



You're at... Mary Wattis Brown Garden

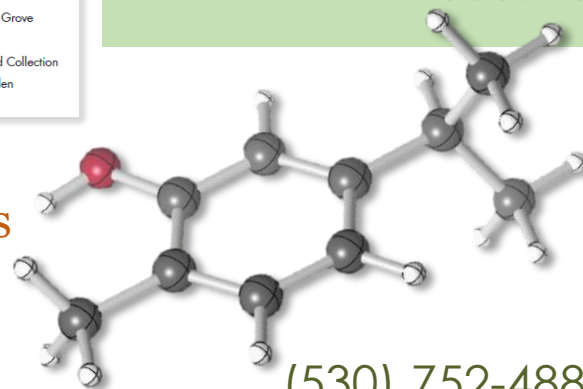
One of the 4 *“Walking in the Woods with Chemistry”* sites
(Mary Wattis Brown Garden, Conifer Collection,
Mediterranean Collection, and Storer Garden)



This section of the exhibit features 5 of the 13 selected compounds. We hope you will enjoy reading about these molecules and get to know some of the related science research.

Attached to the signs are also the 3D models of the molecules (the raised dots on the 3D models are Braille shorthand).

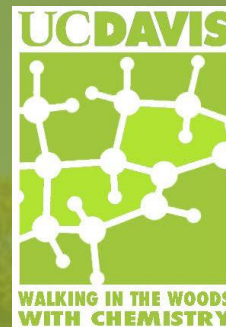
For the molecule pictures on the signs, black spheres represent carbons; white spheres are hydrogens, and red spheres are oxygens.



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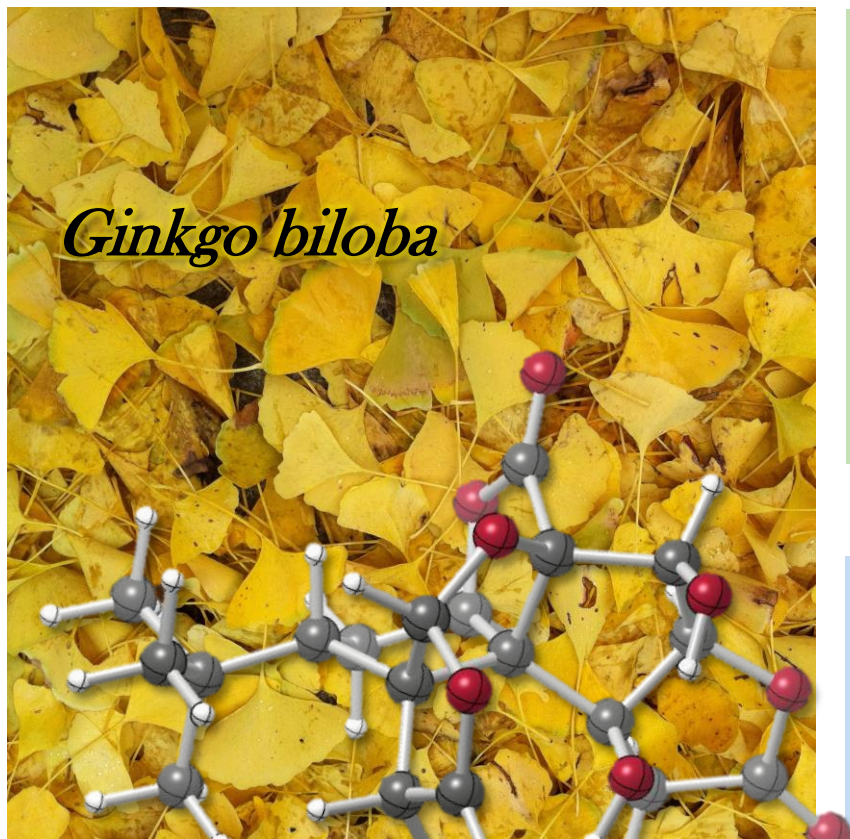


ARBORETUM AND PUBLIC GARDEN



Say Hi to... Ginkgolide B!

A key component of ginkgo biloba extract



Ginkgo biloba

In nature

Ginkgolide B, and other ginkgolides, are isolated from the leaves of *Ginkgo biloba*, one of the oldest species of trees on earth. Its leaf extracts are used extensively in traditional Chinese medicine.

