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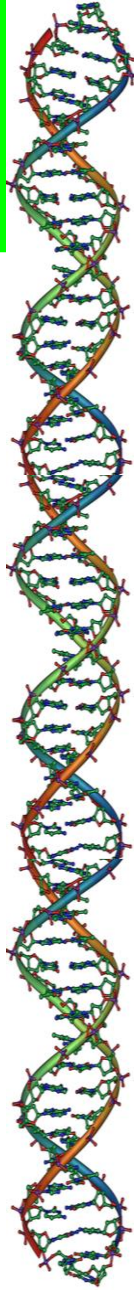
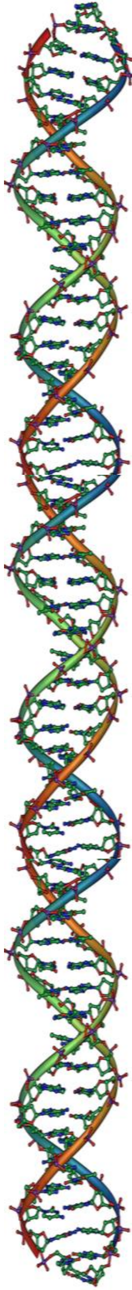
V101 – Course intro



BCBT 100 – Welcome!

Class organization, logistics



Dr. Bodwin Info

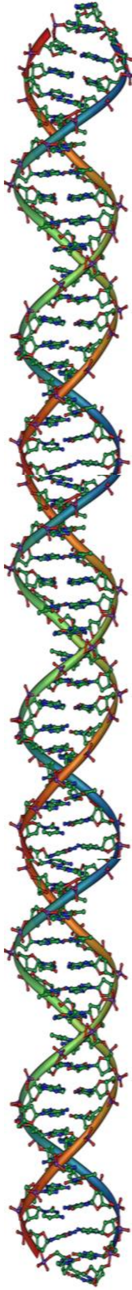
Dr. Bodwin

bodwin@mnstate.edu

www.drbodwin.com/teaching

D2L Brightspace

@DrBodwin (twitter)



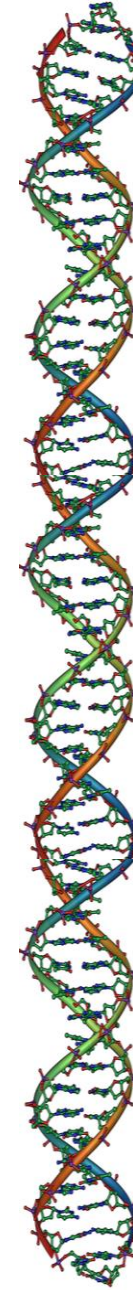
Philosophy of Class

LASC 3 with Lab

- Employ a scientific approach to food, flavor, and cooking

Lab/Experiential activities

NOT a cooking class, a science class about food and cooking



Grading

D2L quizzes

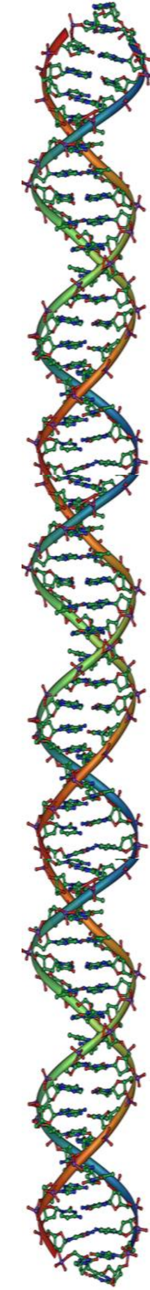
Lab assignments

Participation in D2L discussions

Pace of the Class

If this were a 3-week face-to-face class, it would meet 3 hours a day, 5 days a week. PLUS there would be lab and homework time outside of class.

Expect to devote an equivalent amount of time!



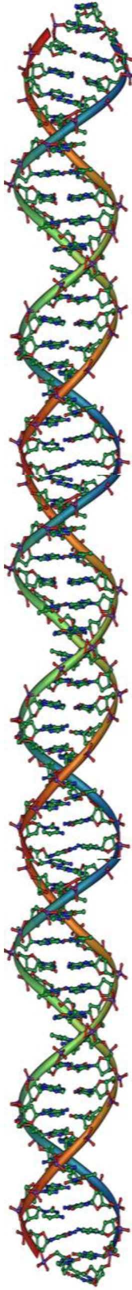
Labs

Things you will need:

Access to a kitchen (At least a microwave and some basic containers and kitchen tools)

A scale that can read to 1 gram

A thermometer with a range of at least -10°C to 200°C.



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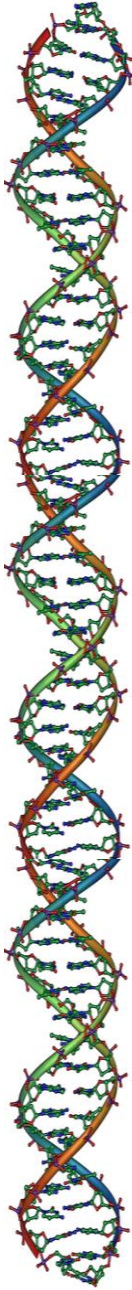

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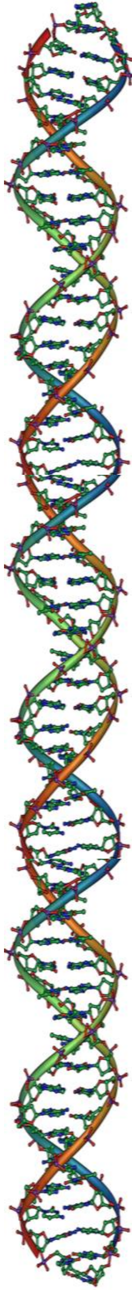

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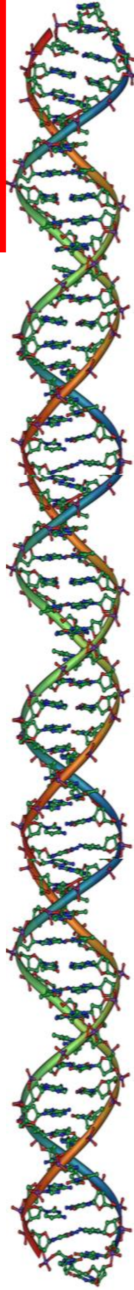
V101 – Course intro



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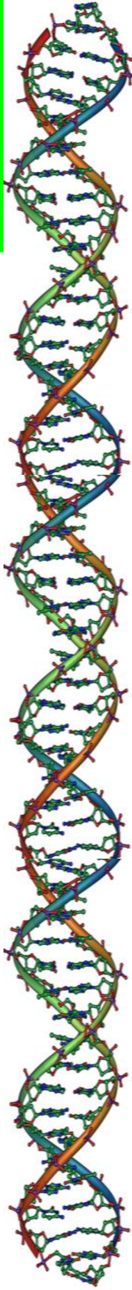

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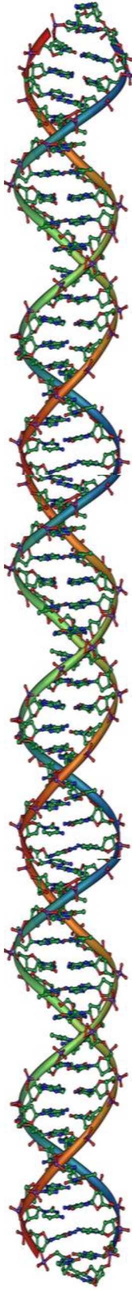

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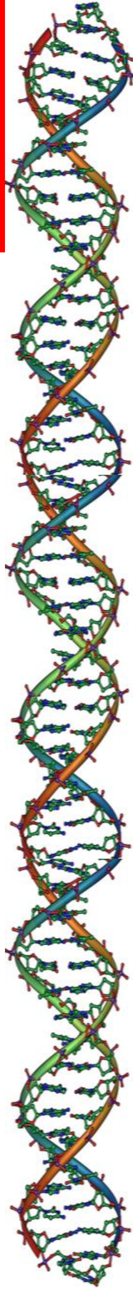

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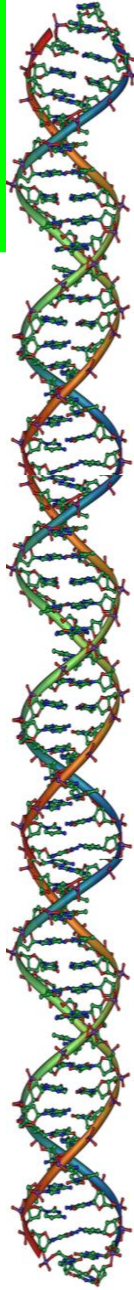

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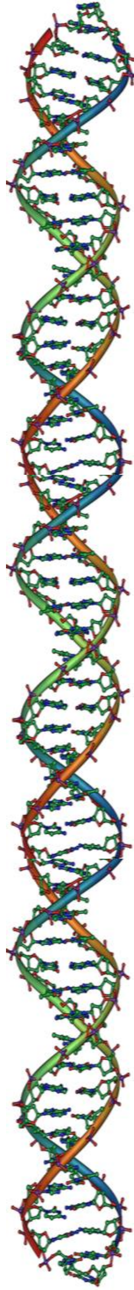

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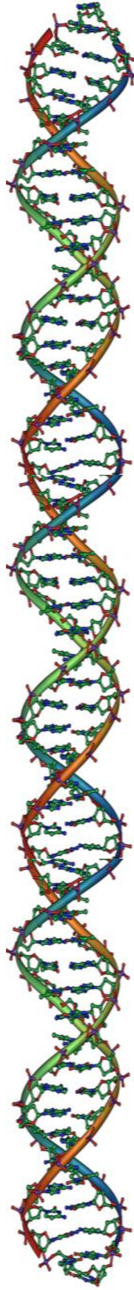

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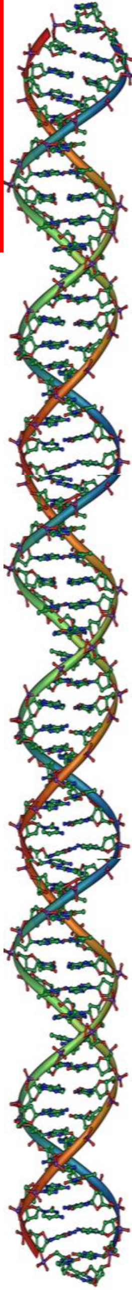

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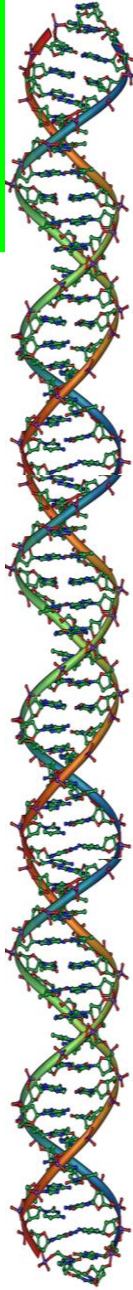

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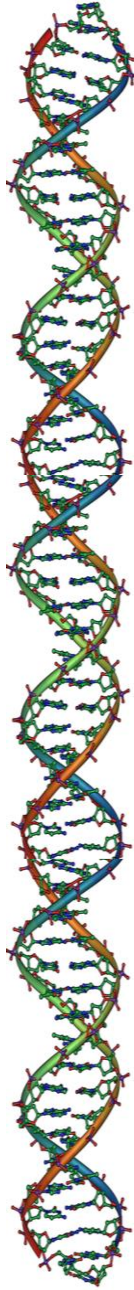

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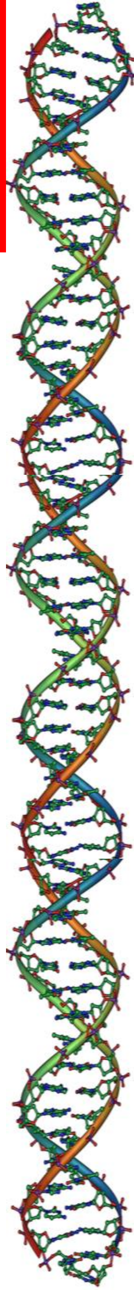

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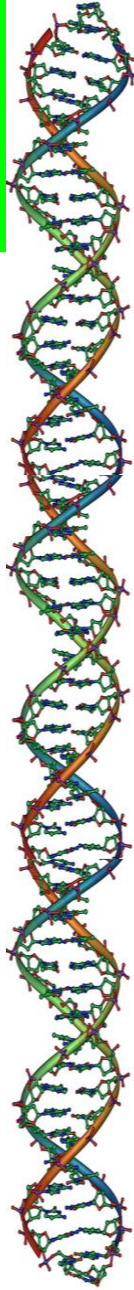

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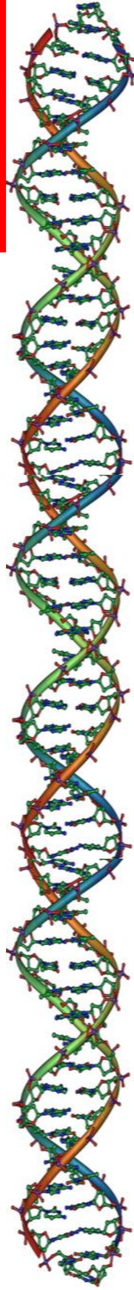

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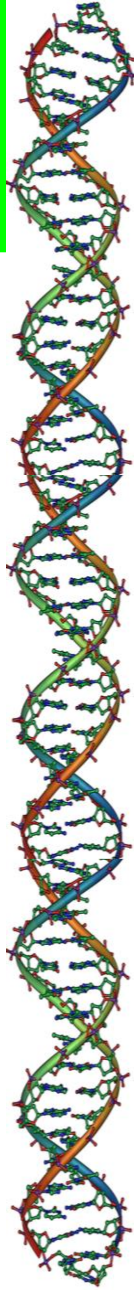

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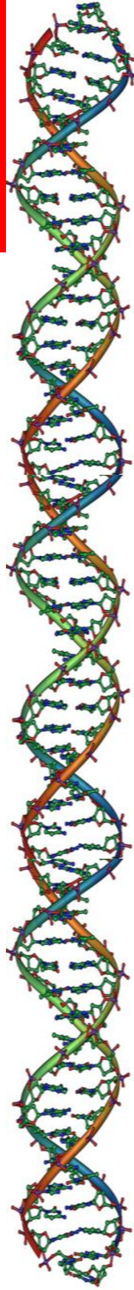

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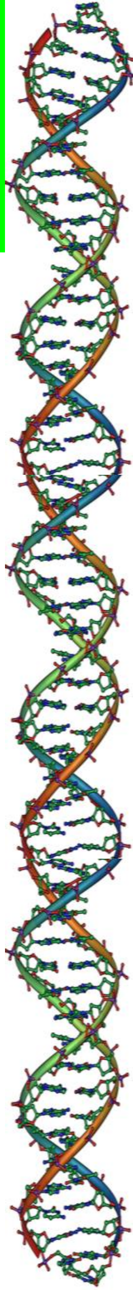

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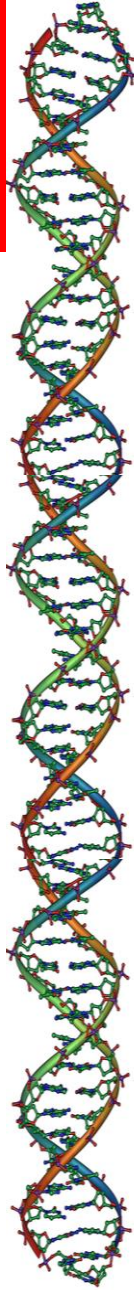

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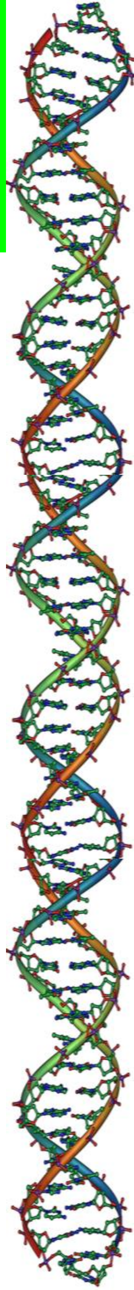

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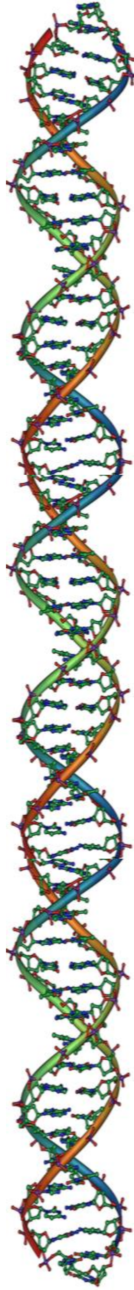

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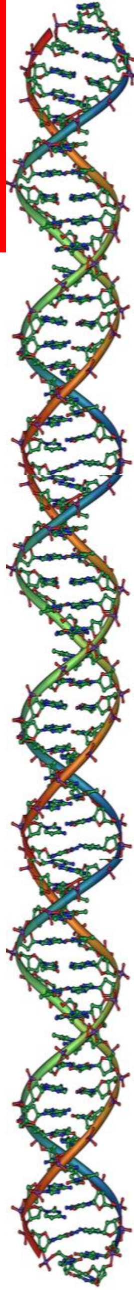

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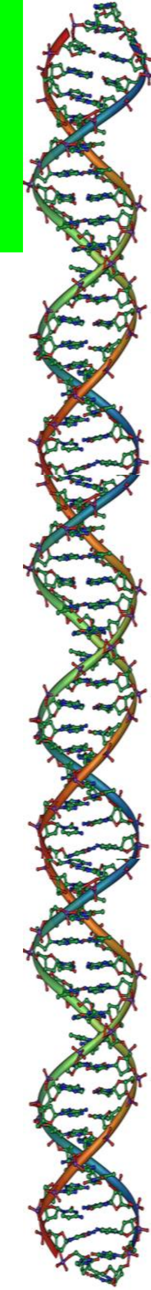

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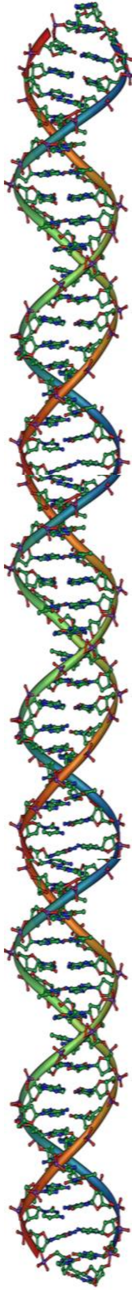

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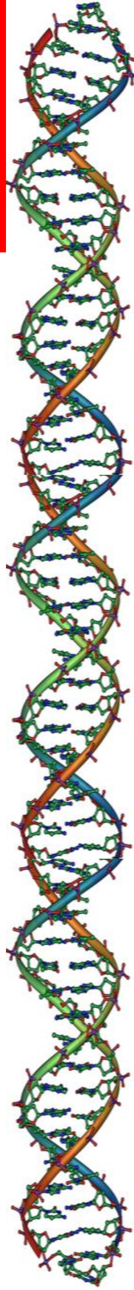

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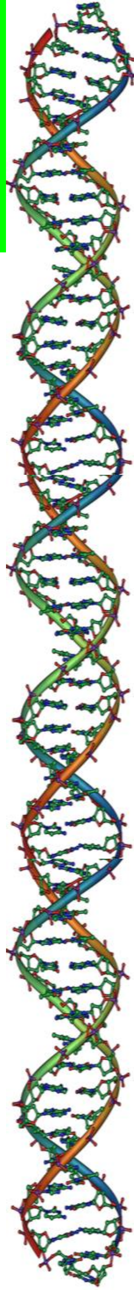

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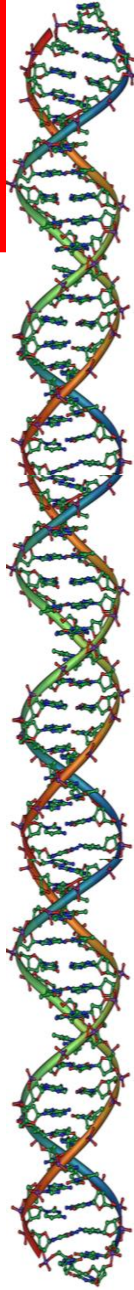

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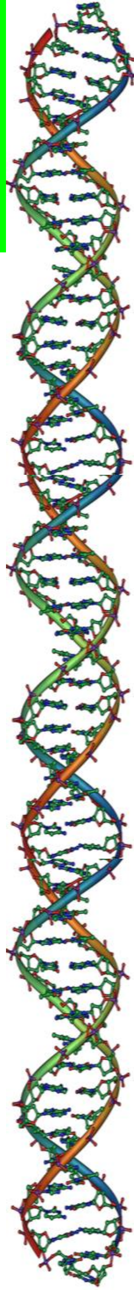

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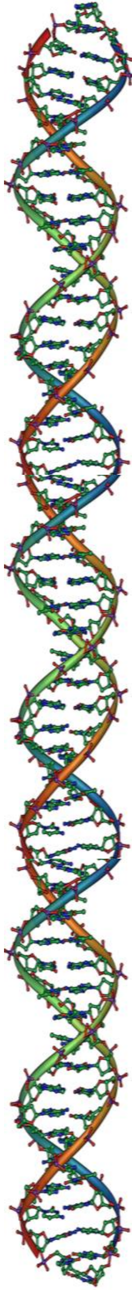

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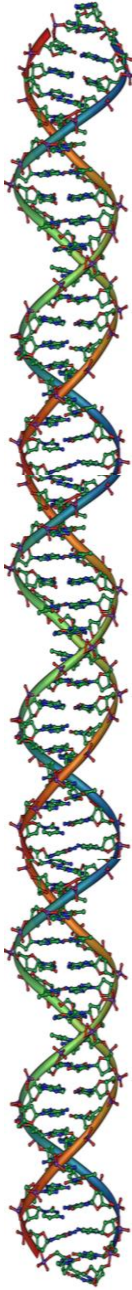

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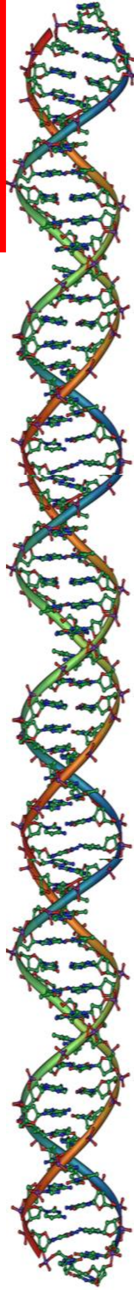

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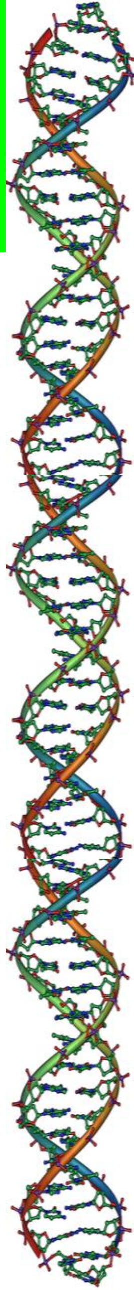

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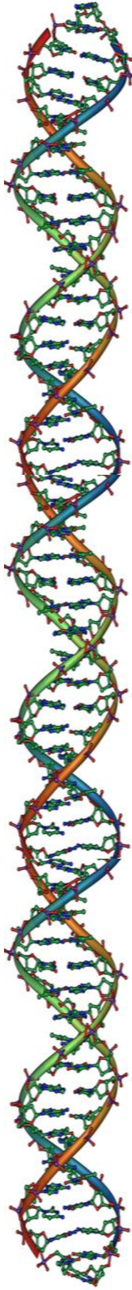

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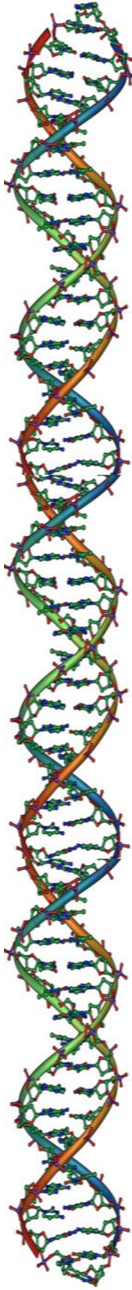

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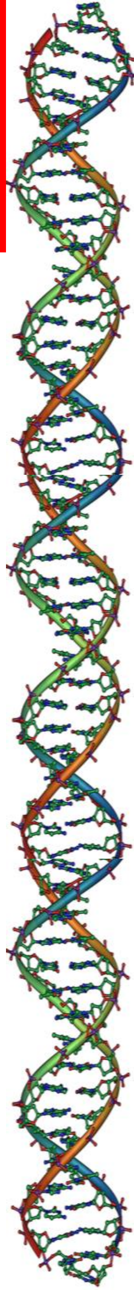

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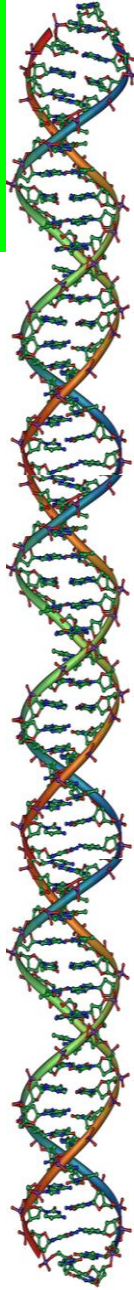

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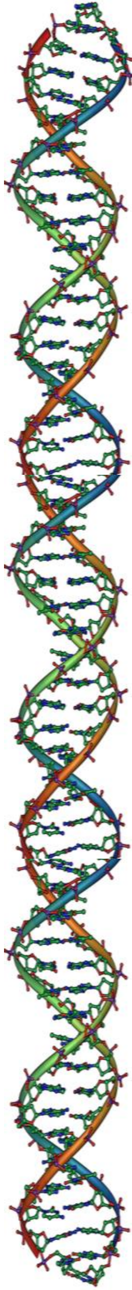

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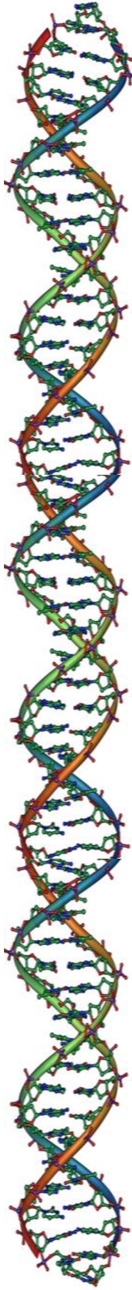

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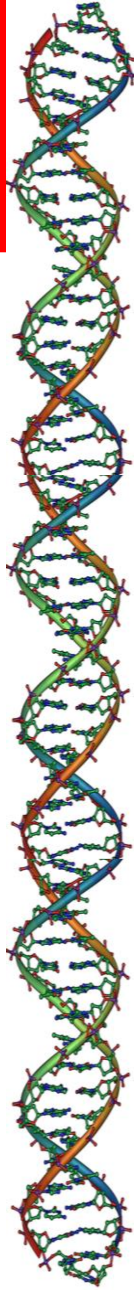

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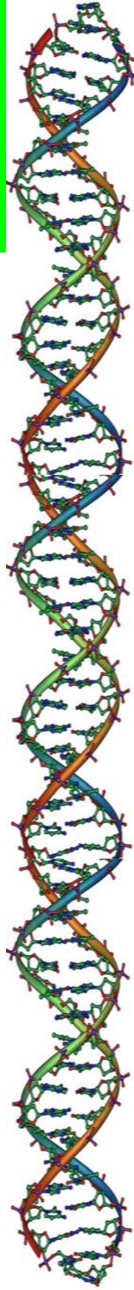

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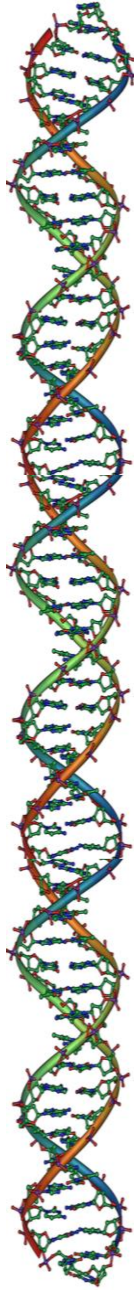

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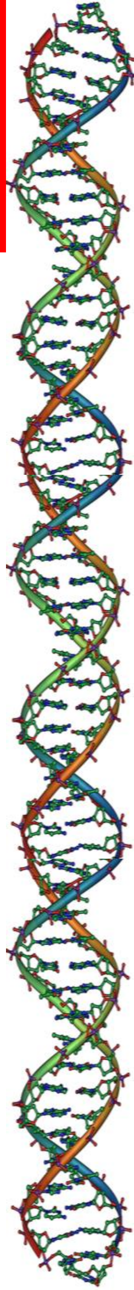

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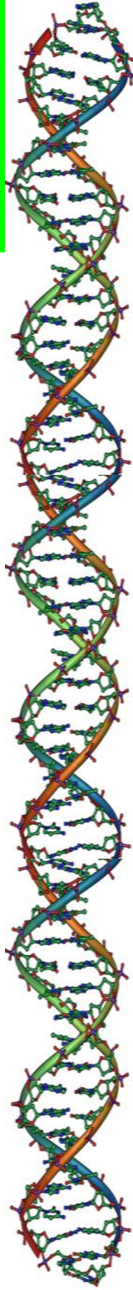

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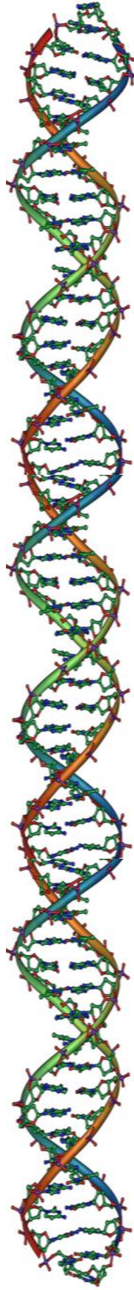

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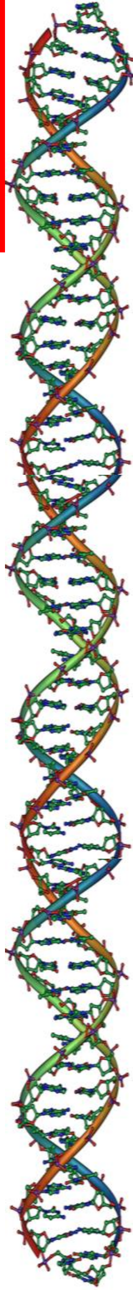

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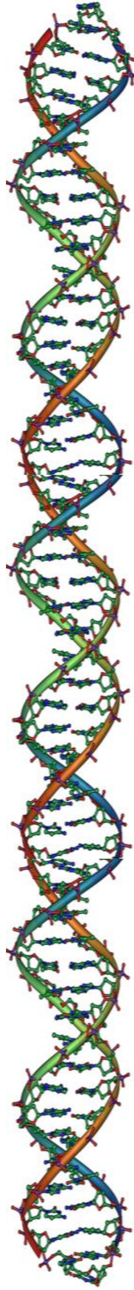

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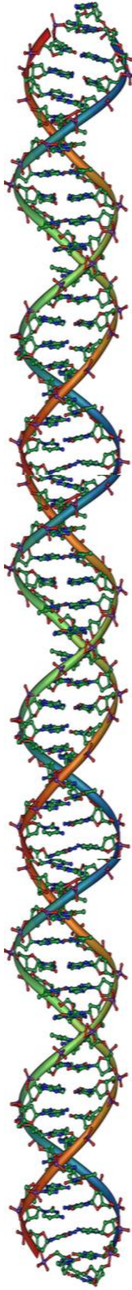

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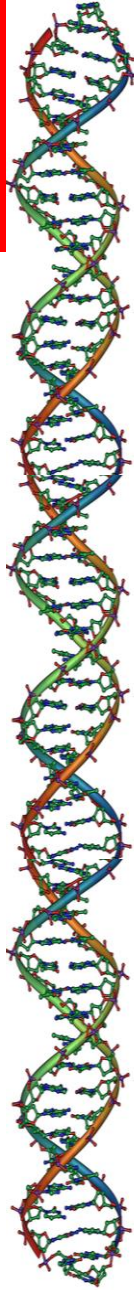

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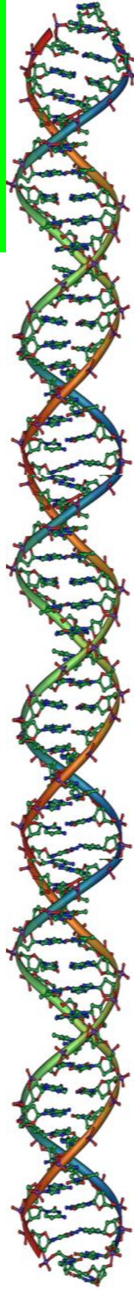

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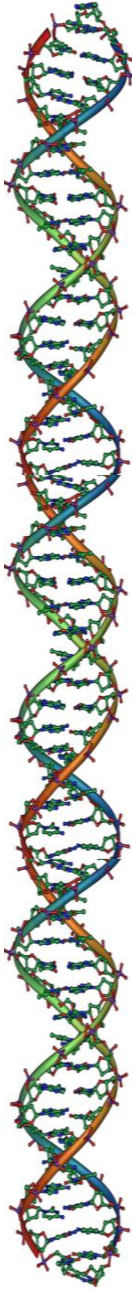

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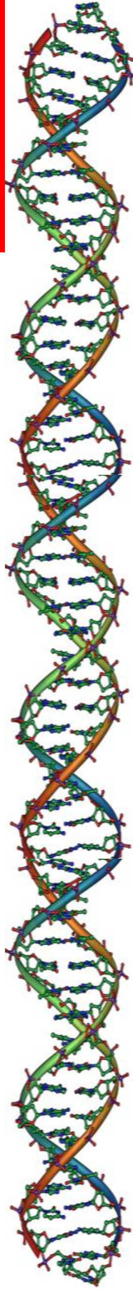

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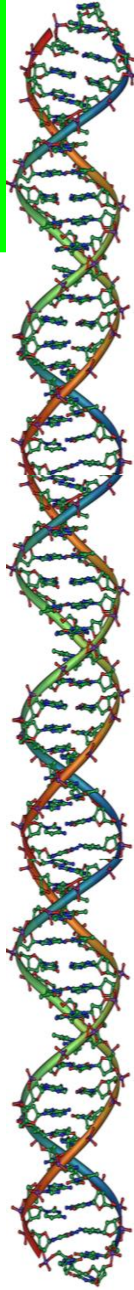

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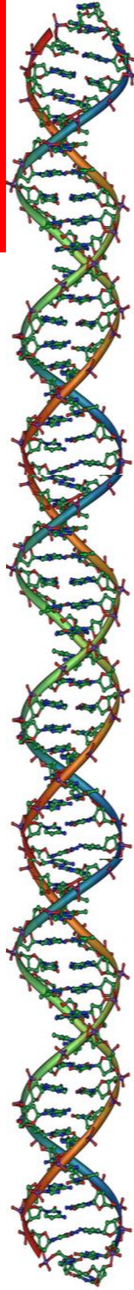

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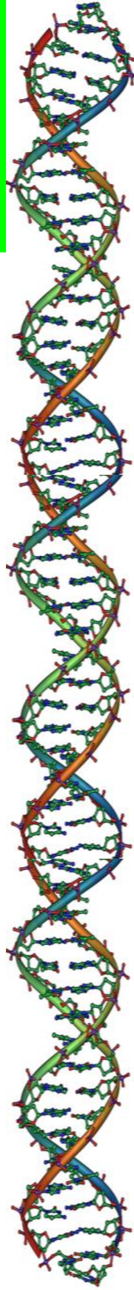

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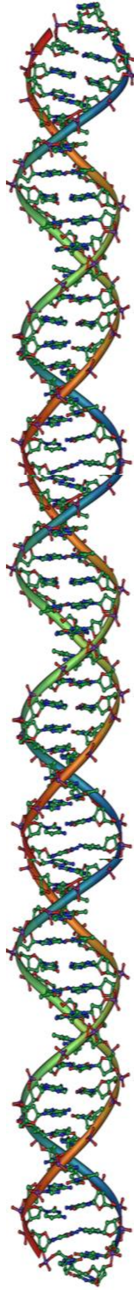

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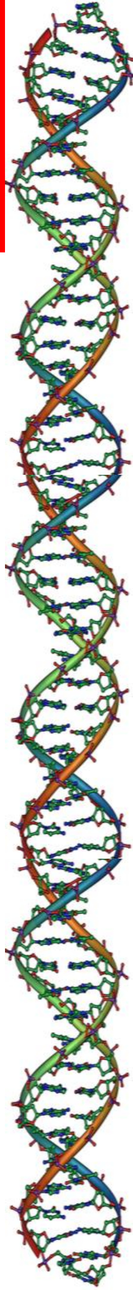

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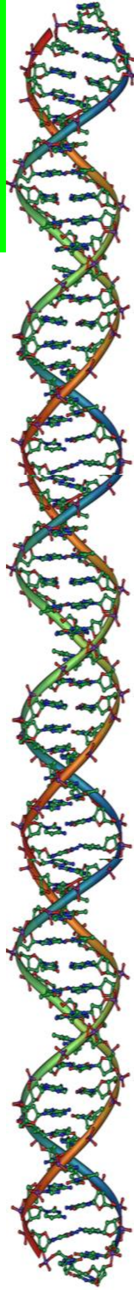

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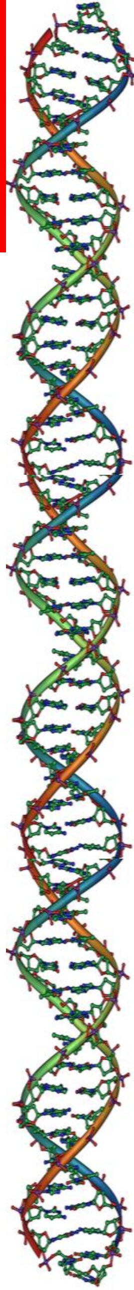

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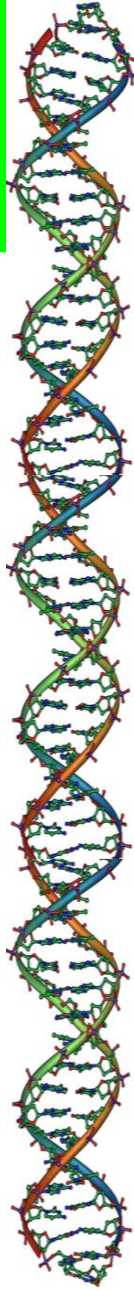

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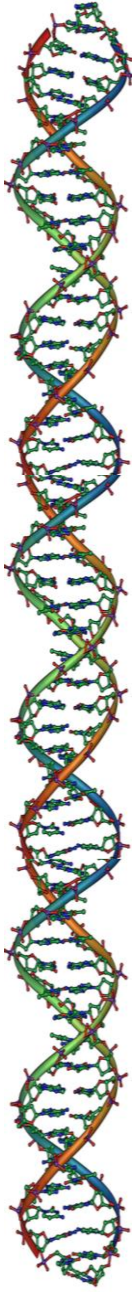

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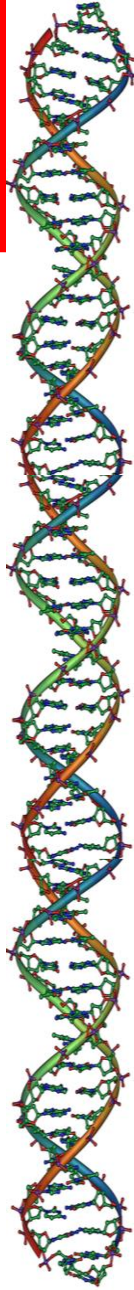

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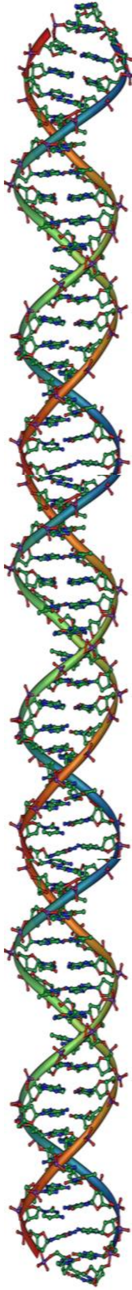

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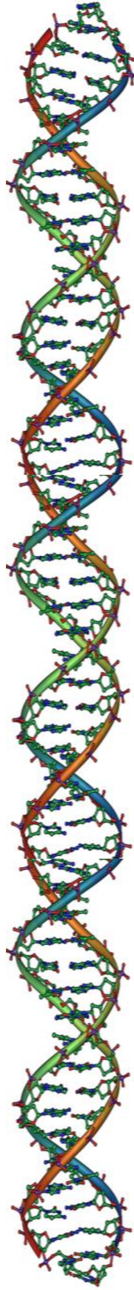


Course Information

Come to class

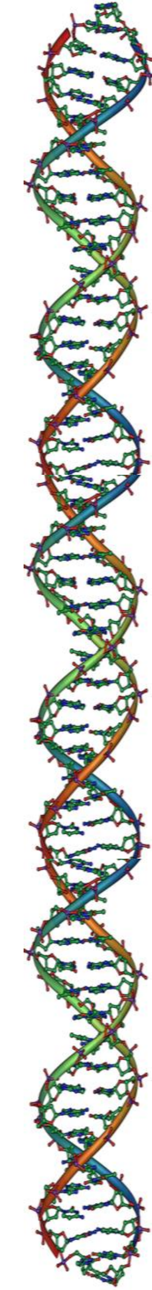
D2L

http://www.drbodwin.com/teaching/bcbt100.php

Blog http://scienceofcooking100.blogspot.com/

Twitter @DrBodwin #ChemKitchen

Office Hours (check schedule)



What will we cover?

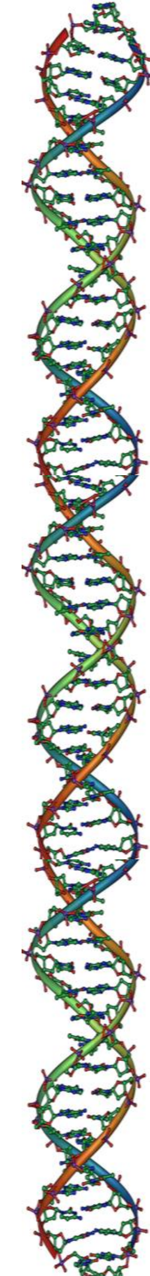
"Matter and its changes"

Food molecules

Cooking methods

Food production

Experiencing food



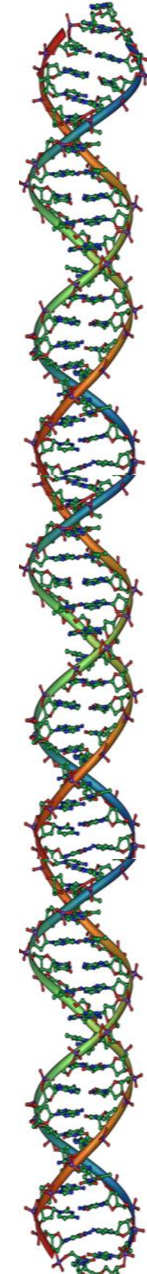
Food Categories

Animal-based Foods

Dairy, eggs, cheese, meat

Plant-based Foods

Fruit, veg, seeds, “other”

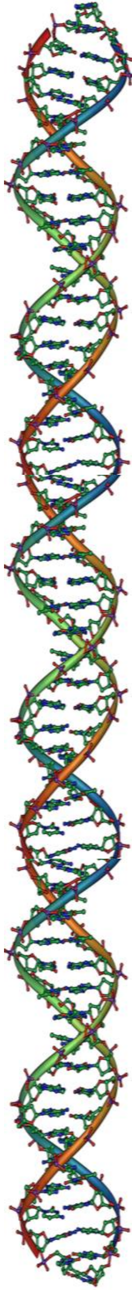


Cooking/Preparation

Heating methods

Other methods

Growing/raising food



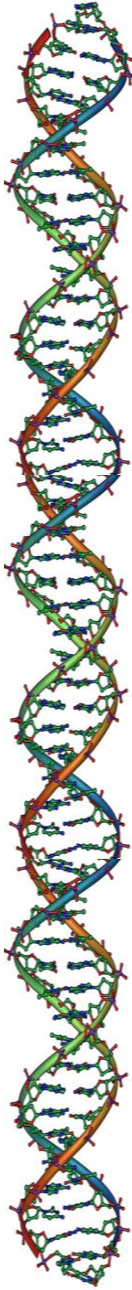
What is “science”?

Curiosity

Organization

Data

Relationships



The Scientific Method

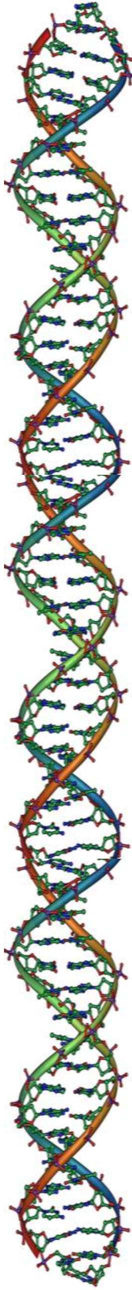
Observe something

Ask a question

Predict an answer

Test your prediction

Repeat, repeat, repeat



Doing “Good” Science

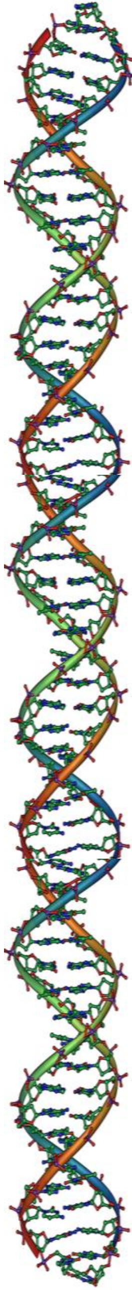
It’s not random

Testable prediction

Statements not questions

1 variable at a time

Reflective



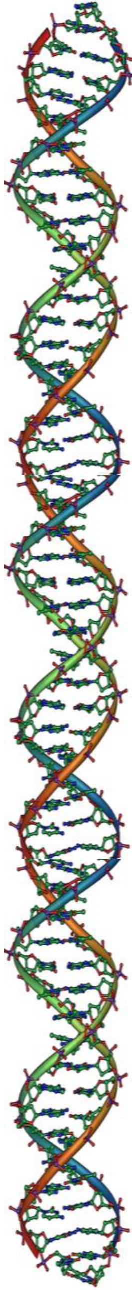
What is “cooking”?

Preparation of food & drink

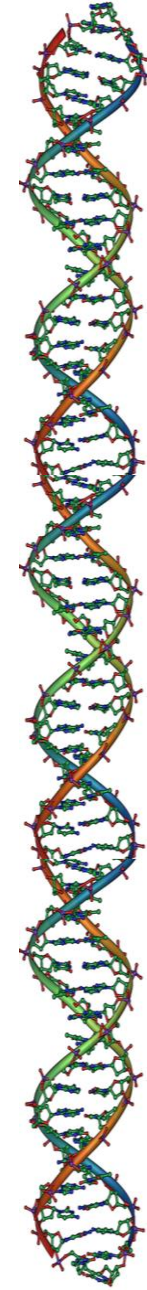
Understanding flavors

Exploring combinations

Experiencing textures



Sciences of Cooking



Biology
Plant & animal tissues
Microbiology

Chemistry
Change
Structure
Interactions

Food and Cooking

Engineering
Processing
Textural
Applied physics

Physics
Energy Transfer
Change
Matter

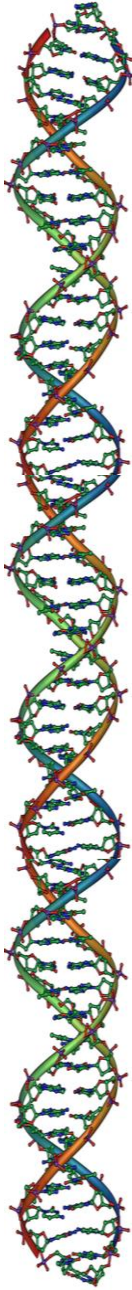
Using recipes

More than a list of ingredients

Process matters

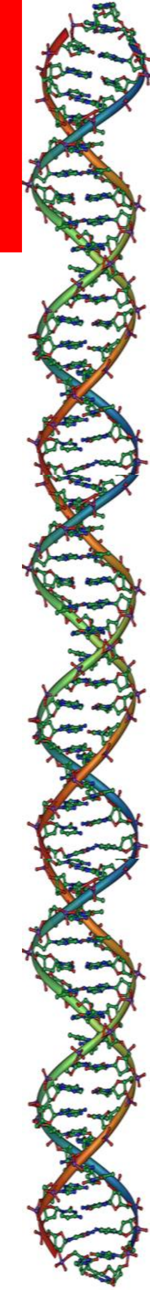
What's happening on a molecular level?

How can a recipe be changed?



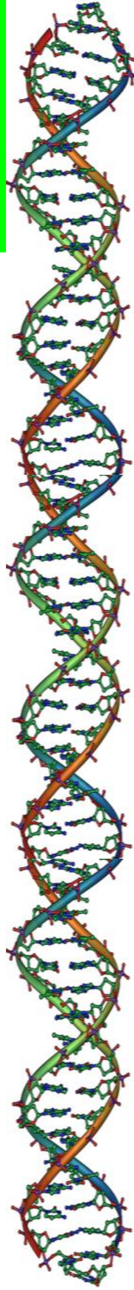
END VIDEO

V1## – Topic

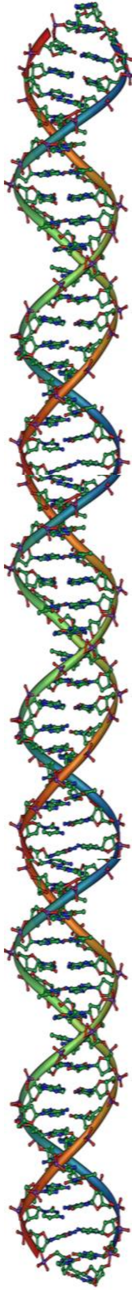


VIDEO BEGIN

V1## – topic



In-Class Assignment

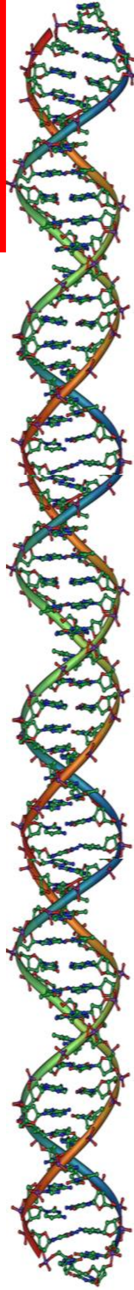


On the back, list the 3 topics you are most interested in discussing in class.

Type of food, cooking technique, science topic, etc.

END DAY 1

Content



From Last Time:

Saute – to cook in a hot pan using very little fat or oil

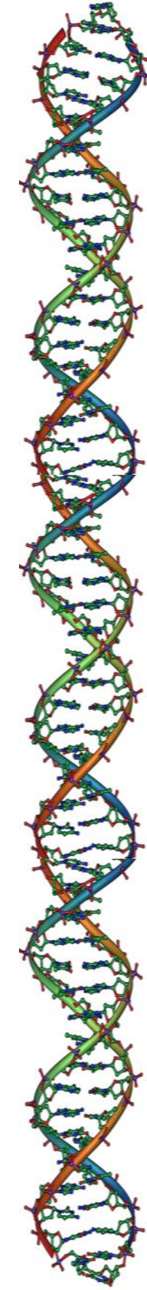
Denature – to change the structure of a protein

Melt – to change from solid to liquid

Cilantro – a herb, the leaves of coriander

Protein – long chains of amino acids

Salt – sodium chloride; can describe any substance made of charged particles

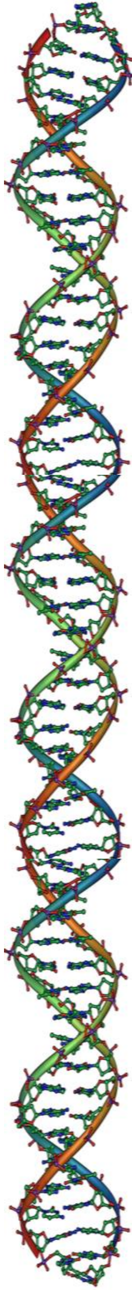


Descriptions of Scale

Macroscale vs. Microscale

Chemistry & Molecular Biology bridge these worlds

http://htwins.net/scale2/

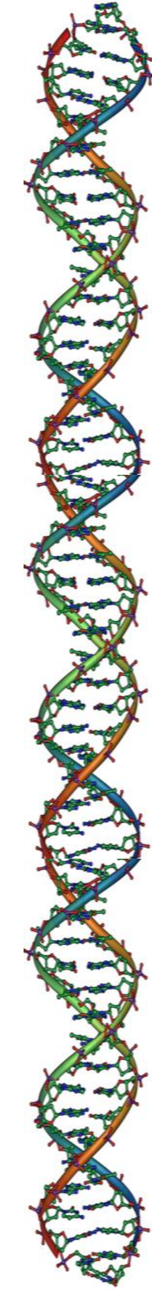


What is food made of?

Organic vs. Inorganic

Organic = “from life”, contains C-H bonds

Inorganic = no C-H bonds



What is food made of?

Water

Inorganic components

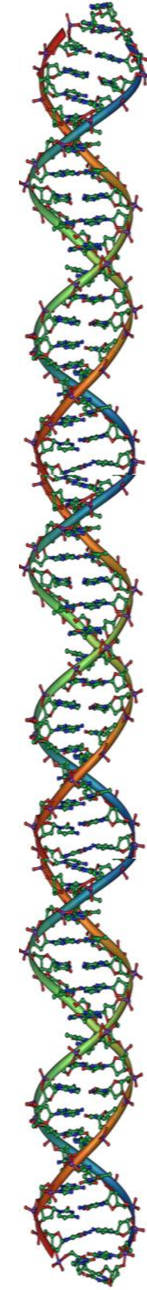
Salts, minerals

"Small" Organic Molecules

Vitamins, metabolites

Macromolecules

Lipids, proteins, carbohydrates



Water

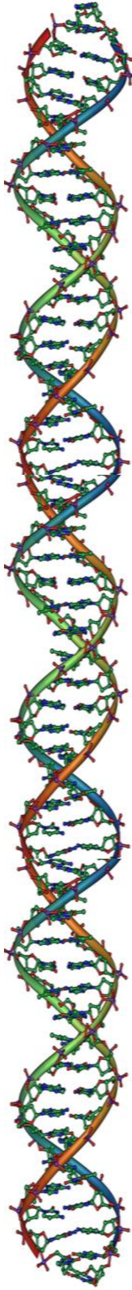
H_2O!

Very small, simple

Essential to all life on Earth

Search for Extraterrestrial Life

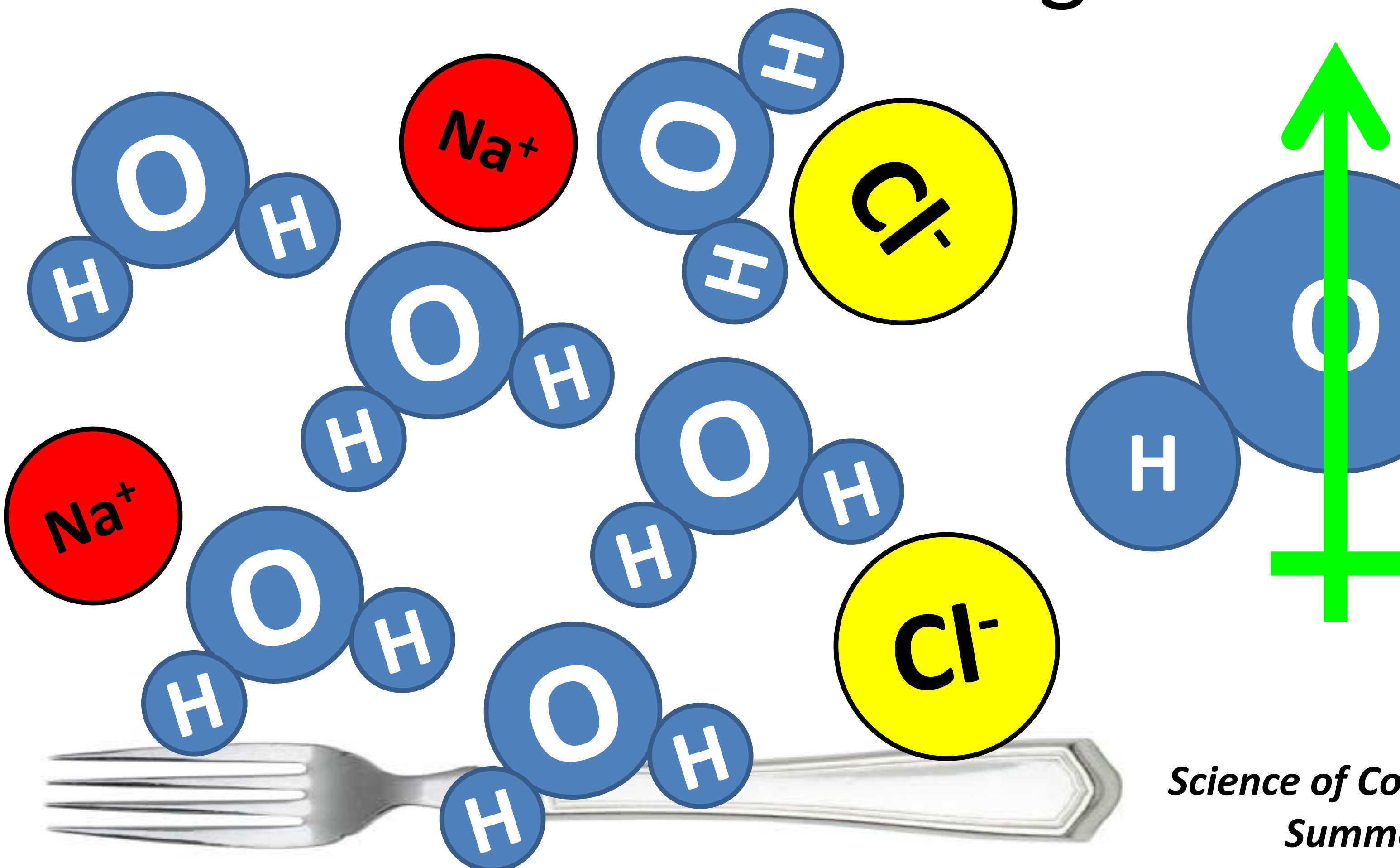
Most food is mostly water



Why is water liquid?

Water molecules are bent → polar

Polar molecules stick together



Water Content of Foods

Food	Water Content (%)
Meat	
Pork, raw, composite of lean cuts	53-60
Beef, raw, retail cuts	50-70
Chicken, raw meat without skin	74
Fish, muscle proteins	65-81
Fruits	
Berries, cherries, pears	80-85
Apples, peaches, oranges, grapefruit	85-90
Rhubarb, strawberries, tomatoes	90-95
Vegetables	
Peas (green)	74-80
Beets, broccoli, carrots, potatoes	80-90
Asparagus, beans, cabbage, cauliflower, lettuce	90-95

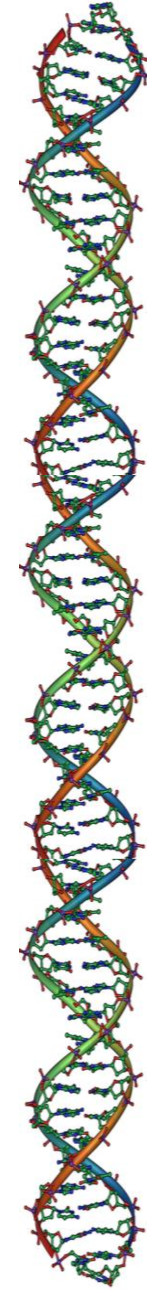
Source: http://class.fst.ohio-state.edu/fst605/605%20pdf/Water.pdf

Water in Foods

Water content of some foods

Food	Water content (%)
Beef	50 to 70
Chicken meat	74
Fish	65 to 81
Pears	80 to 85
Apples, peaches, oranges	85 to 90
Tomatoes, strawberries	90 to 95
Avocado, banana	74 to 80
Carrot, potato	80 to 90
Lettuce, lentils	90 to 95
Honey	20
Jam	28
Flour, rice	12
Milk powder	4

Source: http://www.azaquar.com/en/doc/water-in-food



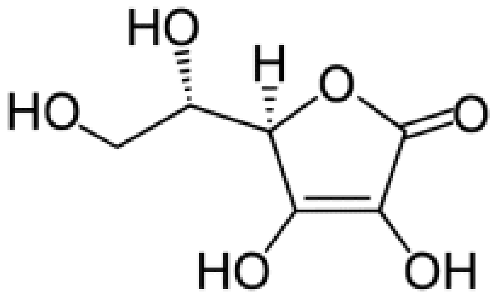
Inorganic Components

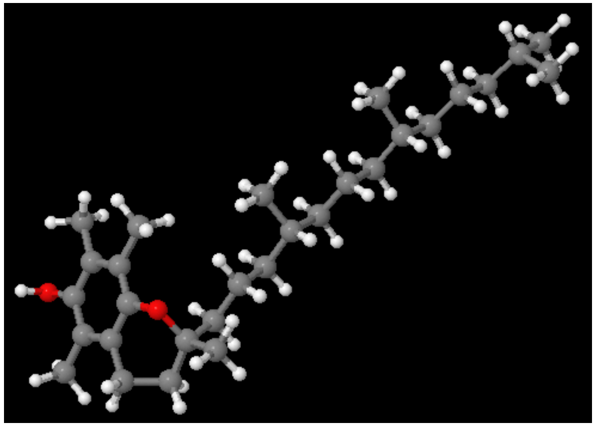
- "Salts" – charged particles
  - Sodium chloride → Na^+ and Cl^-
- Other trace minerals
  - Iron, potassium, calcium, magnesium, etc

“Small” Organic Molecules

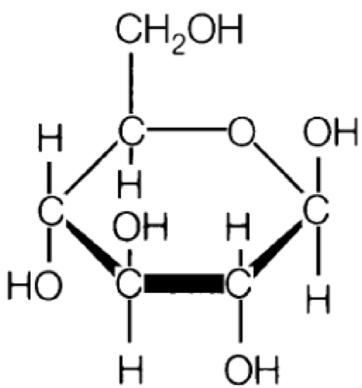
“Organic” = containing C and H

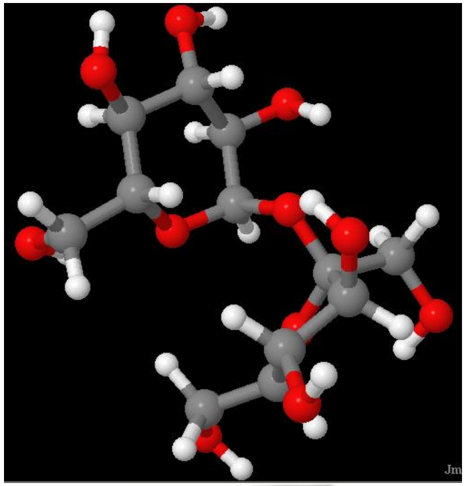
Vitamins



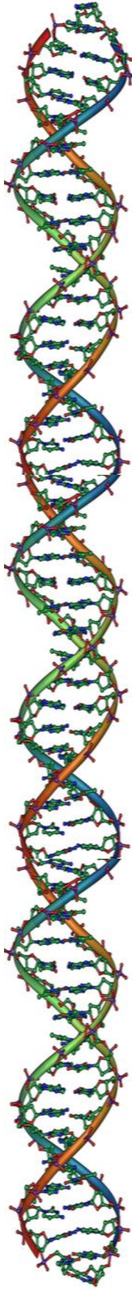


Sugars





Others



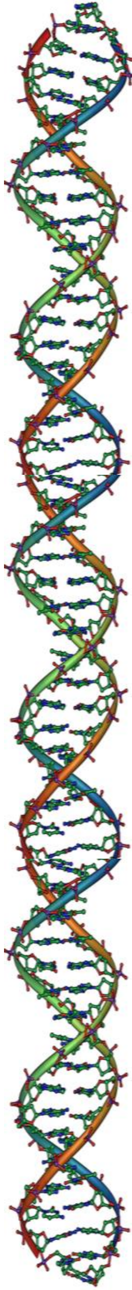
BIG Food Molecules

Lipids

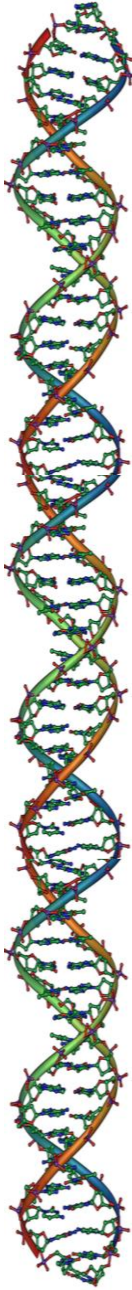
Proteins

Carbohydrates

DNA/RNA



Lipids



Fats

Long chains of (mostly) C and H

Lipids are non-polar

- Don't mix w/water = "hydrophobic"
- "like dissolves like"

Molecule animations: http://www.biotopics.co.uk/JmolApplet/jcontentstable.html

Fatty acids Jmol:

http://www.mpcfaculty.net/mark_bishop/Bishop_Jmol_fatty_acids_triglyceride.htm

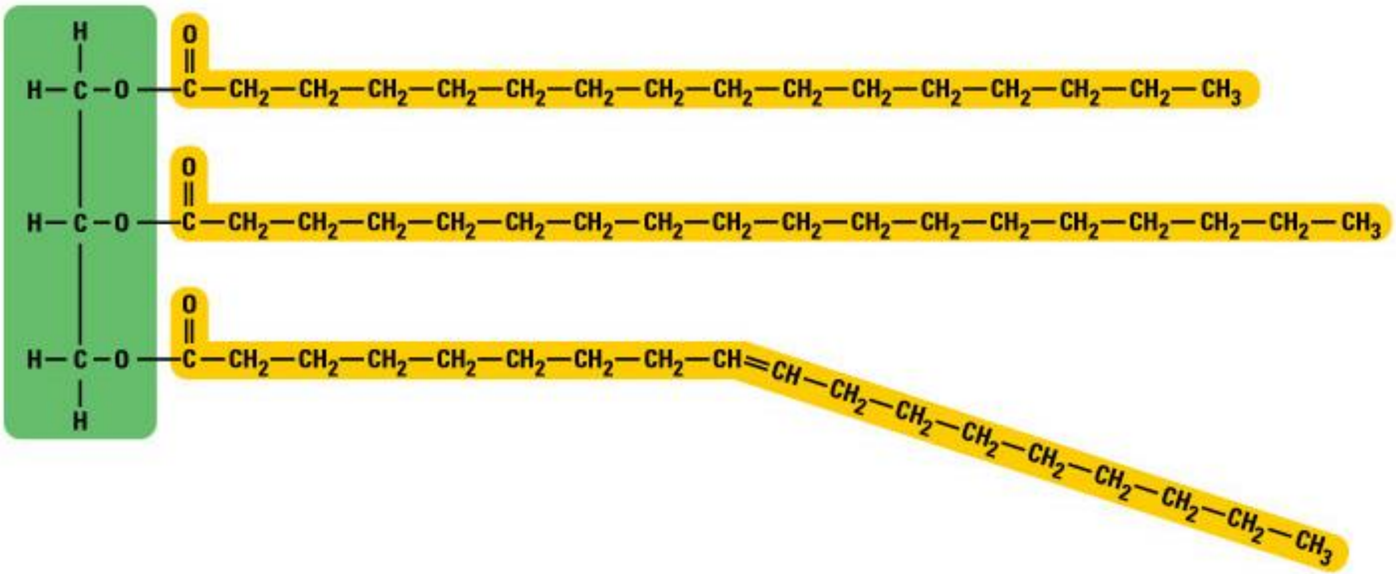
Fatty Acids/Triglycerides

Vinegar = 2 carbons

- Water soluble

Stearic acid = 18 carbons

- NOT water soluble



Types of Fats

Saturated vs. Unsaturated

Mono- vs Polyunsaturated

“Hydrogenated”

“Omega-3”

Macromolecules

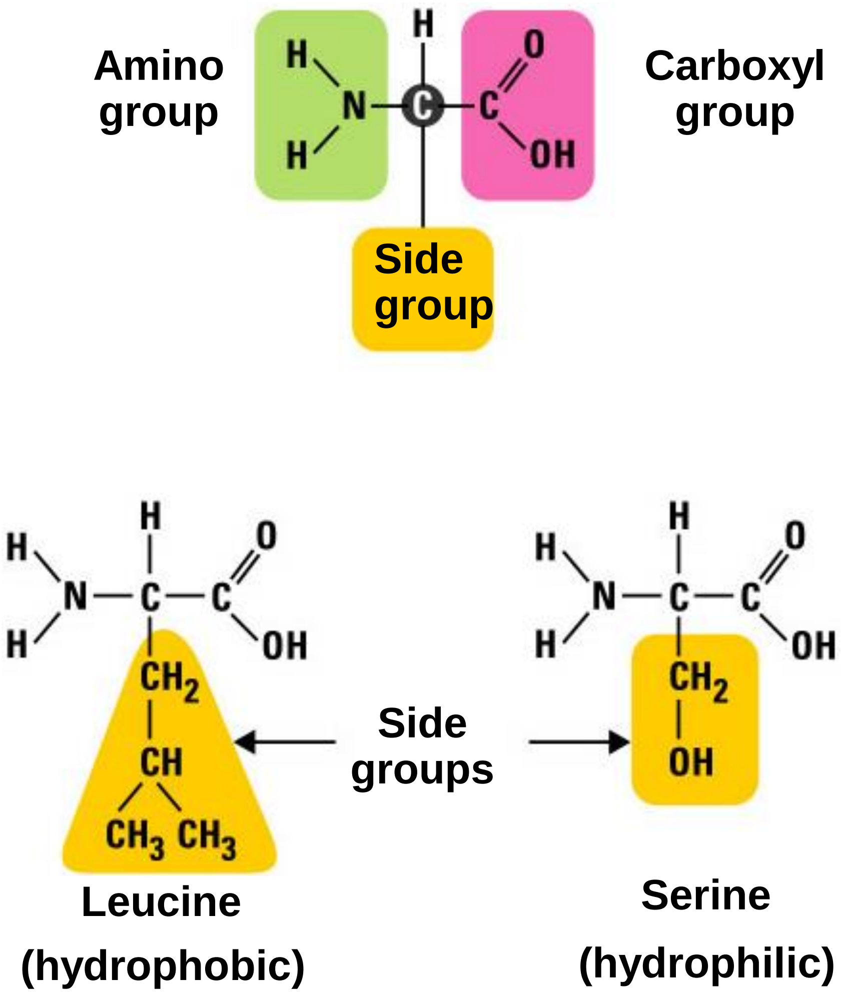
Polymers –

poly="many", meros="parts"

