

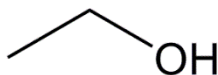
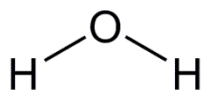
Physical Properties of Molecules

Learning Outcomes

1. Identify a lipid by its structure
2. Predict whether a vitamin is water soluble or fat soluble.
3. Identify by structure a hydrophilic, hydrophobic, or amphiphilic molecule.
4. Apply the concepts of hydrophilicity and hydrophobicity to explain the interaction between water and some materials found in nature (example: lotus leaf).
5. Identify a steroid by its structure

Hydrophilic Compounds Mix Well With Water

Hydrophilic “Water Loving”



THE CHEMISTRY OF VODKA



RAW MATERIALS

Traditionally made using cereal grains or potatoes



FERMENTATION

Yeast added to mash to make approx 16% alcohol solution



DISTILLATION & FILTRATION

Removes most impurities and concentrates alcohol up to 96%

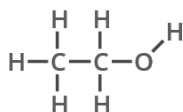


DILUTION

Water is added to the alcohol to dilute it to 40%

In the USA and Europe, filtration through activated charcoal to remove impurities is used extensively. More traditional methods keep filtration to a minimum, instead utilising accurate distillation to remove impurities.

ETHANOL HYDRATES

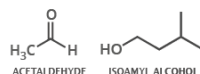


ETHANOL

principal alcohol found in alcoholic beverages

Ethanol and water molecules in vodka can bunch together in clusters called hydrates. The most common hydrate has a cage-like structure, and around 5 water molecules to every ethanol molecule. This hydrate varies in concentration in different vodkas, and it's been suggested it may affect a taster's perception of vodka (though this hypothesis is yet to be confirmed).

IMPURITIES



Though distillation and filtration removes most impurities in vodka, milligram amounts of some compounds, including those shown here, can remain. Cheaper brands of vodka tend to have a larger amount of remaining impurities, which could affect flavour perception.



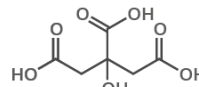
METHANOL



PROPANOL



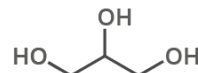
ADDITIVES



CITRIC ACID

acts as a 'smoothing agent' in vodka

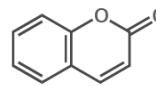
Vodka can sometimes be more than just ethanol and water. Some additives are permitted in most countries. These include citric acid, which is permitted up to 0.1% by volume, glycerol, and sugar (maximum of 0.2% by volume). These additives do not need to be disclosed on the label.



GLYCEROL

another compound used as a 'smoothing agent'

Flavoured vodkas can also be produced using additives. One of the best-known is Żubrówka, a vodka of Polish origin flavoured using bison grass. The bison grass gives it a yellowish colouring but also leads to the vodka containing coumarin. Coumarin has minor liver toxicity in large amounts, and as such Żubrówka was banned in the USA until a coumarin-free version could be formulated.