Current research

Researchers at MIT recently combined advanced protein and metabolic engineering to increase the level of biotechnologically produced levopimaradiene, a ginkgolide precursor, by 2,600 fold.

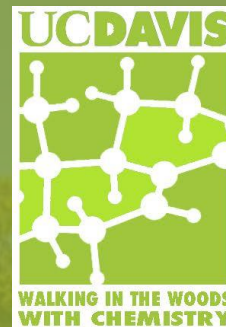
Clinical uses

Ginkgolide B is purported to have neuroprotective effects and finds use in treating cardiovascular ailments and migraines.

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Say Hi to... Abietic Acid!

The major ingredient of pine resin and what sticks to your hands when decorating the Christmas tree



Natural tree defense

When stem-boring insects attack the tree, pine resin flows out of the wound and traps the insect. Abietic acid also acts as an antibiotic, protecting the tree against invading fungi and bacteria.



Research at UCD

The Zerbe and Tantillo groups, and researchers across the world, study the biology and chemistry of this fascinating terpene compound to better understand its formation, protective properties, and industrial uses.

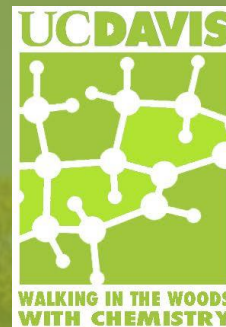
Industrial uses

As a byproduct of the wood and paper industry, abietic acid is used in your printer ink, lubricants, paint thinner, and linoleum.

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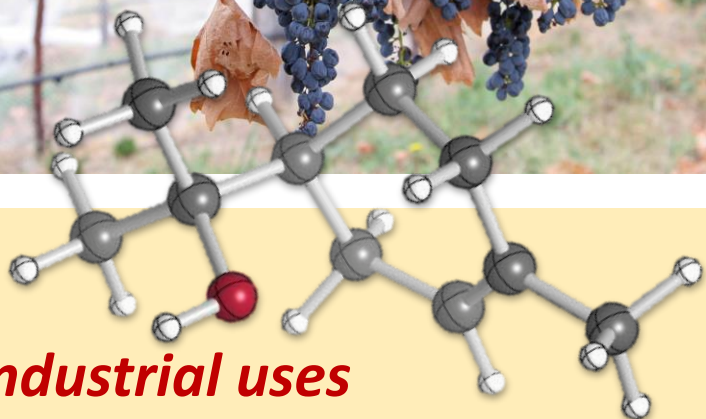


Say Hi to... α -Terpineol!

*The flavor of your wine
and the scent of your soap and perfume*



Vitis species



Industrial uses

Having an odor reminiscent of lilac, α -terpineol is a popular ingredient in perfumes, soaps, paints, disinfectants and medicines.

Natural attractant

As a major compound defining the scent and flavor of many plants, such as grape wine, α -terpineol has captivated humans for centuries. It's natural role is likely the attraction of pollinators.

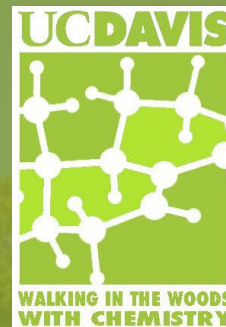
Current research

At UCD, the Tantillo group has computationally modeled the reactions by which α -terpineol is produced in nature. Viticulture research at UCD showed that α -terpineol confers part of the floral aroma of Viognier, Muscat, and Gewuerztraminer wines.

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Say Hi to... Communic acid!

Naturally produced in juniper trees and an ingredient in amber, gin and perfume



Juniperus sabina

In nature

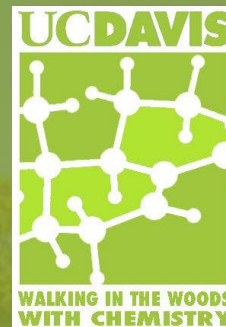
Communic acid is an abundant terpene in fruits of *Juniperus* trees, which are also used in gin manufacturing. Polymerization of communic acid is part of the formation of natural amber.

Current research

Due to its many industrial uses, researchers in Europe, Japan and the USA have developed elegant chemical synthesis approaches to produce pharmaceuticals and fragrances from communic acid.

Uses

Communic acid is a versatile bioproduct with therapeutic (antimicrobial, anti-cancer, anti-inflammatory) properties, and use as a starting material for the synthesis of fine chemicals, such as ambrox, an important perfume ingredient.



