



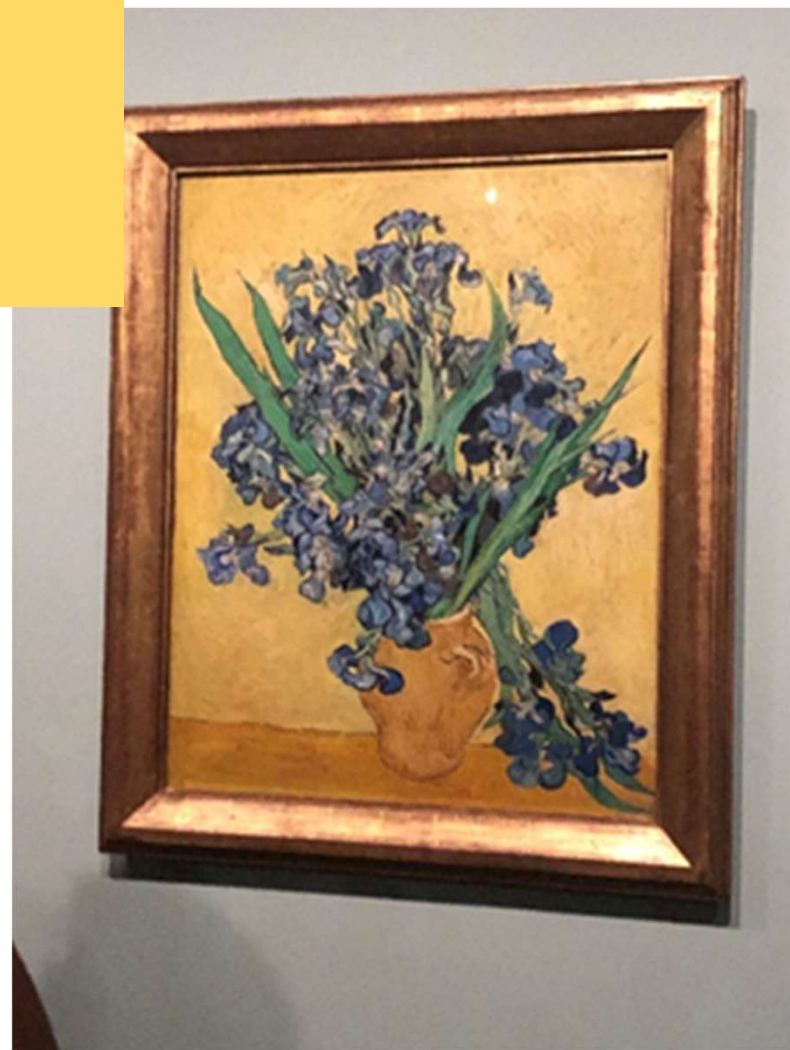
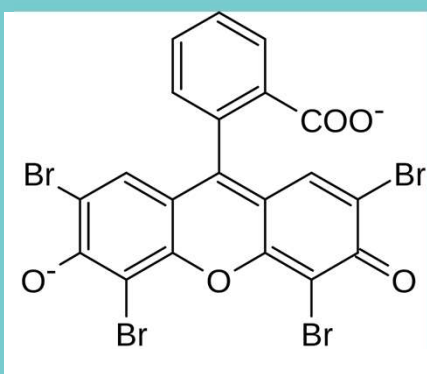
# Chimie Organique À L'Étranger

CHEM 2801

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Matthew Raeside, & Catherine Wang

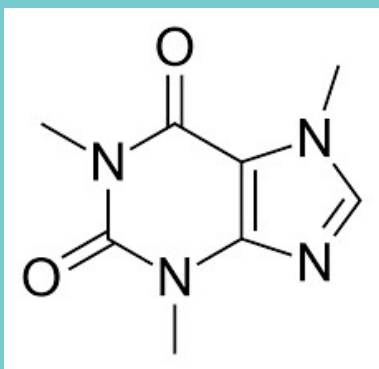
# Eosin Y

- Red lake pigments are often used in paints, but relatively unstable, causing the color to fade upon interactions with reagents, changes in pH, and even light. These molecules include alizarin, discussed in a previous post, but also other molecules like purpurin and Eosin Y. While red lake pigments contribute to the stunning composition and colors of Van Gogh's works, they also cause its importance, all the more reason to visit the works.



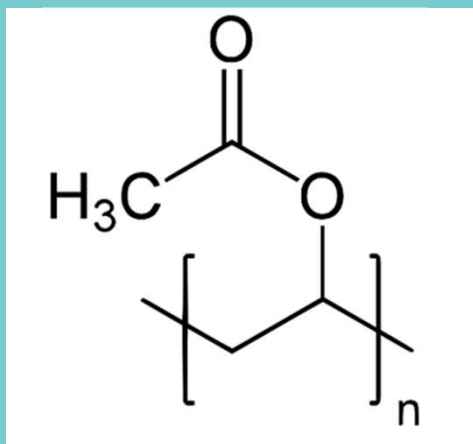
# Caffeine

- The driving power behind this espresso drink is the organic molecule caffeine. Caffeine, which occurs naturally and is often manufactured synthetically, acts as a stimulant by imitating adenosine, blocking adenosine receptors in the brain and preventing sleepiness. It also interacts with other neurotransmitters, increasing the activity of dopamine and cortisol, for example.



# Vinyl Acetate

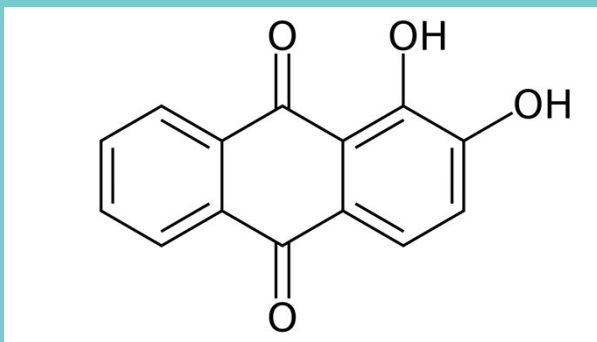
- Vinyl acetate the monomer of an organic molecule called polyvinyl acetate that is used in glue. The structure of PVA allows it to be a strong adhesive due to the way its polymer fibers seep into porous materials when wet, and remain anchored there when dry. It is likely the same type of glue that is holding the books in this picture together, allowing the beautiful display and intriguing stories to exist.