COUMARIN

compound found in bison grass vodka

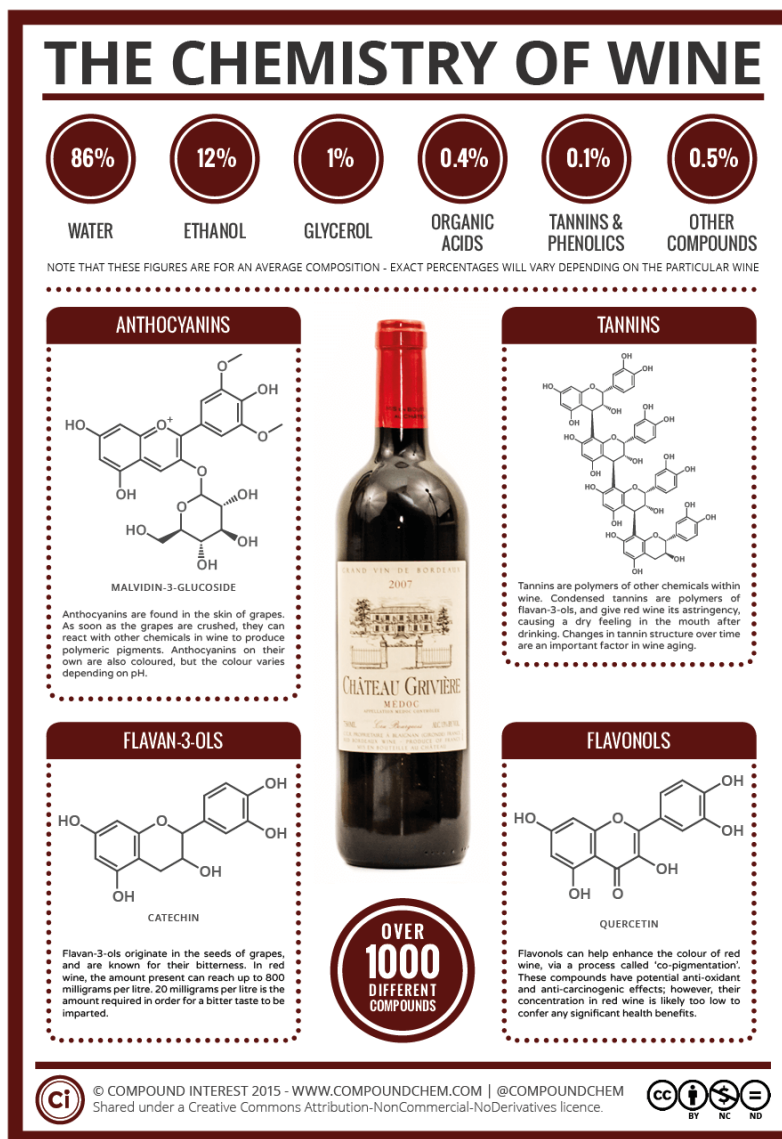


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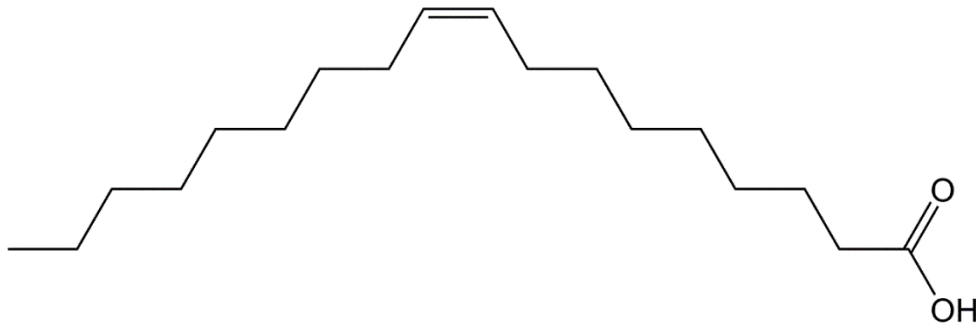
Hydrophilic Compounds Mix Well With Water

Hydrophilic
“Water Loving”



Hydrophobic Compounds Do Not Mix Well With Water

Hydrophobic
“Water Hating”

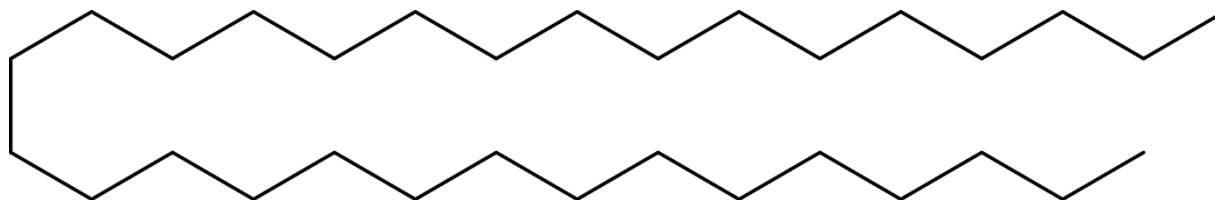


Oleic Acid
(main component of olive oil)

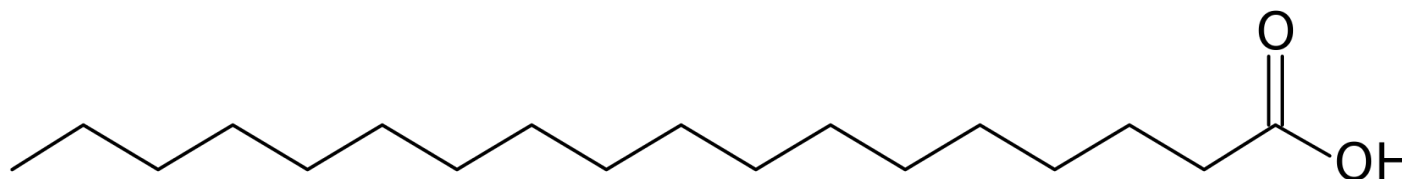


Hydrophobic Compounds Do Not Mix Well With Water

Hydrophobic
“Water Hating”

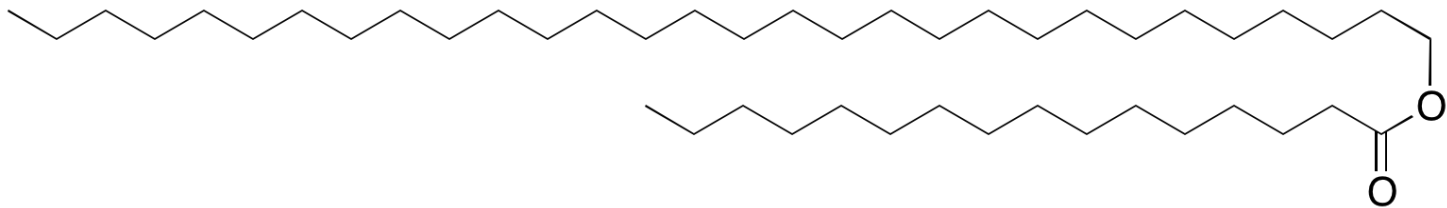


Hexatriacintane
(main component of paraffin wax)



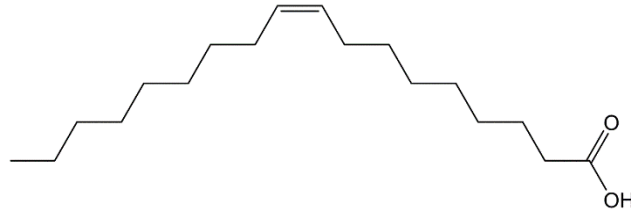
Stearic Acid

Hydrophobic “Water Hating”

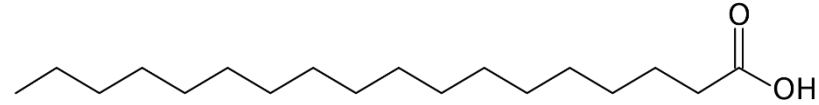


Triacontanyl Palmitate
(major component of beeswax)

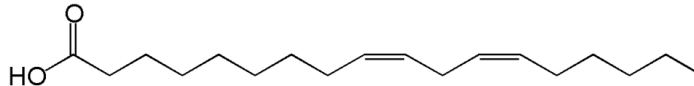
Lipids are Hydrophobic (Lipophilic) Molecules of Biological Origin: Lipids are Soluble in Nonpolar Solvents and Insoluble in Polar Solvents (i.e. Water)