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Say Hi to... Grindelic acid!

A sticky terpene compound from California that might help treating Alzheimer's disease

Gumweed (Grindelia)



In nature

Gumweed (*Grindelia*) is a native Californian, common along the coastal regions. It is recognizable by its sticky resin, mostly made from grindelic acid that the plant likely uses as a defensive wall.

Research at UCD

Students in the Zerbe group recently identified the unique precursor of grindelic acid and have now set out to discover the remaining building blocks for its production in the plant.

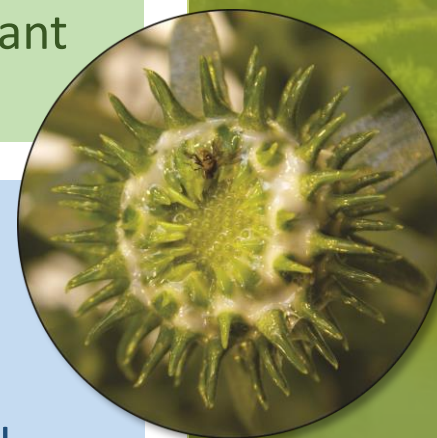
Industrial uses

Much like pine resin, grindelic acid can be used to produce polymers, but, more importantly, recent research unraveled its potential use in the treatment of Alzheimer's disease.

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You're at... Conifer Collection

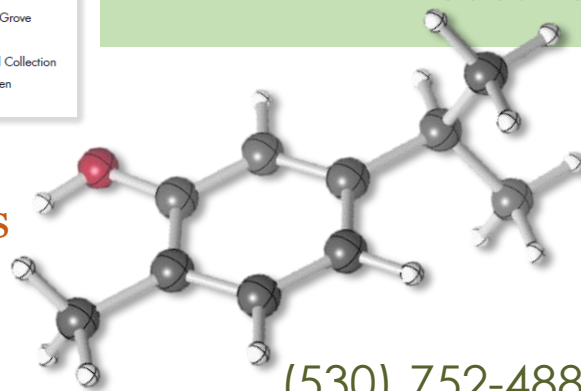
One of the 4 *“Walking in the Woods with Chemistry”* sites
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This section of the exhibit features 3 of the 13 selected compounds. We hope you will enjoy reading about these molecules and get to know some of the related science research.

Attached to the signs are also the 3D models of the molecules (the raised dots on the 3D models are Braille shorthand).

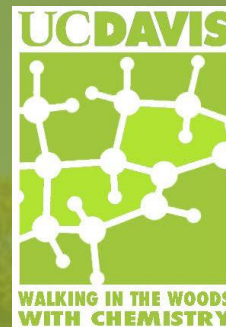
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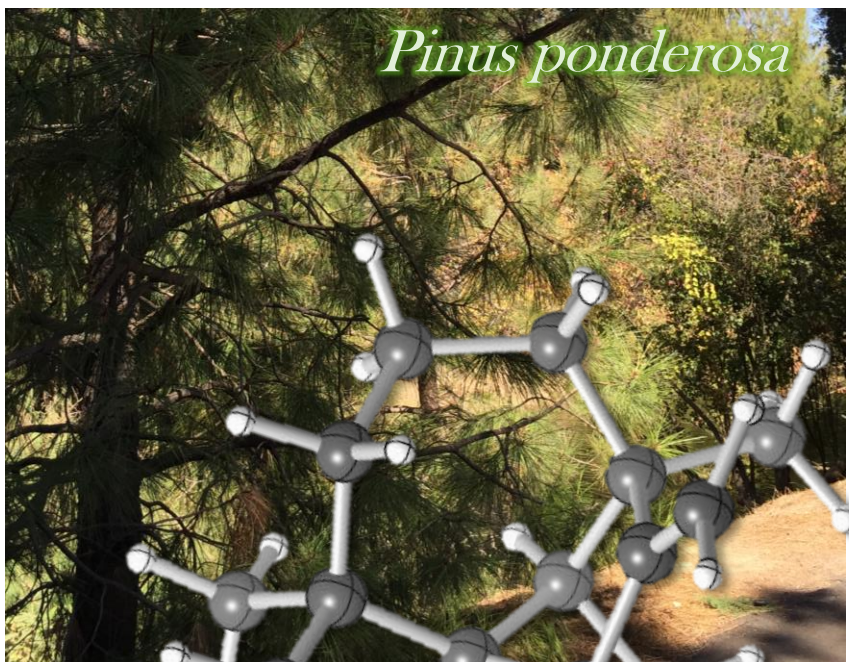


ARBORETUM AND PUBLIC GARDEN



Say Hi to... Longifolene!