Different "parts" result in

different function/properties

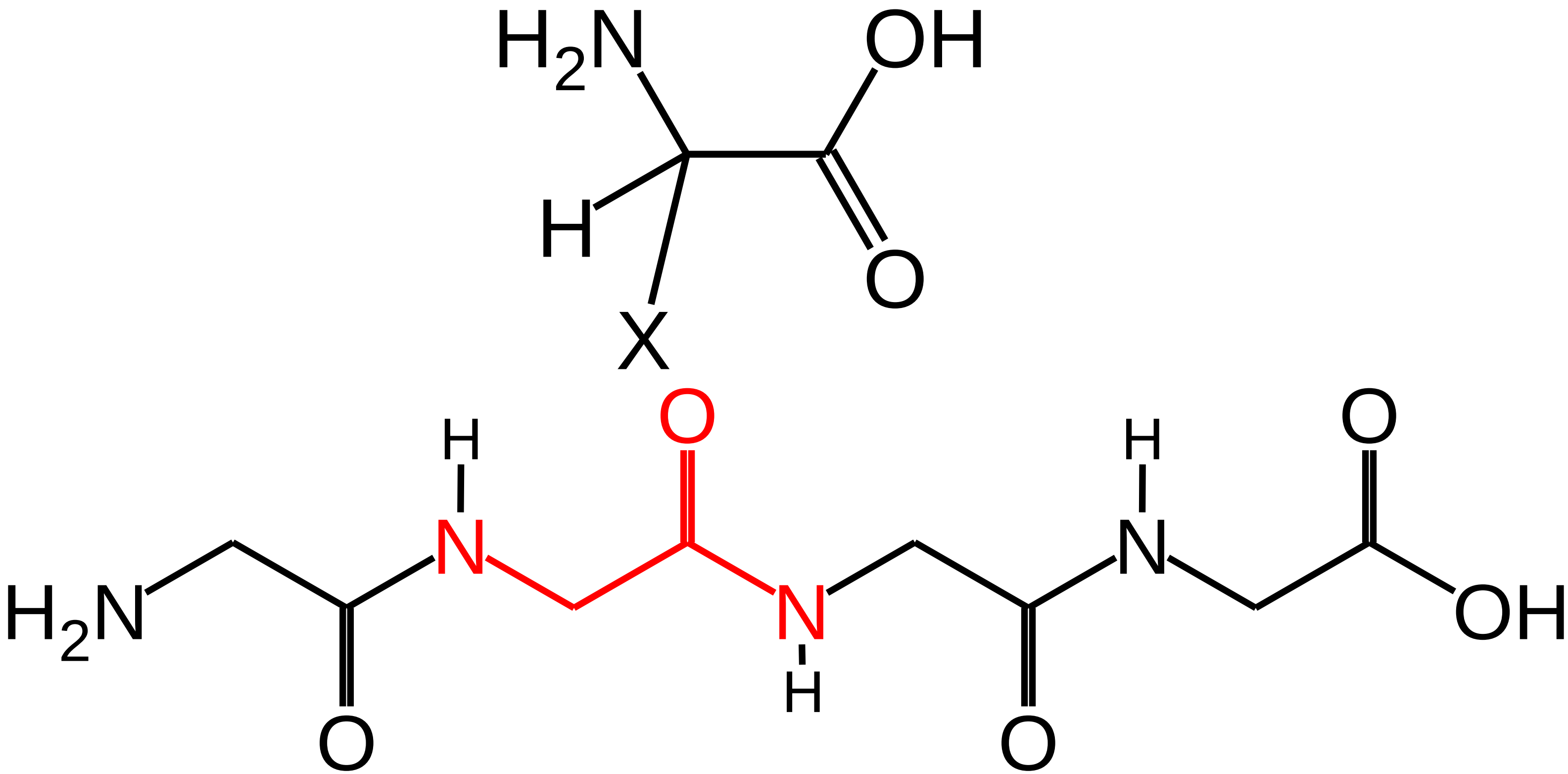
Amino Acids

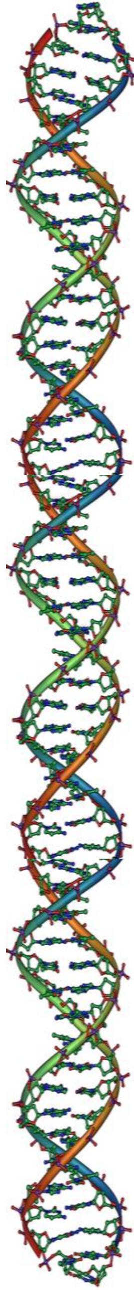


Central Carbon
Carboxyl group
Amino group
Side chain - varies

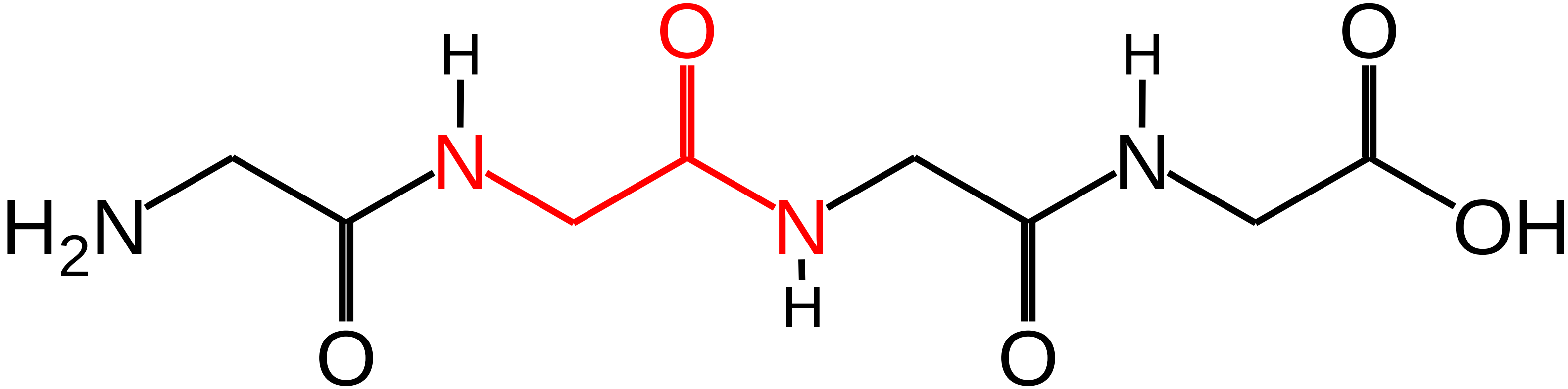
Proteins

Polymers made of amino acids





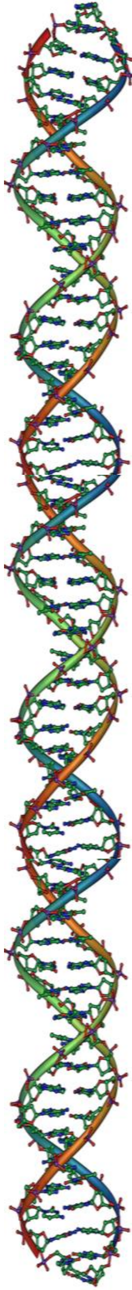
Proteins



Shape depends upon properties of side chains interacting with water

Shape = Function

20 “letters”, many “words”



4 Levels of Protein Structure

Primary – aa order

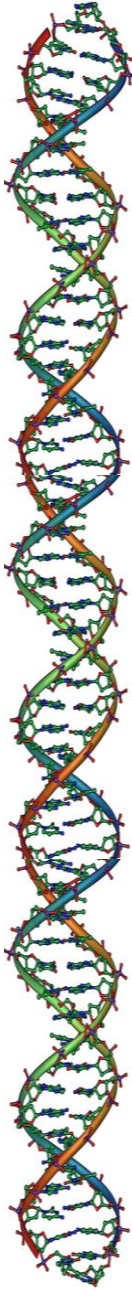
Secondary – near aa interactions

Tertiary – long range in 1 protein

Quaternary – clusters of proteins

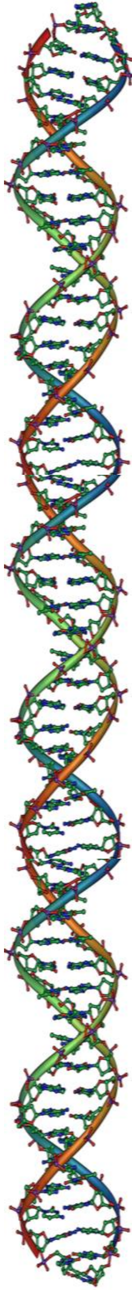
Denaturing disturbs structure

Protein structure: http://en.wikipedia.org/wiki/File:Main_protein_structure_levels_en.svg

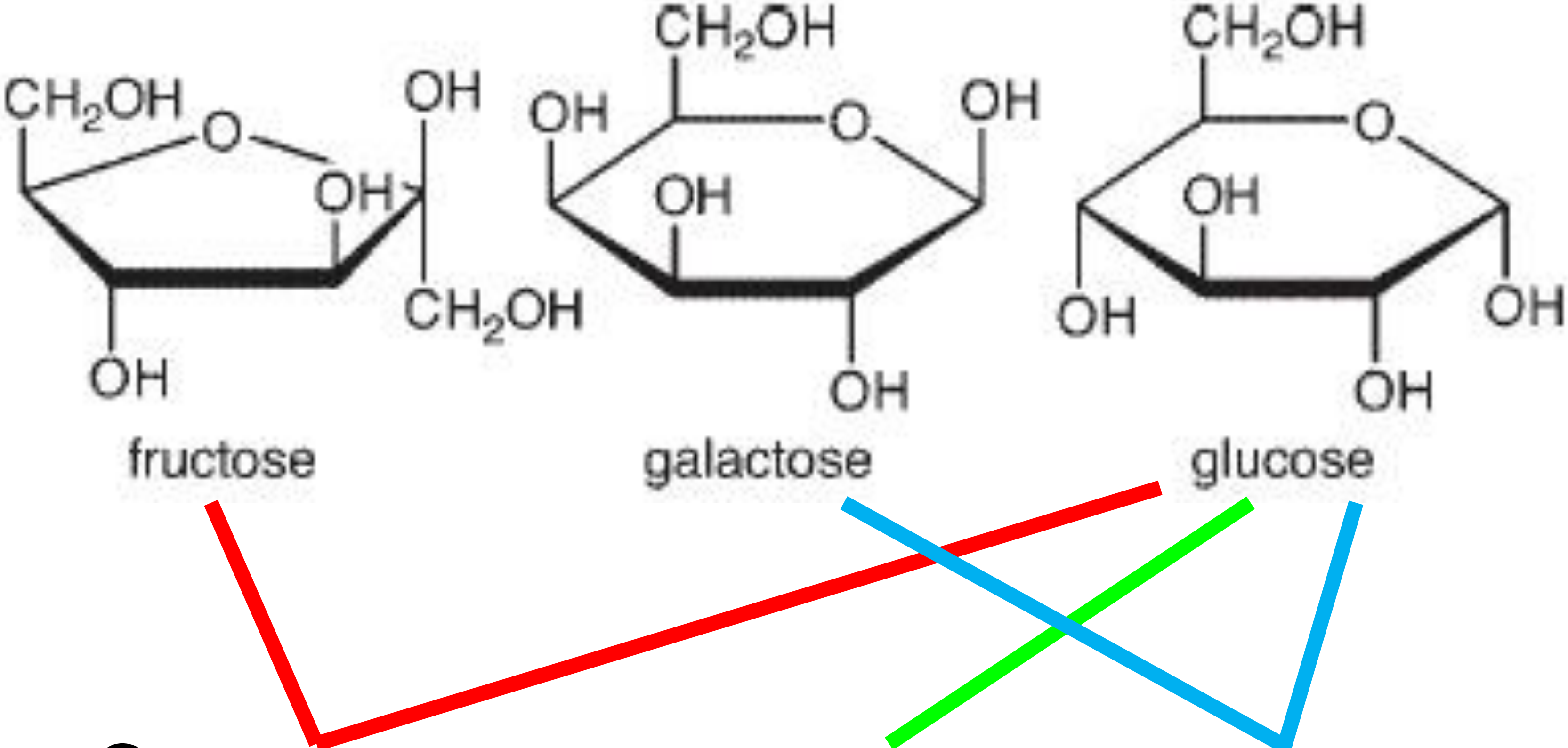


Carbohydrates

"Carbo" → carbon
"hydrate" → water, O and H



Common Sugars



Sucrose   Maltose   Lactose

Image: http://en.wikipedia.org/wiki/File:Glycolysis2.svg

Common Sugars

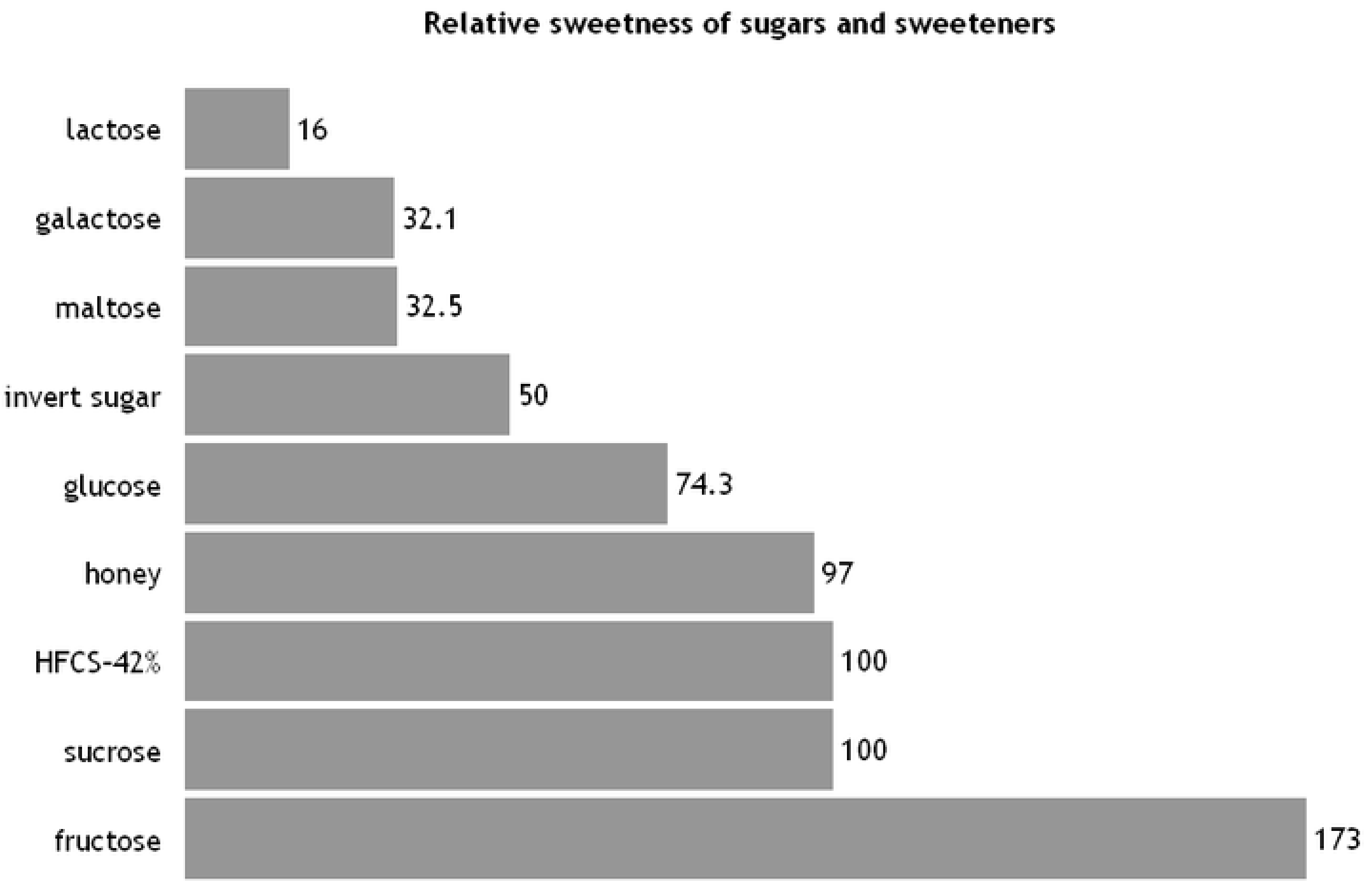
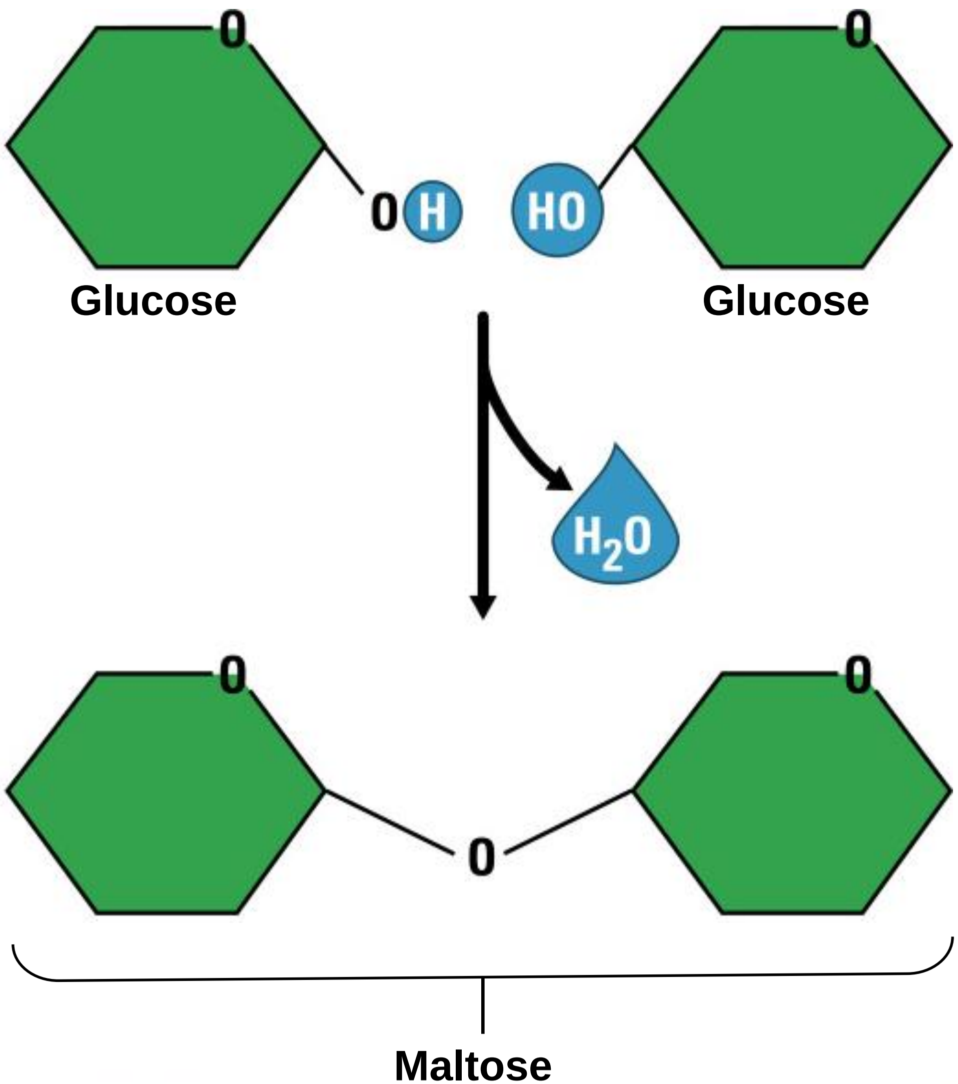


Image: http://en.wikipedia.org/wiki/File:Relativesweetness.png

Disaccharides



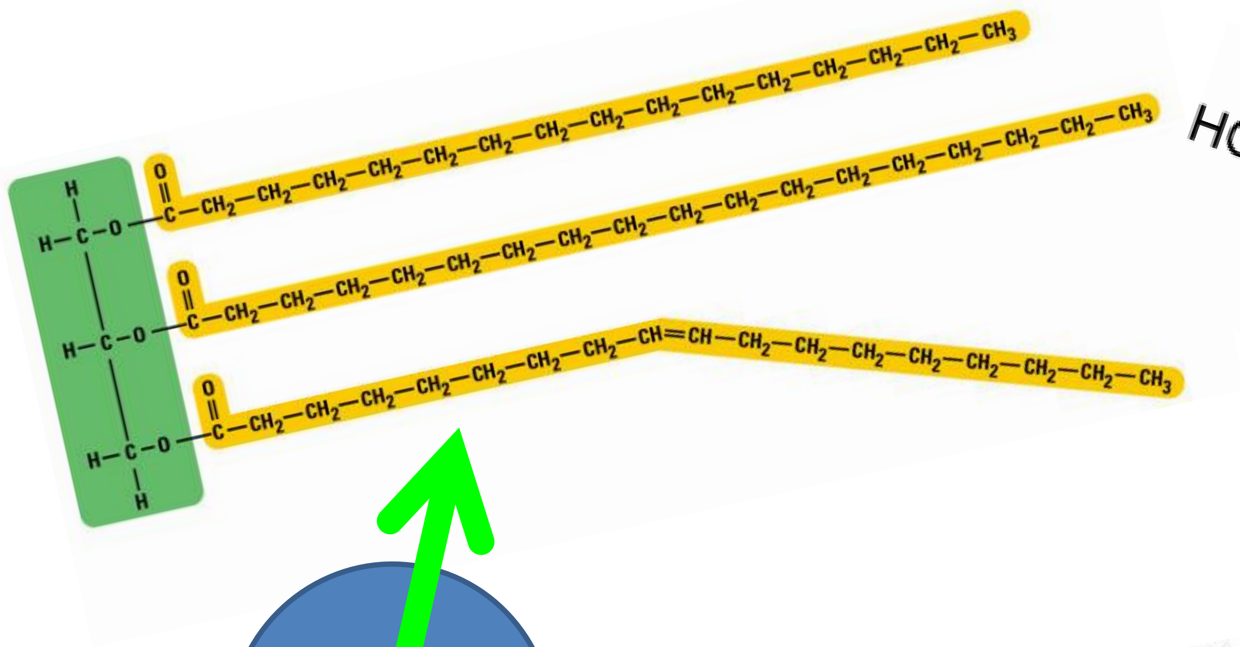
- Monosaccharides react to form disaccharides
- Liberate water
  - *Dehydration*
  - *Condensation*
- Reversible
  - *Hydrolysis*
  - *"-ase" enzymes*

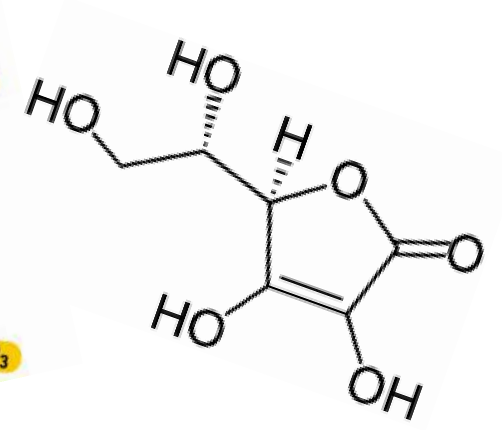
Image: http://en.wikipedia.org/wiki/File:Glycolysis2.svg

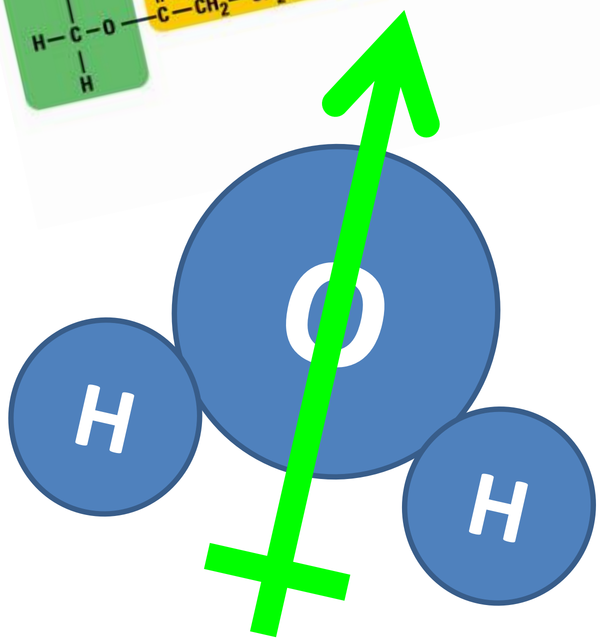
END DAY 2

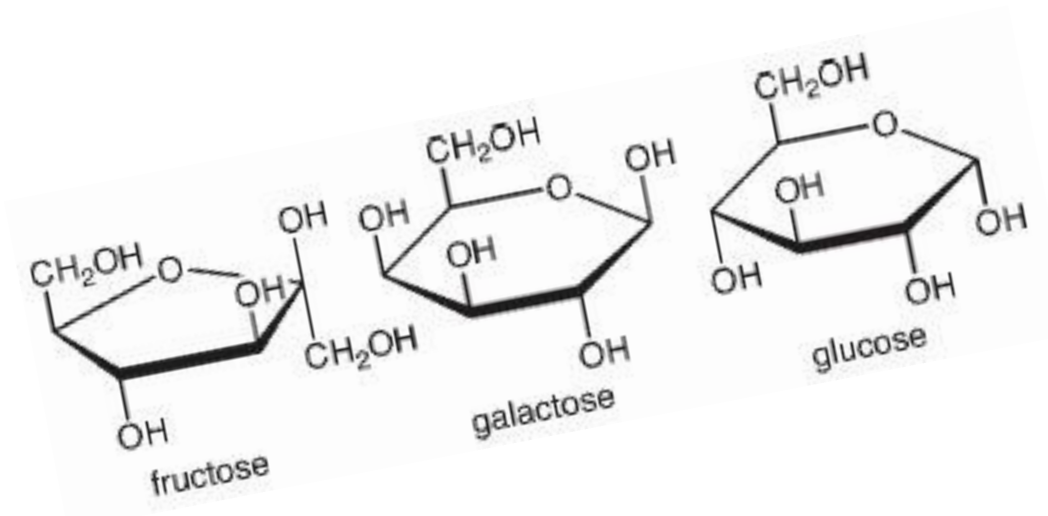
Content

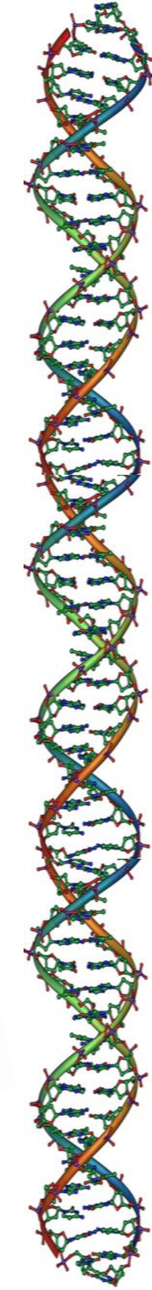
From Last Time:











Disaccharides

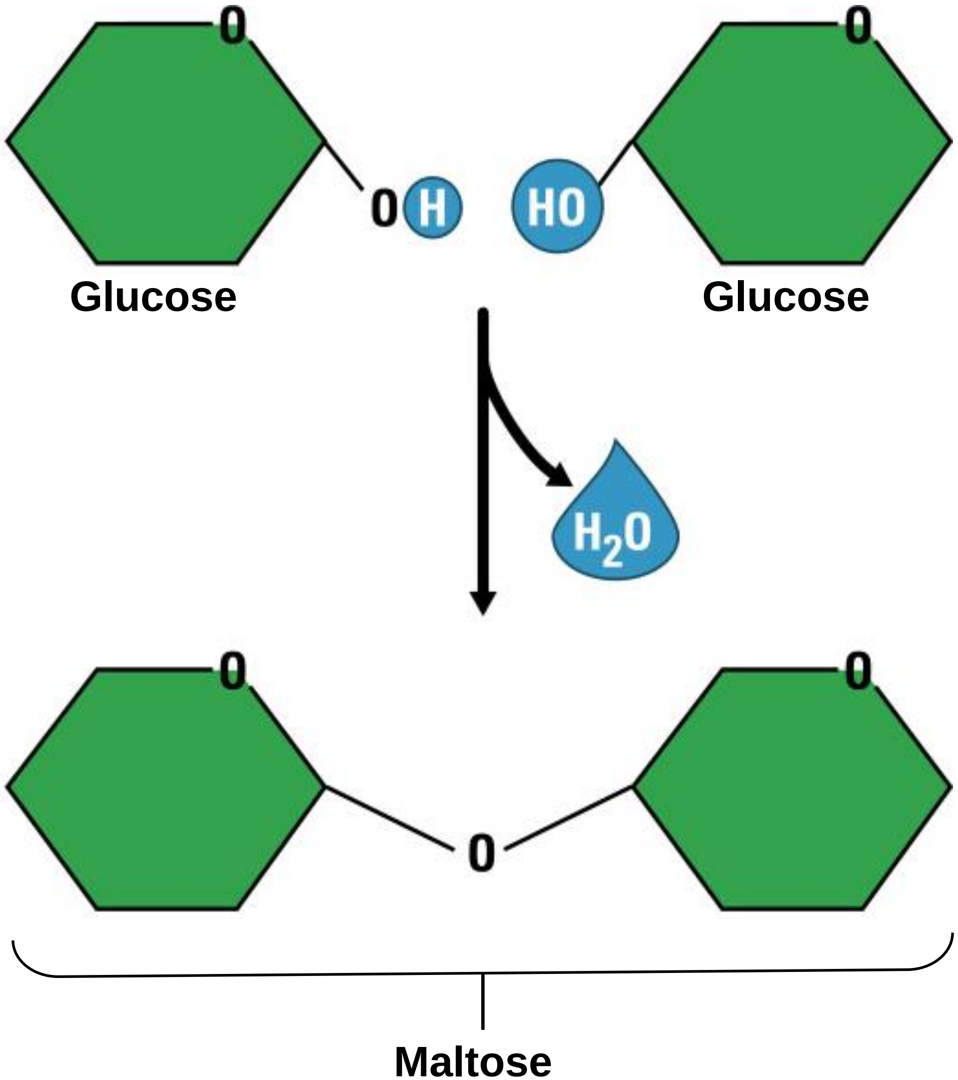


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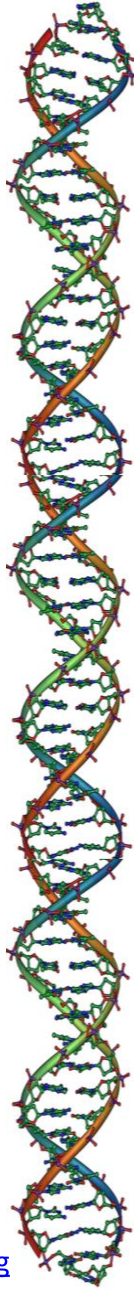
Image: http://en.wikipedia.org/wiki/File:Glycolysis2.svg



Sugar Metabolism

Glycolysis

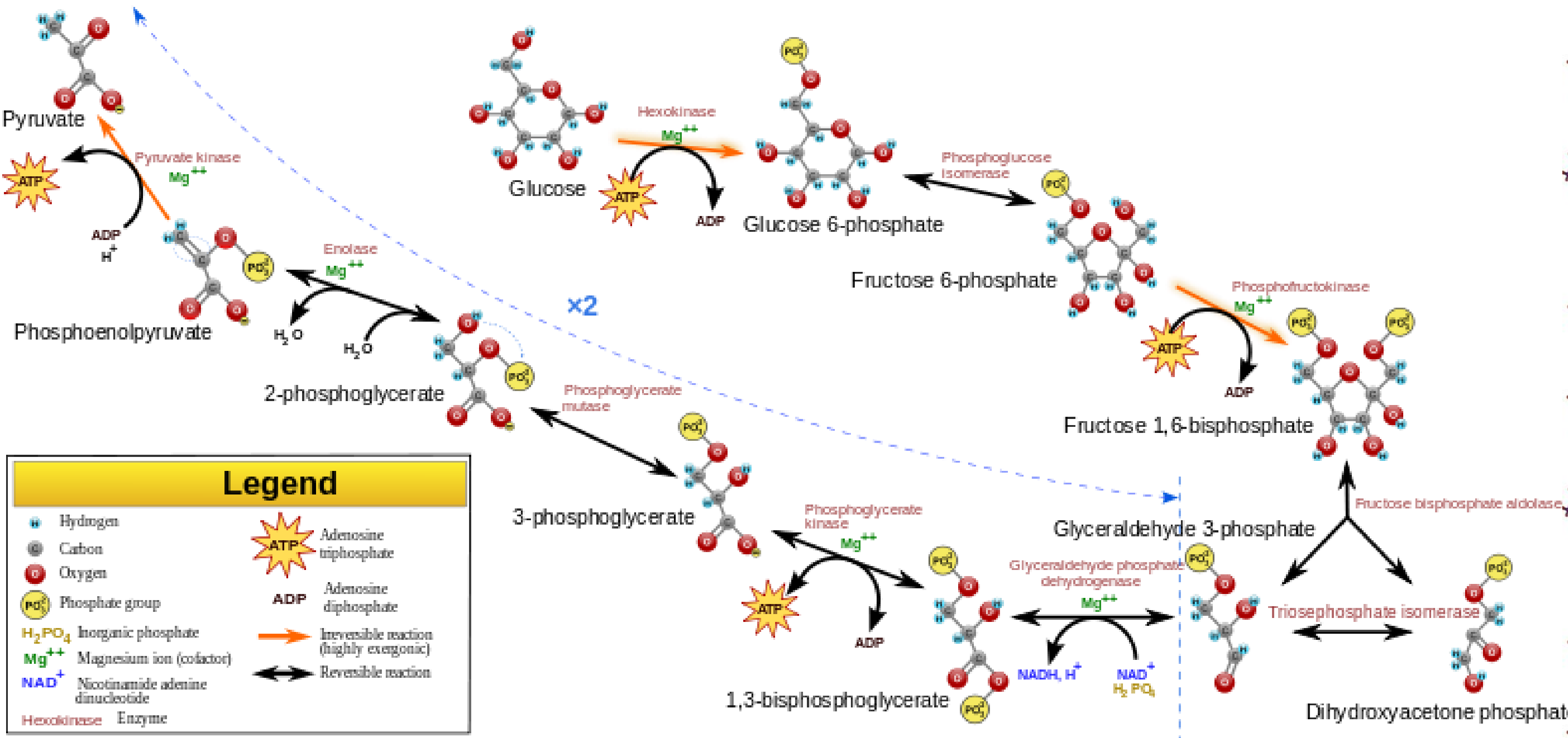
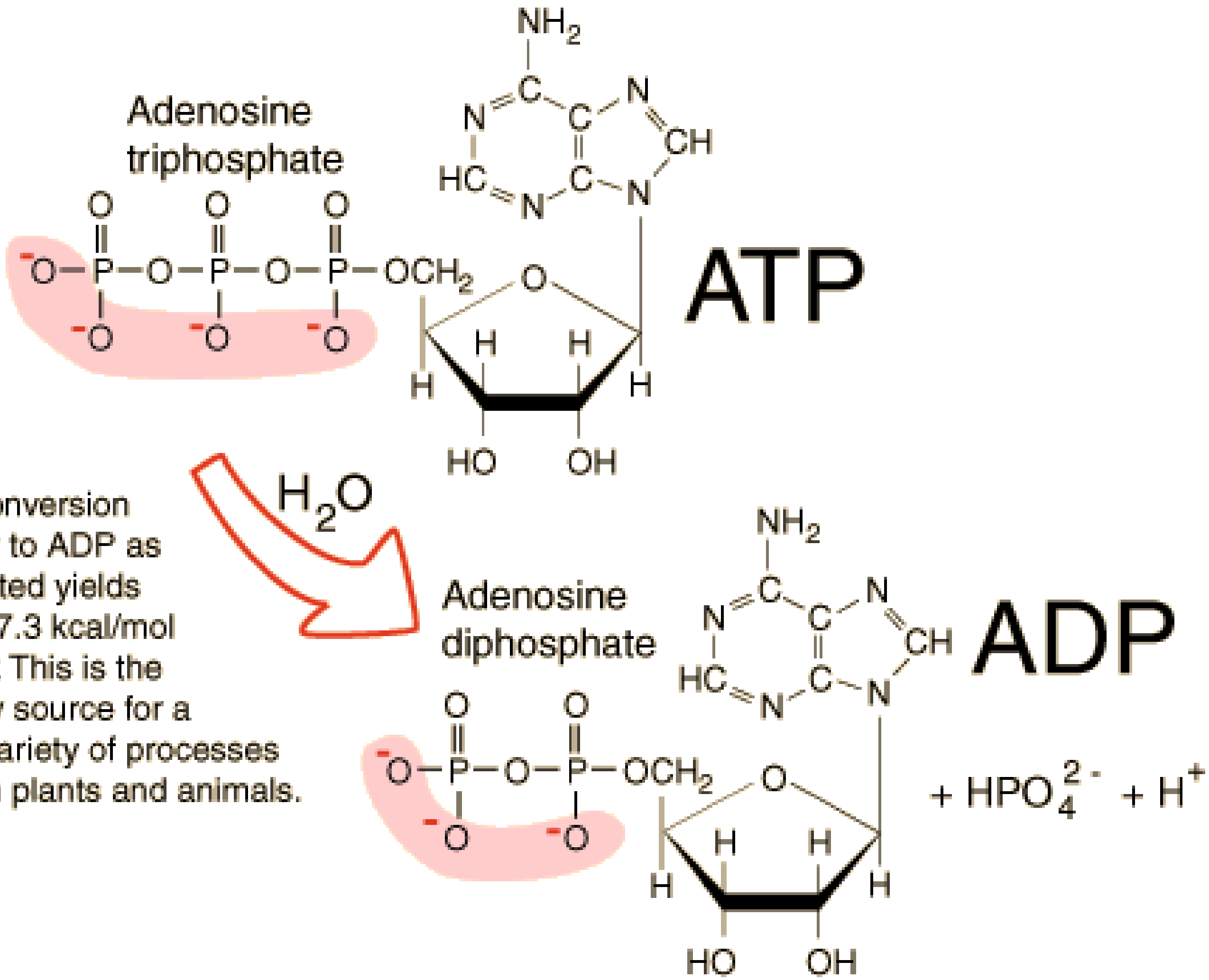


Image: http://en.wikipedia.org/wiki/File:Glycolysis2.svg

ATP ⇔ ADP ⇔ ATP

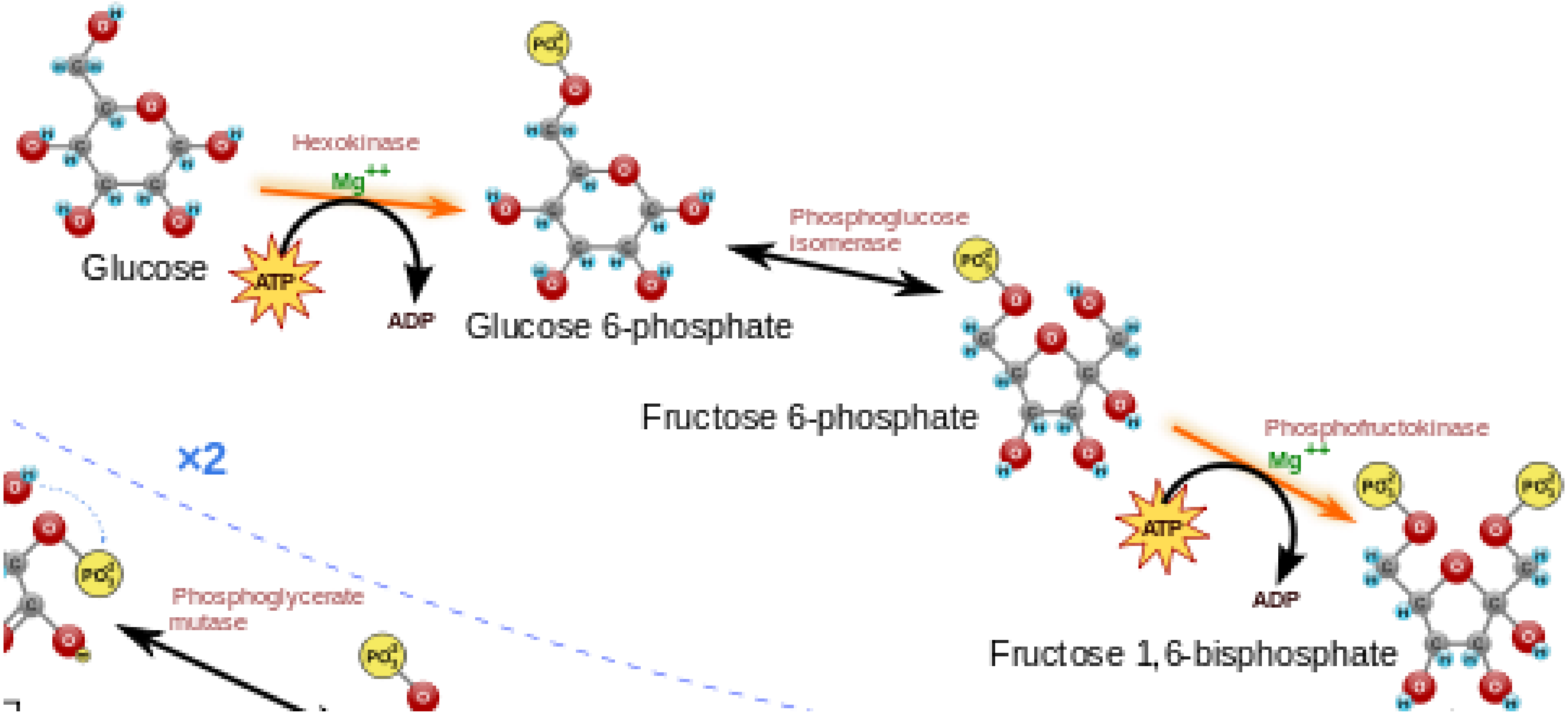


The conversion of ATP to ADP as illustrated yields about 7.3 kcal/mol of ATP. This is the energy source for a wide variety of processes in both plants and animals.

Image: http://en.wikipedia.org/wiki/File:Glycolysis2.svg

Sugar Metabolism

Glycolysis



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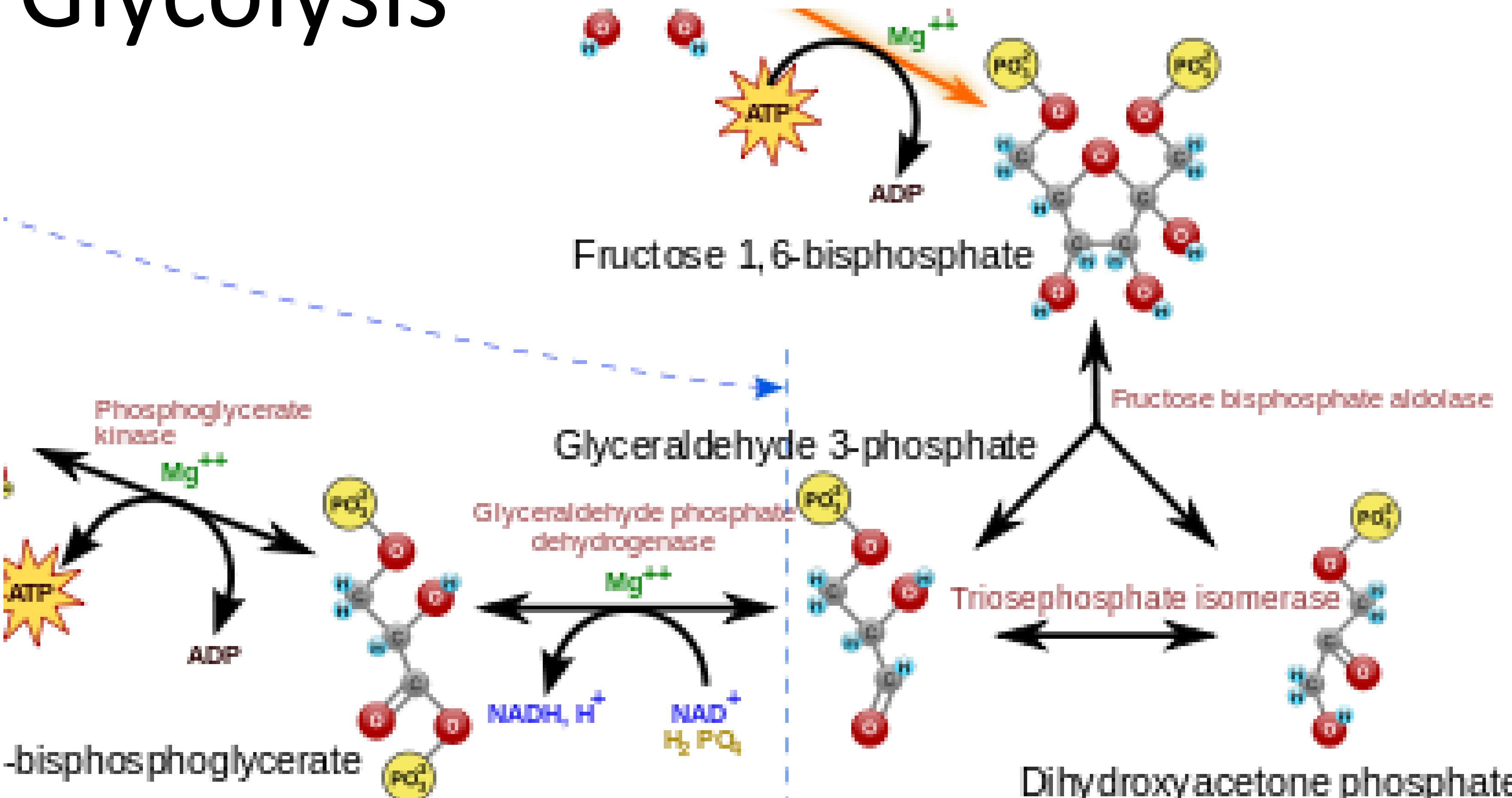
Sugar Metabolism

Glycolysis



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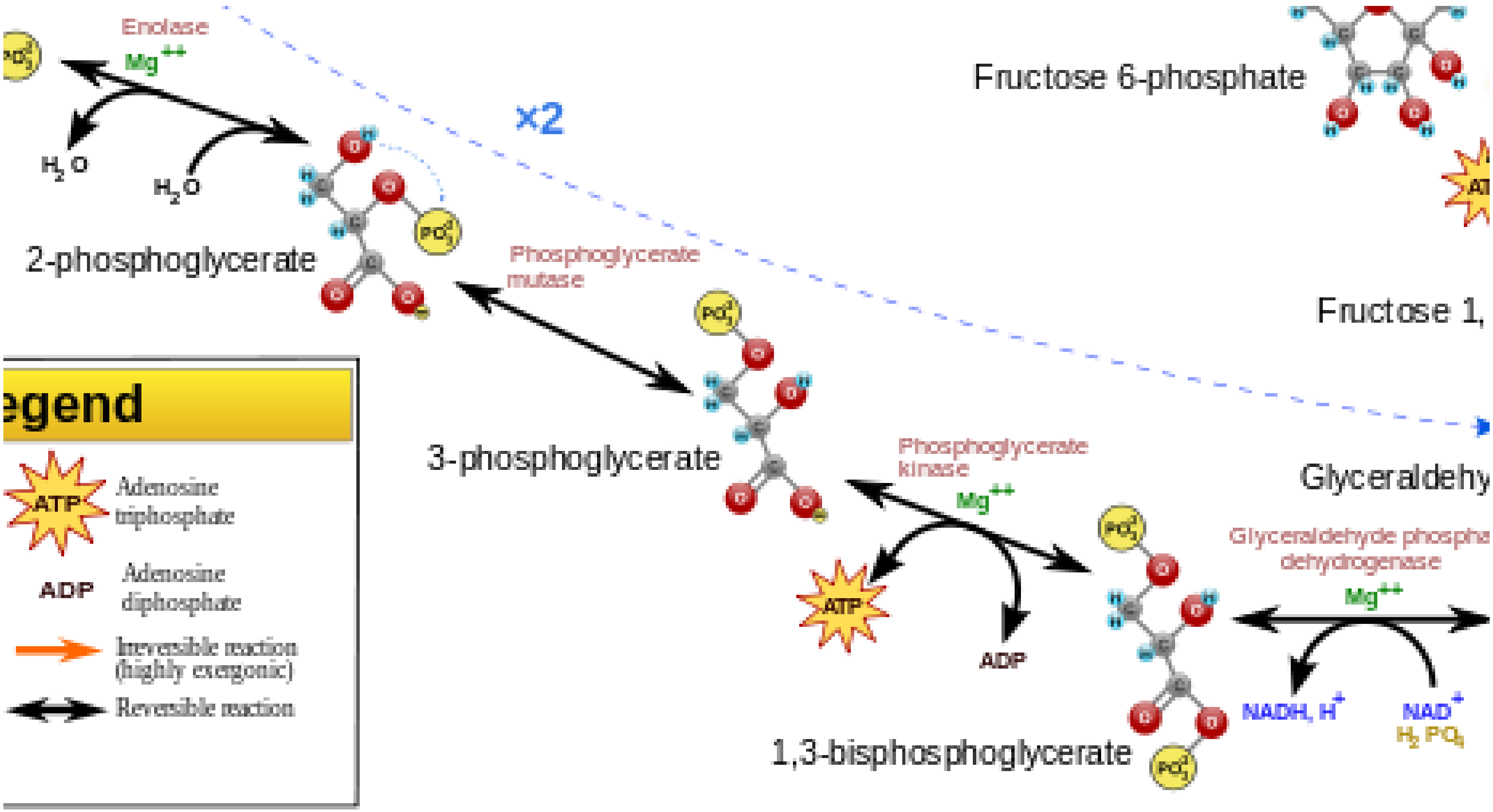
Sugar Metabolism



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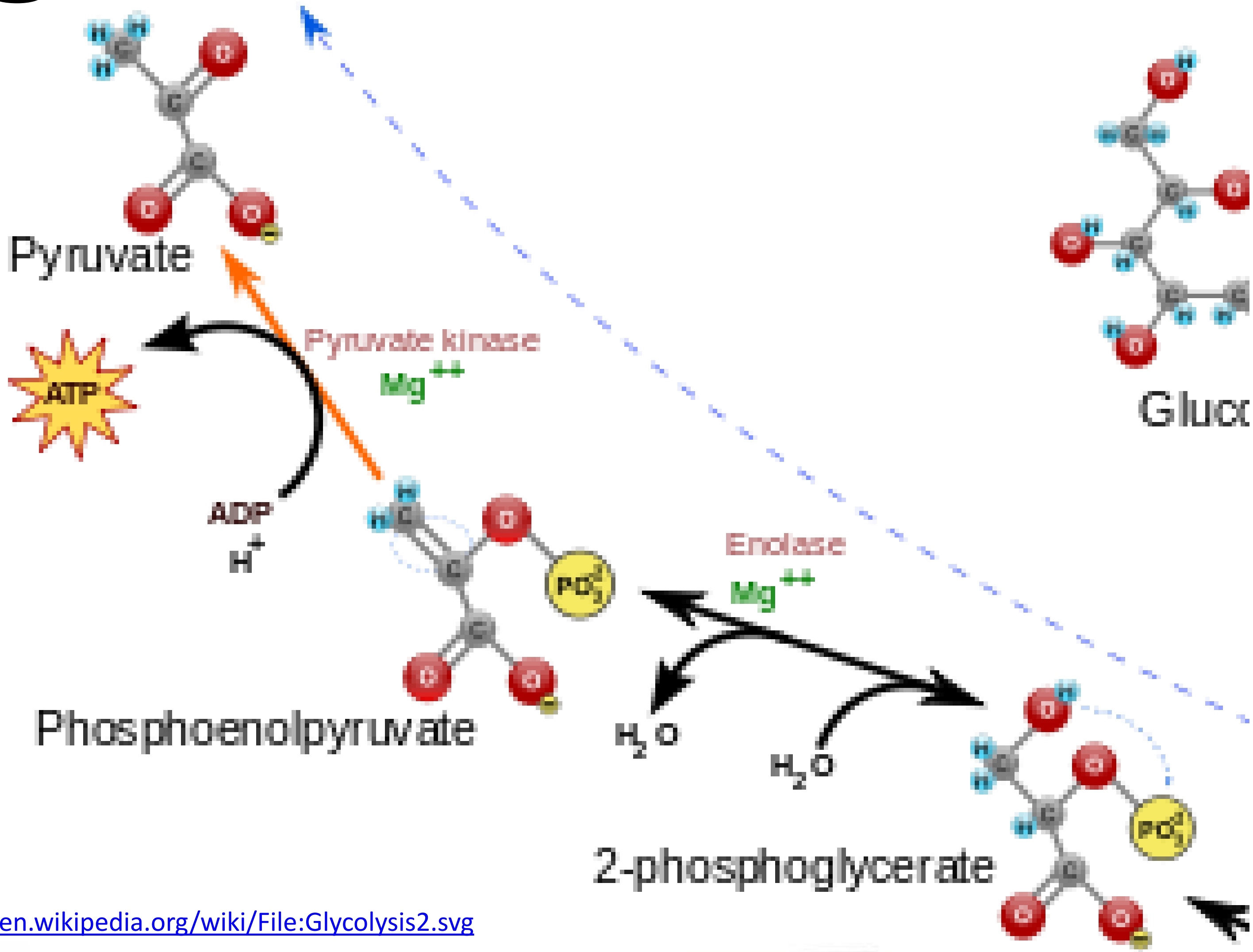
Sugar Metabolism



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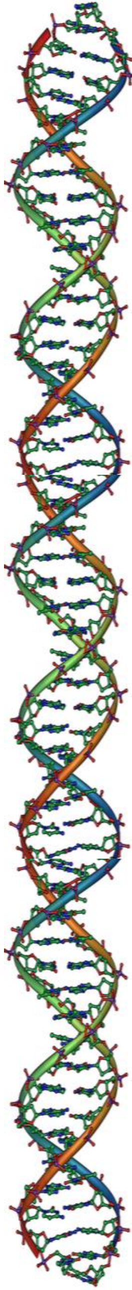
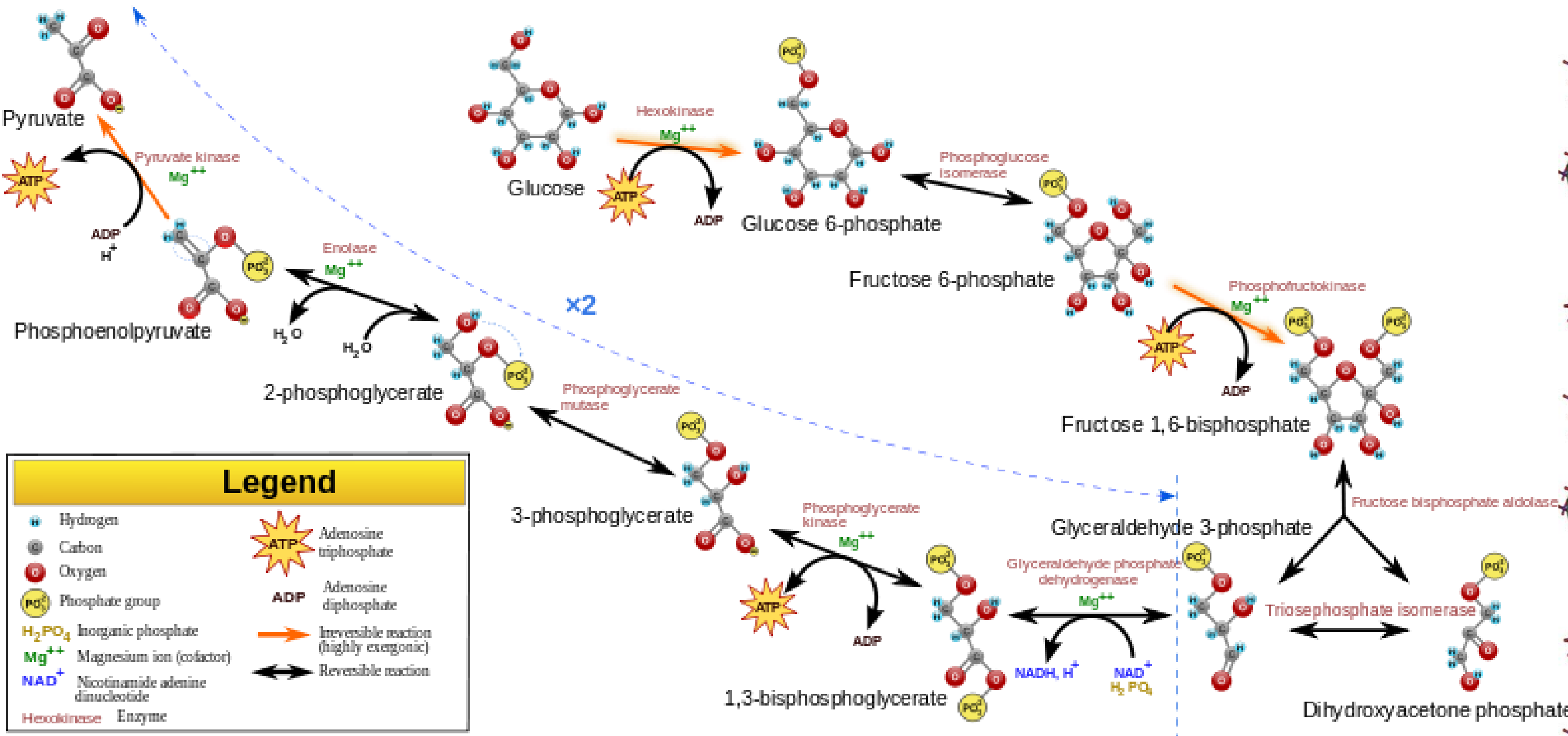


Sugar Metabolism

Glycolysis



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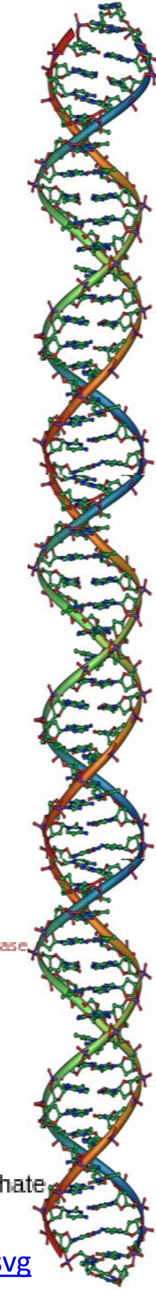


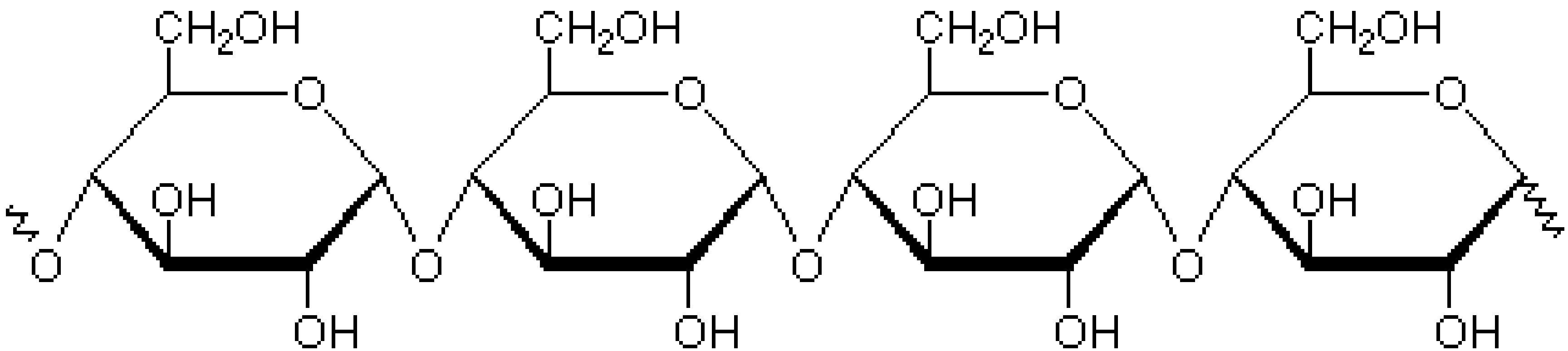
Science of Cooking – BCBT100
Summer 2016 - Bodwin

Polysaccharides

Storage and structure

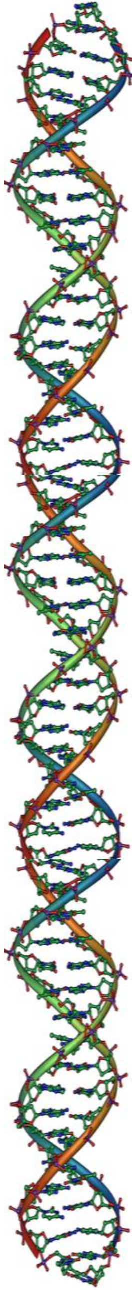
Starch, Glycogen, Cellulose

Sugar polymers



polysaccharide (amylose starch)

Image: http://en.wikipedia.org/wiki/File:Amylose2.svg



Starch

Glucose polymers

Energy storage in plants

Potatoes, rice, grains

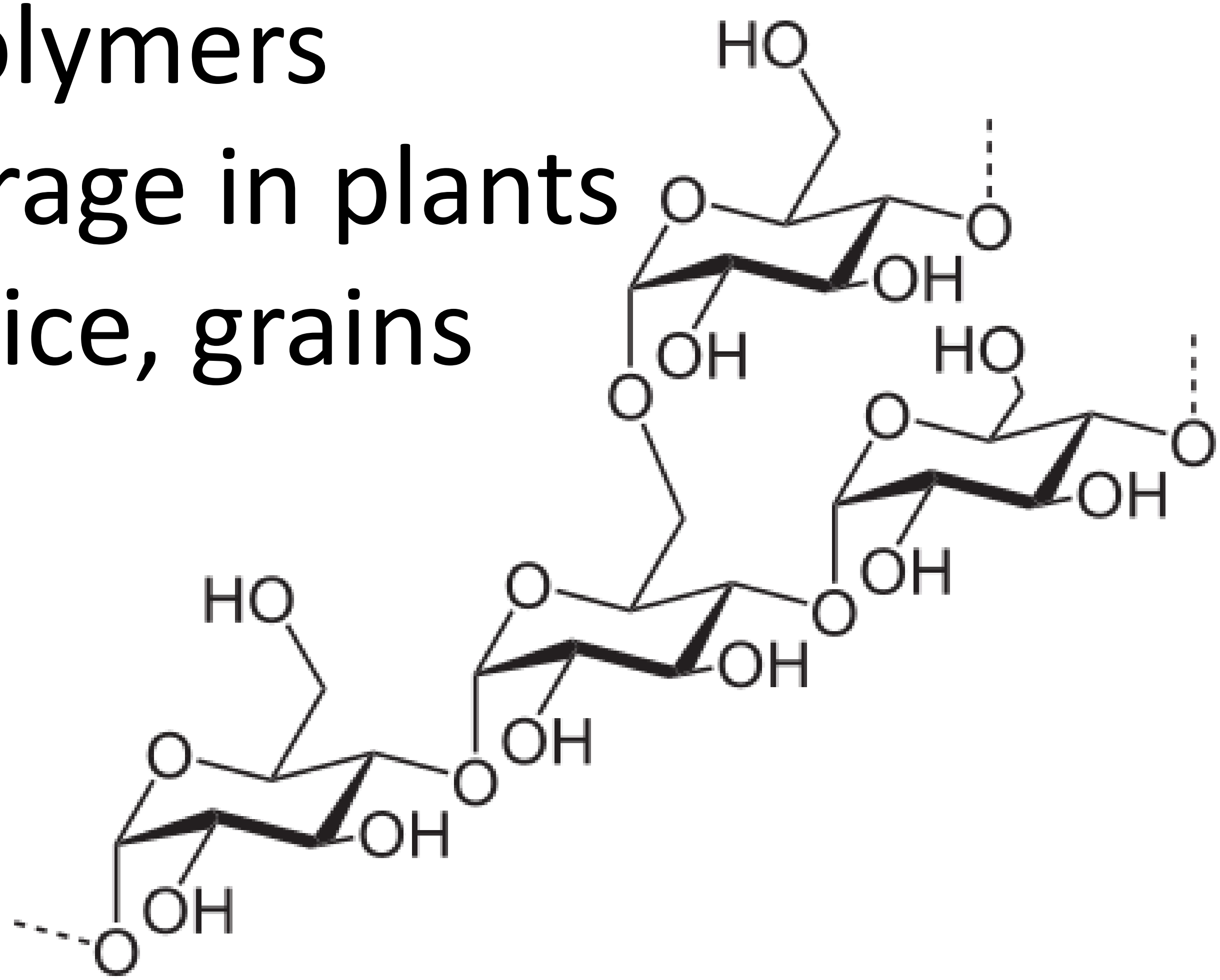
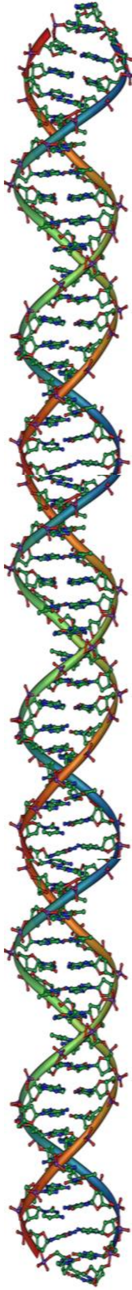


Image: http://en.wikipedia.org/wiki/File:Amylopektin_Sessel.svg



Starch - Structure

Straight chain

Amylose

Branched chain

Amylopectin

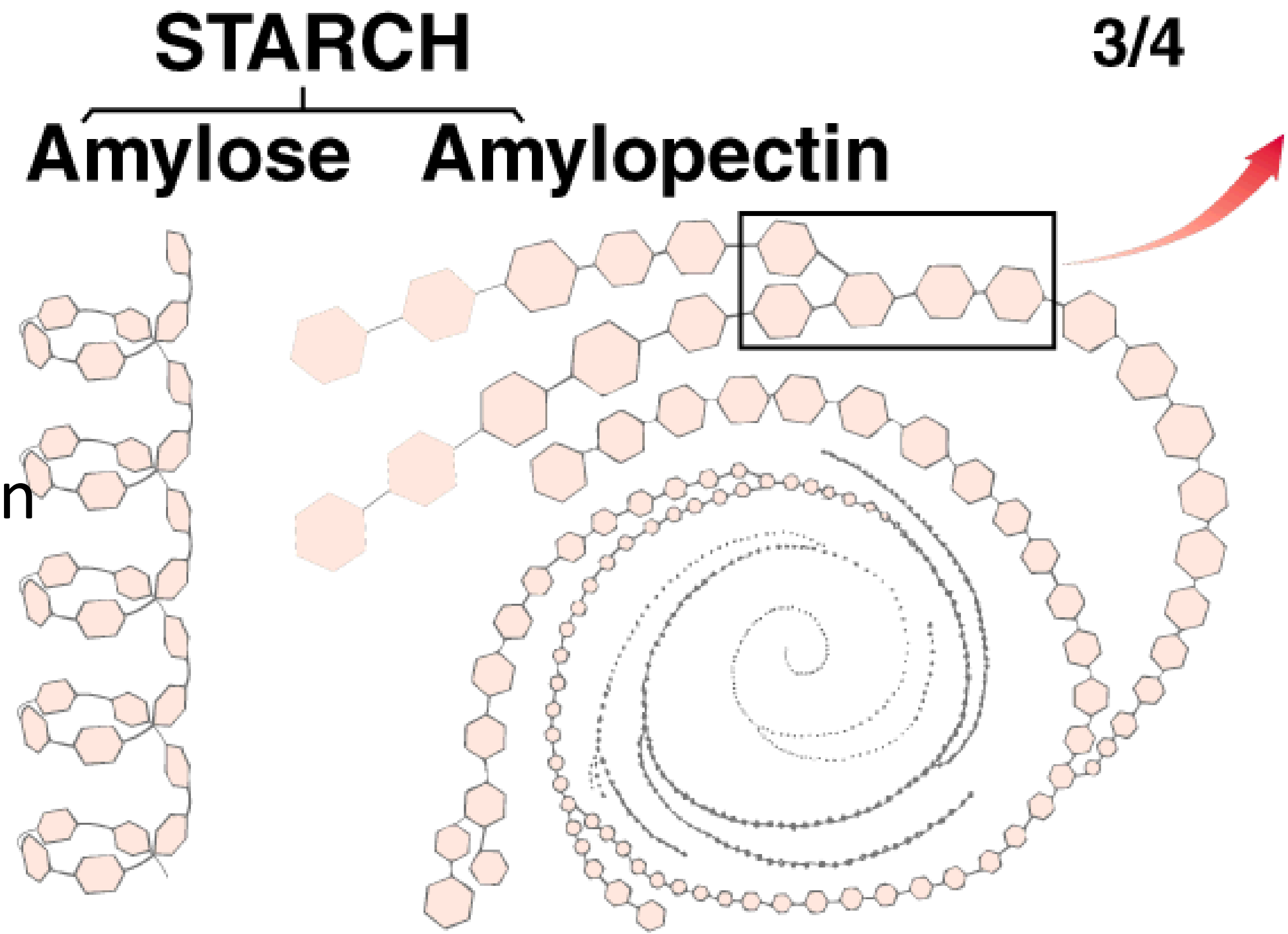
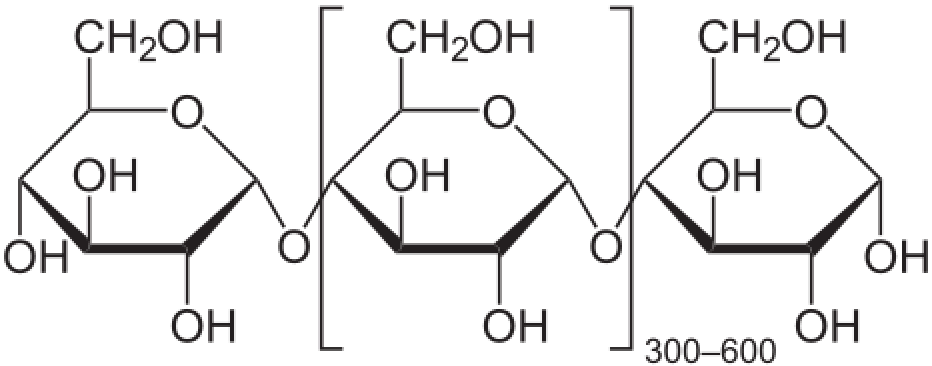


Image: http://en.wikipedia.org/wiki/File:Amylose2.svg

Starch – In foods

Thickener – binds a LOT of water

Provides energy - amylase



Industrially:

- Dextrose = glucose derived from hydrolyzed starch
- HFCS – dextrose treated with glucose isomerase

Image: http://en.wikipedia.org/wiki/File:Amylose2.svg

Glycogen – "animal starch"

Highly branched glucose polymer

Energy storage

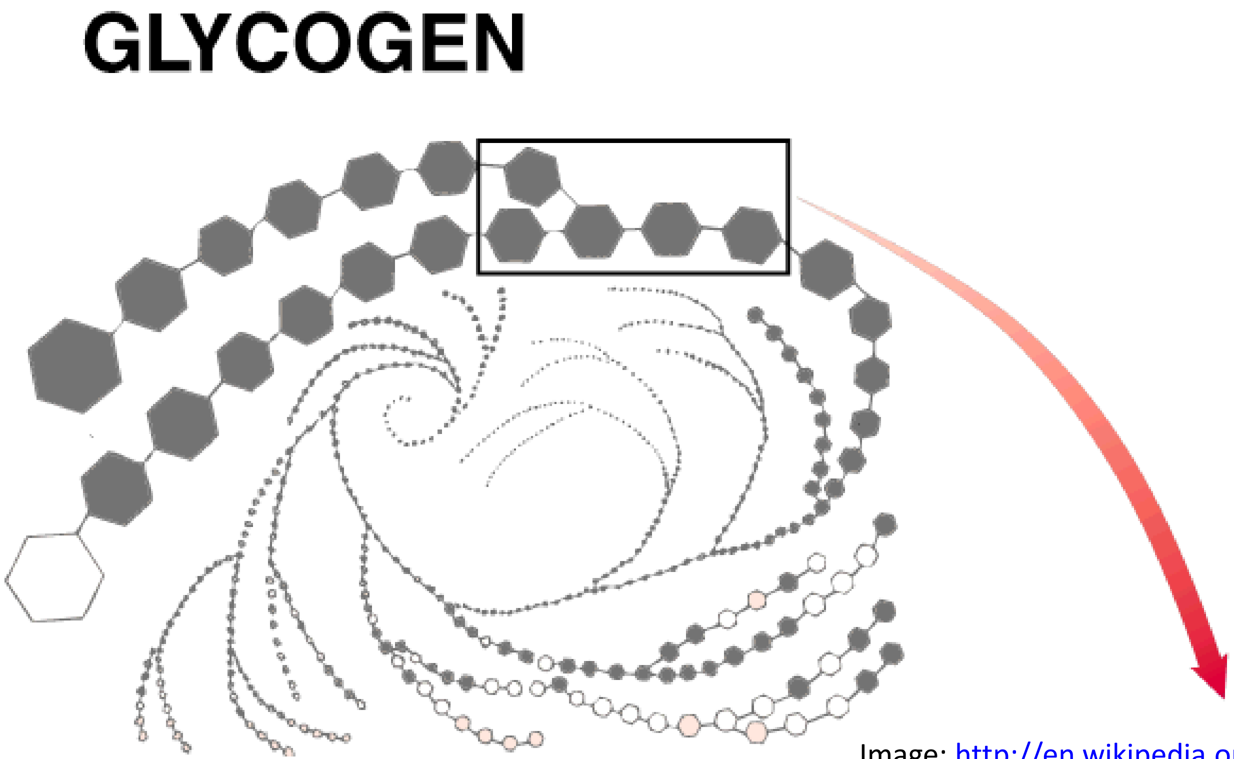
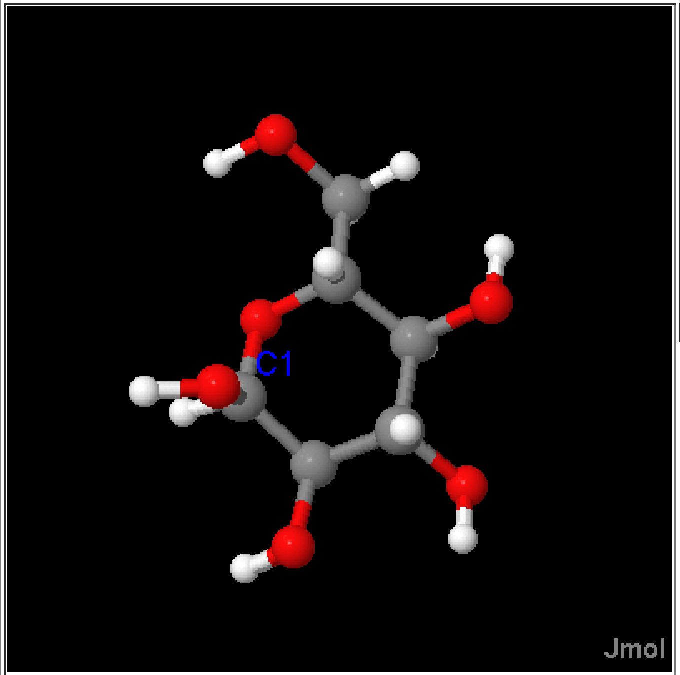
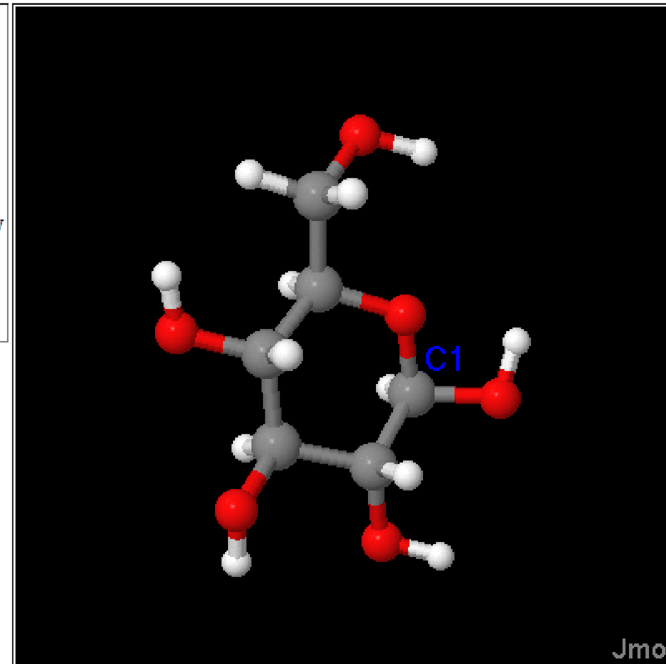


Image: http://en.wikipedia.org/wiki/File:Amylose2.svg

Cellulose

Polymers made from β-glucose

α-Glucose	*Click on links below to highlight sections of the molecules*	β-Glucose
	Alpha and beta glucose differ only in the direction that -H and -OH groups point on carbon 1 (labelled). Alpha glucose has an -OH [hydroxyl] group (red sphere attached to white sphere) that points "downwards", away from the ring, whereas the -OH on carbon 1 of beta glucose is above the ring.	

