Terpenes

Learning outcomes

- Terpenes are unsaturated compounds formed by joining together isoprene units.
- Terpenes are components of a wide variety of fruit and floral flavours and aromas.
- Terpene derivatives are responsible for the distinctive aroma of spices.

Objectives

- What are Hemiterpenes.
- Definition of Monoterpenes and Their types..
- Monoterpene classification& Structures.
- Monoterpenes properties & uses.
- Monoterpenes biosynthesis.
- How we can synthesis it?
- Their biological activities
- Their natural occurrence

Terpenes

- The name ‘terpene’ is derived from the Greek word ‘terebinth’.
- Terebinth is a type of pine tree from which terpene-containing resins are obtained.

What are terpenes?

- Natural organic compounds.
- Components of a variety of fruit and floral flavours and aromas.
- Used in perfumes, essential oils and medicines.

Essential oils contain terpenes

- Lavender – used to relieve tension.
- Ylang-ylang – used to treat anxiety.
- Lemon oil – aids good circulation.
- Essential oils often contain a mixture of terpenes.

Spices contain terpenes

- Terpenes in plants can be oxidised to produce the compounds responsible for the distinctive aroma of spices.
- Terpenes containing oxygen or other functional groups are known as ‘terpenoids’.
- Common spices containing terpenes include cloves, cinnamon and ginger.

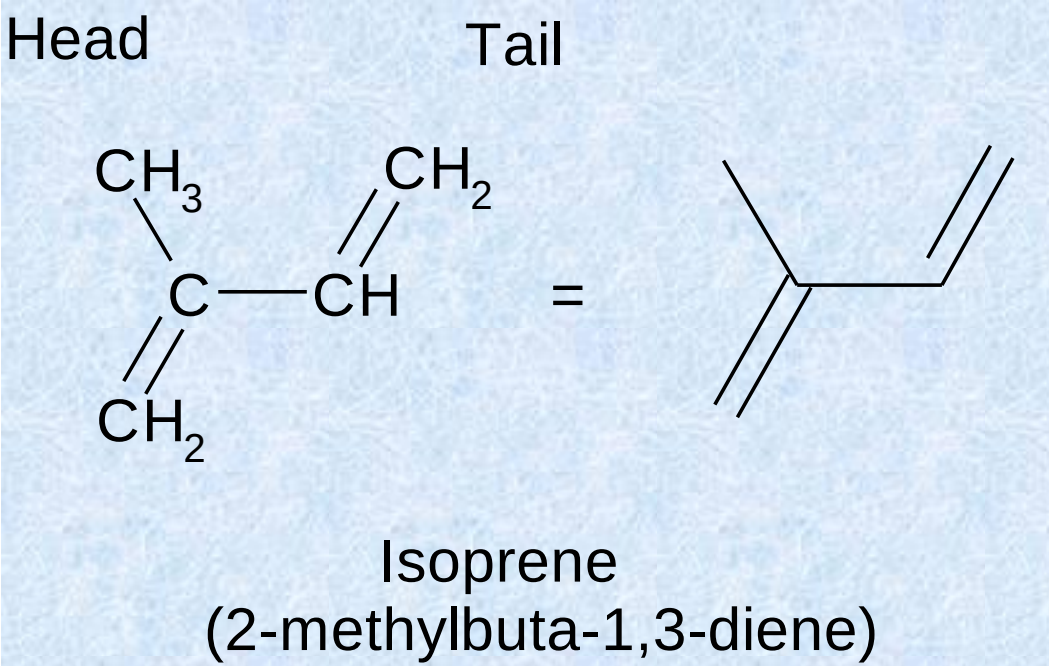
Terpenes are unsaturated

- Terpenes are unsaturated compounds.
- All terpenes are built up from units of **isoprene**.

Isoprene

- Isoprene is the common name for 2-methylbuta-1,3-diene

Isoprene



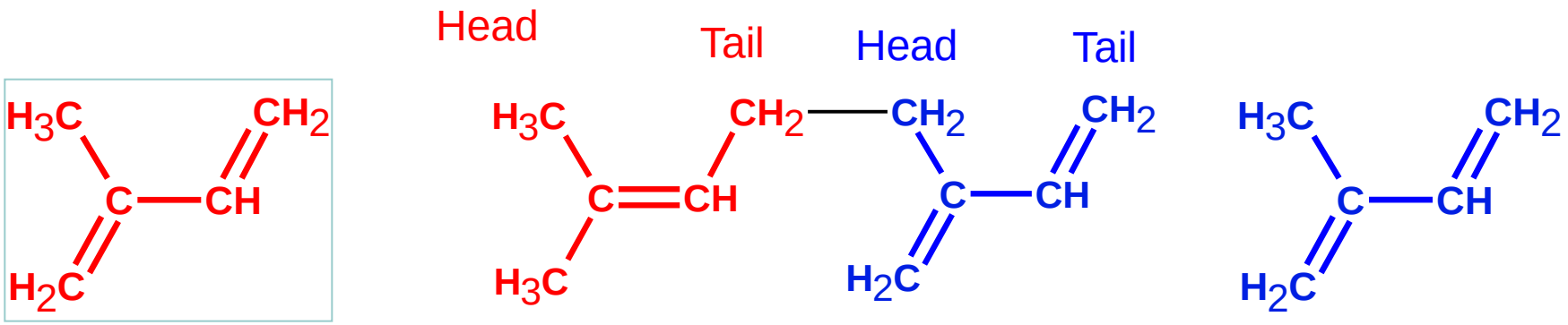
One isoprene unit contains five carbon atoms

Building terpenes from isoprene

Isoprene units can be linked:

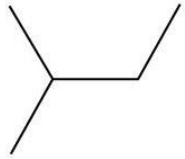
- head to tail to form linear terpenes
- in rings to form cyclic terpenes.

Myrcene – a linear terpene

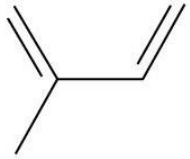


- Myrcene is a component of plants, including bay, ylang-ylang and thyme.