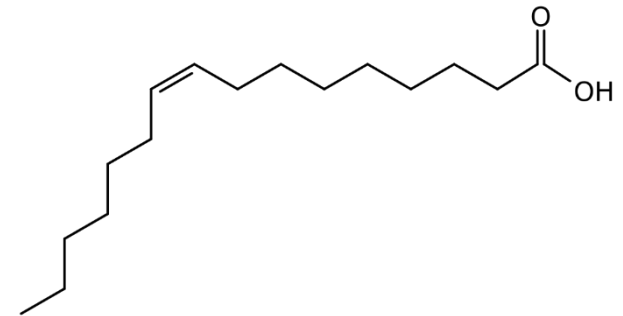
Oleic Acid (70.0%)



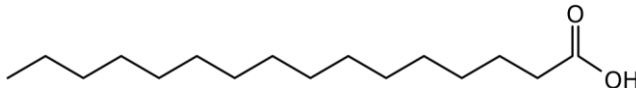
Stearic Acid (1.5%)



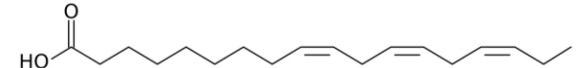
Linoleic Acid (15%)



Palmitoleic Acid (0.3 – 0.5%)

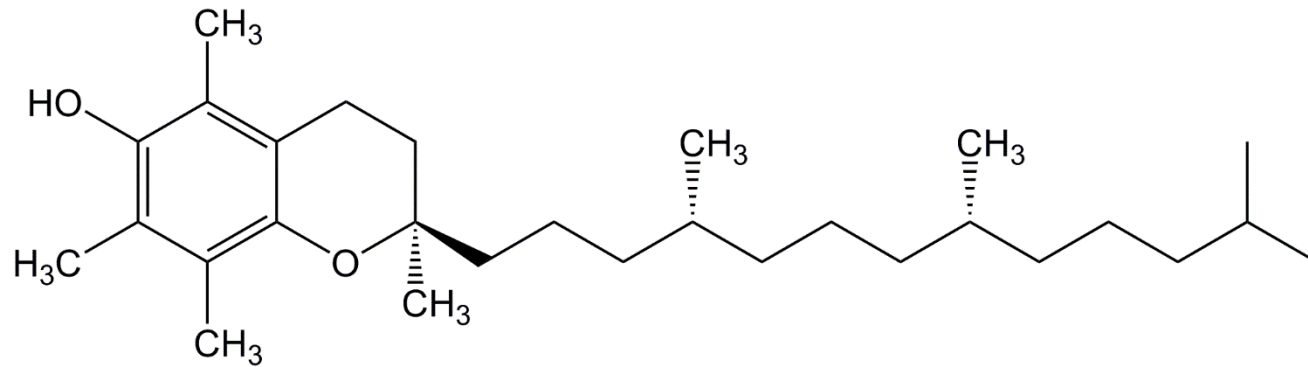


Palmitic Acid (13.0%)



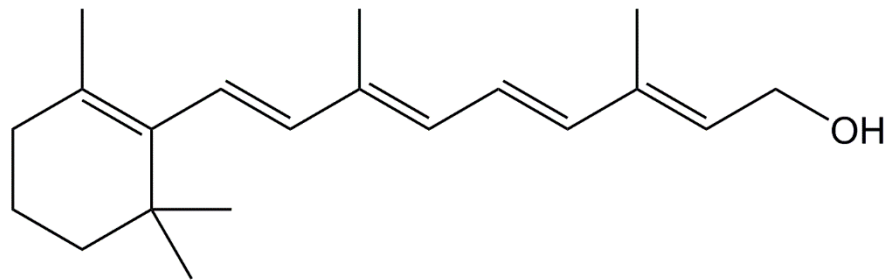
α -Linoleic Acid (0.5%)

Vitamins Are Compounds, Other Than A Fat, Protein, Or Carbohydrate That Are Required For The Normal Growth And Maintenance Of Organisms



Vitamin E
α-Tocopherol

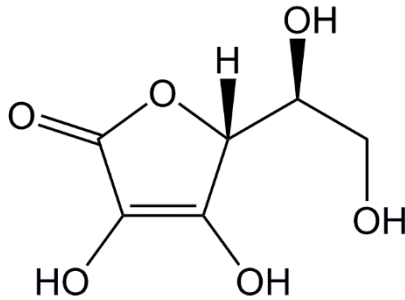
Protects cells from radicals and the associated oxidative damage



Vitamin A
Retinol

Incorporated in the photon-harvesting protein rhodopsin and is essential for vision

Vitamin C (Ascorbic Acid)



Vitamin C
Ascorbic Acid

An antioxidant

DIRECTIONS: Drop one tablet in 4-6 oz of water, let dissolve (about 1 minute) and drink. May be used in hot or cold water.

Adults 14 years and older, repeat every 3-4 hours as necessary, up to 3 times per day, no more than 3 tablets.

Children 12-13 years old, repeat every 3-4 hours as necessary, up to 2 times per day, no more than 2 tablets.

Supplement Facts

Serving Size 1 Tablet

	Amount Per Serving	% Daily Value
Calories	5	
Total Carbohydrate	1 g	<1%*
Vitamin A (as retinyl acetate)	2000 IU	40%
Vitamin C (as ascorbic acid)	1000 mg	1667%
Vitamin E (as dl-alpha tocopheryl acetate)	30 IU	100%
Magnesium (as magnesium oxide and magnesium sulfate)	40 mg	10%
Zinc (as zinc sulfate)	8 mg	53%
Selenium (as selenium amino acid chelate)	15 mcg	21%
Manganese (as manganese gluconate)	3 mg	150%
Sodium (as sodium bicarbonate)	150 mg	6%
Potassium (as potassium bicarbonate)	80 mg	2%
Proprietary Herbal Blend	350 mg	†
Maltodextrin, <i>Lonicera japonica</i> (flower), <i>Forsythia suspensa</i> (fruit), <i>Schizonepeta tenuifolia</i> (aerial), <i>Ginger</i> (<i>Zingiber officinale</i> [root]), <i>Vitex trifolia</i> (fruit), <i>Isatis tinctoria</i> (root), <i>Echinacea purpurea</i> (aerial)		
Proprietary Amino Acid Blend	50 mg	†
L-Lysine hydrochloride, L-Glutamine		

*Percent Daily Values are based on a 2,000 calorie diet.