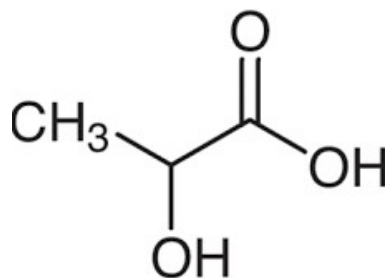
# Alizarin

- The organic molecule shown here is a very influential red dye called Alizarin. This molecule features 3 carbon rings with 2 alcohol groups on the 3rd and 2 carbonyl on the middle. Alizarin, like all dyes, binds to the threads in a fabric, in this example velvet, and reflects and absorbs wavelengths of light that determine its color. Dyes allowed for industrial development, interest in chemistry as an industry, and beautiful displays like the Prague National Theatre.



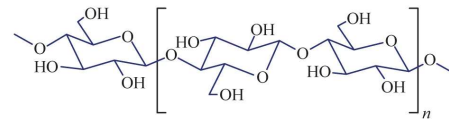
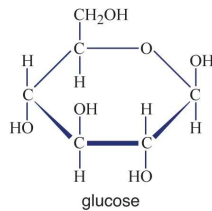
# Lactic Acid

- From fine cheeses found at markets and fromageries, to the melted dip of the fondue shown, cheese is a delicious and prolific element of European food. Like many foods, its production would not be possible without organic molecules, specifically lactic acid. Lactic acid is formed when the sugar lactose (another organic compound) is acidified by lactic acid bacteria. Lactic acid bacteria release proteases, which assist with the fermenting process that eventually results in cheese!

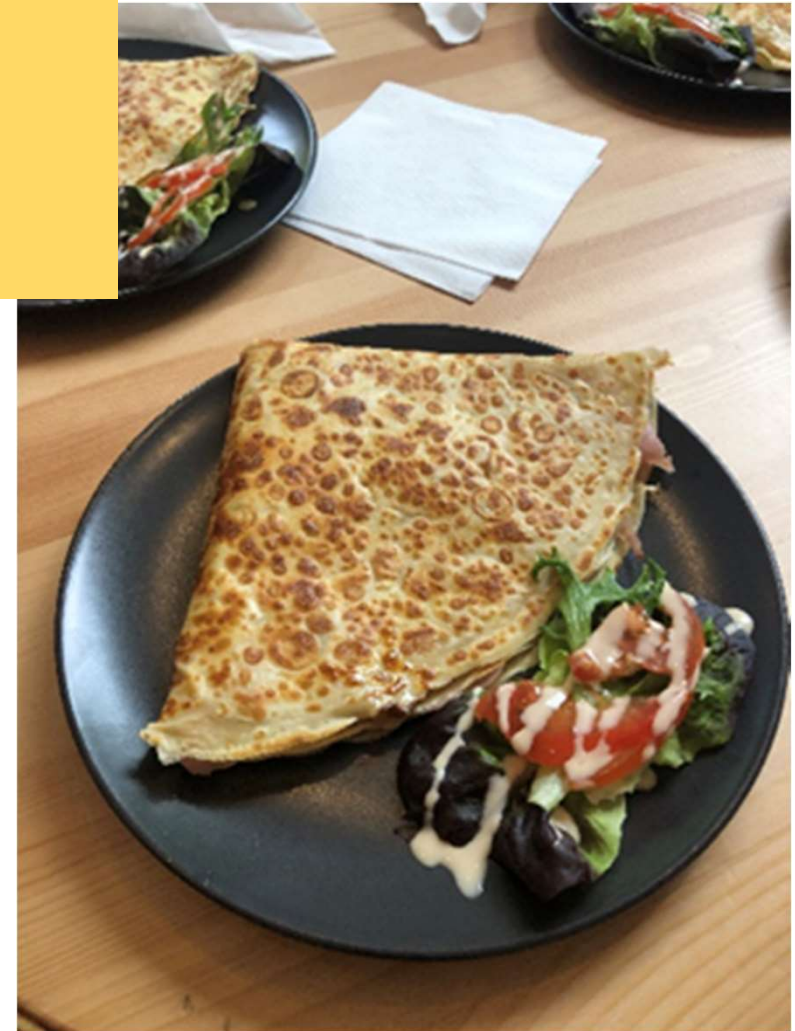


# Cellulose

- One essential ingredient of this treat is flour, which contains the organic molecule cellulose. The chemical formula for a monomer of cellulose is  $C_6H_{10}O_5$ , and it exists as a polymer. This means that flour is composed of long structures with multiple of these subunits linked to one another. This allows flour to have its thickening ability, which lets it make the batters and doughs that compose some of our favorite foods, including crepes!



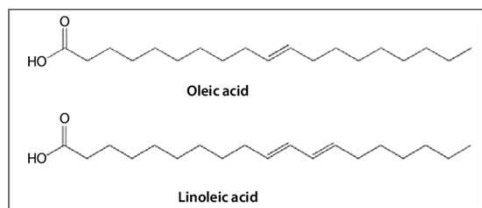
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# Oleic Acid

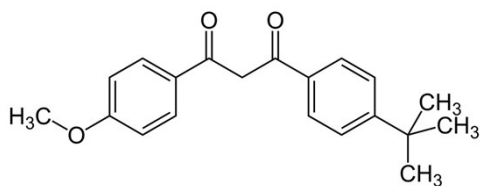
- Argan oil is extracted from kernels of the Moroccan argan tree and around 80% of its fatty acids are unsaturated fatty acids oleic and linoleic acid. These molecules help to moisturize the skin and contribute to the shelf life of the soap. Additionally, being nonpolar, they help repel polar pollutants and pathogens from the skin, contributing to the hygienic nature of soap. Oleic and linoleic acid have a number of other uses, as does argan oil, but they are particularly useful as components of soap.





