



Bridging the gap between oil and water

MILK, CREAM, AND BUTTER



What is milk? Mostly water!

Species	Water	Fat	Casein	Whey	Lactose
Human	87.1	4.6	0.4	0.7	6.8
Cow	87.3	4.4	2.8	0.6	4.6
Buffalo	82.2	7.8	3.2	0.6	4.9
Goat	86.7	4.5	2.6	0.6	4.4
Sheep	82.0	7.6	3.9	0.7	4.8
Horse	88.8	1.6	1.3	1.2	6.2
Rat	79.0	10.3	6.4	2.0	2.6
Reindeer	66.7	18.0	8.6	1.5	2.8
Camel	86.5	4.0	2.7	0.9	5.4

Water is major component.

Second major component varies.



Milk is an emulsion of water and fat phases



When a mixture is composed of two different types of phases, it is called **heterogeneous** – where “hetero” means different

The water phase and the molecules dissolved in it are *polar* or *hydrophilic*

The fat/oil phase and the molecules dissolved in it are *non-polar* and *hydrophobic*

Table. The components of milk

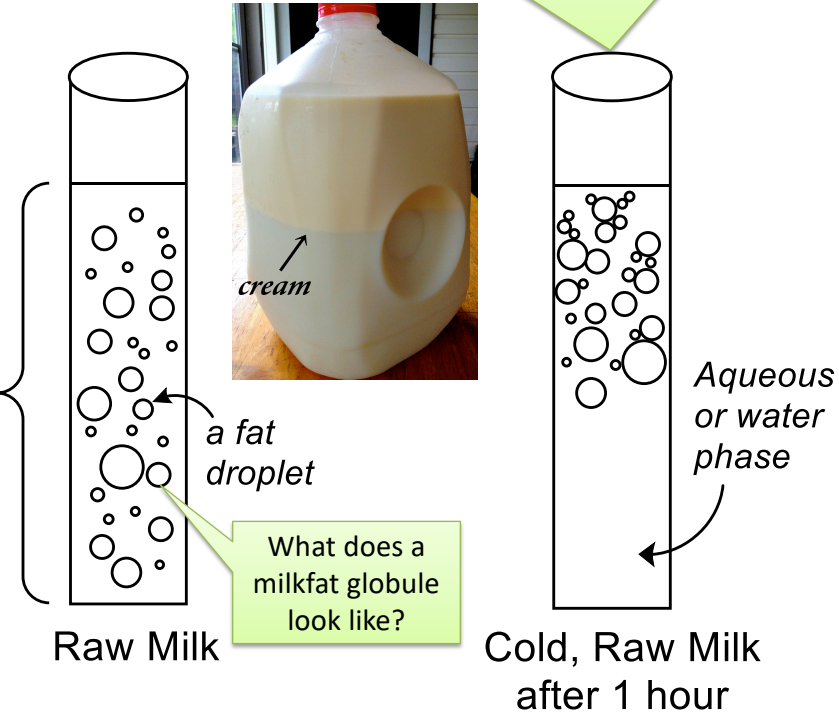
Water (Aqueous) Phase = <i>Serum</i>			Fat/Oil Phase		
Water	<u>Protein</u> Casein, whey	Lactose	Fat droplets (globules)	Fat soluble vitamins	Select proteins
Minerals	Water soluble Vitamins	Some	The enzyme lipase		

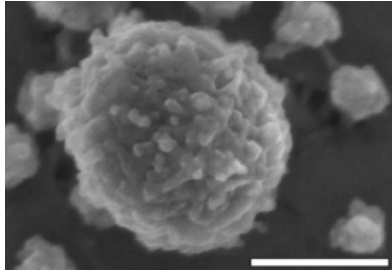
Milk fats are dispersed as fat droplets (also called *fat globules*) within the aqueous/water phase – these fat droplets are encased in a membrane of phospholipids and proteins.



