

Scentsational Flowers

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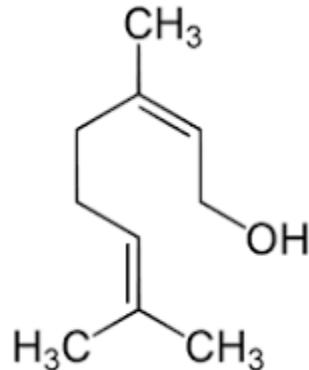
Presentation Overview

- What is *scent* and how is it perceived?
- How and why do flowers make scent?
- Why do we, as humans, care?

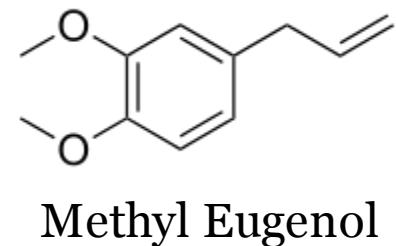


What is scent?

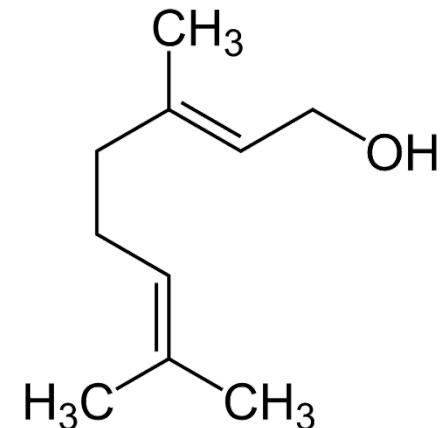
- A **complex mixture** of volatile compounds, which is produced by a flower (other parts of the plant can also produce volatile compounds, e.g. fruits, leaves, roots...)



Nerol



Methyl Eugenol

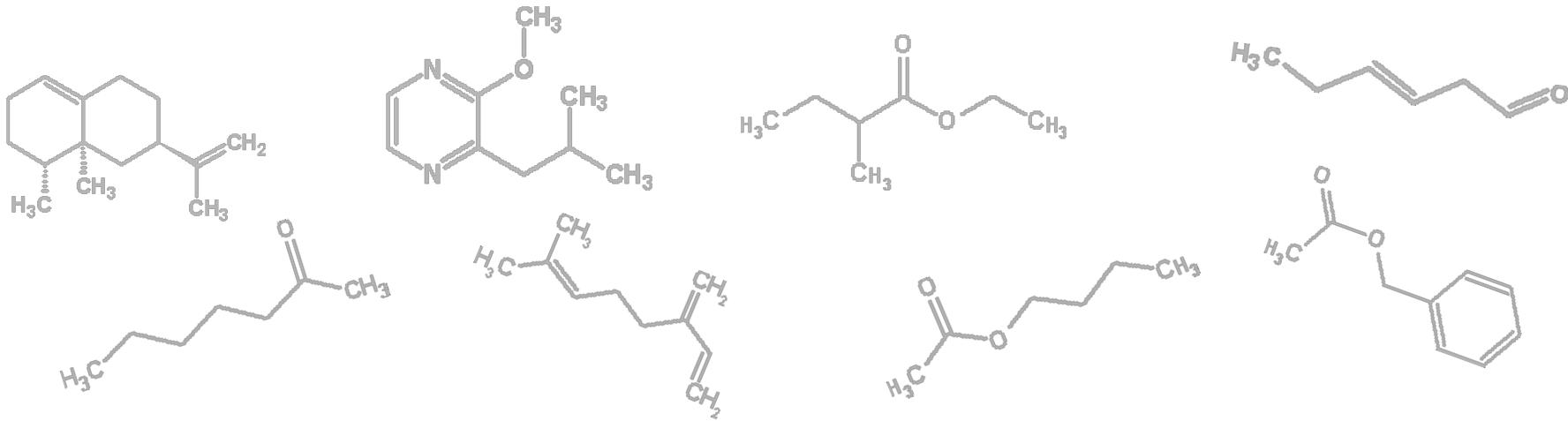


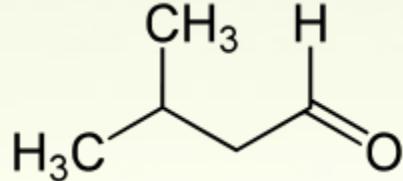
Geraniol

What is a volatile compound?

- A small molecule which has a high tendency to evaporate.
- Volatiles are naturally made by plants (flowers, fruits, vegetables, herbs...) and pretty much all other living organisms.

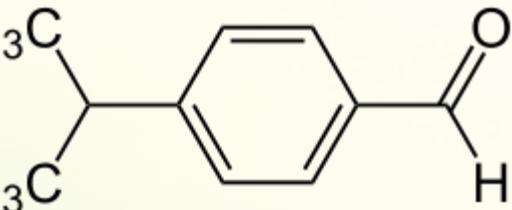
They can also be produced artificially (think Fragrance and Flavor Industries).