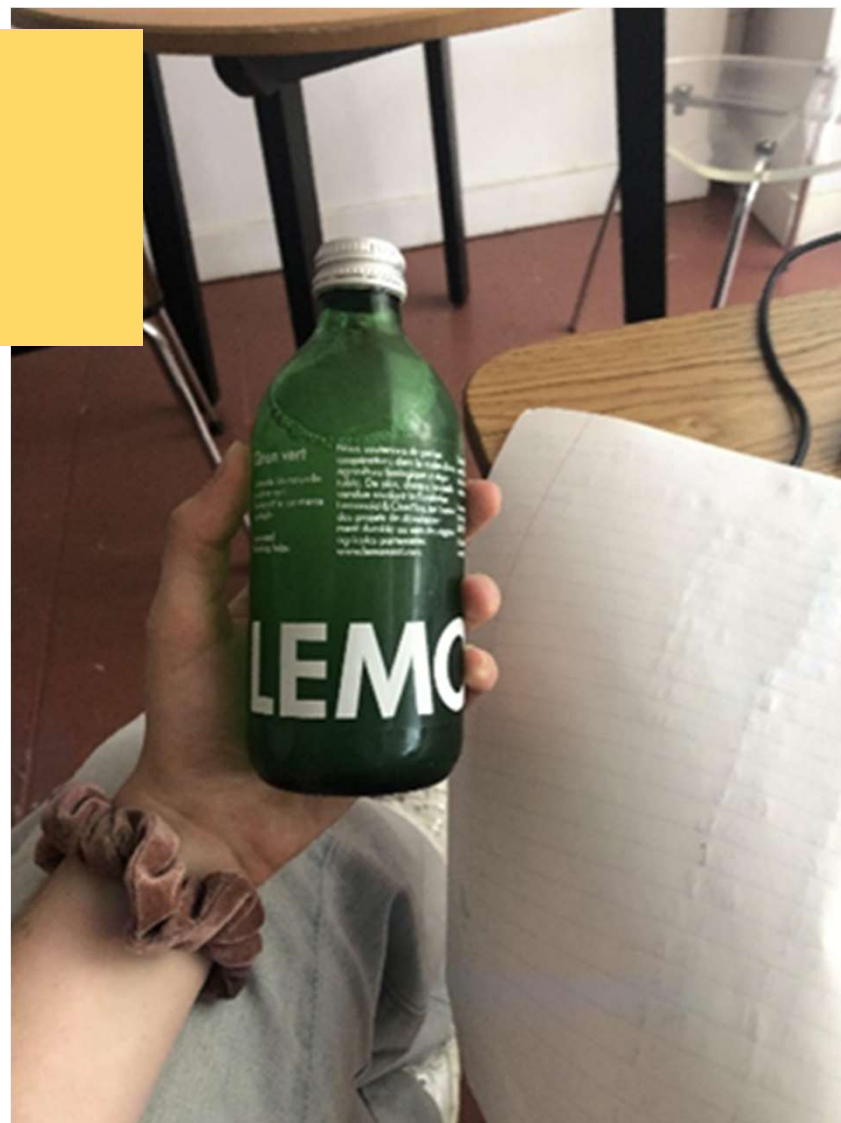
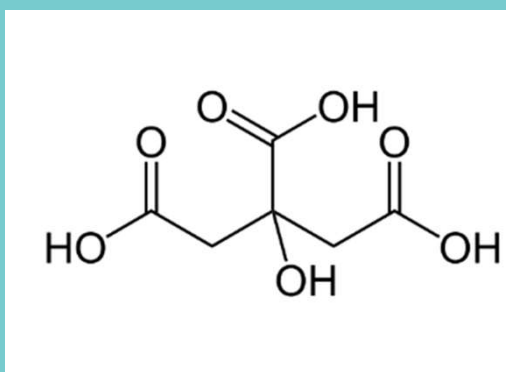
# Avobenzone

- Although you can't see it in this photo, I have sunscreen and the organic molecule Avobenzone to keep sunburns from being a problem in my travels! Avobenzone is a molecule used in a lot of common sunscreens to absorb the sun's UV rays and prevent them from burning and damaging skin. It can do this because it generates an excited state when exposed to UV radiation. This eventually causes it to degrade, which is why it's important to reapply.



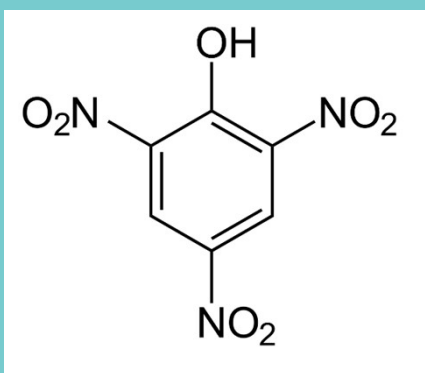
# Citric Acid

- Citric acid occurs naturally in fruits, especially (unsurprisingly) in citrus fruits. It is very flavorful and has lots of culinary uses, both in flavor and in making products last longer, but it has numerous applications outside the kitchen. These include being used as a pesticide and disinfectant, and preservative for non-fruit things like wine and meat.



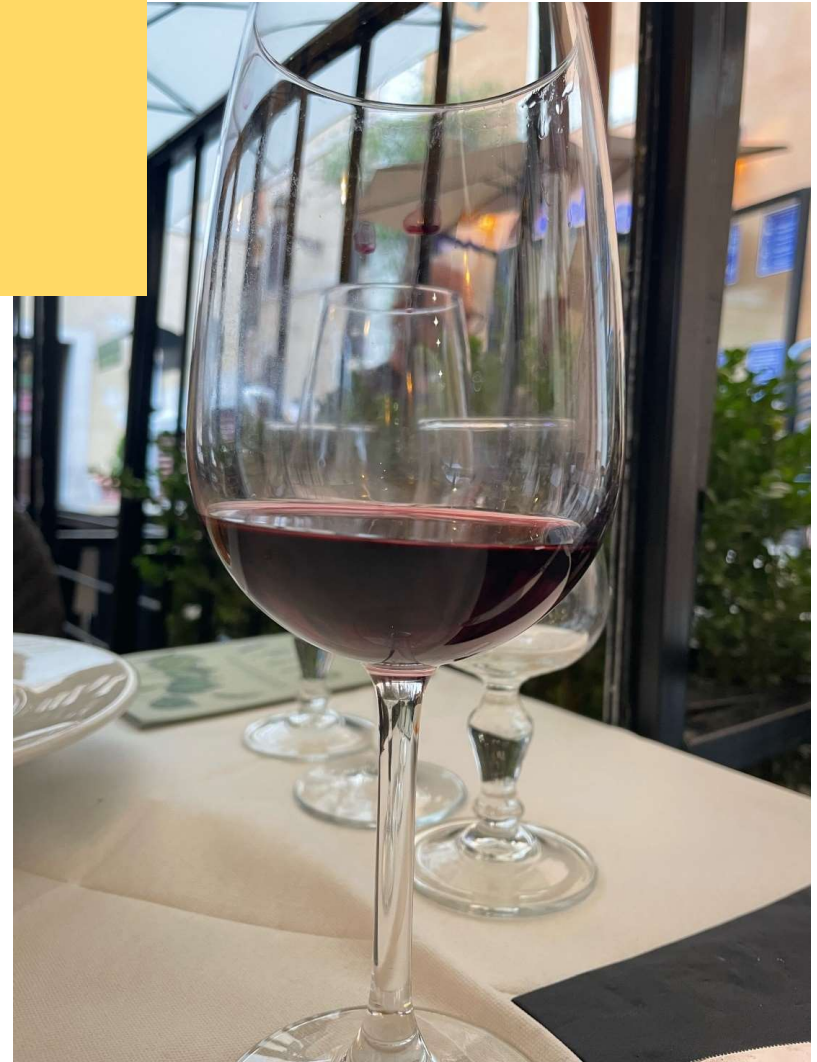
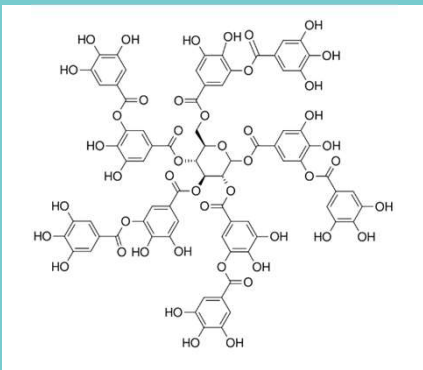
# Picric Acid

- Fireworks owe their whistle to organic aromatic compounds, such as picric acid, a nitrated phenol. Due to its high level of nitration, picric acid is commonly used as an explosive, hence its use in fireworks, as were seen on Bastille Day in Lyon. Picric acid is a highly acidic phenol (due to the numerous  $\text{-NO}_2$  groups), with a  $\text{pK}_a$  of 0.38.