Side-by-side animations:

http://www.biotopics.co.uk/JmolApplet/alphabetajglucose2.html

Cellulose

Enzymes that break amylose can't break cellulose

Rigid, tough *fibers* that make plant cell walls and stalks

Cross-linking

Cellulose - Dietary

Insoluble Fiber

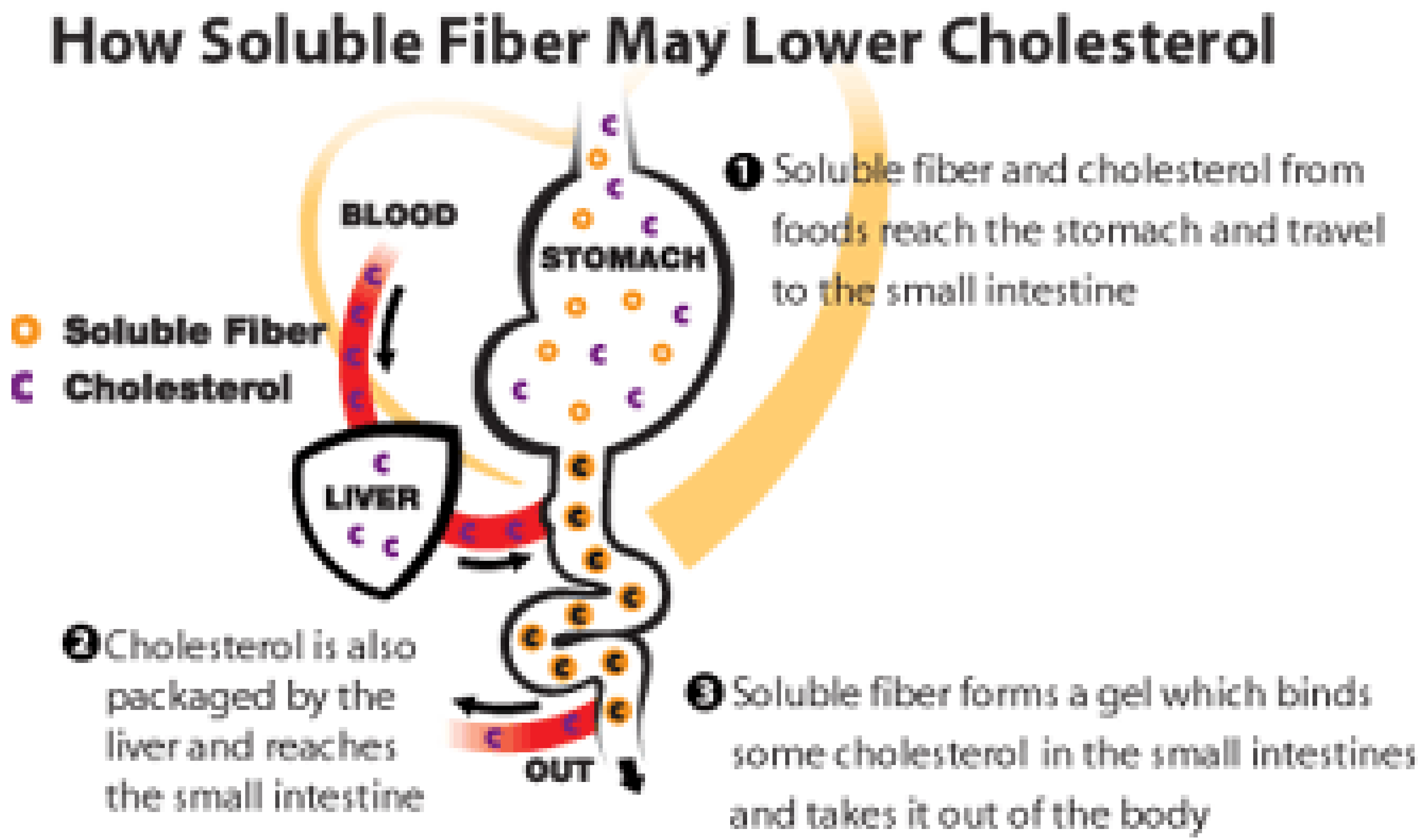
- Highly modified cellulose, up to ~1/2 the mass of a plant
- Binds water, “feel full”
- Draws water into gut
- Fruits, vegetables, whole grains

Cellulose - Dietary

Soluble Fiber

- Highly modified cellulose
- Forms gel with high water content
- Water-soluble substances absorbed by gel – “intestine sweeper”

Cellulose - Dietary



Cellulose – Food source?

Cellulosic fiber is indigestible

- Most animals lack enzymes to break down cellulose
- Ruminants have bacteria in the gut that {partially} digest cellulose to glucose

Image:http://www.publicdomainpictures.net/view-image.php?image=627&picture=black-cow, http://www.cvm.ncsu.edu/vhc/efac/rhm/

Interactions

Fats and water

Amphiphiles

Micelles

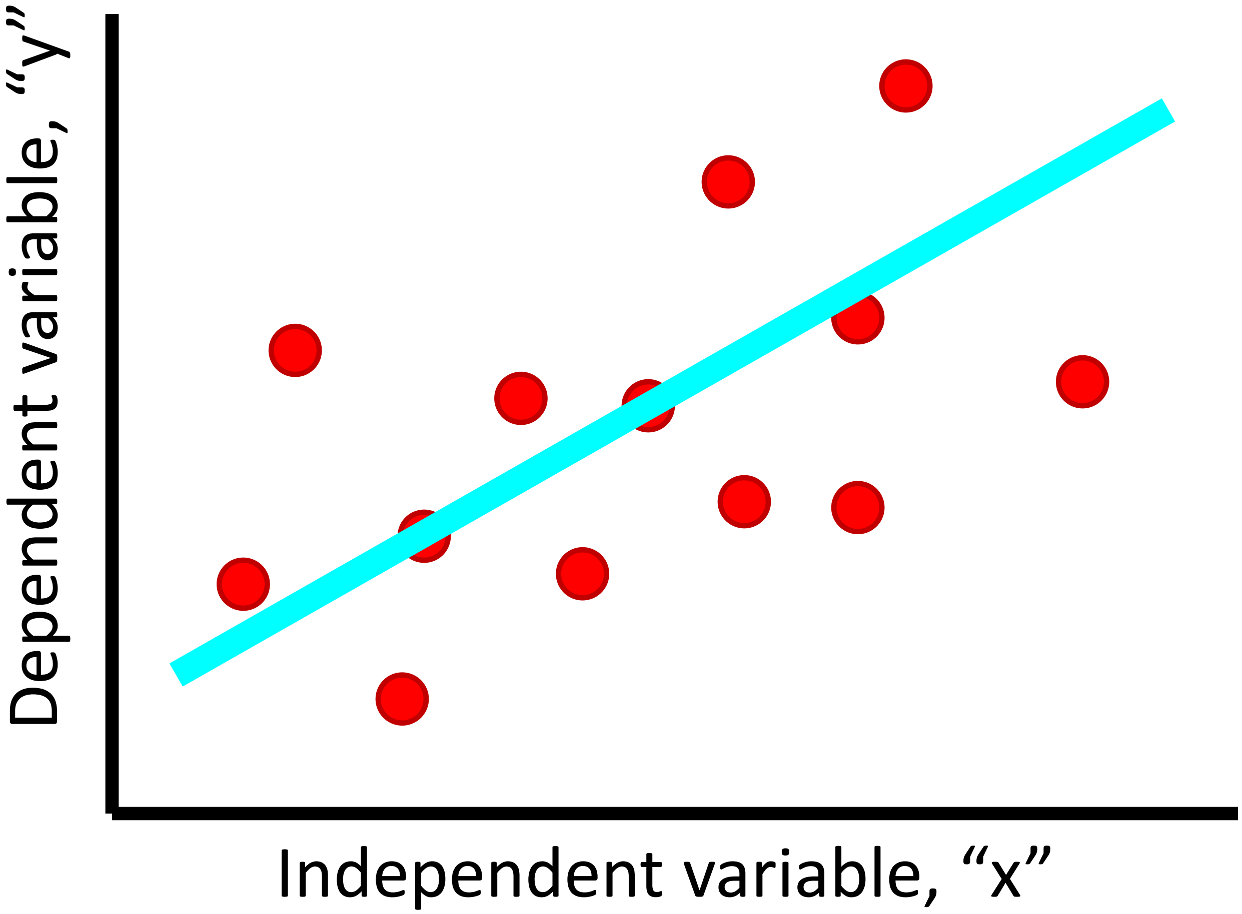
Emulsifiers

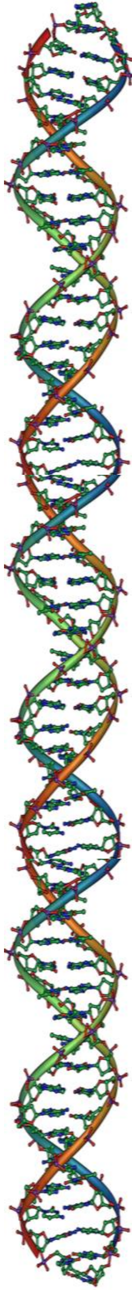
Working with Data

Table → organize related info

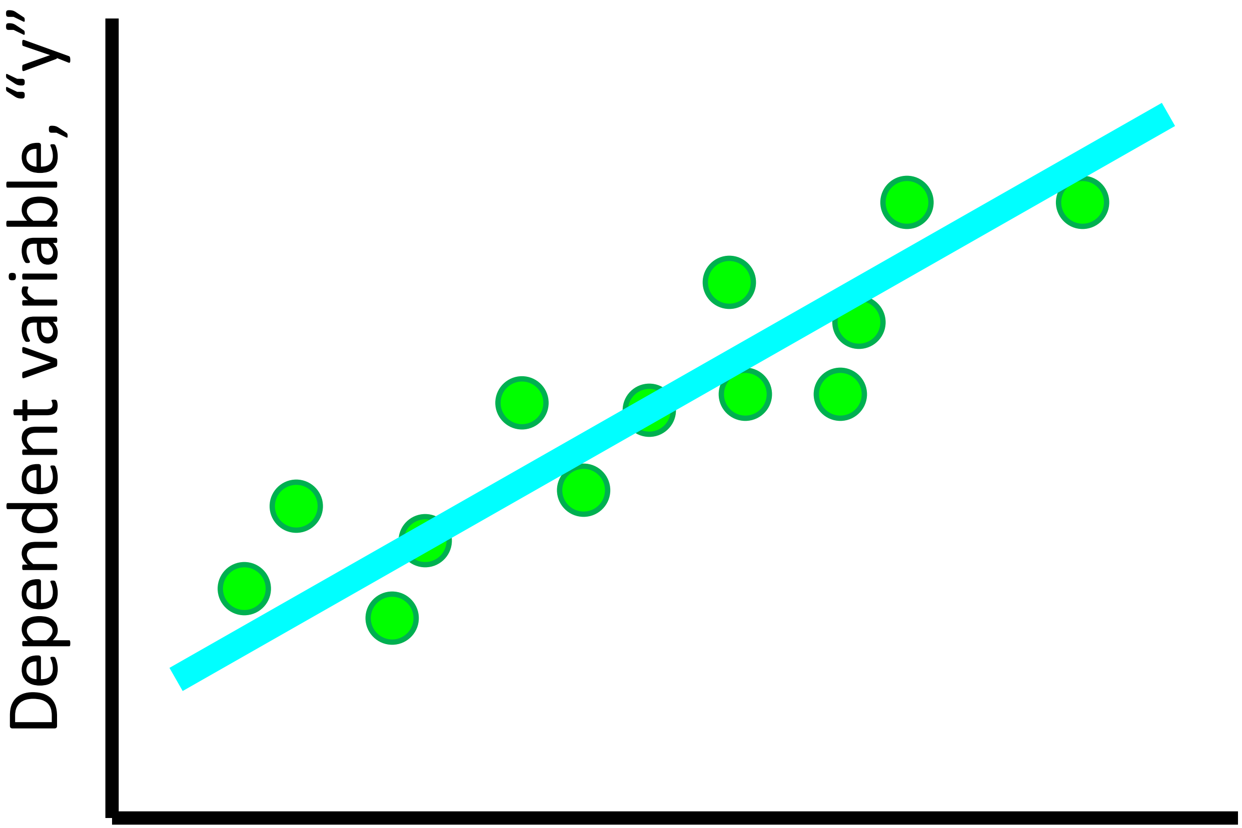
Graphs → show trends

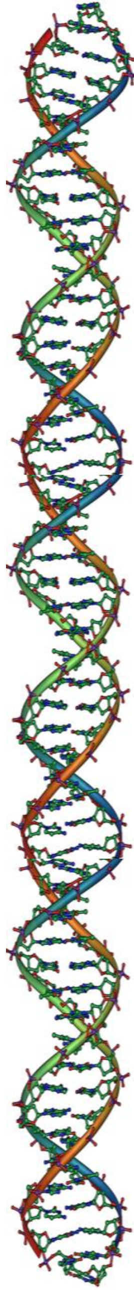
Making graphs





Making graphs





“Good” Graphs

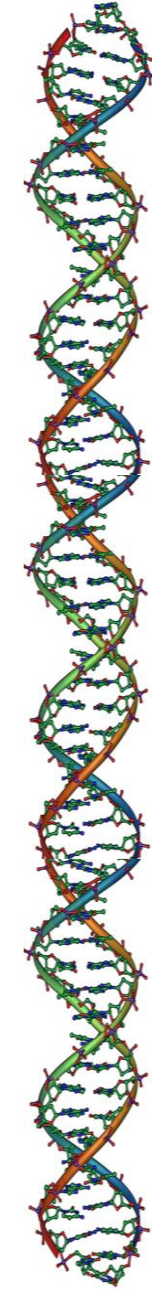
Choose “x” & “y”

Scatter plot – no connectors

Fill the area

Label axes clearly

Use meaningful fit lines/trends



Graphing

You've gone for a walk and recorded the distance travelled at a number of times.

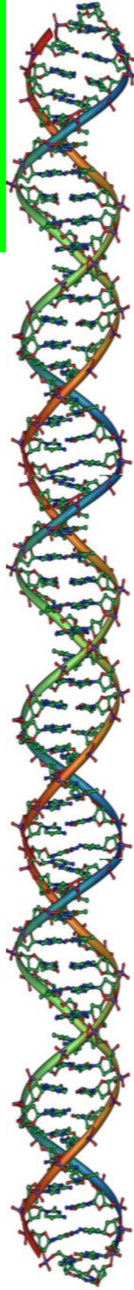
5 minutes = 296meters; 10min = 608m; 15min = 882m; 20min = 1207m; 25min = 1562m; 30min = 1803m

What was your average speed?

END DAY 3

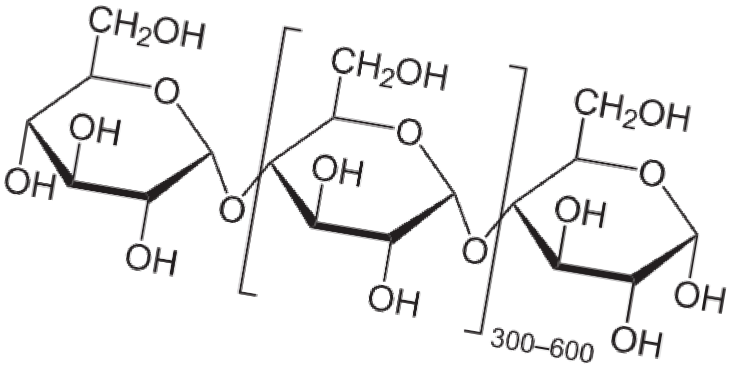
Content

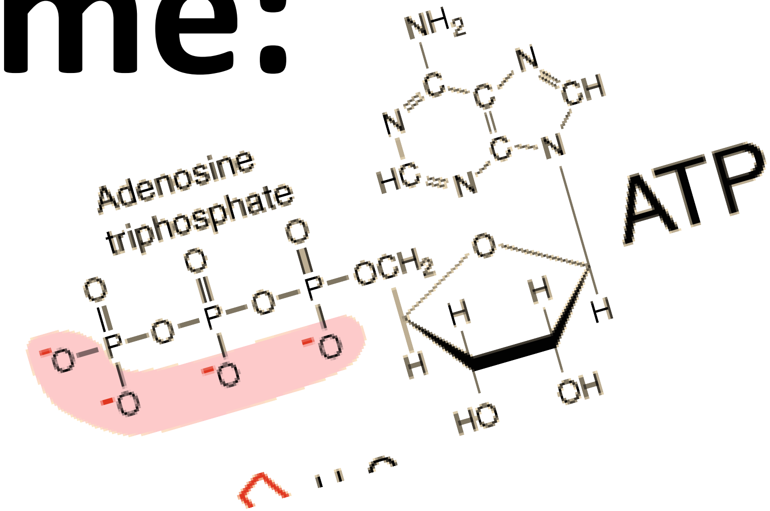
TOPIC BEGIN

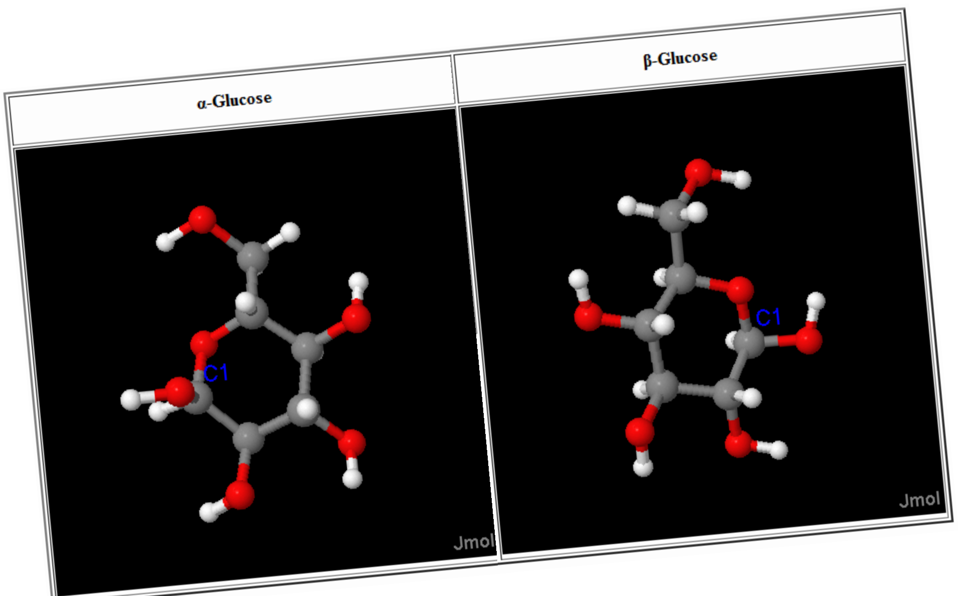


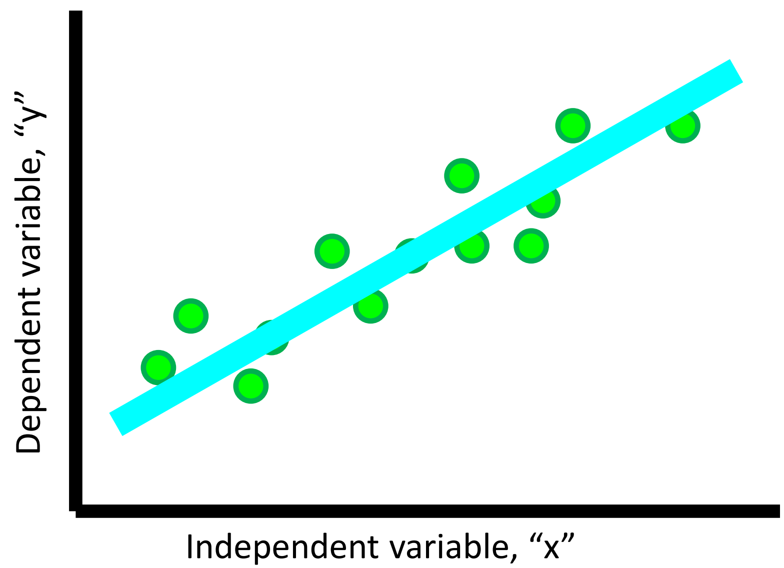
MILK AND DAIRY

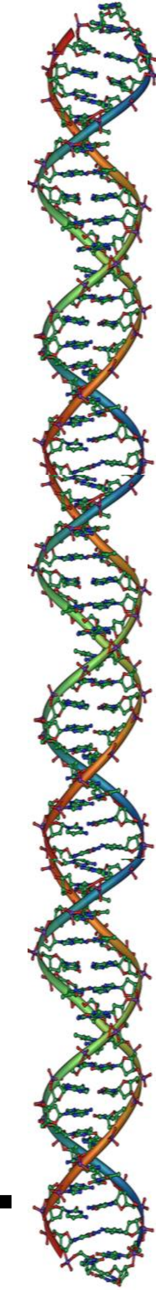
From Last Time:







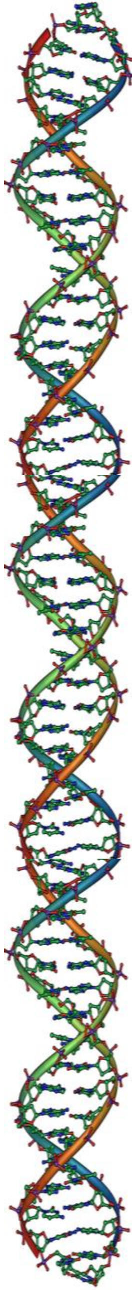




Science of Cooking – BCBT100
Summer 2016 - Bodwin

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):

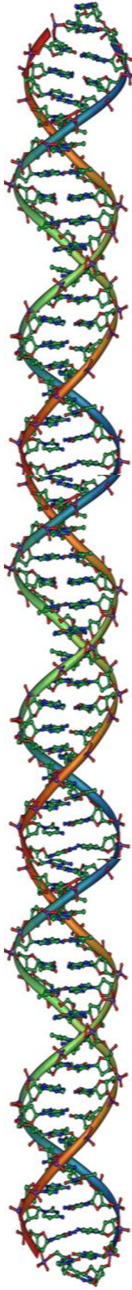
Slightly acidic water (pH ~6.6)

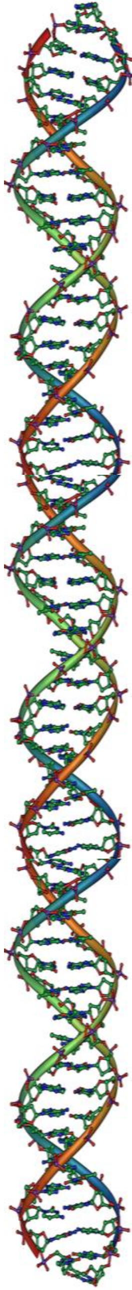
Protein bundles

Lactose

Fat phase:

Droplets of oil with a protein shell





Mixtures

Homogeneous

Pure substances

Solutions

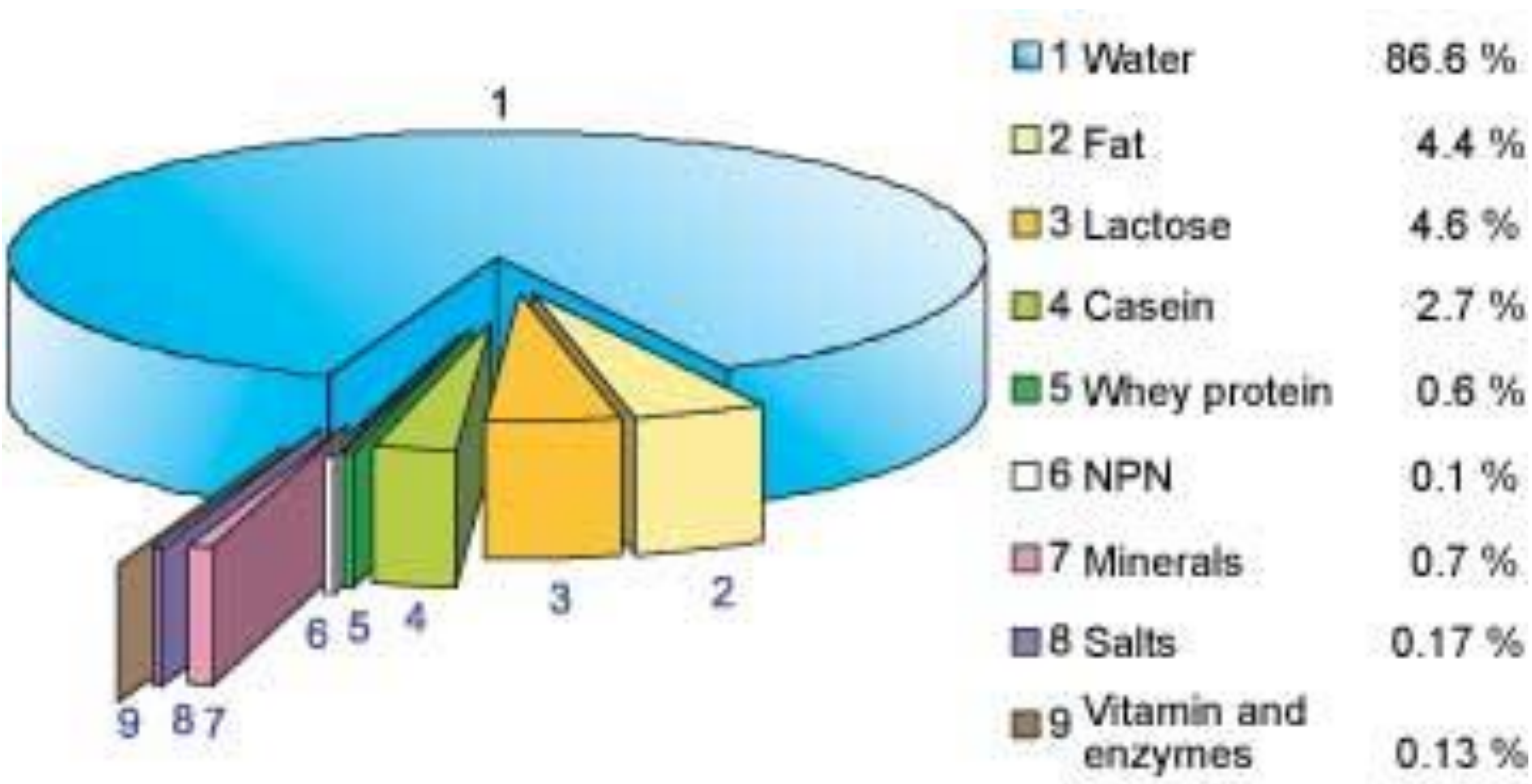
Heterogeneous

Bulk mixtures, melange

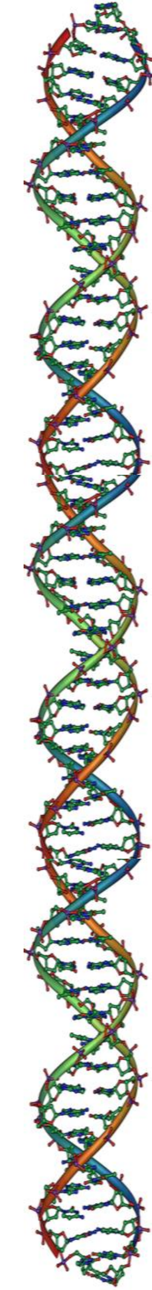
Suspension/colloid, emulsion

Emulsifiers and amphiphiles

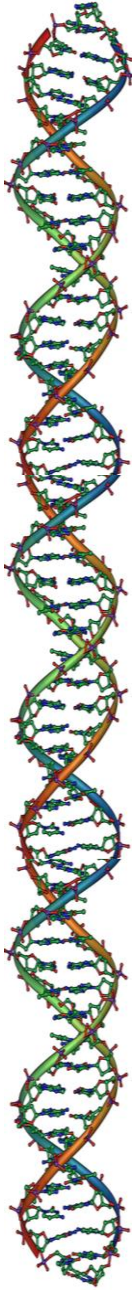
Milk Composition



NPN – Non-protein nitrogenous compounds

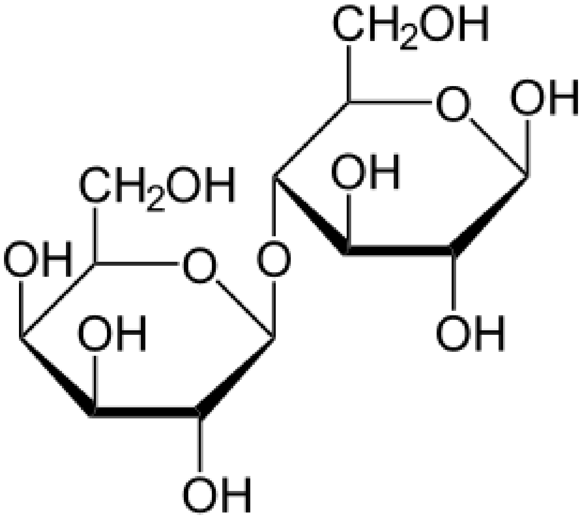


Sources of milk:

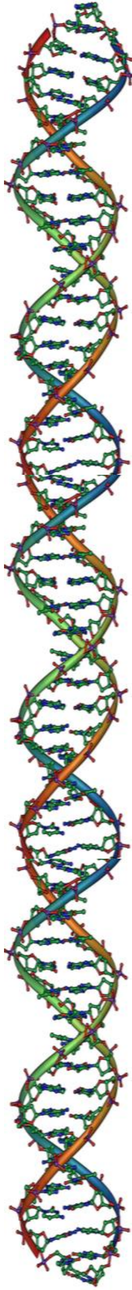


Species	Water	Fat	Casein	Whey	Lactose
Human	87.1	4.6	*0.4*	0.7	**6.8**
Cow	87.3	4.4	2.8	*0.6*	4.6
Buffalo	82.2	7.8	3.2	*0.6*	4.9
Goat	86.7	4.5	2.6	*0.6*	4.4
Sheep	82.0	7.6	3.9	0.7	4.8
Horse	**88.8**	*1.6*	1.3	1.2	6.2
Rat	*79.0*	**10.3**	**6.4**	**2.0**	*2.6*
Donkey	**88.3**	*1.5*	*1.0*	1.0	**7.4**
Reindeer	*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

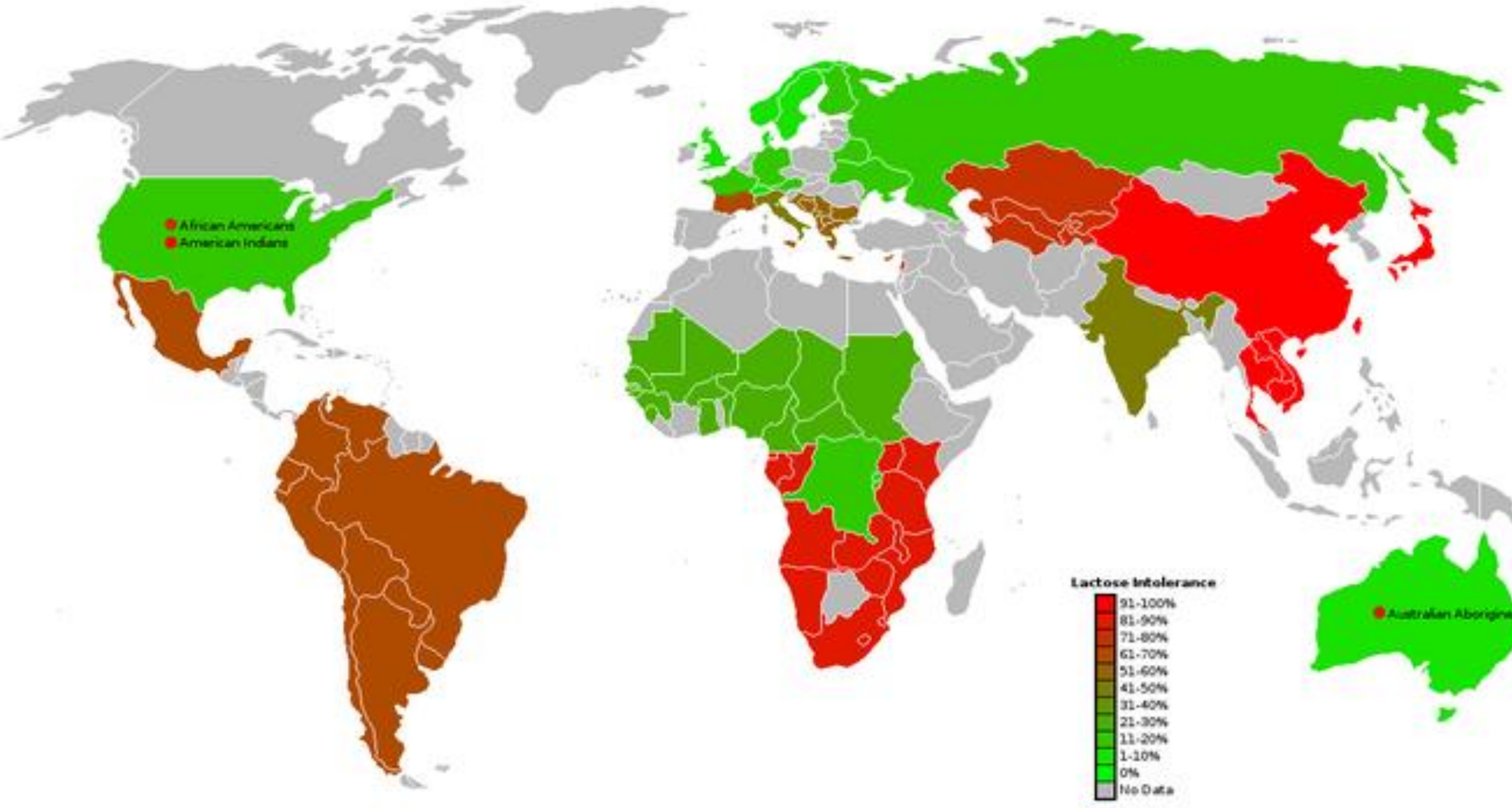


Image: http://www.oliverbenjamin.net/dudespaper/wp-content/uploads/2009/06/lactose-intolerance-map.jpg

Lactose Intolerance

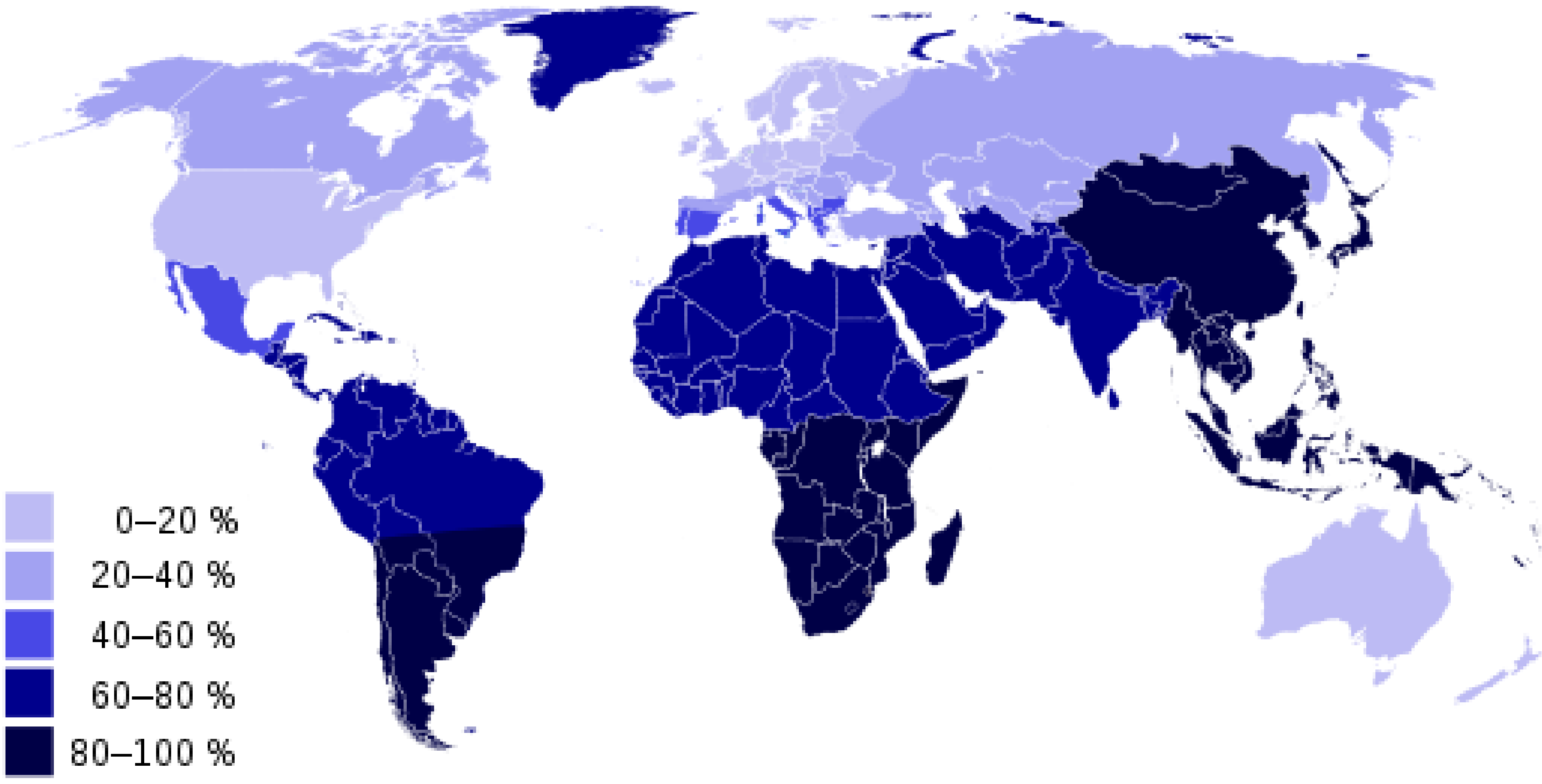
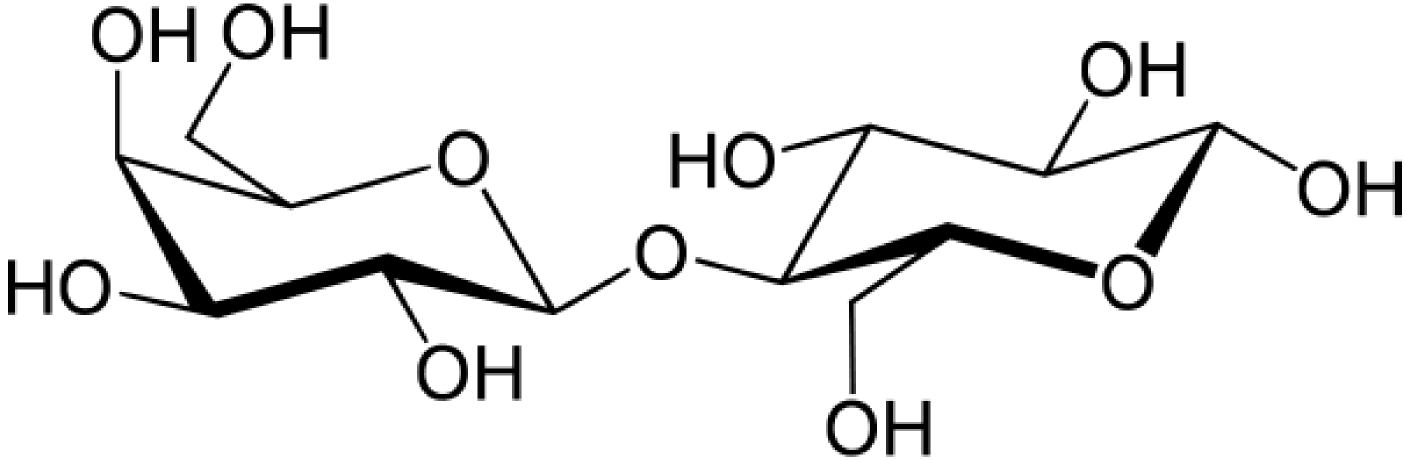


Image: http://supervegan.com/blog/entry.php?id=1638

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.svg

Purpose of Lactose

Glucose

Protected as disaccharide

Energy source

Galactose

Neural tissue

Make brains…

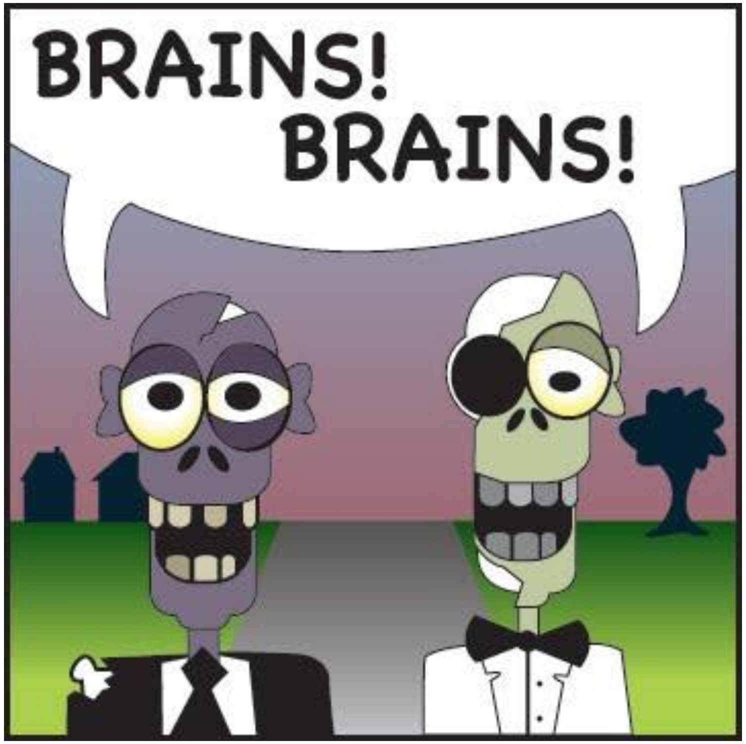
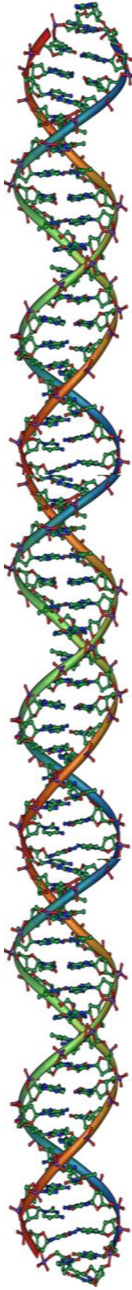


Image: http://blogity-blah-blah-blog.blogspot.com/2012_01_01_archive.html

Milk Protein - Casein

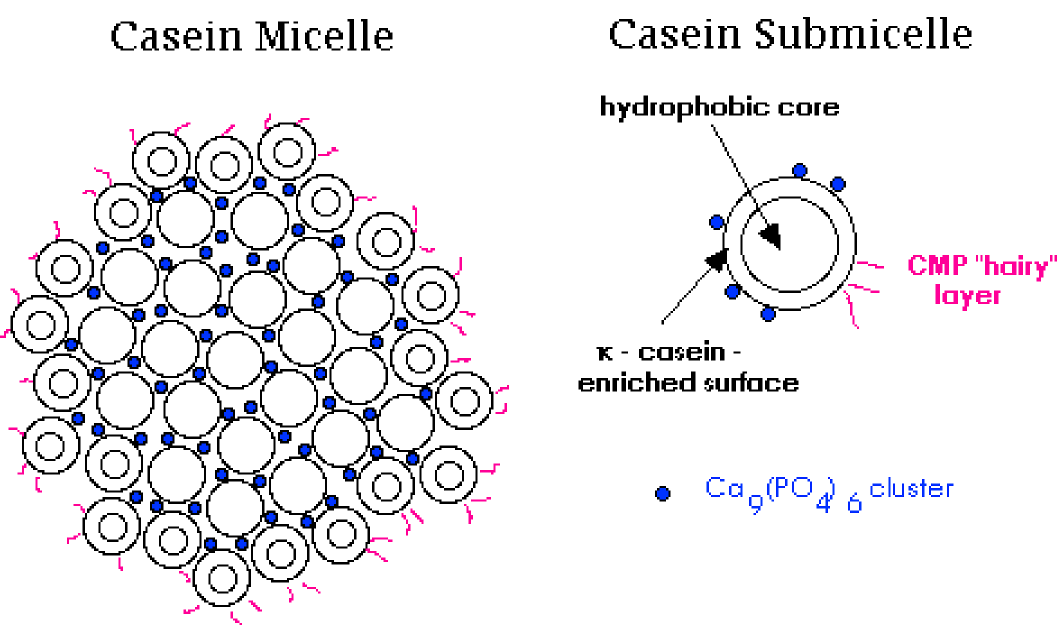


- Major single protein produced in most milk
- Key characteristics of casein
- Heat stable – well folded protein
- “floats” in micelle form (globs of protein arranged to keep the protein in solution)
  - Hydrophobic portion of protein in middle
- Calcium binds tightly to this protein – helps to carry 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



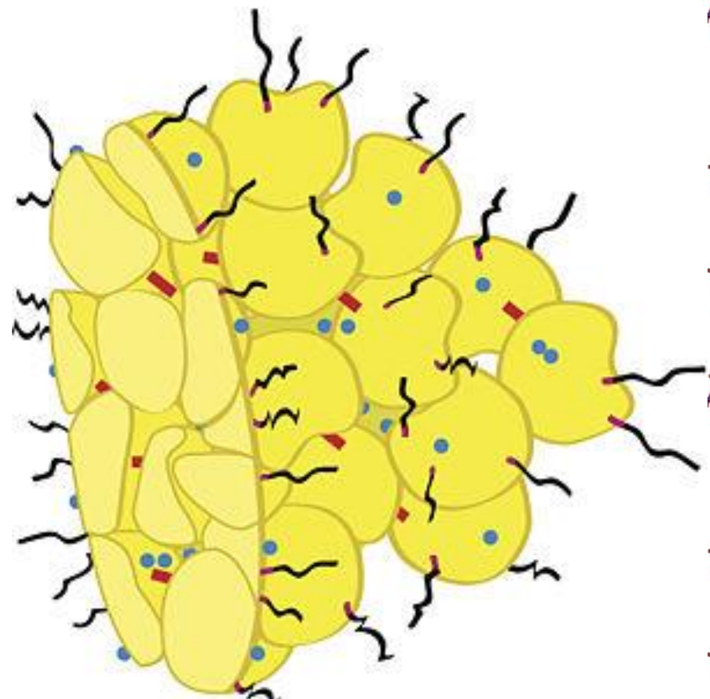
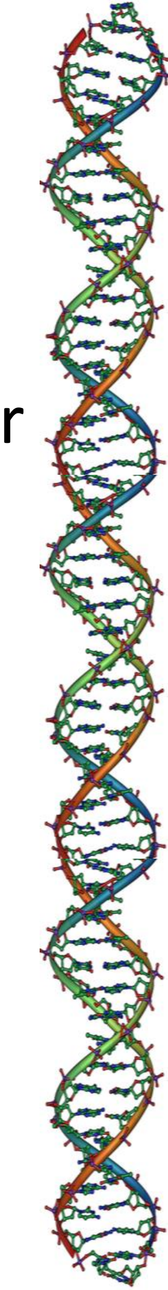


Image: http://www.foodsci.uoguelph.ca/deicon/casein.gif

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

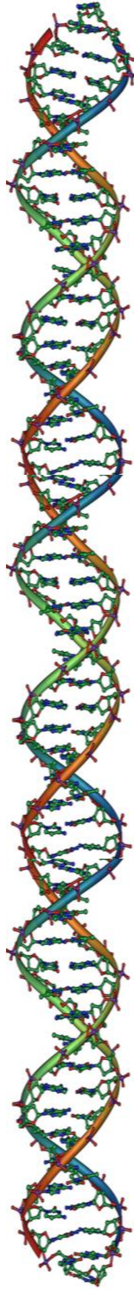
Milk Protein - Whey

- 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



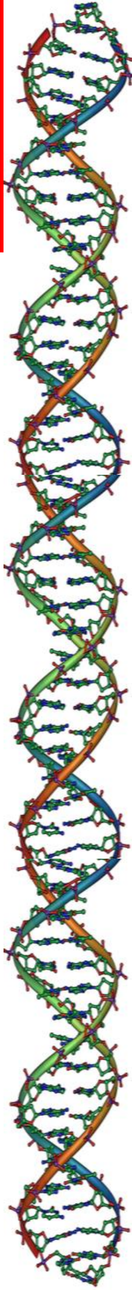
Pop Quiz!

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

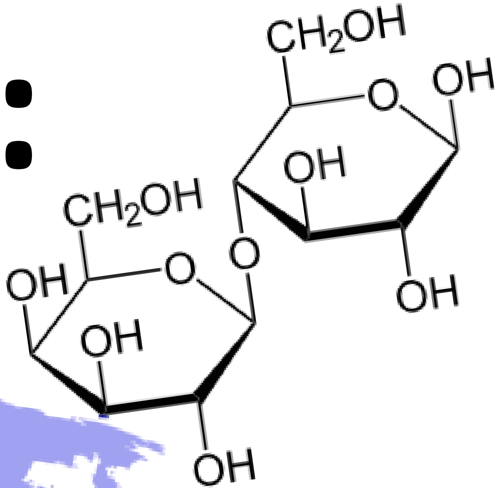


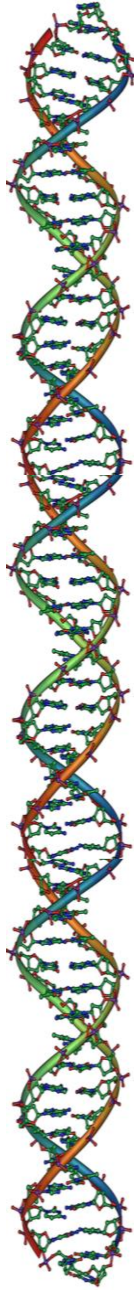
END DAY 4

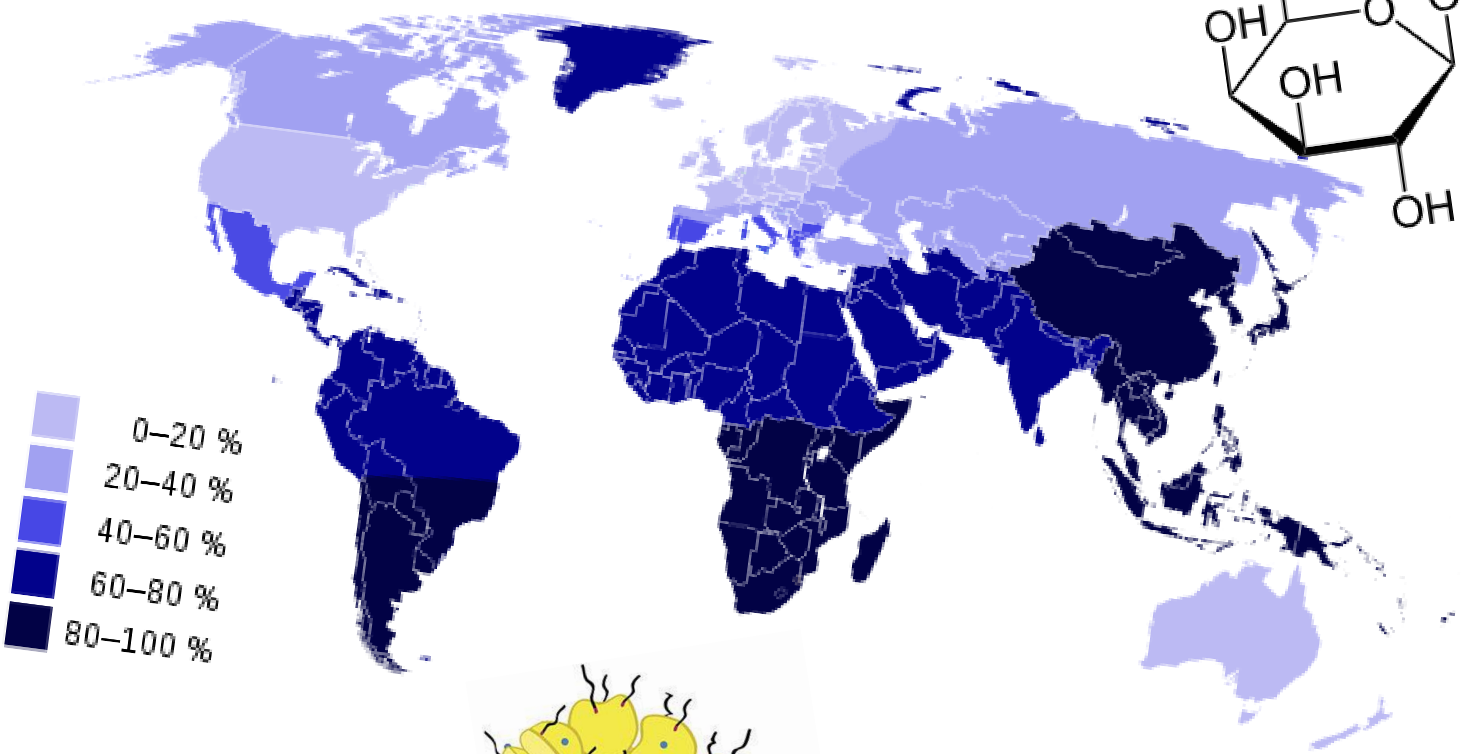
Content

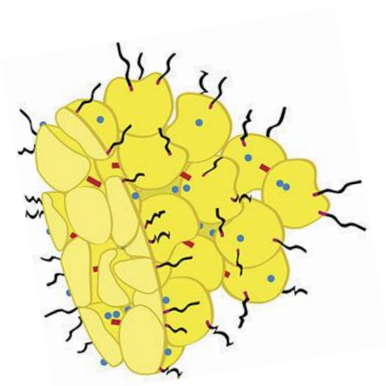


From Last Time:









Acids and Bases

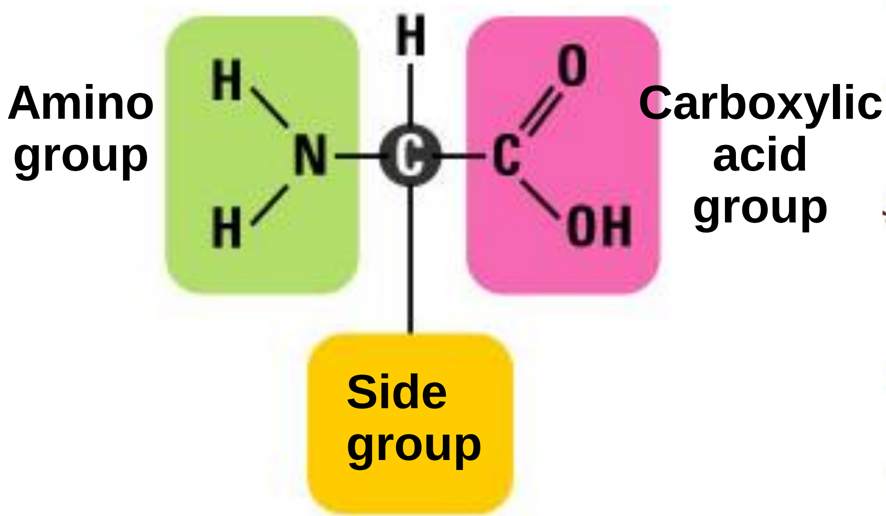
Acids = increase concentration of hydrogen ion (H^+) when dissolved in water

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

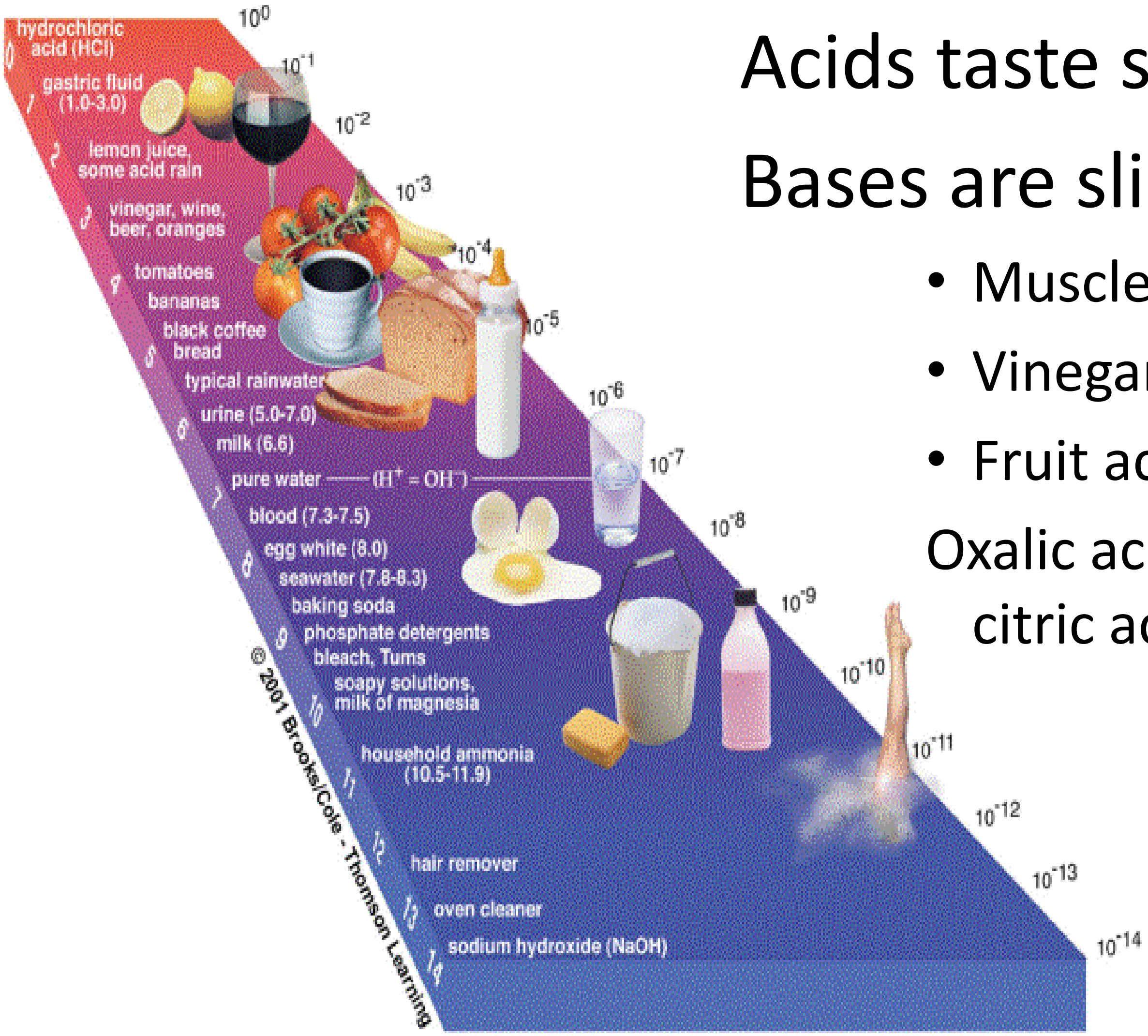
$H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$

"Neutralization"

pH scale



Acids and Bases

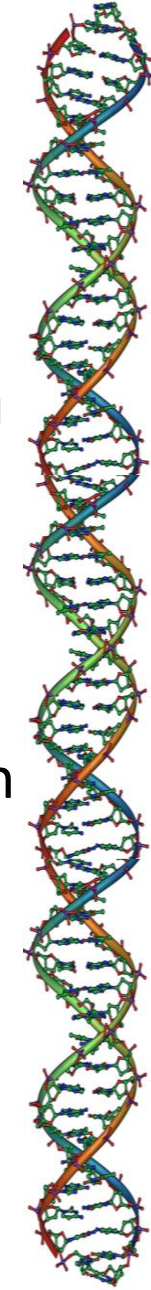


Acids taste sour

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

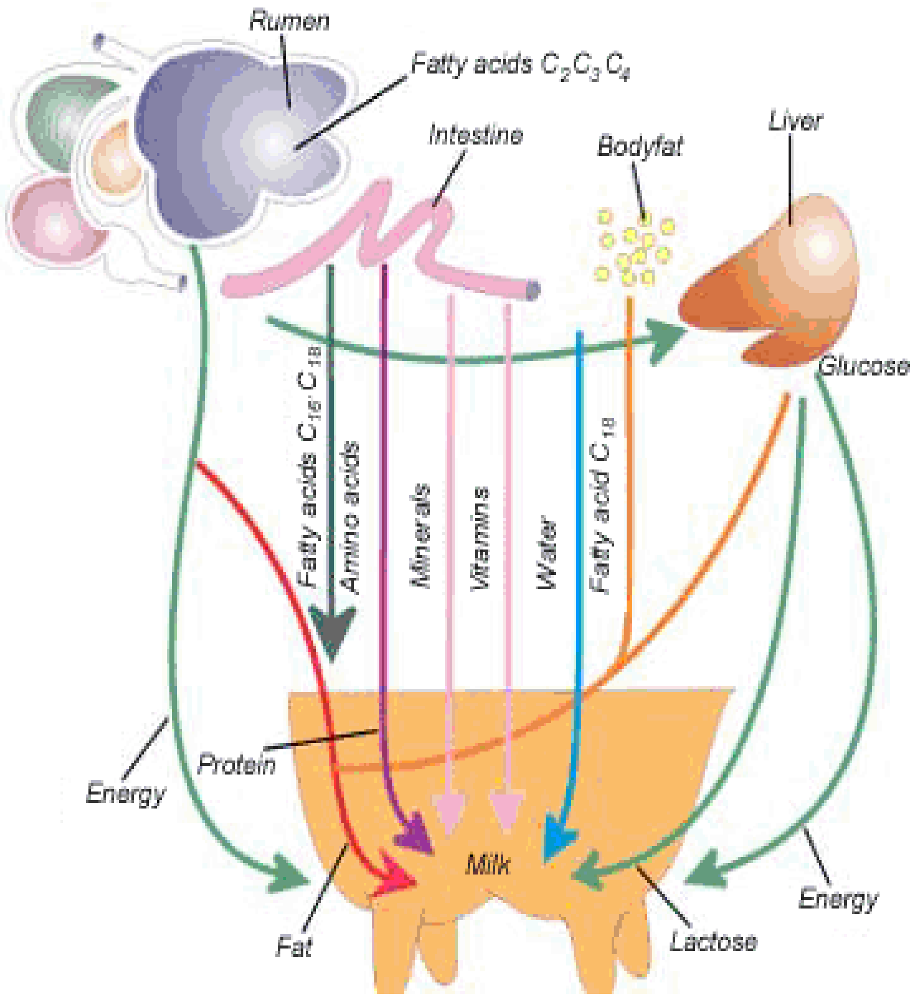


Science of Cooking – BCBT100
Summer 2016 - Bodwin

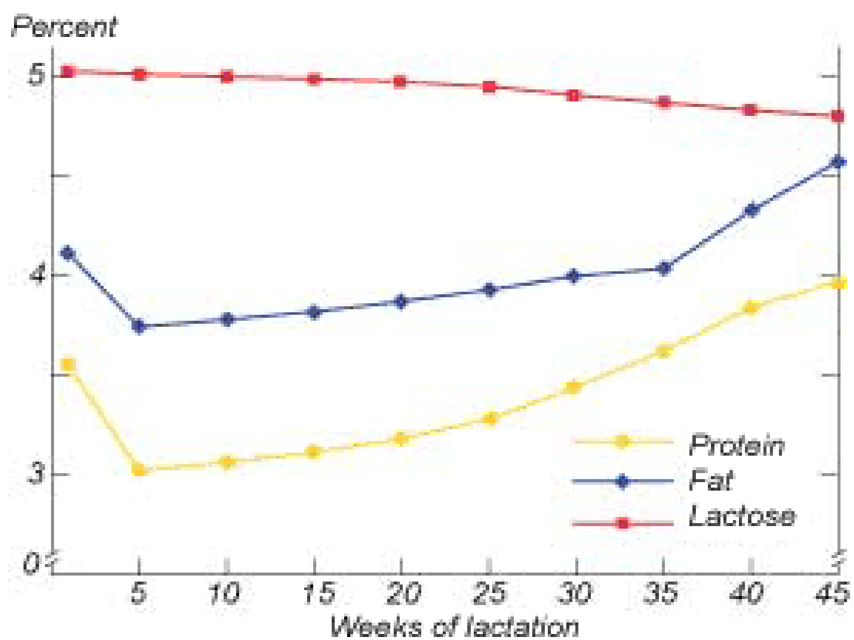
Milk Fat

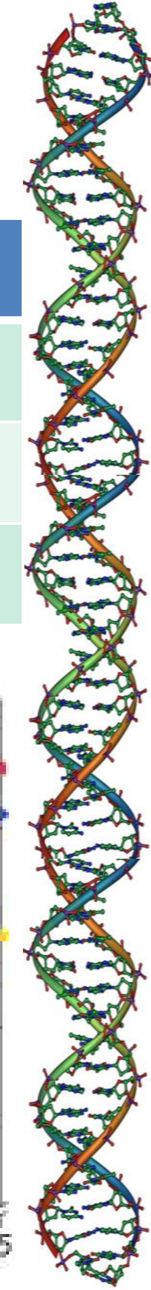
- Globules of fat in a phospholipid and protein shell (Emulsifiers)
- Homogenization
- Heat-stable globules
- Cold breaks fat globules – ice, ice, baby
- Fat soluble vitamins – A, D, E, K

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



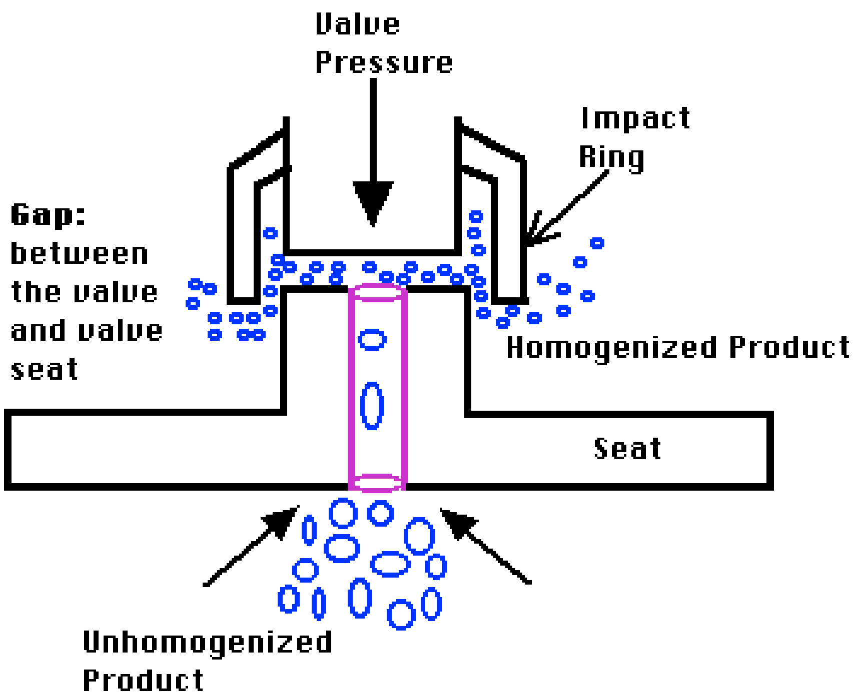


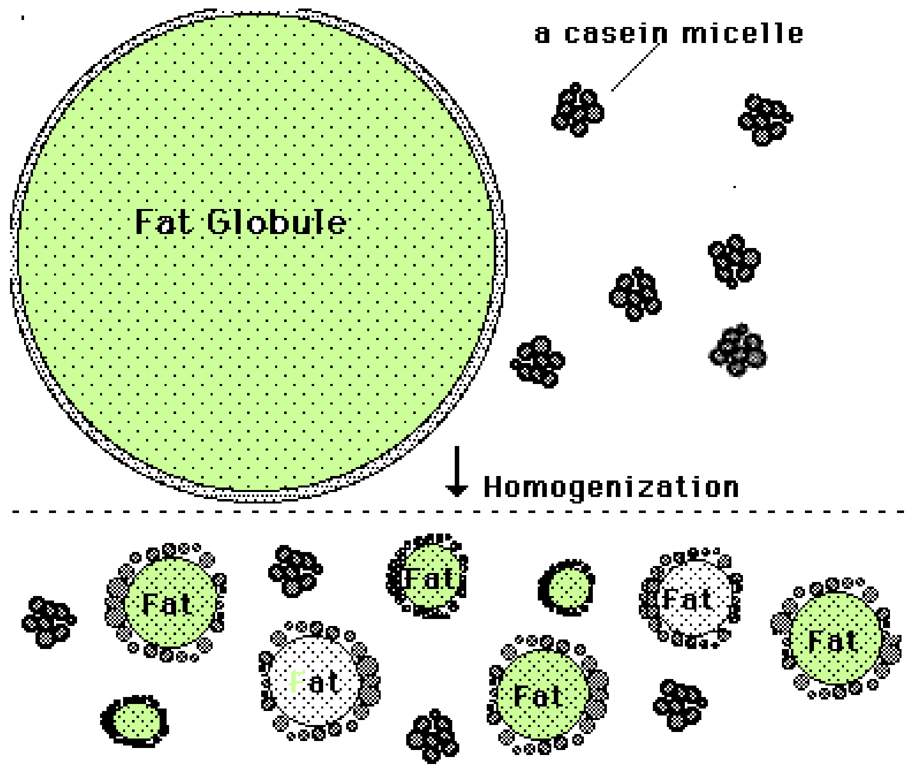
- Delaval.com

Homogenization

Increase surface area

Casein proteins coat – Negative





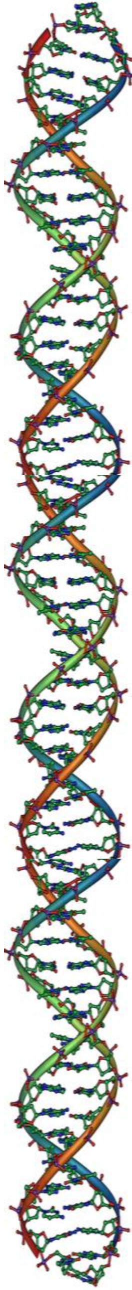
Sphere Math

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

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

1 sphere, 2cm radius
Volume = $^4/_3\ \pi\ (2\text{cm})^3 = 34\text{cm}^3$
Surface = $4\ \pi\ (2\text{cm})^2 = 50.\text{cm}^2$

Break into 2 spheres:
Volume of each = $17\text{cm}^3 = {}^4/_3\ \pi\ (x)^3 \rightarrow x = 1.6\text{cm}$
Surface of each = $4\ \pi\ (1.6\text{cm})^2 = 32\text{cm}^2$
Total surface = $64\text{cm}^2 \rightarrow$ too much!