† Daily Value not established.

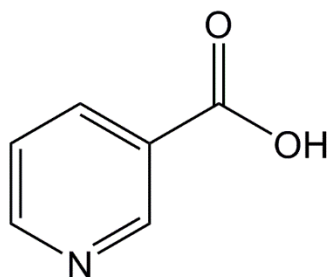
Other Ingredients: sorbitol, citric acid, artificial flavor, silicon dioxide, polyethylene glycol, hydroxypropyl methylcellulose, acesulfame potassium, sucralose, carmine color

take
up to **3X**
per day

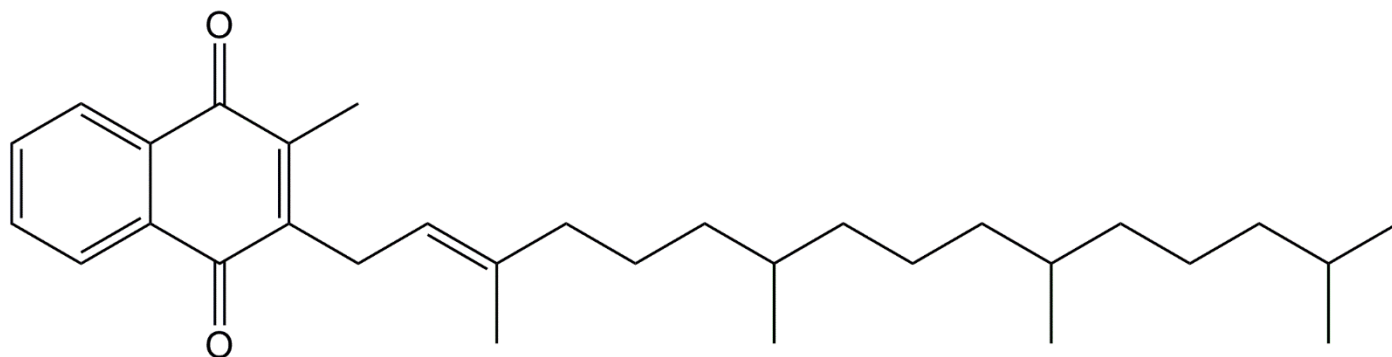
Problem 1

There are no major adverse health effects for consuming megadoses of water-soluble vitamins because they are hydrophilic and excreted by the body when taken in excess. Fat-soluble vitamins, however, are hydrophobic, stored in the fat, and can accumulate when taken in large doses. Thus, over time, megadoses of fat-soluble vitamins can result in vitamin toxicity. This makes megadoses of fat-soluble vitamins potentially more dangerous than water-soluble vitamins.

Shown below are the chemical structures for Vitamin B₃ and Vitamin K₁. Which vitamin's dose should be more carefully monitored over prolonged use?



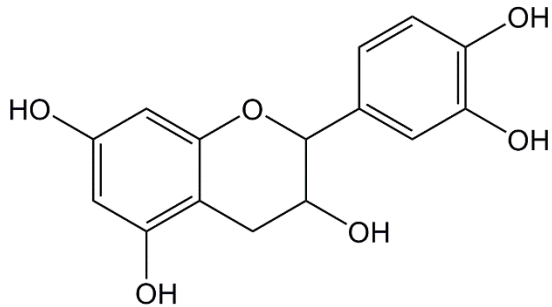
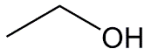
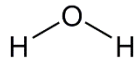
Vitamin B₃
Niacin



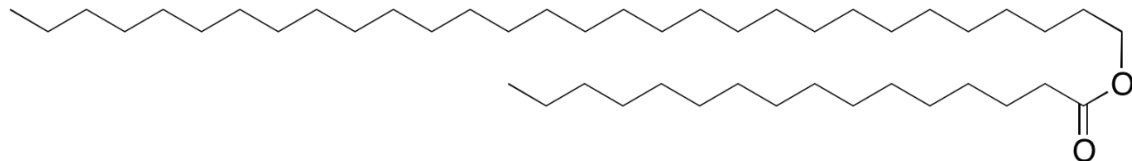
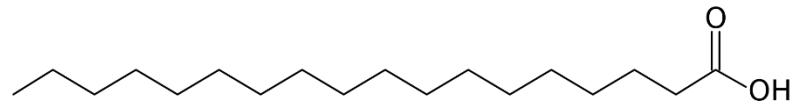
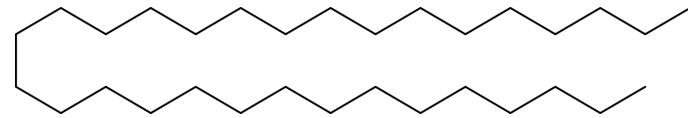
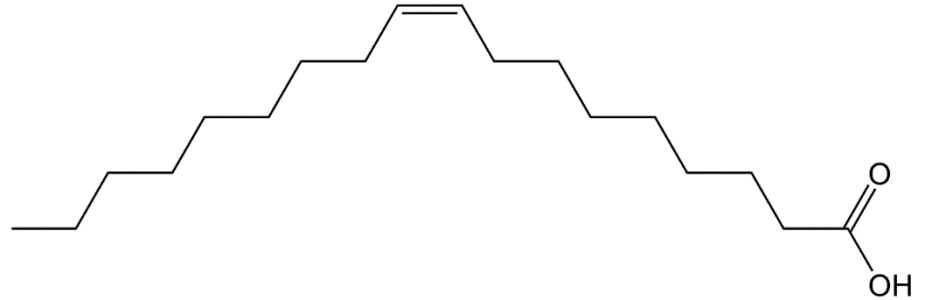
Vitamin K₁
Phylloquinone

What Do You Notice About Hydrophilic and Hydrophobic Compounds?