Aldehydes

Isovaleraldehyde



Cuminaldehyde



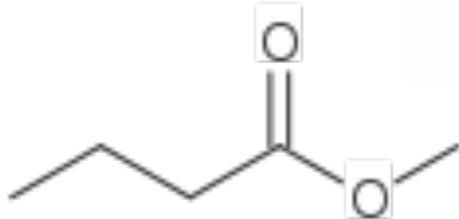
Hexanal



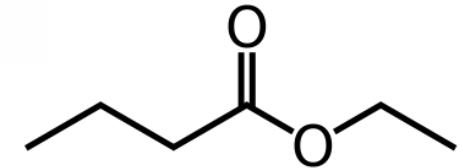
Esters

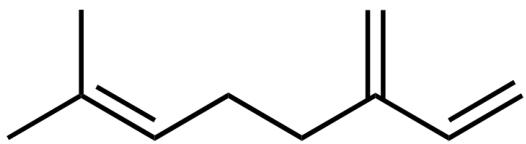


Methyl butarate

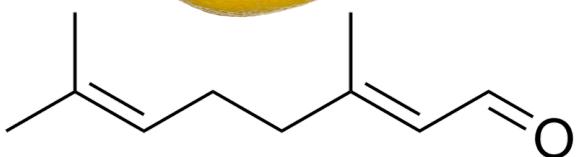
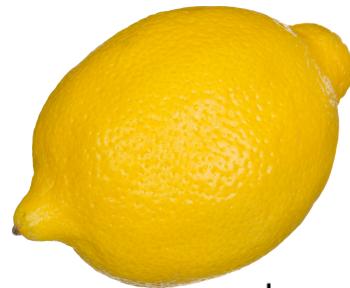