Homogenization

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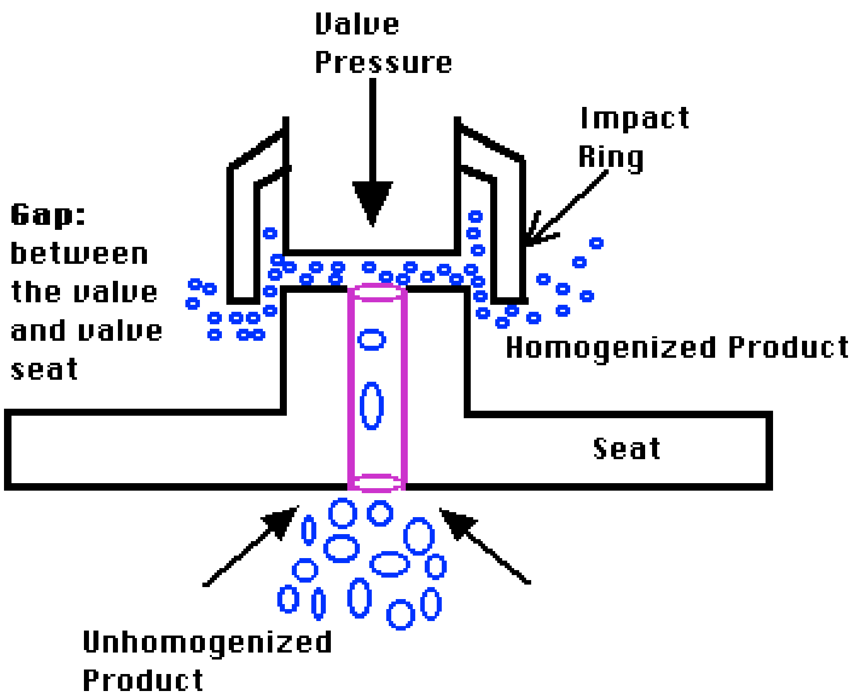
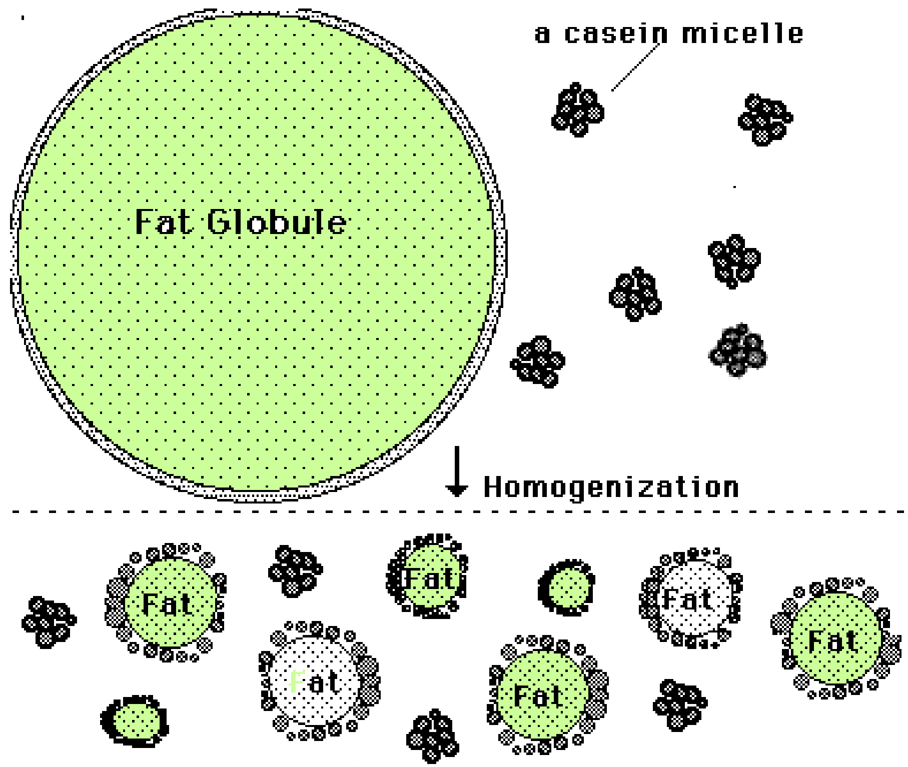
Casein proteins coat – Negative





Pasteurization

Hot enough to sterilize, not cook

Batch = 145°F, 30 minutes

HTST = 162°F, 15 seconds

UHT = 265°F, 1-3 seconds

Cooked flavor due to sulfur cmpds

Foams

Heterogeneous Mixtures

Air in solid or liquid

Milk foams

Protein and/or fat and/or sugar

Milk Foams

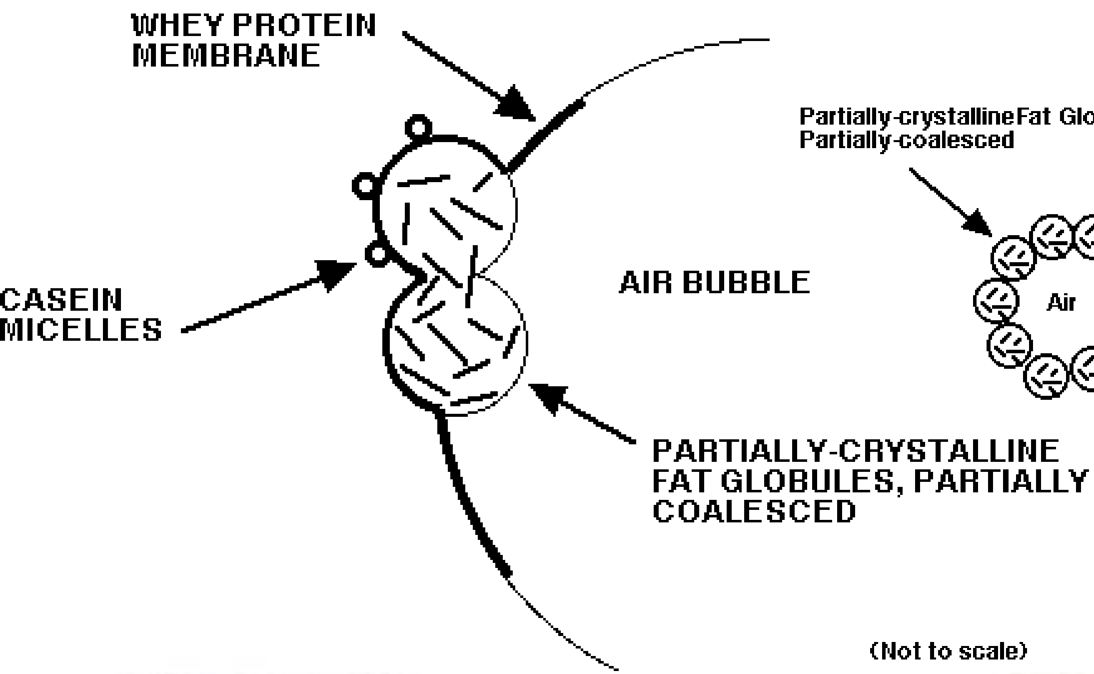
Frothed Milk or "Espresso Foam"

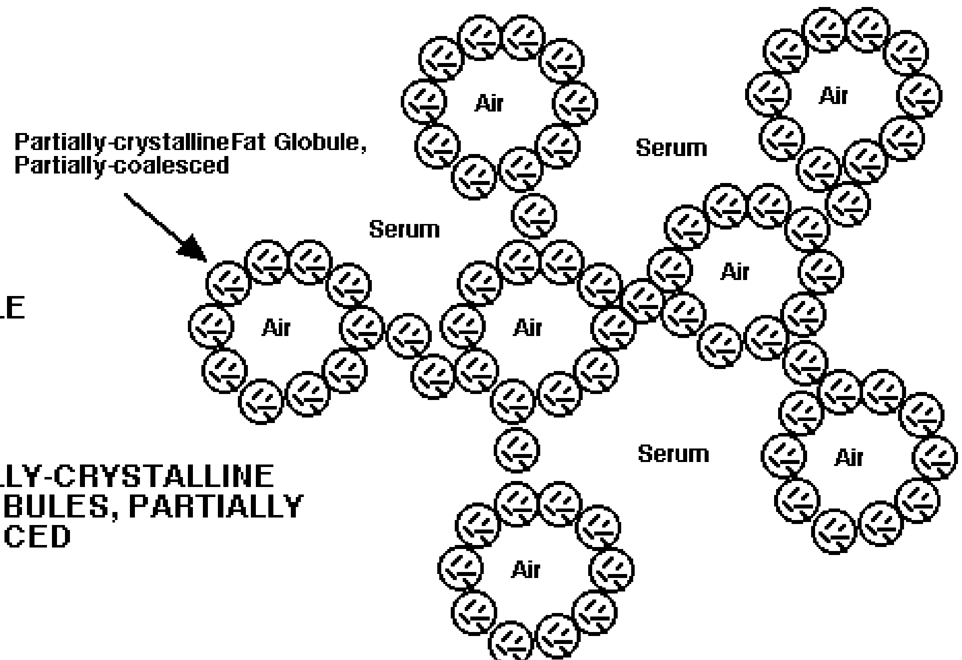
- Protein-based foam
- Heat from steam denatures milk protein (whey)
- Denatured proteins tangle, form net around air
- Not stable – as water drains, bubbles collapse

Milk Foams

Whipped Cream

- Fat-based foam
- Mechanically shearing fat globules
- Homogenization without the extra casein





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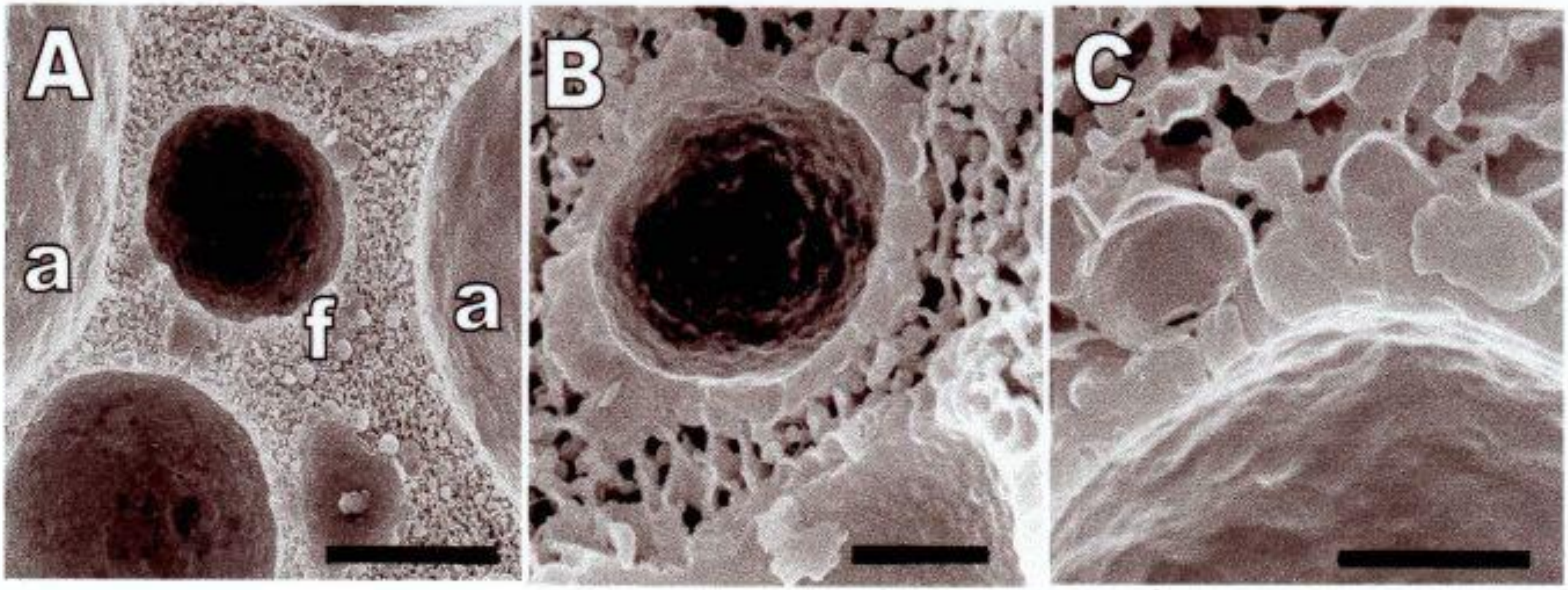
Whipped Cream



The structure of whipped cream as determined by scanning electron microscopy. A. Overview showing the relative size and prevalence of air bubbles (a) and fat globules (f); bar = 30 um. B. Internal structure of the air bubble, showing the layer of partially coalesced fat which has stabilized the bubble; bar = 5 um. C. Details of the partially coalesced fat layer, showing the interaction of the individual fat globules. Bar = 3 um.

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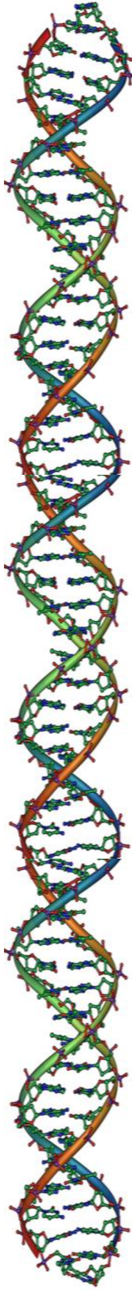
Whipped Cream

Cold, cold, cold – Keep fat solid

Don’t over-whip

Let’s whip!



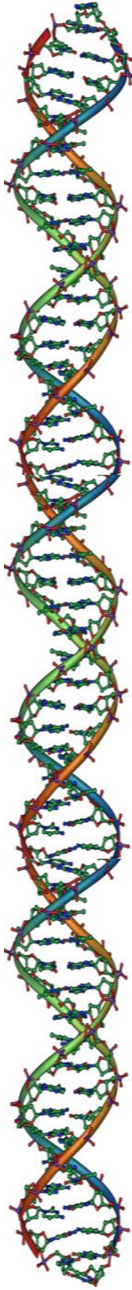
Over-whipped!

Fat globules combine = butter

Water and whey = buttermilk

“modern” buttermilk

Add protein and acid



Butter

80% milkfat

21 pounds milk = 1 pound butter

“Churning” = mechanical shearing of fat globules

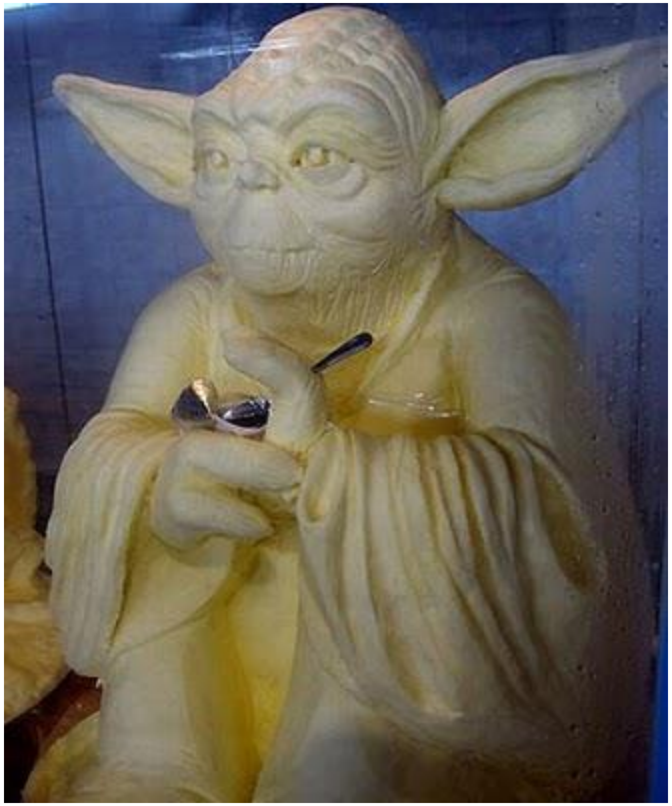
Finishing

Butter

Salted Butter

Reduces spoilage

Add salt or soak in brine



Sweet Cream Butter

No salt

Color?

Image: http://funandmania-creatives.blogspot.com/2010/02/butter-sculptures.html

Butter

Cultured Butter

- Bacteria added
- Acidified

Diacetyl – "butter flavor"

- Used in butter substitutes
- Inhibits enzymes that protect against oxidative damage
- Exposure risk for workers and heavy "fake butter" eaters (popcorn)

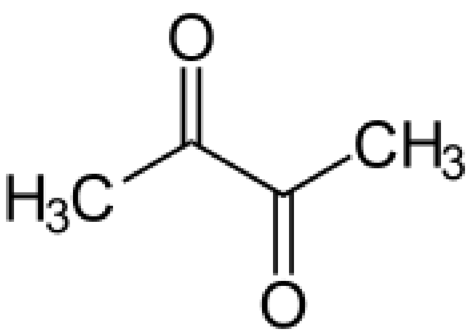
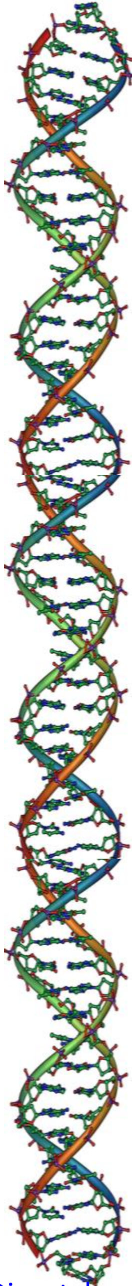


Image: http://en.wikipedia.org/wiki/Diacetyl



Cooking with Butter

Lemon Butter

- Add lemon and sugar

Restaurant trick

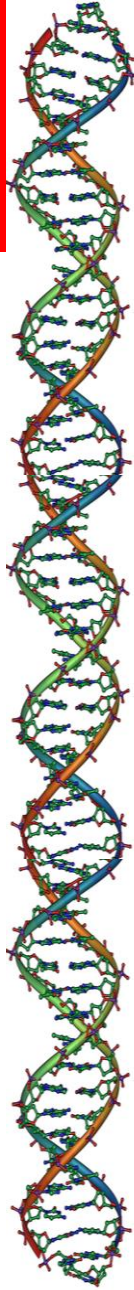
- On steaks, and just about anything else

Clarified Butter

- Heat to evaporate water (gently!)
- Milk solids (proteins) separate
- Used to flavor, fry or garnish – almost pure fat
- Popcorn!
- Ghee – south Asia

END DAY 5

Content

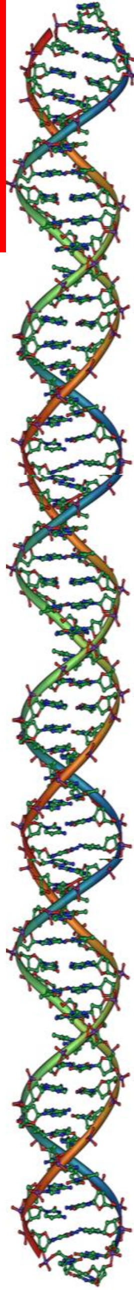


Experiment in Class

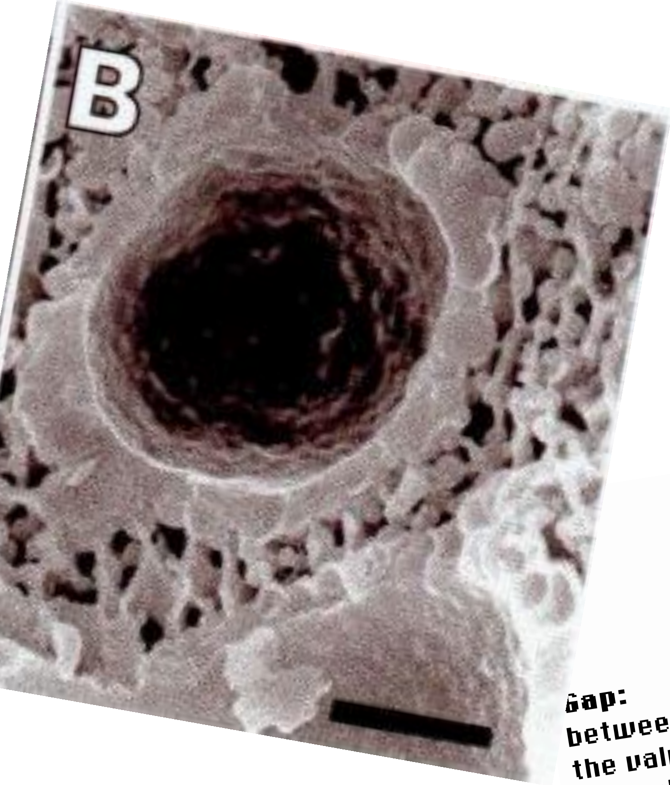
Candy Mass experiment – M&Ms and Skittles(2015-09-10)

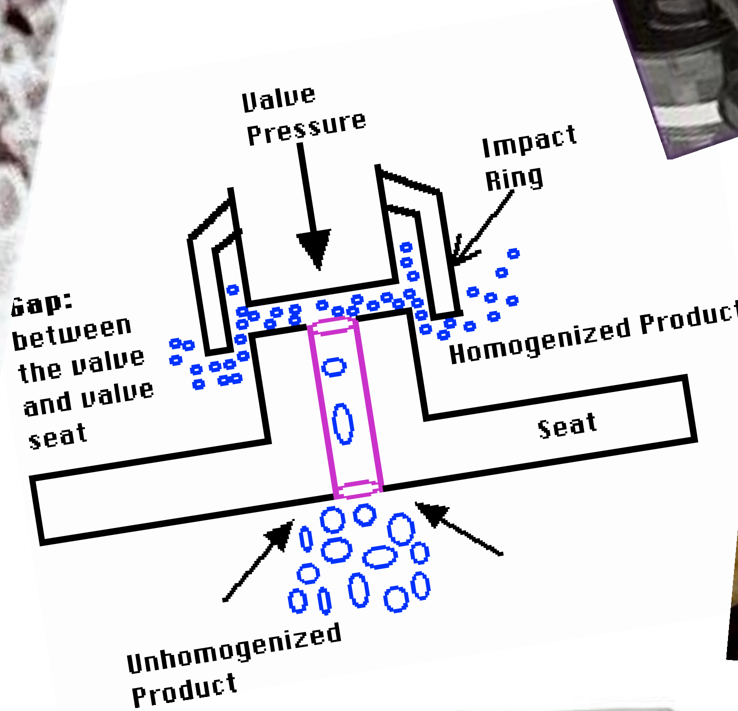
END DAY 6

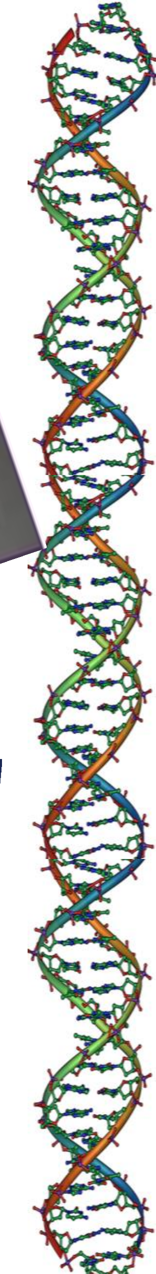
Content



From Last Time:







Imitating Butter

Fake Butter

- Emulsified vegetable oils
- Added sugars and proteins – scorch easily
- Not good for cooking

Margarines

- “Partially hydrogenated” vegetable fat
- Tallow from beef fat mixed with milk {traditional “oleo margarine”}
- Saturated fats

Fermentation

Yogurt

- Bacteria “digestion” of lactose
  - Impact on lactose intolerance?
- Produces lactic acid
  - Impact on properties?
- Streptococcus salivarius – thermophilus
  - More active at lower acid concentration (higher pH)
- Lactobacillus delbrueckii – bulgaricus
  - More active at higher acid concentration (lower pH)
- High acetaldehyde production – green apples

Yogurt properties

Stabilizes milk for storage

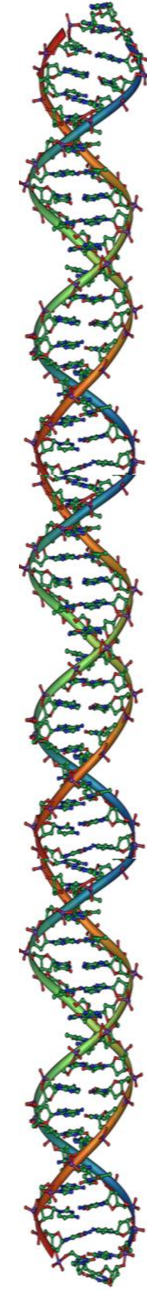
Lactoglobulin (a whey protein)

- facilitate casein networks
  - Similar to fat globules in whipped cream
  - Casein networks hold aqueous phase rather than air

Probiotic bacteria

- Contributes to and enhances intestinal floral
- Aids digestion

Read the label!



What should yogurt contain?

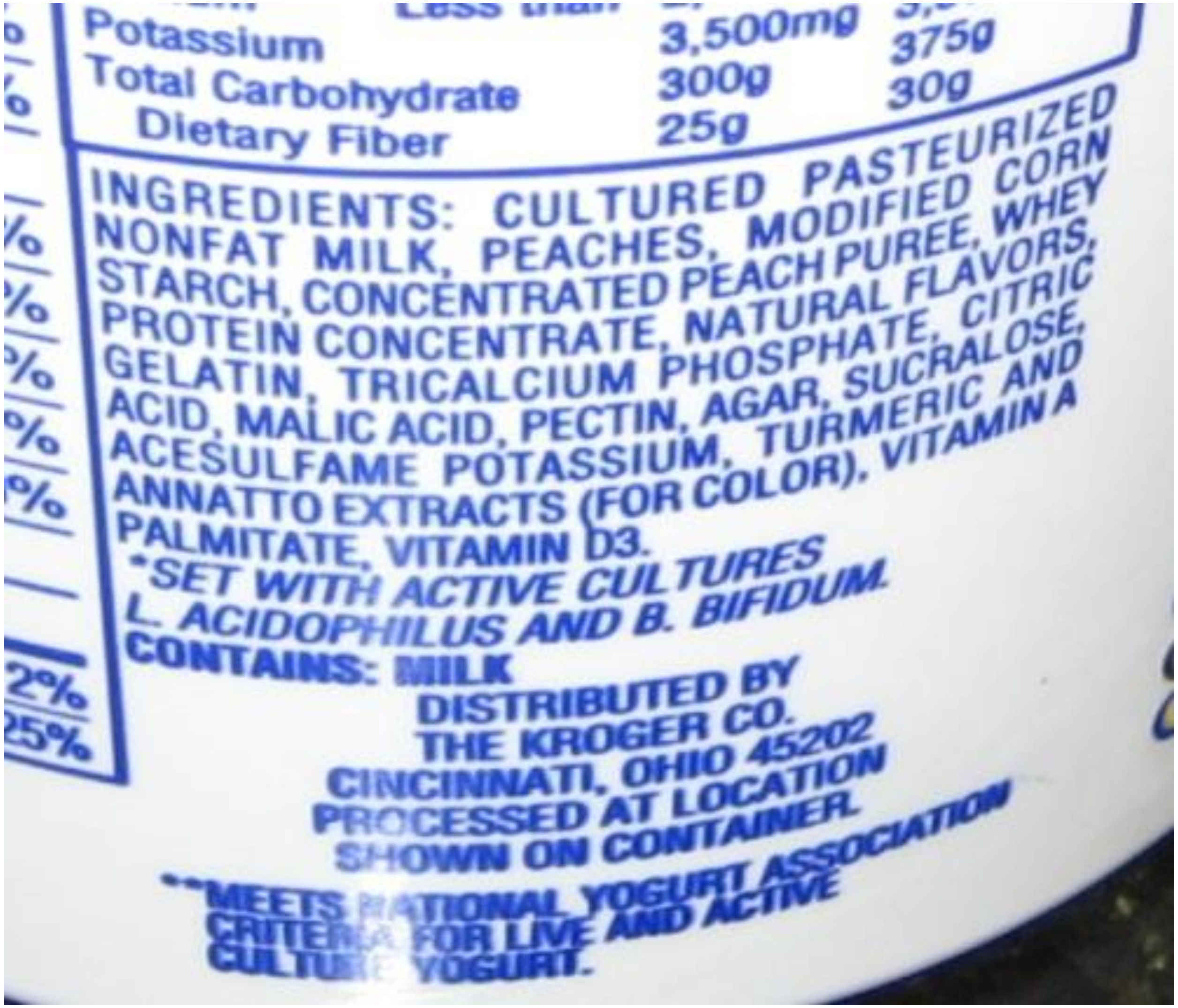


Image: http://cheeseforum.org/forum/index.php?topic=546.0

What should yogurt contain?

Image: http://ronjones.org/CurrentComments/GutCheck/June-08.htm

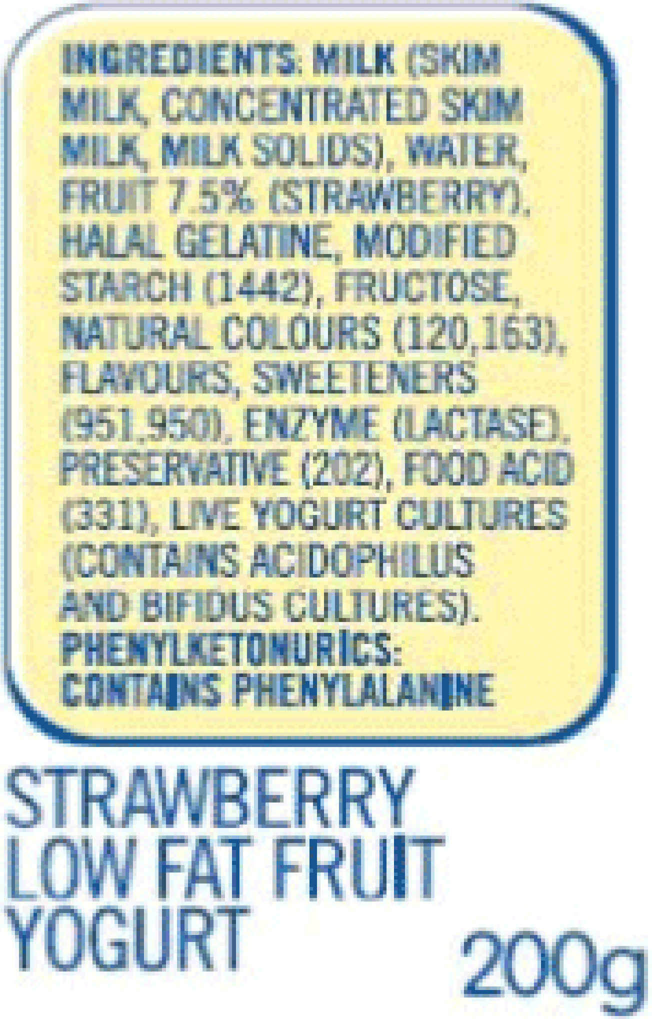


Image: http://www.nestle.com.au/Nutrition-Health-Wellness/Fact-Sheets/Decoding-Food-Labels

What should yogurt contain?

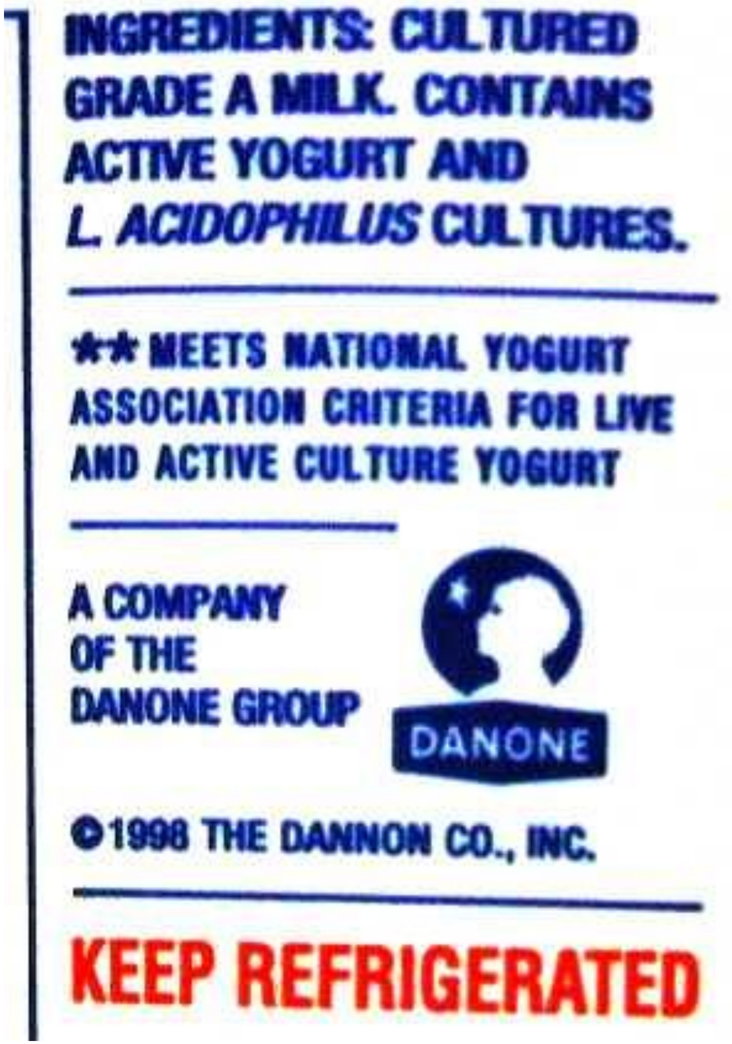


Image: http://gourmandgrammarian.blogspot.com/2011/07/greek-yogurt.html

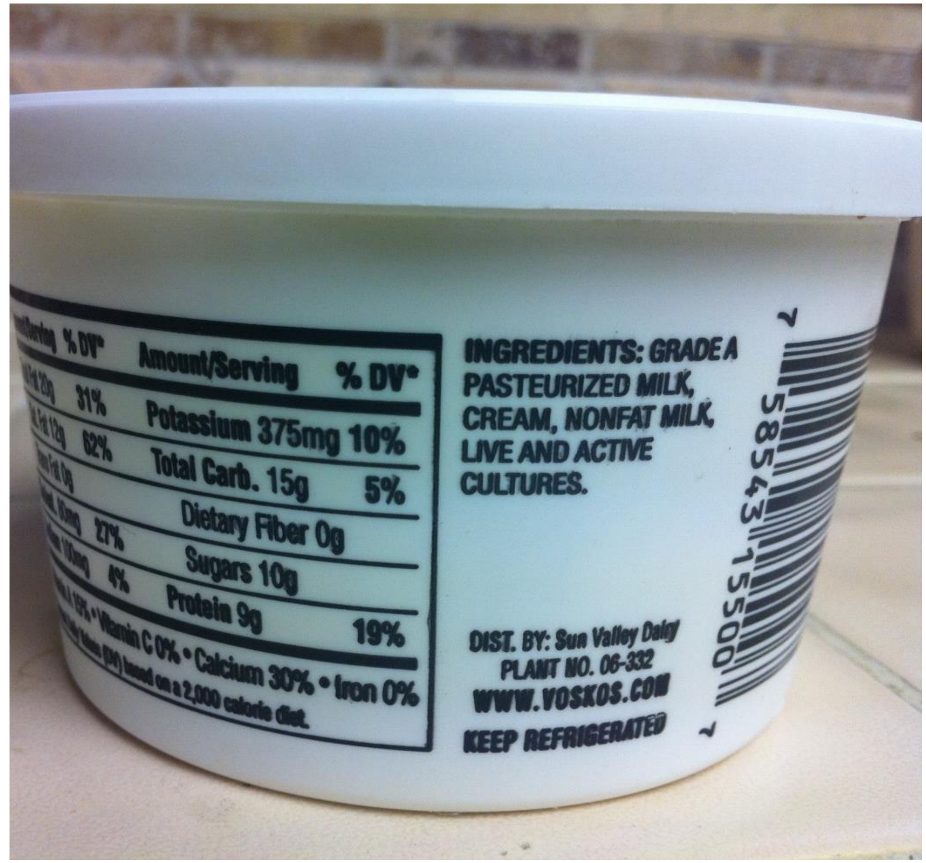


Image: http://bare5.com/grocery-labelsingredients-guide/

Why all the thickeners?

Texture

Smoother

Limit separation

Fat replacement

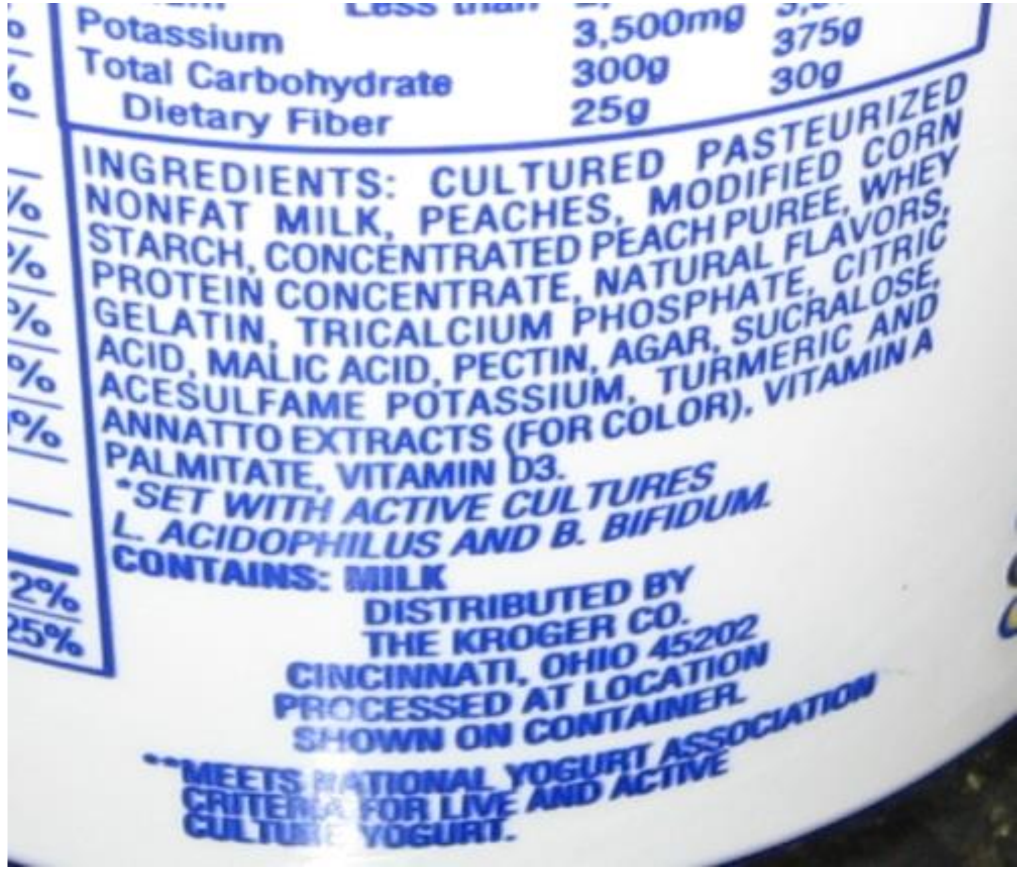


Image: http://cheeseforum.org/forum/index.php?topic=546.0

Making Yogurt

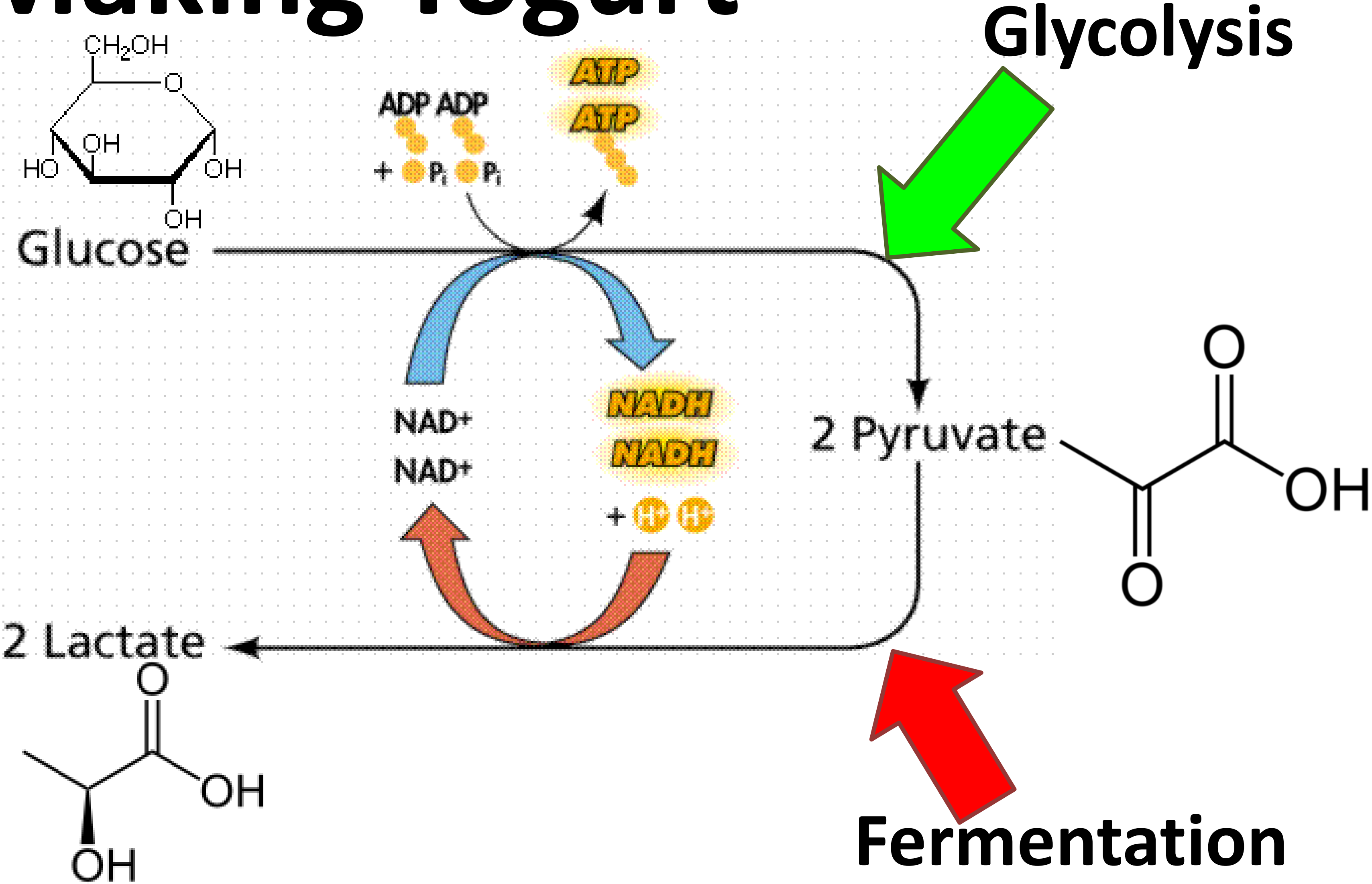
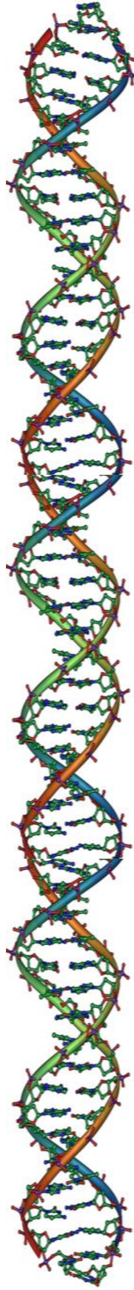
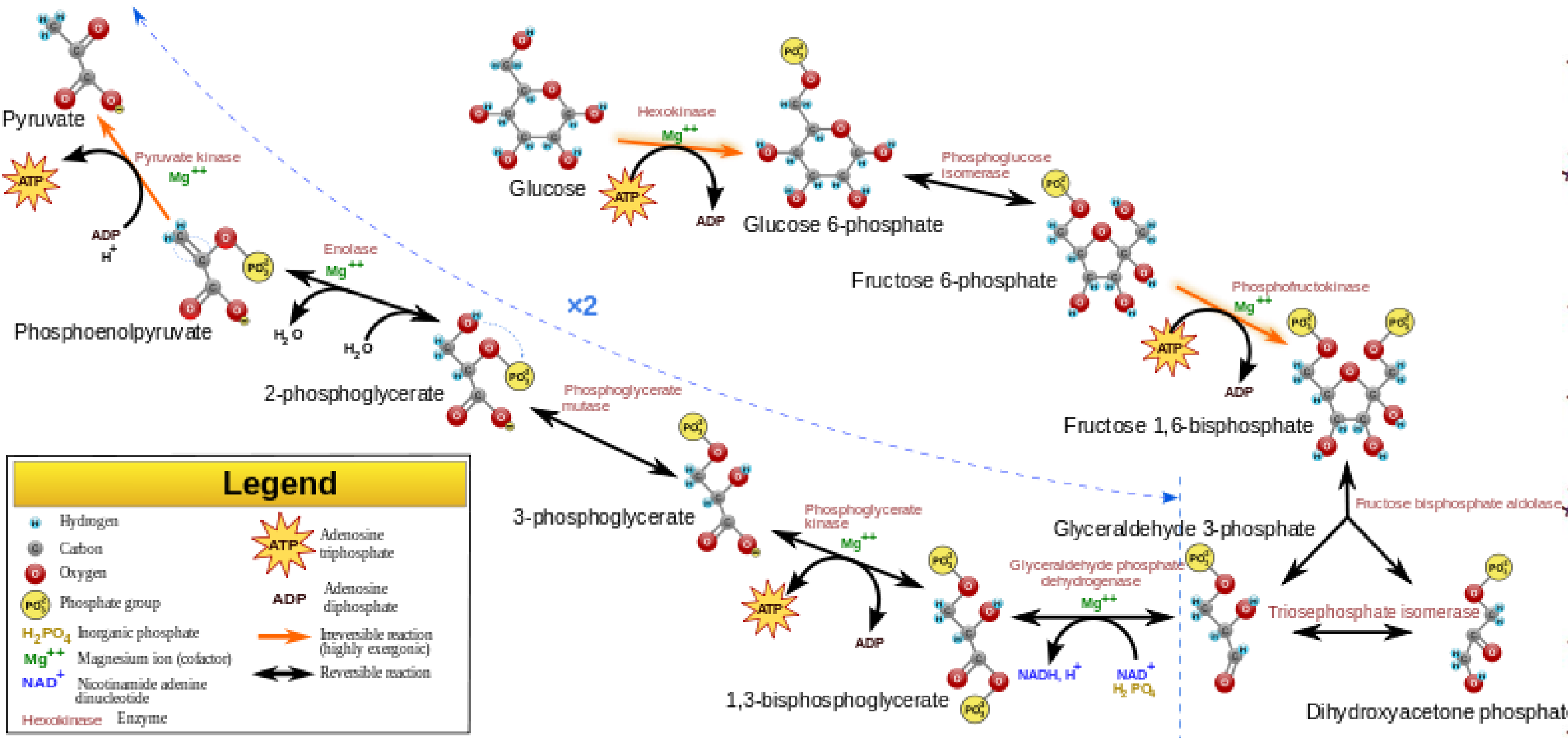


Image: http://www.emc.maricopa.edu/faculty/farabee/biobk/biobookglyc.html



Sugar Metabolism

Glycolysis



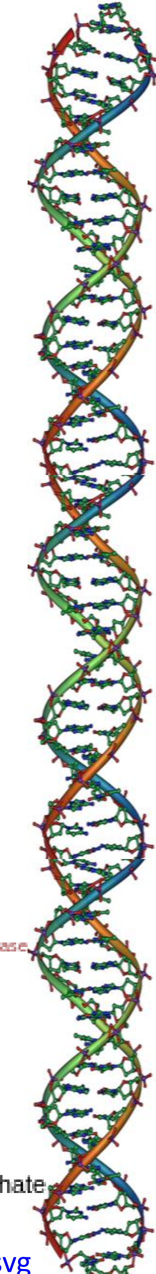
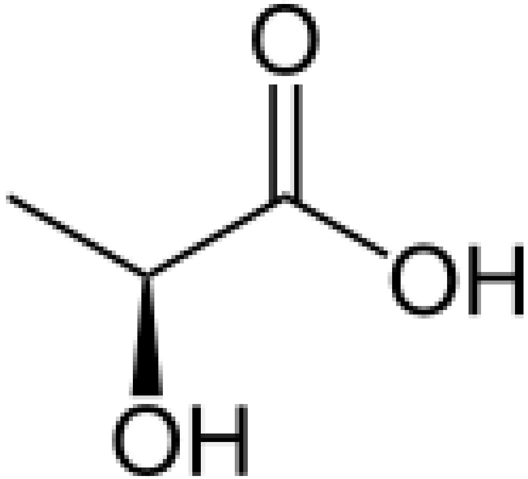


Image: http://en.wikipedia.org/wiki/File:Glycolysis2.svg
Image: http://cheeseforum.org/forum/index.php?topic=546.0

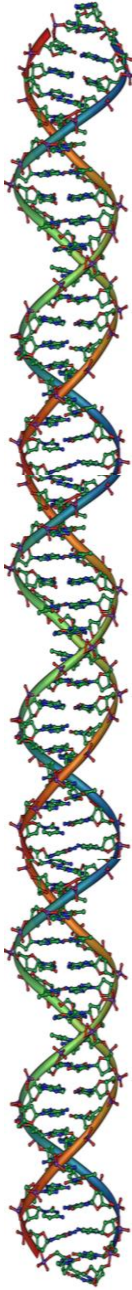
Making yogurt

Role of Lactic Acid



- Denatures casein micelles
  - Re-form as protein networks
- Acidifies
  - Preservative
  - Sour flavor

{figure on p45 of McGee}



Yogurt or Sour Cream?

Mesophilic

lactococci, leuconostoc
"particles of pasturage"
~85°F/30°C

Thermophilic

lactobacilli, streptococci
More lactic acid
~113°F/45°C

Exam 1

"Good" science

Many fields involved in cooking

Food molecules

- Water
- Inorganics
- Small organics
- Macromolecules

Exam 1

Small Organics

- Vitamins, sugars, metabolites

Macromolecules - Fats/Lipids

- Long carbon/hydrogen chains
- Hydrophobic
- Fatty acids, triglycerides, phospholipids
- Saturated vs. Unsaturated

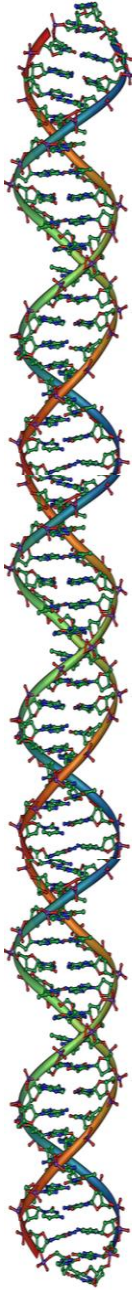
Exam 1

Proteins – polymers of amino acids

- Side chain/Side group tunes properties
- Structure determines function
- Formed by dehydration/condensation

Carbohydrates – C/H/O molecules

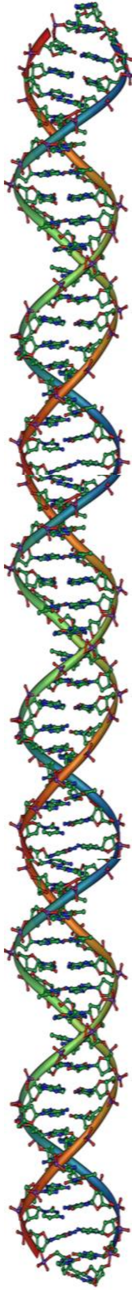
- "Simple" sugars – monosaccharides
- "Simple" sugars – disaccharides
- Polysaccharides – sugar polymers



Exam 1

Polysaccharides

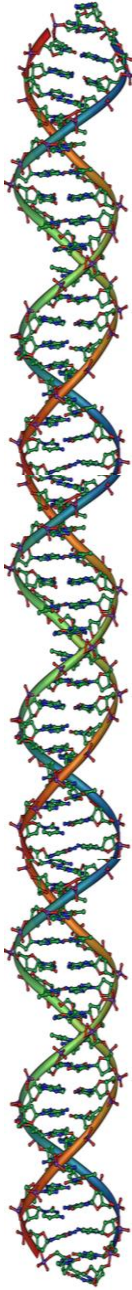
- Starch – glucose polymer, plants
- Amylose – unbranched
- Amylopectin - branched
- Binds water, thickening agent
- Formed by dehydration/condensation
- Broken down by amylase (hydrolysis)



Exam 1

Polysaccharides

- Glycogen – glucose polymer, animal
- Highly branched, compact
- Binds water, thickening agent
- Formed by dehydration/condensation
- Broken down by hydrolysis



Exam 1

Polysaccharides

- Cellulose – β-glucose polymer, plants
- Rigid, tough, cross-linked fibers
- Insoluble vs. soluble fiber
- Binds water
- Ruminant animals break down with bacteria in their rumen

Exam 1

Milk and Dairy

Milk – aqueous phase

Milk – fat phase

Lactase & lactose intolerance

Milk proteins – whey & casein

Curdling

Acids and Bases

Exam 1

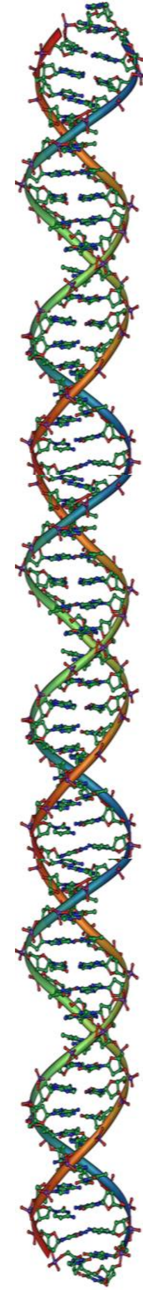
Homogenization

Pasteurization

Milk foams – protein or fat

Butter – whip it good…

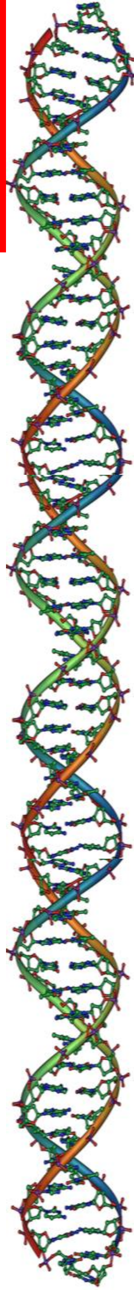
Fermentation – yogurt and others



Good luck!

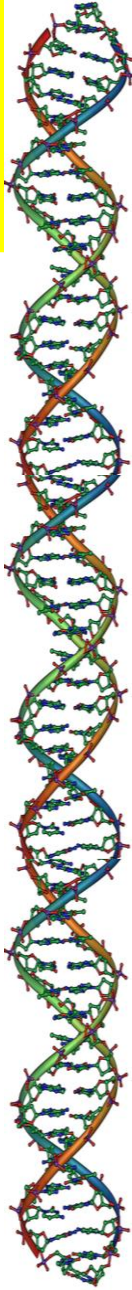
END DAY 7

Content



EXAM DAY

Exam 1 given in class on Day 8 (2015-09-17)

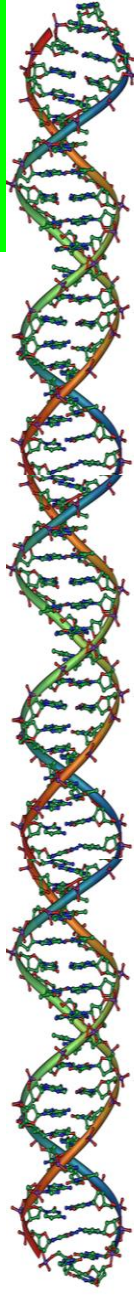


END DAY 8

Content

TOPIC BEGIN

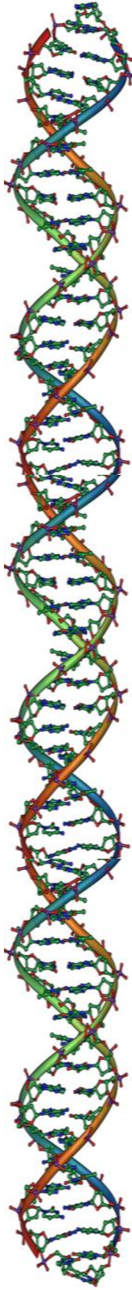
Cheese



From Last Time:

Exam 1 Results & Feedback:

Average =



Cheese

- Curdled milk with most of the water removed
  - Add acid and salt
    - Discourages “spoilage microbes”
- Enzymes hydrolyse fats and proteins
  - Smaller molecules = flavor, aroma

Image: http://blog.fooducate.com/2011/06/26/if-milk-is-white-why-is-cheese-yellow/

Storage & transport

Waterproof "bags"

- Animal parts…
- Stomach → Rennet (enzymes)
  - Makes cheese more cohesive, pliable

This is (was) SCIENCE!

Image: http://blog.fooducate.com/2011/04/05/10-things-to-know-about-rennet-its-in-your-cheese/

Rennet

The original Biotechnology!

- Chymosin enzyme (digests milk) from the 4th stomach of a milk-fed calf
- Calf <30 days old
- Once off milk, chymosin stops

Image: http://www.peta2.com/blog/warning-babies-die-for-cheese/

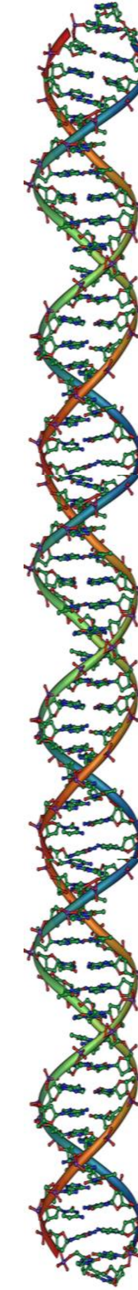
Rennet

Modern rennets – "vegetable rennet"

- Chymosin from yeast, mold, bacteria
- From "genetic engineering"
  - Is that good or bad?

Image: http://www.cheesesupply.com/

Rennet



What does it do?

- Very specific activity
- Attacks kappa-casein
  - Casein micelles merge/string together
  - Analogous to fat globules in whipping cream

Why not just use acid?

- Destroys casein micelles too much
- Lose some protein & calcium - nutrition
- Tangy cheese?

Cheese Ingredients

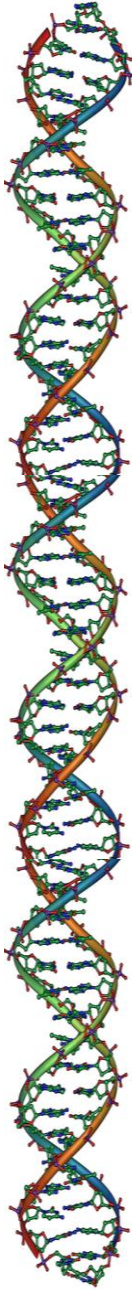
Milk

Milk bacteria

Rennet

Salt

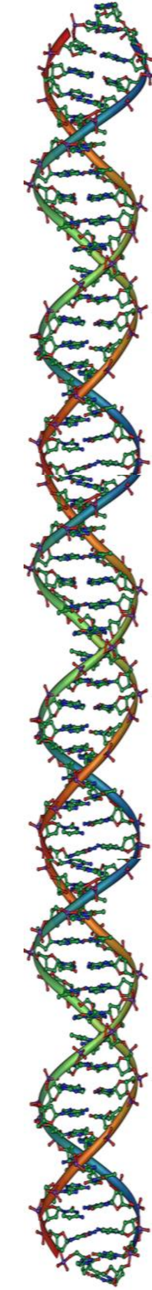
Time



Cheese Microbes

Bacteria are what make cheese

- Lactococci (mesophilic, sour cream)
- Lactobaccilli & streptococci (thermophilic, yogurt)
- Propionibacteria (holes, variant causes acne)
- Brevibacterium linens (stronger flavors, salty environment, seashore & skin, “smear bacteria”)



Cheese Microbes

Molds

Penicillium – large family

Blue molds – *roqueforti*

- Survive lower oxygen (inside cheese)
- Breaks down fats – "peppery", aroma

White molds – *camemberti*

- Surface ripening
- Break down protein – creamy, flavor

Image: http://www.gourmetsleuth.com/Dictionary/M/Maytag-blue-cheese-6166.aspx

Making Cheese

Acidify (bacterial)

- Milk sugar to lactic acid

Curdle casein (rennet) and drain whey

- Stabilizes curd

Ripening

- bacteria + time = good

Curdling

Acid

- Fine, fragile gel
- Formed over hours
- Retains moisture

Rennet

- Firm, rubbery curds
- Formed under an hour
- Cut to small grains, loses more water

Image: http://jamesranch.net/cheese/cheesemaking/

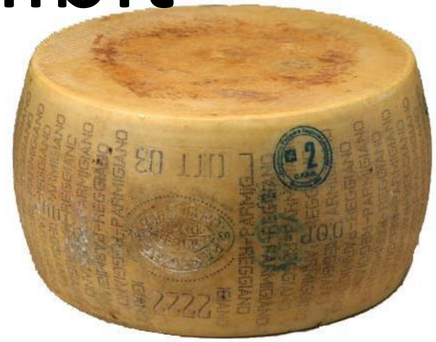
Image: http://www.thekitchn.com/better-lunch-snacks-make-squeaky-cheese-at-home-167439

Image: http://www.thechoppingblog.com/tag/cheese-curd

After the curd…

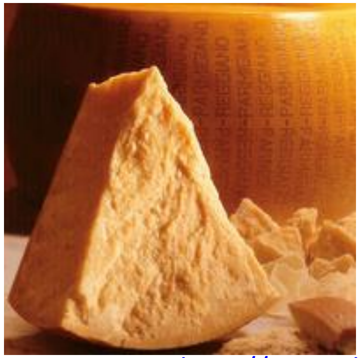
Draining – gravity, press, heat

Salting – mix or smear, inhibit spoilage



Shaping – Why wheels?

Ripening – Let the bacteria work!



Images: http://www.theardentepicure.com/2010/04/food-of-day-parmigiano-reggiano.html

Enjoying cheese…

- Don't cut too soon
  - Aromatics lost
  - Oxygen attacks!
- Let it warm a bit
  - Humid & 55-60°F ideal
  - Softens fats – Don't go too far!
- Store loosely wrapped
  - Puddles of moisture are bad

Image: http://www.khiewchanta.com/archives/snacks/chilli-cheese-experiment-1.html

Cooking with cheese

Melting

- ~90°F – milk fats melt
- ~130-180°F – protein matrix breaks

Non-melting cheeses

- Acid curdled – Why?

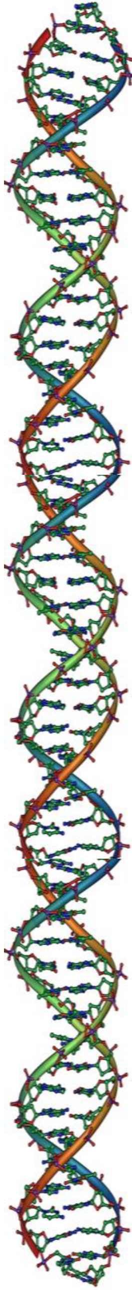
Stringiness

- Casein strings stick together - crosslinking
- Aging, acid, moisture, salt

Cooking with cheese

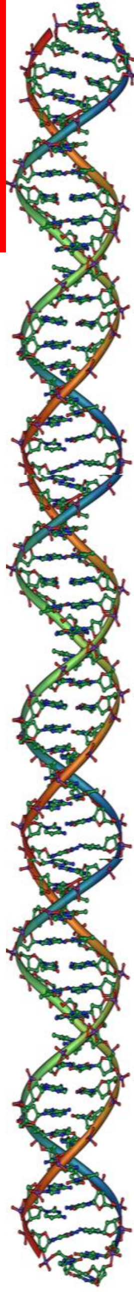
Avoiding "stringiness"

- Grate finely
- Heat carefully
- Minimize stirring
- Add starch – coats protein and fat



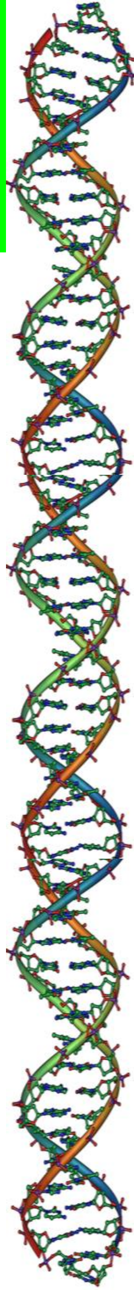
END DAY 9

Content

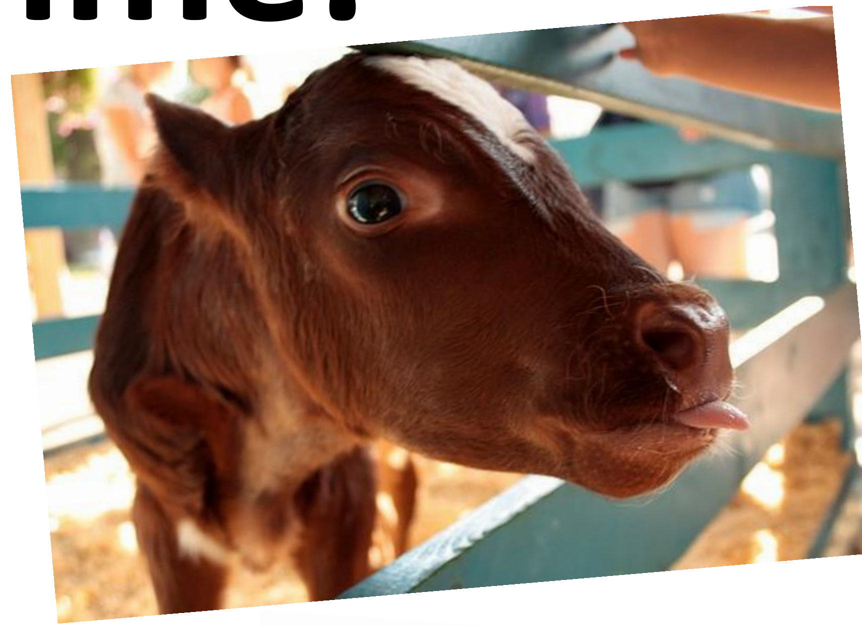


TOPIC BEGIN

Measurement & Error



From Last Time:



Measurements

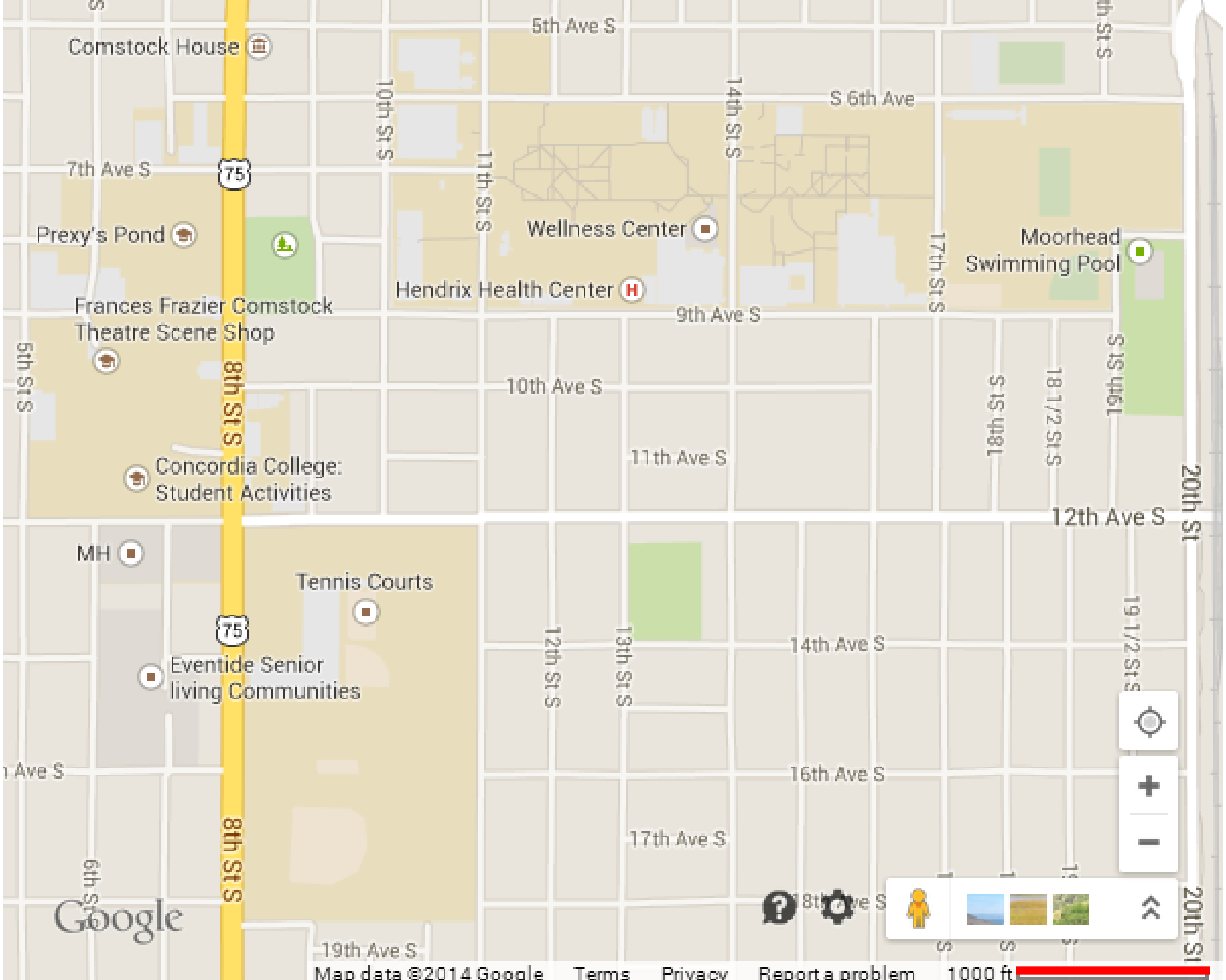
How far is it from MSUM to NDSU?

