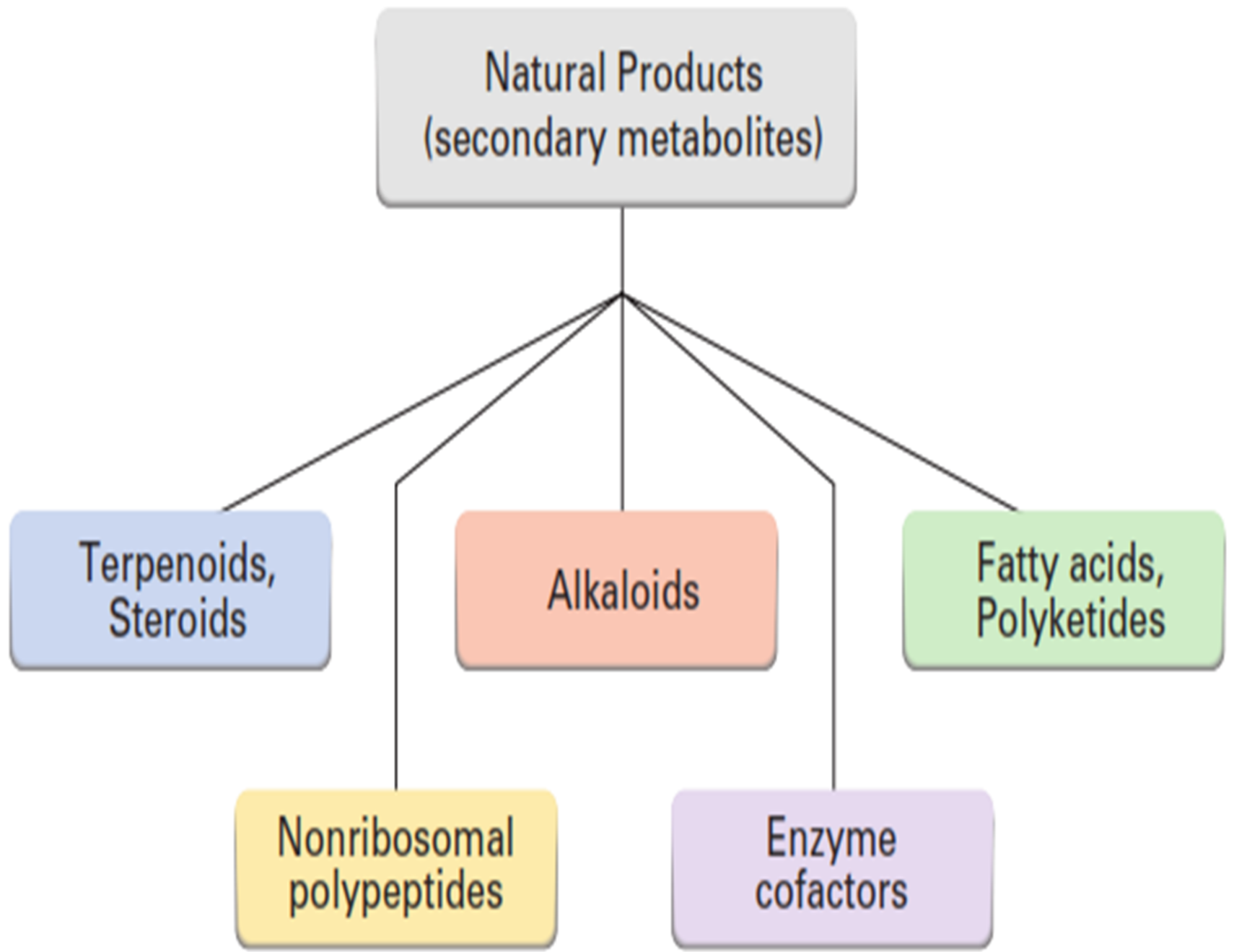
Terpenoids,
Steroids

Alkaloids

Fatty acids,
Polyketides

Nonribosomal
polypeptides

Enzyme
cofactors



Number of known secondary metabolites from higher plants

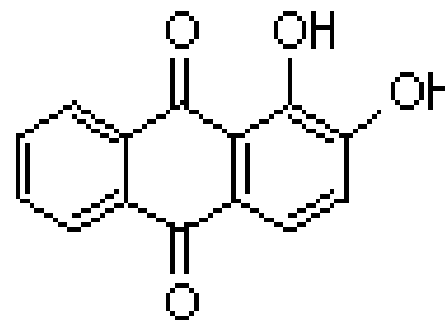
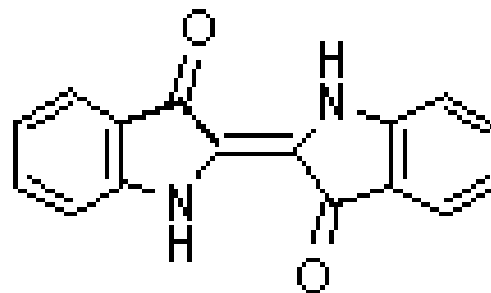
Type of secondary metabolite	Number ^a
<i>Nitrogen-containing</i>	
Alkaloids	21 000
Non-protein amino acids (NPAAs)	700
Amines	100
Cyanogenic glycosides	60
Glucosinolates	100
Alkamides	150
Lectins, peptides, polypeptides	2000
<i>Without nitrogen</i>	
Monoterpenes (C10) ^b	2500
Sesquiterpenes C15) ^b	5000
Diterpenes (C20) ^b	2500
Triterpenes, steroids, saponins (C30, C27) ^b	5000
Tetraterpenes (C40) ^b	500
Flavonoids, tannins	5000
Phenylpropanoids, lignin, coumarins, lignans	2000
Polyacetylenes, fatty acids, waxes	1500
Polyketides	750
Carbohydrates, organic acids	200

