Solutions

- CHARACTERISTICS OF A SOLUTION
- SOLUTION TERMINOLOGY
- FACTORS THAT DETERMINE SOLUBILITY
- FORMATION OF A SOLUTION

THE CHARACTERISTICS OF A SOLUTION

1. A solution is a homogeneous mixture.
   (Is our lip balm homogeneous or heterogeneous?)

2. A solution may exist in any of the three states: gas liquid or solid.

3. Particle size distinguishes solutions from other mixtures, generally these particles are less than 5×10^{-7} cm in diameter.

Terminology

- **Soluble-** able to dissolve in a particular solvent
- **Insoluble-** not able to dissolve in a particular solvent
- **Solute-** the substance that dissolves
- **Solvent-** the substance that dissolves the solute
- **Miscible**- liquids that are soluble in each other
- **Immiscible**- liquids that are not soluble in each other

- **Solvation-** the process of surrounding solute particles with solvent particles
- **Heat of Solution-** the energy change that accompanies the dissolving process
- **Concentration-** the amount of solute dissolved in a measured amount of solvent

FACTORS THAT DETERMINE SOLUBILITY

The extent to which a particular solute dissolves in a given solvent depends on three things

1. **The strength of the intermolecular forces (we will look at this concept in some detail)**

2. **The partial pressure of a solute gas over a liquid solvent (we will not go into this concept here)**

3. **The temperature (we will heat our mixture which increase the dissolving process)**

INTERMOLECULAR FORCES

- **Solubility is a macroscopic process that depends on microscopic intermolecular (IM) forces**

- **Generally speaking, if IM forces between solute-solute are similar to IM forces between solvent-solvent, then solute and solvent will probably dissolve in one another.**

In other words…

"LIKE DISSOLVES LIKE"

Heterogeneous mixtures

The substances exist in distinct phases:

- Two solids blended together
- A solid undissolved in a liquid
- Two immiscible liquids (oil and water)

Two types of heterogeneous mixtures

- Suspensions
- Colloids

Suspension- A heterogeneous mixture in which one substance is "suspended" in another substance

Example: Cornstarch mixed with water

- **Gravity acts on suspended particles causing them to settle out**
- **The solid particles will fall to the bottom if left undisturbed**
- **The solid particles are often large enough to be filtered**
- **The suspended particle size is approximately 1000 times larger than atoms**

Colloid- A mixture in which solute particles are larger than solution particles but smaller than suspension particles

Colloids may be homogeneous or heterogeneous- the distinction is not always clear

Colloids are often described as a dispersed phase in a continuous phase

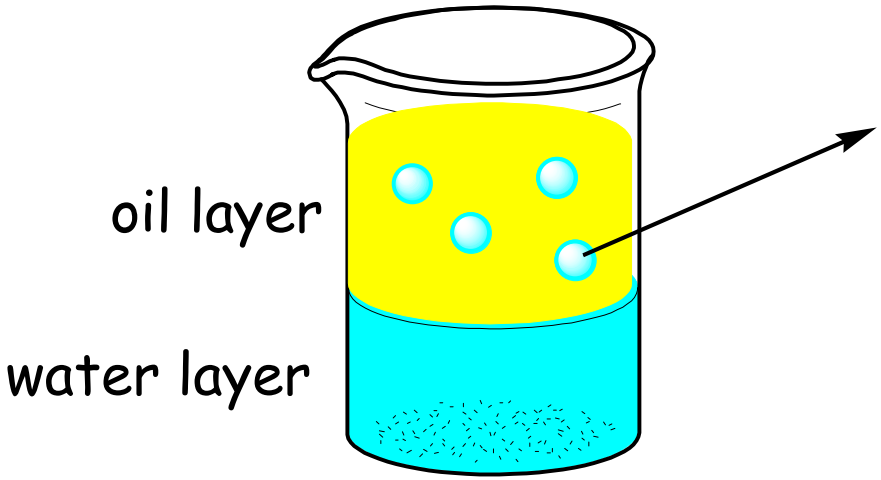
The dispersed phase is the solute and the continuous phase is the solvent