Ethyl butarate

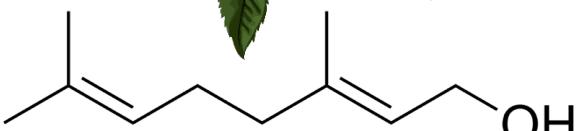




Myrcene

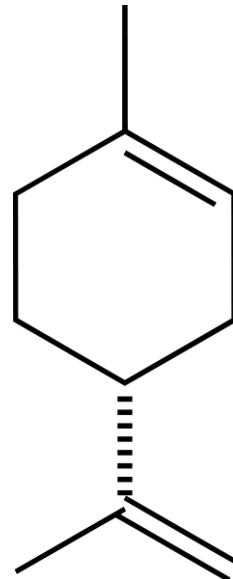


Geranial

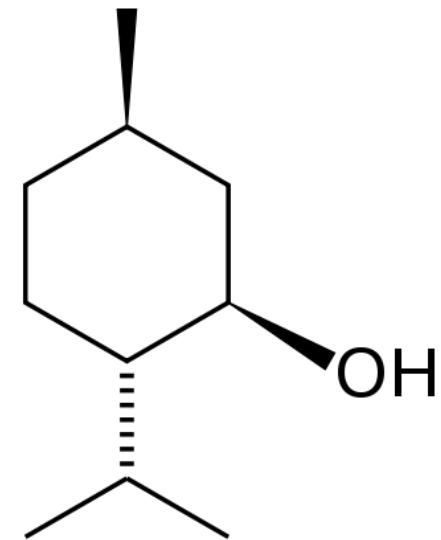


Geraniol

Terpenes

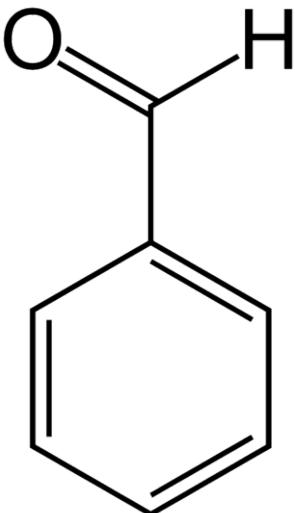


Limonene

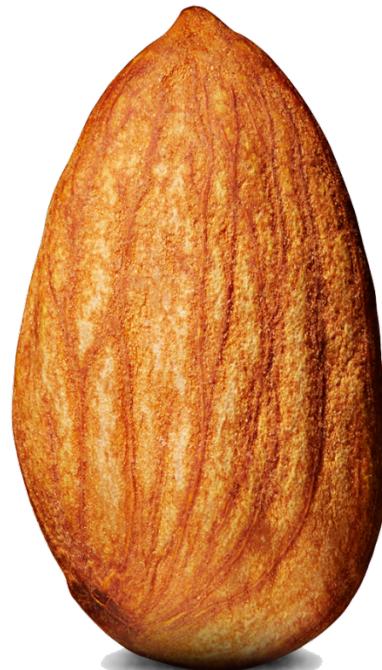


Menthol

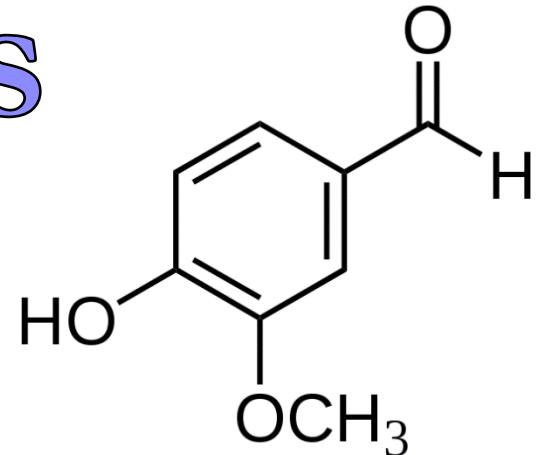




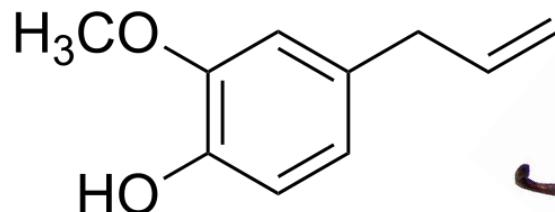
Benzaldehyde



Aromatics



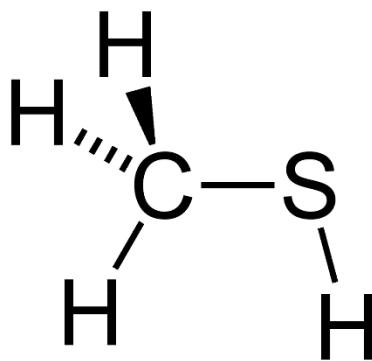
Vanillin



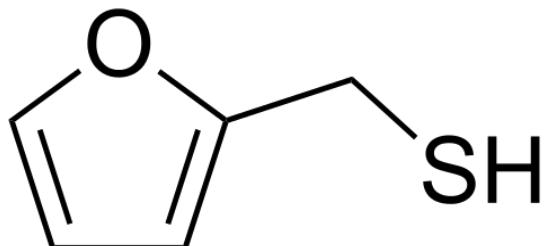
Eugenol



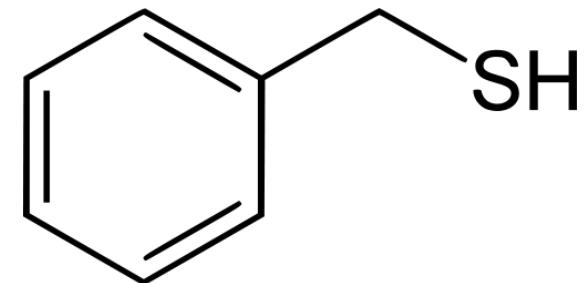
Thiols



Methanethiol

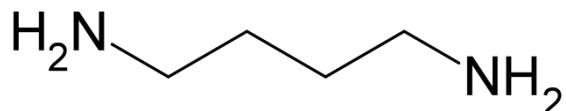


2-Furanmethanethiol

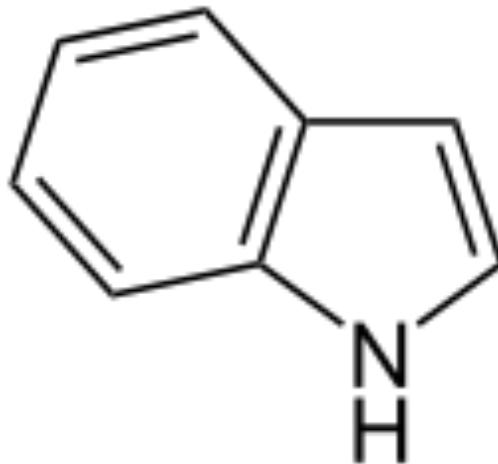


Benzenemethanethiol

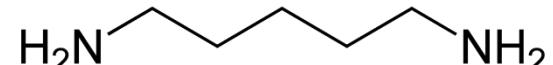
Amines - Indole



Putrescine



Fecal



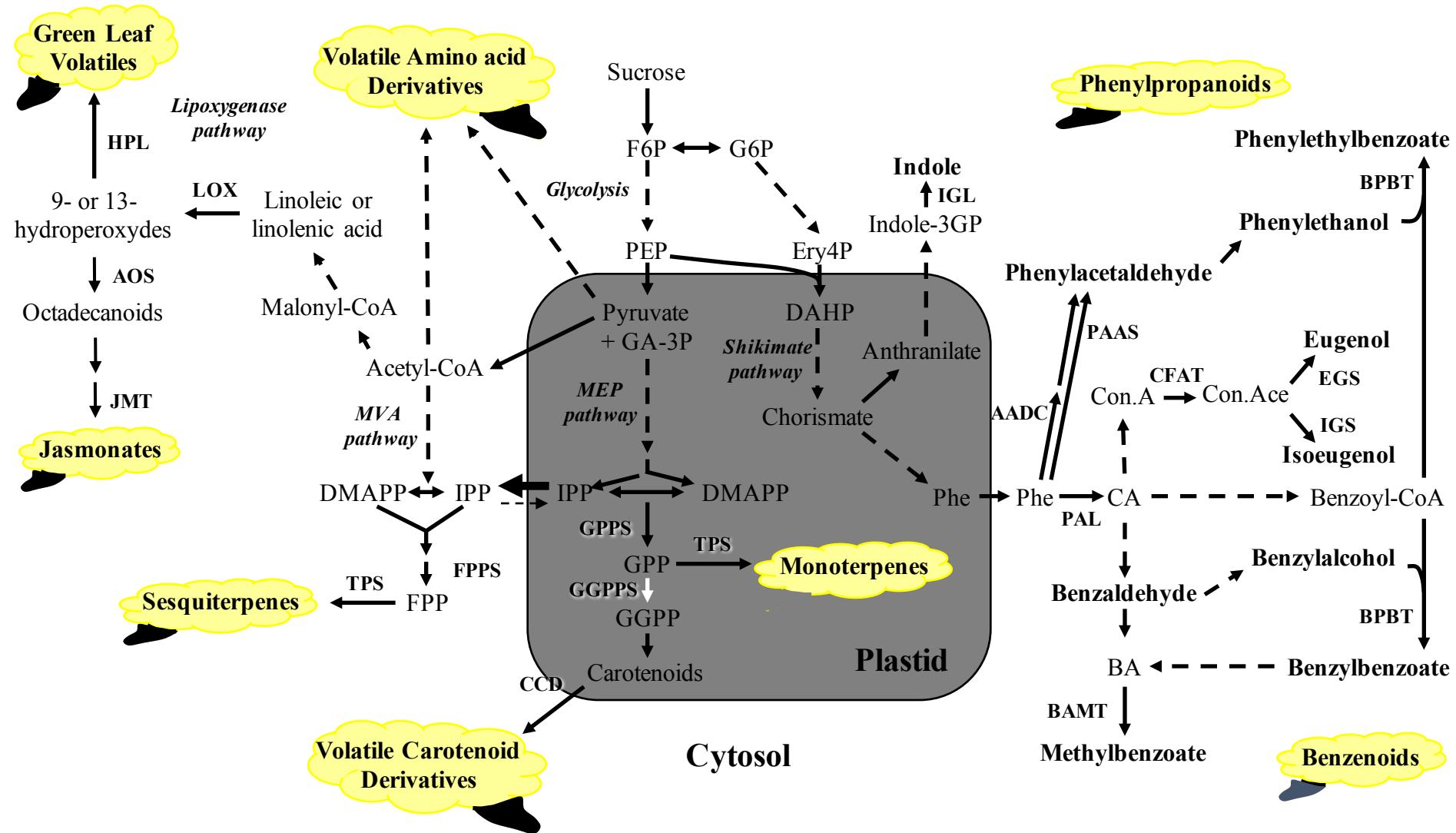
Cadaverine

Floral



Scent production in flowers

Many, many biochemical reactions converting non-volatile molecules to volatile ones



How many volatiles are there?

- Scientists have identified more than 2,000 different volatile compounds in nature (plants). There are probably more...
- Many more volatiles (not found in nature) have been artificially synthesized in chemical factories (flavor/fragrance industry).