# Tannic Acid

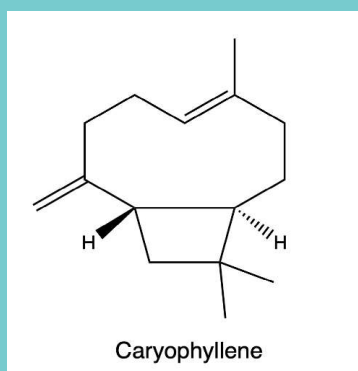
- Red wine and red wine grapes contain tannic acid, which is a tannin, a class of polyphenolic compounds with astringent properties. Tannic acid is most concentrated in red wine grape skin. Organic compounds that are astringents contract body tissues. Tannic acid binds to salivary proteins, such as amylose, to precipitate and aggregate them, causing the dry, puckery feeling in one's mouth associated with drinking red wines.





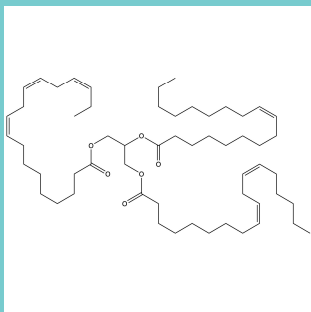
# Caryophyllene

- Peonies are fragrant often pink and white flowers, that owe their smell to many volatile compounds; namely terpenes and alcohols. One of the most abundant terpenes in peony fragrance is caryophyllene. Caryophyllene is a natural bicyclic terpene of three isoprene molecules (known as sesquiterpenes). It is an essential oil also found in cloves, rosemary, and hops. Note the cyclobutane ring: rare in nature due to its steric strain.



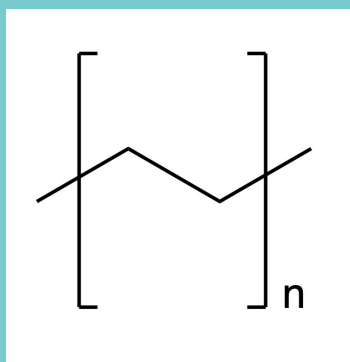
# Linseed Oil

- The painting is an oil painting, and oil paint is composed of paint pigment mixed with linseed oil. Linseed oil is pressed from flax seed. Linseed oil is a triglyceride of three fatty acids: linolenic, linoleic, and oleic acids, and a central glycerol head. Each of the three fatty acids have unsaturation levels from 1-3, and this unsaturation allows for the slow curing of oil paint. In the presence of oxygen, autoxidation of dienes allows for cross-linking between fatty acid tails, and the resulting polymerization causes the oil paint to harden.



# Polyethylene

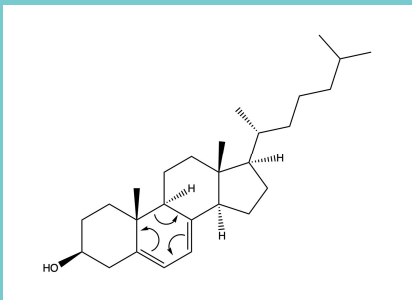
- Paragliders are primarily composed of ultra-high density polyethylene (UHDPE), a type of polyethylene. Polyethylene is a light and versatile synthetic resin that is the most used plastic in the world. It is made via the polymerization of ethylene, making it a type of polyolefin resin (an olefin is another name for alkene). The resulting resin is spun into synthetic fibers with a highly crystalline state, such that UHDPE can have tensile strength much greater than that of steel.





# 7-dehydrocholesterol

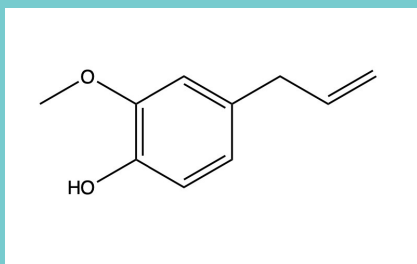
- 7-dehydrocholesterol, a waste product, is a precursor to vitamin D3. When cholesterol (found in animal cell membranes) is improperly synthesized in lathosterolosis to lathosterol, lathosterol accumulates as waste. Via lathosterol oxidase, it is converted to 7-dehydrocholesterol. 7-dehydrocholesterol, found in the epidermis, is converted to provitamin D3 when exposed to UV-B rays. From there, precholecalciferol is converted to cholecalciferol, what we know as vitamin D3. The active form of vitamin D3, calcitriol, is produced from cholecalciferol in the kidneys and is an important transcription factor.





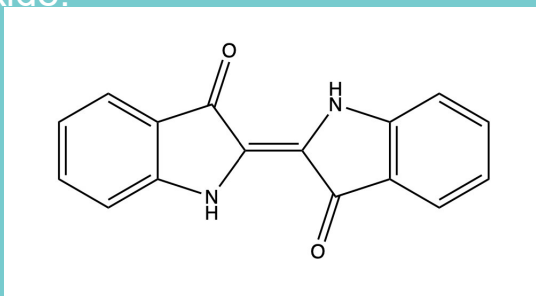
# Eugenol

- These Italian dishes from Carmelo's are adorned with basil leaves – which contain eugenol - a guaiacol molecule substituted with an allyl group. It is an aromatic essential oil - meaning it is both hydrophobic and highly volatile - owing to its scent. The oil is yellow and found in high concentrations in cloves, nutmeg, cinnamon, and of course, basil. It gives cloves their spicy, characteristic scent, which is detectable in basil. Eugenol is synthesized from the amino acid tyrosine in a complex biosynthetic pathway utilizing numerous enzymes.