Units – miles, minutes, steps, etc

Start/End points

Uncertainty {“error”}

Significant Figures


Comstock House
5th Ave S
10th St S
11th St S
14th St S
S 6th Ave
7th Ave S
75
Prexy's Pond
Wellness Center
Hendrix Health Center
Moorhead
Swimming Pool
17th St S
Frances Frazier Comstock
Theatre Scene Shop
9th Ave S
5th St S
8th St S
10th Ave S
18th St S
18 1/2 St S
19th St S
11th Ave S
Concordia College:
Student Activities
12th Ave S
20th St
MH
Tennis Courts
75
Eventide Senior
living Communities
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19 1/2 St S
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19th Ave S
20th St
Map data ©2014 Google
Terms
Privacy
Report a problem
1000 ft

Uncertainty {“error”}

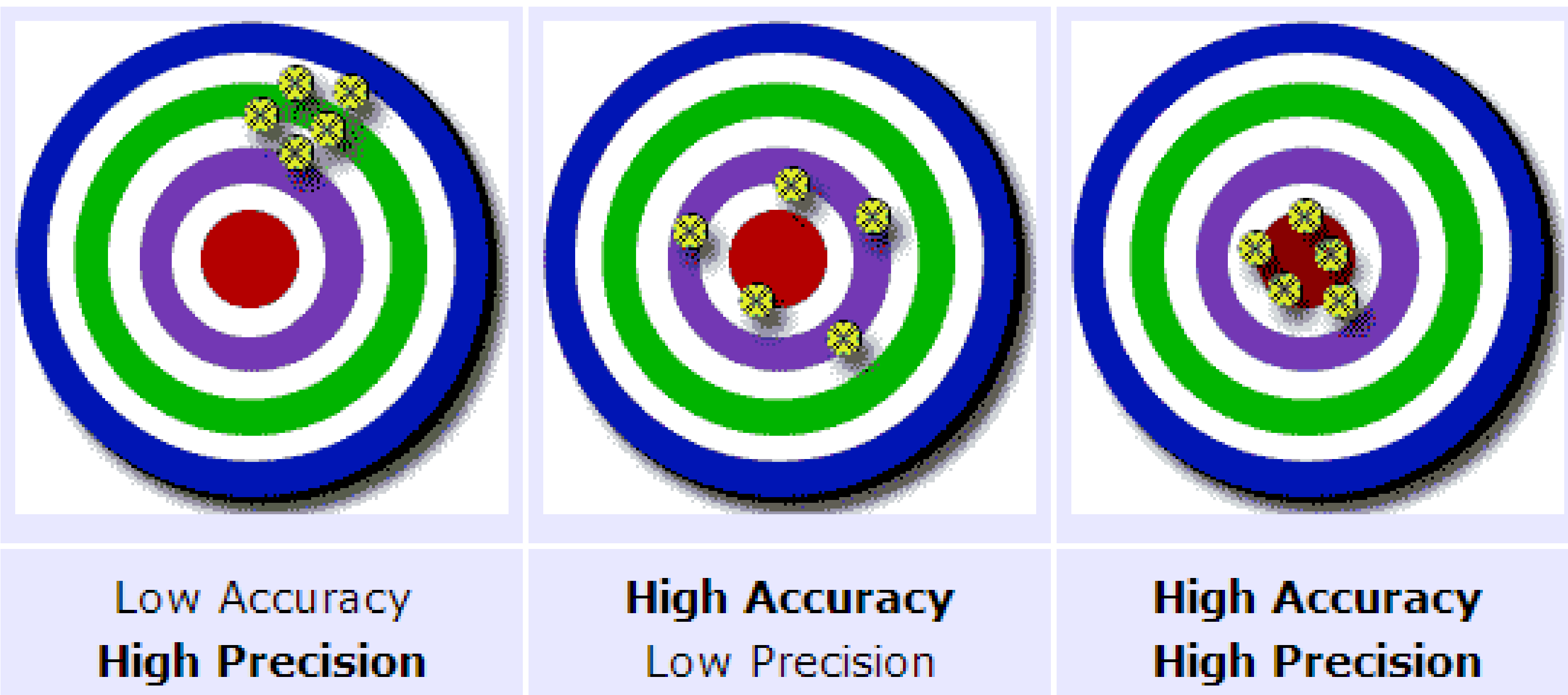
Indicates reliability of a number or variability in repeated measurements

Communicates precision and accuracy

Precision & Accuracy

Accuracy = bullseye

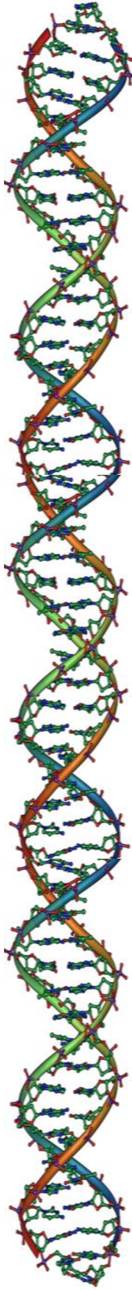
Precision = tight grouping



Significant Figures

Communicates error

Rounding numbers introduces error – be careful!

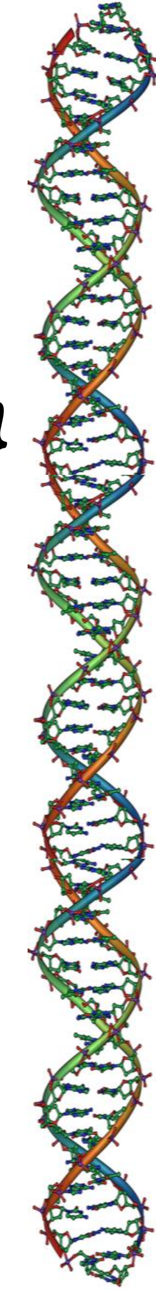


Significant Figures

Round error to a single digit

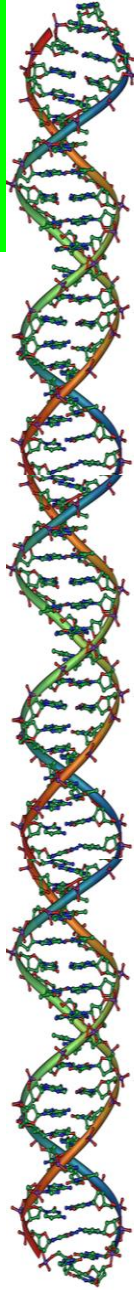
{unless it's "1", then keep two digits}

Round the reported value to the same digit as the error is rounded.



TOPIC BEGIN

Eggs



Eggs

Shell
- Calcium carbonate

White
- Albumin (protein)
- Thick and thin

Yolk
- Fat
- Lecithin (emulsifier)

http://www.youtube.com/watch?v=DkL-Npm3_cI

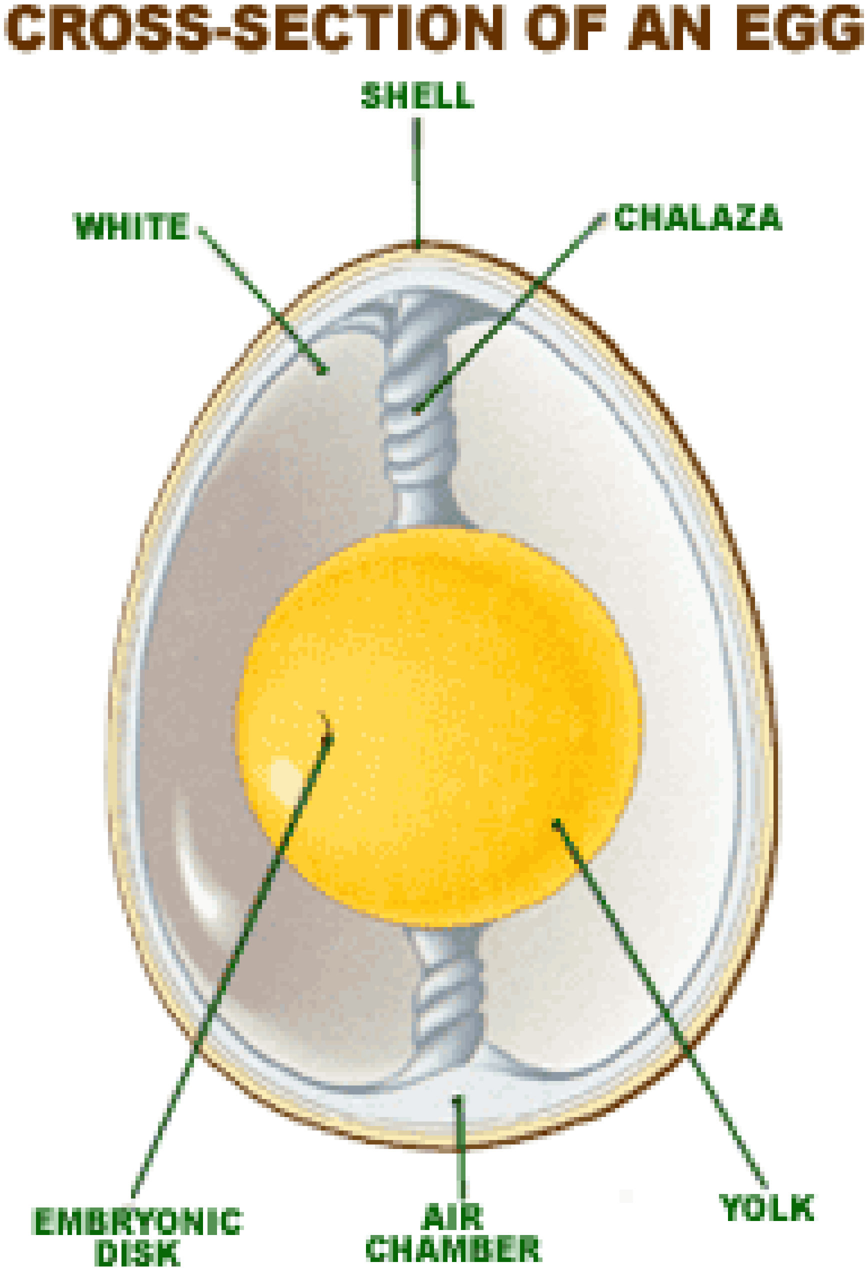
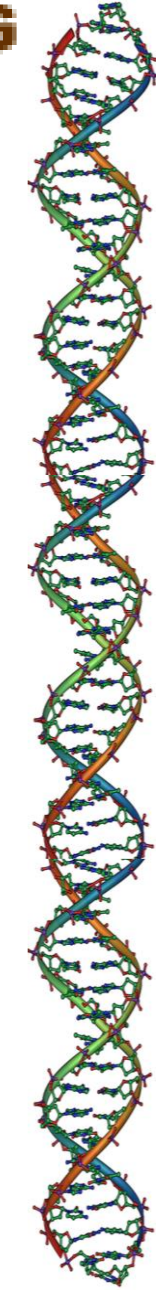


Image: http://victoriapacking.com/egginfo.html



Eggs

Fresher Eggs

- Thick albumen
- Prominent chalazae
- Sink in water

Aging…

- Albumen & chalazae break down
- Air bubble grows…

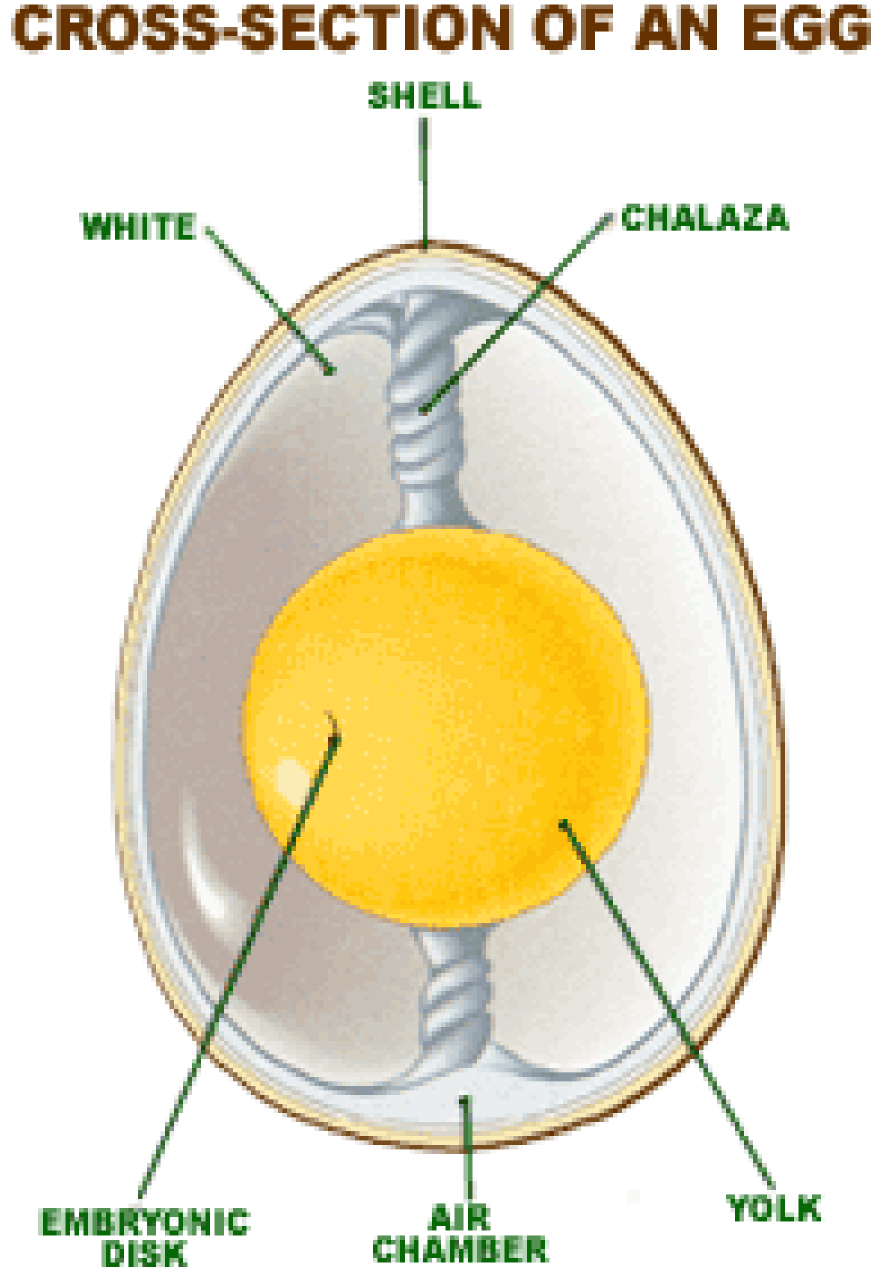


Image: http://victoriapacking.com/egginfo.html

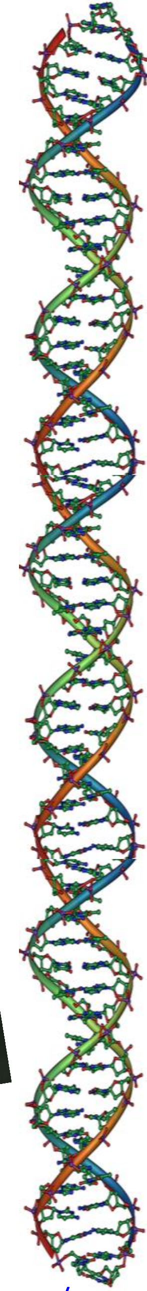
White or brown?

Shell color is largely meaningless

- Indicates breed
- Pinks, greens, etc

Image: http://www.whitmorefarm.com/eggs

Image: http://www.theinnovationdiaries.com/613/how-to-raise-chickens-to-lay-eggs/



Eggs and Chickens

"Indeterminate layers"

- ~25 hour cycle (industrial)
- 200-300 eggs per year
- 2-3 year laying "lifetime"

Image: http://www.motherearthnews.com/Sustainable-Farming/Best-Chicken-Breeds-For-Backyard-Flocks.aspx

Image: http://organicconnectmag.com/wp/are-there-drugs-in-your-chicken-dinner/#.UG2MCU3yrPA

Eggs

Yolk

- Fat, food

White

- Shock absorber

Shell

- Protection

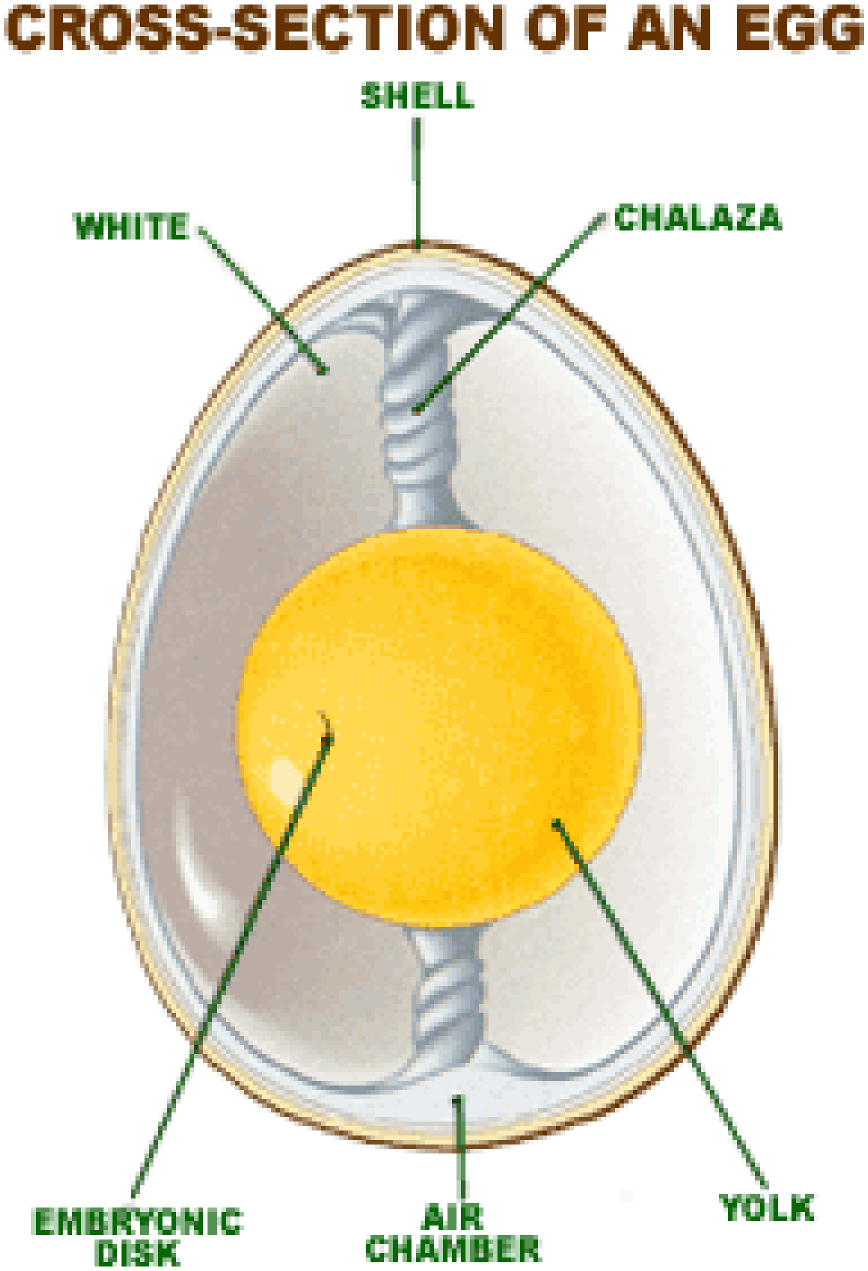


Image: http://victoriapacking.com/egginfo.html

Cooking with Eggs

Consider composition

White = protein + water

“Cooking” denatures protein

Yolk = protein + fat

and all the other nutrients…

Image: http://whatscookingamerica.net/Eggs/BoiledEggs.htm

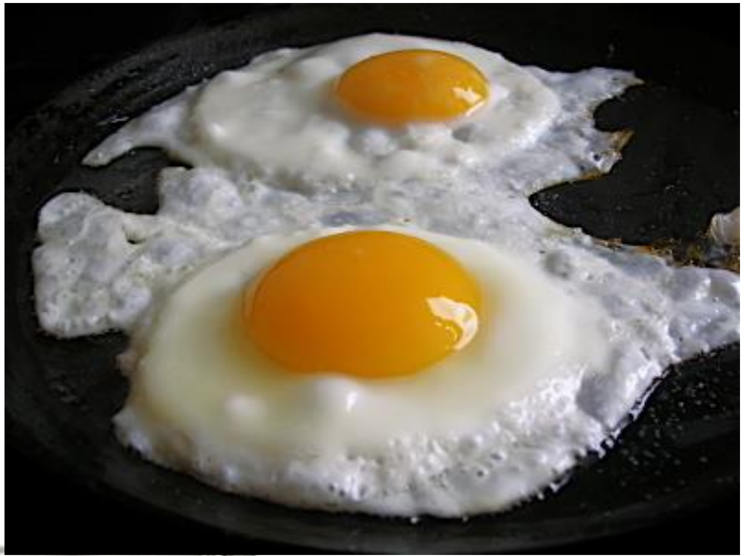
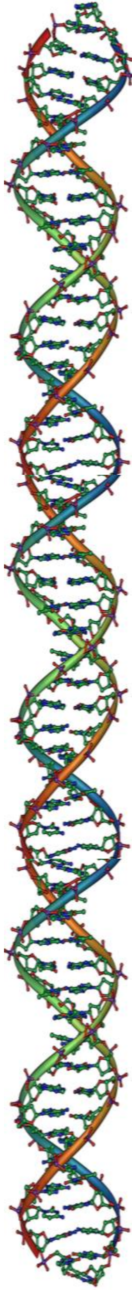


Image: http://lukehoney.typepad.com/the_greasy_spoon/2008/07/perfect-fried-e.html

Temperature Conversions

- Fahrenheit (historically)
  - 0°F = Salt water freezing (colligative)
  - 32°F = Water freezing
  - 96°F = “blood heat”
- Celsius (historically)
  - 0°C = Water freezing
  - 100°C = Water boiling
- Adjustments over time…



Do the math

What is “body temperature”?

END DAY 10

Content

Experiment in Class

Cheese Tasting experiment – (2015-09-29)

Tasting

Use all your senses!

Sight – What does it look like?

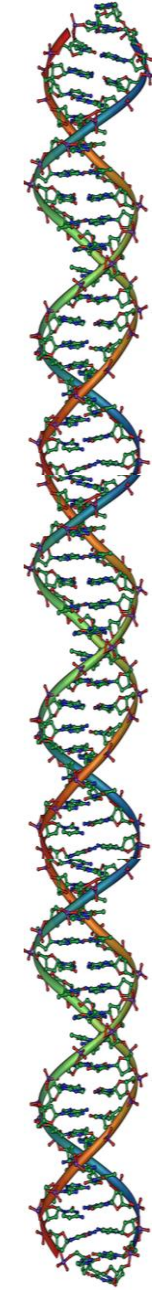
Touch – Is it smooth? Crumbly? Sticky?

Smell – Surface and inside

Taste – Salty? Sweet? Like it smells?

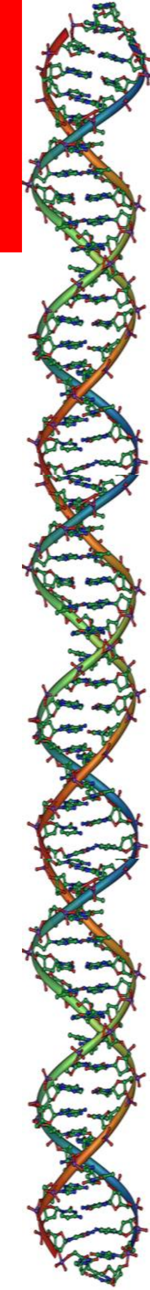
Touch – How does it feel on your tongue?

Hearing – OK, maybe not *all* your senses…



END DAY 11

Content



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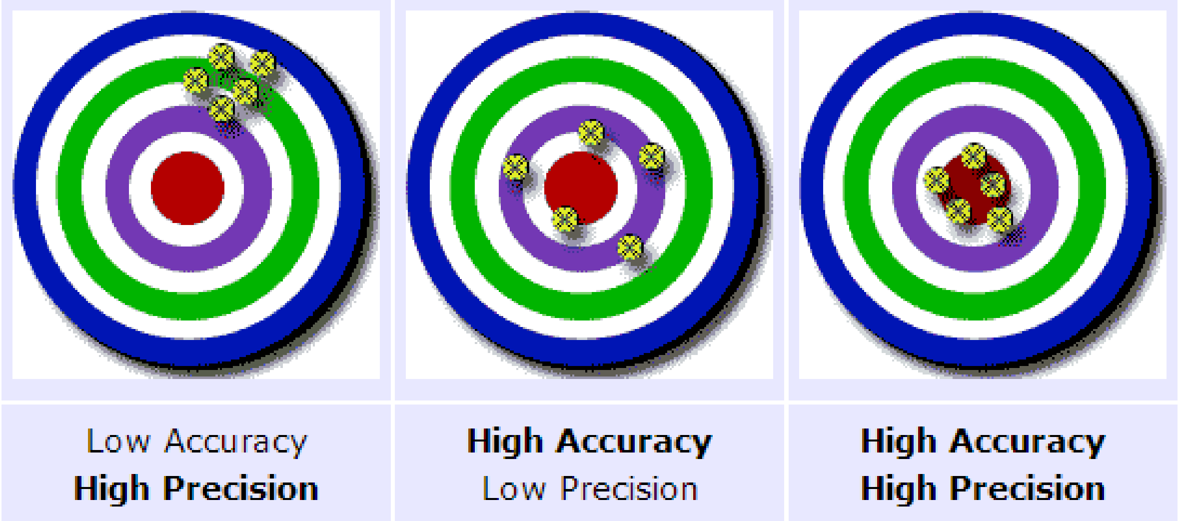
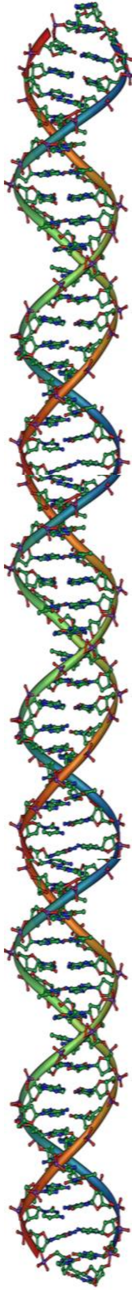
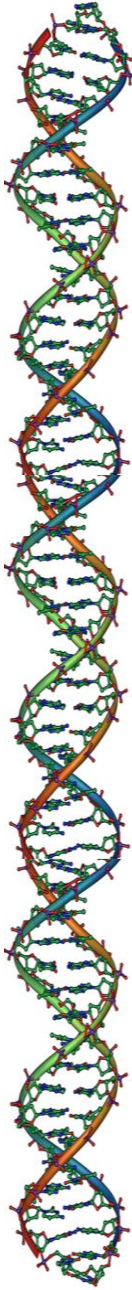




Science of Cooking – BCBT100
Summer 2016 - Bodwin

Absolute Scales

- Kelvins
    - 1K = 1°C
    - “Zero” really means “zero”
    - 0°C = 273.15K
- Rankine (rarely used)
    - 1°R = 1°F
    - “Zero” is absolute zero
    - 0°F = ??°R



Temp!

Scales

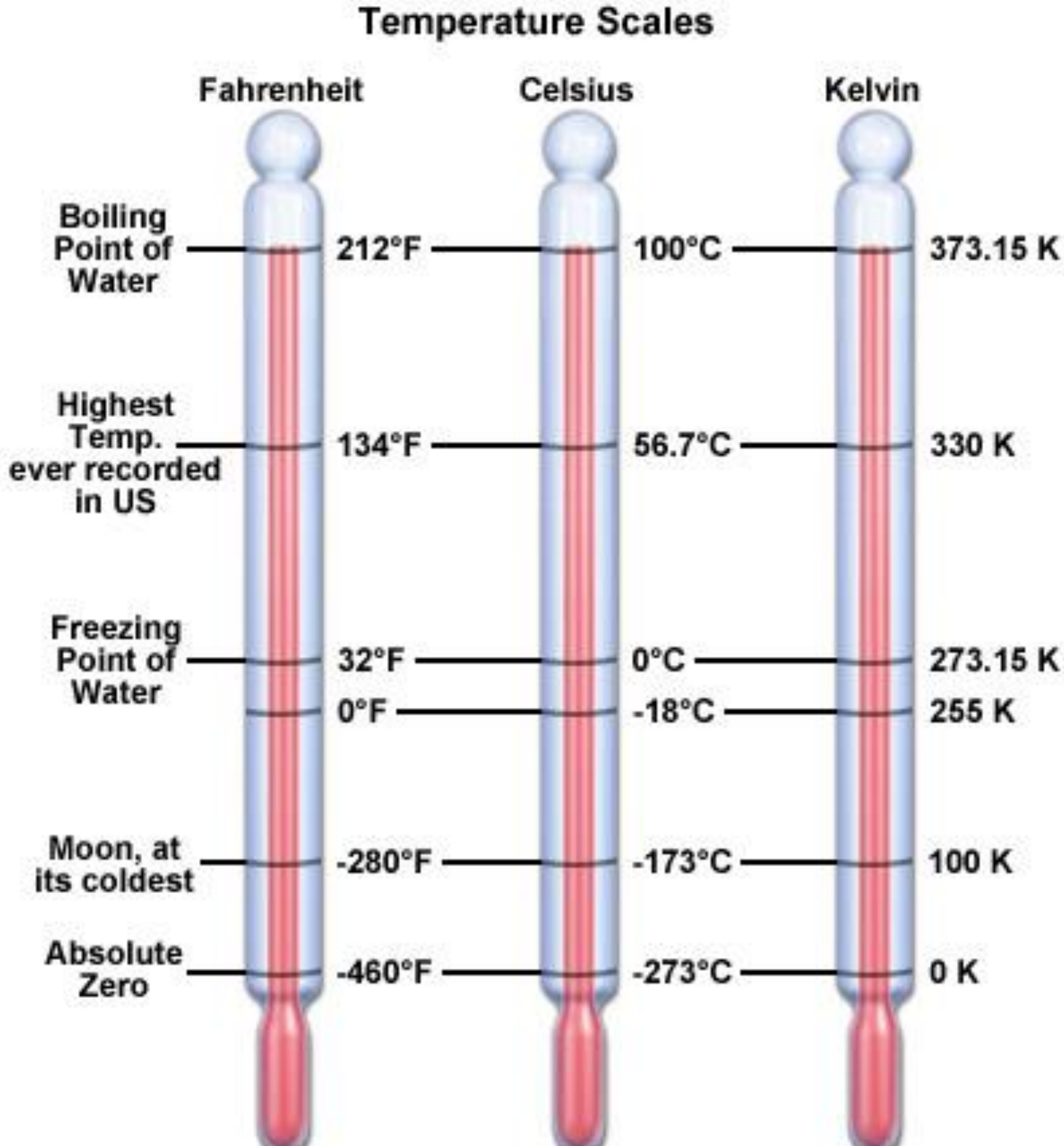
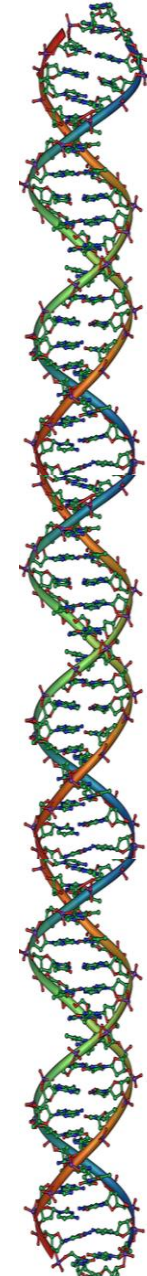


Image: http://www.nc-climate.ncsu.edu/edu/k12/.Temperature

Egg Whites – Whip It!



Foams – Meringue (albumin only)

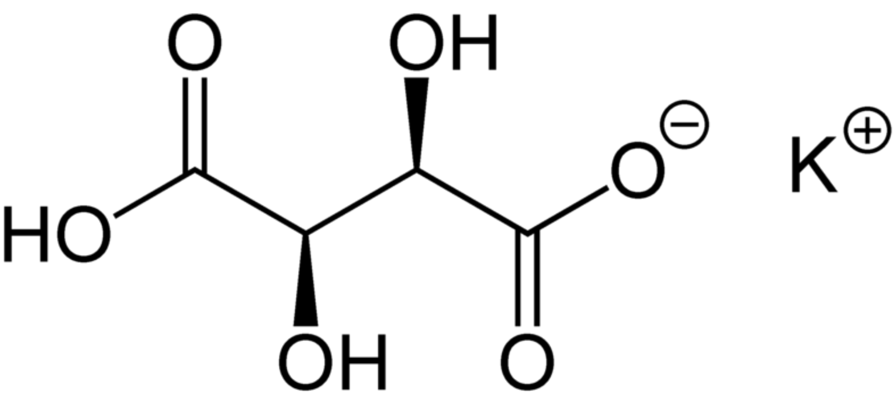
- Review micelles – water/air interface
- Similar in concept to whipped cream or yogurt curdling
- Mechanical shearing of protein bundles
- Soft foam – water lubricates bubbles
- Hard/Stiff/Dry peaks – protein bubble walls squeeze out excess moisture

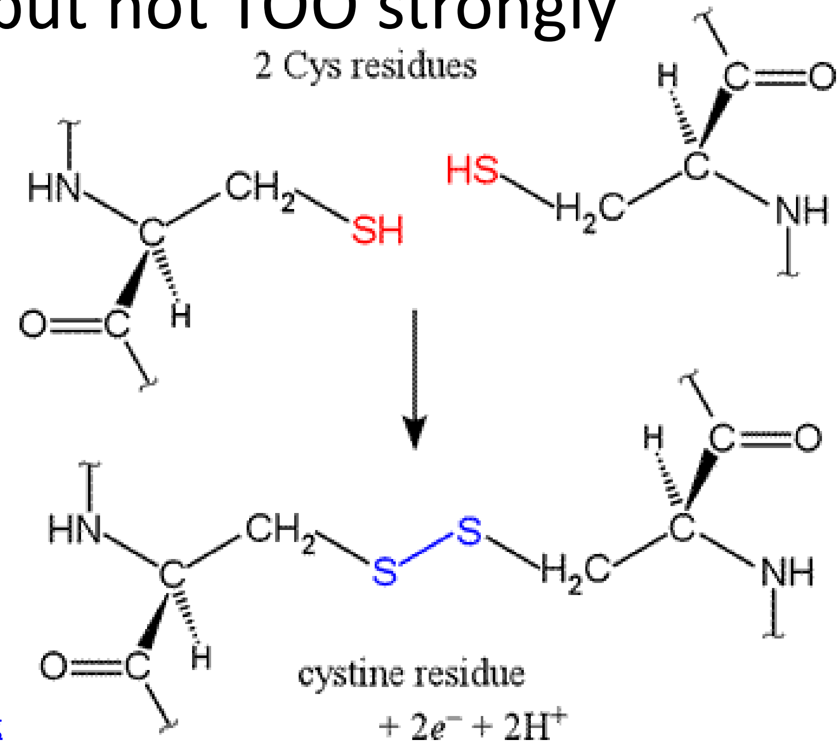
Cream of Tartar

Potassium tartrate – adds acid

Prevents disulfide bond formation

Proteins need to interact, but not TOO strongly





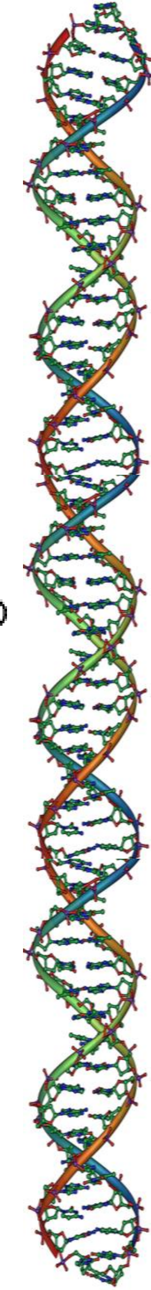
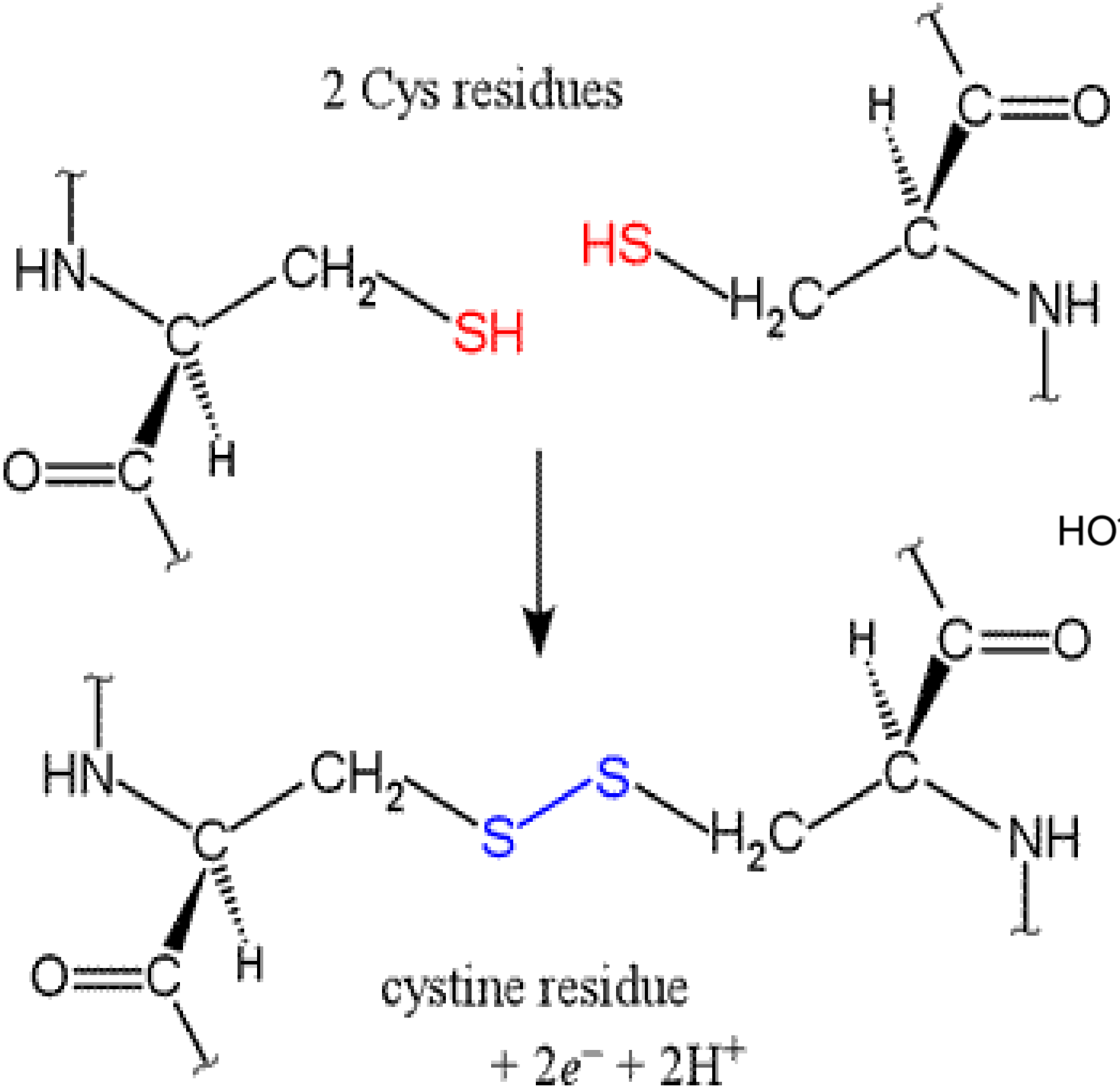
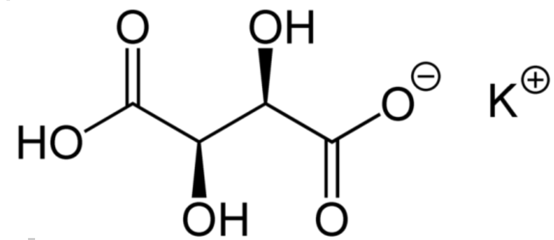


Image: http://en.wikipedia.org/wiki/File:Weinstein_Strukturformel.png

Image: http://guweb2.gonzaga.edu/faculty/cronk/biochem/D-index.cfm?definition=disulfide_bond





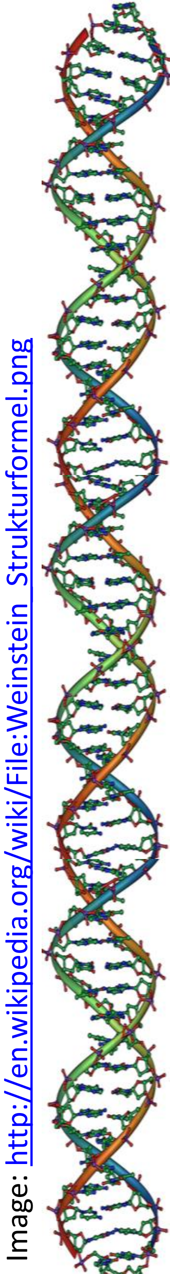


Image: http://en.wikipedia.org/wiki/File:Weinstein_Strukturformel.png

Image: http://guweb2.gonzaga.edu/faculty/cronk/biochem/D-index.cfm?definition=disulfide_bond

Setting White Foams

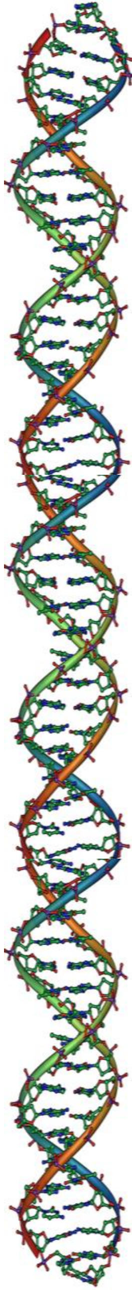
Heating dehydrates

Ovalbumin denatures at higher T

- Secondary network, reinforces

Role of sugar

- Strengthens “cages” with sugar strands
- Delays dehydration (ovalbumin denature)



Whipped yolks

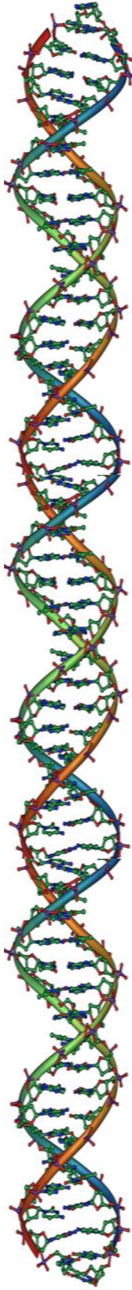
- Fat prevents foam
  - A little yolk ruins a meringue
- Air bubbles lighten color
- Low “free” water content
- The beginnings of a custard
  - Network of egg proteins
  - Suspends milk fat

Whipped Whole Eggs

Not as fluffy as whites

Not as silky as yolks

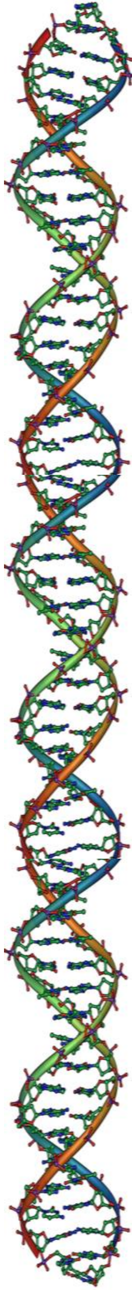
Will they foam?



Cooking Eggs

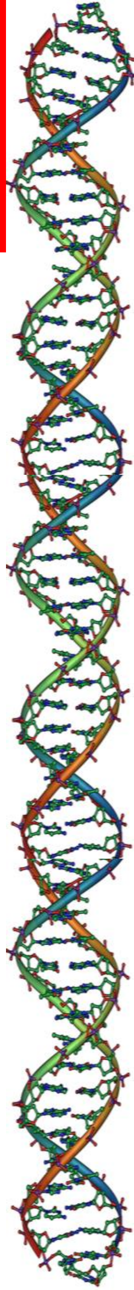
Balance of fat, protein, water, air

- Water – high heat capacity
- Fat – solidifies, liquifies, separates
- Protein – denatures or not?
- Air – excellent insulator {Why?}



END DAY 12

Content



From Last Time:

Custard "I" – base – rank = 3

sweet, pudding, eggy,

Custard "II" – double yolk – rank = 2

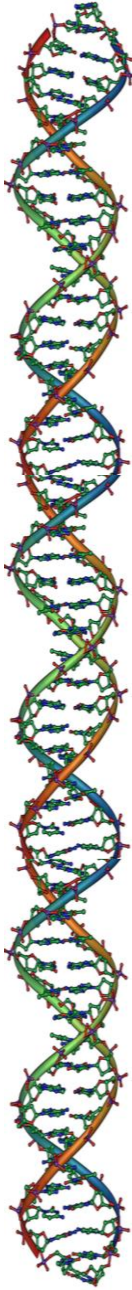
watery, stronger smell

Custard "III" – cream – rank = 1

buttery, sweet, "like ice cream", smooth

Custard "X" – whipped – rank = 4

watery, thick skin, less smooth, strong smell



Custard

Crème caramel

Crème brulee

Cheesecake

Kuchen

Quiche

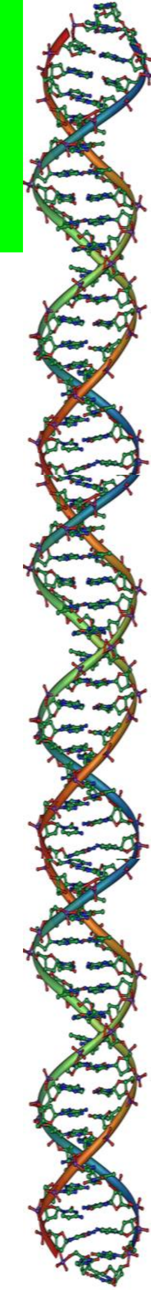
"Egg Bake"

Image: http://gwenskitchencreations.blogspot.com/2011/04/creme-brulee.html

Image: http://raefrazier.blogspot.com/2011/04/q-quantum-physics.html

TOPIC BEGIN

Fruits and Vegetables



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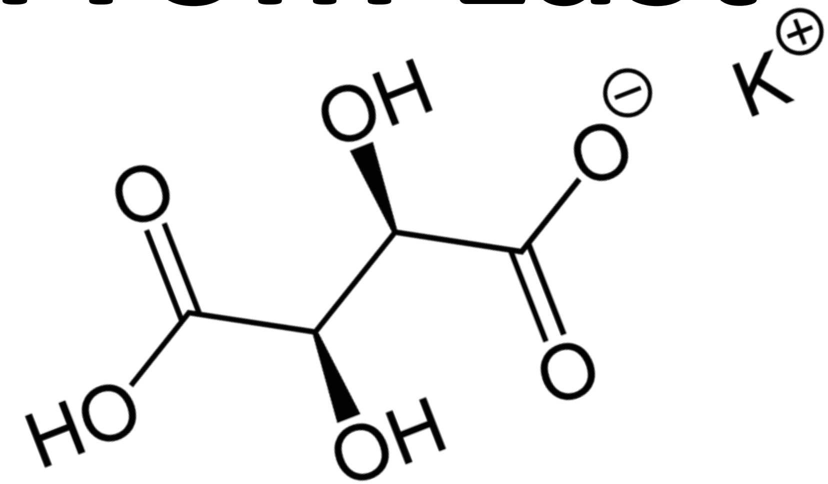
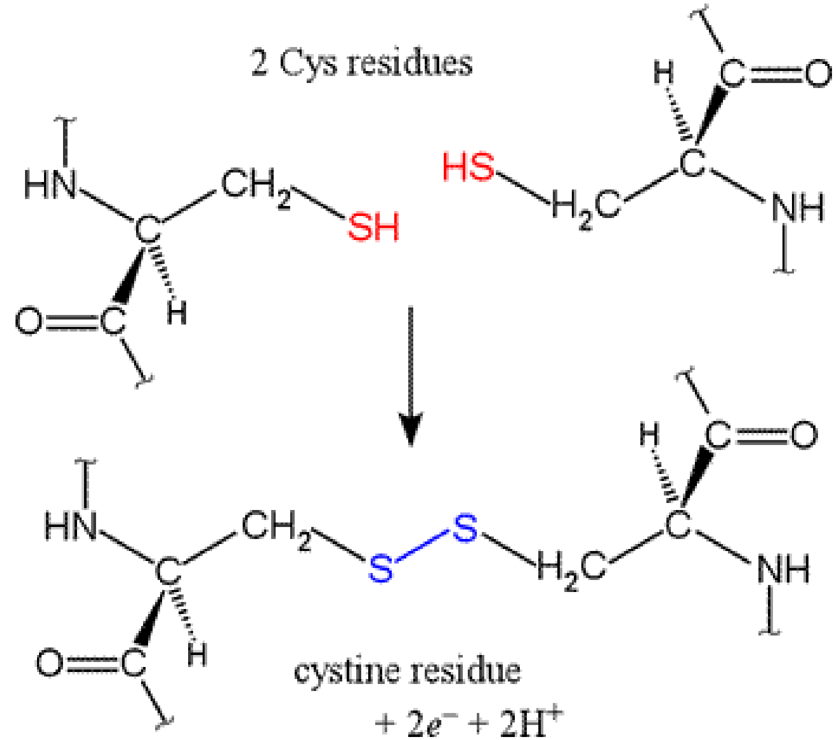
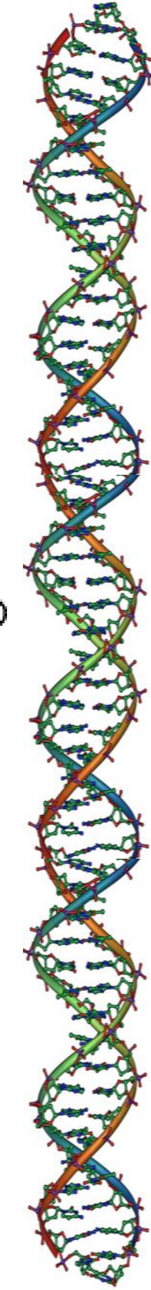






Advising

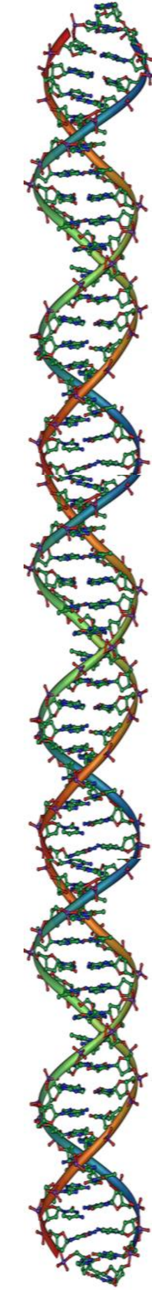
Make an appointment early

Show that you've planned

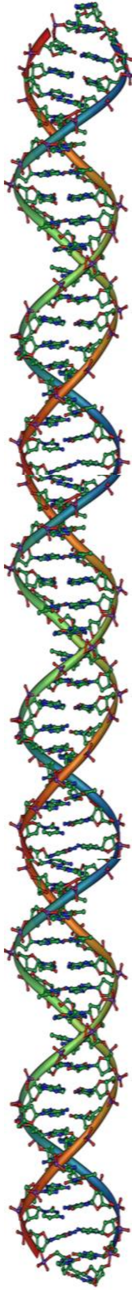
- Look at DAR and degree requirements

Have alternatives

Look at the long term



Fruits & Vegetables



Fruit

Examples:

Vegetable

Examples:

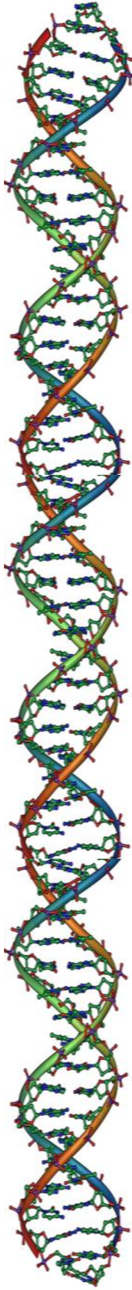
Fruit

From http://www.biology-online.org/dictionary/Fruit

1. (botany) Seed-bearing structure in angiosperms formed from the ovary after flowering.
2. The edible, usually fleshy and sweet smelling part of a plant that may or may not contain seed(s).

Fruit = Reproduction

Evolved to spread seeds



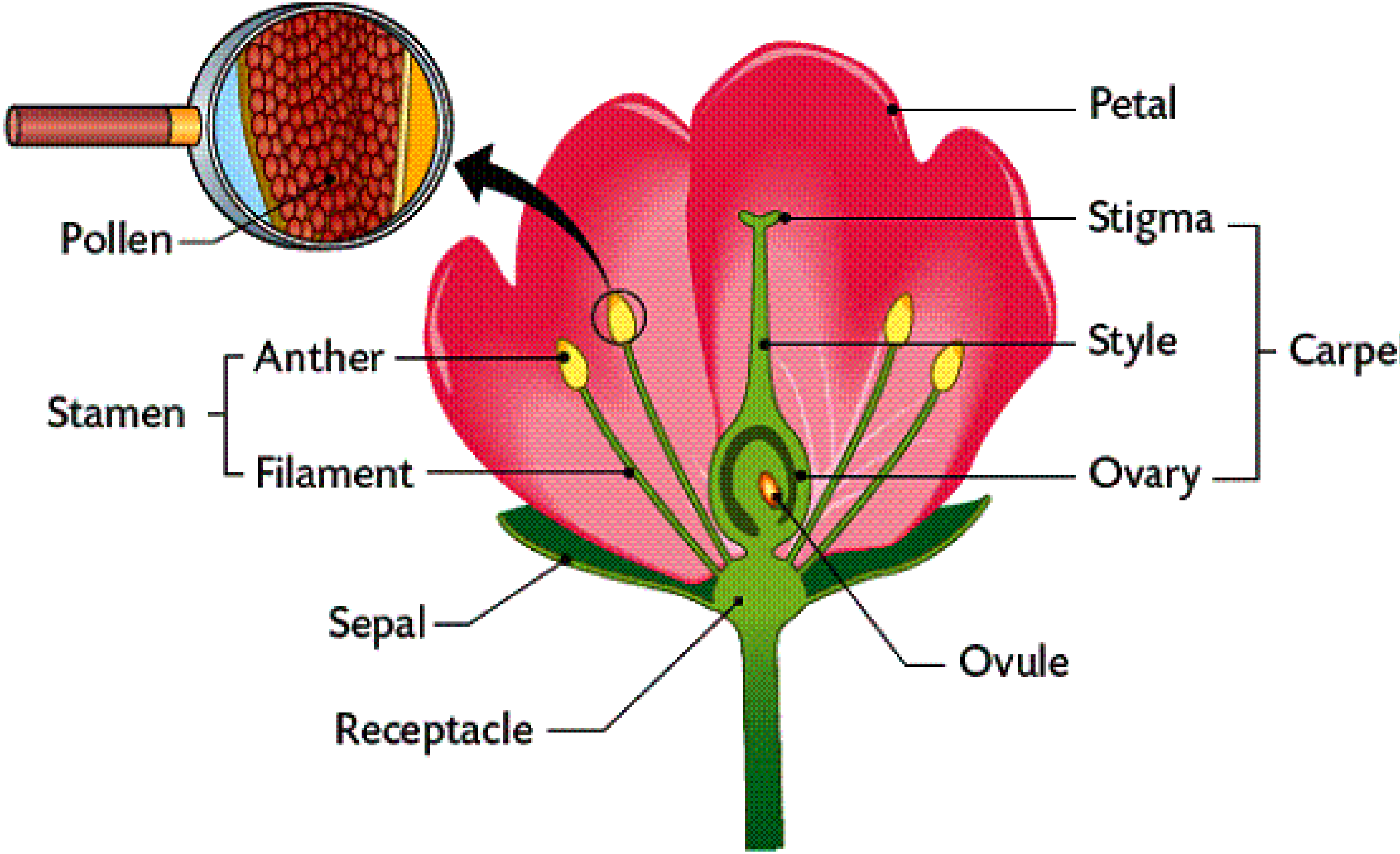


Image: http://leavingbio.net/the%20structure%20and%20functions%20of%20flowers.htm

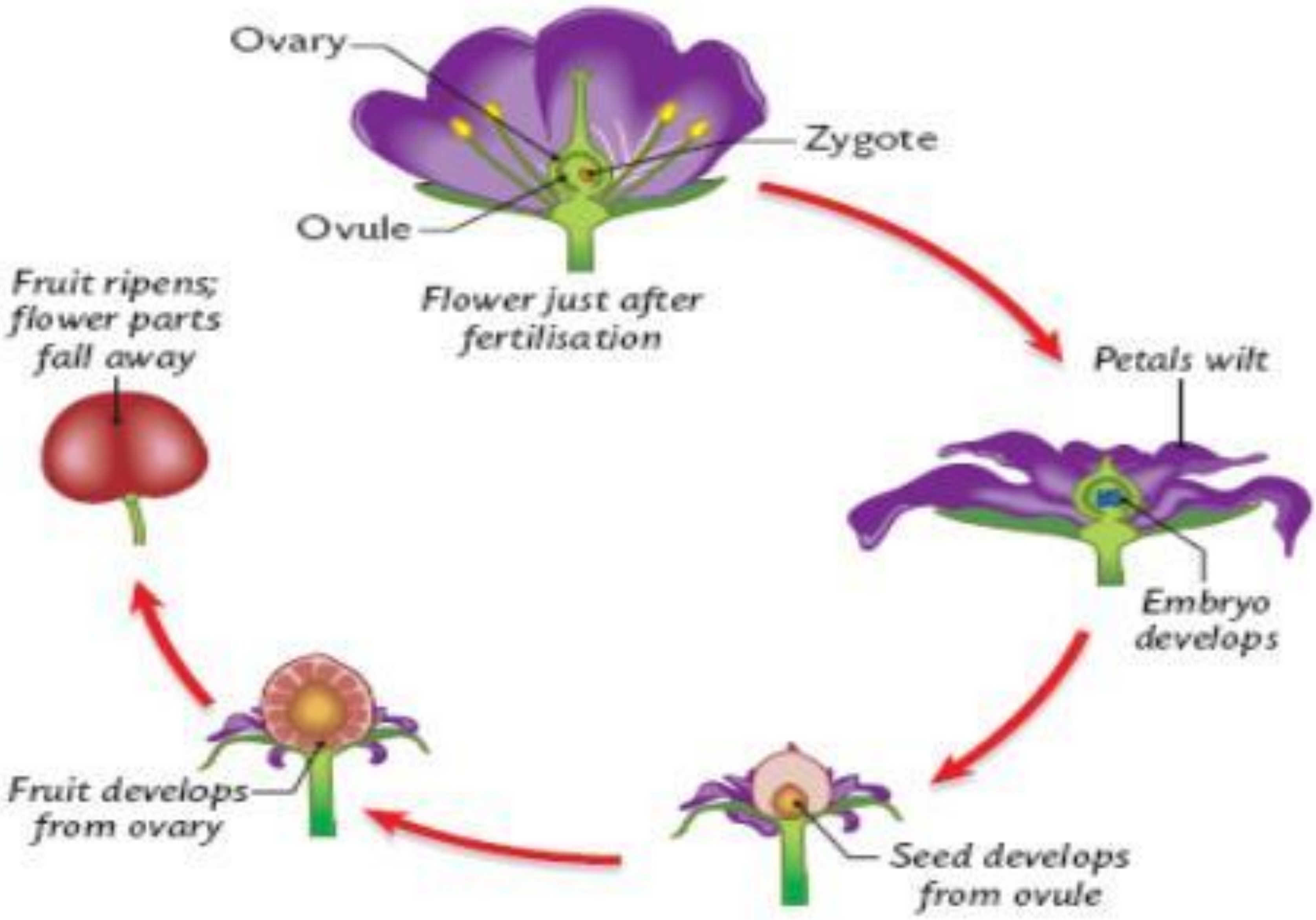


Image: http://leavingbio.net/the%20structure%20and%20functions%20of%20flowers.htm

Apple
Flower
to
Fruit

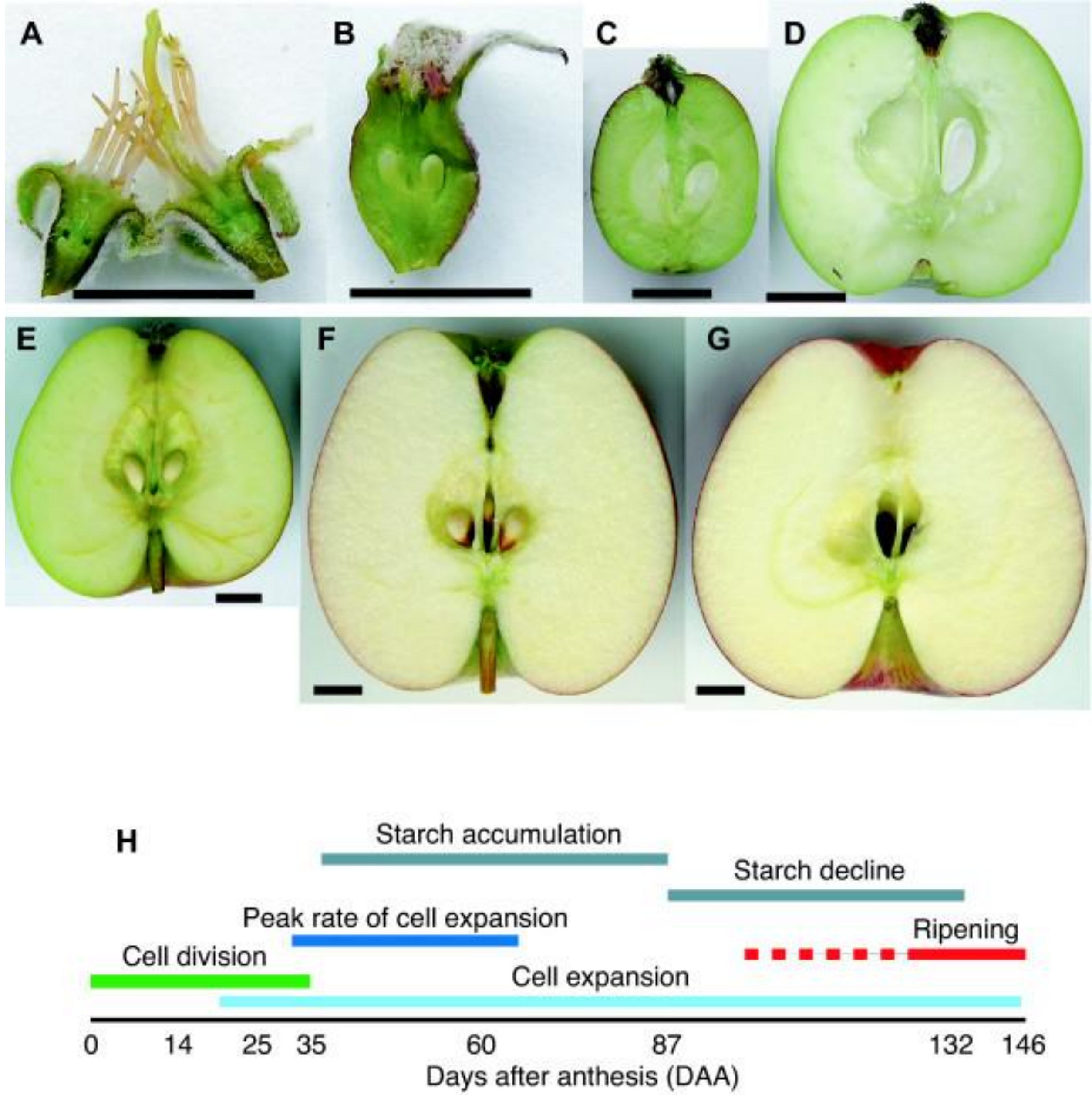


Image: http://www.geochembio.com/biology/organisms/apple/

Fruits

Image: http://www.aaas.org/news/releases/2012/0628sp_tomato.shtml

Image: http://www.classroomscience.org/check-an-apple-for-pollination

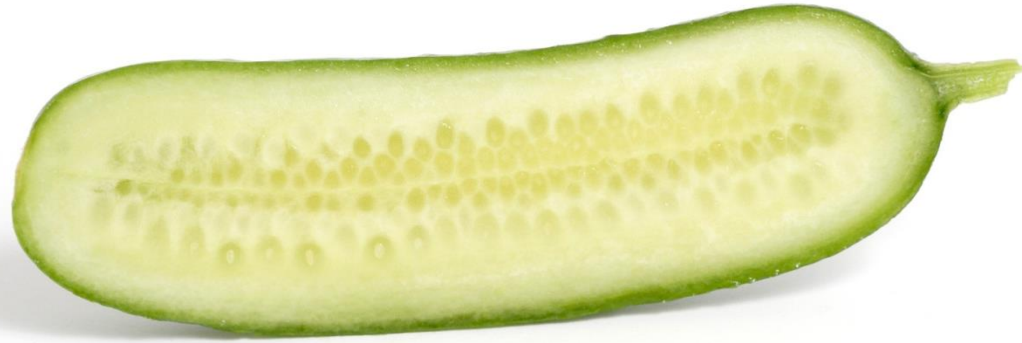


Image: http://en.wikipedia.org/wiki/File:Cucumber_and_cross_section.jpg

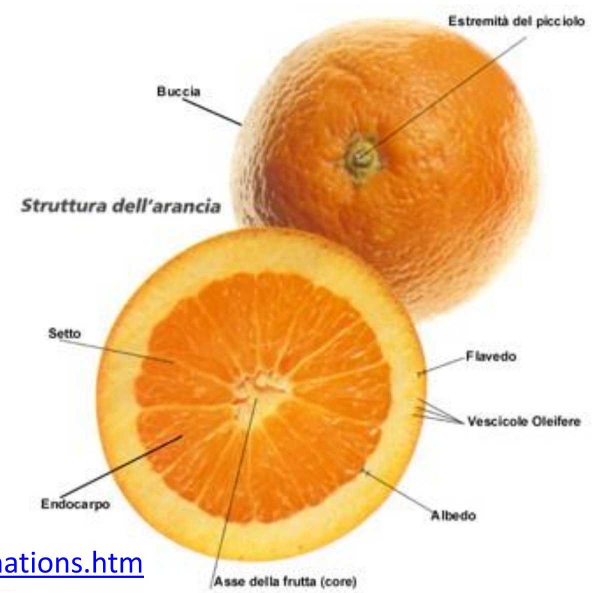
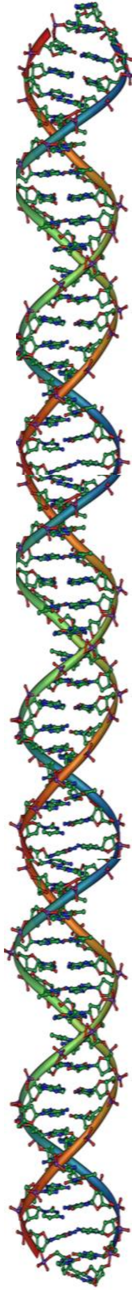


Image: http://www.citrech.it/English/Informations.htm



Main Fruit Molecules

Reproductive bodies = energy

- Sugars
- Starch
- Carbohydrates

Low protein

Low fat*

Image: http://www.shannondelvesfitness.com/2011/04/10-day-raw-fruit-and-vegetable-cleanse/

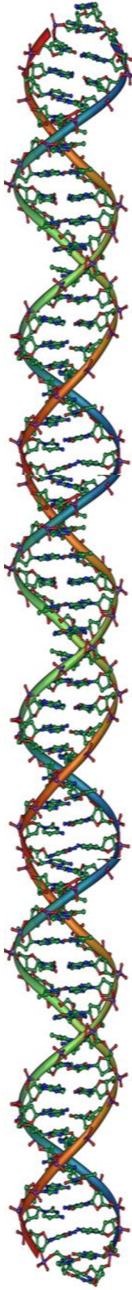
Fat in Fruits

Watermelon = 0.15% fat

Olives, pickled, canned or bottled, green - Fat
In 100g, Fat content = 15.32 g
Typical Fruits serving, 1 olive (or 2.7g), Fat content = 0.41 g

Avocados, raw, all commercial varieties - Fat
In 100g, Fat content = 14.66 g
Typical Fruits serving, 1 cup, cubes (or 150g), Fat content = 21.99 g

Roast beef = ~4-7% fat



from: http://www.dietandfitnesstoday.com/fruits-high-in-fat.php

Other Fruit Molecules

- Nutrients
  - Vitamins – What type?
  - Minerals
- Phytochemicals – often colored
  - Anti-oxidants
  - Hormone-like activity

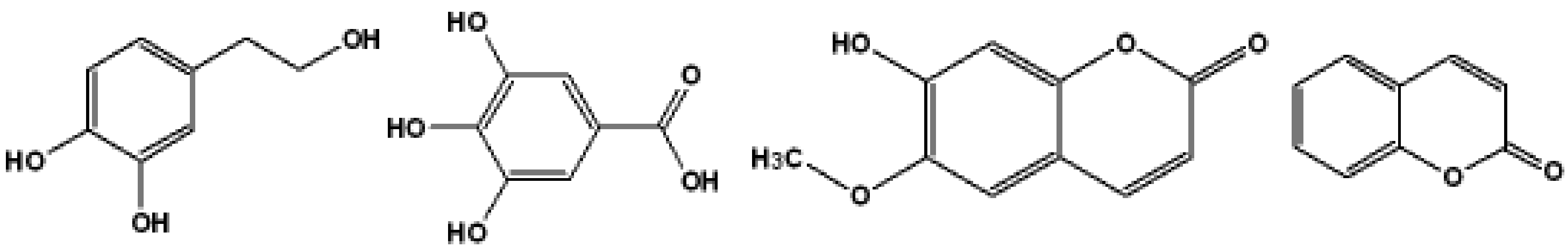


Image: http://www.phytochemicals.info/

Carotenoids

- Alternating bonds = color
- More = more color

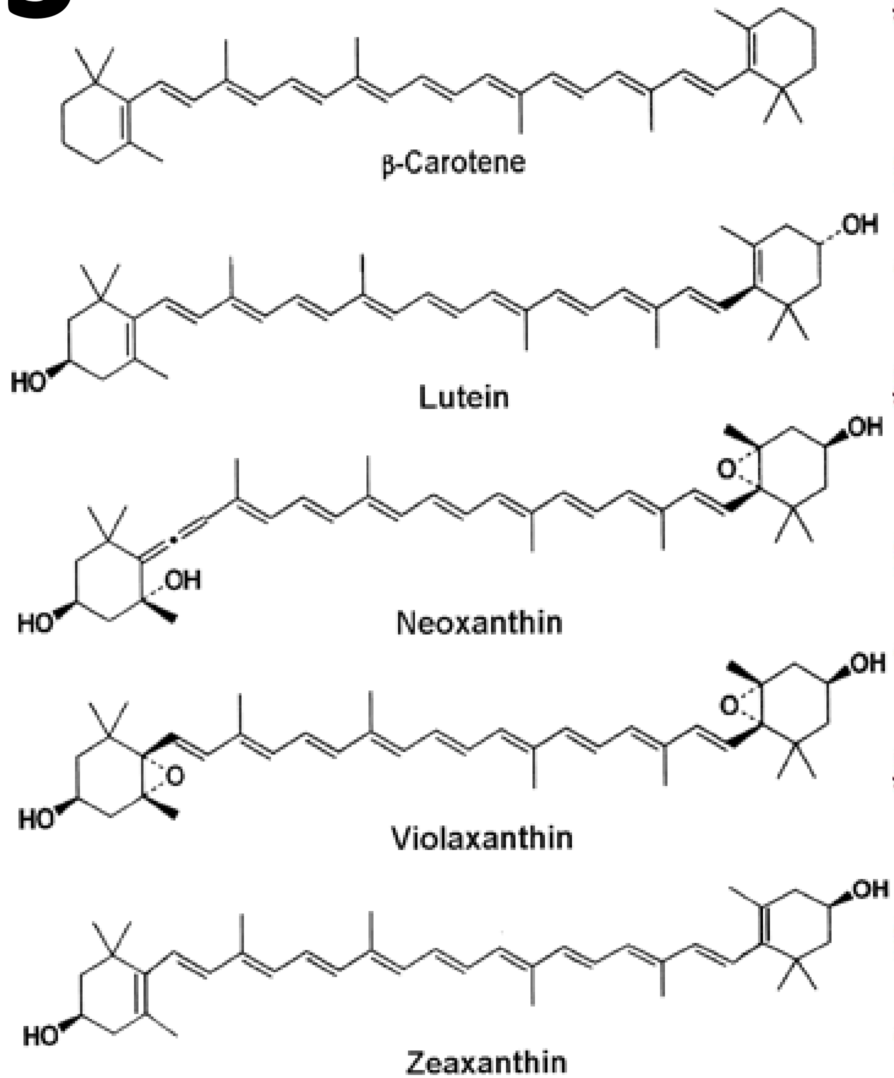


Image: http://www.jbc.org/content/274/42/29613.full

Hormone Mimics

Shape and polarity

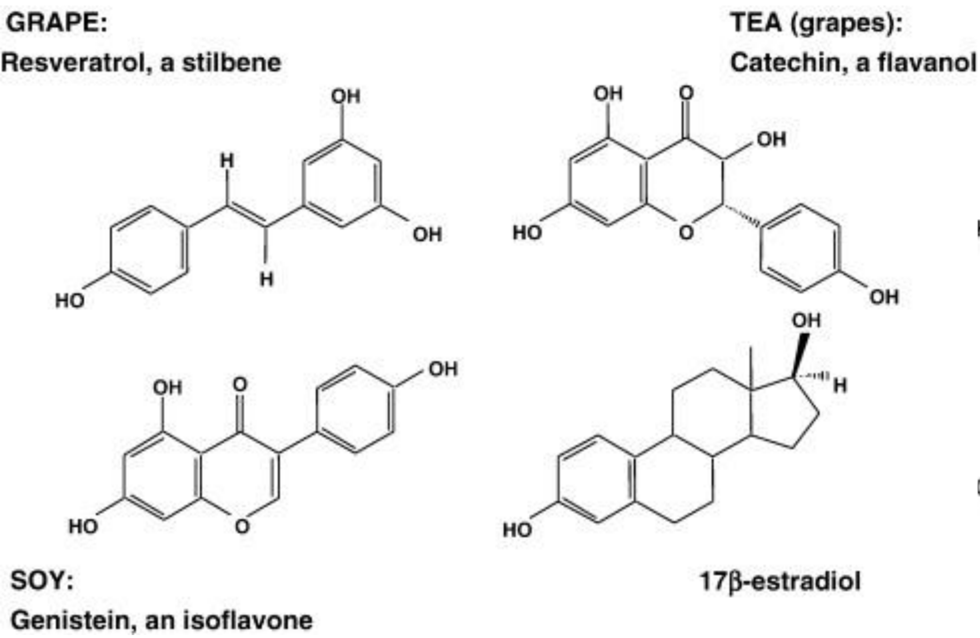


Image: http://www.sciencedirect.com/science/article/pii/S0024320505012439

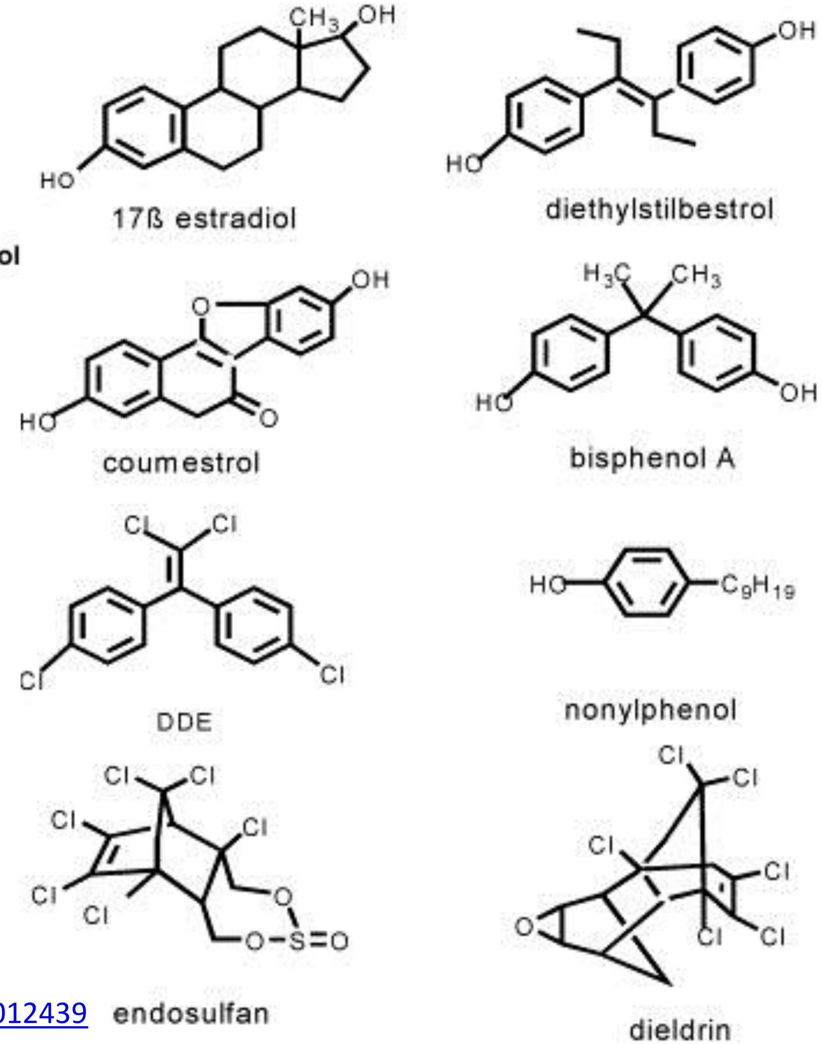
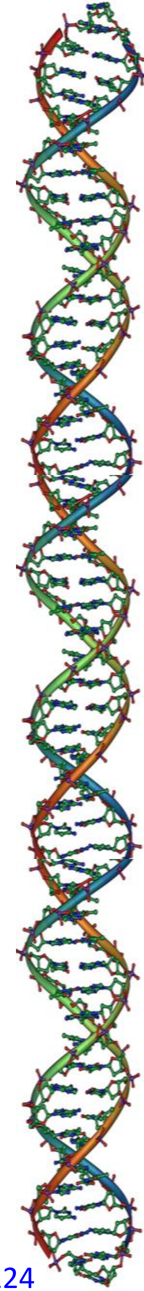


Image: http://www.sciencedirect.com/science/article/pii/S0039128X06002224



Properties of Fruits

Usually sweet

Often brightly colored

High water content

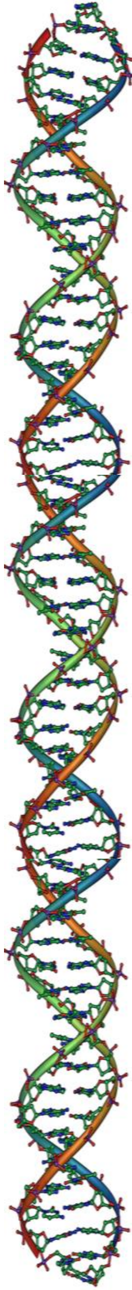
Vegetables

Edible parts of plants that are ***not***:

- Fruit
- Seed

Vegetables are:

- Leaves, stems, roots



Plant Toxins

Why do they exist?