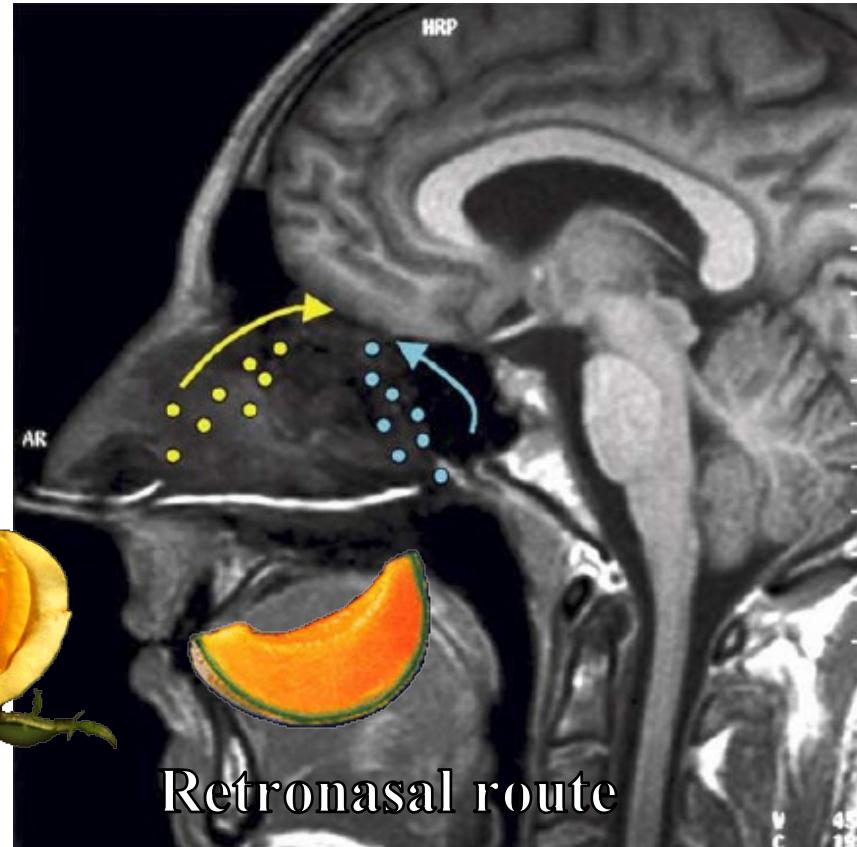
Dr. Roman Kaiser, Givaudan (Switzerland)

The “canopy raft”

Perception of scent

Scent (aroma/fragrance/odor/smell) is the sensation perceived when volatile compounds are sniffed through the nose.

Orthonasal
route



Retronasal route

Olfaction 101

- Humans have millions of odor receptors in the nose.
- Odor receptors are coded by a gene family which comprises about 1,000 genes (only ~350 are active). This gene family represents about 1% of all our genes, making it the largest gene family in humans.
- Genes for odor receptors were discovered by Dr. Linda Buck and Dr. Richard Axel in 1991. These scientists were awarded the Nobel Prize of Medicine in 2004 for their discovery.



Linda Buck



Richard Axel

Time to test your nose

Scent and Sensory Perception

- A natural scent is typically made up of tens or sometimes hundreds of different volatile compounds.
- A mixture of volatile compounds is not perceived as “the sum of its parts”: volatiles interact to create a unique, distinct, aroma.

Question 1: Yellow

Question 2: Red

Question 3: Blue

Question 4: Black

Question 5: Green

Choose the option that best describes what you smell. Remember to waft!