Hydrophilic

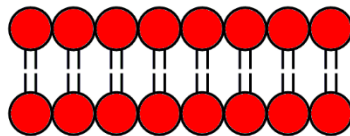
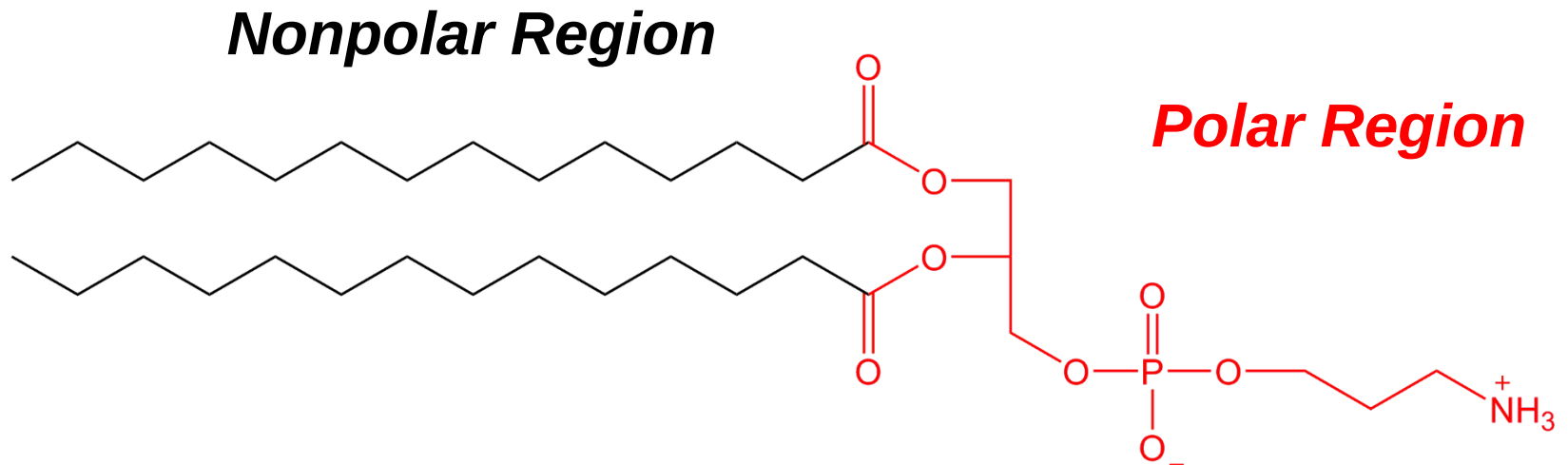


Hydrophobic



Amphiphilic Molecules Have Both Polar and Nonpolar Regions

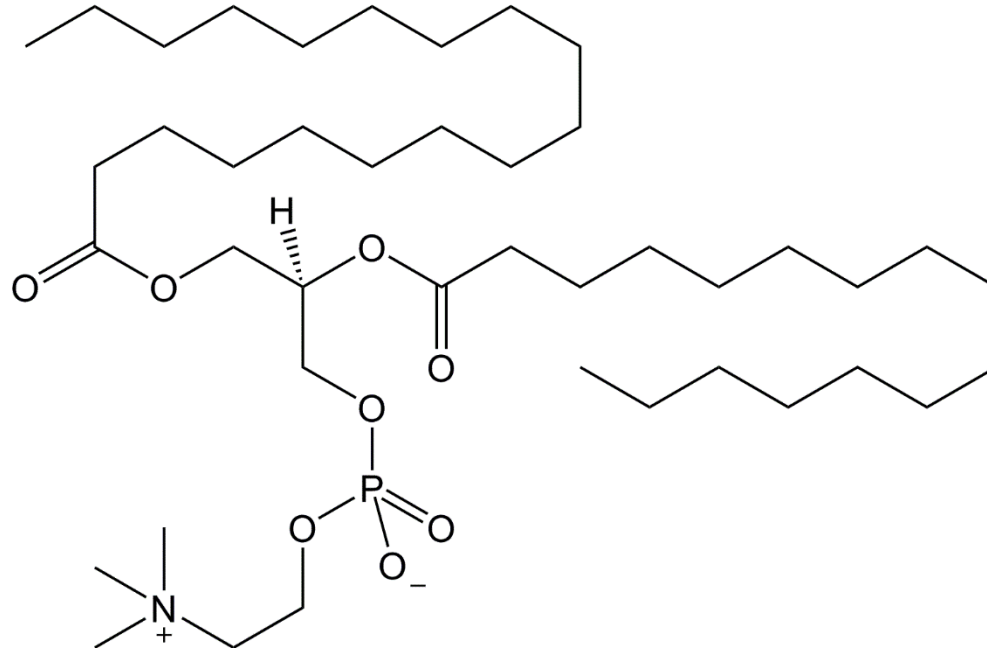
Phospholipid



Phospholipid Bilayer

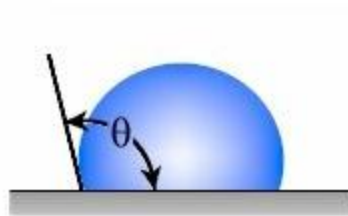
Problem 2

Shown below lecithin, which is commonly used as a food additive (often seen as soy lecithin). Describe why this molecule is amphiphilic?