A component of pine resin that trees use as a wall of defense against invading bacteria, fungi and insects



Pinus ponderosa

Industrial uses

Longifolene is used in fine chemical synthesis. It also contributes to the unique flavor of the popular lapsang souchong tea made with a pine smoking procedure.

Natural tree defense

Longifolene is a major component of pine resin. Its antimicrobial properties protect the tree against fungal and bacterial pests that invade the tree with the help of stem boring insects.



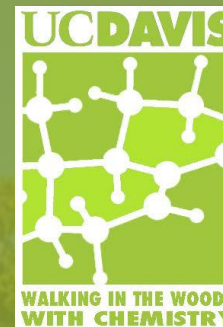
Research at UCD

The Tantillo group has used computational chemistry to study the mechanism of longifolene formation, while the Zerbe group investigated the enzymatic reactions relevant for forming this compound in pine trees.

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Say Hi to... Taxadiene!

*The critical intermediate in the biosynthesis of Taxol,
one of the most important anti-cancer drugs*



Taxus brevifolia

Natural tree defense

Taxadiene, a precursor of Taxol, is only found in yew trees. Taxol is very toxic, interrupting cell division, and likely acts as a feeding deterrent. Taxol's toxicity is also exploited for its medicinal use.

Current research

Researchers worldwide investigate the clinical use of taxol and its formation in nature to improve the large-scale production of this important drug. At UCD, the Tantillo group has computationally modeled its biosynthesis.

Industrial uses

Taxol is one of the most important chemotherapeutic drugs to treat various cancer types. It is currently produced in the world's largest cell culture system, worth several billion dollars annually.

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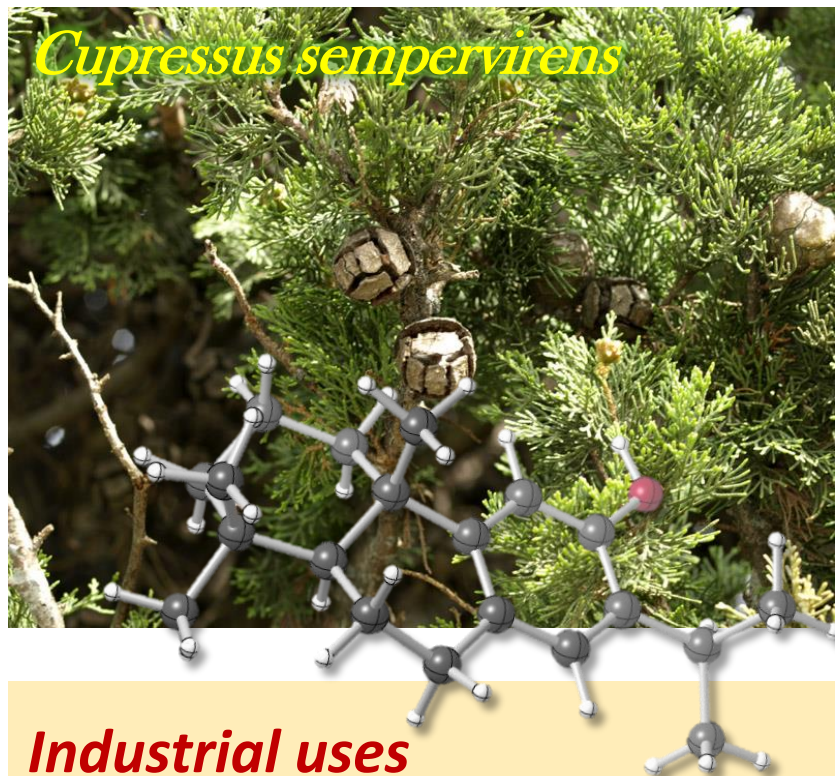


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Say Hi to... Ferruginol!

A potentially powerful drug, naturally occurring in Cupressus sempervirens and other plants



Industrial uses

Ferruginol has attracted much interest for its antibacterial and potential anticancer activity. It is also the precursor to tanshinones, prominent in traditional Chinese medicines for treating inflammatory and cardiovascular ailments.