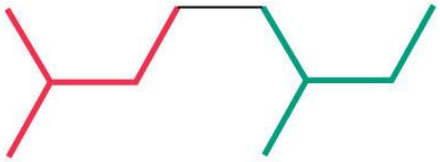
Terpenes are made from C5 units



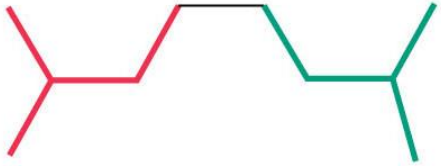
Isopentane



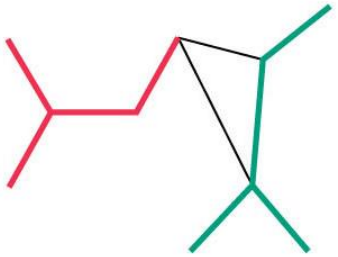
Isoprene



Head-to-tail

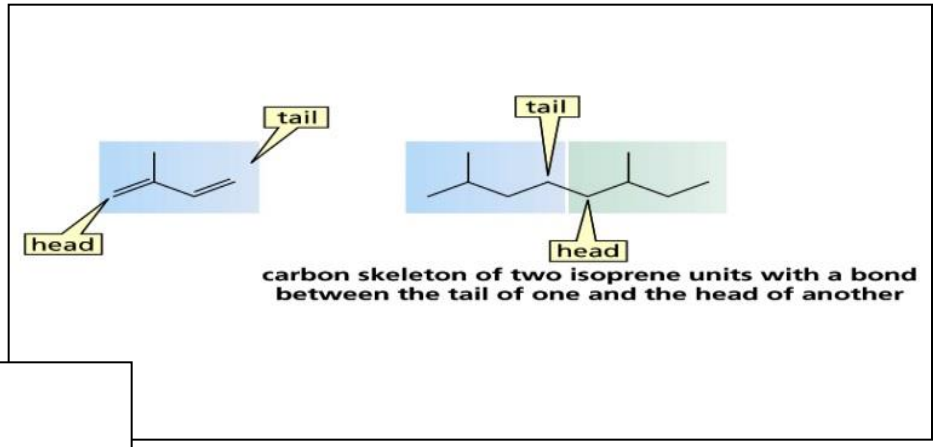


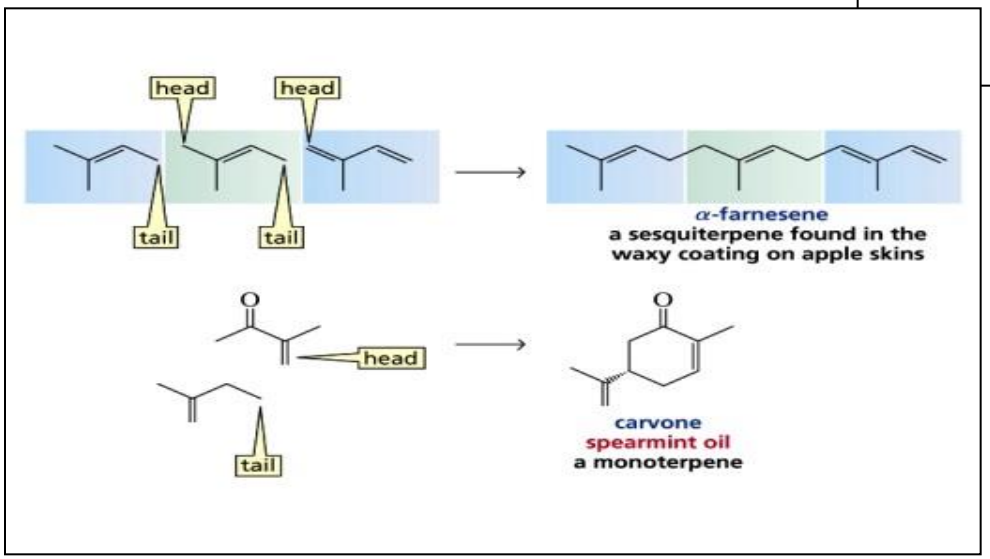
Head-to-head



Head-to-middle

Terpenes


tail
head
tail
head
carbon skeleton of two isoprene units with a bond between the tail of one and the head of another

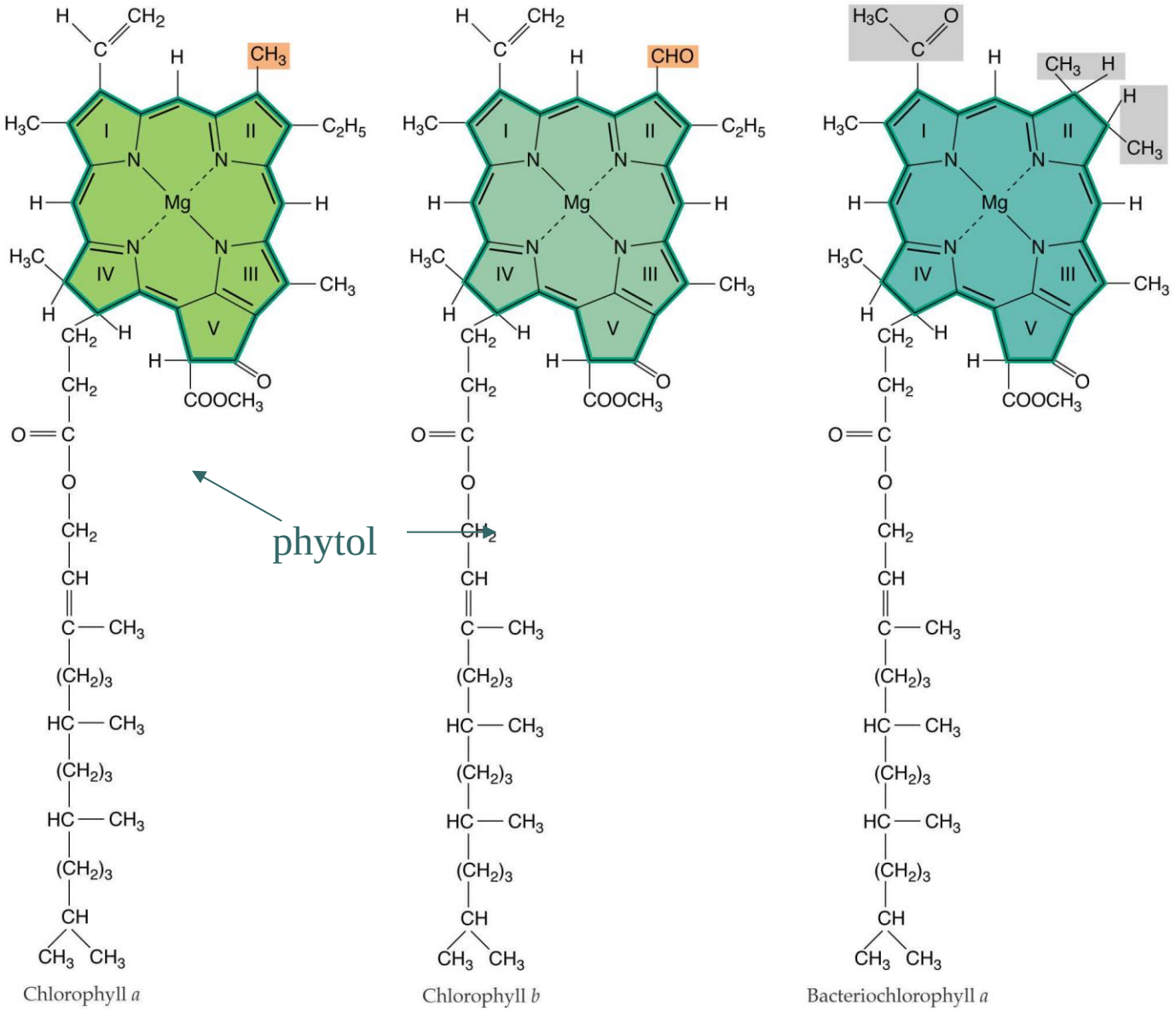

head
head
tail
tail
α-farnesene
a sesquiterpene found in the waxy coating on apple skins
O
head
tail
O
carvone
spearmint oil
a monoterpene

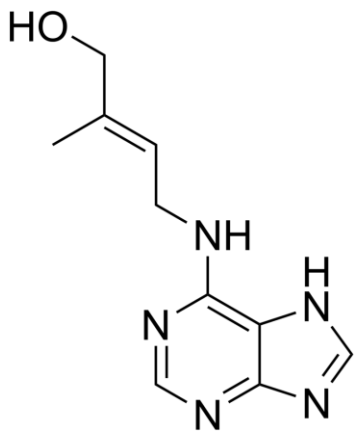
Kinds of terpens

وحدات الايزوبرين 5 = (C)	التربينات C Unite 5 -	Examples
1 X 5 =(C)	Hemiterpenes	reduce in Quinones and Coumarins"Prenyl"
2 X 5 =(C)	Monoterpenes	Open chain: Citral, Geraniol, linalool Monocyclic: Limonene, Menthol, Thymol, Menthone, Carvone, Cineole, Bicyclic: Camphor, Pinene
3 X 5 =(C)	Sesquiterpenes	Open chain: Farnesol Cyclic: Cadinene
4 X 5 =(C)	Diterpenes	Open chain: Phytol Cyclic: Gibberellins, resin acids
6 X 5 =(C) = 2X15 =(C)	Triterpenes	Open chain: Squalene Cyclic: Triterpene alcohols and acids, Steroids, Gossypol, Cucurbitacine
8 X 5 =(C) = 2X20 =(C)	Tetraterpenes	Carotenoids:Carotenes, Xanthophylls
n x 5 =(C)	Polyterpenes	Rubber, Gutta-percha, Balata

