

# Ethnobotany

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Lecture 20

# Outline

- 1 Natural product chemistry
  - Introduction
  - Polyketides and other small molecules
- 2 Natural product chemistry: what to extract
  - Terpenes

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# Natural product chemistry

## Introduction

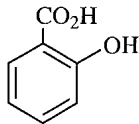
# Types of drugs

- Fully natural
- Semisynthetic
- Fully synthetic

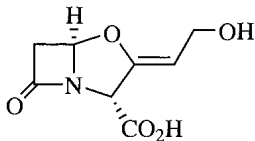
# Types of medicinal agents

## Medicinal agents from natural sources

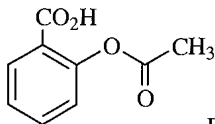
- (a) Fully natural
- (b) Semisynthetic
- (c) Fully synthetic



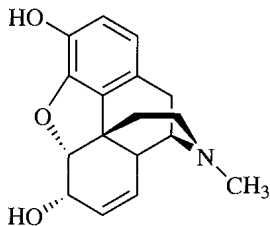
salicylic acid



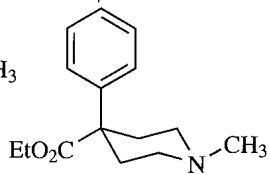
(a) clavulanic acid



(b) aspirin



morphine



(c) pethidine

# Drug discovery

We need new drugs, and plant secondary compounds of plants could accidentally have medicinal value.

- Sampling: soil, markets, natural habitats
- Extraction
- Bioassay screening
- Structure elucidation
- Chemical modification
- Clinical trials
- Drug

# Natural product chemistry

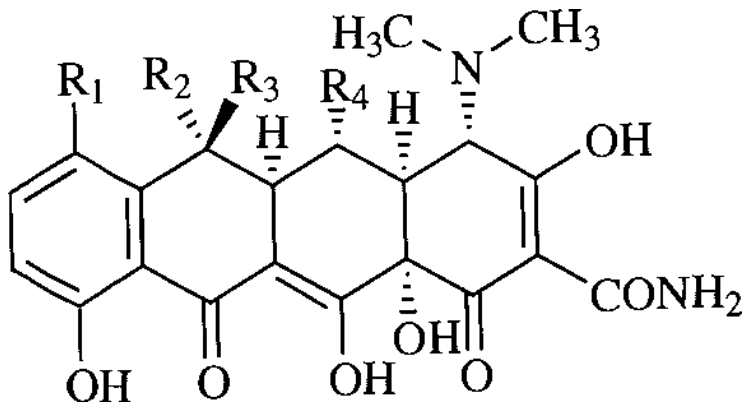
## Polyketides and other small molecules



# Polyketides and derived products

- Short molecules with interleaving ketogroups
- Many antibiotics (e.g., tetracycline, erythromycin)

# Tetracycline



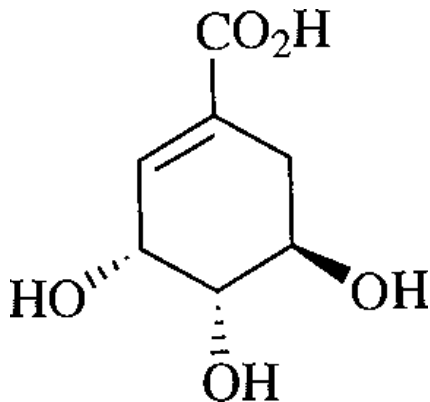
# Glycerides

- Saturated fats
- Unsaturated fats, especially omega-n-unsaturated

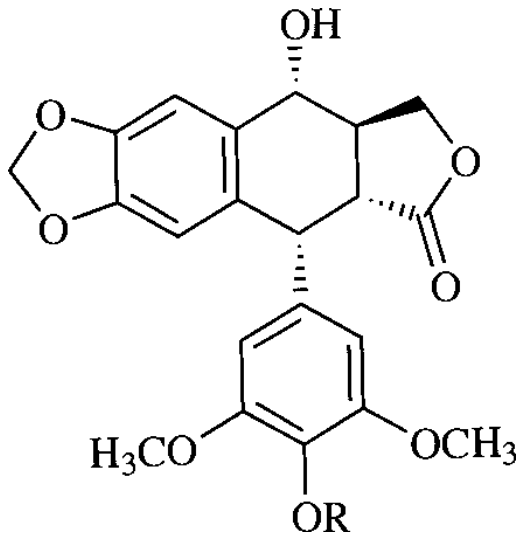
# Shikimic acid and derived products

- Phenylpropenes, like eugenol
- Lignans like podophyllotoxin

# Shikimic acid



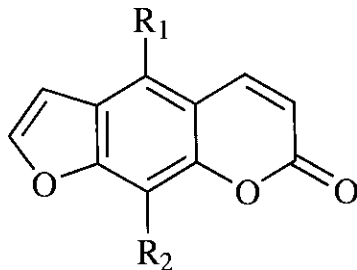
# Podophyllotoxin



# Coumarins

- Phytoalexins with anti-bacterial properties
- Some (psoralens from umbel family plants and bergapten from citrus family) are phototoxic

# Psoralen

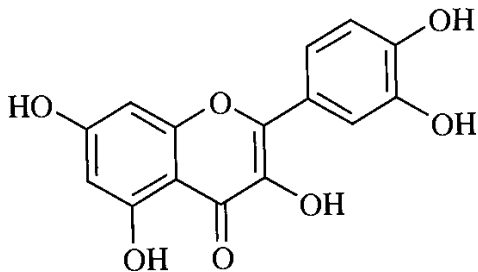




# Flavonoids

- Derivatives of phenylpropane ( $C_6-C_3$ )
- Strong antioxidants
- Examples: naringin from grapefruit, quercetin from oak and other plants, resveratrol from grapes