^aApproximate number of known structures.

^bTotal of terpenoids number exceeds 22 000 at present.

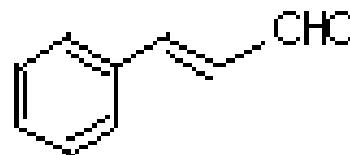
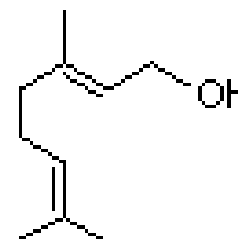
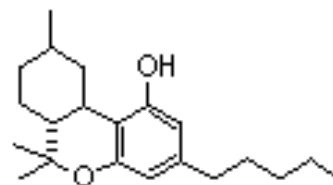
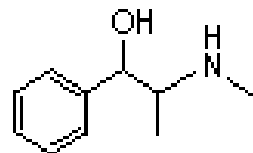
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- Crude aqueous extracts of certain plants (and animals) provided pigments, such as indigo and alizarin.



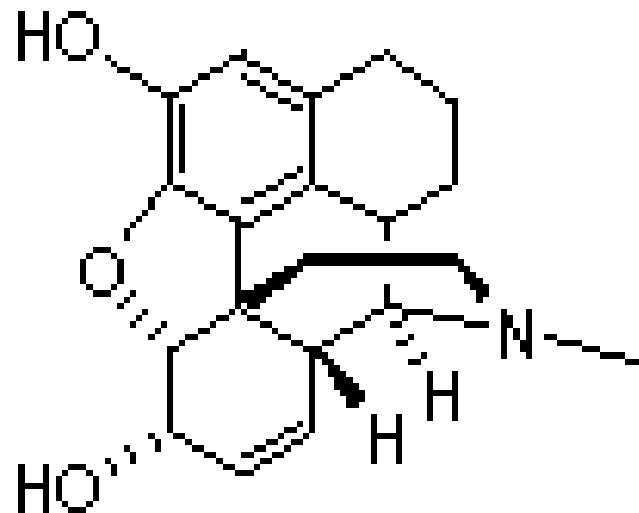
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- Other examples of natural products:
- ephedrine
from *Ephedra sinica*
(respiratory ailments) tetrahydrocannabinol
(marijuana) geraniol
(rose oil)
- cinnamaldehyde
(cinnamon) diallyl disulfide (garlic)



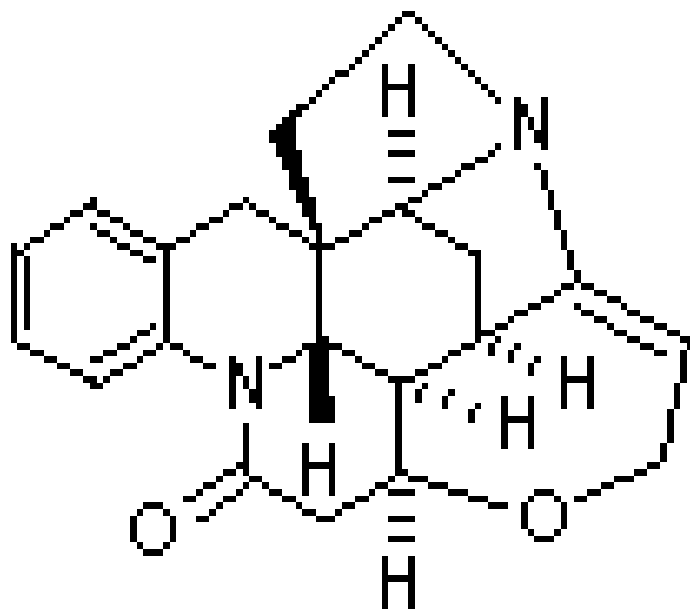
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- morphine
(narcotic analgesic)
1817