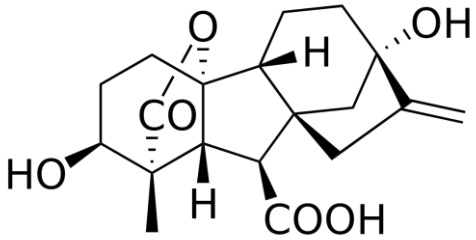
Terpenes

Phytol tail on chlorophyll
Ubiquinone tail
Gibberellins
Cytokinin
Steroids
Many secondary products

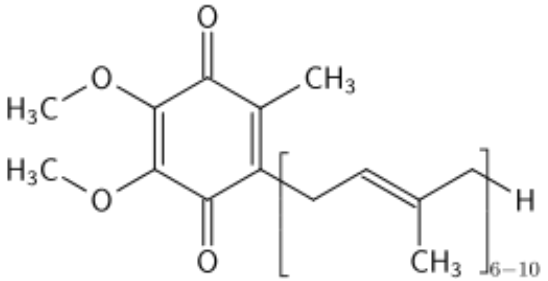

phytol
Chlorophyll a
Chlorophyll b
Bacteriochlorophyll a



Cytokinin

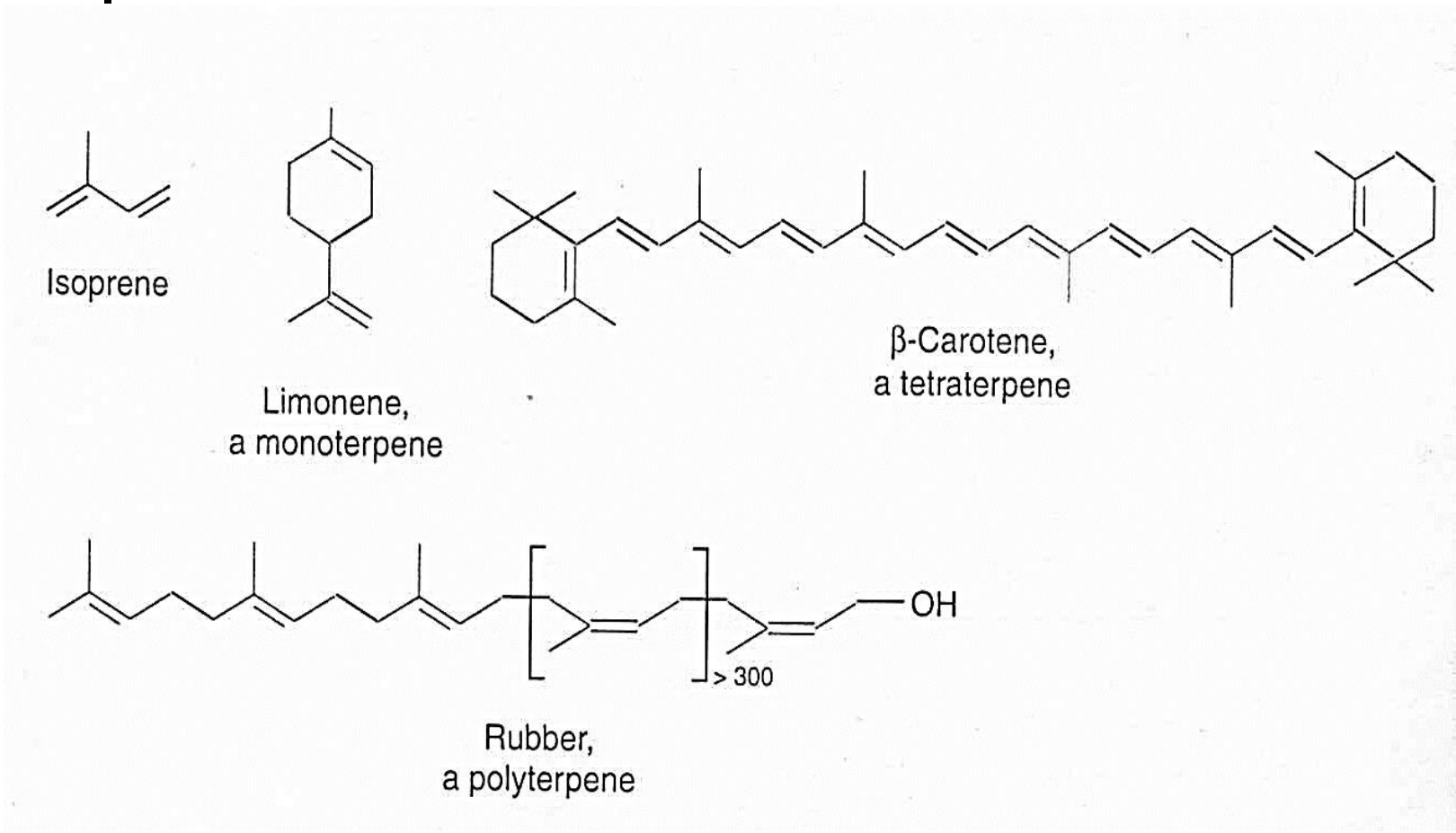


Gibberellins



ubiquinone

Coenzyme Q_{10}

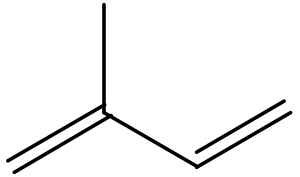

Isoprene
Limonene,
a monoterpene
β-Carotene,
a tetraterpene
OH
> 300
Rubber,
a polyterpene

Terpenes

Terpenes contain carbon atoms in multiples of five

They are made by joining together 5-carbon isoprene units

Oxygen-containing terpenes are sometimes called terpenoids

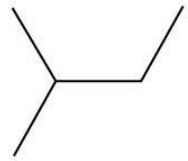


(2-Methyl-1,3-butadiene)

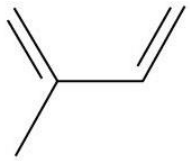
Condensation reactions can occur in three ways:

- Head to head linkage
- Head to tail linkage
- Tail to tail linkage

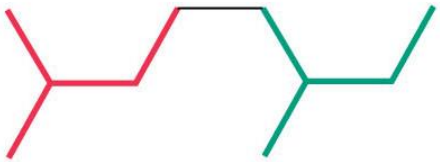
Terpenes are made from C5 units



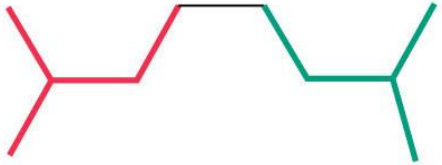
Isopentane



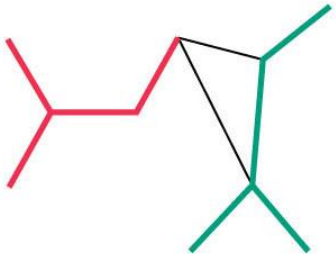
Isoprene



Head-to-tail

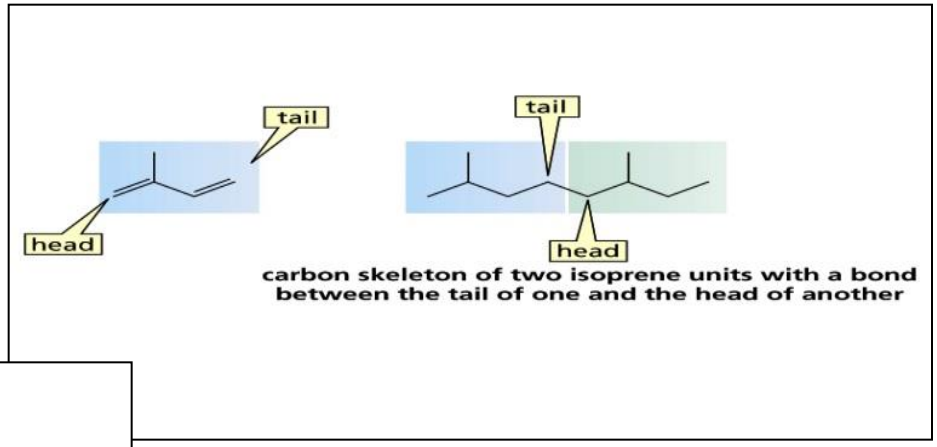


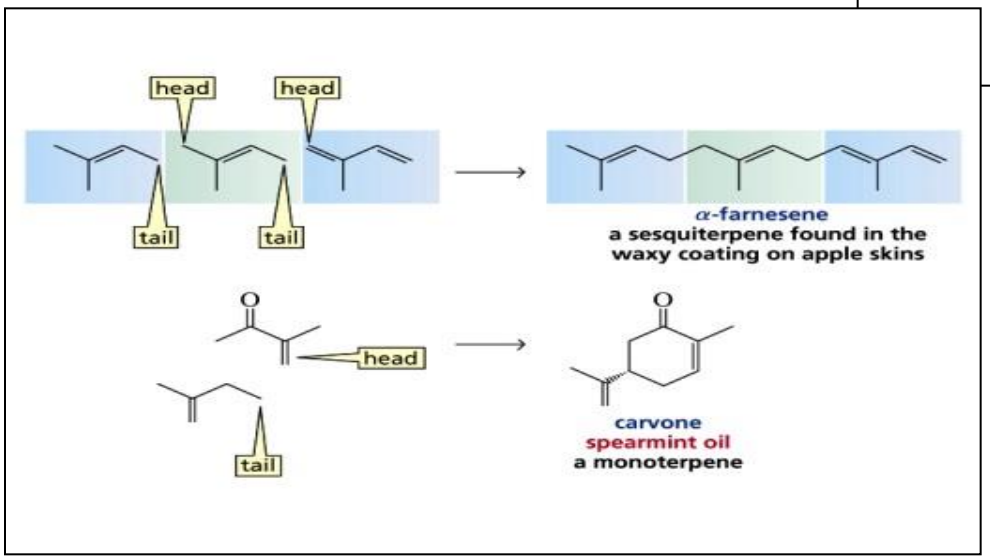
Head-to-head



Head-to-middle

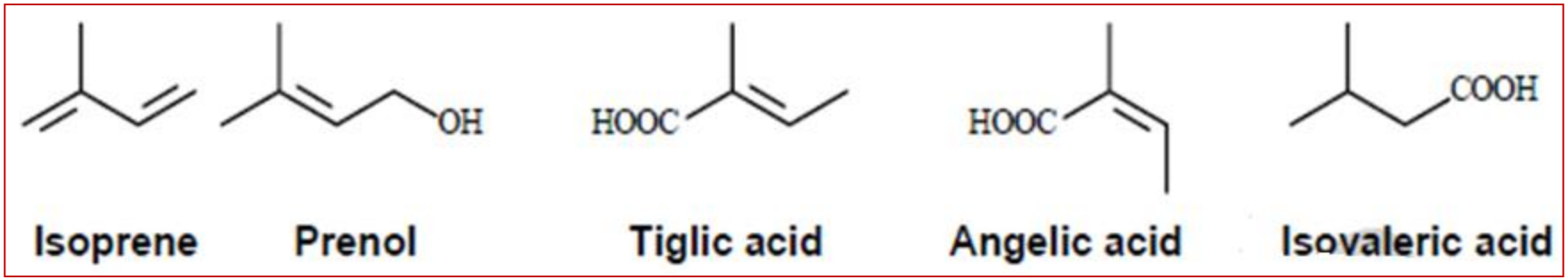
Terpenes


tail
head
tail
head
carbon skeleton of two isoprene units with a bond
between the tail of one and the head of another


head
head
tail
tail
α-farnesene
a sesquiterpene found in the
waxy coating on apple skins
O
head
tail
O
carvone
spearmint oil
a monoterpene

Hemiterpenes (C_5) :

- Hemiterpenes are the simplest terpens, it can be found in different plant partes .
- Examples :



- Isoprene is a basic unite of terpenes .

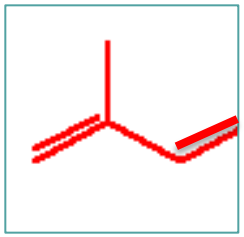
[1] http://www.eolss.net/sample-chapters/c06/e6-151-05-00.pdf

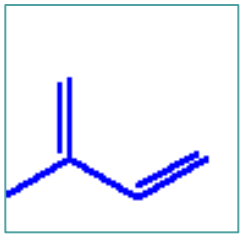
Monoterpenes:

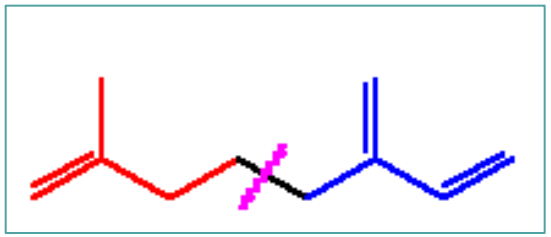
Definition

Monoterpenes($\mathbf{C_{10}}$) : are a secondary metabolites of plants,

Hydrocarbons or their derivatives formed by the condensation of two isoprene units .

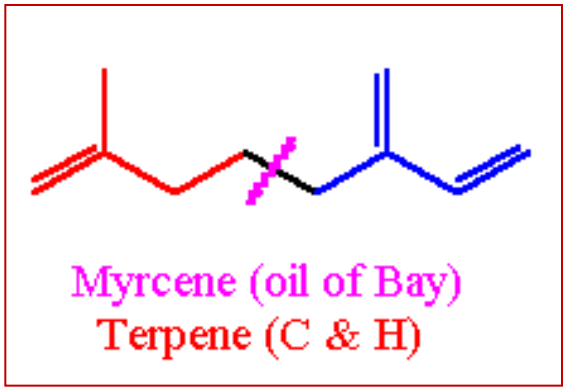


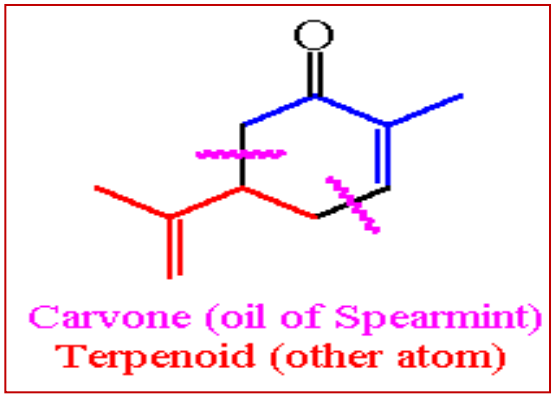




Isoprene
(2-methyl-1,3-butadiene)

Examples:





Terpene (C&H)

Terpenoid

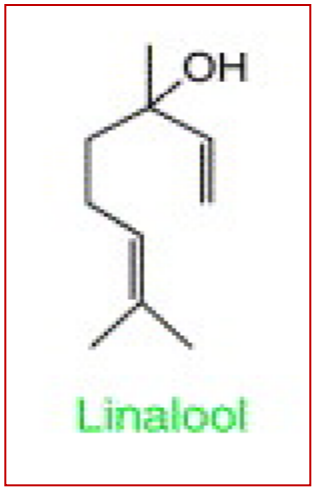
Addition of functional groups such as OH, COOH, Aldehydes,