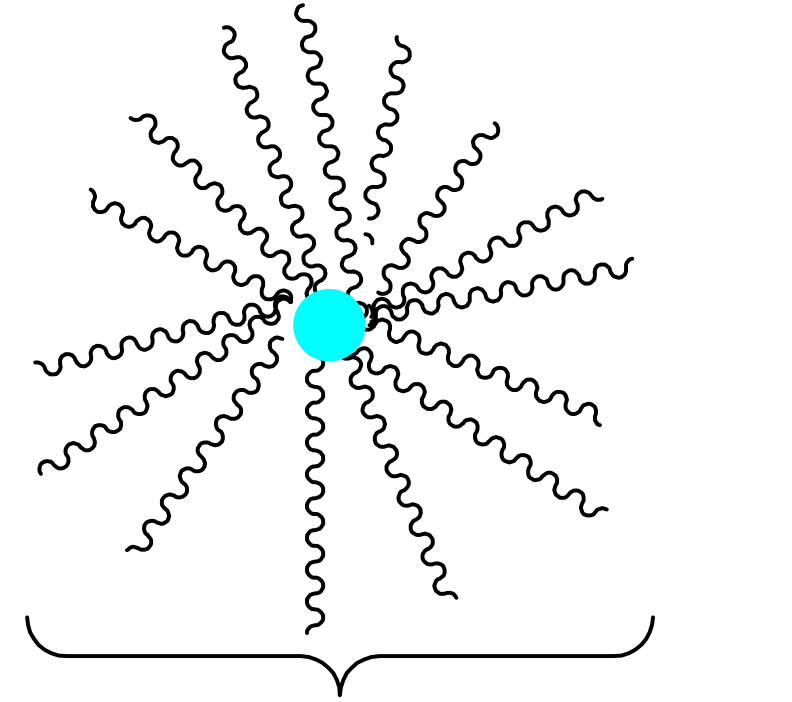
Example: cow's milk

Milk resembles the cornstarch mixture except the particles in milk will not separate over time; the solutes cannot be filtered

Here is a suspension- water droplets dispersed in an oil layer

Oil and water mixture- some water dispersed into the oil layer





If the water droplets are big enough, they will settle back into the water layer.

Lipstick-
a colloid or a suspension?

If we can filter the particles, it would seem to fit the definition of a suspension

If we cannot filter the particles, we could classify lipstick as a colloid

What if we filter some of the solutes but not all? The definition gets a little ambiguous.

Why does lipstick stick to lips?

There must be some attraction between the lips and the lipstick product.

The ingredients of lipstick must have similar properties to the lipid bilayer of human skin

What are the ingredients in lipstick?

We use the concept of a colloid to describe lipstick

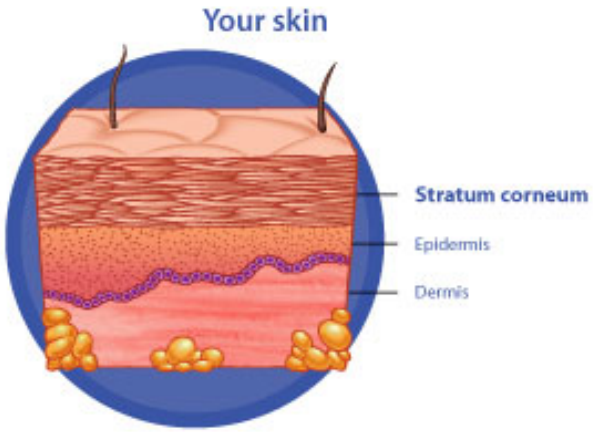
The continuous phase is primarily:

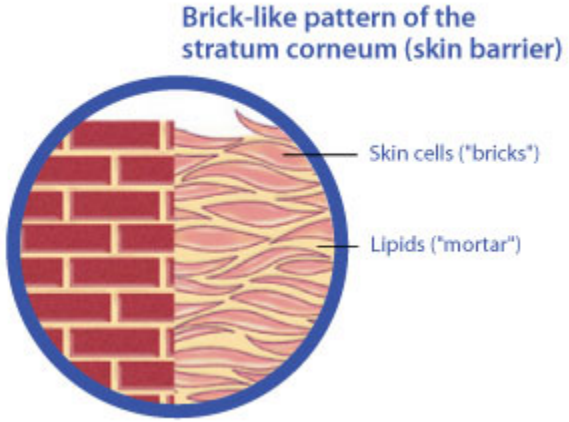
- Beeswax
- carnauba wax

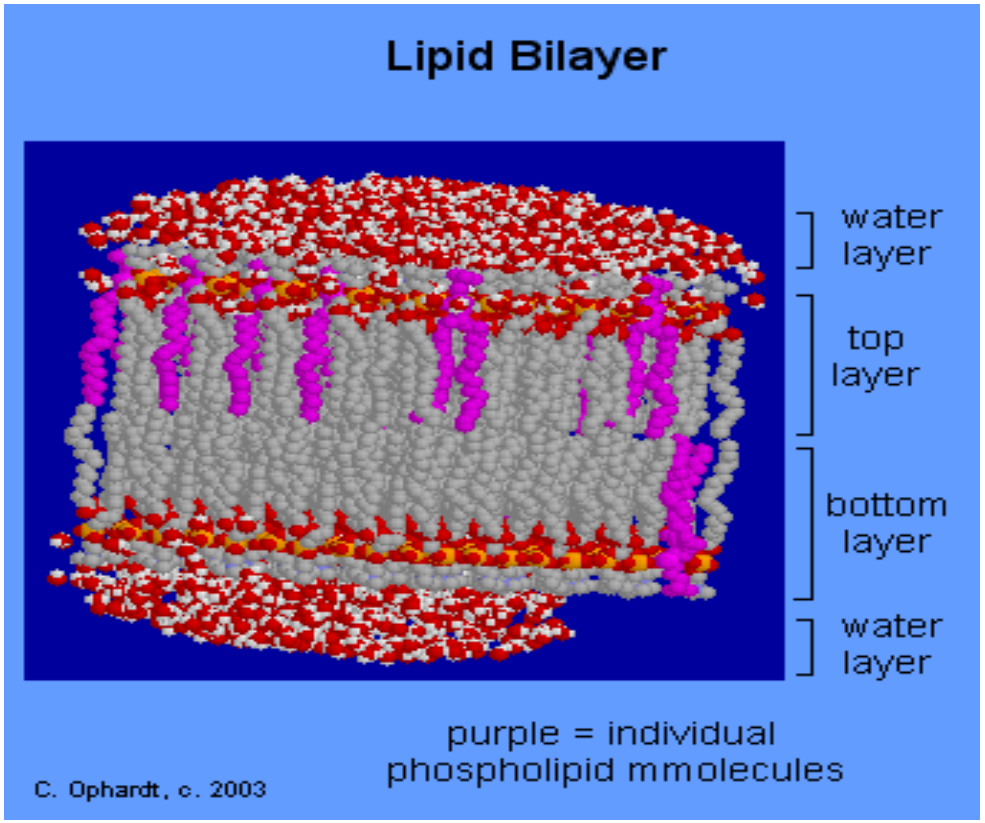
The dispersed phase is a combination of:

- vitamin E
- lanolin
- natural flavors and scented oils
- mica

Take a closer look at your skin



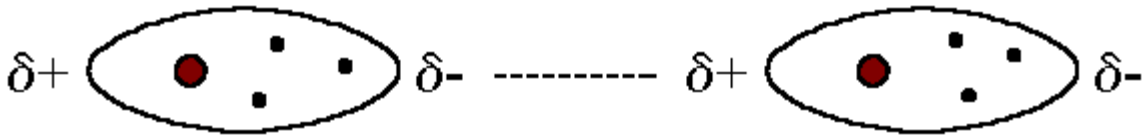




TYPES OF INTERMOLECULAR FORCES

- **London dispersion Forces: attraction of instantaneous and induced**

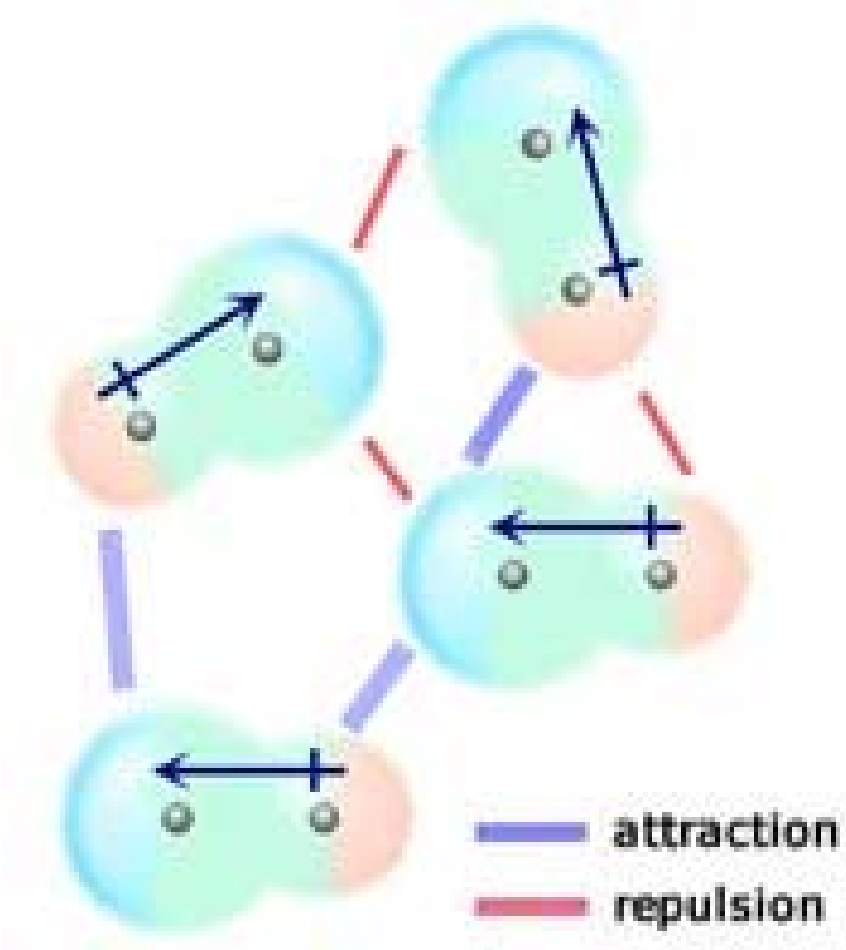
  dipoles; exist between all molecules.