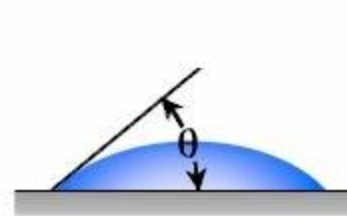
Contact Angle Defines Hydrophobic and Hydrophilic Surfaces

Hydrophobic
Surface



Large
Contact Angle

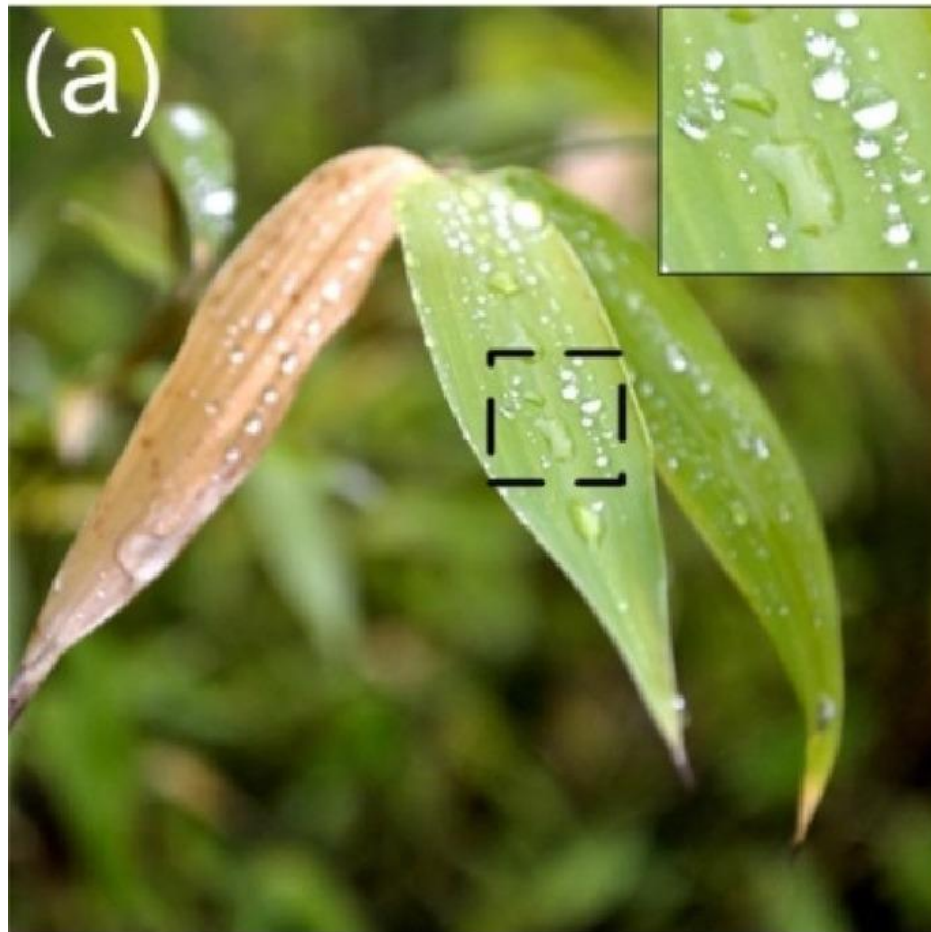
Hydrophilic
Surface



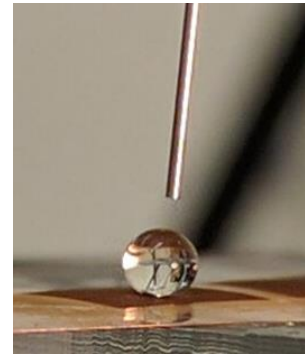
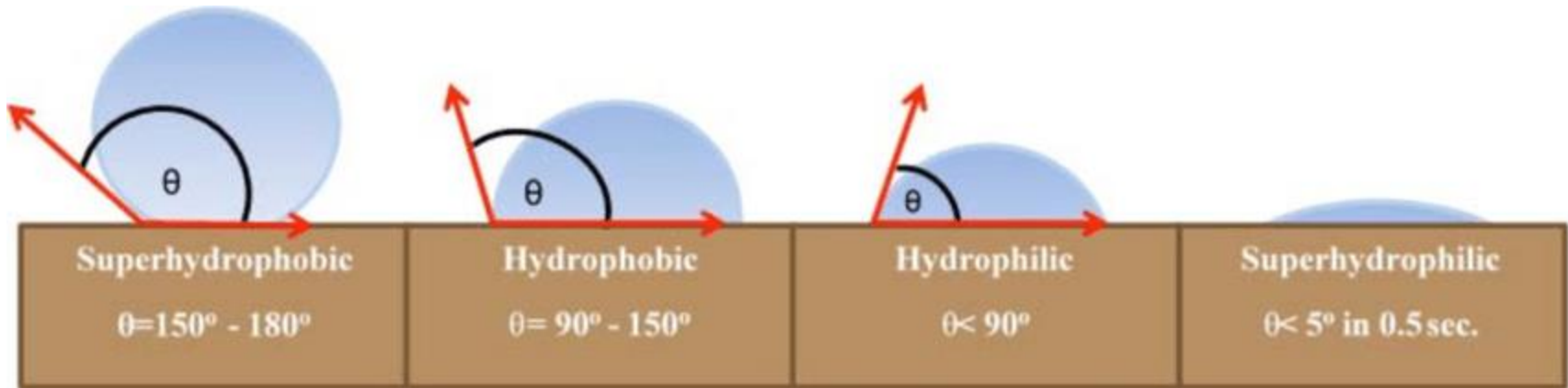
Small
Contact Angle

Problem 3

What can you conclude about the middle region of the leaf vs. the edges?