Natural tree defense

Ferruginol is a chemical that occurs in many different plant species. Although its biological function is not clear, its antibacterial and antiparasitic properties suggest a role in plant defense.

Current research

Researchers in the USA and Europe recently identified the genes and enzymes involved in ferruginol biosynthesis, paving the way for the large-scale production of this promising natural drug precursor.

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You're at... Mediterranean Collection

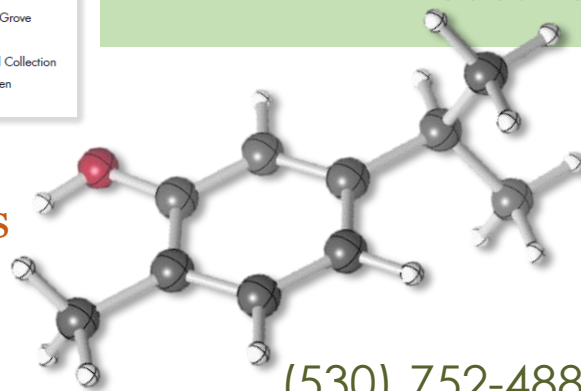
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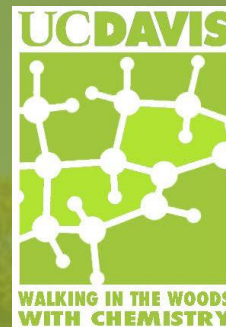
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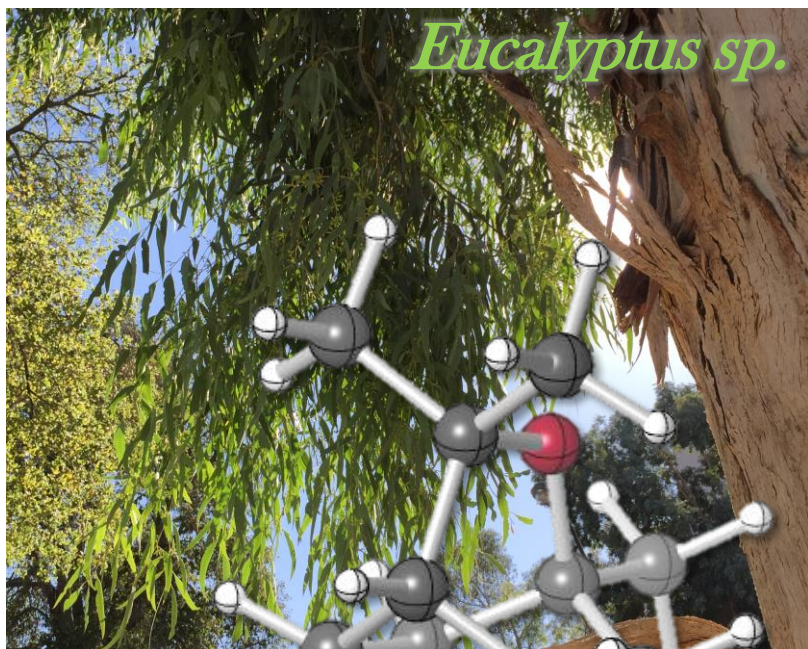


ARBORETUM AND PUBLIC GARDEN



Say Hi to... 1,8-Cineole!

a.k.a. eucalyptol, the major component of Eucalyptus oil, that also contributes to the flavor of rosemary and basil



Natural function

Gum trees produce large amounts of eucalyptol to ward off insects and other animals feeding on leaves. In some species of orchids, 1,8-cineole plays a major role in attracting bees that are essential for pollinating the flower.



Current research

1,8-cineole is being actively studied for its ecological roles and its antioxidant and antimicrobial properties. At UCD, the Ramirez group studies chemical cues used by orchids and associated bees.

Industrial uses

Due to its aroma and antioxidant properties, 1,8-cineole is used in many commercial products, such as mouthwash, cough suppressant, fragrances, as well as baked goods and beverages.

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Say Hi to... Carvacrol!

Have you ever wondered what contributes to the typical flavor and scent of oregano?

Oregano



Natural plant defense

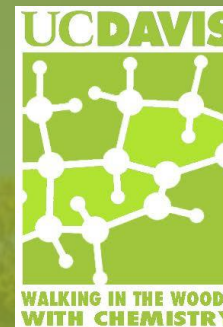
Carvacrol is the major compound in oregano, thyme and marjoram, giving them a savory flavor and pungent scent. Its biological role is unclear, but likely involves defense against bacterial and fungal pests.