- A: Woody, Earthy, or Grassy
- B: Fruity, Flowery, or Sweet
- C: Minty, Spicy, or Fresh
- D: Other
- E: I didn't smell anything

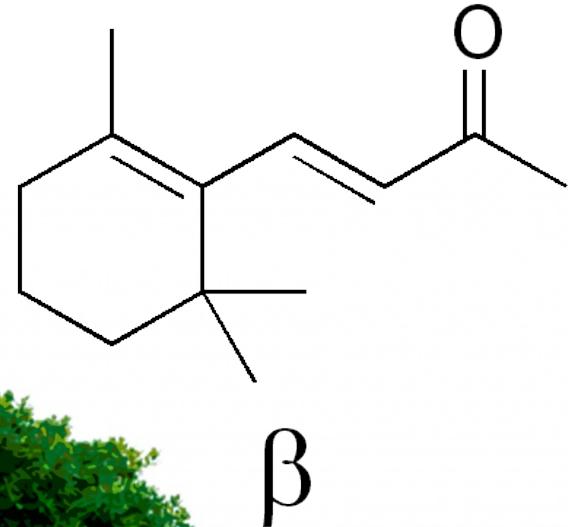
And now, the results

β -ionone

Woody

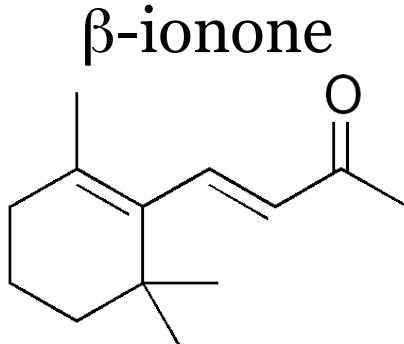
Floral

Sweet



Sensory Perception of Aroma

- Non-character impact compounds



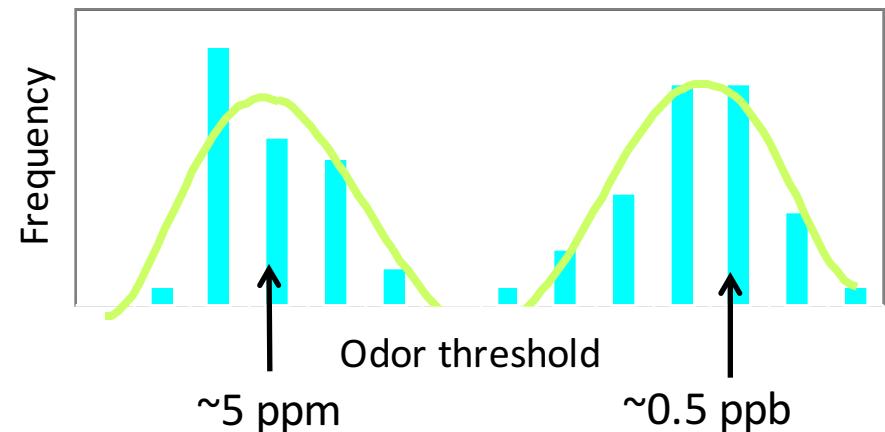
β

Floral, woody, sweet, fruity,
berry, tropical, beeswax



Partial/Specific Anosmia

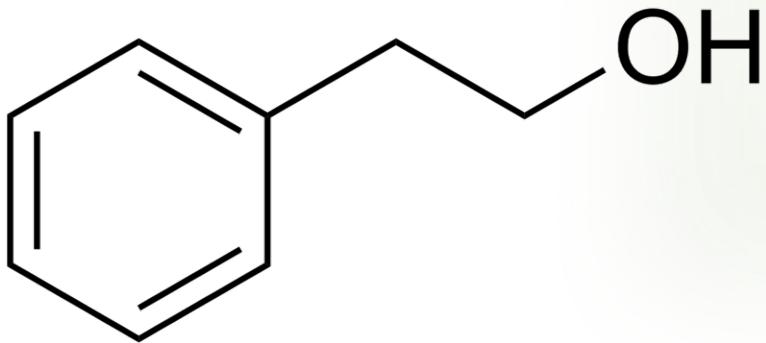
β -ionone



Phenylethanol

Floral

Rose

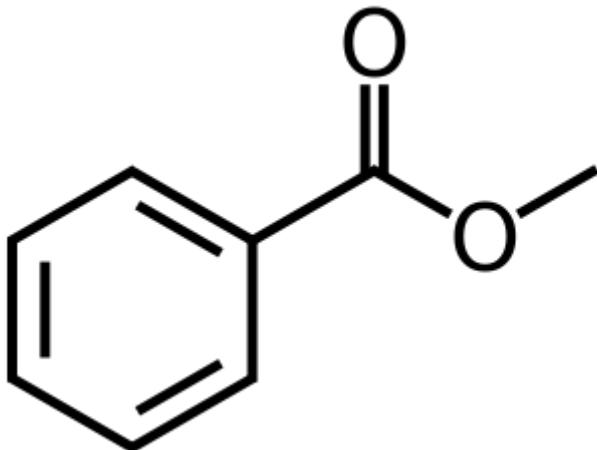


Methyl Benzoate

Wintergreen

Almond

Floral

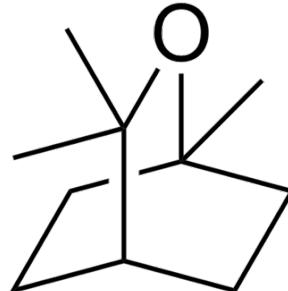
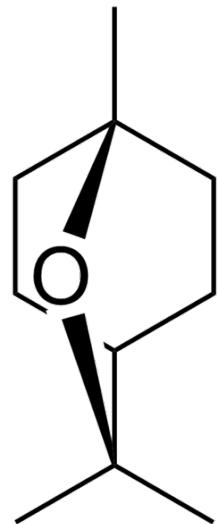