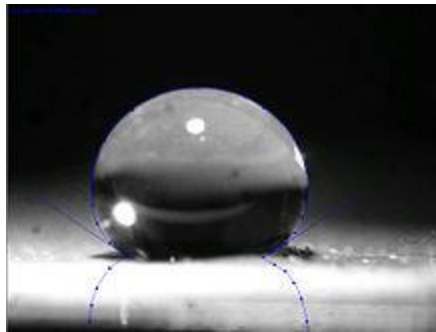


Superhydrophobicity and Superhydrophilicity

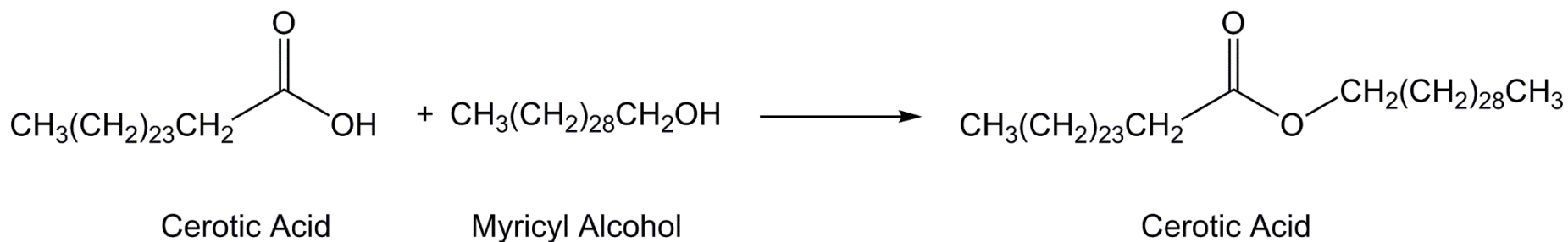


Think-Pair Share

What causes a surface to be superhydrophobic and not just hydrophobic?
Hint, consider the surface at microscale to nanoscale size regime.

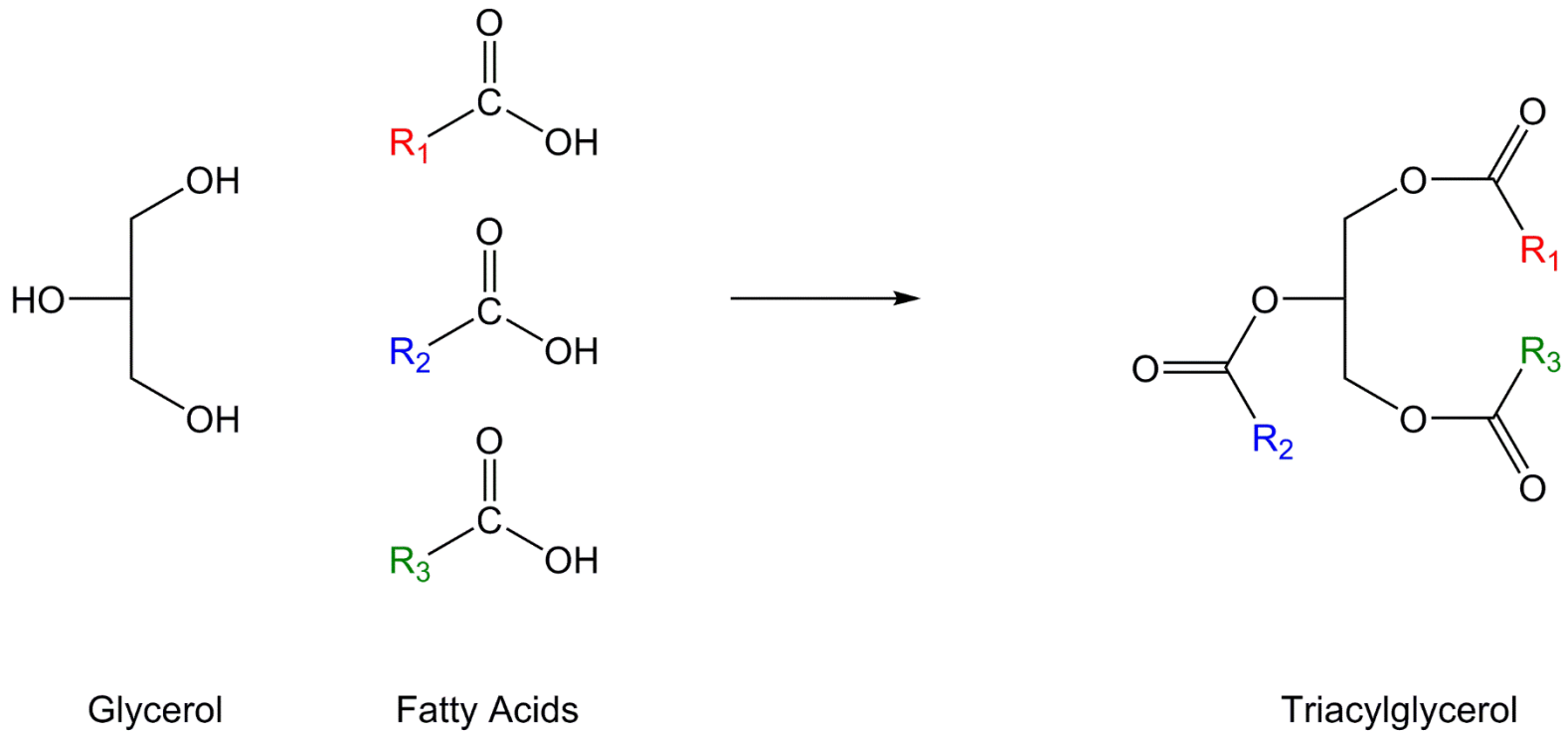


A Wax is an Ester That is Derived From a Fatty Acid and a Long-Chain Alcohol

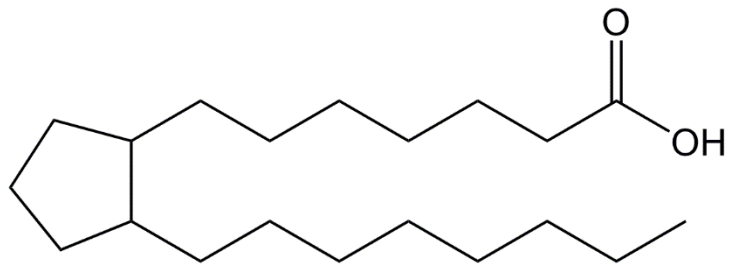


The most abundant Natural Lipids are *Triacylglycerols* or *Triacylglycerides*.