# Quercetin (flavonoid)



# Tannins

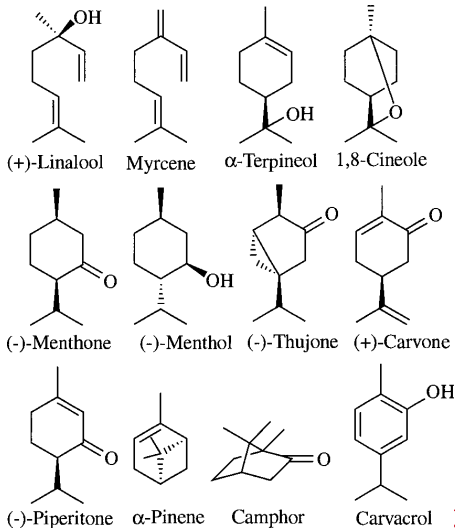
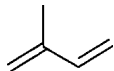
- Similar to flavonoids, but much heavier
- Bind to proteins and provide astringent taste

# Natural product chemistry: what to extract Terpenes

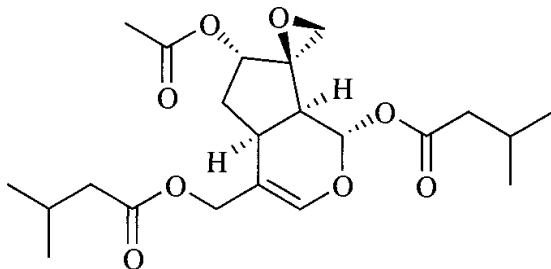
# Terpenes and monoterpenes

- Terpenes = isoprenoids, derivatives of isoprene (C<sub>5</sub> unit)
- Monoterpenes are simplest, they are constituents of volatile (essential) oils
- Examples: menthol from mint, myrcene from *Eucalyptus*, camphor, iridoids like valepotriates from valerian

# Isoprene and monoterpenes



# Didrovaltrate (iridoid)

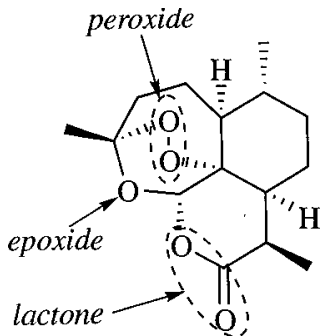


# Sesquiterpenes

- Have C<sub>15</sub> skeleton
- Example: artemisinin from sage



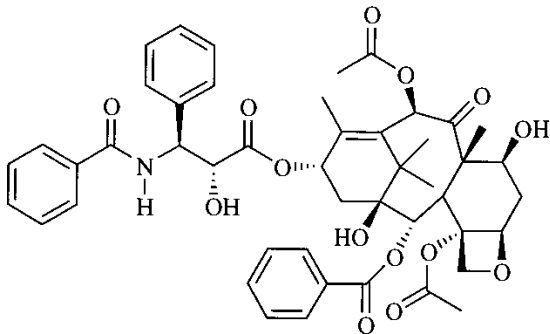
# Artemisinin (sesquiterpene)



# Diterpenes

- Have C<sub>20</sub> skeleton
- Example: taxol from yew tree (actually, mostly from its endophyte *Taxomyces*)

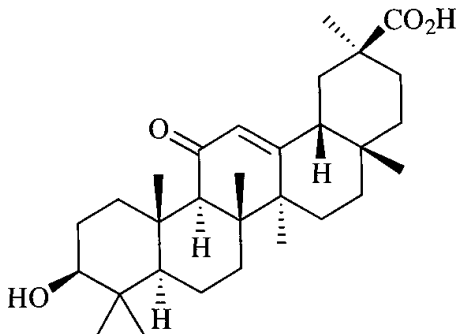
# Taxol (diterpene)



# Triterpenes

- Have C<sub>30</sub> skeleton and (often) four condensed rings
- Examples: steroids, glycyrrhetic acid from liquorice and resins

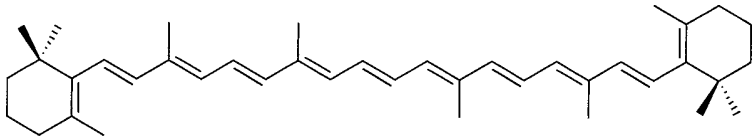
# Glycyrrhetic acid (triterpene)



# Tetraterpenes

- Have C<sub>40</sub> skeleton and four condensed rings
- Carotenes, like  $\beta$ -carotene from carrot and lycopene from tomato

# $\beta$ -carotene (tetraterpene)



# Summary

- Polyketides are source chemicals to many antibiotics
- Derivatives of shikimic acid are phenylpropenes, lignans, coumarins, flavonoids and tannins
- All terpenes (including carotenes, steroids and resins) are derivatives of isoprene



# For Further Reading



A. Shipunov.

*Ethnobotany* [Electronic resource].

2011—onwards.

Mode of access:

[http://ashipunov.info/shipunov/school/biol\\_310](http://ashipunov.info/shipunov/school/biol_310)



Heinrich et al. 2012 (or 2004).

*Fundamentals of Pharmacognosy and Phytotherapy.*

Churchill Livingstone, Edinburgh.

Mode of access: [http://ashipunov.info/shipunov/school/biol\\_310/heinrich2004\\_fund\\_pharm\\_part.pdf](http://ashipunov.info/shipunov/school/biol_310/heinrich2004_fund_pharm_part.pdf)