Eucalyptol

Eucalyptus

Fresh

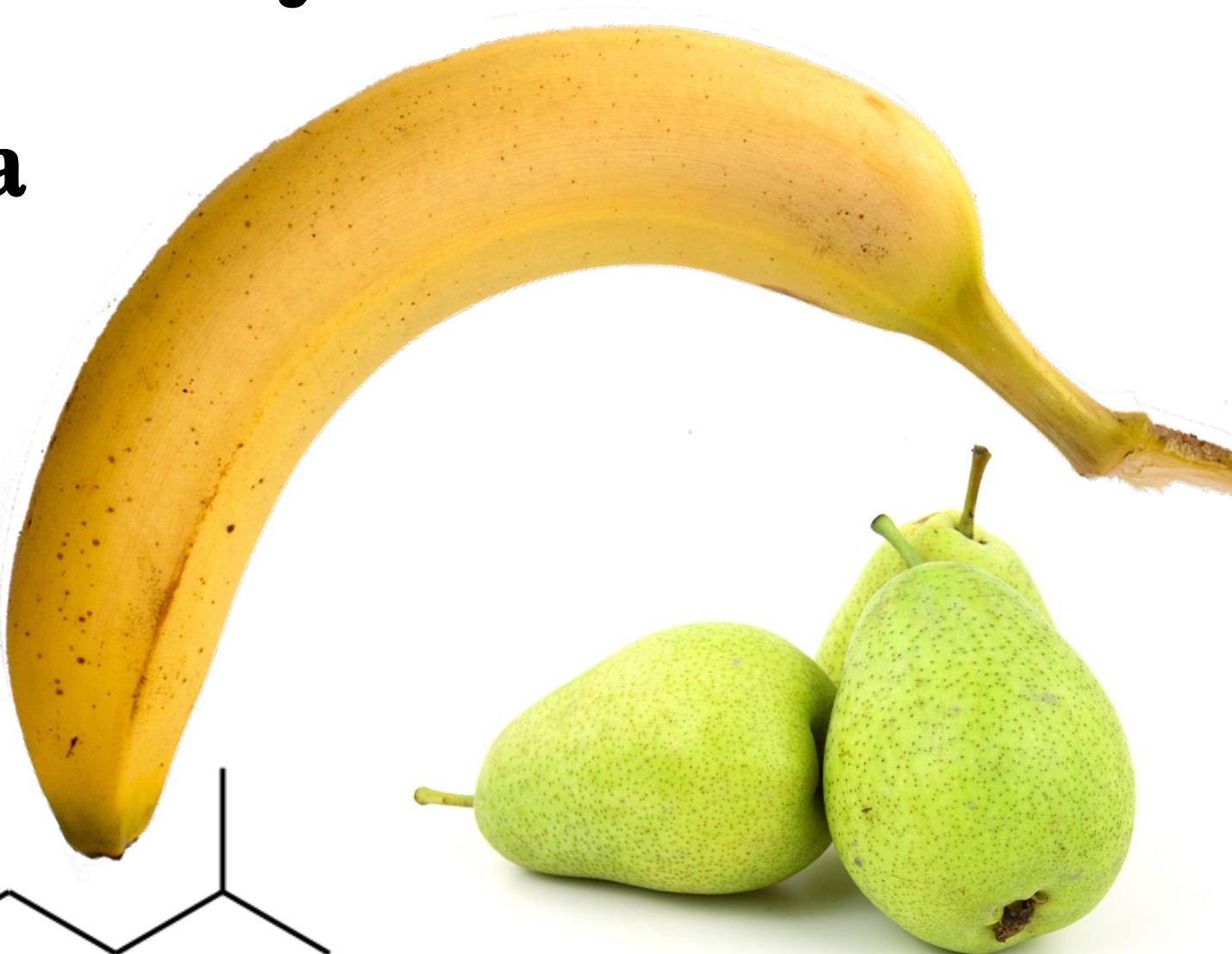
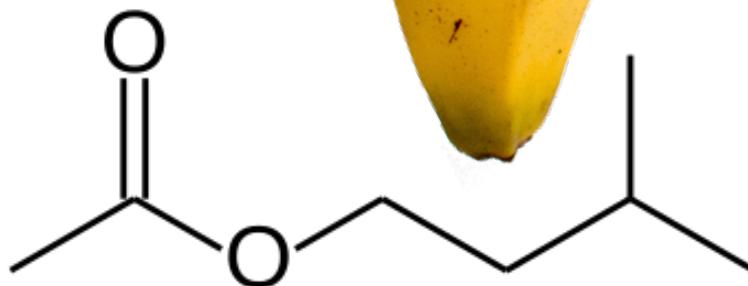
Minty