Research at UCD

The Carstens group studies the medicinal properties of carvacrol, and recently demonstrated the effect of this natural compound on heat pain in clinical trials.

Industrial uses

Carvacrol finds use as an essential oil in many perfumes and soaps. Recent studies demonstrated its anti-bacterial and anti-viral properties, for example, against the infamous norovirus.



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You're at... Storer Garden

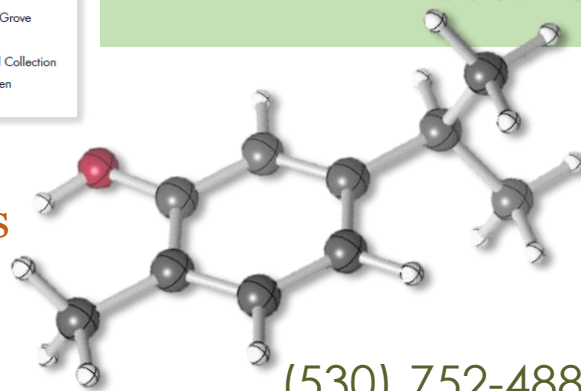
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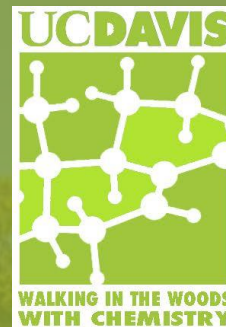
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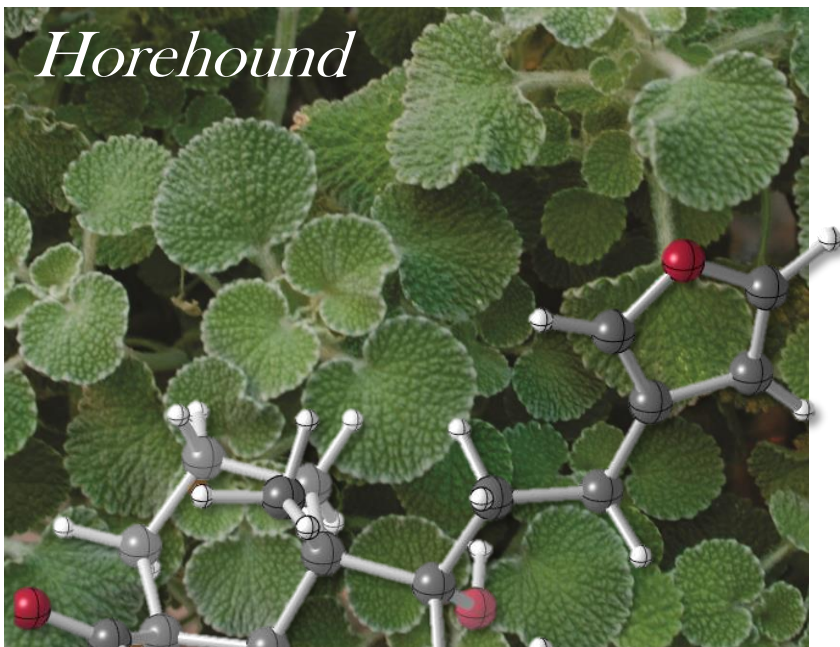


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Say Hi to... Marrubiin!

The major compound in horehound is one of the 13 herbs in Ricola cough lozenges



Horehound

Traditional uses

From the ancient Romans to modern cough lozenges, such as the popular Ricola® brand, horehound (a close relative of mint) is renowned for its use as a treatment of respiratory ailments.

Research at UCD

The Zerbe group studies the genes and enzymes responsible for producing marrubiin and related compounds in horehound. They then use this knowledge for developing alternative means for its scalable production.

A new anti-diabetic drug?

Recent research suggests the potential use of marrubiin as a natural drug for treating type II diabetes, due to its effect on starch and sugar utilization in our body.