- **London dispersion forces increase with increasing molecular weight.**

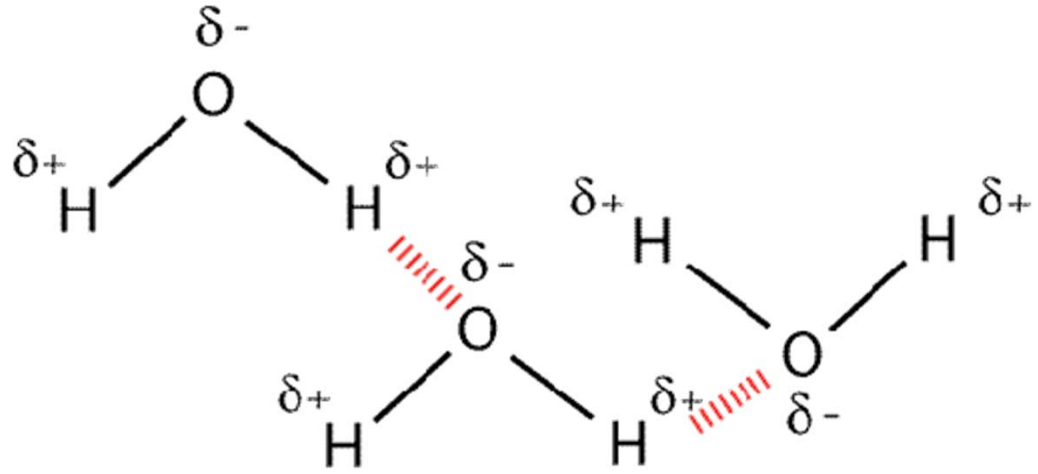
TYPES OF INTERMOLECULAR FORCES

- **Dipole-Dipole:** Dipole-dipole attractions take place when two or more neutral, polar molecules are oriented such that their positive (+) and negative (-) ends are close to each other.



TYPES OF INTERMOLECULAR FORCES

- **Hydrogen Bonding:** The hydrogen bond is really a special case of dipole forces. A hydrogen bond is the attractive force between the hydrogen attached to an electronegative atom of one molecule and an electronegative atom of a different molecule. The electronegative atom is oxygen, nitrogen, or fluorine, which has a partial negative charge. The hydrogen then has the partial positive charge.



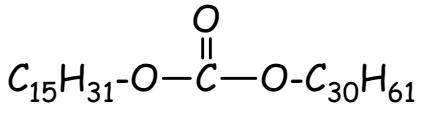
WHAT TYPES OF INTERMOLECULAR FORCES ARE INVOLVED IN THE LIPSTICK MIXTURE?

- Lets look at the structures of the molecules involved
- Some of our ingredients are solutions in their own right
- For example – castor oil

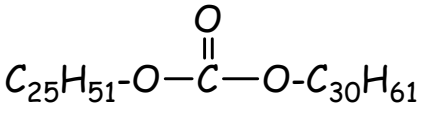
WHAT TYPES OF INTERMOLECULAR FORCES ARE INVOLVED IN THE LIPSTICK MIXTURE?