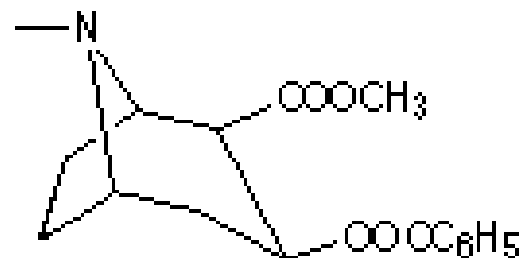
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- strychnine
(poison) 1818



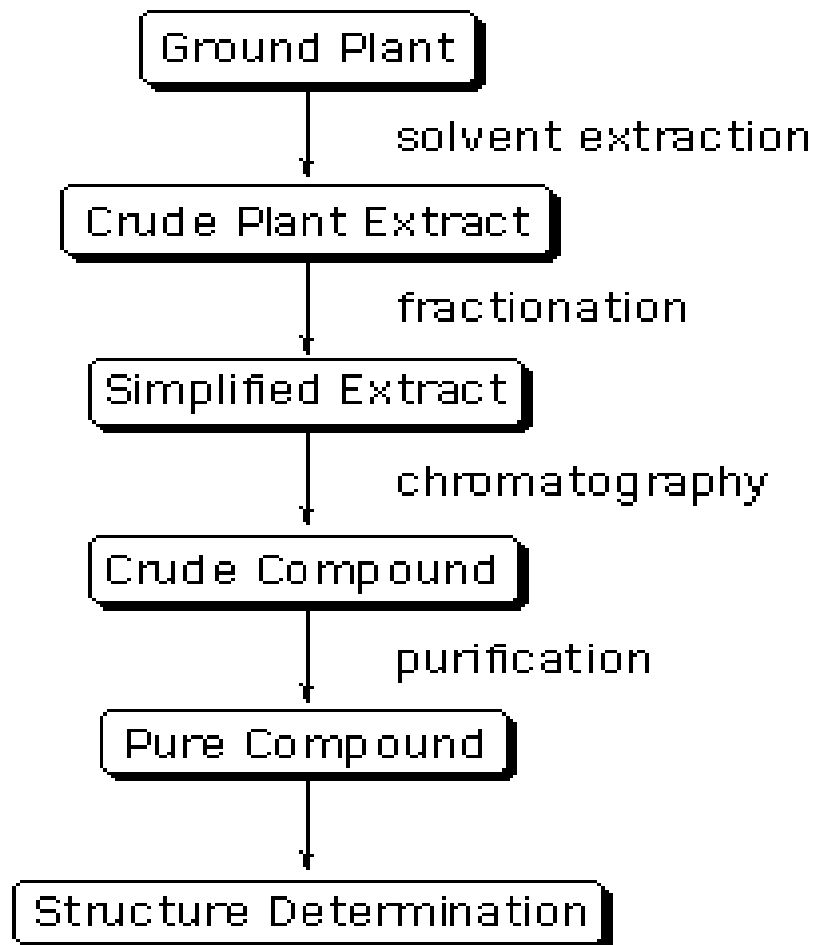
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- cocaine
(narcotic stimulant)
1859
- nicotine
(toxic) 1828



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**General
isolation
strategy of
natural
products:**



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- Mild heating of certain plants afforded perfumed distillates.
- Plants and animals have provided substances used for their biological activity, to heal or to kill, and form the foundation for folk medicine. Most natural products have usually come from plants and microorganisms due to practical difficulties in extracting them from animals.

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- Plants are particularly interesting because:
- They have the broadest spectrum of biosynthetic capability, and produce a wide variety of compounds.
- They use simple starting materials: water, carbon dioxide, nitrogen (elemental and in salts), phosphorus compounds, and salts.
- Their biosynthetic paths are known

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- 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. Some examples of natural products and when they were discovered are as follows

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- In the late 1800's, natural products were identified and analyzed by mp, bp, $[\alpha]$ (optical rotation), hoping to find correlations between data and structure. This initiative was not successful in predicting structure, but useful data on natural products were obtained.

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- Modern chromatographic methods have been greatly developed to isolate and purify a large number of different compounds in very small quantities: column, GC, TLC, HPLC, paper, electrophoresis, ion exchange, etc.
- Natural products are usually given names that are derived from the species name of the plant or animal, or from the biological action, or property, of the compound.

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- **More modern structural elucidation and characterization by spectroscopy:**
- **1930's UV (ultraviolet) light (cf. Woodward's Rules, 1941)**
- **1940's IR (infrared) spectroscopy (note: penicillin structure problem in W.W.II)**
- **1950's NMR (nuclear magnetic resonance) spectroscopy**
- **1960's MS (mass spectrometry)**
- **ESR (electron spin resonance) spectroscopy**

- **and by other methods:**
- **ORD (optical rotatory dispersion)**
- **CD (circular dichroism)**
- **acidity and basicity measurements (pK)**
- **advanced synthetic and biosynthetic technology**
- **X-ray crystallography**

THANK YOU

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