Alkaloids – bitter, poisonous

- Potato sprouts

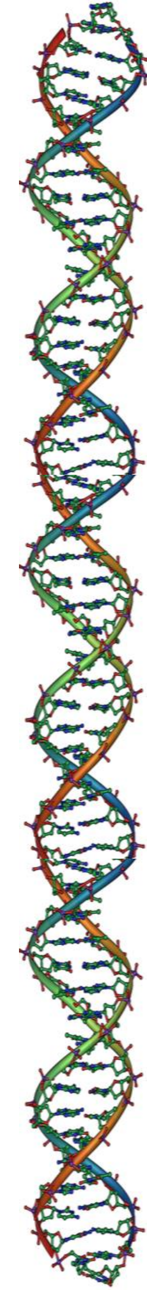
Protease inhibitors – block digestion

- Soy/kidney/lima beans (undercooked)

Flavors – If some is good, more kills

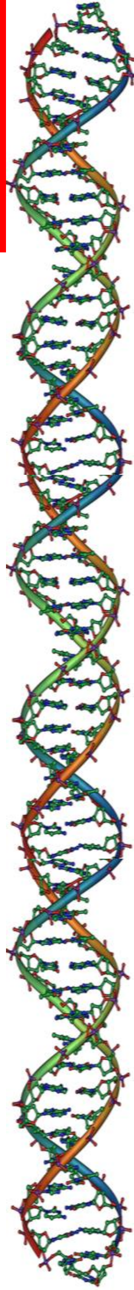
Oxalates – insoluble crystals, “gout”

- Spinach, chard, beets, rhubarb



END DAY 13

Content



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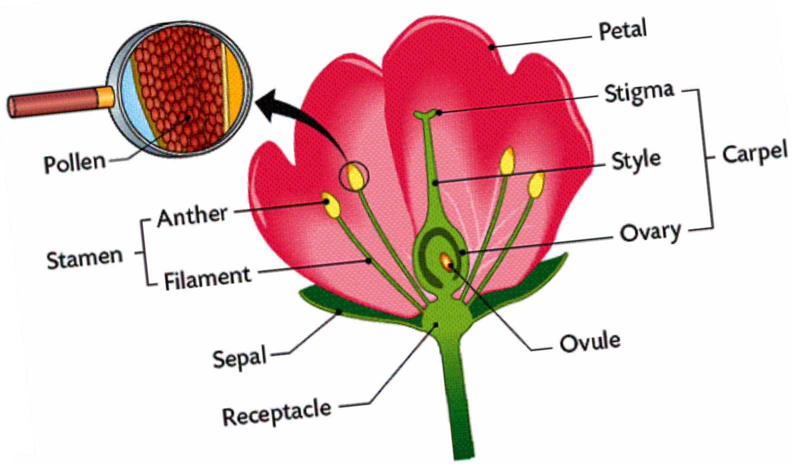
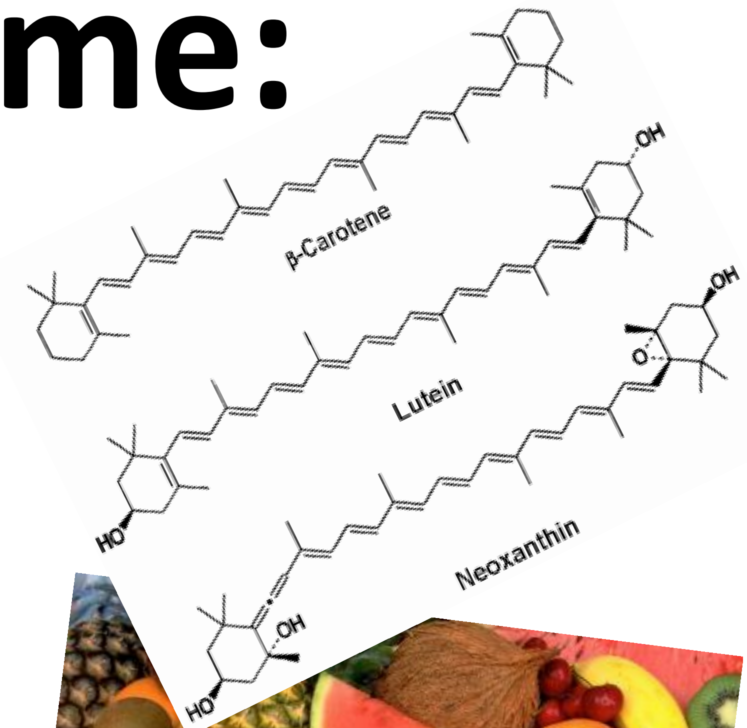
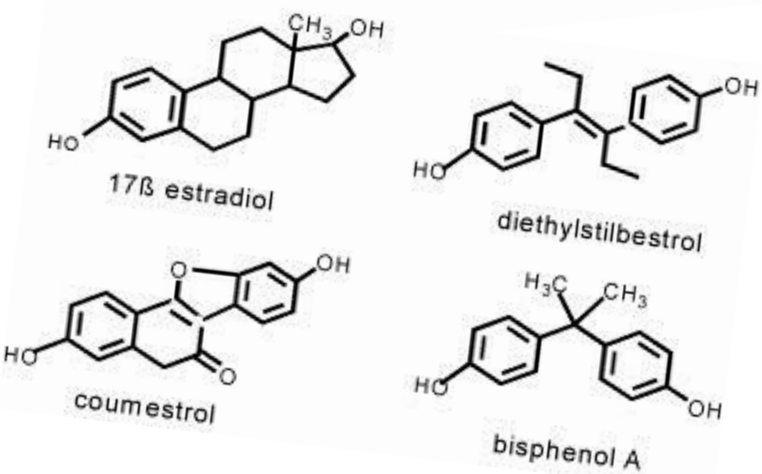
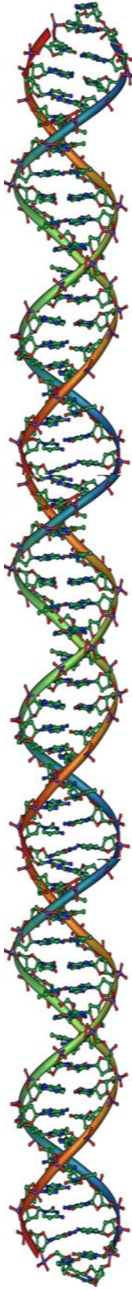






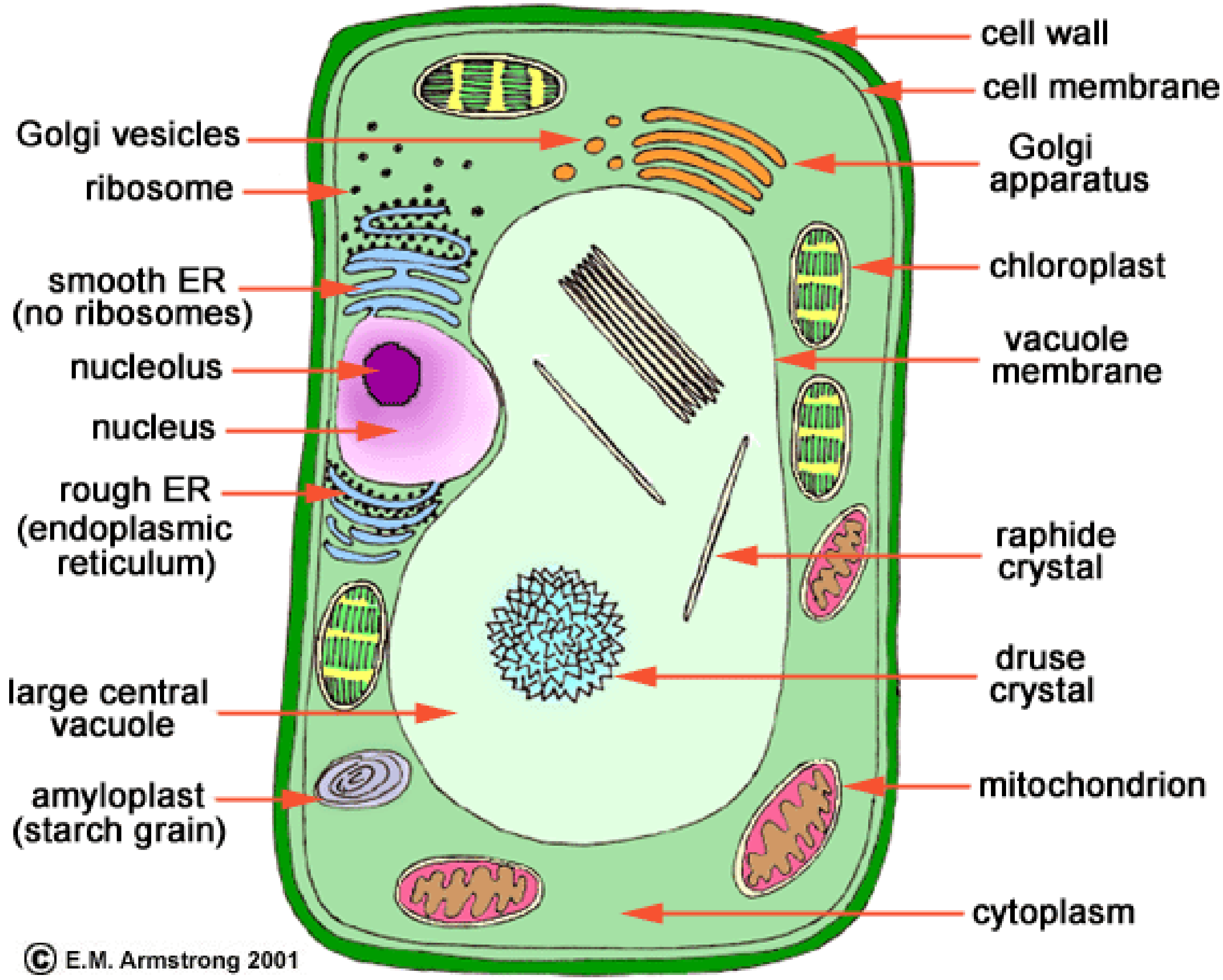


Science of Cooking – BCBT100

Summer 2016 - Bodwin

Plant Structure

Cells and cell walls



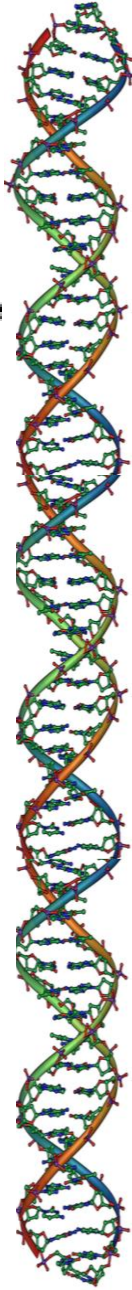


Image: http://waynesword.palomar.edu/lmexer1a.htm

Cell Wall

Structural, prevents dehydration

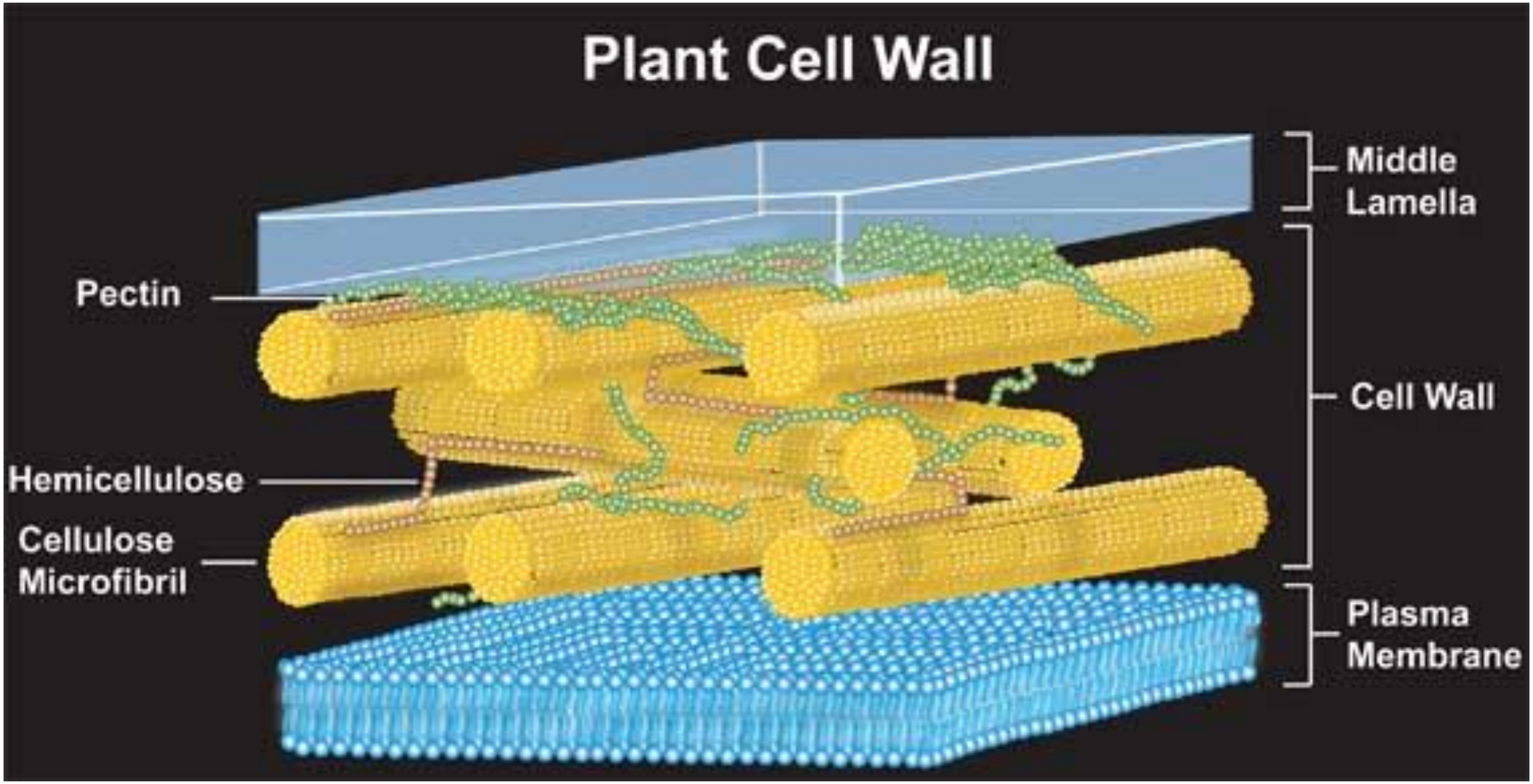


Image: http://www.sigmaaldrich.com/life-science/metabolomics/enzyme-explorer/learning-center/lysing-enzymes.html

Cell Wall

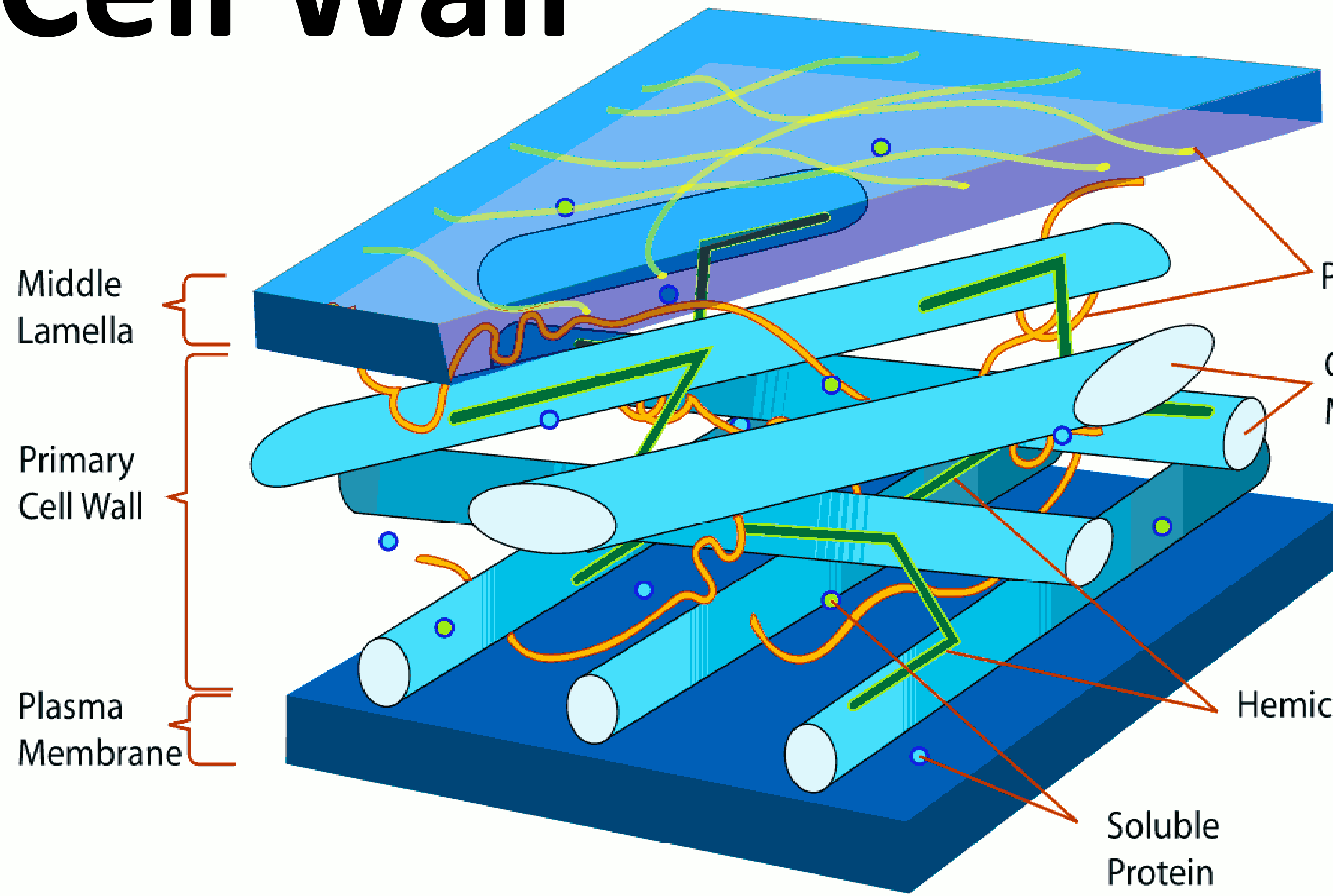


Image: http://www.wpclipart.com/plants/diagrams/Plant_cell_wall_diagram.png.html

Vacuole

“Fullness” alters rigidity of plant

Contains water & water soluble bits

- Acids, sugars, proteins, pigments, enzymes, etc

Chloroplasts

Contain chlorophyll

Makes green plants green (leaf)

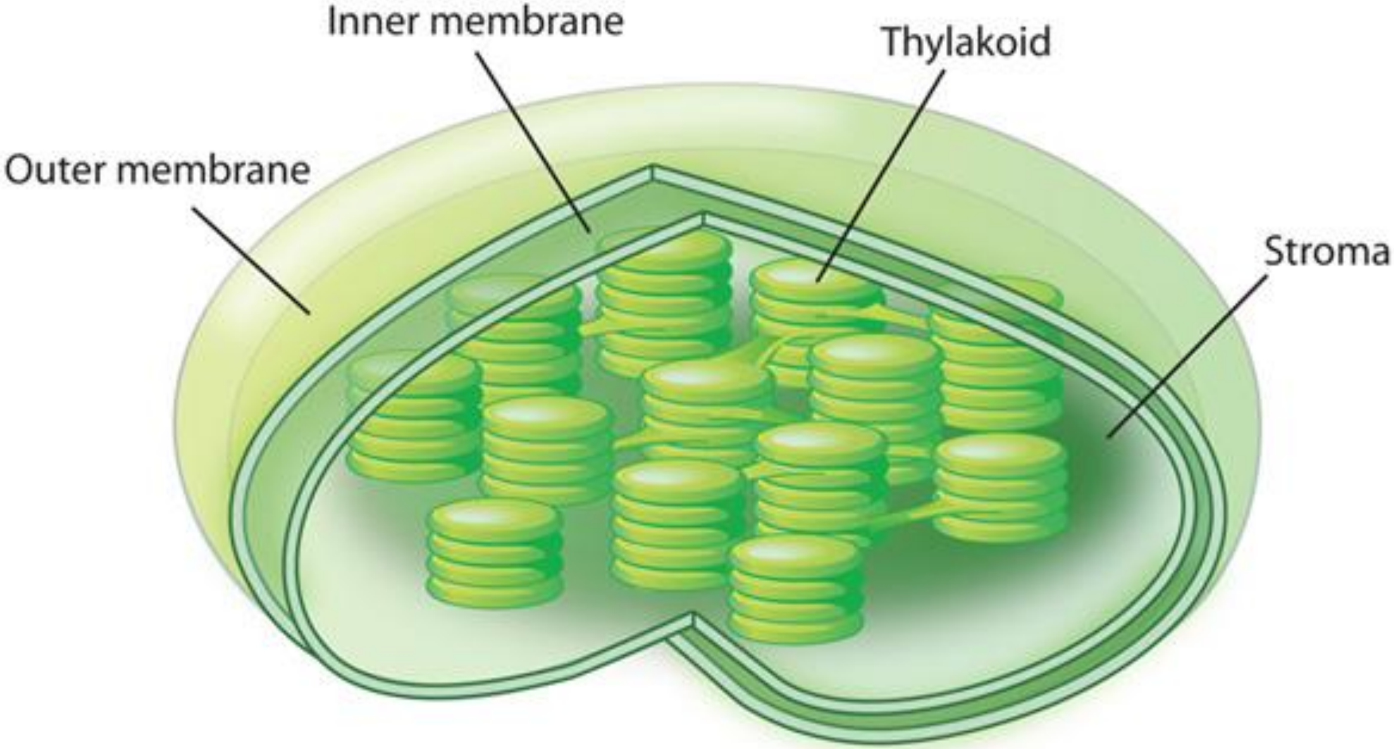


Image: http://www.nature.com/scitable/topicpage/plant-cells-chloroplasts-and-cell-walls-14053956

Plant Tissues

Ground

- Most of the cell mass, thin cell walls

Vascular

- Nutrient transport, tough & fibrous

Dermal

- Surface (“skin”), epidermis/periderm

Secretory

- Oozes things…

What do we eat?

Roots

Stems

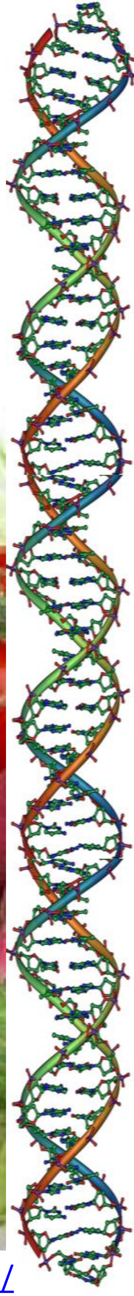
Leaves

Flowers

Fruits

Seeds

Image: http://sagharborfoodpantry.com/



Cooking!

Consider the molecules

Cell walls = rigid/tough, fiber

- Cooking removes non cellulose part

Removing water?

Tasting Fruit & Veg

Multisensory:

- Flavor
- Aroma
- Touch
- Irritation

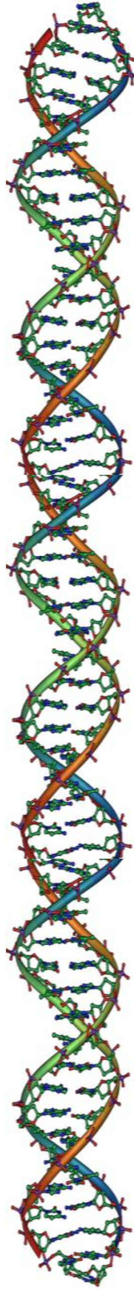
Fruit & Veg Allergies

Fruit = Pollen

Allergies – reaction to “foreign” bits

Can be severe, deadly

“Oral allergy syndrome”



OAS Triggers

Alder pollen: almonds, apples, celery, cherries, hazel nuts, peaches, pears, parsley, strawberry, raspberry

Birch pollen: almonds, apples, apricots, avocados, bananas, carrots, celery, cherries, chicory, coriander, fennel, fig, hazel nuts, kiwifruit, nectarines, parsley, parsnips, peaches, pears, peppers, plums, potatoes, prunes, soy, strawberries, wheat; Potential: walnuts

Grass pollen: fig, melons, tomatoes, oranges

Mugwort pollen : carrots, celery, coriander, fennel, parsley, peppers, sunflower

Ragweed pollen : banana, cantaloupe, cucumber, green pepper, paprika, sunflower seeds/oil, honeydew, watermelon, zucchini, echinacea, artichoke, dandelions, honey (if bees pollinate from wild flowers), hibiscus or chamomile tea

Possible cross-reactions (to any of the above): berries (strawberries, blueberries, raspberries, etc), citrus (oranges, lemons, etc), grapes, mango, figs, peanut, pineapple, pomegranates, watermelon

List from: http://en.wikipedia.org/wiki/Oral_allergy_syndrome

How Humans Experience Their Food

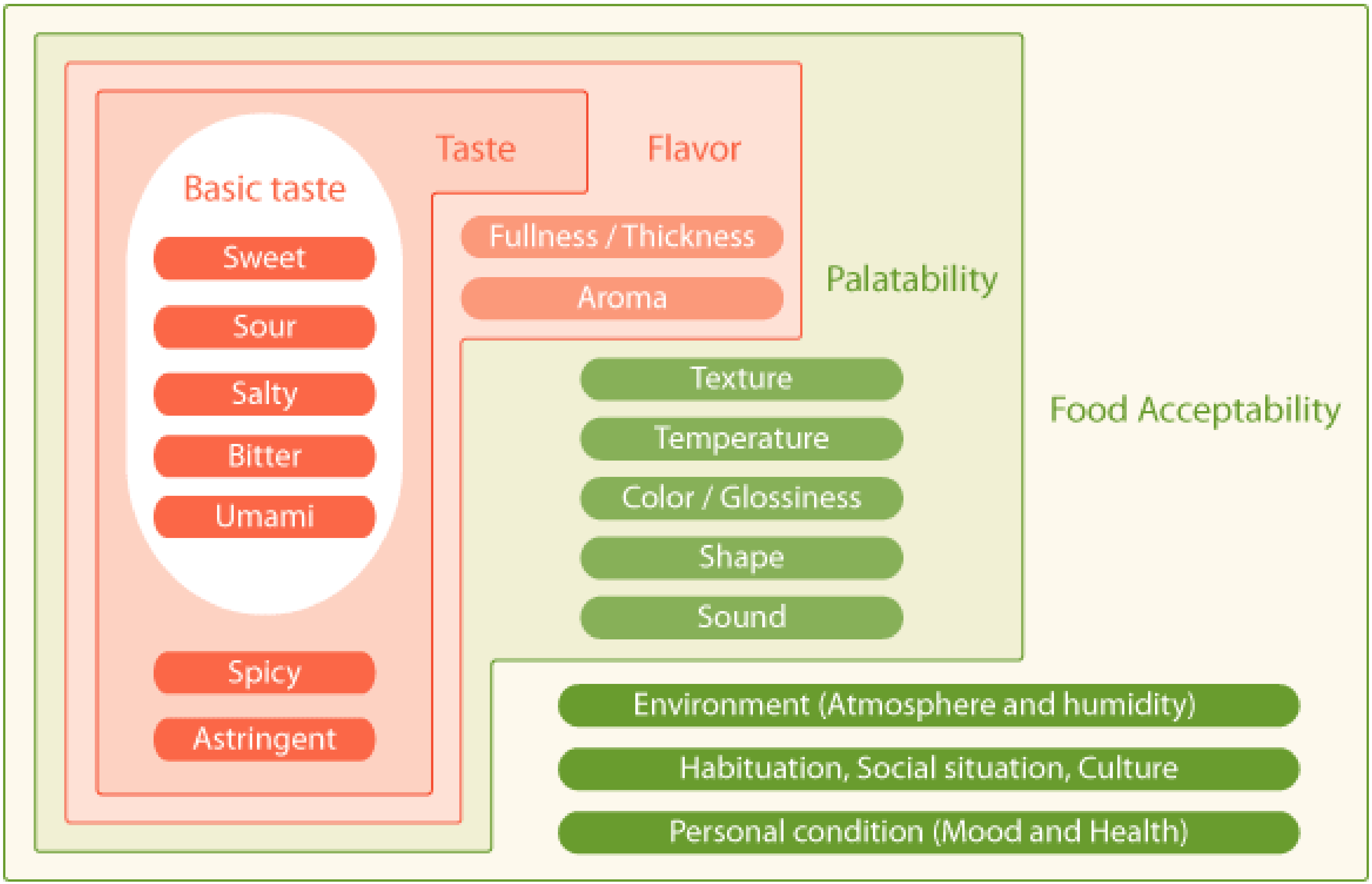
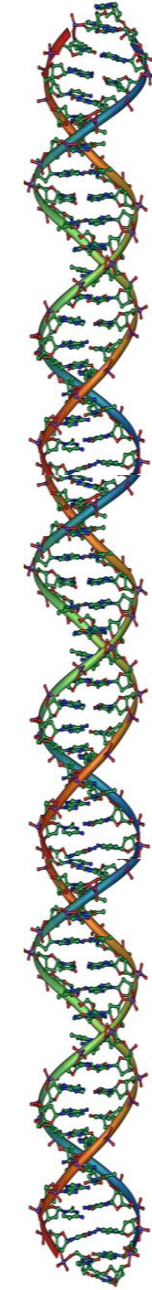


Image: http://www.umamiinfo.com/2011/02/What-exactly-is-umami.php

Flavor/Taste



Salty – salt

Sweet – sugar & sugar-like molecules

Sour – acids

Savory – protein richness

Bitter – alkaloids

Umami – glutamate/DNA richness

Metallic – bitter/sour

Tastes
Receptors

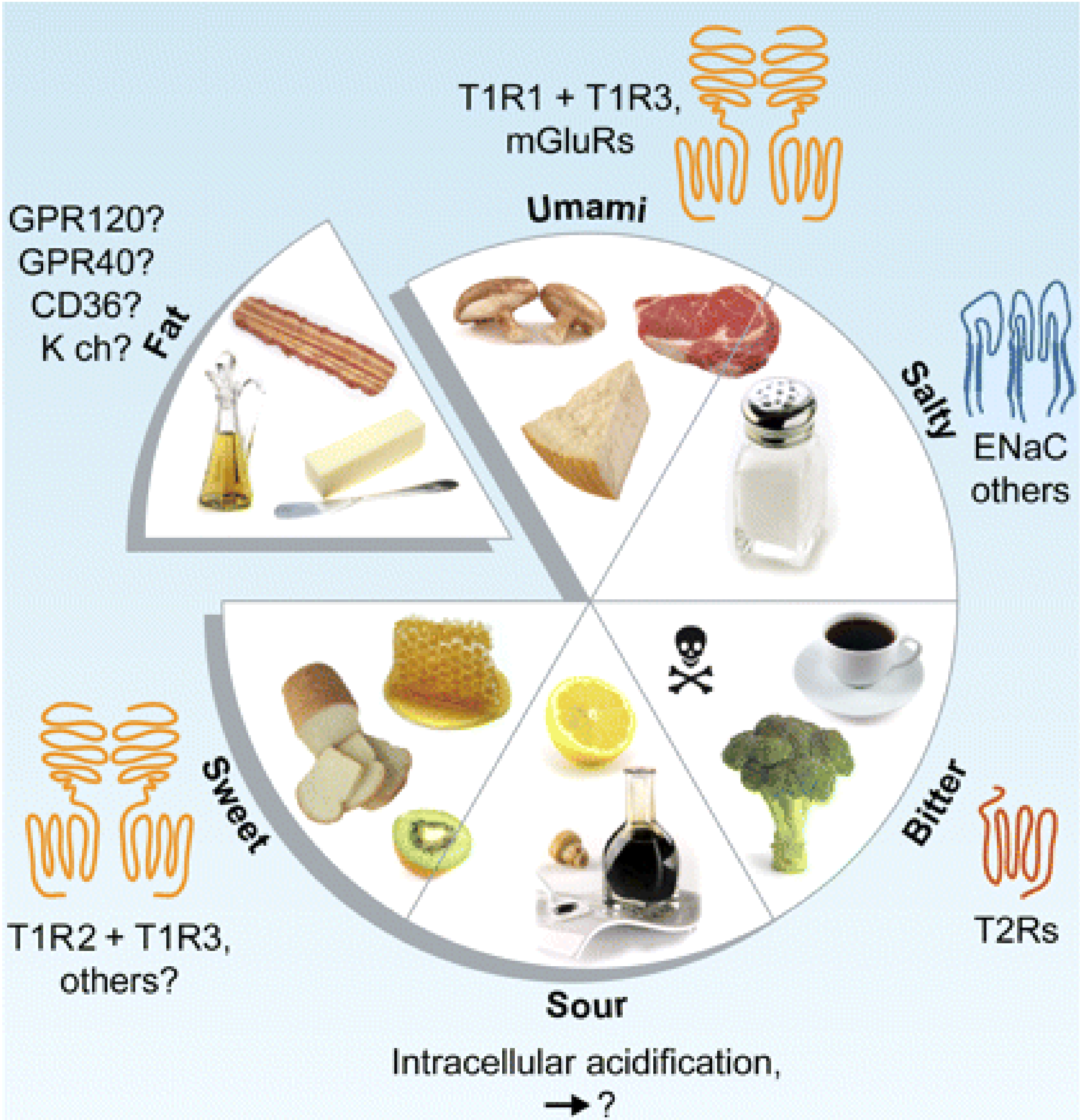


Image: http://jcb.rupress.org/content/190/3/285/F1.expansion.html

Tongue Map…

Where do we taste?

Use ***science*** to ***test*** this!

Not completely accurate…

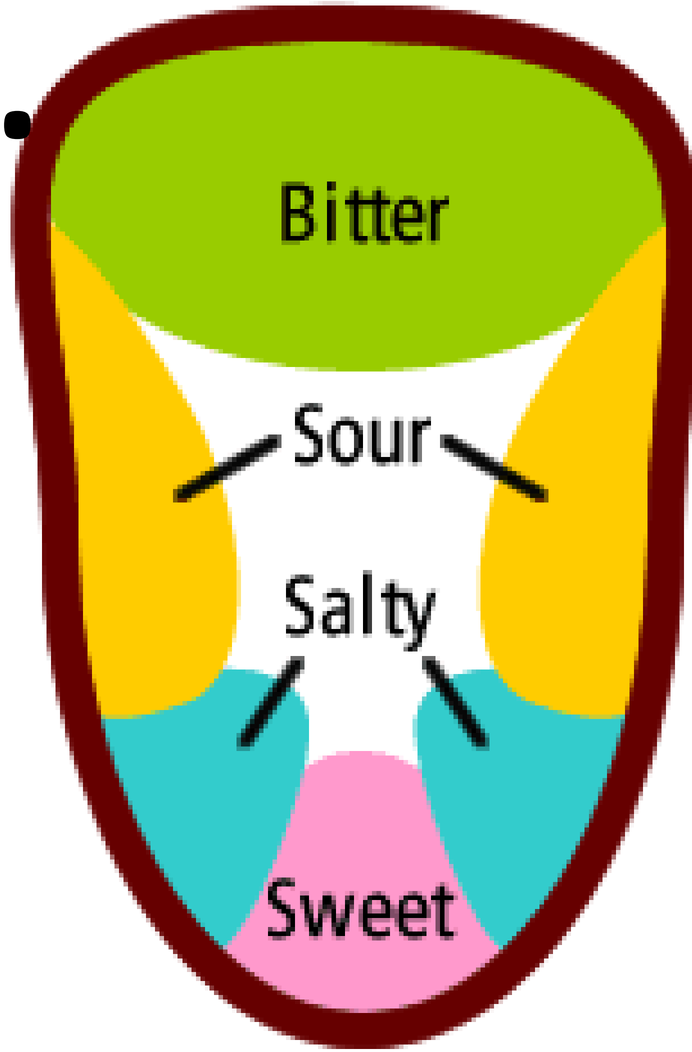


Image: http://www.musingsonthevine.com/tips_pai.shtml

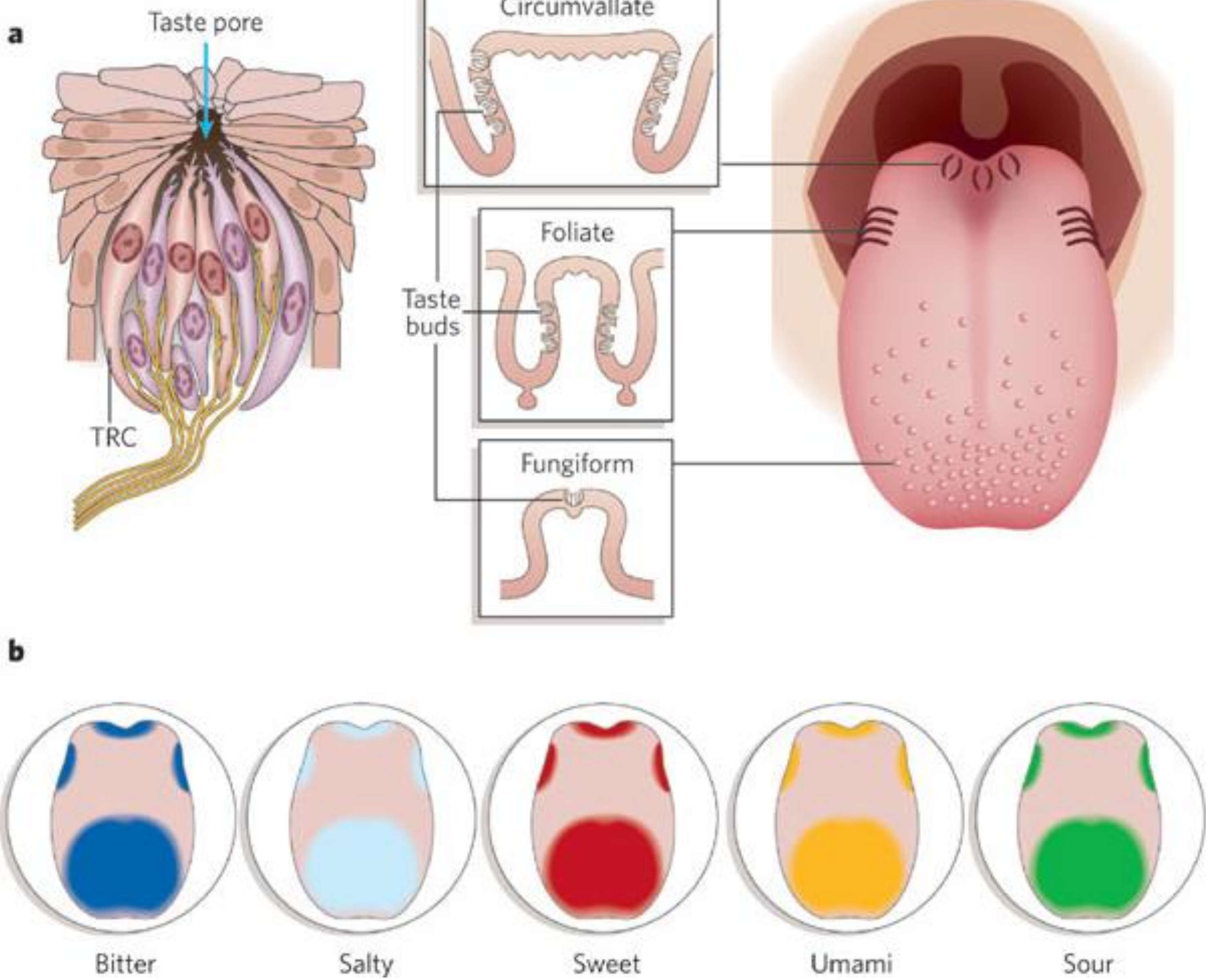


Image: http://www.nature.com/nature/journal/v444/n7117/fig_tab/nature05401_F1.html

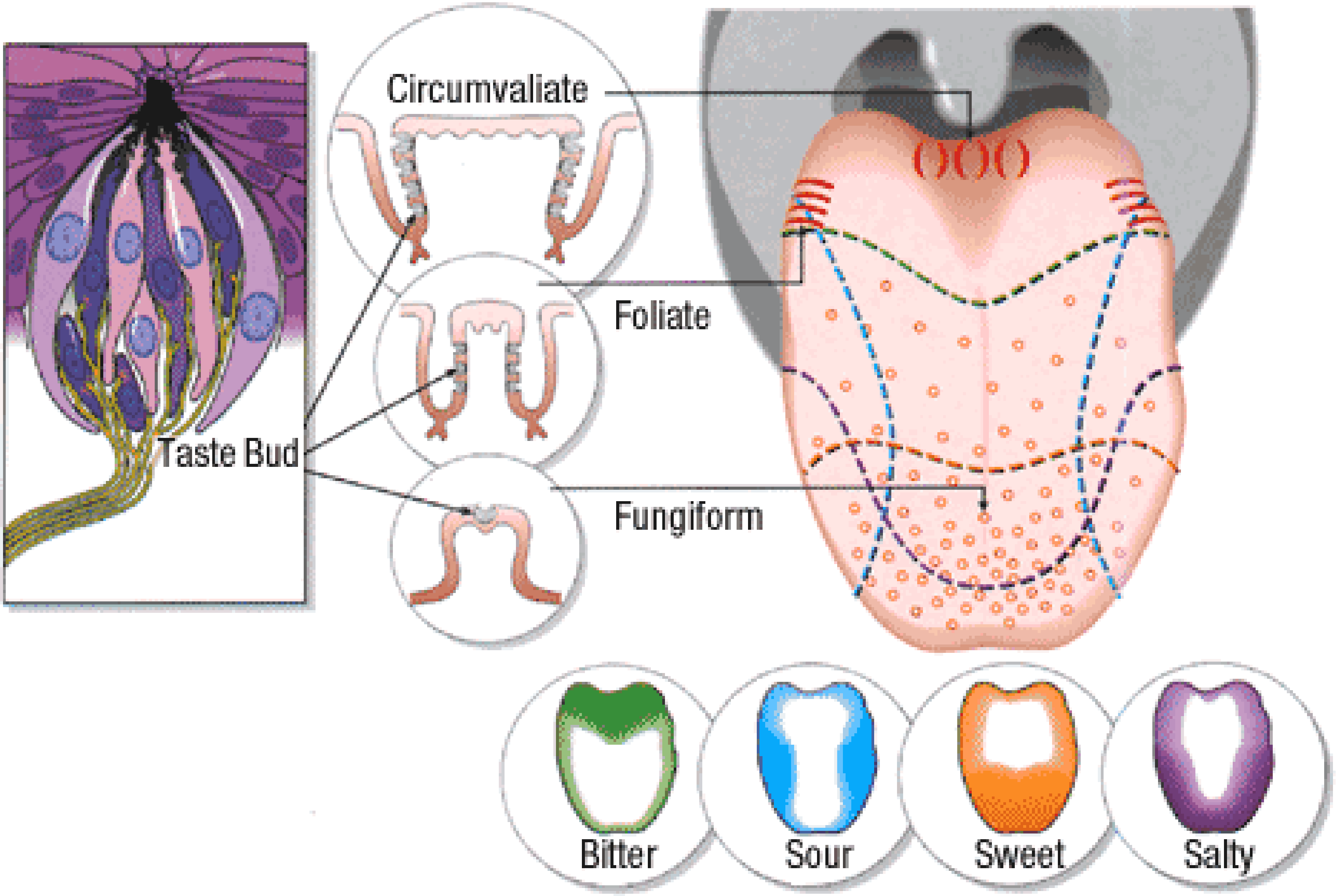
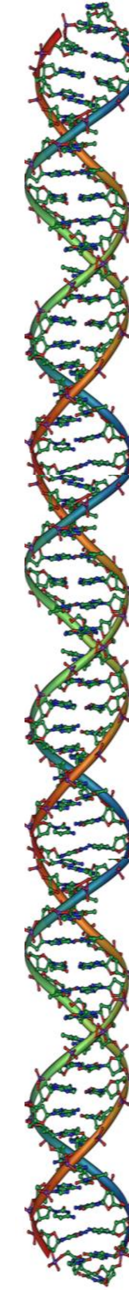


Image: http://www.hhmi.org/zuker/2pic.html



Cooking Plants

Chlorophyll

Acid or base hydrolysis

Displace Mg^{2+}

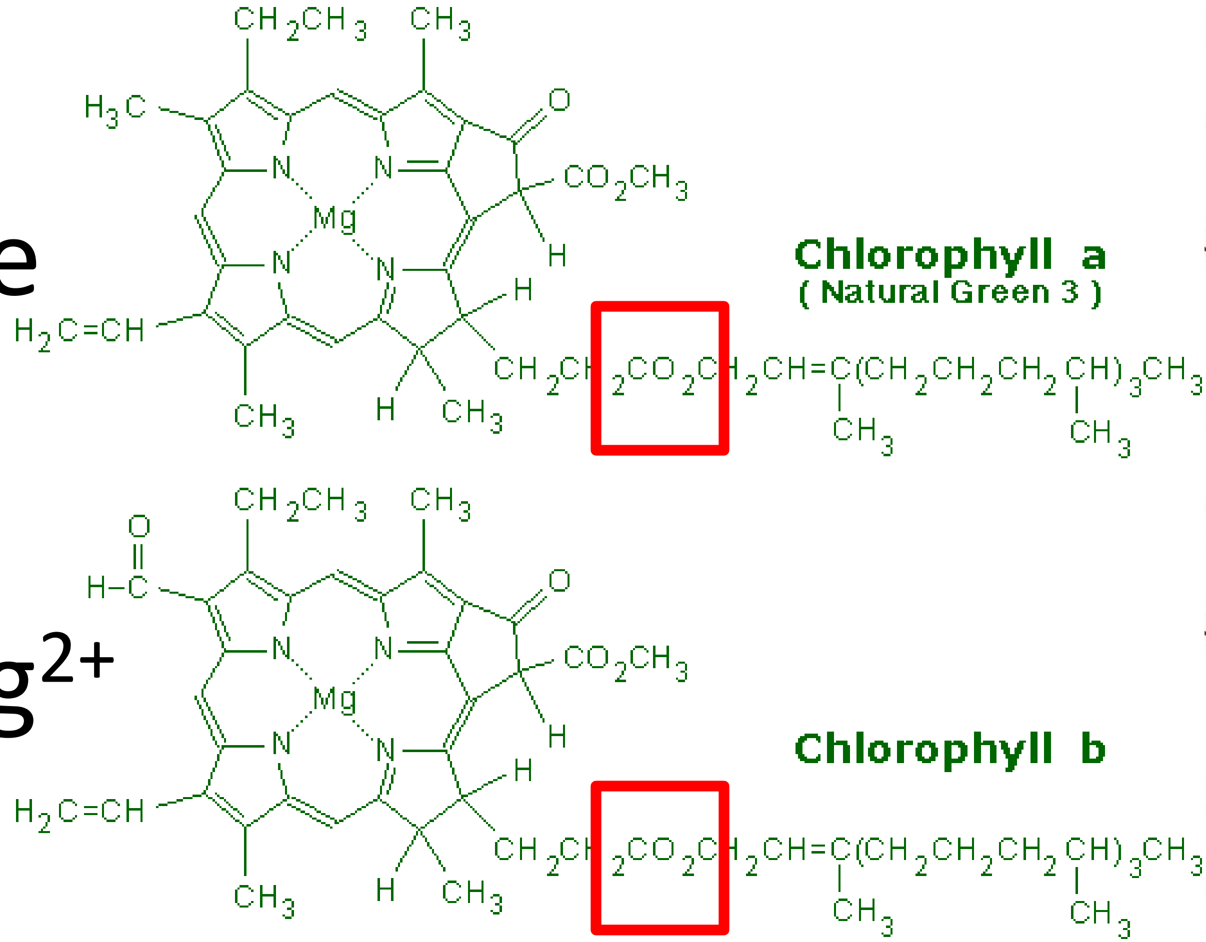


Image: http://www.bio.miami.edu/dana/226/226F08_10print.html

Keeping them green

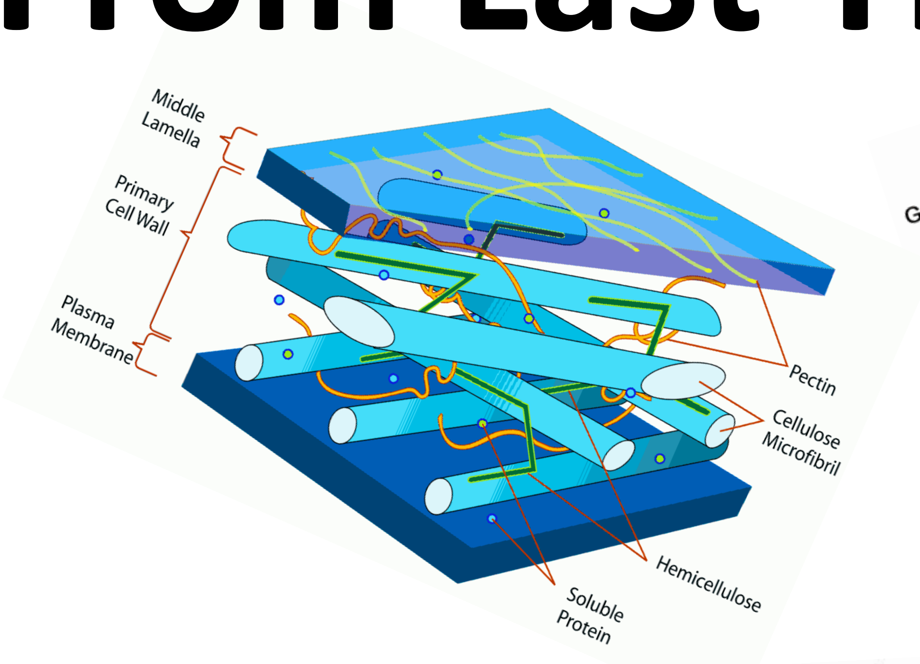
Neutralize acid with baking soda

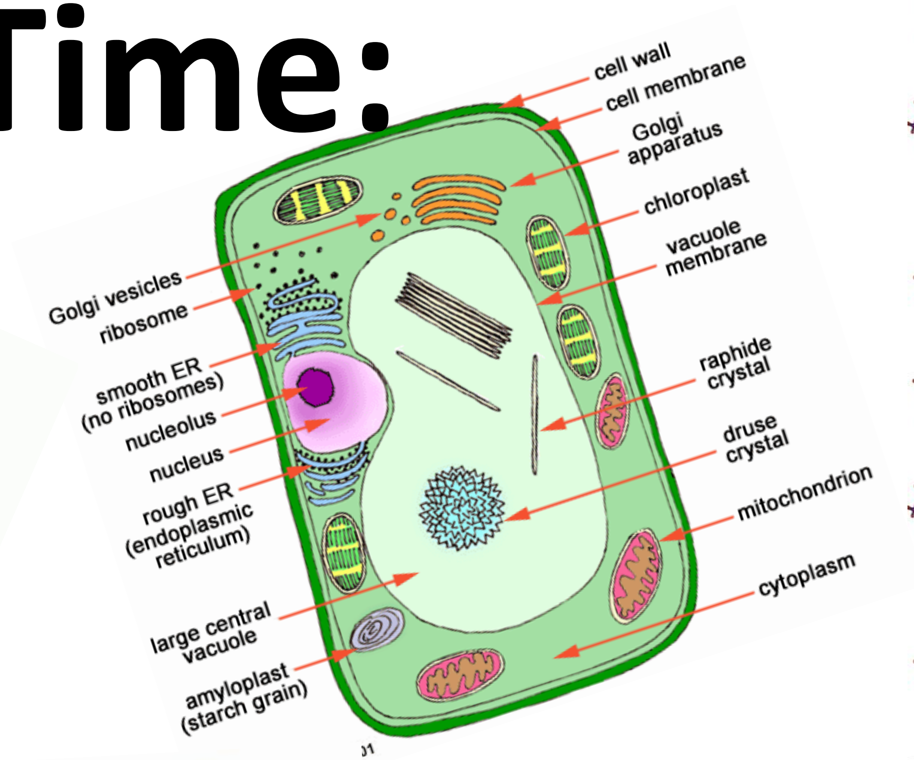
Baking soda = Sodium bicarbonate

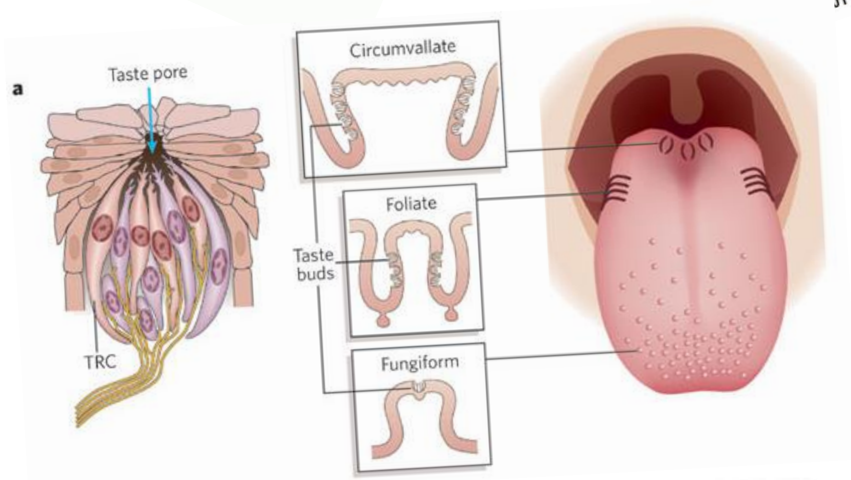
END DAY 14

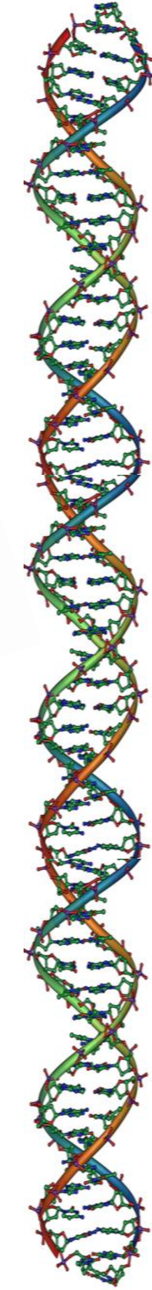
Content

From Last Time:









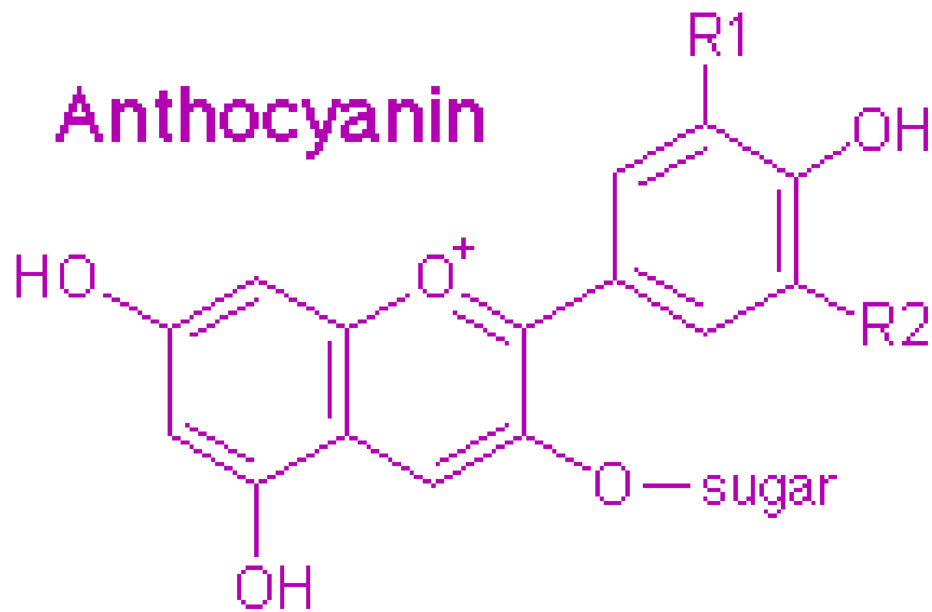
Science of Cooking – BCBT100
Summer 2016 - Bodwin

Cooking Plants

Anthocyanins and Anthoxanthins

pH sensitive

Keep acidic?



R1, R2 = H, OH, OCH_3
sugar = glucose, arabinose,
galactose

Image: http://www.succulent-plant.com/glossary/images/anthocyanin.png

Cooking plants

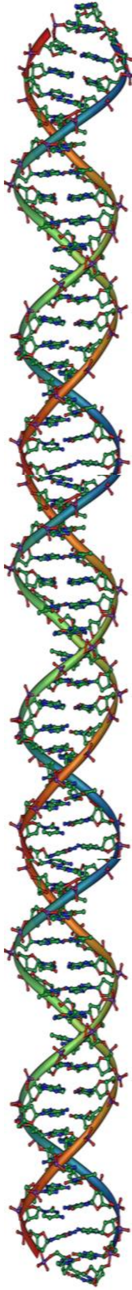
Texture = firmness of cell walls

Acid + “hard” water = firm

- “hard” = metals with +2 charge = bridge

Base + salt = soft

- Sodium = Na^{+1} = cap

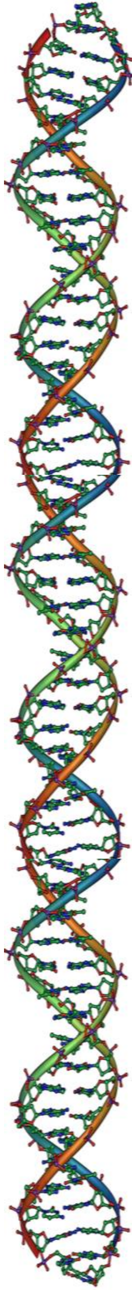


Starchy plants

Starch grains are hard, BUT absorb water and swell when heated

Heat breaks down cell walls, starch absorbs water that's released

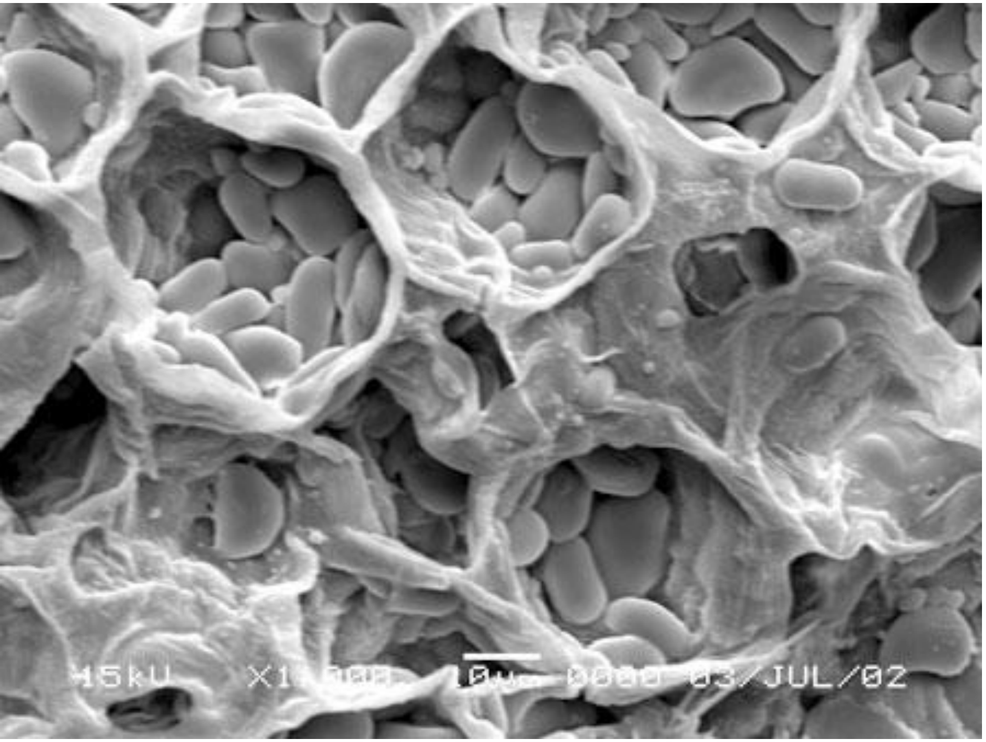
figure on p. 282 in McGee book…



Starch

Starch is hydrophilic, but hard

Gel loses water, crystallizes



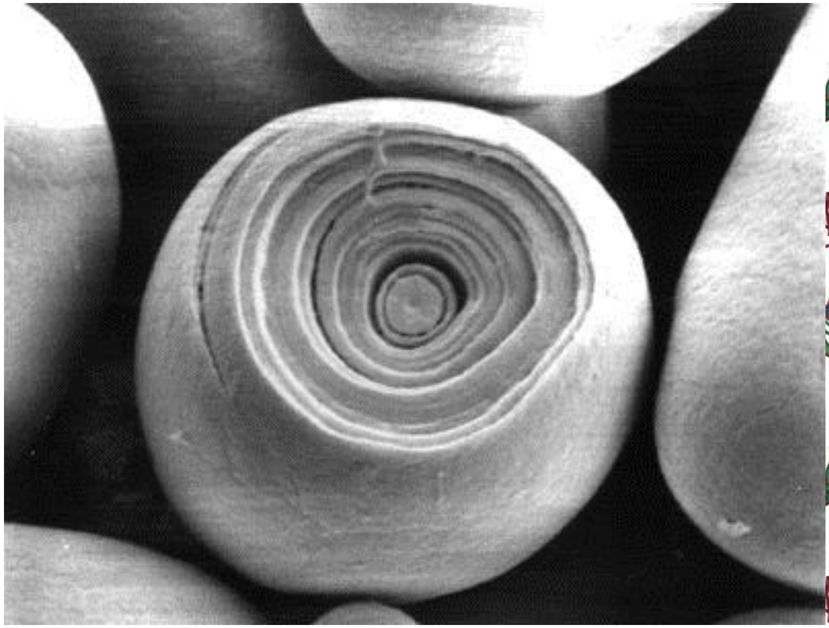


Image: http://www.aroid.org/gallery/held/starch_grains.php

Image: http://sciencegirlsrock.wordpress.com/2011/05/30/women-of-outstanding-achievement/

Heat Management

Specific Heat Capacity –

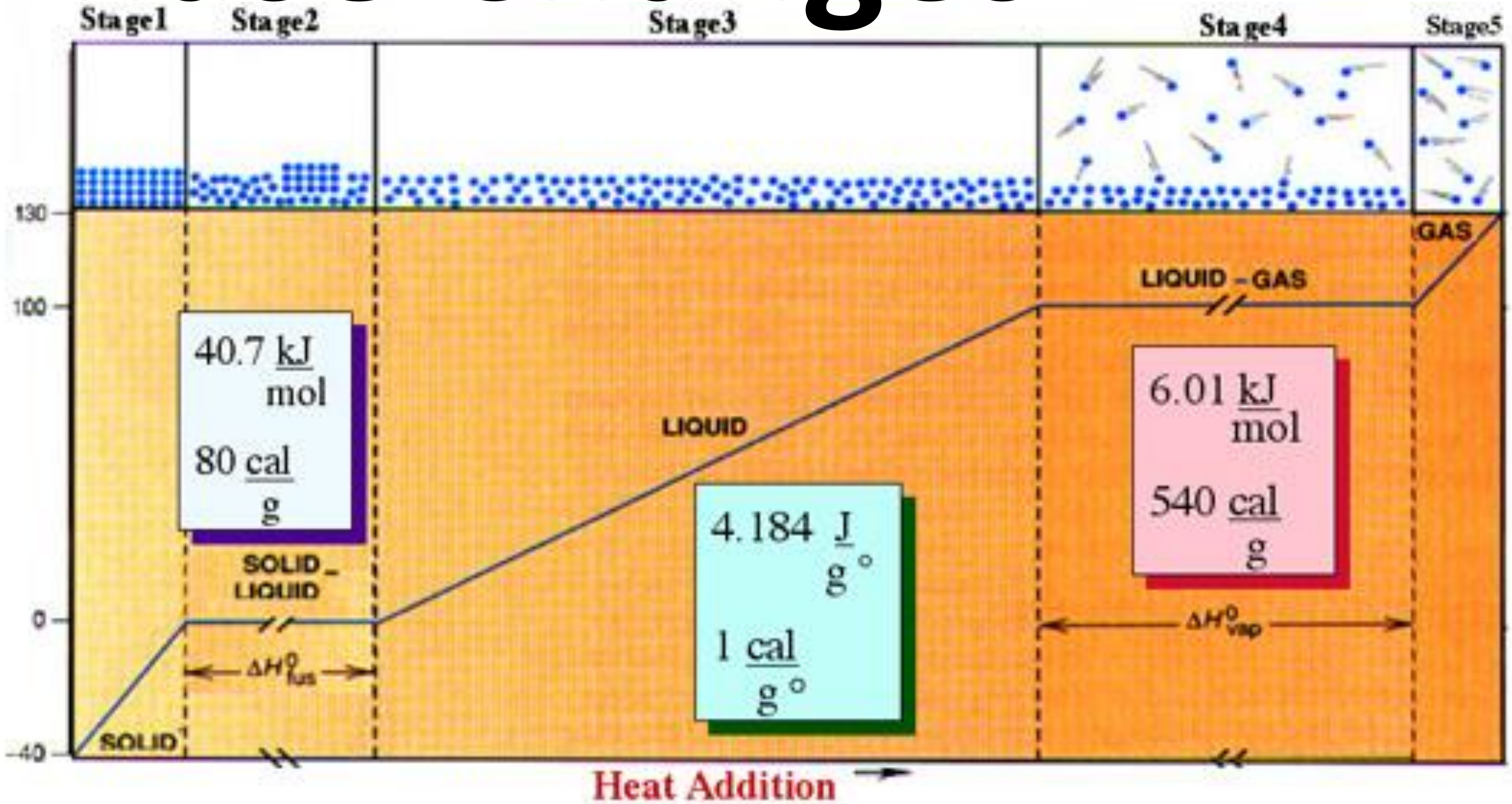
- the amount of heat energy required to raise the temperature of 1 gram of a substance 1°C.