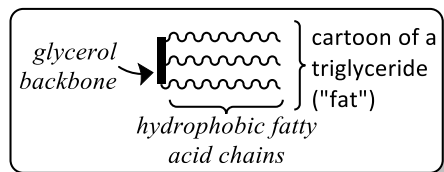
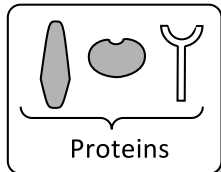
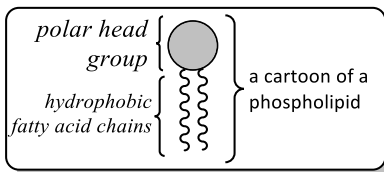
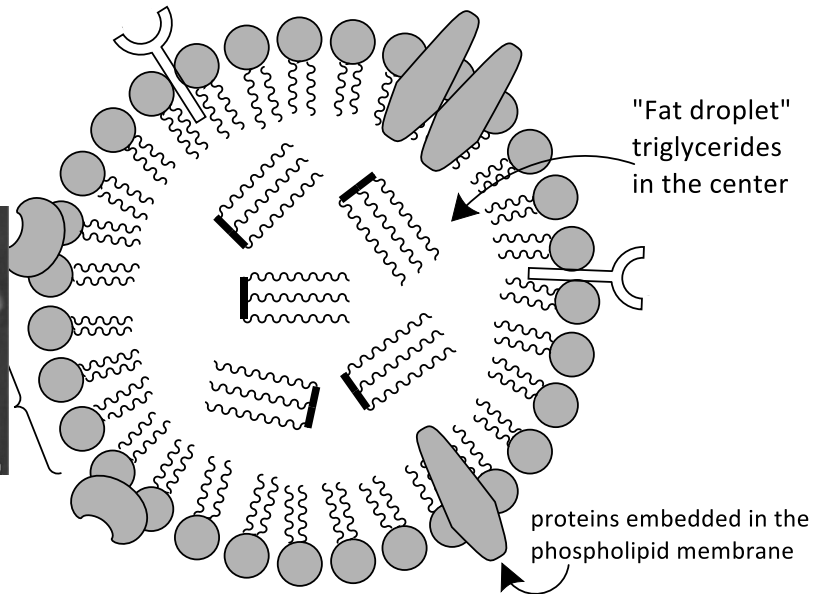
Raw milk straight from the dairy cow will eventually separate into two phases upon standing - the water phase on the bottom, and the cream (or fat phase) on top

Milk fats are dispersed as fat droplets (also called fat globules) within the aqueous/water phase.



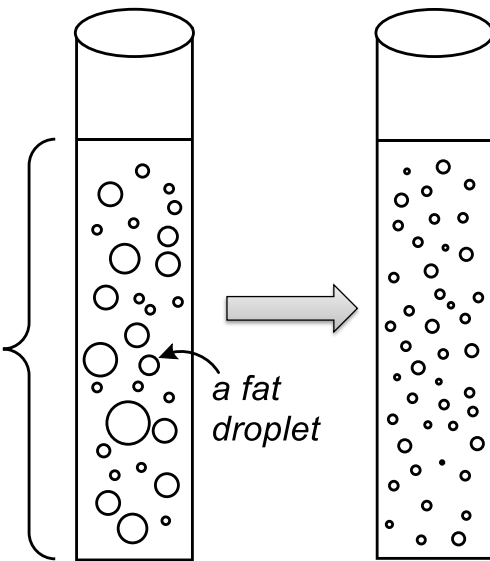


Milk Fat Globule



When fats/oils and water are aggressively mixed until they form a stable mixture (i.e. one that is not separated into two phases) it is called an **emulsion**.

Milk fats are dispersed as fat droplets (also called fat globules) within the aqueous/water phase.