Isoamyl Acetate

Banana

Pear



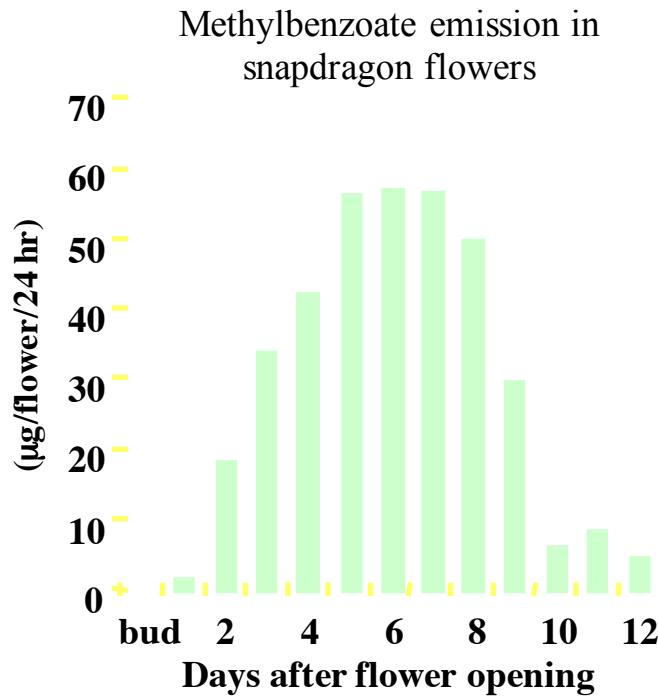
Presentation Overview

- What is *scent* and how is it perceived?
- How and why do flowers make scent?
- Why do we, as humans, care?



Scent is important for Plant Reproduction

Most flowering plants rely on animals (insects, birds...) for their pollination.



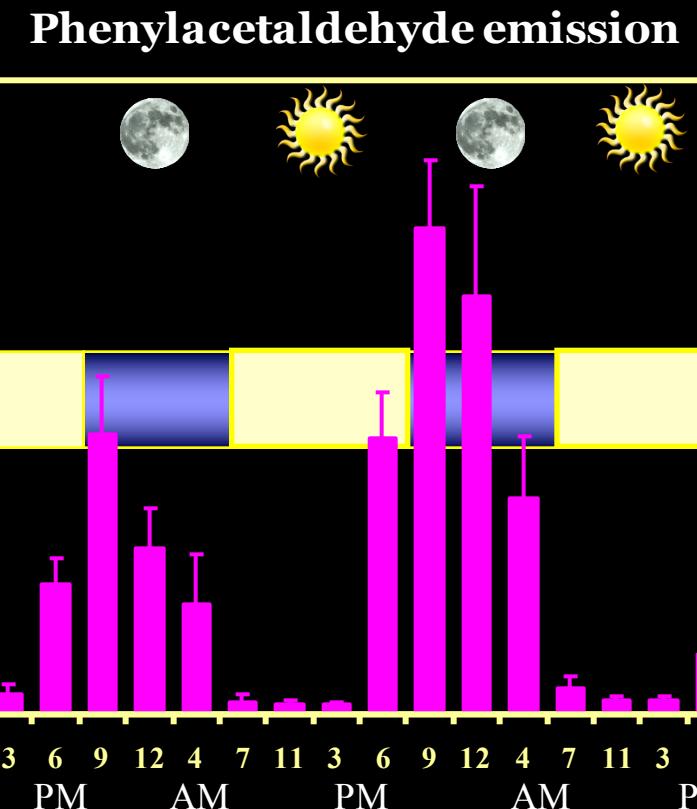
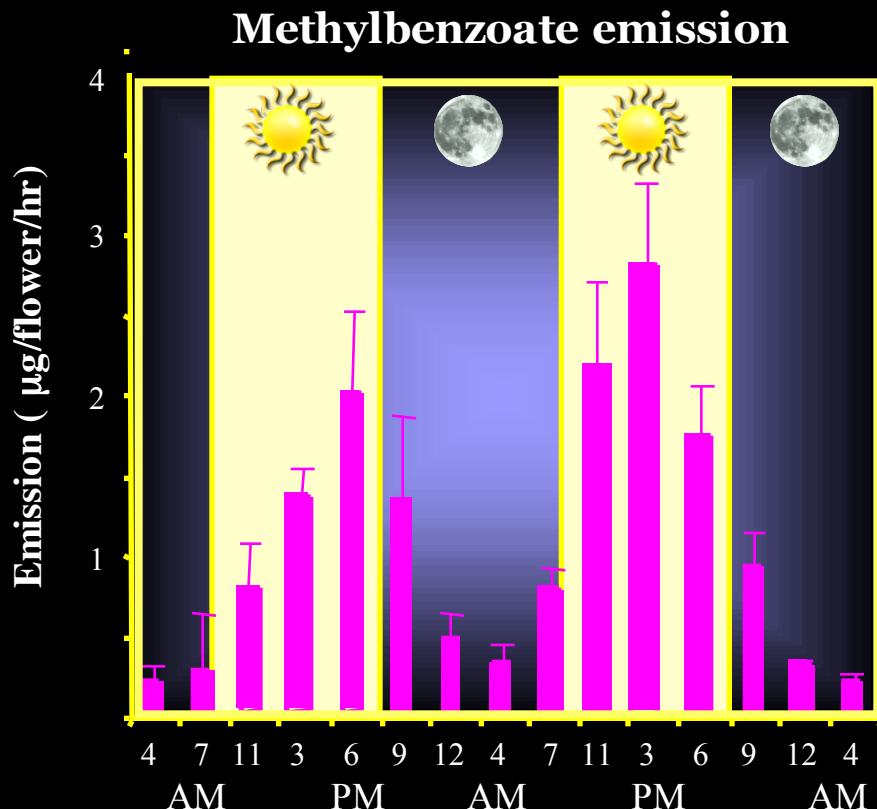
Scent is important for Plant Reproduction