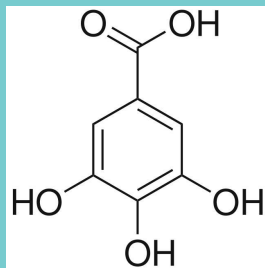
# Indigo

- One of the most popular and famous dyes to be used ubiquitously in clothing - indigo. Historically, indigo was extracted from indigo plants. But now is produced synthetically and is used most frequently in dyeing jeans (as I happened to be wearing). Around 20 thousand tons of synthetic indigo are produced annually. In plants, indigo's precursor is indican, which is a derivative of the amino acid tryptophan. Synthetically and industrially, indigo is produced via heating of N-(2-carboxyphenol)glycine in sodium hydroxide.



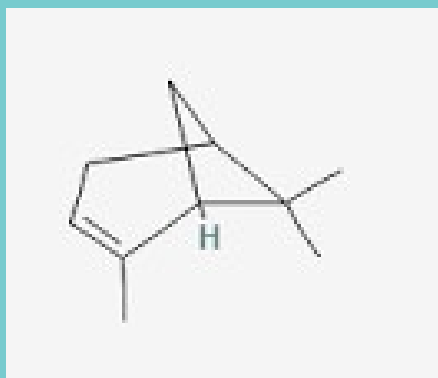
# Gallic Acid

- Bananas contain the potent and bioactive compound, gallic acid. Gallic acid is a trihydrobenzoic acid and a phenolic acid. Gallic acid is an antioxidant that scavenges radicals produced during oxidative stress. The overproduction and accumulation of free radicals, highly reactive species, leads to ageing, cancer, and inflammatory diseases. Gallic acid effectively "neutralizes" ROS. Gallic acid is an efficient apoptosis agent and is indicated in many related cell signaling pathways. The minions high consumption of bananas (and thus gallic acid) may explain their continued longevity.



# Alpha-Pinene

- Pistachio is a popular flavor found in France. Here is a pistachio macaron on top of an Amorino ice cream. The main compound that gives pistachios their taste is the molecule alpha-pinene, or  $\alpha$ -Pinene. It is a bicyclic molecule in the terpene class, and it is used by plants for metabolism.

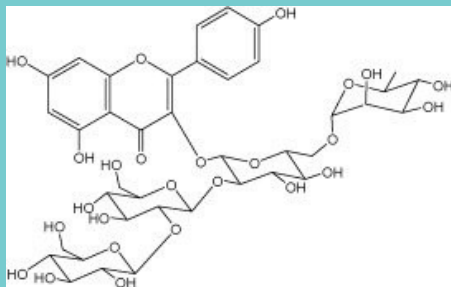


*Ice cream from Amorino Ice Cream in Lyon, France*



# Flavonoids

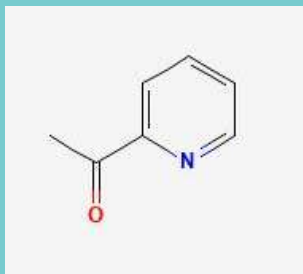
- These flowers are likely carnations, which are a part of the Dianthus genus and the Caryophyllaceae family. The molecules that help regulate the pigmentation of these flowers are called flavonoids. Today Dianthus flowers are used in cooking as decoration, similar to how the Romans used them and helped lead to their popularity in the Middle Ages.



*Carnations in front of CPE, Lyon, France*

# 2-acetylpyridine

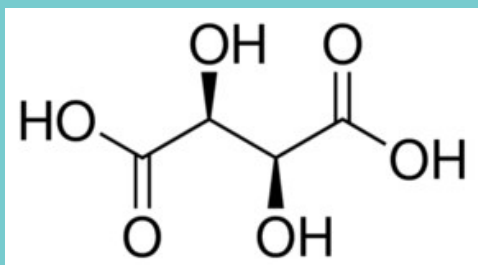
- The crunchiness of croissants is due to a molecule produced by a Maillard reaction. The amino group of proteins and the carboxyl group of carbohydrates react endothermically and can produce a variety of molecules. One is 2-acetylpyridine, which is a cyclic molecule that is linked to the crunchiness and the color of a croissant, the latter due to the molecule's ability to bend light.



*An almond croissant from Boris Lumé Bakery, Paris, France*

# Tartaric acid

- One of the molecules found in grapes and wine is the flavor molecule tartaric acid. It is a dicarboxylic acid that has three stereoisomers. The stereoisomer found in grapes and all types of wine is dextrorotatory tartaric acid (D-tartaric acid), which has a sour taste. Tartaric acid is also the molecule studied by Lois Pasteur that helped lead to the present-day understanding of stereoisomers.

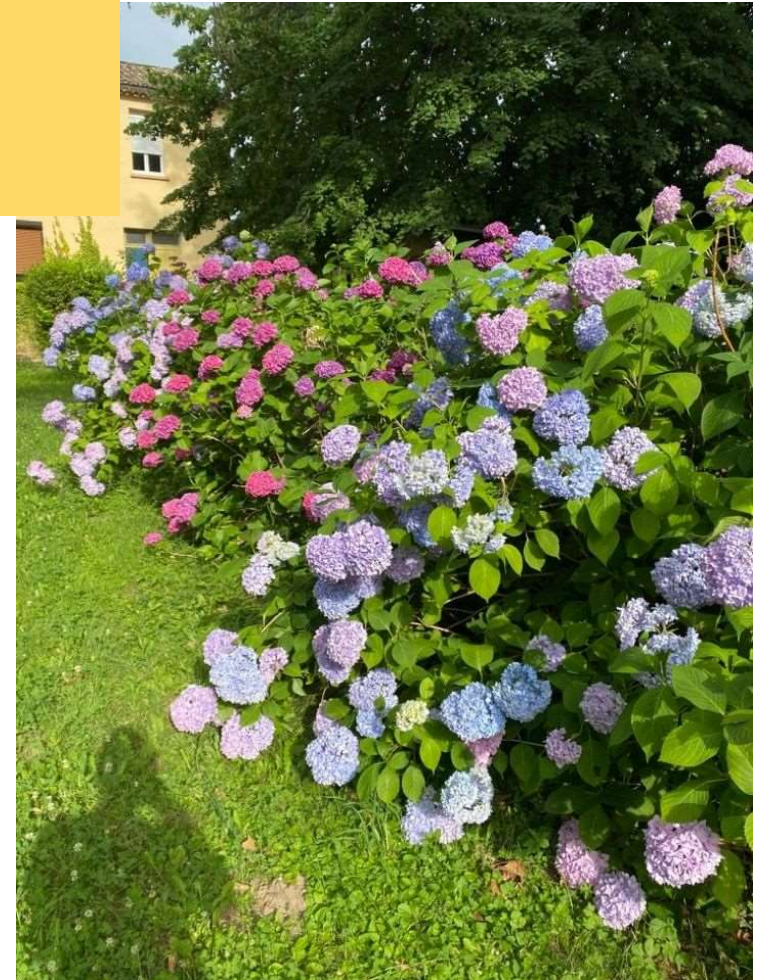
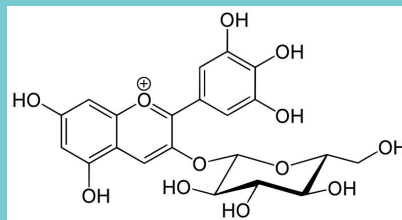