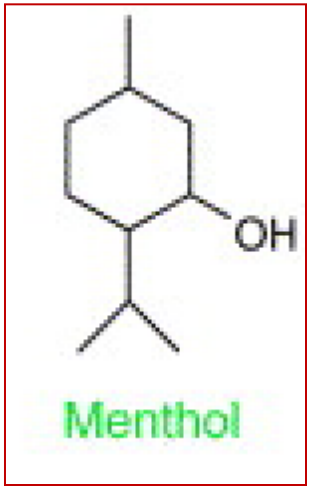
turn these monoterpenes into monoterpenoids. [2]

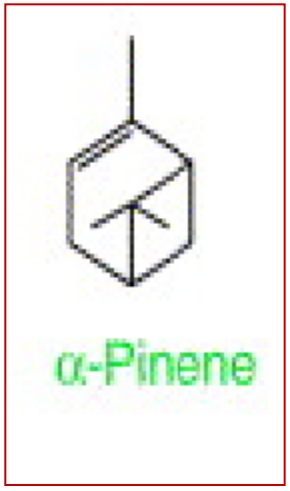
Monoterpene classifications:

Monoterpenes are found in the essential oils extracted from many plants, and are classified into:

- Acyclic.
- monocyclic.
- bicyclic .

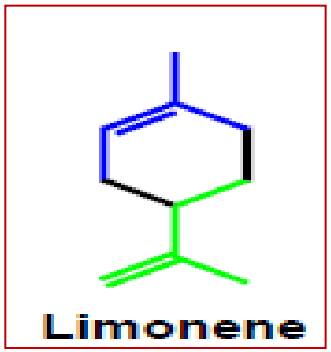




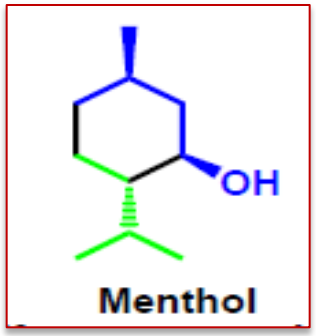


Other classifications:

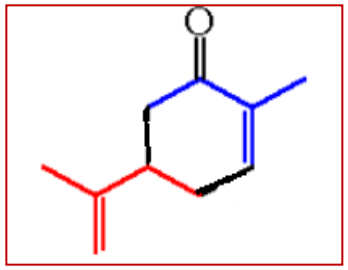
- unsaturated hydrocarbons (limonene)



- Alcohols (menthol)

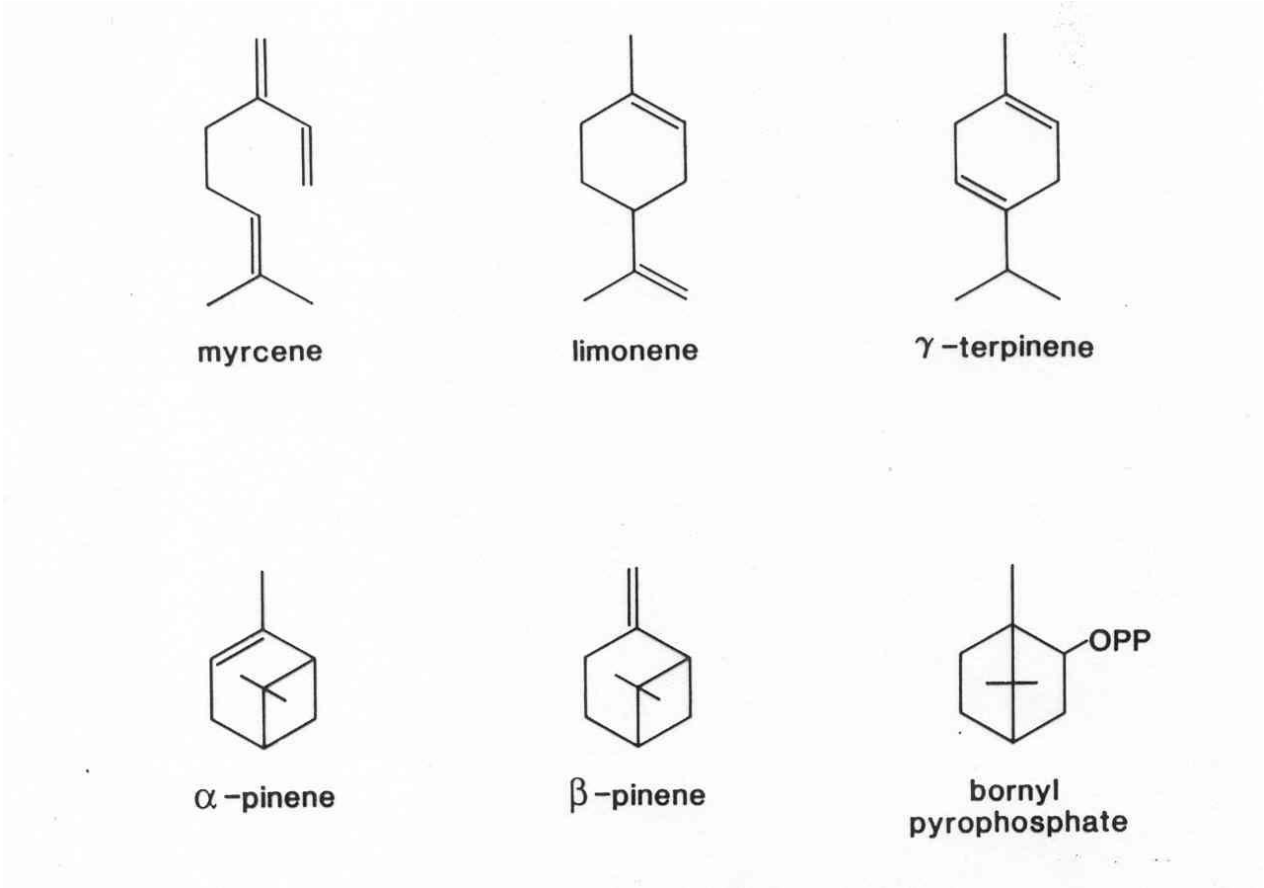


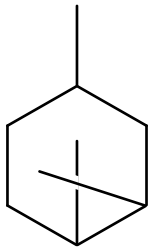
- ketones (carvone)