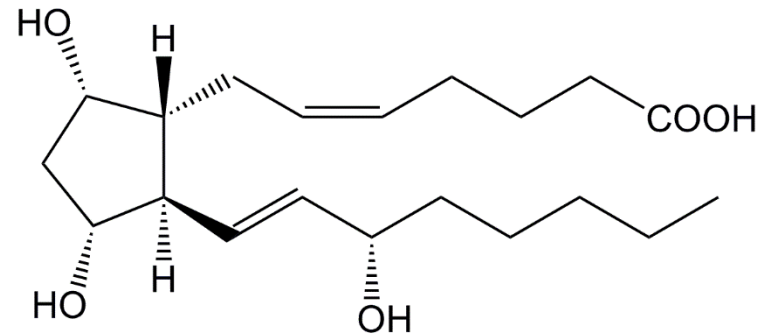
Triacylglycerols (aka triglycerides) are a ***fat*** if solid at room temperature and an ***oil*** if a liquid at room temperature



Lipids That Have The Skeleton Structure Of Prostanoic Acid Are Called Prostaglandins

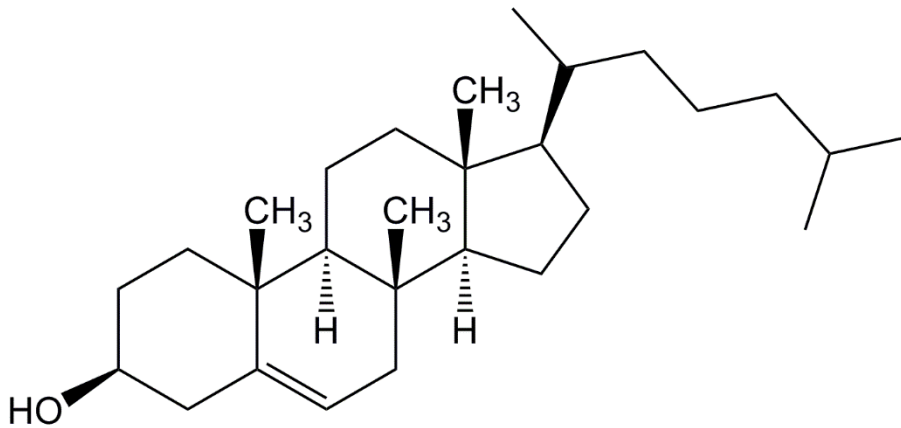
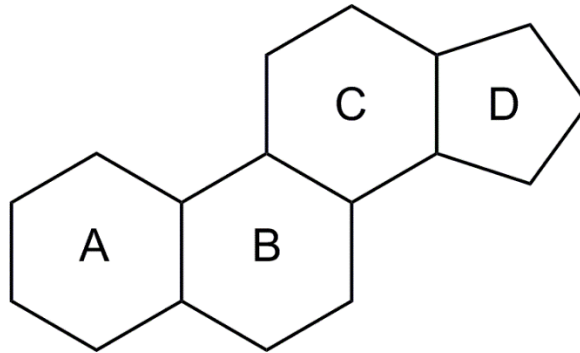


Prostanoic Acid

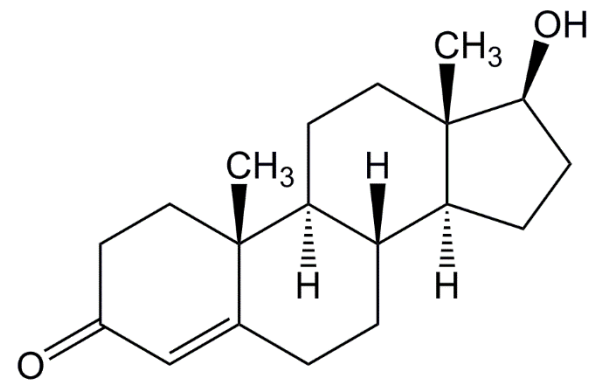


Prostaglandin F_{2α} (PGF_{2α})

Steroids



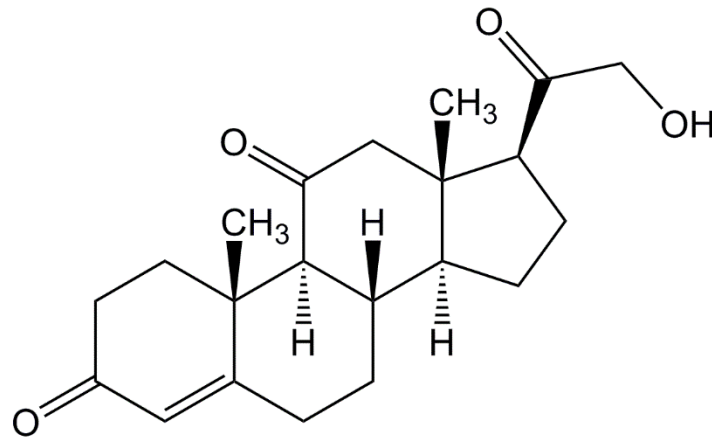
Cholesterol



Testosterone

Cortisone

Corticoid hormones such as cortisone, are glucocorticoid hormones that regulates inflammation and regulate glucose metabolism



Cortisone