*Grapes in an Italian vineyard*



# Myrtillin

- The colors produced by hydrangeas are due to the molecule myrtillin, also known as delphinidin-3-glucoside and anthocyanin. It has a natural reddish pigment, and when exposed to basic soil, the citric acid produced by the plant reacts with aluminum ions in the soil and ultimately has no effect on the molecule, causing the flowers to be reddish or pink. However, as pH of the soil decreases (becomes more acidic), the plants tend to absorb more aluminum ions through reaction with hydroxides. The ions are transported throughout the plant and form aluminum-anthocyanin complexes, or metalloanthocyanin molecules. The different shape bends light differently and causes the plants to be more blue.

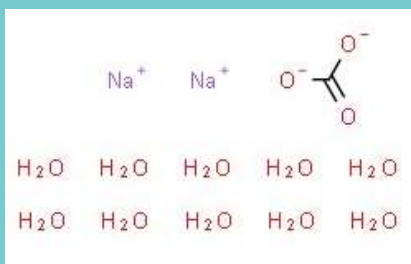


*Hydrangeas in Ardèche region of France*



# Sodium carbonate decahydrate

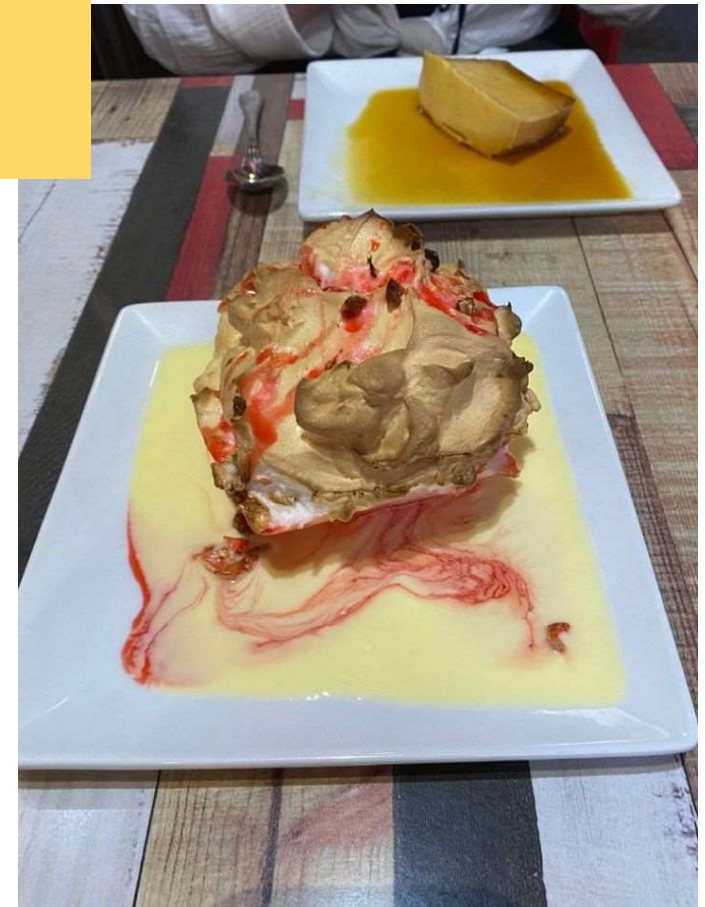
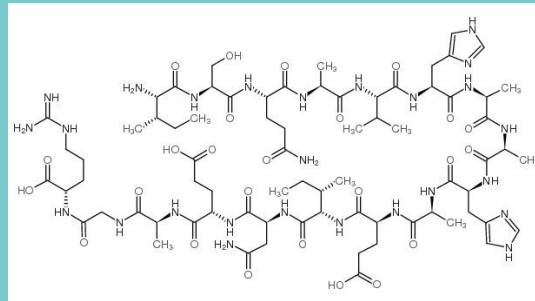
- The drying process in mummification involves the use of the molecule natron, or native soda. It is a mixture of sodium carbonate decahydrate and sodium bicarbonate. It can be found existing naturally in salt beds. Its absorption property is what made it incredibly important in mummification, but it also had a variety of other uses, such as an early form of soap when added to oil



*Mummy in the Louvre Museum, Paris, France*

# Ovalbumin

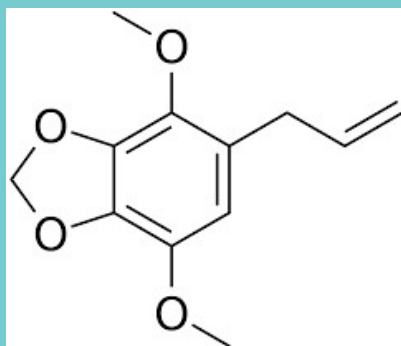
- One French dessert is île flottante, or floating cloud, which consists of a mound of merengue and any of a variety of toppings. The main ingredient in the dish is egg whites, which are comprised of proteins, the most prominent being ovalbumin. It accounts for 54-58% of the total weight of proteins in eggs, but its exact function is unknown. In the process of whisking egg whites to make merengue, air is added which denatures the proteins. When this happens, hydrophobic and hydrophilic parts of proteins are exposed. The hydrophobic parts are attracted to the air bubbles while hydrophilic parts stay in the aqueous environment of the egg whites, making the eggs "fluffy."



*The dessert from a restaurant in Lyon, France*

# Apiole

- A popular garnish on food, also shown here on top of an English breakfast, is parsley. Parsley contains a molecule called apiole, aka 1-allyl-2,5-dimethoxy-3,4-methylenedioxybenzene. The molecule was discovered in 1715 by Heinrich Christoph Link, but its history goes back as far as the 400s BCE, when Hippocrates wrote about parsley being used for abortions in early medicine. The molecule itself helps keep the menstrual cycle on track by kickstarting menstrual bleeding (as observed by Joret and Homolle in 1855). However, the molecule can be dangerous and even fatal if ingested in large quantities, which is what prompted its downfall as a method for abortion in the United States.