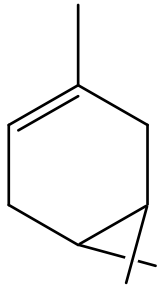


http://depts.washington.edu/pse406/Notes%20pdf/406-12%20Monoterpenes.pdf

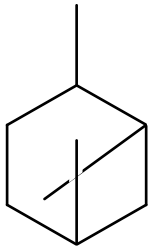
Monoterpenes

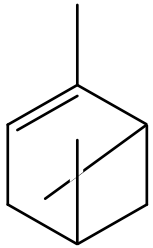




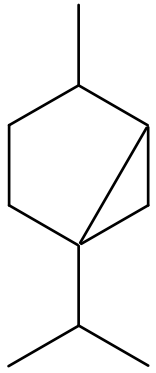


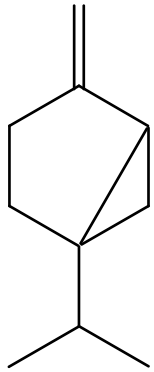
Carane **eg, 3-Carene**



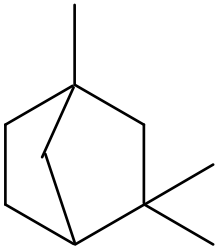


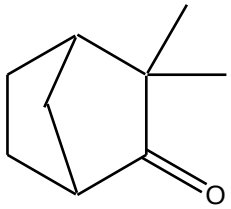
Pinane **eg. α-Pinene**



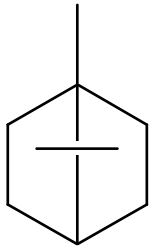


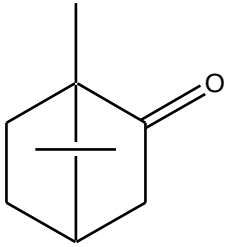
Thujane **eg. Sabinene**





Fenchane **eg. Camphene**

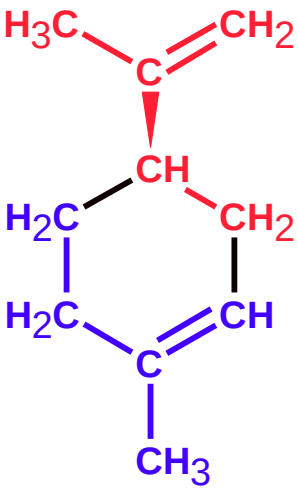




Camphane **eg. Camphor**

or bornane

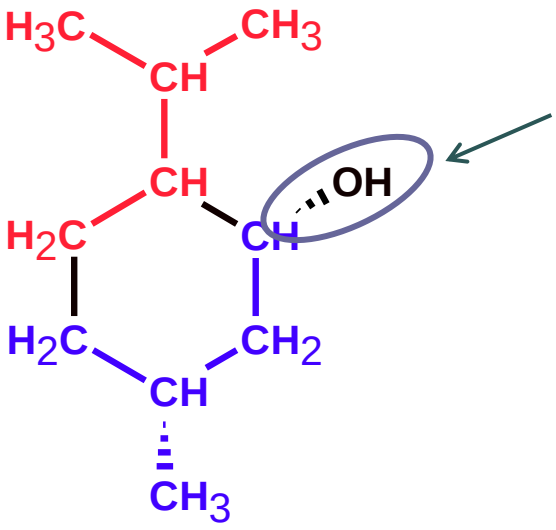
Limonene – a cyclic terpene



Limonene

(skin of citrus fruits)

Menthol – a cyclic terpenoid

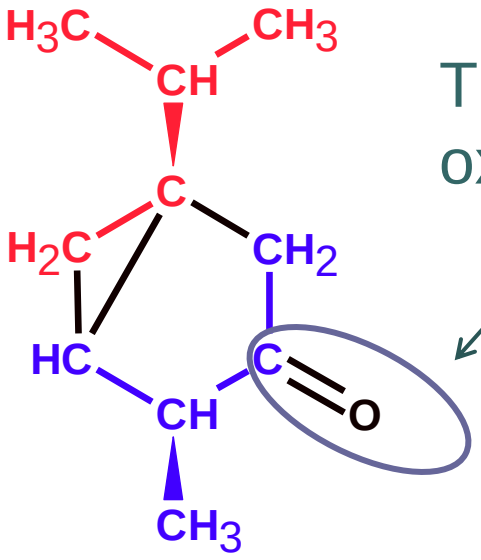


This terpene has been oxidised to a terpenoid

Menthol

(peppermint)

Absinthe – a cyclic terpenoid

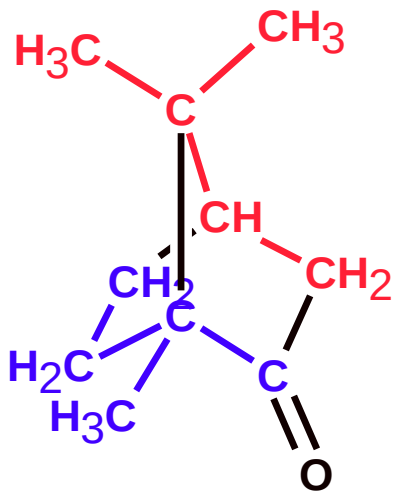


This terpene has been oxidised to a terpenoid

Thujone

(Absinthe)