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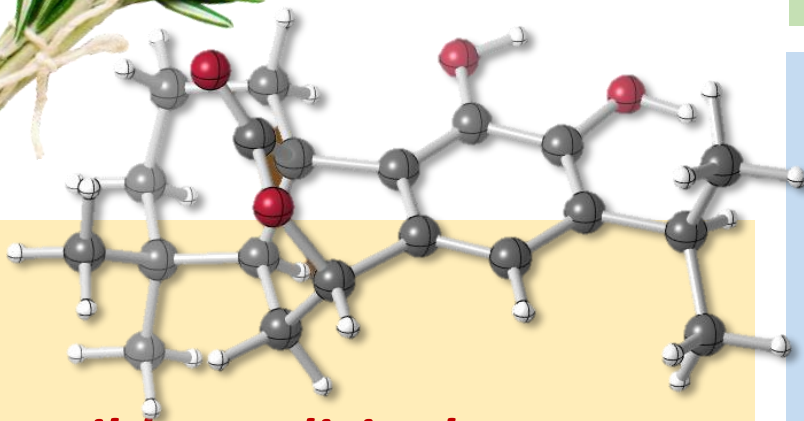
Say Hi to... Carnosol!

A new therapeutic from your every day garden herb?

Rosemary



*contains carnosol
in its leaves*



In nature

Rosemary produces many terpene compounds such as carnosol that make up its typical fragrance and flavor. Plants use these terpenes, for example, to fend off enemies and attract pollinators.



Current research

Several research groups across the world recently discovered the enzymes relevant for producing carnosol in rosemary. These can be used to further investigate its possible anti-cancer and anti-inflammatory properties.

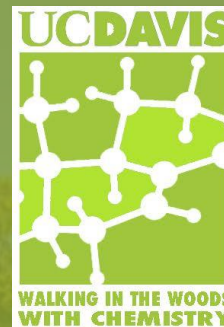
Possible medicinal uses

Carnosol has recently been shown to be effective in treating various cancers - *giving your garden herb a whole new dimension!*

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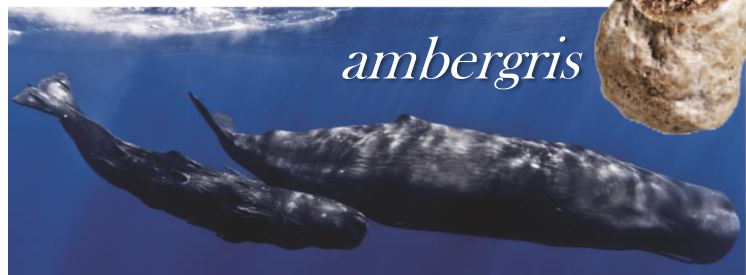


Say Hi to... Manool!

Eau de sage: manool from common sage can be used in perfume manufacture



Common Sage



ambergris

Industrial uses

Not just a famous cooking herb! Manool can be used to produce Ambrox, a base note in valuable perfumes that was historically obtained from ambergris, a secretion of sperm whales!

Natural plant defense

As one of many terpene compounds found in common sage, recent research associates manool with protection of the plant from invading fungi and other environmental stresses.

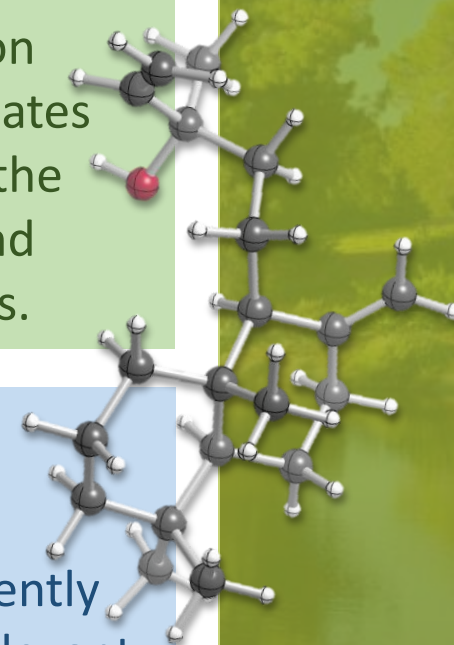
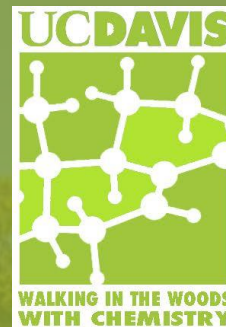
Research at UCD

Together with researchers in Europe, the Zerbe group recently discovered plant enzymes relevant for producing manool, which are now used toward its industrial production.

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