Beeswax-

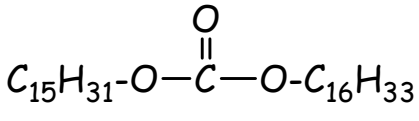
a complex mixture



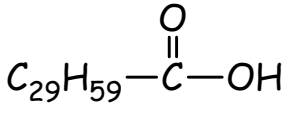
ester of palmitic acid and myricyl alcohol



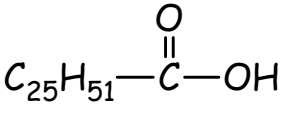
ester of hexaeicosanic acid and myricyl alcohol



ester of palmitic acid and cetyl alcohol



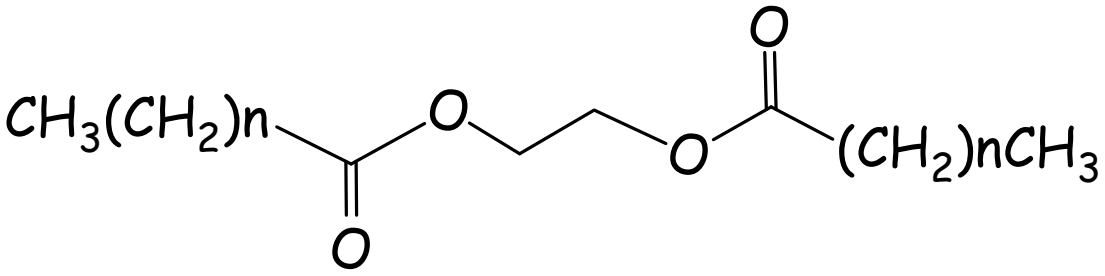
melissic acid



cerotinic acid

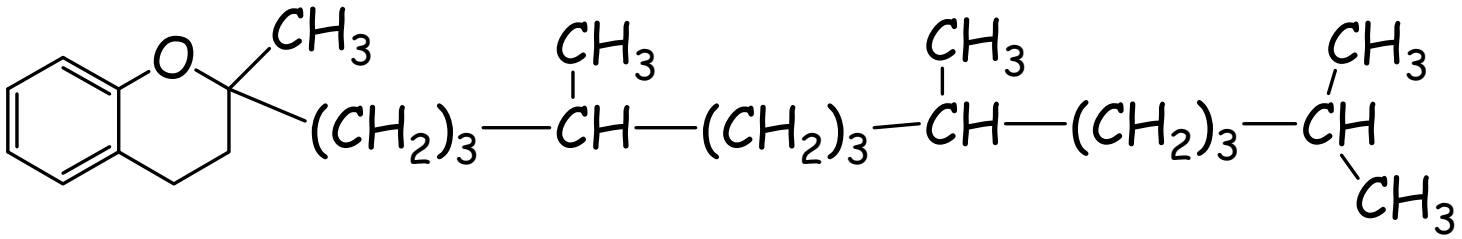
WHAT TYPES OF INTERMOLECULAR FORCES ARE INVOLVED IN THE LIPSTICK MIXTURE?

- **Carnauba wax- a complex mixture of mostly saturated fatty acid ester, and fatty acid ester diols**



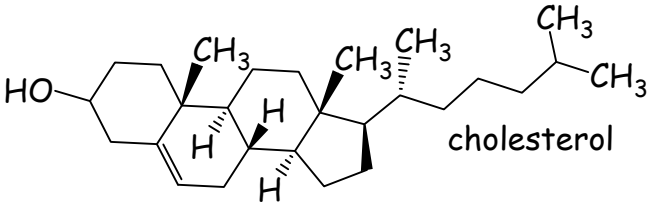
fatty ester diol
n = 14 - 20

- **Vitamin E Oil**



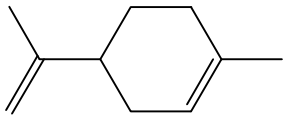
WHAT TYPES OF INTERMOLECULAR FORCES ARE INVOLVED IN THE LIPSTICK MIXTURE?

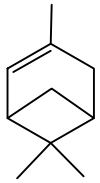
- **Lanolin- a complex mixture of cholesterol, fatty acid esters and even some wood alcohol (methanol) in crude mixtures.**

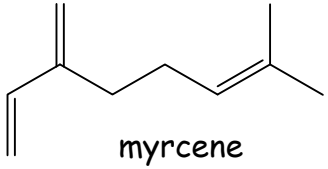


cholesterol

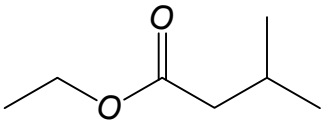
- **Grapefruit oil- most likely the aroma is due to a mixture of terpenes:**


limonene

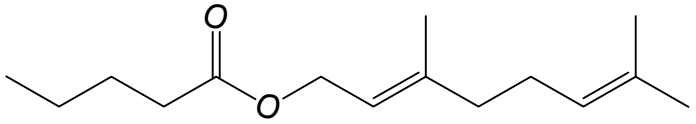

α-pinene


myrcene

- **Apple oil- mixture of esters such as ethyl isovalerate and a long chain pentanoate**



ethyl isovalerate



geranyl pentanoate