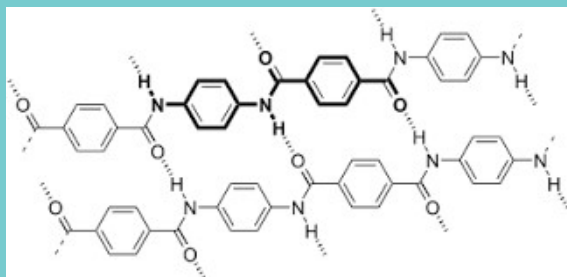


*An English breakfast with an American twist, London, England*



# Kevlar

- Wind turbine blades can be made using a chemical for reinforcement called Kevlar, also known as para-aramid. It is a heat-resistant synthetic fabric. It is also incredibly strong, which makes it a good pick for industrial uses. Hydrogen bonds between the nitrogens and carboxyl groups of the molecules in the chain alongside pi-stacking of the aromatic rings account for this molecule's strength.

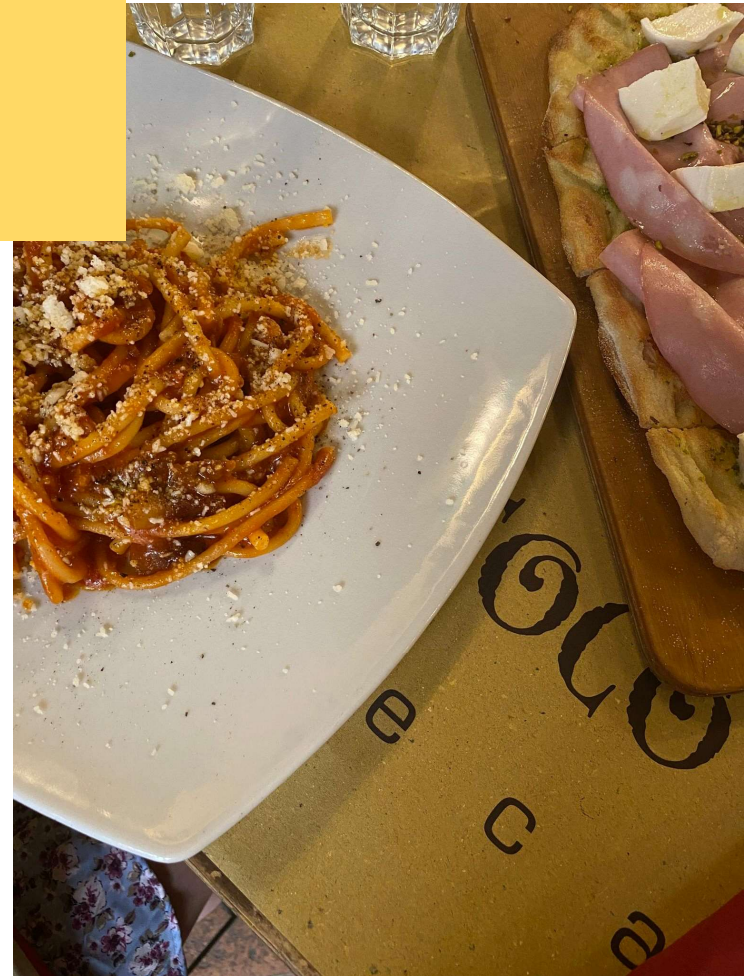


*Wind turbines in a field of sunflowers, North France*



# Lycopene

- Lycopene is a type of pigment under the class of pigments called carotenoids. This pigment is responsible for the red and pink colors in fruits such as tomatoes, watermelon, and grapefruits. However, it is not present in either strawberries or cherries. Lycopene has antioxidative properties which helps with chronic illness such as respiratory illnesses and cancer.



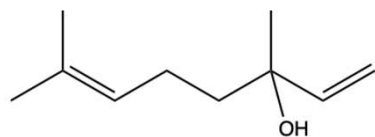
# Sinigrin

- Sinigrin is a part of a class of molecules called alkylglucosinolates. It can be found in the mustard seeds that are used to make dijon mustard. Sinigrin is known to have a bitter taste. It is responsible for the pungent spicy taste that comes from mustard after being degraded by the myrosinase. Sinigrin can also be found in other foods including radish and wasabi which also have a more pungent and distinct taste.



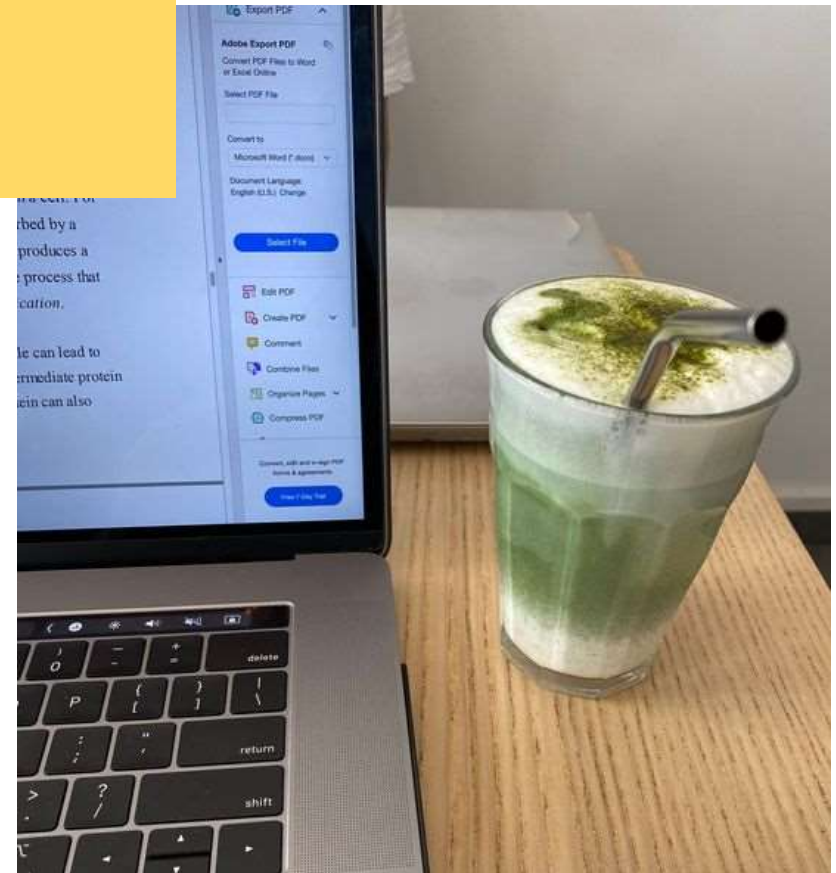
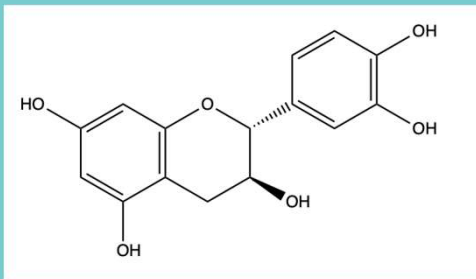
# Linalool

- Linalool is a clear oil that acts as a metabolite in plants and gives lavender flowers their distinct scent. The molecule belongs to a group of molecules known as terpenes which provide aroma to a lot of different plants. As a terpene, Linalool is known to have a calming effect which has led to its use in aromatherapy with a variety of health benefits. It has been used to help treat anxiety, depression, as well as insomnia.