Plants “advertise” their presence to pollinators from a distance by providing:

- Visual cues (color and shape)
- Chemical cues (odor = volatiles) which are especially important for species pollinated at night



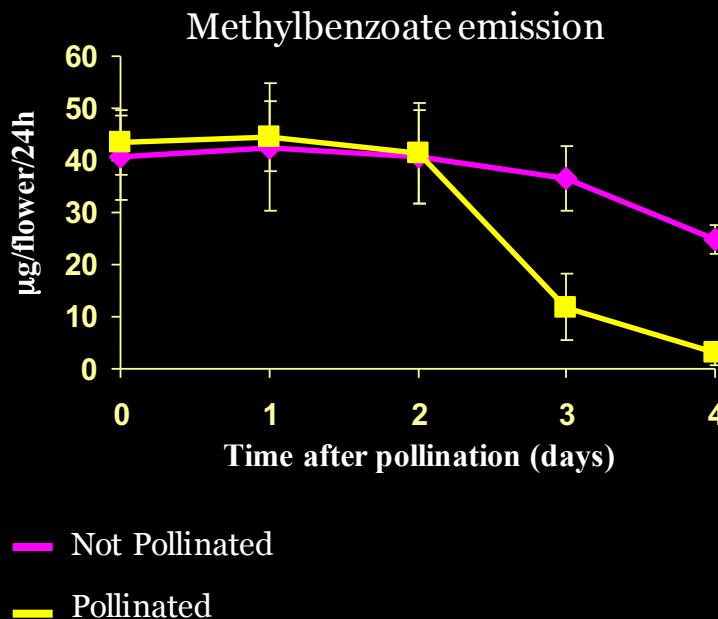
Scent is important for Plant Reproduction



Flowers generally emit higher levels of volatiles when their pollinators are active

Scent is important for Plant Reproduction

- Some flowers stop producing scent after they are pollinated, as a way to direct pollinators to yet unpollinated flowers.



Scent is important for Plant Reproduction

Visitors feed on flower nectar or pollen

Pollen sticks to their bodies and gets transported from flower to flower

Benefit for animal: food

Benefit for plant: successful reproduction

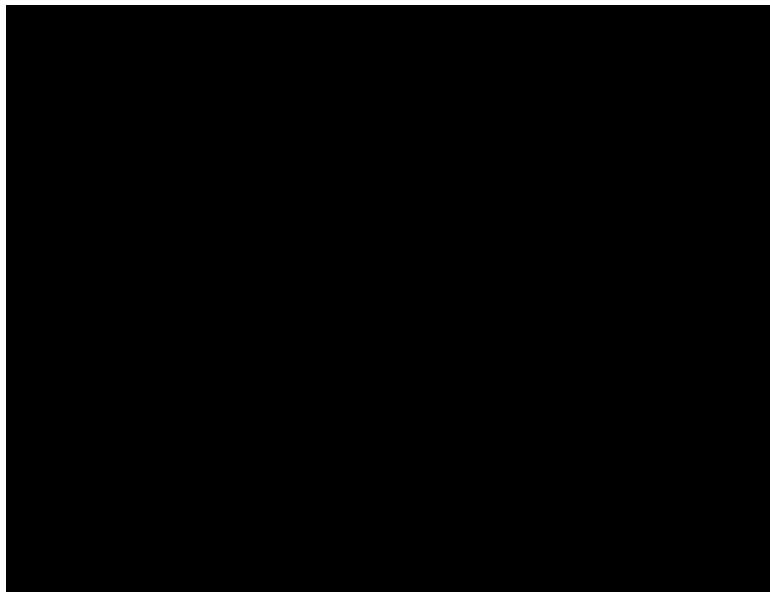


Not Always “Fair Game”...

- Some orchids of the genus *Ophrys* attract their pollinators, solitary bees of the genus *Andrena*, by deceptive visual, tactile and chemical signals.
- These orchids emit volatiles which are identical to the female bee’s sex pheromones.



Not Always “Fair Game”...



Ophrys bilunulata visited by *Andrena flavipes*
Movie by Nico Vereecken

Watch the movie again at: www.youtube.com/watch?v=FbmlpJJRGeI

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Scents have a significant economic importance in...



- **perfume** and **cosmetic** industries



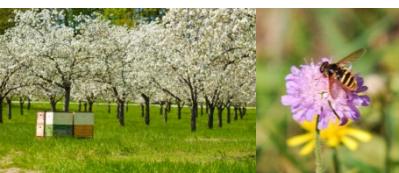
- **food** industry (natural and artificial aromas)



- **floriculture** industry (mostly cut flowers)



- **medicine** (pharmaceutical industry)



- **agriculture** (pollination and plant defense)

Scents are important for us

- Provide information about surrounding environment



- Source of pleasure in foods and fragrances



- Medicinal properties (antibacterial, antifungal, anticancer, cardiovascular disease protection, anti-viral, mood altering properties...)

Searching for the lost scent...

... or “why doesn’t this beautiful bouquet of roses smell like anything?”



Questions?

- Contact information:

Nick Claypool, nclaypool@ucdavis.edu

- Classes related to this topic:

Winter – MCB 126 (Plant Biochemistry)

Spring – PLS 173 (Molecular and Cellular Aspects of Postharvest Biology)