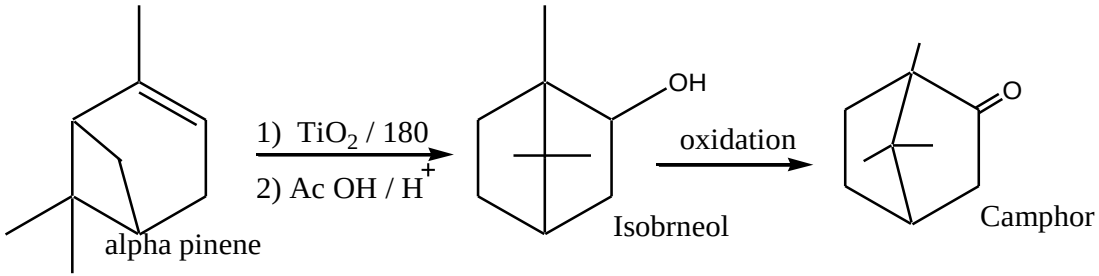
Camphor – a cyclic terpenoid



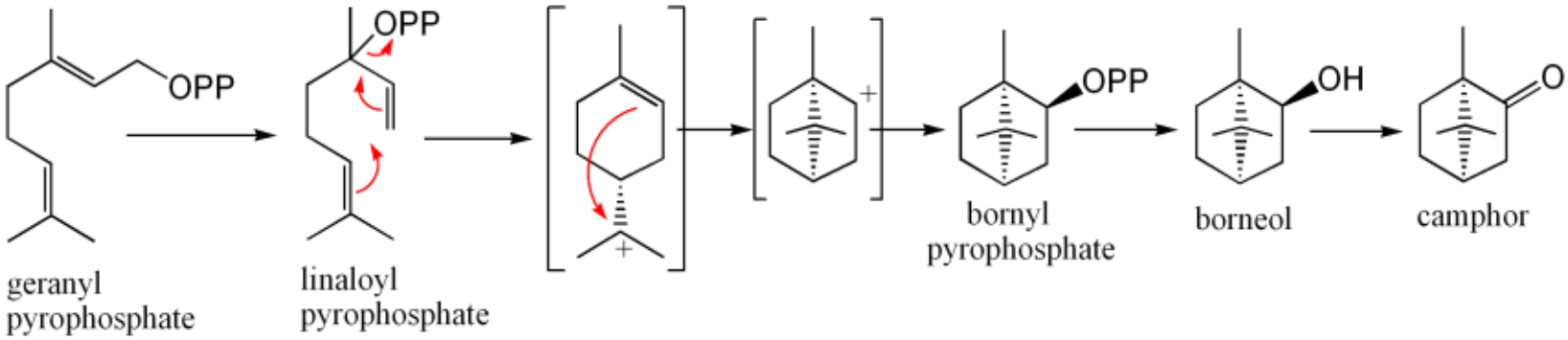
Camphor

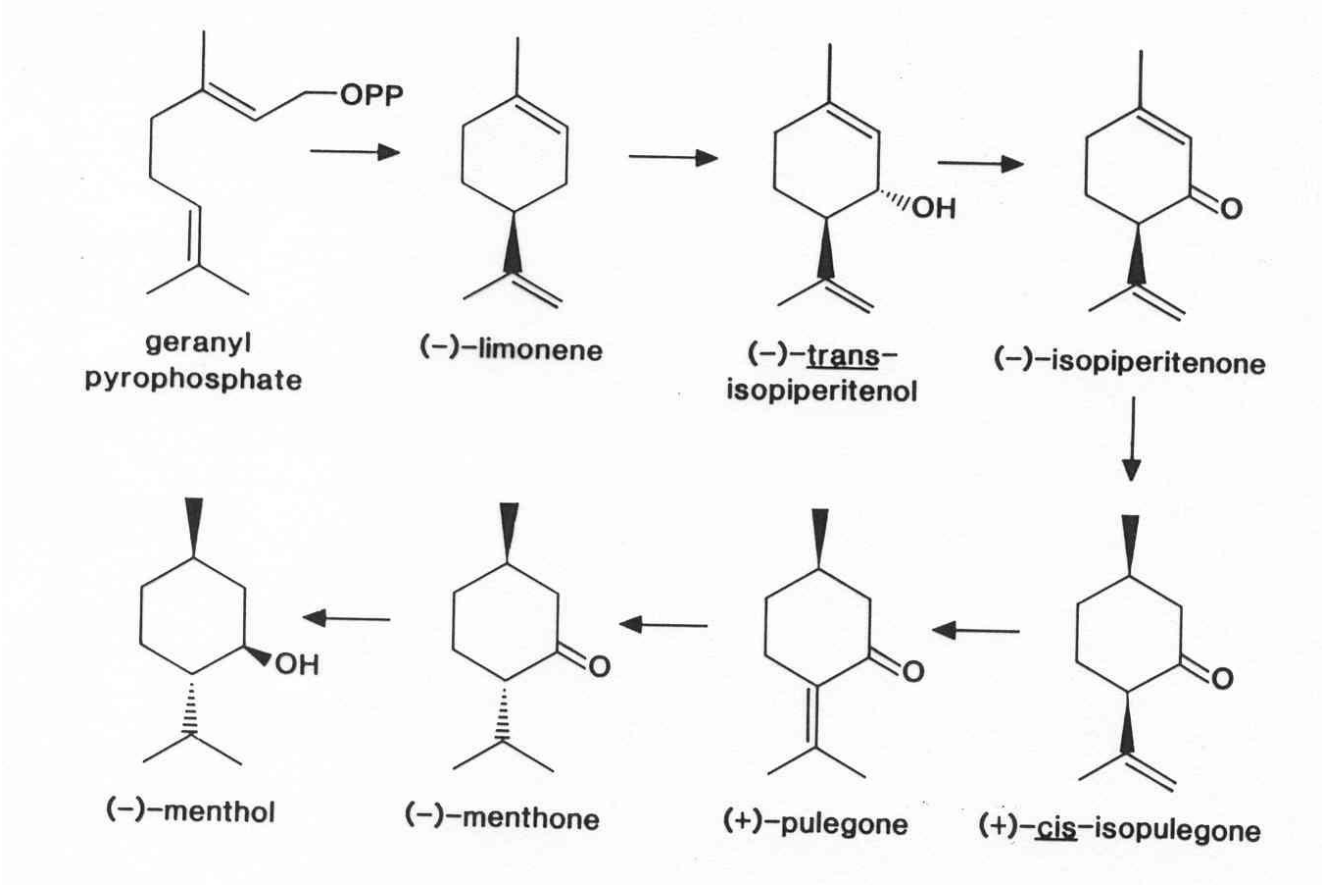
(Camphor tree)

Prepared in the laboratory



Biosynthesis



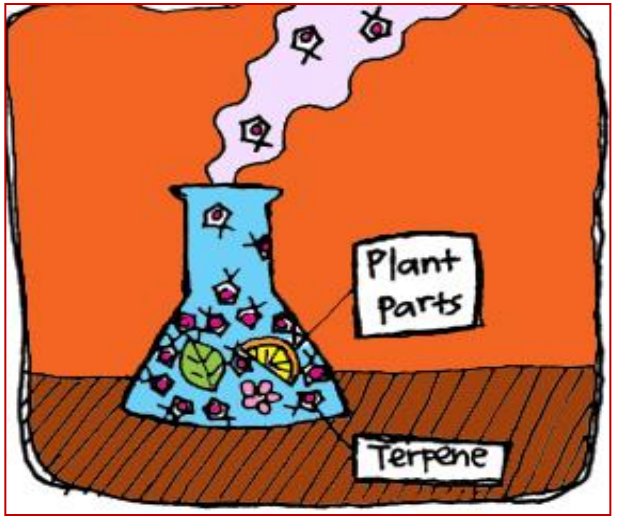

OPP
OH
O
O
O
OH
O
geranyl pyrophosphate
(–)–limonene
(–)–trans–isopiperitenol
(–)–isopiperitenone
(+)–cis–isopulegone
(+)–pulegone
(–)–menthone
(–)–menthol

Monoterpenes properties

Monoterpenes are found in the essential oils extracted from many plants.

The monoterpenes are have various pharmacological properties including:

- Antifungal .
- Antibacterial .
- Antioxidant.
- Anticancer .



Monoterpenes uses:

monoterpenes are involved in the production of:

- pharmaceuticals
- flavors/fragrances ,
- the agriculture,
- cosmetic,
- and food industries,
- antiseptics .

Questions

- Which unit makes up every terpene?
- How many carbons are there in an isoprene unit?
- What is the systematic name for isoprene?
- What is an oxidised terpene known as?

Answers

- Which unit makes up every terpene?

  Isoprene unit

- How many carbons there are in an isoprene unit?

  Five

- What is the systematic name for isoprene?

  2-methylbuta-1,3-diene

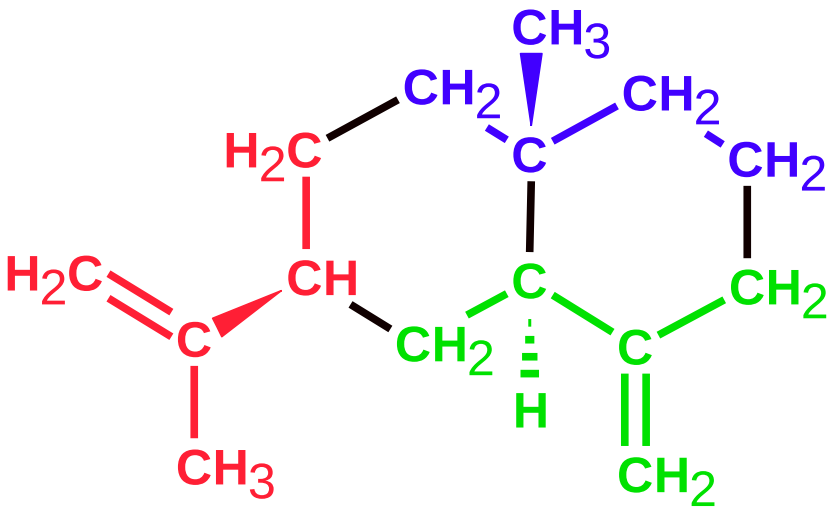
- What is an oxidised terpene known as?

  Terpenoid

Summary

- Terpenes are unsaturated compounds formed by joining together isoprene units.
- Terpenes are components in a wide variety of fruit and floral flavours and aromas.
- Terpenes can be oxidised within plants to produce the compounds responsible for the distinctive aroma of spices.

