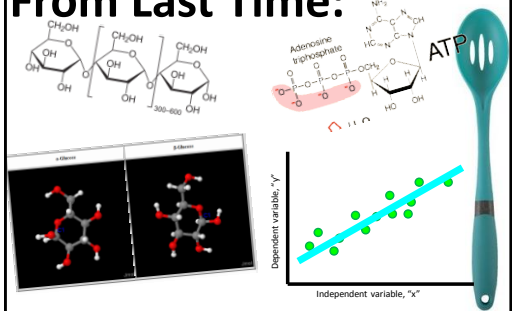
From Last Time:



Milk

- ***WHAT IS MILK***? U.S. Code of Federal Regulations, Title 21, Vol. 8, Chpt 1, Pt 1240, subpart A, Section 1240.3(j), Release 13
- "Milk is the lacteal secretion, practically free from colostrum, obtained by the complete milking of one or more healthy cows. Milk that is in final package form for beverage use shall have been pasteurized or ultrapasteurized, and shall contain not less than 8 1/4 percent milk solids not fat and not less than 3 1/4 percent milkfat. Milk may have been adjusted by separating part of the milkfat therefrom, or by adding thereto cream, concentrated milk, dry whole milk, skim milk, concentrated skim milk, or nonfat dry milk. Milk may be homogenized."

Milk

Protein-rich water with an emulsion of protein-coated fat globules

Water phase (aqueous):

Slightly acidic water (pH ~6.6)

Protein bundles

Lactose

Fat phase:

Droplets of oil with a protein shell

Mixtures

Homogeneous

Pure substances

Solutions

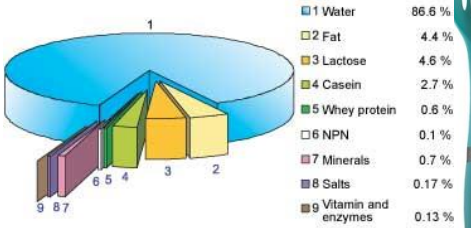
Heterogeneous

Bulk mixtures, melange

Suspension/colloid, emulsion

Emulsifiers and amphiphiles

Milk Composition

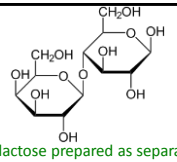


NPN – Non-protein nitrogenous compounds

Sources of milk:

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*
Donkey	**88.3**	*1.5*	*1.0*	1.0	**7.4**
Reindeer	*66.7*	**18.0**	**8.6**	**1.5**	*2.8*
Camel	86.5	4.0	2.7	0.9	5.4

Lactose



- Disaccharide - glucose and galactose prepared as separate molecules and condensed into "milk sugar" through the secretory cells
- Ability to digest (metabolize or "break down") lactose requires a special enzyme – lactase
- Lactase is produced in gut by children but levels decrease in adults.
- Northern Europeans maintain levels but only 30% of others can produce significant quantities

Lactose Intolerance

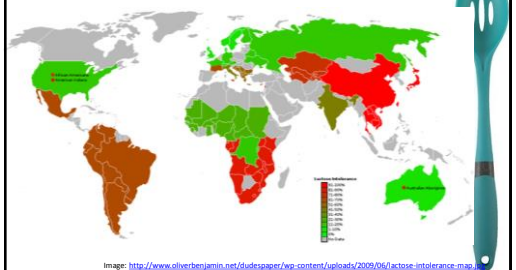


Image: http://www.oliverbenjamin.net/dudespaper/wp-content/uploads/2009/06/lactose-intolerance-map.jpg

Lactose Intolerance

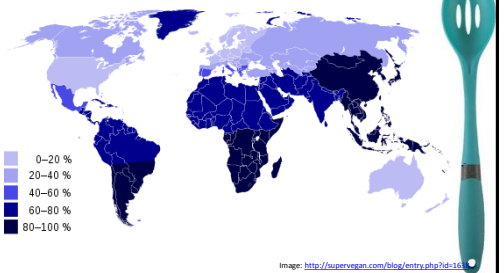
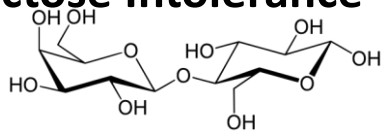


Image: http://supervegan.com/blog/entry.php?id=161

Lactose Intolerance



Lactase – <u>hydrolytic</u> enzyme

Lactose passes through to gut

- *Draws water in (osmosis)*
- *Bacterial digestion – $CH_4(g)$, $CO_2(g)$*
- *Cramps, gas, diarrhea*