Raw Milk

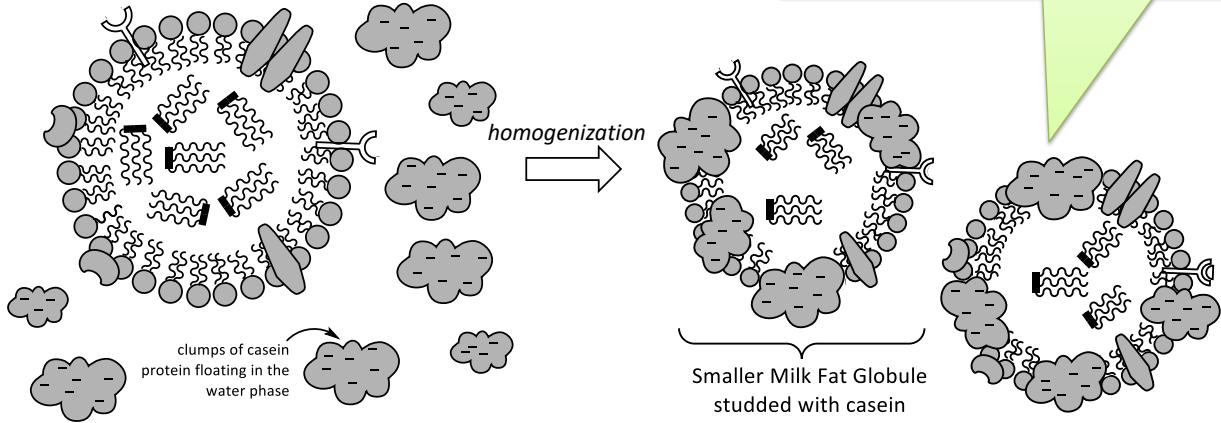
Homogenized milk

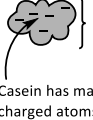
Aggressive mixing of the fat globules during **homogenization** shears the globule membranes making many smaller fat globules.

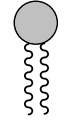


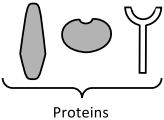

 a clump of casein protein called a *micelle*
 Casein has many negatively charged atoms on its surface

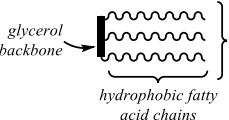
The phospholipid membrane is torn to make two smaller globules. Clumps of casein protein fill in the gaps of the fat globule membrane and are additional emulsifying agents




 a clump of casein protein called a *micelle*
 Casein has many negatively charged atoms on its surface

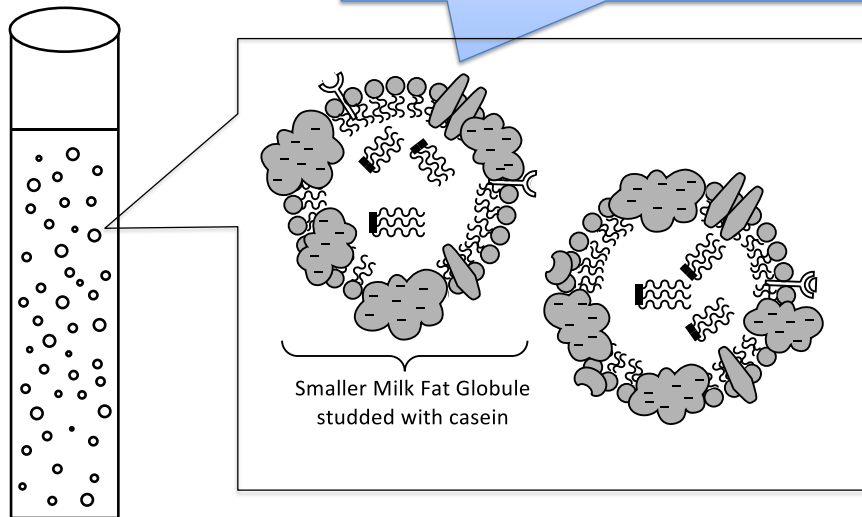
polar head group

 a cartoon of a phospholipid
hydrophobic fatty acid chains


 Proteins

glycerol backbone

 a cartoon of a triglyceride ("fat")
hydrophobic fatty acid chains



Why are the casein-studded fat globules less likely to combine with one another? What keeps them separate? (and keeps *your milk* from separating into water and cream!)



Homogenized milk



Whole milk contains 3.5% fat while skim milk contains 0.5% fat, while heavy/whipping creams contain 30-40% fat. Skim milk and heavy cream are both made from whole milk while the milk is still “raw” (that is, before *homogenization*).



Why must the milk be un-homogenized?



Creams

Cream

- the fat-enriched portion of milk that rises to the top of milk.
- If fresh, unhomogenized milk is left undisturbed, the lighter-than-water fat globules will eventually float to the top and gather together,
 - Fat globules can be skimmed away from the "skim milk" left on the bottom.

