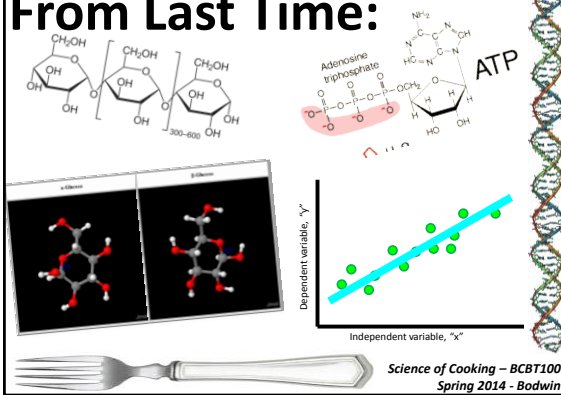


From Last Time:



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
- “the lacteal secretion obtained from one or more healthy milk-producing animals, e.g. cows, goats, sheep, and water buffalo, including, but not limited to, the following: lowfat milk, skim milk, cream, half and half, dry milk, nonfat dry milk, dry cream, condensed or concentrated milk products, cultured or acidified milk or milk products...”

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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

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Mixtures

Homogeneous

Pure substances

Solutions

Heterogeneous

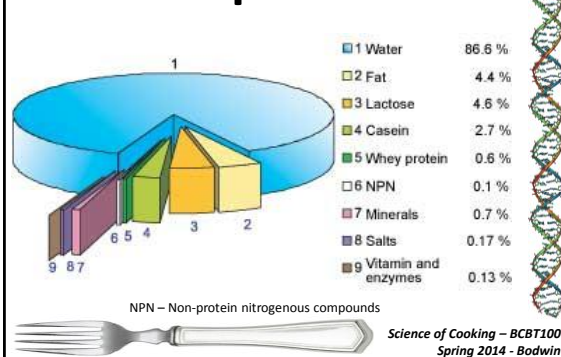
Bulk mixtures, melange

Suspension/colloid, emulsion

Emulsifiers and amphiphiles

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Milk Composition

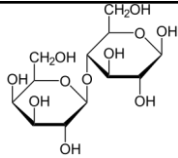


Sources of milk:

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

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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



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Lactose Intolerance

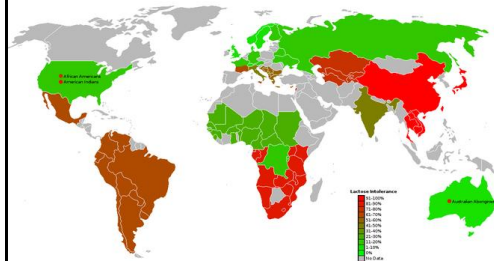
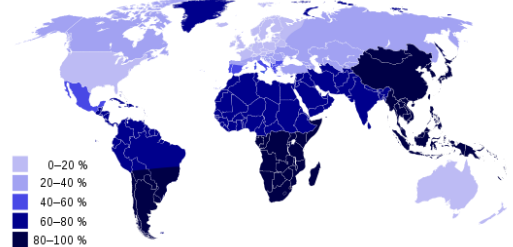


Image: <http://www.oliverbenjamin.net/studiespaper/wp-content/uploads/2009/06/lactose-intolerance-map.jpg>



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Lactose Intolerance



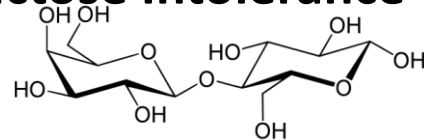
0–20 %
20–40 %
40–60 %
60–80 %
80–100 %

Image: <http://supervegan.com/blog/entry.php?id=1633>



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Lactose Intolerance



Lactase – hydrolytic enzyme

Lactose passes through to gut

Draws water in (osmosis)

Bacterial digestion – $\text{CH}_4(\text{g})$, $\text{CO}_2(\text{g})$

Cramps, gas, diarrhea

Image: <http://en.wikipedia.org/wiki/File:Beta-D-Lactose.svg>



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Purpose of Lactose

Glucose

Protected as disaccharide

Energy source

Galactose

Neural tissue

Make brains...

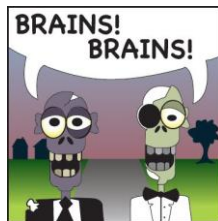


Image: http://bobby-blah-blah.blogspot.com/2012/01/01_archive.html



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Milk Protein - Casein

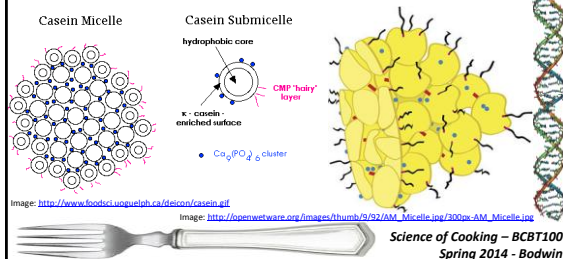
- Major single protein produced in most milk
- Key characteristics of casein
 - Heat stable – well folded protein
- "floats" in micelle form (globs of protein arranged to keep the protein in solution)
 - Hydrophobic portion of protein in middle
- Calcium binds tightly to this protein – helps to carry calcium into the blood system!
- Four main forms of Casein – one "caps" micelles limiting the size
- At acid 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)



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Casein Micelles

kappa-Casein coating
Calcium-binding



Milk Protein - Whey

- Soluble in acidic aqueous phase
- Many whey proteins are immunoglobins (antibodies for the young animal)
- Lactoglobulin 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

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Pop Quiz!

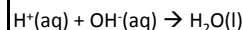
What would happen if a mutant cow created casein proteins with different amino acids which were not negatively charged in milk?

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Acids and Bases

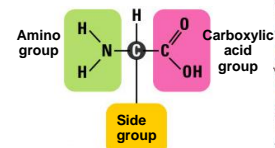
Acids = increase concentration of hydrogen ion (H^+) when dissolved in water

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



"Neutralization"

pH scale



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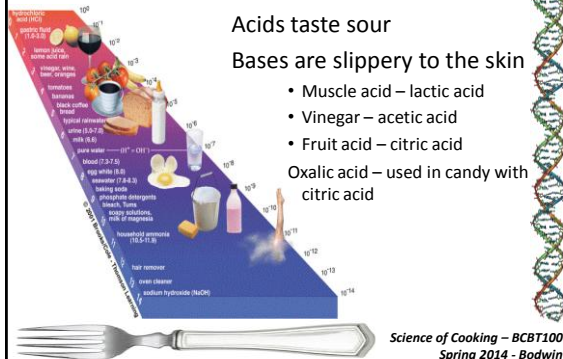
Acids and Bases

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 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

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Variations in Milk