For water, 1 calorie per gram °C

- "Dietary Calorie" vs. calorie

http://www.engineeringtoolbox.com/specific-heat-capacity-food-d_295.html

Phase Changes



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80 +100+ 540 =720cal

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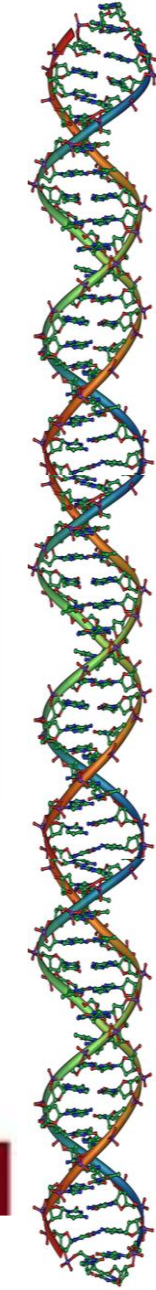
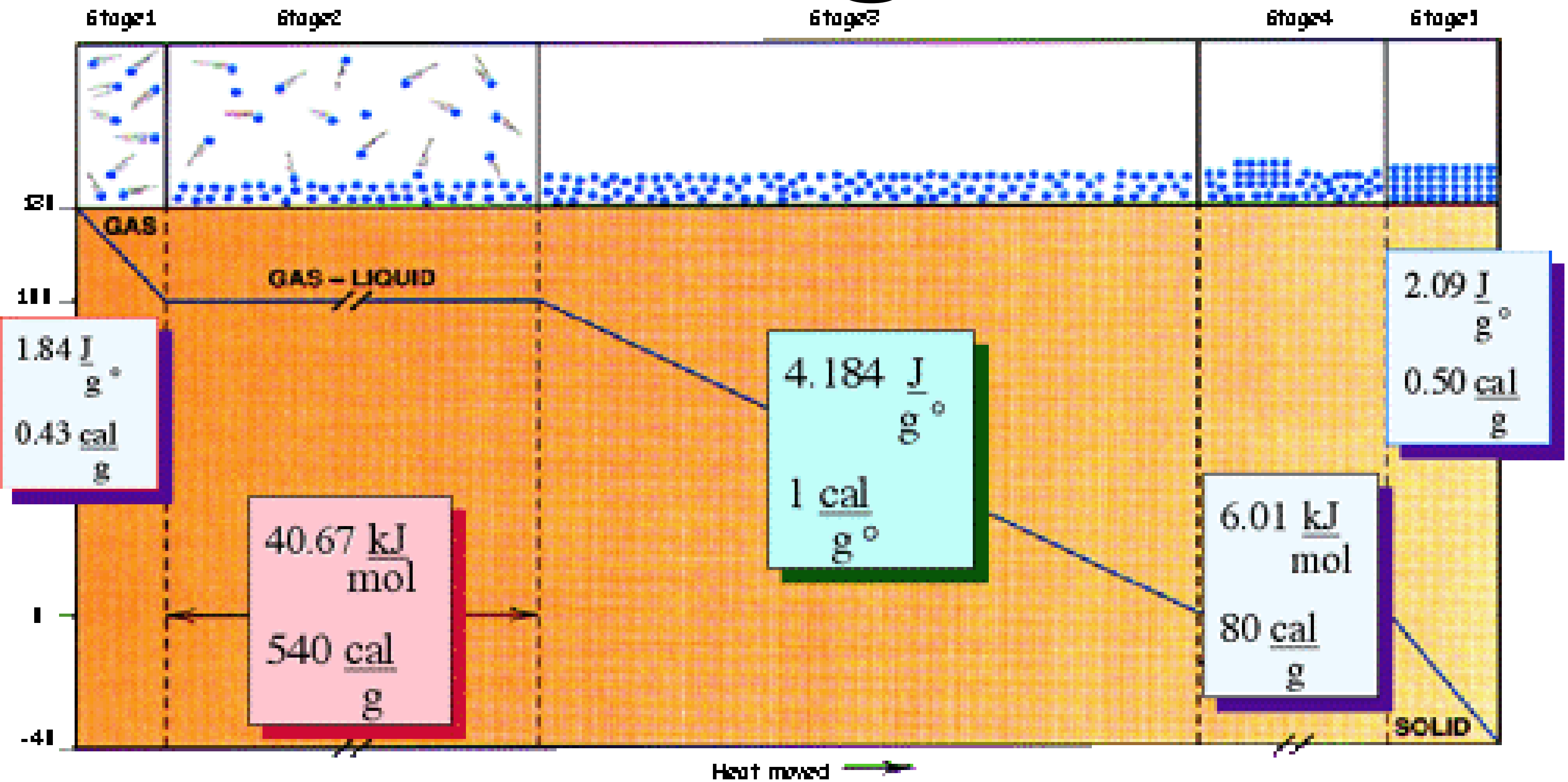


Phase Changes



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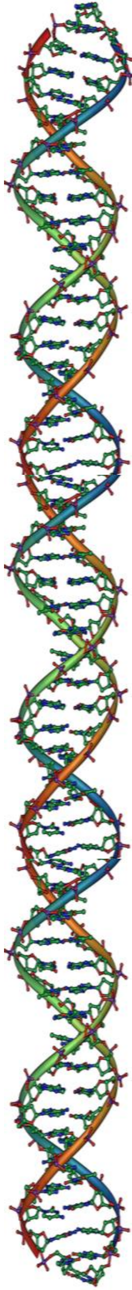
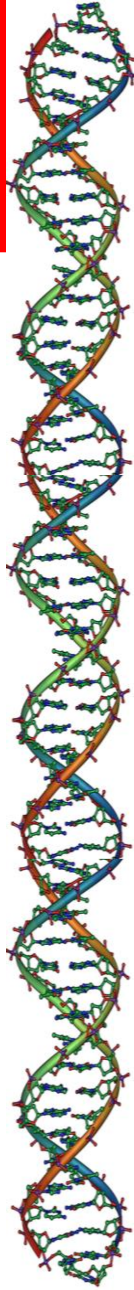
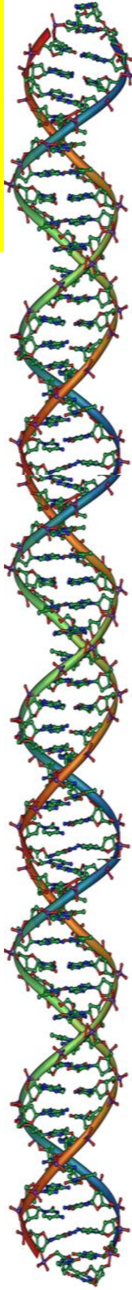


END DAY 15

Content



EXAM DAY



Exam 2 given in class on Day 16 (2015-10-15)

Exam XX

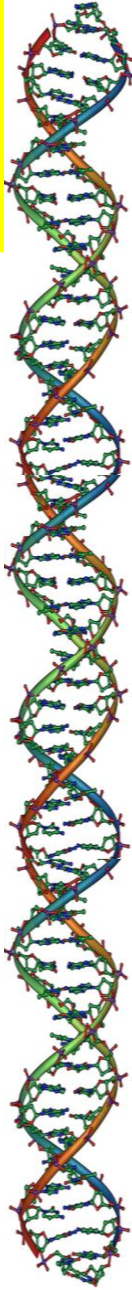
Number of takers =

Max score = XXX/150

Average score = XXX/150

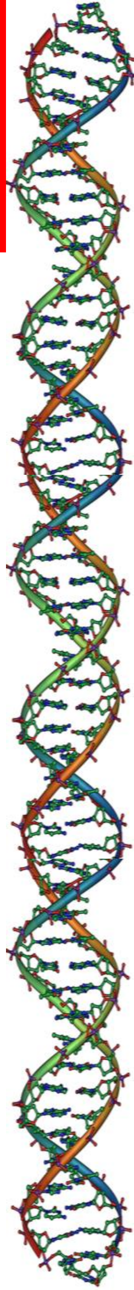
Min score = XXX/150

Standard Deviation =



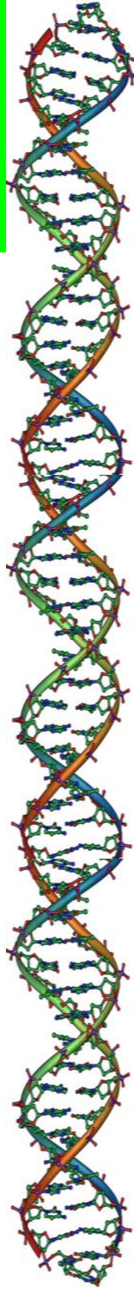
END DAY 16

Content



TOPIC BEGIN

Cooking Methods
Heat Transfer



From Last Time:

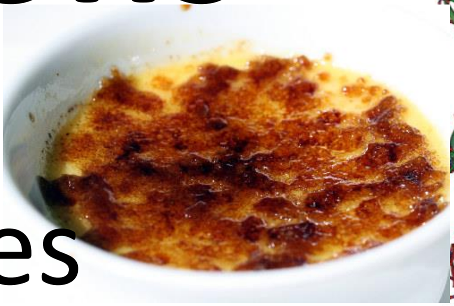
“Browning”

Different meaning in different foods

Browning Reactions

Many foods "brown"

Reactions differ by molecules



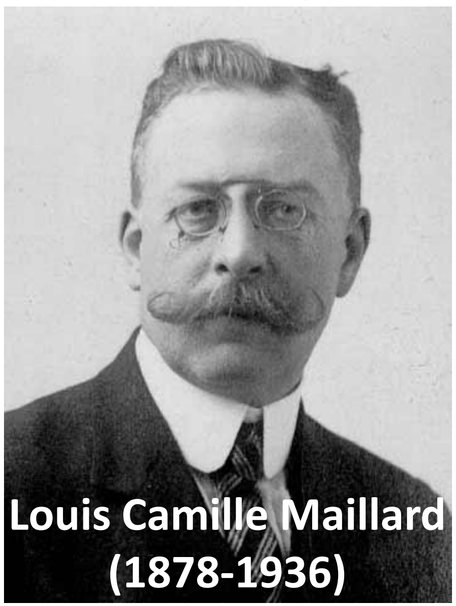
Images: http://theculinarybutler.blogspot.com/2010/09/how-to-bake-freezing-bread-baking-bread.ht
http://www.davidlebovitz.com/2011/06/chili-recipe-with-chocolate/
http://www.frenchrevolutionfood.com/2010/09/franglais-maple-brown-sugar-creme-brulee/
http://openwalls.com/image?id=22369
http://blog.friendseat.com/how-to-make-hot-chocolate/

Maillard Browning

Proteins (+ reducing sugars)

Produce color and flavors

250°F/120°C



Louis Camille Maillard
(1878-1936)

Images: http://www.telegraph.co.uk/foodanddrink/8426388/White-bread-falls-from-favour-as-shoppers-prefer-brown.html
http://www.food-info.net/uk/colour/maillard.htm

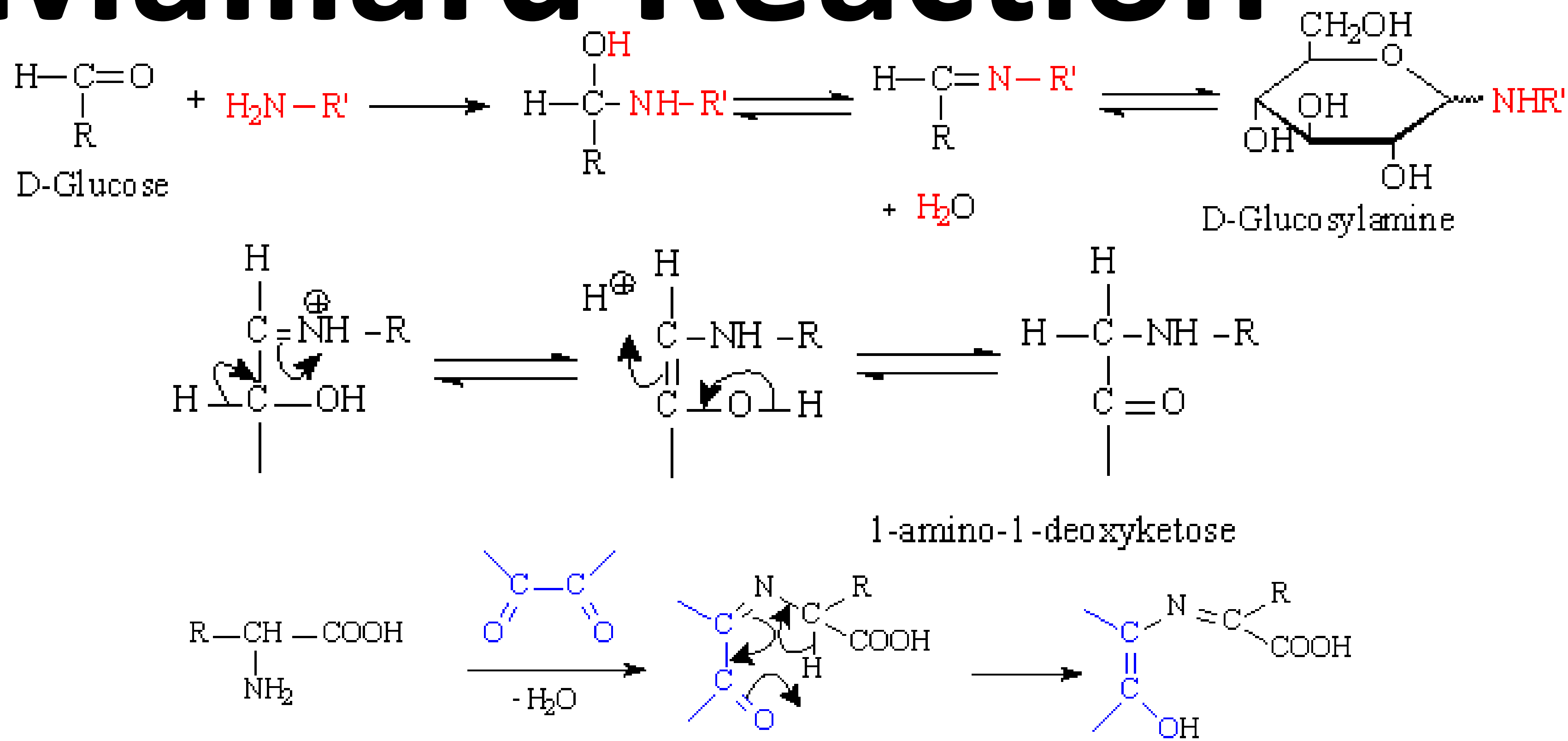
Encouraging Maillard

High heat, little water

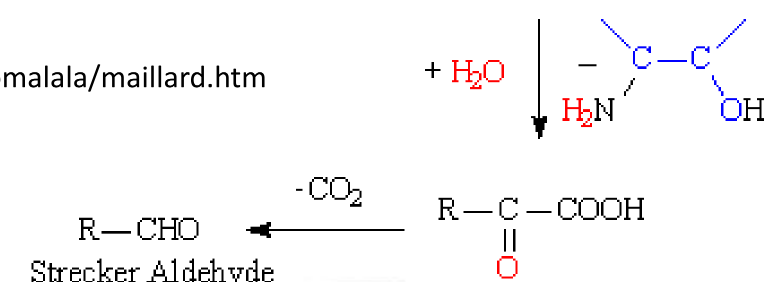
Browning before stewing

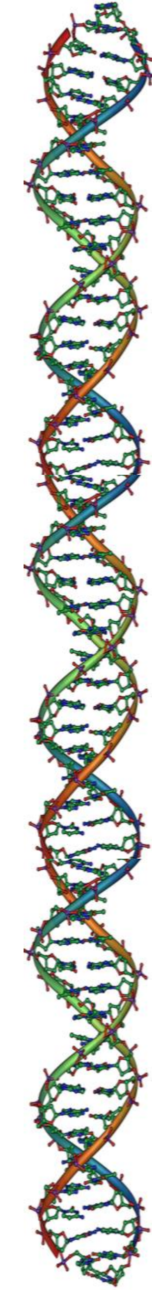
Images: http://wellfed.typepad.com/well_fed/2005/12/mahogany_beef_s.html
http://www.onceuponachef.com/2012/09/roasted-tomato-salsa.html

Maillard Reaction



Images: http://www.chm.bris.ac.uk/webprojects2002/rakotomalala/maillard.htm





Sugar Browning

Sugar pyrolyzes (burns)

Flavor development

Caramelization

330°F/165°C

Enzymatic Browning

Phenol oxidase

Polymerizes phenols

Usually undesirable

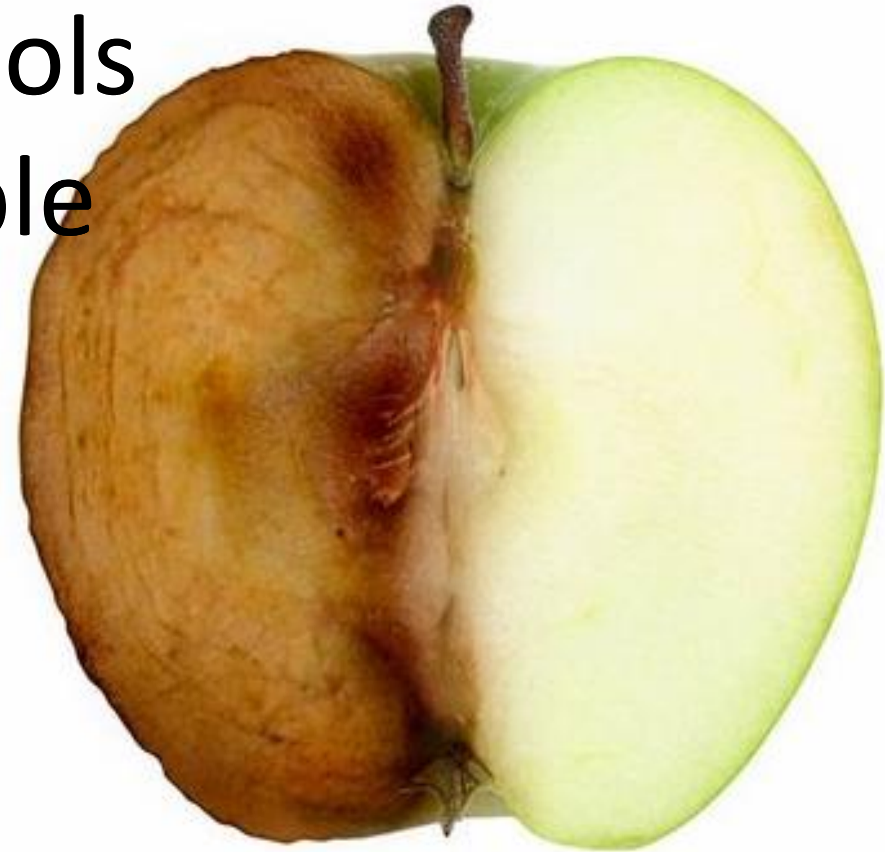


Image: http://www.oneresult.com/articles/nutrition/what-are-antioxidants-and-how-do-they-help

Enz Brown

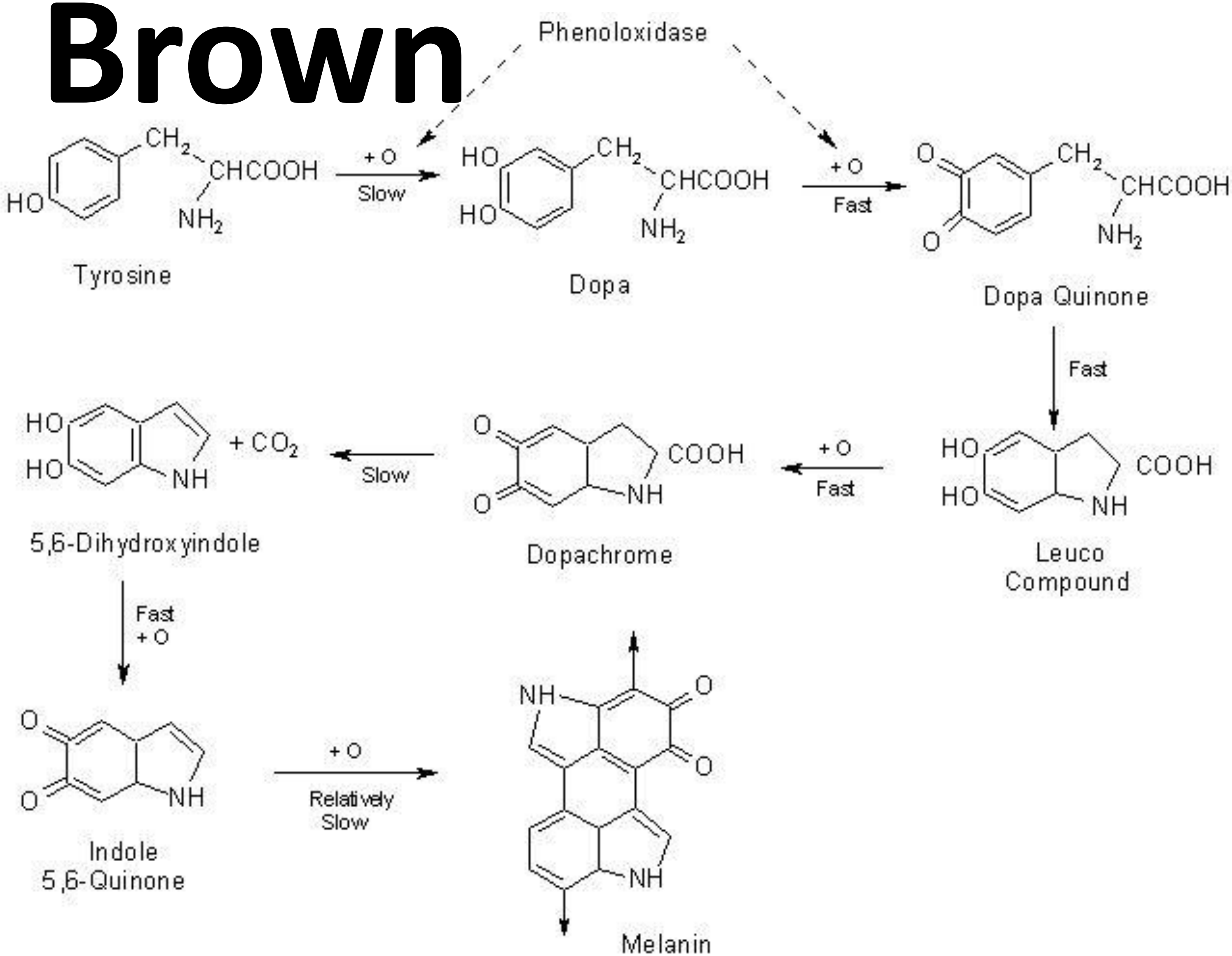


Image: http://www.food-info.net/uk/colour/enzymaticbrowning.htm

Balanced Browning

- Control heat
  - Sugar browning @ higher Temp
- Control water
  - Keeps Temp low

Cooking Methods

Boiling

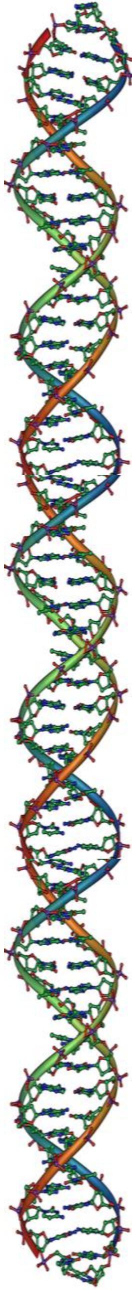
Steaming

Pressure cooking

Baking

Frying

Grilling



Heat Management

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- “Dietary Calorie” vs. calorie

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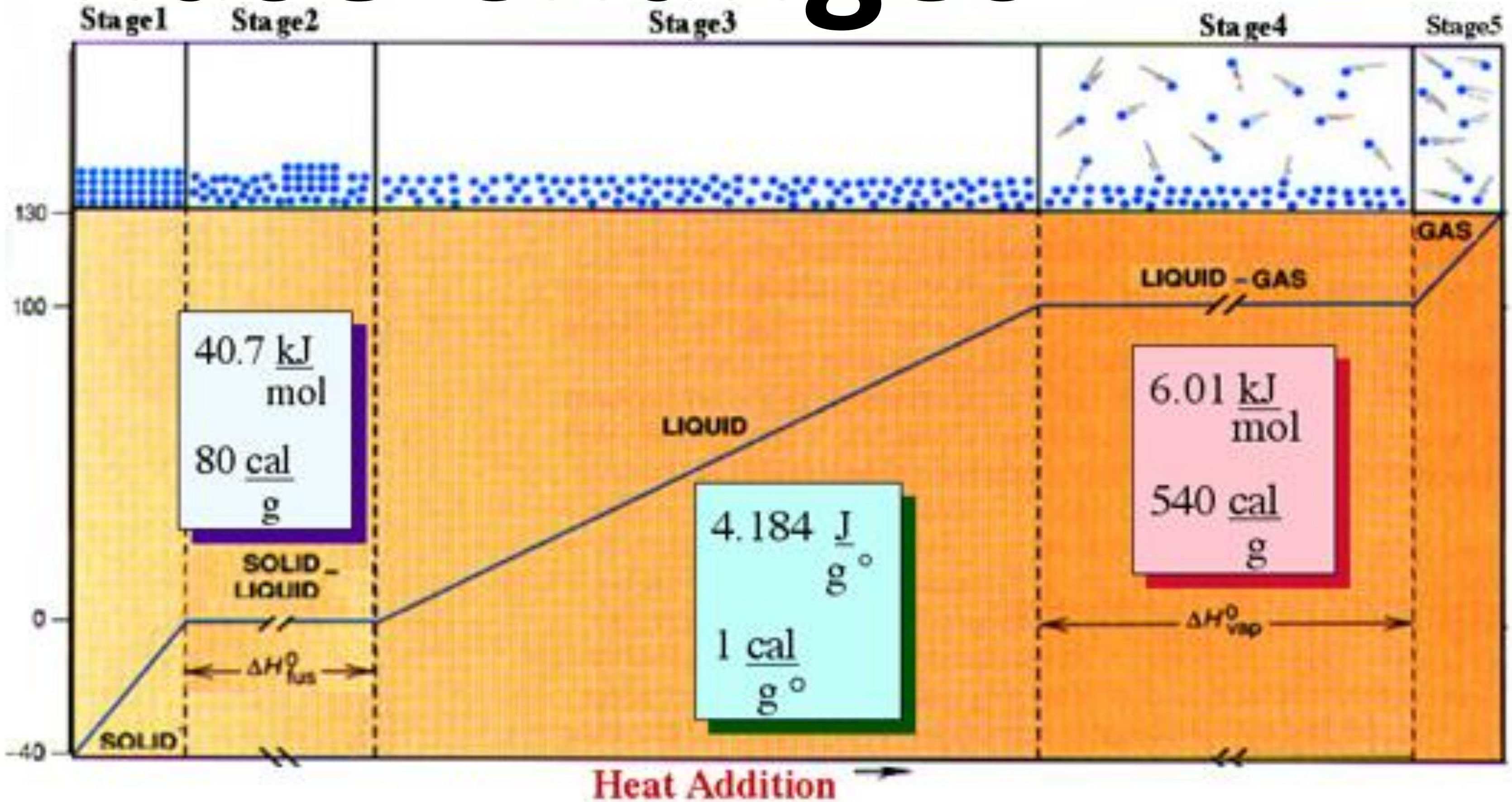
Phase Changes



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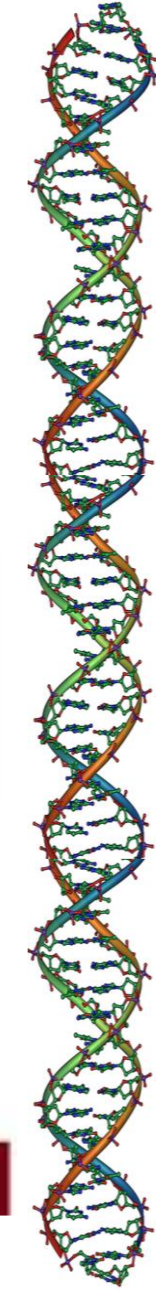
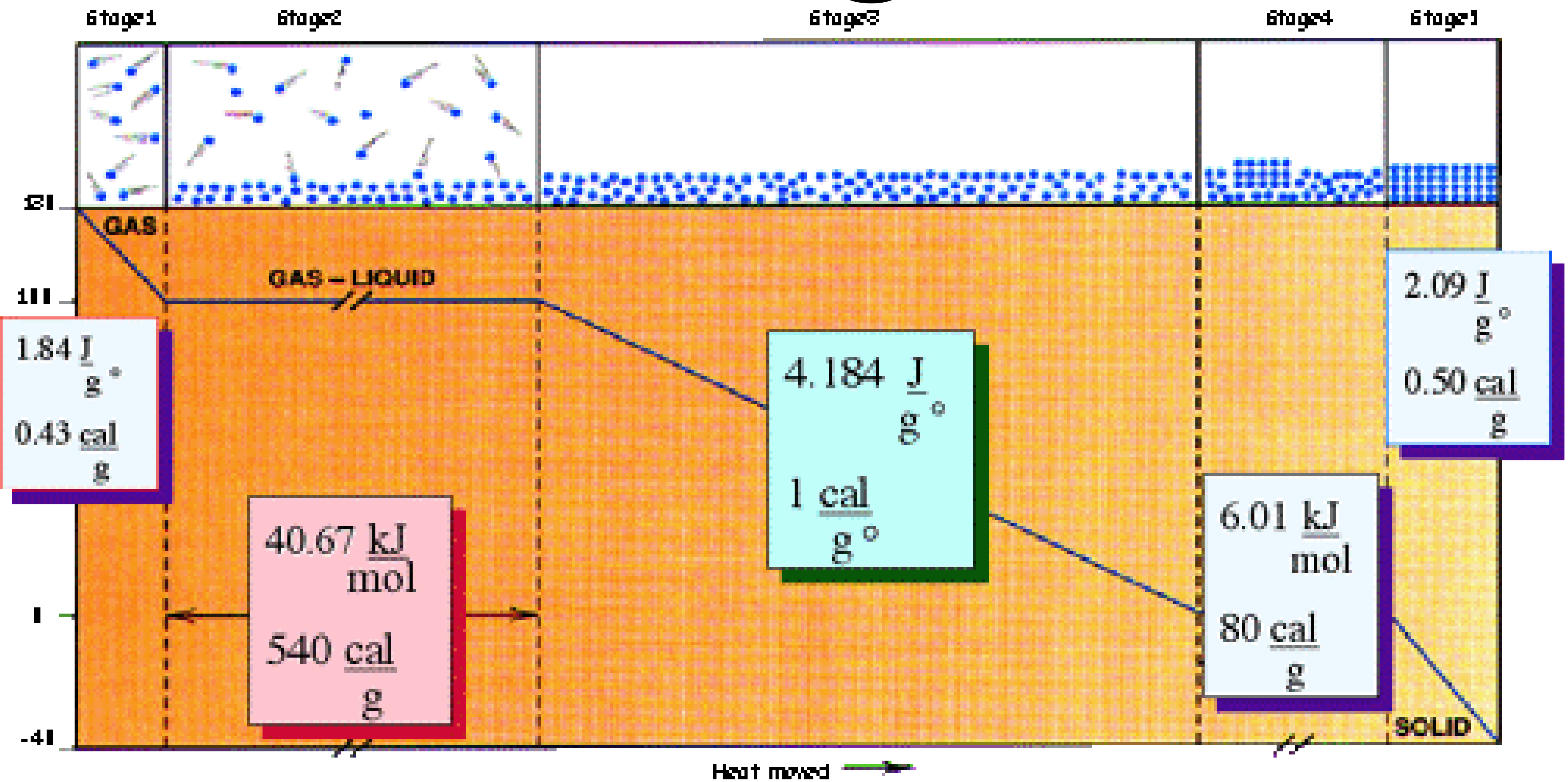


Phase Changes



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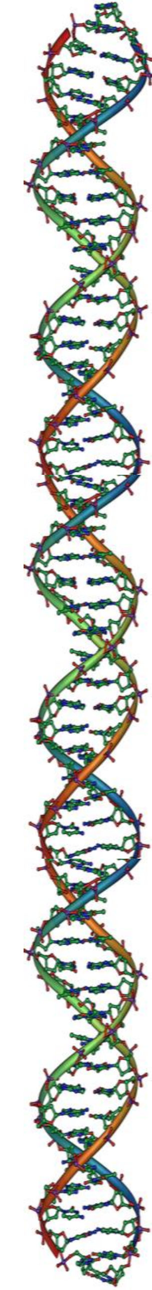


Water-based Cooking

Effective heat transfer

High heat capacity

Boiling

Steaming

Pressure cooking

Image: http://preparednesspro.wordpress.com/2009/08/11/myths-and-facts-of-water-storage/water-storage-myths-boiling-water/

Boiling

- Even heating
- Extracts flavors
  - Good for intense flavors (bitter, alkaloids)
  - Bad for subtle flavors
- Easier to control cooking

Steaming

Even heating

Less flavor extraction

Easy to control

Retain color

Retain nutrients

Image: http://www.vegetariantimes.com/article/full-steam-ahead/

Salting the water

Colligative properties

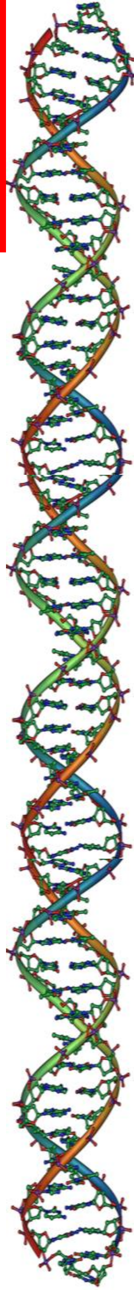
Vapor pressure

Boiling point elevation

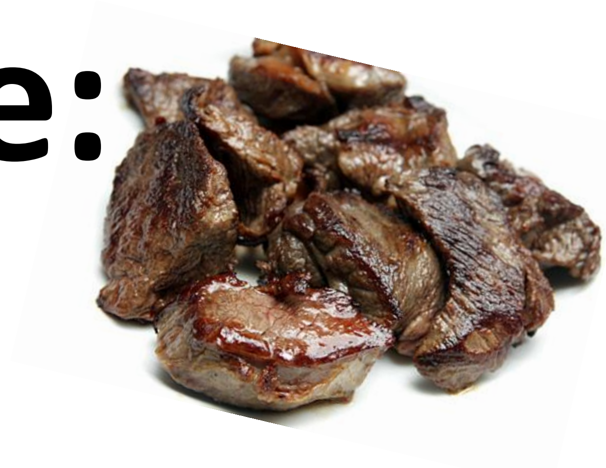
Image: http://rouxbe.com/tips-techniques/322-salting-water-for-cooking

END DAY 17

Content



From Last Time:



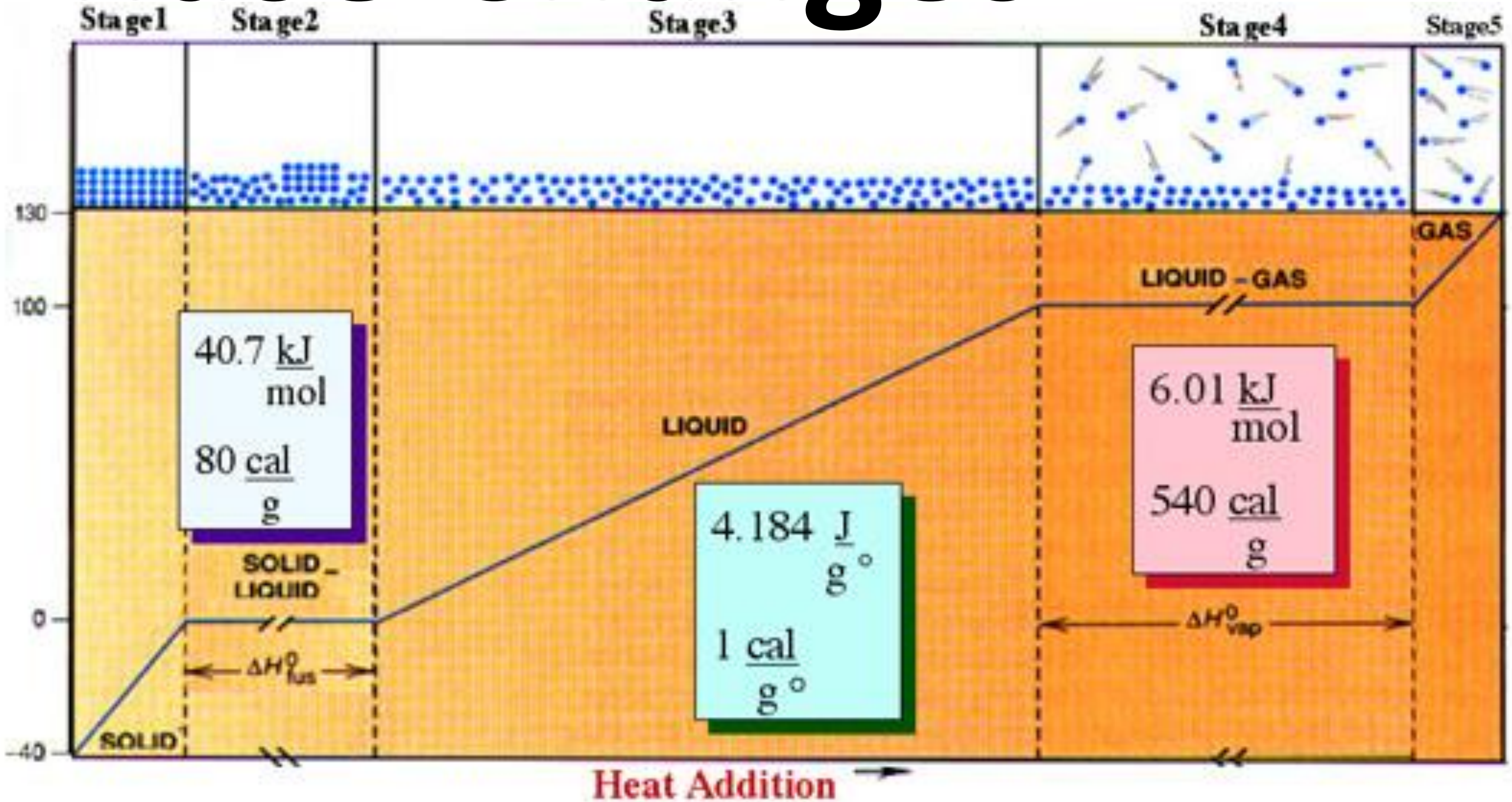
Pressure cookers

Change P_{atm}

Change $T_{boiling}$

Image: http://eartheasy.com/all-american-pressure-canner-cooker-model-941-41-5-quart

Phase Changes



What is the energy needed to take 1g H_2O at 0°C to 100°C ?

80 +100+ 540 =720cal

Image: http://faculty.sdmiramar.edu/fgarces/zCourse/All_Year/Ch100_OL/aMy_FileLec/04OL_LecNotes_Ch100/02_EnergyStateMatter/203_StMatter/203_StMatterIMF.htm

Phase Diagram

P vs. T

Unique to each substance

For water →

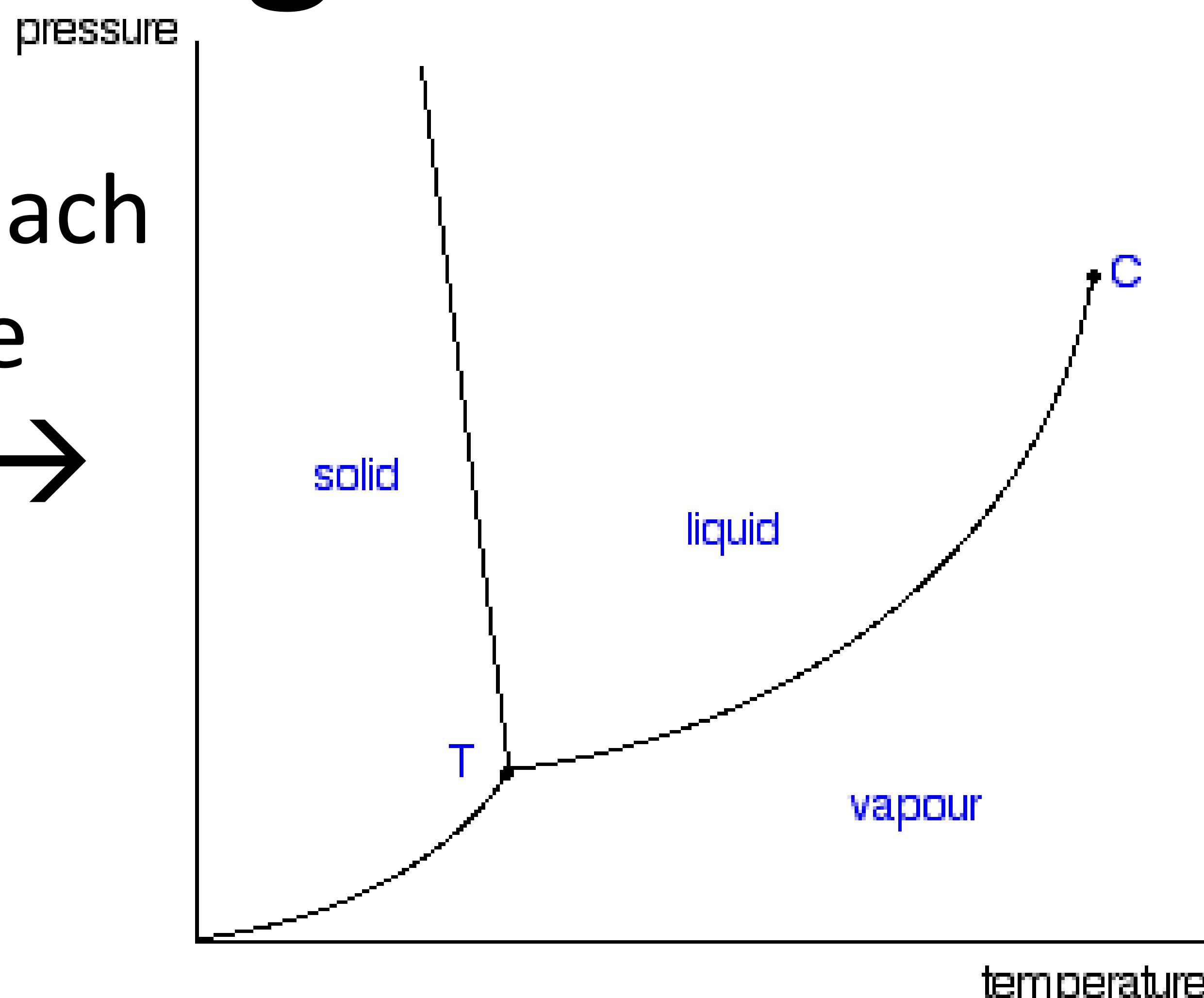


Image: http://www.chemguide.co.uk/physical/phaseeqia/phasediags.html

Phase Diagram

"Normal" conditions

1atm = 15psi

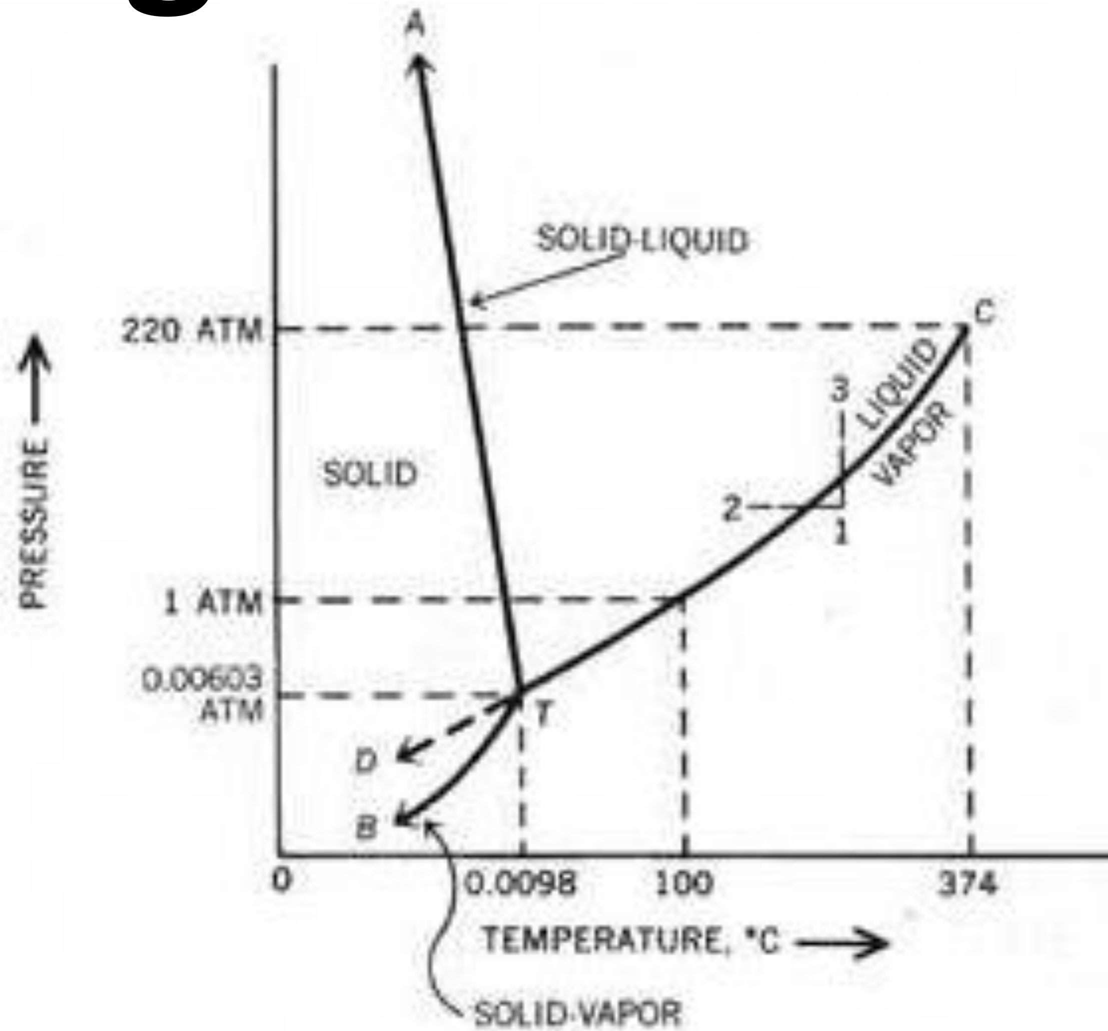


Image: http://www.sv.vt.edu/classes/MSE2094_NoteBook/96ClassProj/examples/triplpt.html

Baking

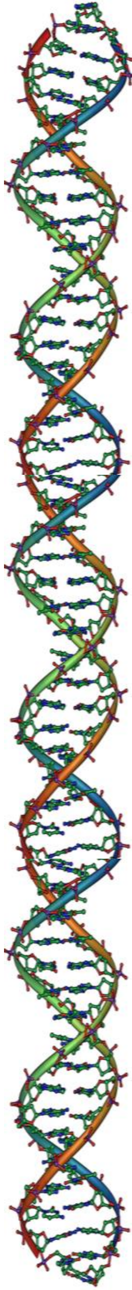
Heat transfer medium is air

Poor conductor of heat

Dehydrates

Intensifies flavor

To preheat or not to preheat…



Preheating

Food safety – time at temperature

Surface heating

- Food

Radiant heat

- Walls

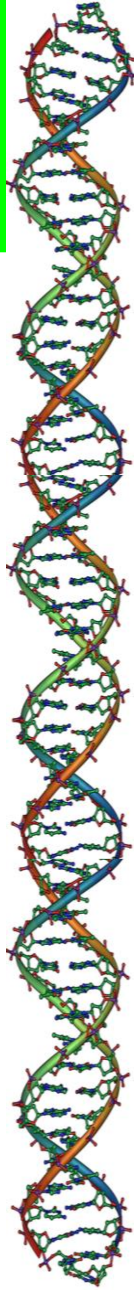
Image: http://momsgoinggreenblog.com/?p=922

END DAY 18

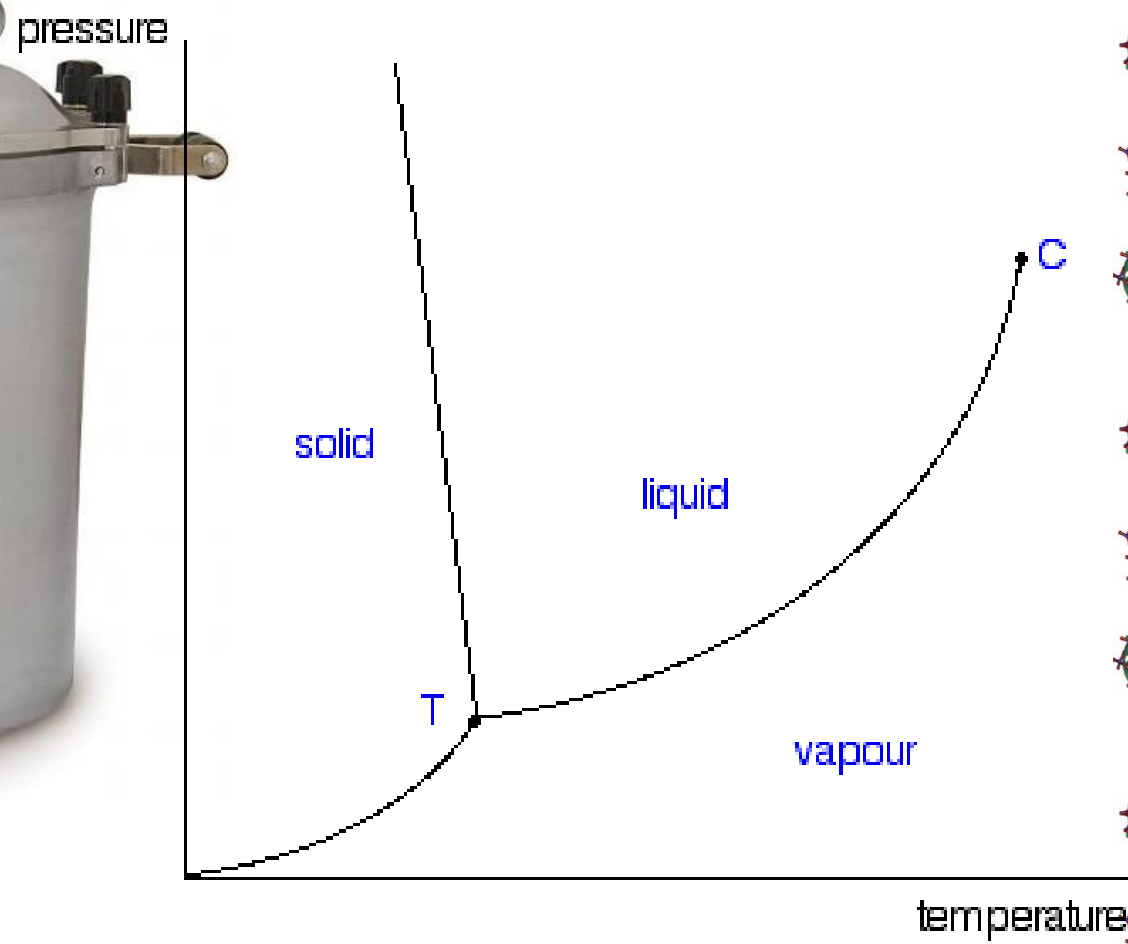
Content

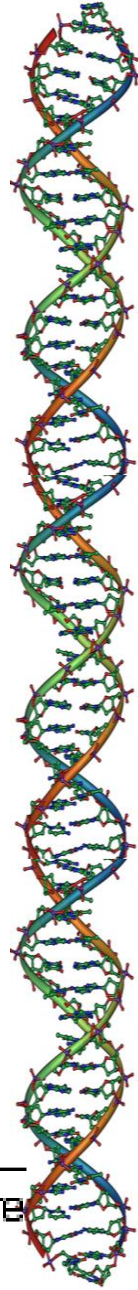
TOPIC BEGIN

Storage and Preservation



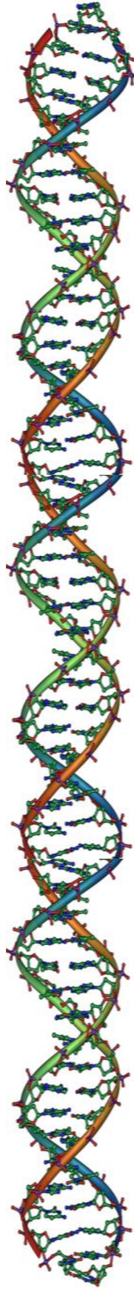
From Last Time:





Experiment

- Describe vs Explain
- Graphing
    - Proper formatting & Analysis
- Record your observations!
- Use common sense
- Be safe!



Frying

Heat transfer medium is oil

Good heat transfer

Seals in water

Creates steam

Image: http://1tess.wordpress.com/category/japanese-cooking-methods/deep-frying/page/2/

Image: http://www.themedifastplan.com/main/eating-fried-foods-wont-lead-to-a-heart-attack-unless/

"Good" Frying

- Hot oil is essential!
- High "smoke point" oils
  - Peanut, canola

Image: http://www.blatherskiter.com/chefali/index.php?option=com_content&view=article&id=76&Itemid=126
Image: http://culinarymasterclass.com/techniques.php?techniques__state=selected_technique&technique_id=95

Grilling

Heat transfer medium is air

Direct radiative infrared heating

Image: http://www.stlmosquitocontrol.com/news/grilling-for-gold/

Image: http://www.gq.com/how-to/eat-and-drink/201007/summer-grilling#slide=1

Storing & Preserving

- Storing food
  - How to prevent spoilage
  - Use quickly
- Preserving food
  - Early science
  - Trial and error

Storage

Cold storage

Kinetics – double every ~10°C

Pasteurization

Vacuum

Drying

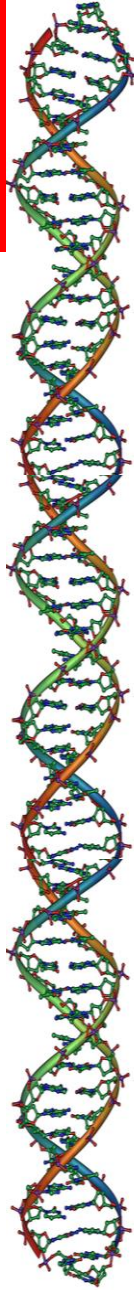
- Most "spoilage microbes" need water to survive
- Removing water concentrates flavor
- Food is slightly heated (130-160°F)
- Prunes, raisins, figs, apricots

Freeze-drying

- Removes water while frozen
- Less heat-based deterioration
- Removes more water (usually)
- More shelf-stable

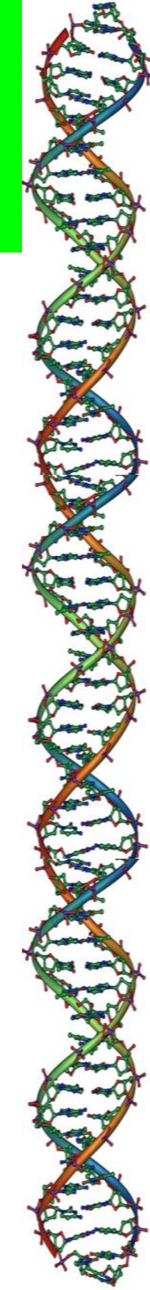
END DAY 19

Content

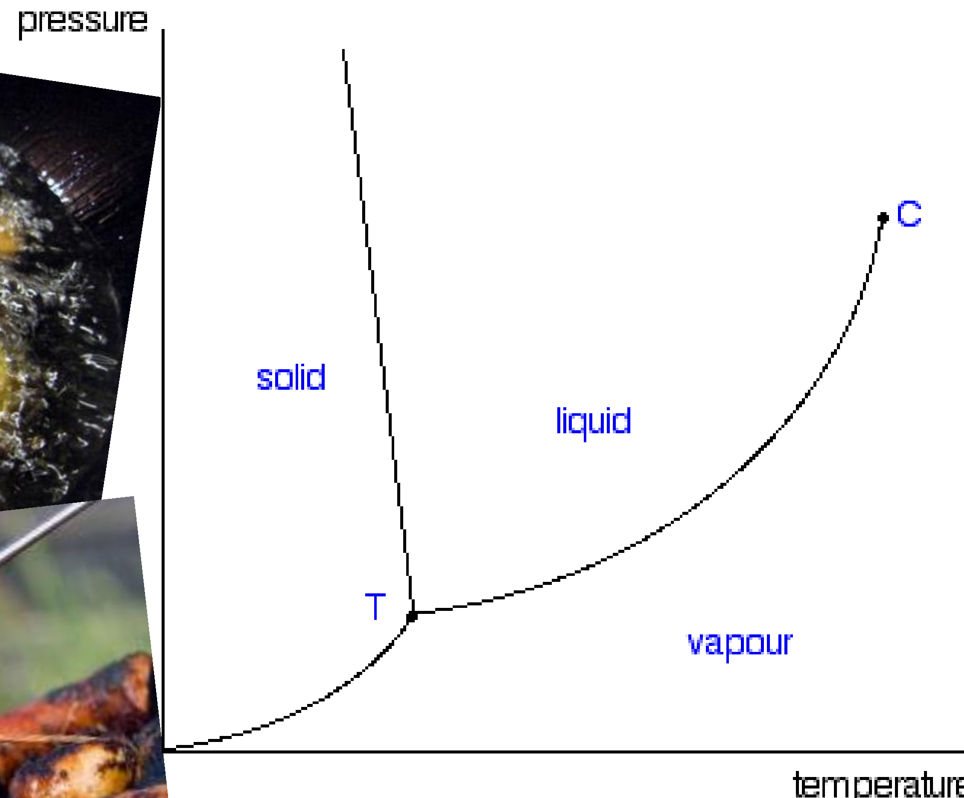


TOPIC BEGIN

Seeds and Nuts



From Last Time:



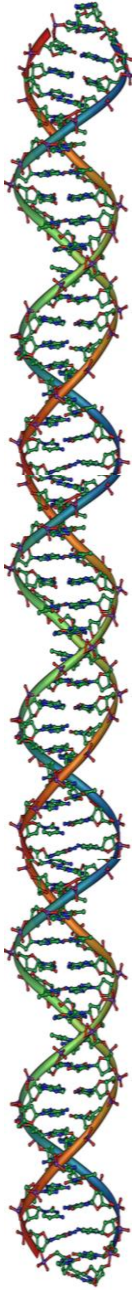
“Pickling”

Food is acidified

Add acid (vinegar)

Fermentation (low oxygen)

Pickles, sauerkraut, kimchi, etc



Sugar Preserves

Too much sugar kills microbes!

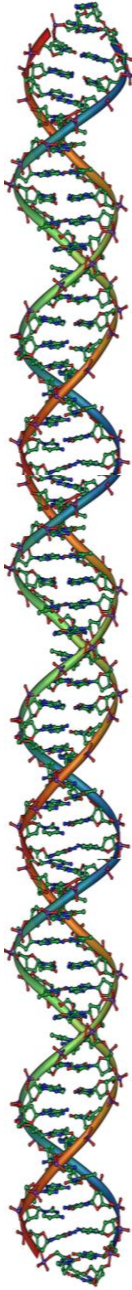
Jellies and Jams:

Pectin extracted from cell walls

- Negative charge in water

Sugar “dehydrates” solution

Acidify to allow pectin binding



Candied Fruits

Sugar is infused in fruit pieces

Fruit maintains more structure

Canning

Seal and heat

Pasteurization of shelf-stable milk

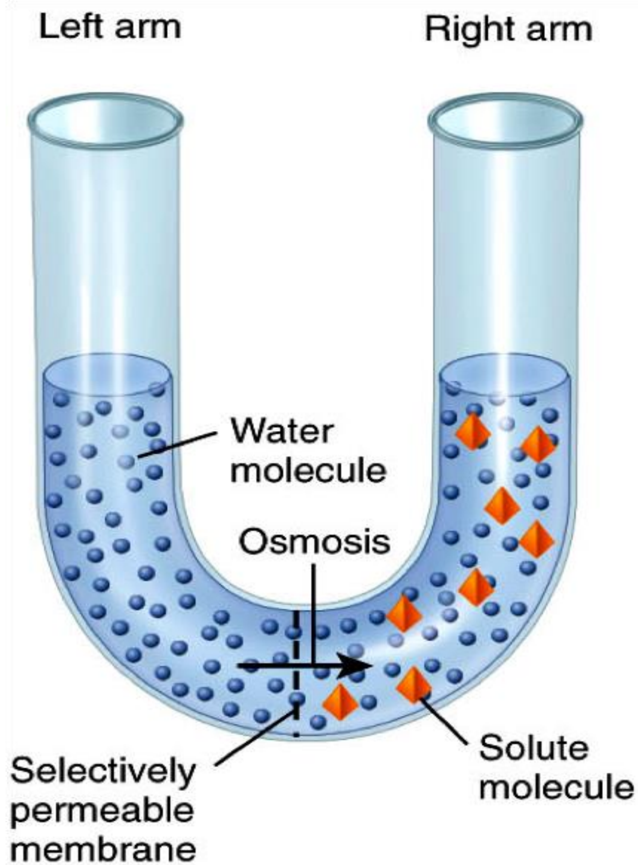
Food is cooked during canning

Safety…

Osmosis

Transport of solvent (water) through a semipermeable membrane from areas of “low” concentration to areas of “high” concentration.

Osmosis

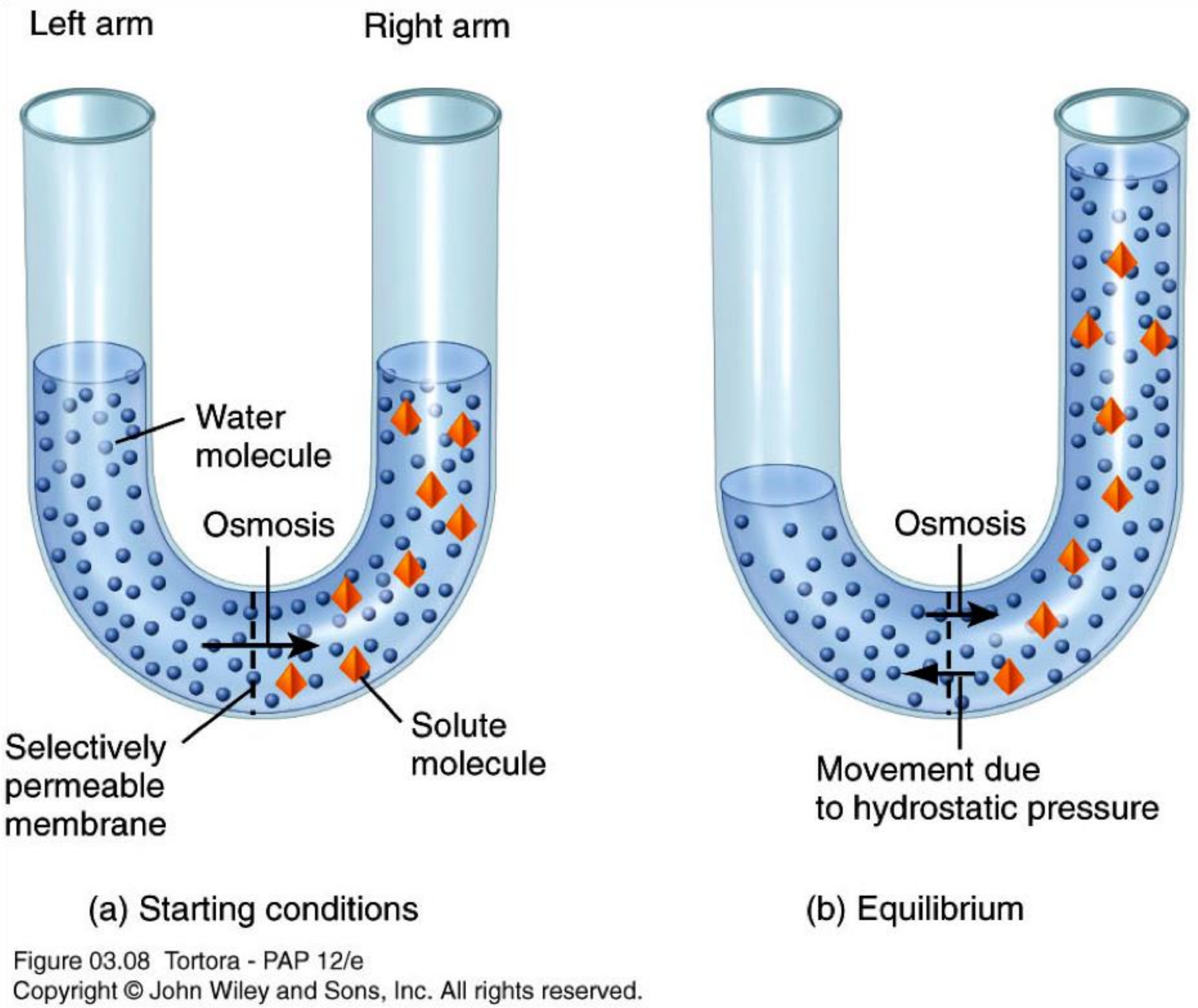


(a) Starting conditions

Figure 03.08 Tortora - PAP 12/e

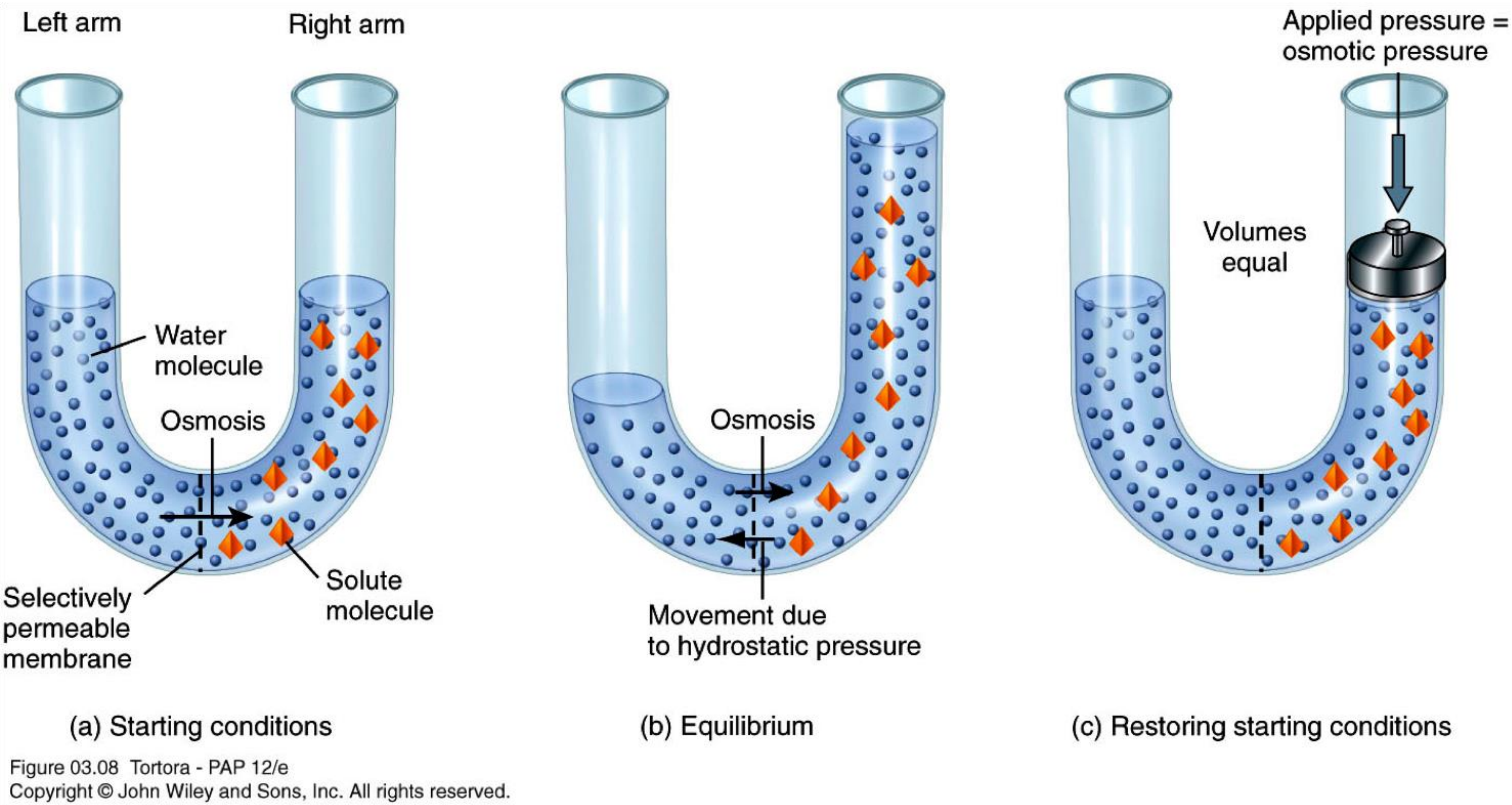
http://www.studyblue.com/notes/note/n/cell-physiology-ii-chapter-3/deck/1069900

Osmosis



http://www.studyblue.com/notes/note/n/cell-physiology-ii-chapter-3/deck/1069900

Osmosis



http://www.studyblue.com/notes/note/n/cell-physiology-ii-chapter-3/deck/1069900

Preservation

Managing water

→ like almost ALL cooking!