# Catechin

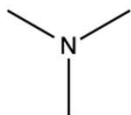
- Catechin is a flavan-3-ol and a type of phenolic compound. It is a great antioxidant which helps reduce damage to the body that is caused by oxidation within the body. It does this by donating an electron to a free radical found in body cells, neutralizing the free radical which decreases the damage it can cause. Catechin can be found in a wide range of plant-based foods and drinks. From more recent studies, it has been suggested that high catechin diets could help prevent and treat chronic illnesses such as cancer.





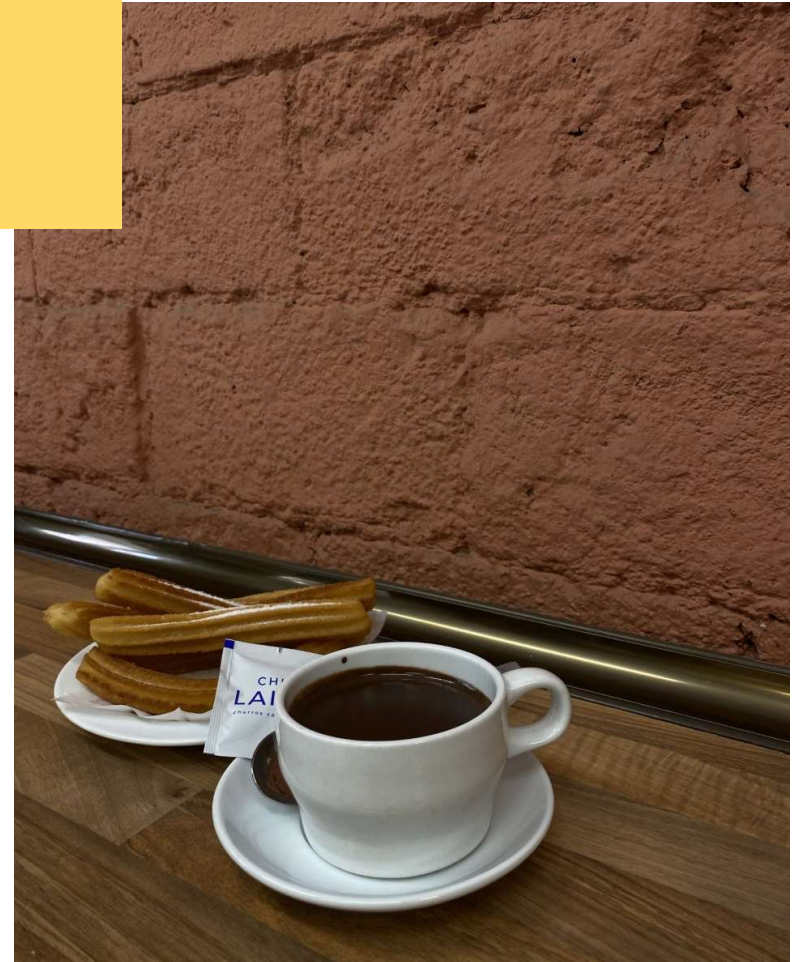
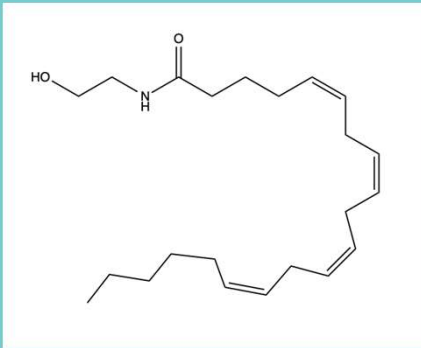
# Trimethylamine

- Trimethylamine is the molecule responsible for the fishy smell that comes from seafood. Trimethylamine is produced in sea animals by their enzymes and other bacteria when they are killed. The molecule is converted from trimethylamine oxide which is used by sea animals to maintain fluid balances by counteracting the salty sea water. The fishy smell caused by trimethylamine can be reduced by treating seafood with acidic foods which helps trimethylamine become less volatile by binding with water.



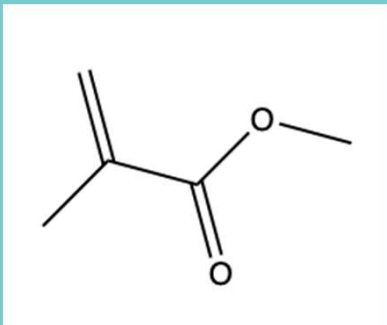
# Anandamine

- Anandamine is a neurotransmitter in the body that can be found in a small quantity in chocolate. The molecule binds to cannabinoid receptors in our brain which are the same receptors bound by THC molecules from cannabis. Since anandamine binds to the same receptors, it's able to mimic the psychoactive effects of cannabis which is linked to the calming and happiness inducing effect that chocolate can have.



# Methyl Methacrylate

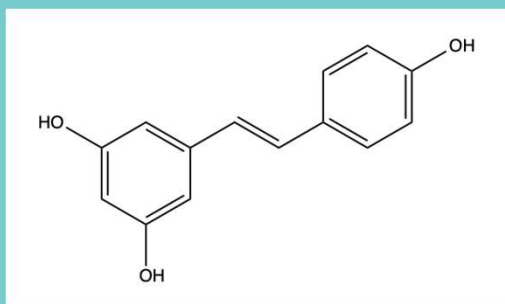
- Methyl methacrylate is the monomer that is used as the binder resin in acrylic paint. A catalyst helps the monomer create long polymer chains known as polymethyl methacrylate. The binder resin is mixed with various dry pigments to create a variety of acrylic paint colors used in paintings such as those seen in the Louvre and Musée d'Orsay.





# Resveratrol

- Resveratrol is found in a larger abundance in red wine than white wine since red wine is fermented for a longer period of time than white wine is. Resveratrol is found in the skin and seeds of grapes and gives wine some of its bitter taste in addition to the organic molecule tannin which also causes a drying/puckering sensation in the mouth. Resveratrol has anti-inflammatory properties, making it good for treating arthritis and skin inflammations.



# Ovalbumin

- Ovalbumin is the major protein found in egg whites which provides many of the major amino acids for chicken embryos, making ovalbumin an important source of amino acids for humans. Egg whites are used to make a variety of baked goods and sweets. One example is meringue which is made by denaturing the ovalbumin protein in egg whites to form sweet, stiff peaks that are enjoyed as desserts or on top of other sweets.