α-Selinene – a cyclic terpene

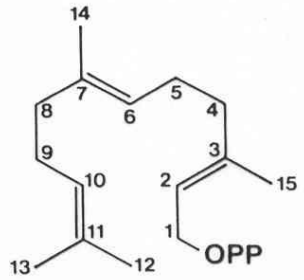


α-Selinene

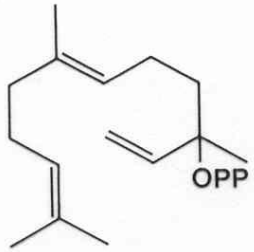
3 isoprene units

15 carbon atoms

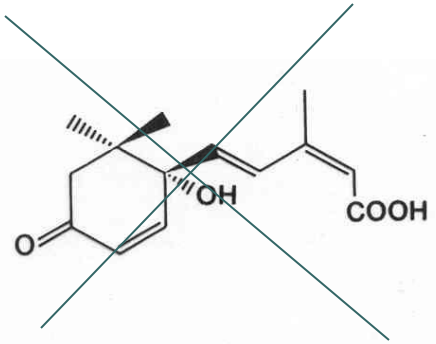
Sesquiterpenes



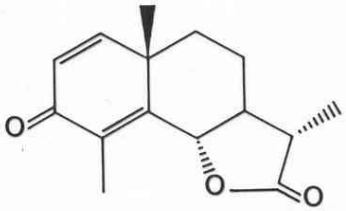
FPP



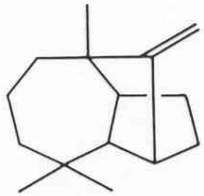
nerolidyl
pyrophosphate



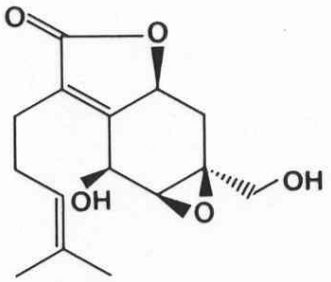
abscisic acid



α–santonin
(a sesquiterpene lactone)

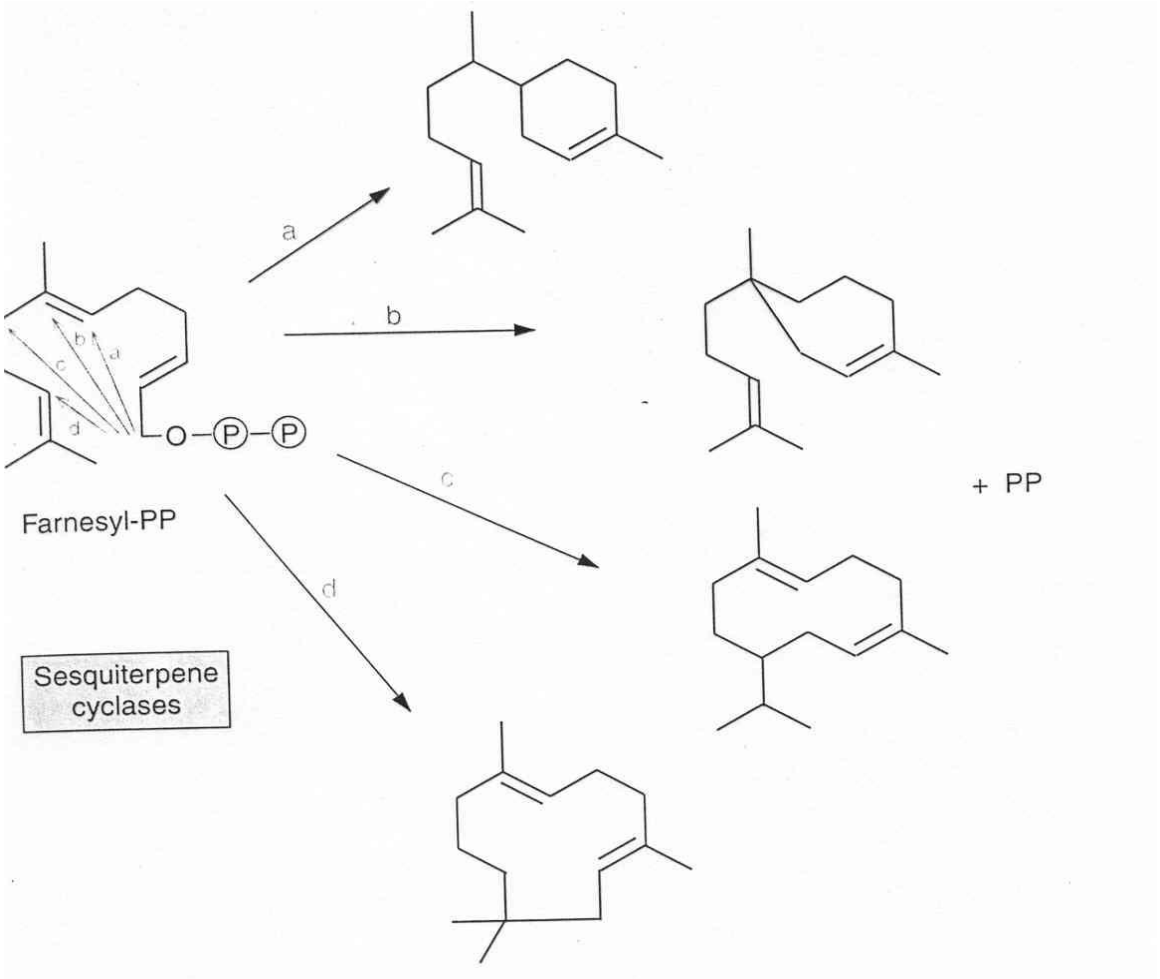


longifolene

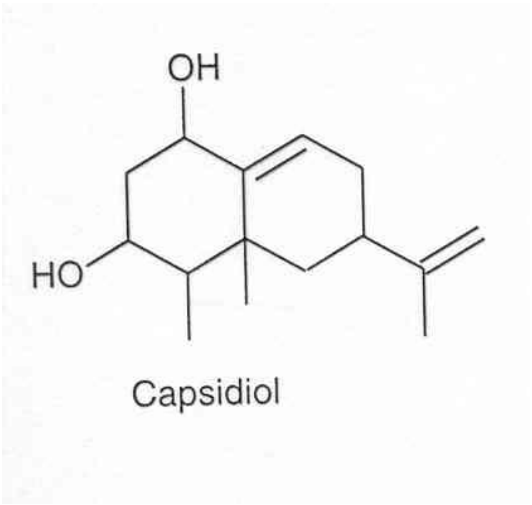


paniculide B

Sesquiterpenes

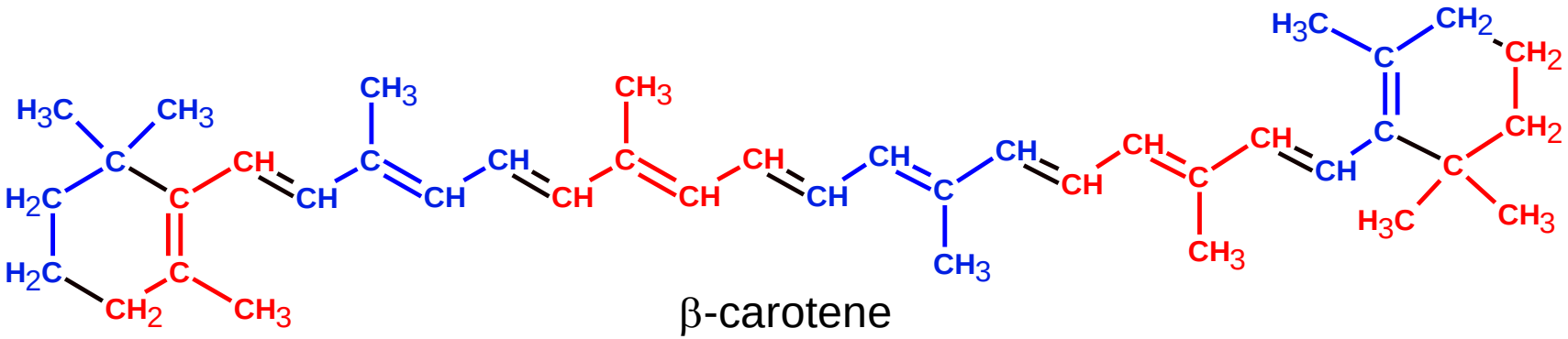


Sesquiterpenes



Capsidiol

β-carotene – a linear terpene



β-carotene

8 isoprene units

40 carbon atoms