Image: http://en.wikipedia.org/wiki/File:Beta-D-Lactose.png

Purpose of Lactose

Glucose

- *Protected as disaccharide*
- *Energy source*

Galactose

- *Neural tissue*
- *Make brains…*

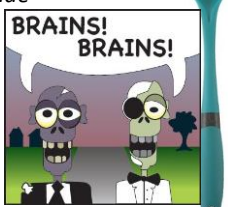


Image: http://blogity-blah-blah-blog.blogspot.com/2012_01_01_archive.html

Milk Protein - Casein

- Major single protein produced in most milk
- Key characteristics of casein
- Heat stable – well folded protein
- "floats" in micelle form (globs of protein arranged to keep the protein in solution)
  - Hydrophobic portion of protein in middle
- Calcium binds tightly to this protein – helps to carry calcium into the blood system!
- Four main forms of Casein – one "caps" micelles limiting the size
- At pH levels above 4.5, proteins are negatively charged and repel.
- When acid increases to pH lower than 4, proteins denature and are not charged – thus they bind to each other and "curdle"
- Body builders sometimes use this as a "slow-digesting protein" (why)

Casein Micelles

kappa-Casein coating

Calcium-binding

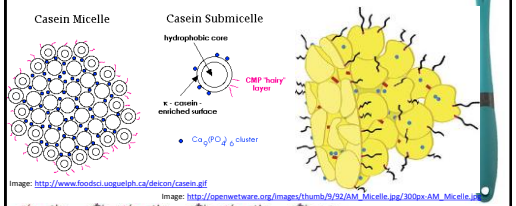


Image: http://www.foodsci.uoguelph.ca/deicon/casein.gif

Image: http://openwetware.org/images/thumb/9/92/AM_Micelle.jpg/300px-AM_Micelle.jpg

Acids and Bases

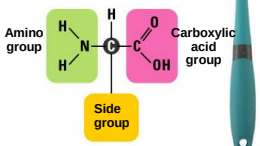
Acids = increase concentration of hydrogen ion (H^+) when dissolved in water

Bases = decrease concentration of hydrogen ion (H^+) when dissolved in water (increase OH^- concentration)

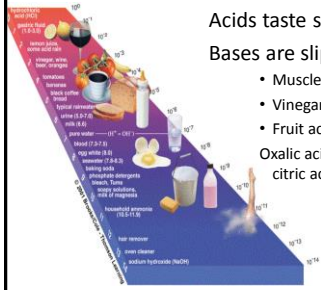
$H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$

"Neutralization"

pH scale



Acids and Bases



Acids taste sour

Bases are slippery to the skin

- Muscle acid – lactic acid
- Vinegar – acetic acid
- Fruit acid – citric acid

Oxalic acid – used in candy with citric acid

Milk Protein - Whey

- Soluble in acidic aqueous phase
- Many whey proteins are immunoglobins (antibodies for the young animal)
- Lactoglobin has several sulfur atoms – provides flavor and odor to cooked milk
- Proteins in whey are used for animals as source of nutrition
- Under more extreme conditions than casein, whey proteins can form small clots – ricotta cheese
- These proteins help make ice cream… creamy

Milk Fat

Globules of fat in a phospholipid and protein shell (Emulsifiers)

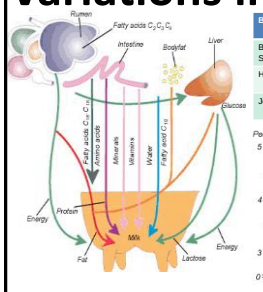
Homogenization

Heat-stable globules

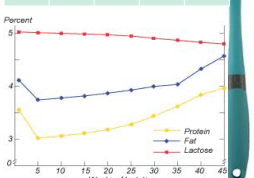
Cold breaks fat globules – ice, ice, baby

Fat soluble vitamins – A, D, E, K

Variations in Milk



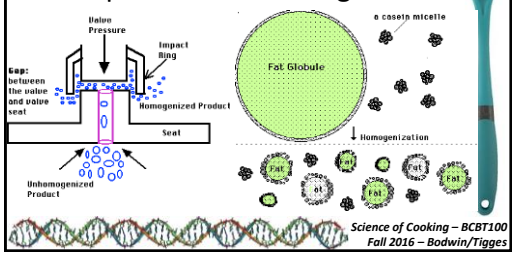
Breed	Fat %	Casein %	Whey %	Lactose %
Brown Swiss	3.8	2.63	0.55	0.72
Holstein	3.56	2.49	0.53	0.73
Jersey	4.97	3.02	0.69	0.77



Homogenization

Increase surface area

Casein proteins coat – Negative



Sphere Math

Volume = $^4/_3\ \pi\ r^3$

Surface area = $4\ \pi\ r^2$

1 sphere, 2cm radius

Volume = $^4/_3\ \pi\ (2cm)^3 = 34cm^3$

Surface = $4\ \pi\ (2cm)^2 = 50.cm^2$

Break into 2 spheres:

Volume of each = $17cm^3 = {}^4/_3\ \pi\ (x)^3 \rightarrow x = 1.6cm$

Surface of each = $4\ \pi\ (1.6cm)^2 = 32cm^2$

Total surface = $64cm^2$ → too much!

Homogenization

Increase surface area

Casein proteins coat – Negative