Preservation

Observations:

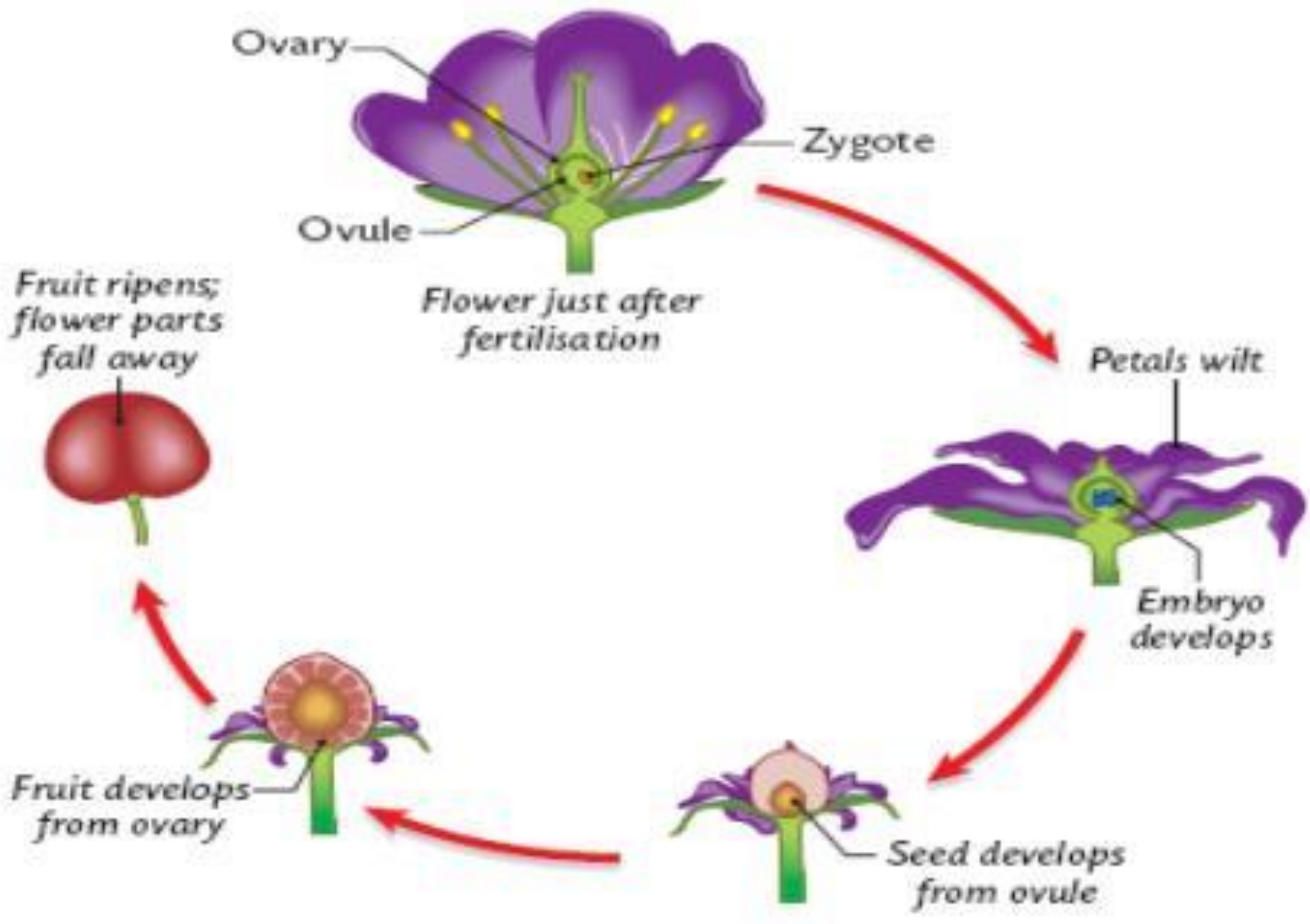


Image: http://leavingbio.net/the%20structure%20and%20functions%20of%20flowers.htm

Seeds

Plant reproduction

Concentrated energy & nutrients

Seed → Fruit

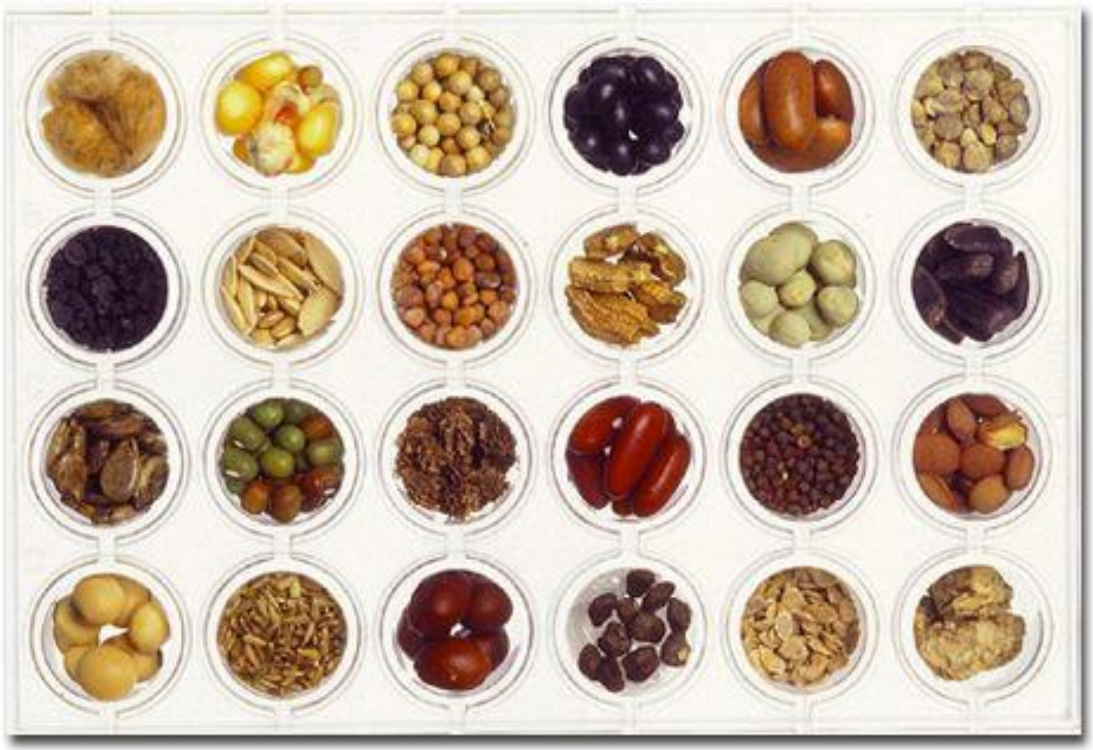
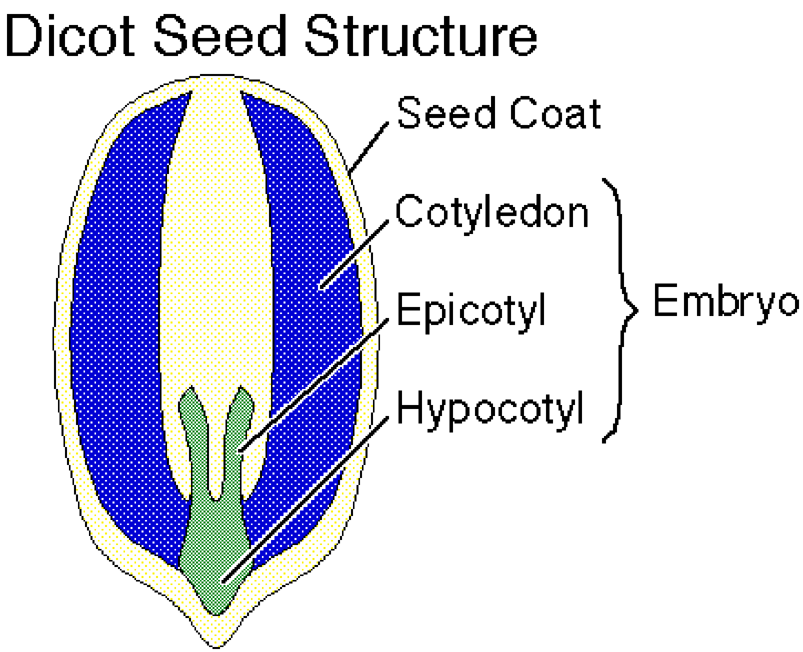


Image: http://www.raw-living-food-success.com/glycemic-impact.html

Seed Structure

True seed = embryo, storage, coat

Monocot vs. Dicot



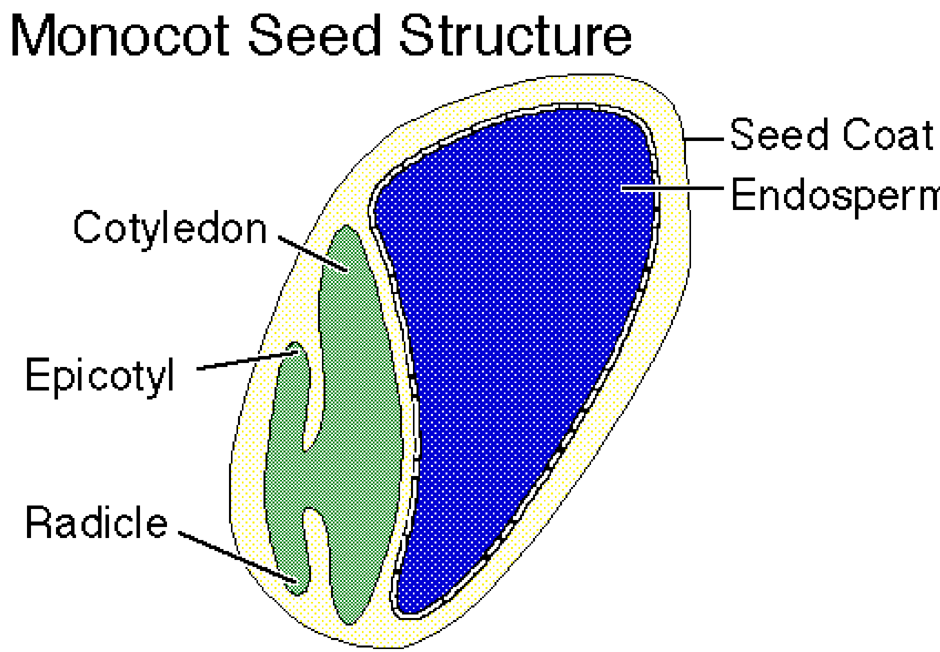
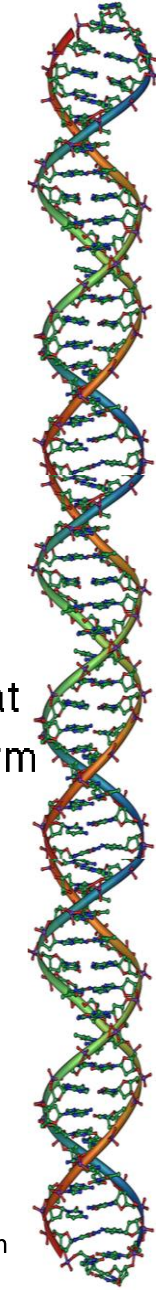


Image: http://www.cartage.org.lb/en/themes/sciences/botanicalsciences/plantreproduction/PlantPropagation/SeedStructure/SeedStructure.htm



Seed structure

Simpler…

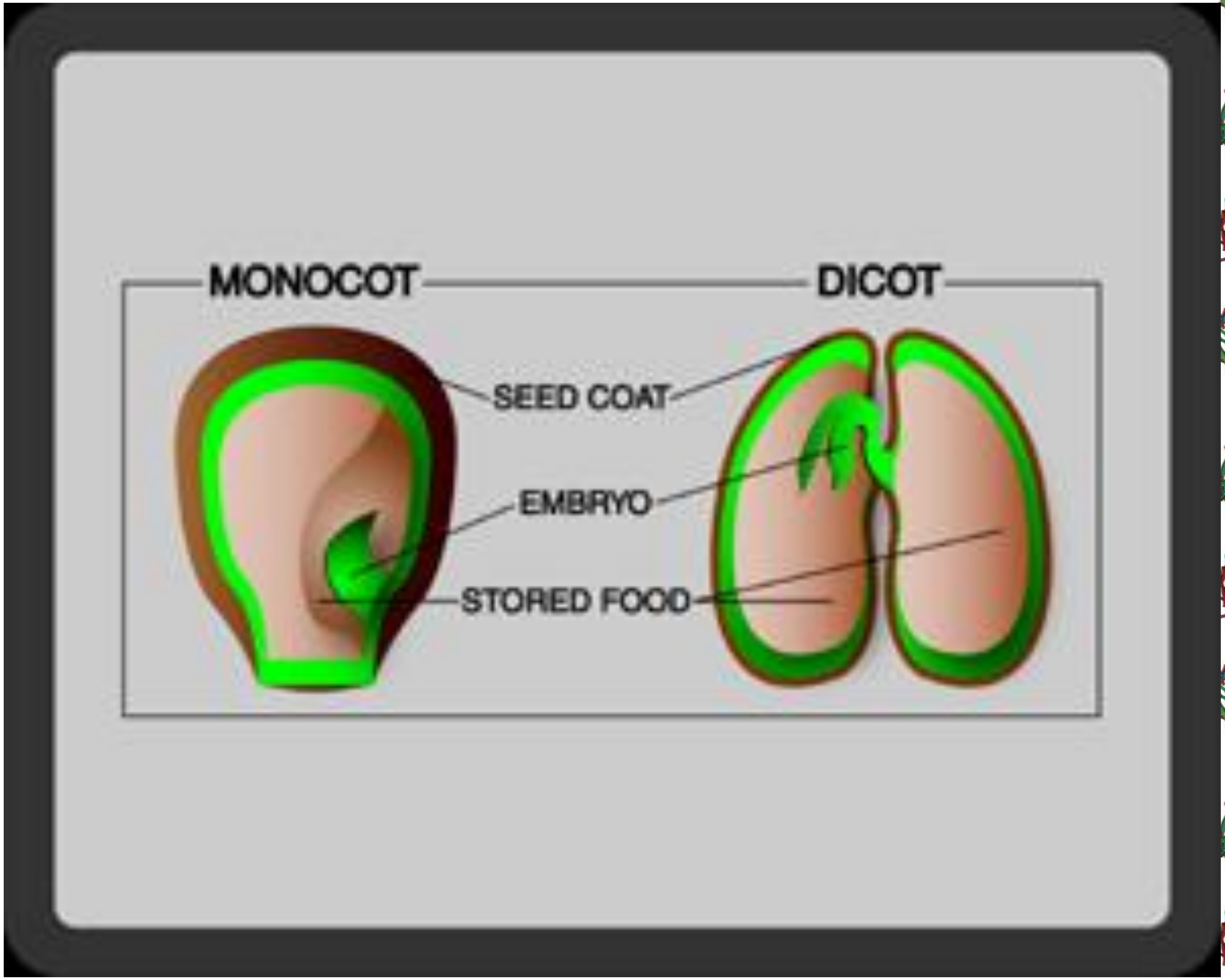


Image: http://www2.yk.psu.edu/~sg3/ist311/games/team3/

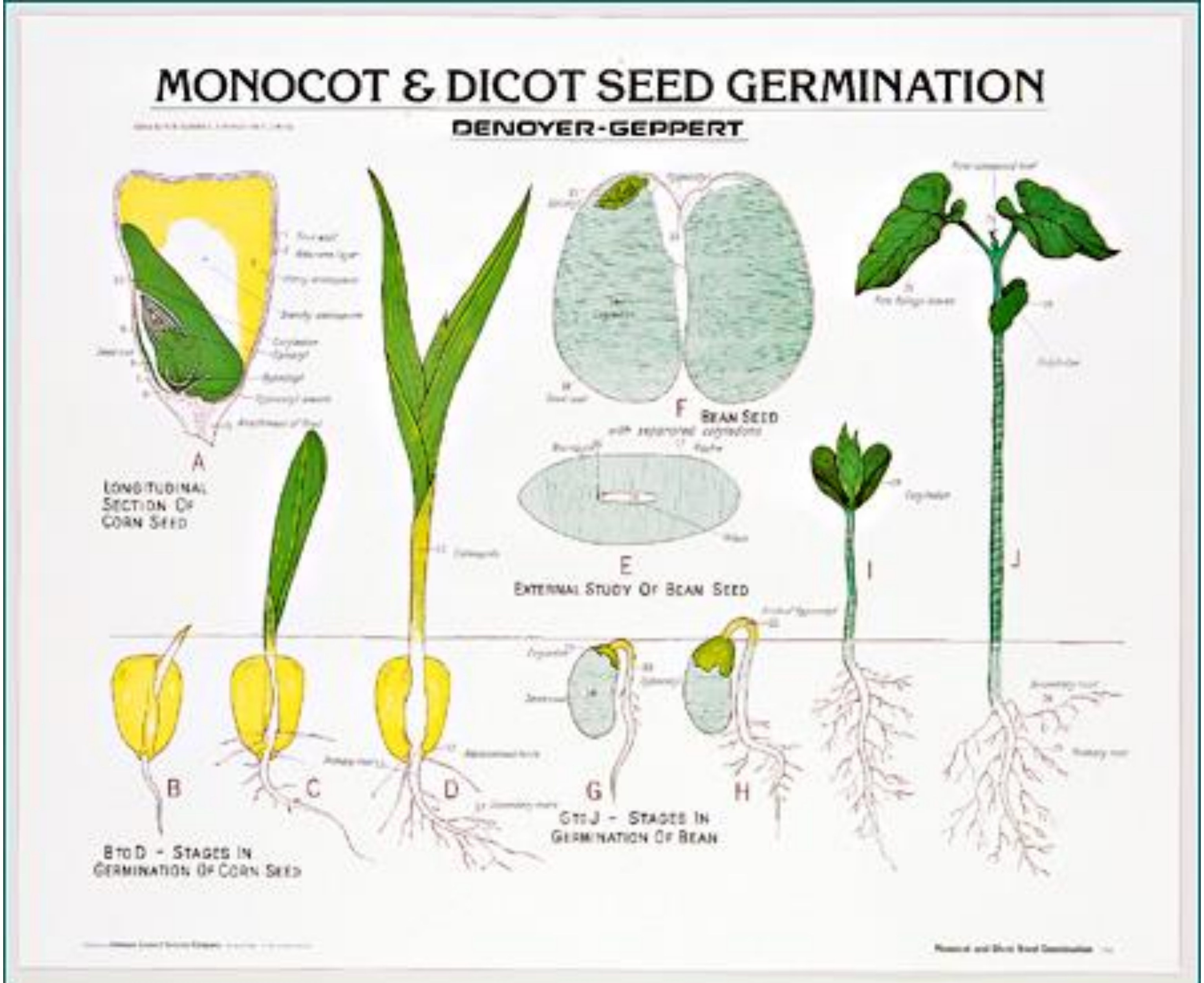


Image: http://denoyer.com/details.php?pid=111&hid=6&htitle=Charts&cid=108&ctitle=Botany

Types of Seeds

Grains (monocots)

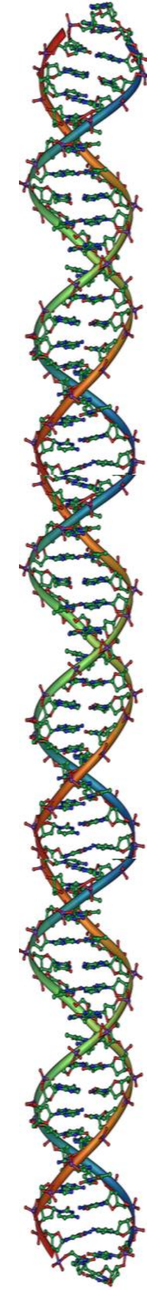
- Grass family, 1 season per year

Legumes (dicots)

- 1 season per year

Nuts

- Trees, multi-year plants



Grains

Modified grasses

- Wheat, corn, barley, rice, sorghum

Carbohydrate rich (starch, etc)

Some protein, little fat

Image: http://www.foodsubs.com/FGGrains.html

Legume

Often multiple seeds in a "pod"

- Beans, peas, peanuts

More fat & protein than "grains"

Image: https://www.eclipsewholefoods.com.au/topic/32-legumes.aspx

Image: http://www.glucocardyouchoose.com/kitchen/little-legumes-and-tiny-nuts-pack-in-the-fiber/#.UKJoGIe7PFI

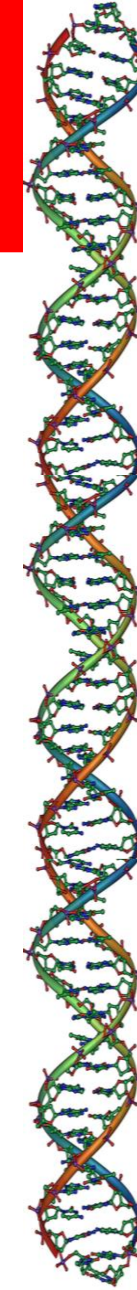
Nuts

Image: http://en.wikipedia.org/wiki/Nut_(fruit)

- True nut
  - hard shell, 1 seed, no seam
  - Acorn, hazelnut
- Culinary nut
  - Dry fruit with an edible kernel in a hard or leathery covering
  - Cashew, almond, walnut
- Higher fat

Image: http://ecosalon.com/high-in-protein-and-omega-3s-test-your-nut-knowledge/

END DAY 20



Content

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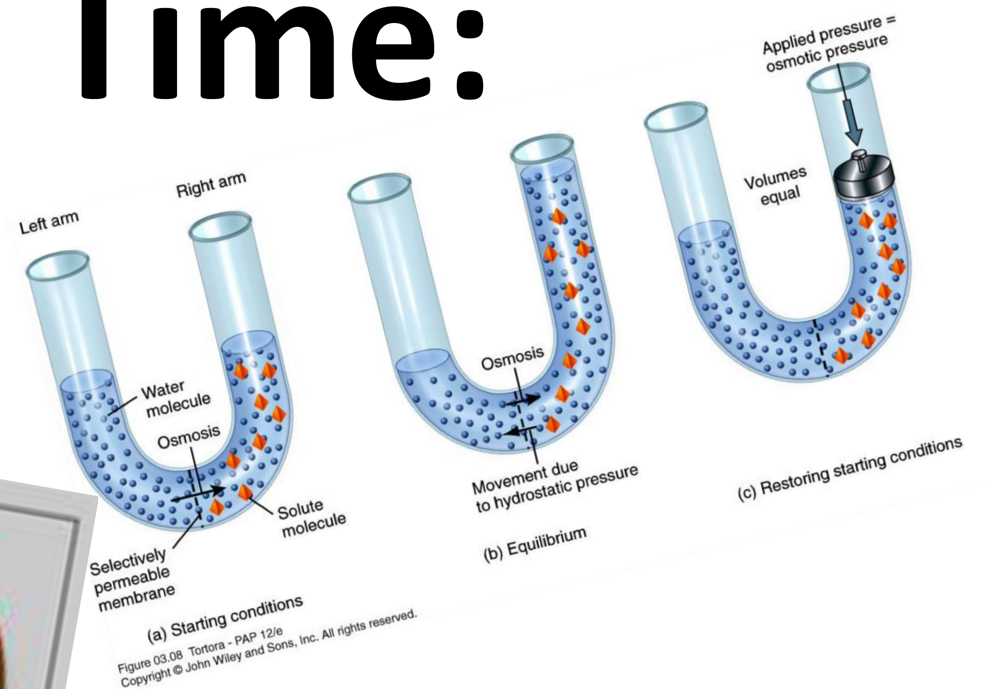
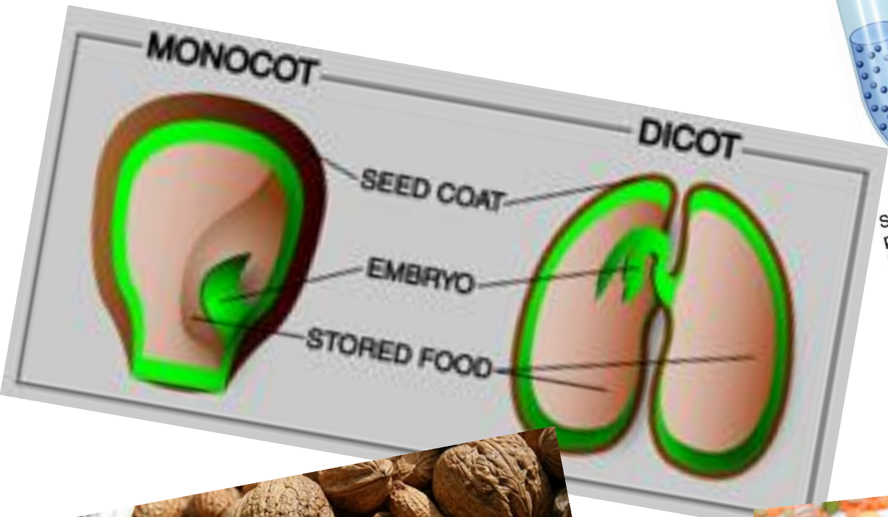
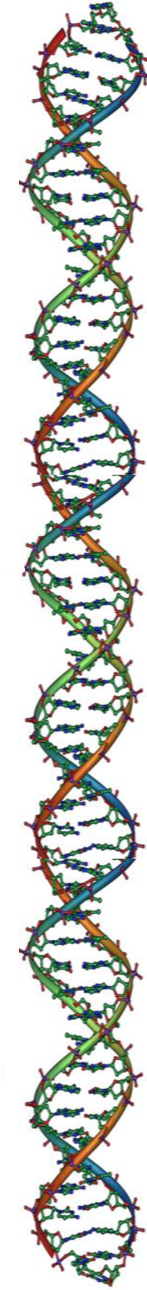






Science of Cooking – BCBT100
Summer 2016 - Bodwin

Graphing

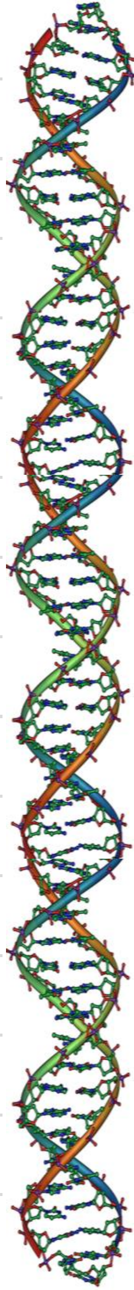
Comparing 2 points

For each day, calculate the rate of apple consumption

Graphically

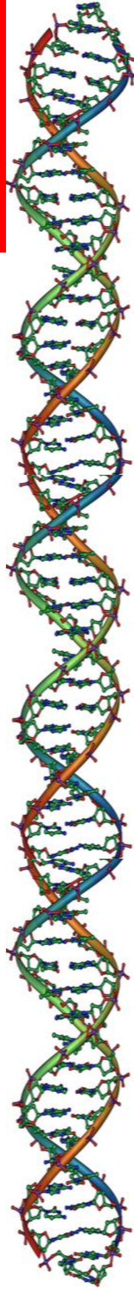
Prepare a graph and use a fit line to determine the average rate of apple consumption

Day	# of apples eaten
0	0
1	29
2	80
3	152
4	200
5	280
6	351
7	396
8	460
9	524
10	566
11	602
12	655
13	718
14	747



END DAY 21

Content

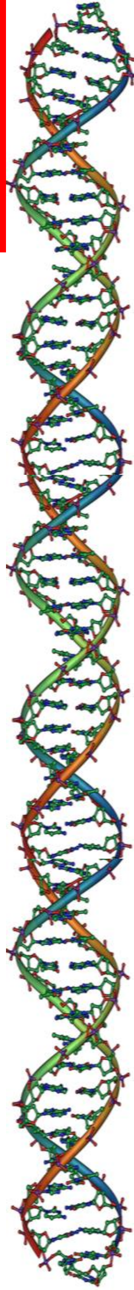


No class

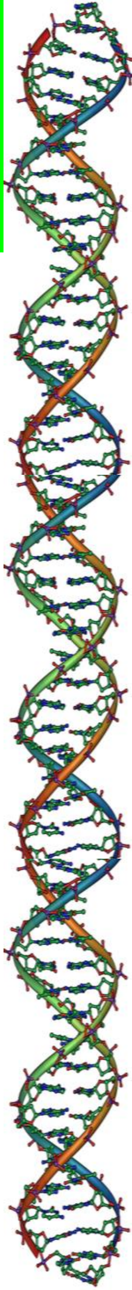
I held an open office hour during class to address questions about the upcoming exam, the lab assignment that was due, etc

END DAY 22

Content



TOPIC BEGIN



Spices

Flavoring Foods

Salt and other minerals

Herbs & Spices

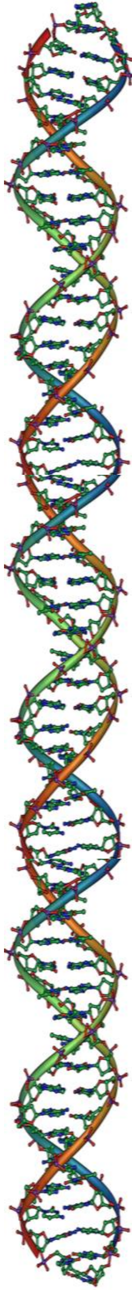
Herbs & Spices

Plant-based foods

Intense flavor, color, odor

Herbs = green parts (leaves)

Spices = other parts



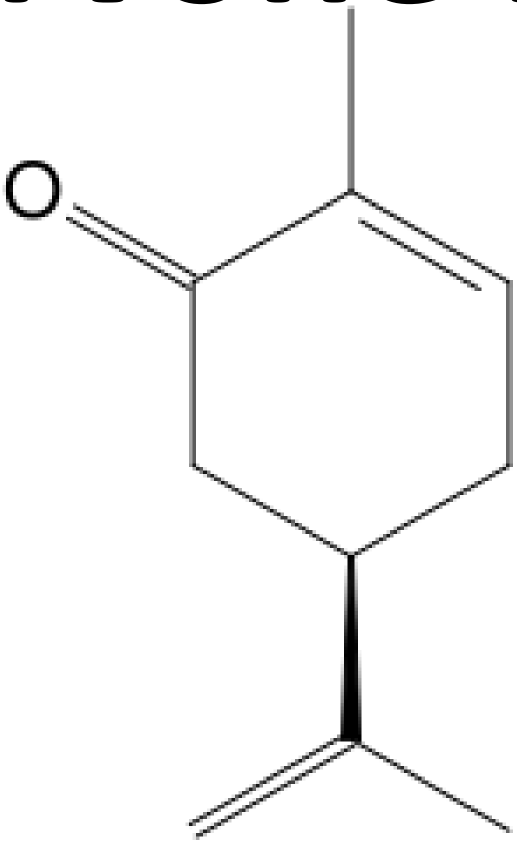
Chemical Defense!

Essential oils often poisons

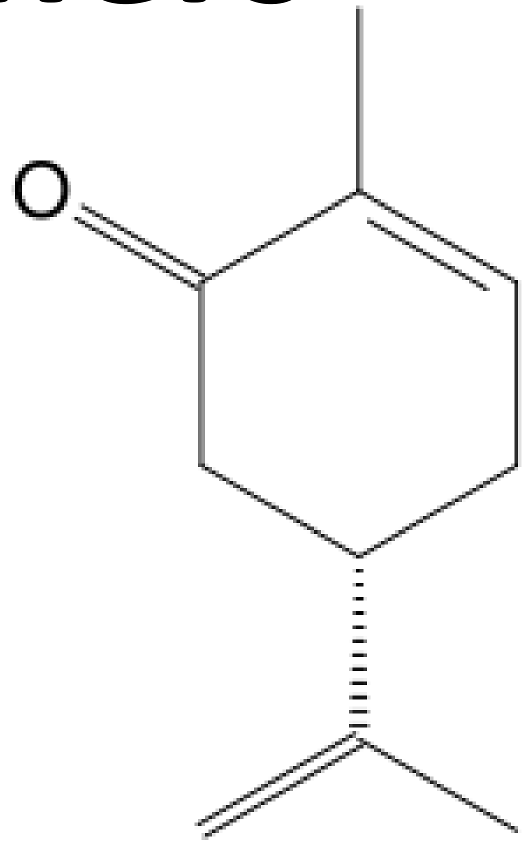
Dose makes the poison…

MSDS and LD50 (*vanillin, menthol, carvone*)

Carvone Isomers



(R)-carvone
(spearmint)

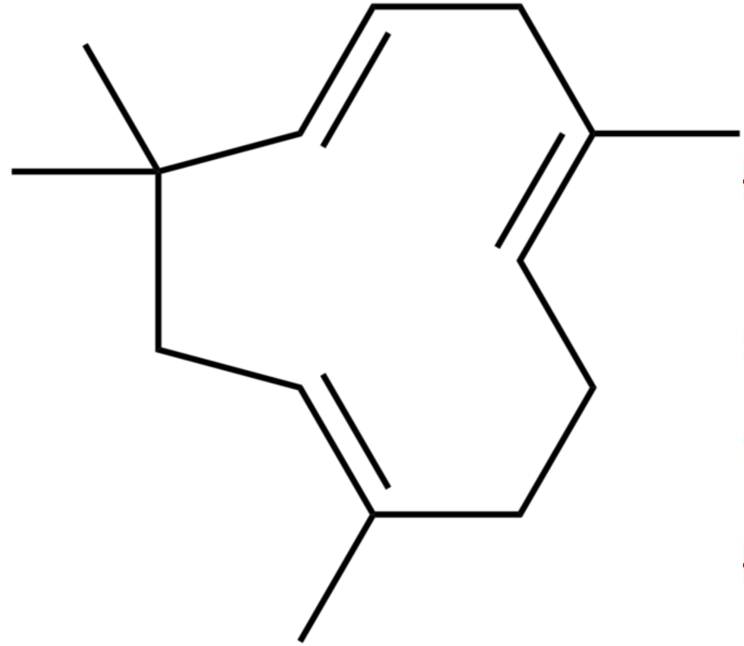


(S)-carvone
(caraway)

Source: http://weakinteractions.wordpress.com/primers/chirality/

Terpenes

"Turpentine"



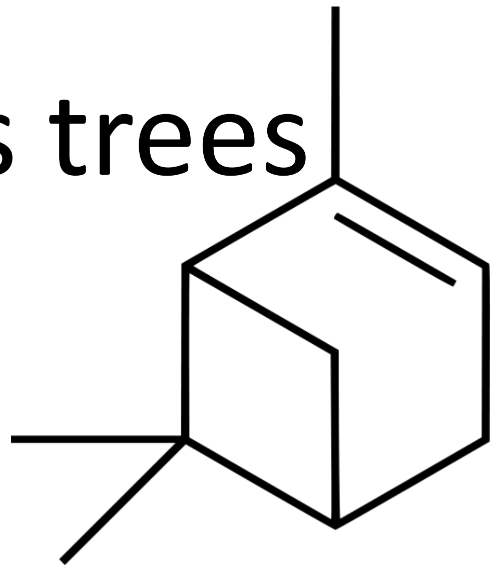
Humulene

Source: http://en.wikipedia.org/wiki/A-humulene

Coniferous trees

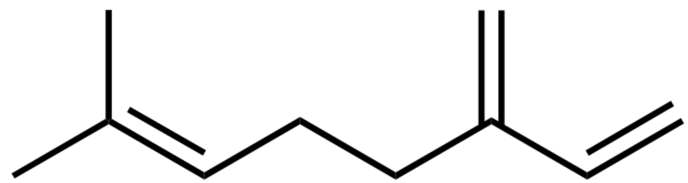
Citrus

Flower



Pinene

Source: http://en.wikipedia.org/wiki/Pinene



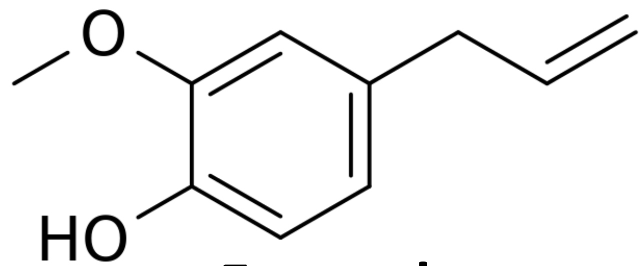
Myrcene

Source: http://en.wikipedia.org/wiki/Myrcene

"fresh" character

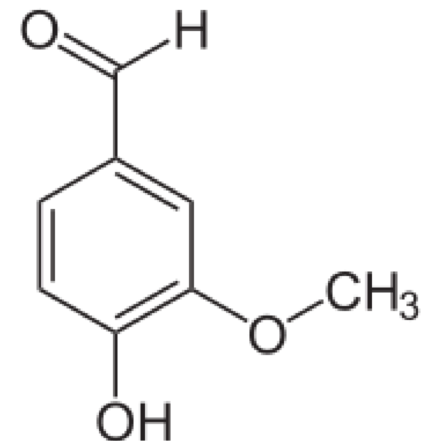
Phenolics

"phenyl"



Eugenol

Source: http://en.wikipedia.org/wiki/Eugenol



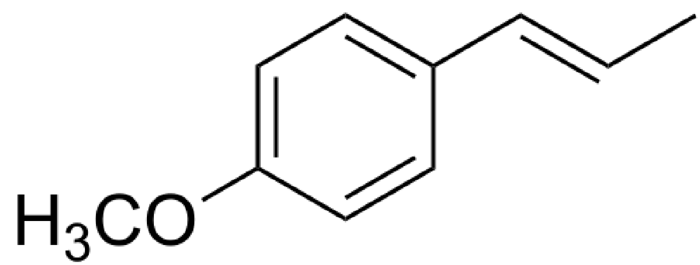
Vanillin

Source: http://en.wikipedia.org/wiki/Vanillin

Clove

Cinnamon

Anise



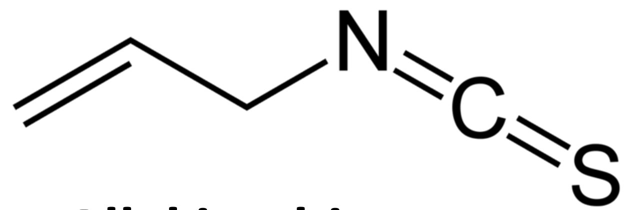
Anethole

Source: http://en.wikipedia.org/wiki/Anethole

more water soluble

Pungents

"Feel" vs. "taste"



Allyl isothiocyanate

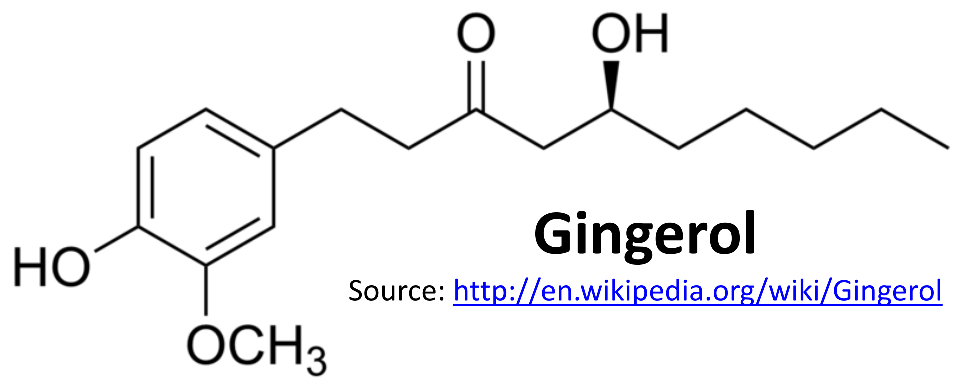
Source: http://en.wikipedia.org/wiki/Allyl_isothiocyanate

Thiocyanates

(*mustard, horseradish*)

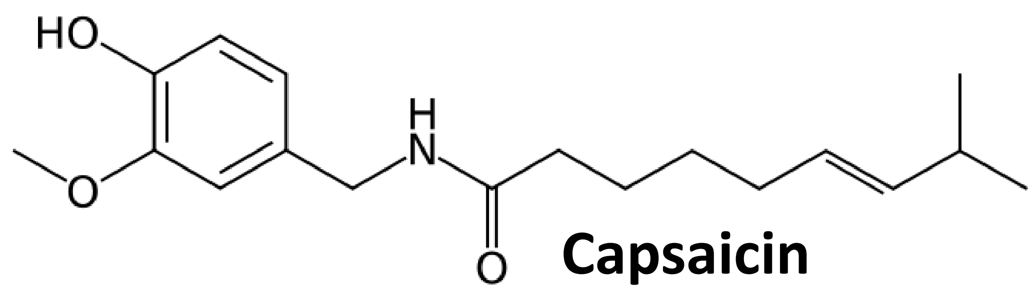
Alkylamides

(*peppers, ginger*)



Gingerol

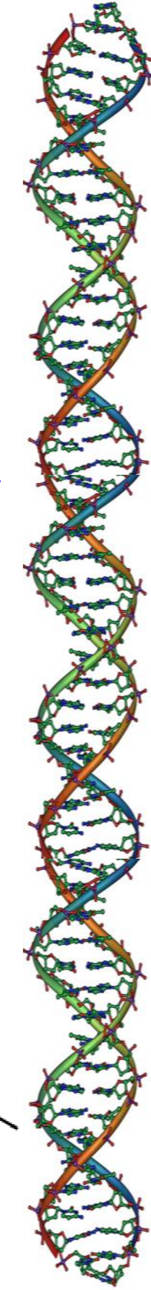
Source: http://en.wikipedia.org/wiki/Gingerol



Capsaicin

Source: http://en.wikipedia.org/wiki/Capsaicin

Solubility?



Matching Flavors

Look at molecular components

McGee p. 392-393

Peppermint vs. Spearmint

Herb & Spice Matching

Web resources:

http://www.localharvest.org/blog/39774/entry/what herbs go with what

Mint Family Herbs

Mints (*peppermint, spearmint, wintergreen, etc*)

Basil

Oregano

Rosemary

Lavender

Bergamot

External oil "glands"

Source: http://thehungrygoddess.com

Source: http://jillshomeremedies.blogspot.com/

Carrot Family Herbs

Celery

Parsley

Cilantro

Dill

Fennel

Oil canals in leaves

Cilantro

Source: http://thehealthmoderator.com/

Dill

Source: http://www.milkandhoneyfarm.com/

Fennel

Source: http://ucanr.edu/

Laurel Family Herbs

Bay leaf

Avocado leaf

Sassafras

Bay Laurel
Source: http://www.thegardenpages.com/

Sassafras
Source: http://www.fcps.edu/islandcreekes/ecology/sassafras.htm

Carrot Family Spices

Coriander

Celery

Cumin

Dill

Fennel

Caraway

Small dried fruits

Cabbage Family Spices

Mustards

Wasabi

Horseradish


Mustard Seed
Source: http://www.cookinglight.com/


Wasabi
Source: http://www.thewasabicompany.co.uk/

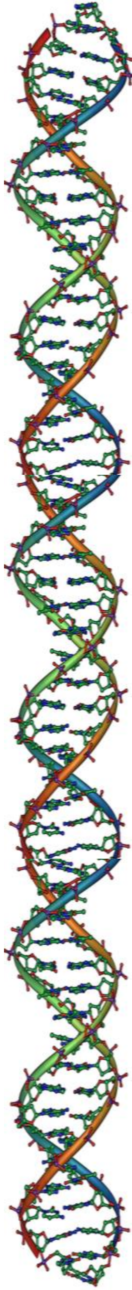
Making “mustard”

Soak seeds

Enzyme activation

Grind and mix

Add acid (vinegar)

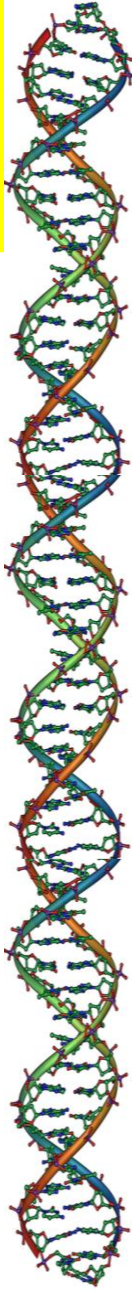


END DAY 23

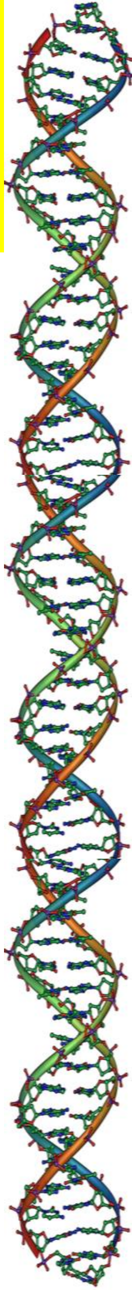
Content

EXAM DAY

Exam 3 given in class on Day 24 (2015-11-12)



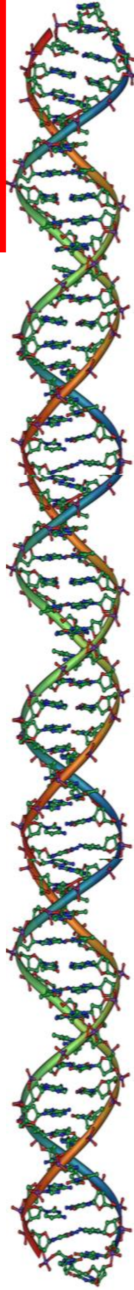
Exam XX



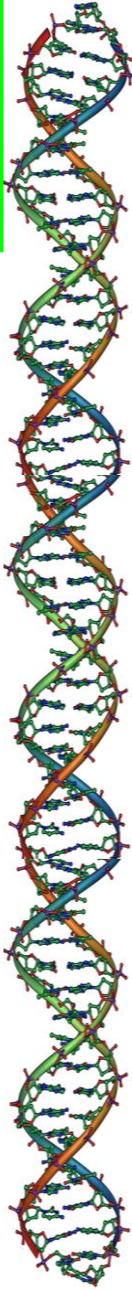
Number of takers =
Max score = XXX/150
Average score = XXX/150
Min score = XXX/150
Standard Deviation =

END DAY 24

Content

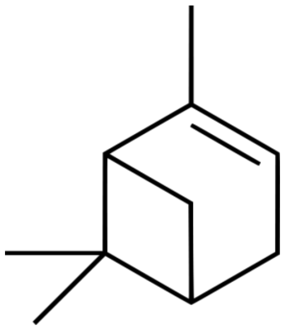


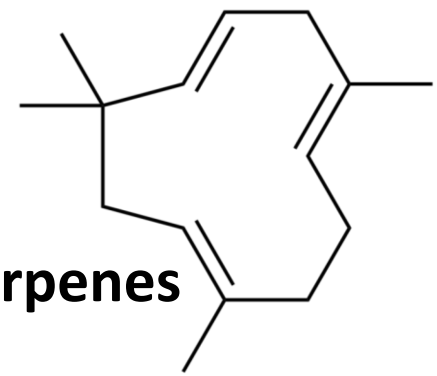
TOPIC BEGIN



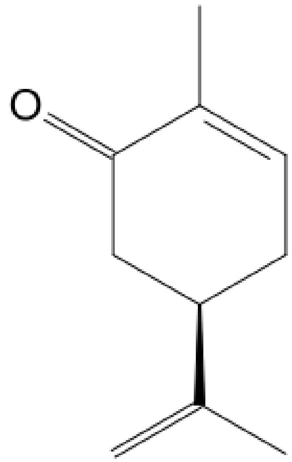
Chocolate

From Last Time:

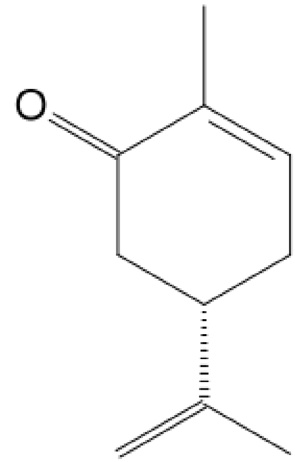




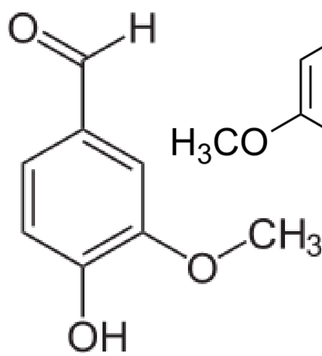
Terpenes

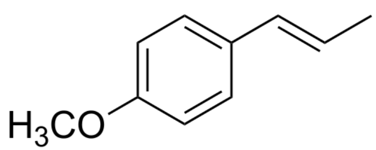


(R)-carvone
(spearmint)

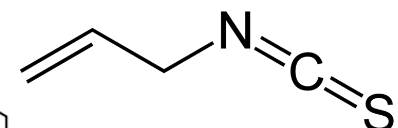


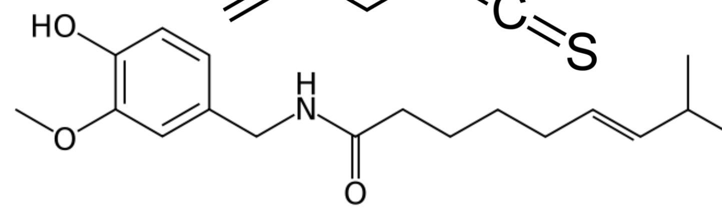
(S)-carvone
(caraway)



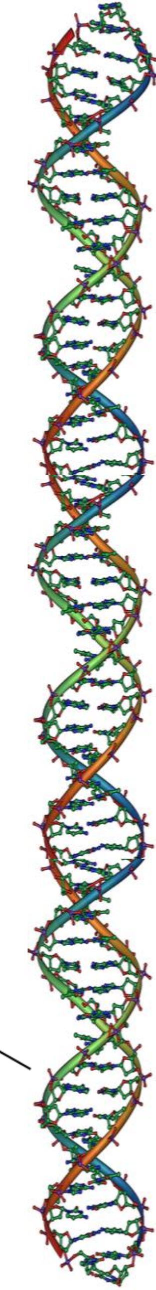


Phenolics





Pungents



Making Chocolate

Theobroma cacao

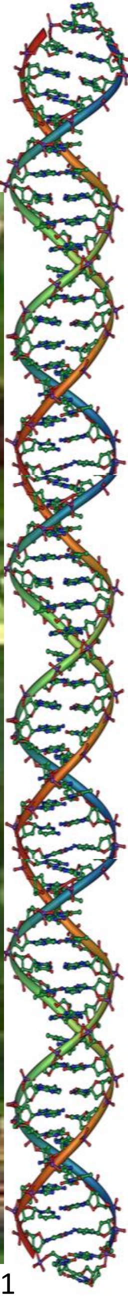


Image: http://www.plantmanagementnetwork.org/pub/php/review/cacao/

imageL http://askville.amazon.com/grow-cocoa-chocolate-plants/AnswerViewer.do?requestId=1267051

Cacao Pods

Content

Image: http://www.fairchildgarden.org/livingcollections/tropicalfruitprogram/jackfruit/cacao/

Cacao Growing

Requires specific climate

Within ~20° of the equator

Image: http://www.sfu.ca/geog351fall03/groups-webpages/gp8/prod/prod.html

Cacao Growing

Requires specific climate, within ~20° of the equator

Image: http://www.barry-callebaut.com/1897

Cacao

- "Beans" removed
  - Very bitter
- Fermented
  - Sugars → acids
  - Flavor develops
- Dried (sun) ~1 week
- Bagged & shipped

Image: http://hnwright-blog.com/2011/12/12/la-comunidad-cofan-part-ii/

Image: http://article.wn.com/view/2010/06/15/Lindts_NH_chocolate_plant_grows_to_process_cocoa/

Beans to Chocolate

http://www.youtube.com/watch?v=cPAn4flcvBI

Crushing/winnowing

Roasting

Grinding/"conching"

Mixing/pressing

Image: http://library.thinkquest.org/08aug/01181/cacao.html

Image: http://www.cacao-beans.com/

Image: http://madrelabsblog.com/2012/10/15/chocolate-controversy-study-says-chocolate-wont-fatten-you-up/

Chocolate Composition

Proteins (10+%)

Fiber (10+%)

Cacao Butter (50+%)

Sugars (1%)

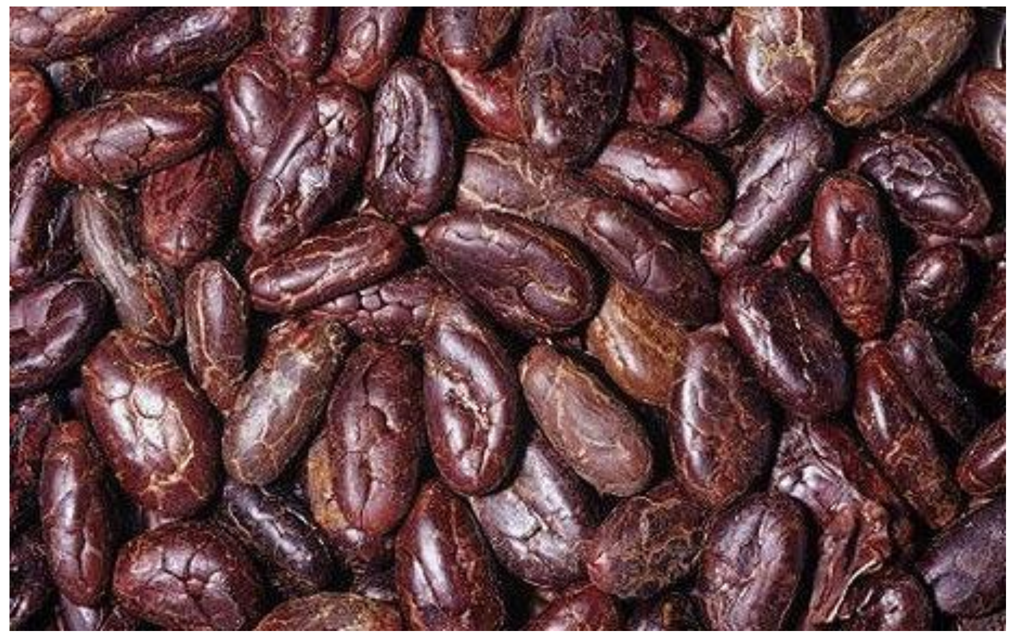


image: http://joyremandocrave.blogspot.com/2011/06/tsokolati-ni.html

Types of Chocolate

Plant types:

Criollo

- Delicate flavors, floral

Forastero

- More robust

Trinitario

- Hybrid of Criollo & Forastero

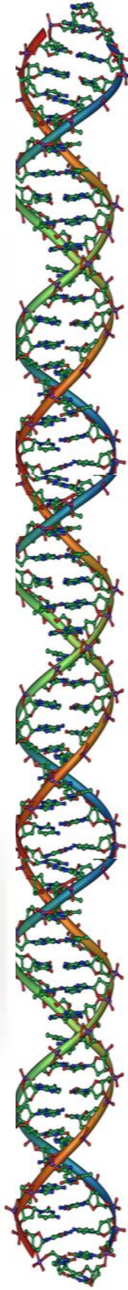


Image: http://www.yourdictionary.com/chocolate

Types of Chocolate

Products, legal definitions

Unsweetened

Bittersweet

Sweet (dark)

Milk

White

{p.704, McGee}

Image: http://en.wikipedia.org/wiki/Chocolate

Cocoa Powder

Residue after butter is removed

"Dutched" = Treated w/base to make more water soluble

Image: http://cocoaandfig.blogspot.com/2009/02/cocoa-powder.html

Storing Chocolate

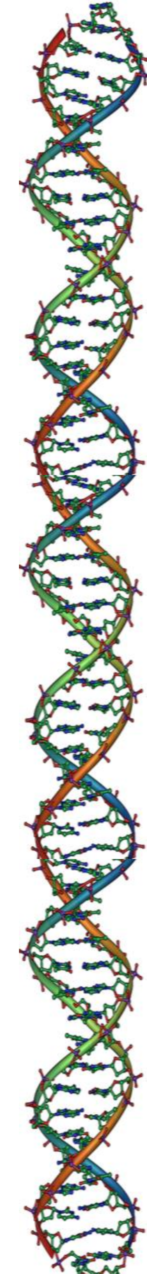
Temperature is critical! Below 70°F

Tempering {p.702, McGee}

- Gives chocolate proper texture

"Bloom"

- Fat melting out of chocolate
- Crystallizes on surface
- Looks dusty



Cooking with Chocolate

- Melting
  - Careful heating
  - "breaking" or "seizing"
- Savory dishes

Image: http://www.marketplace.org/topics/business/british-chocolate-maker-offers-sweet-deal
http://www.poorgirleatswell.com/2010/10/project-food-blog-3-for-love-of.html

Tasting Chocolate

Let it melt in your mouth

- Brings out flavors/aromas
- Feel the fats melt
- Smooth/Gritty texture

Image: http://abcnews.go.com/blogs/lifestyle/2011/10/its-national-chocolate-day/

Chocolate flavors

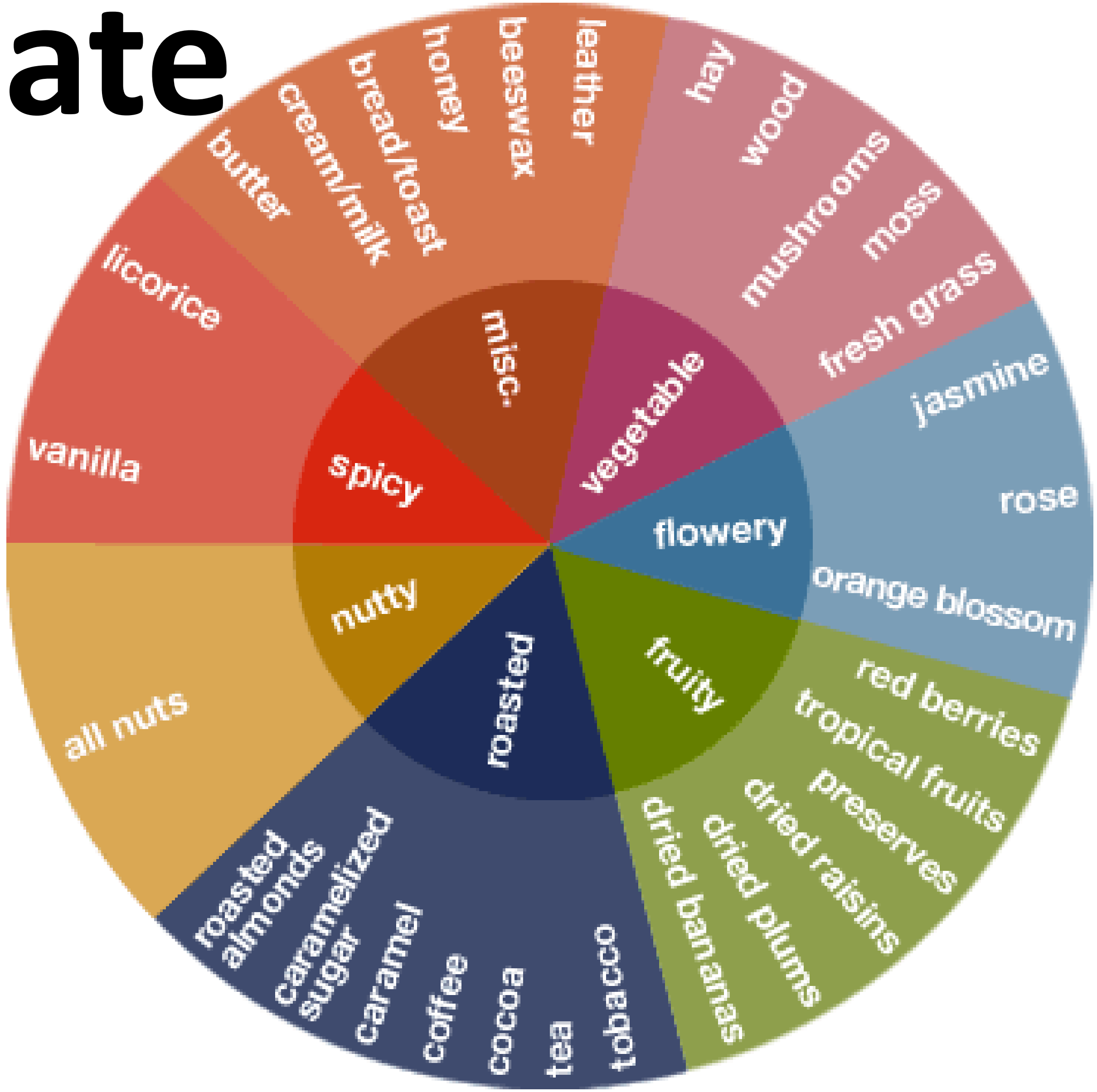
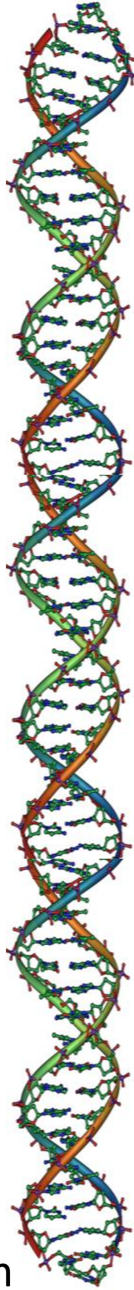


Image: http://www.allchocolate.com/enjoying/intro_to_chocolate/chocolate_notes.aspx

Tasting Notes

- Observe, observe, observe!
- Use all your senses
- Appearance
- Aroma
- Mouth feel
- Flavor
- Finish
- Overall Impressions
- Palate cleansing



www.allchocolate.com

Tasting Notes

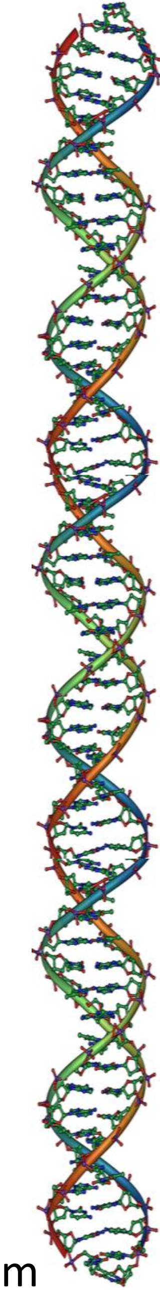
How does the chocolate feel on the tongue?

- Is it smooth, thin, creamy, uniform, grainy, uneven?
- Does it melt evenly?

How complex are the flavors?

- Initial? Develop? Lingering?
- How intense/strong are the flavors?
- Are there multiple flavors?

How bitter/astringent are the flavors?



www.allchocolate.com

Chocolate flavors

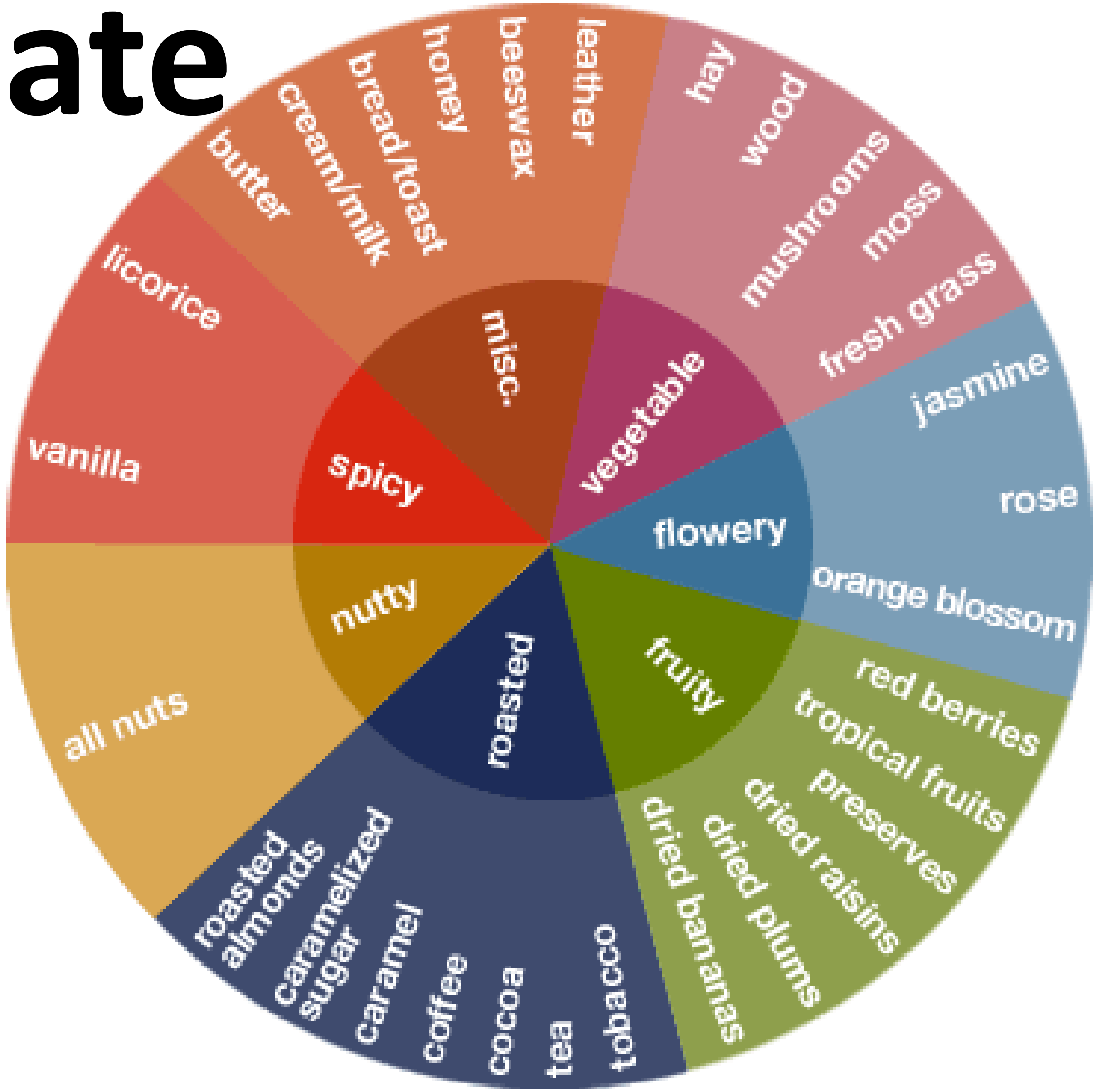


Image: http://www.allchocolate.com/enjoying/intro_to_chocolate/chocolate_notes.aspx

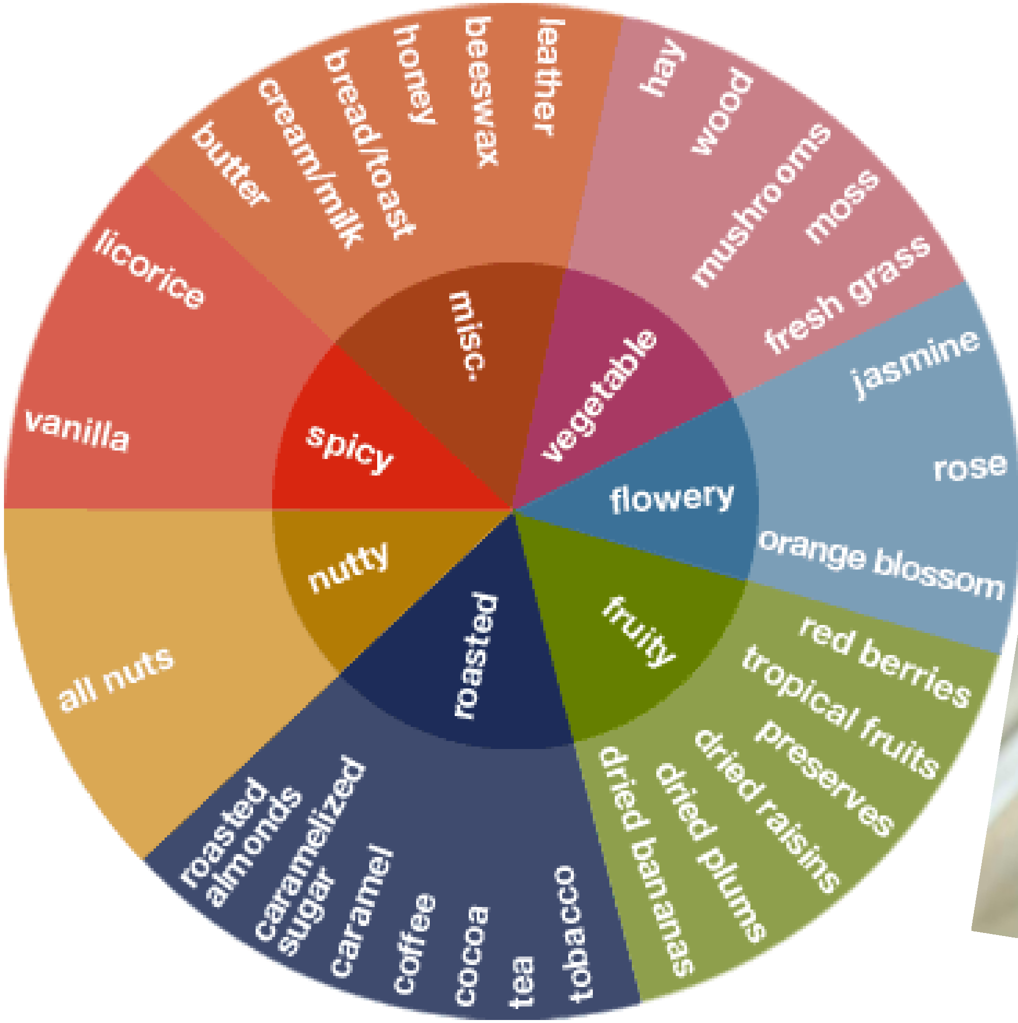
Experiment in Class

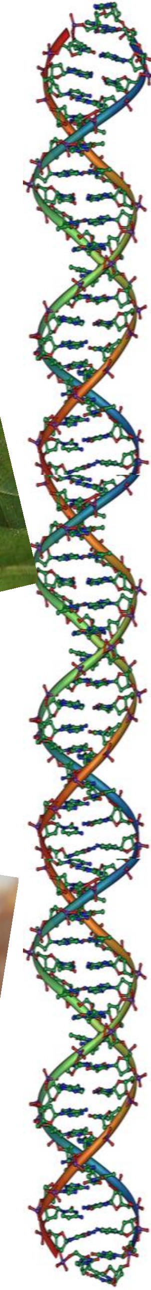
Chocolate Tasting experiment – (2015-11-17)

END DAY 25

Content

From Last Time:





Science of Cooking – BCBT100
Summer 2016 - Bodwin

Mint Family Herbs

- Mints (*peppermint, spearmint, wintergreen, etc*)
- Basil
- Oregano
- Rosemary
- Lavender
- Bergamot
- External oil "glands"

Basil

Source: http://thehungrygoddess.com

Peppermint

Source: http://jillshomeremedies.blogspot.com/

Lavender

Source: http://gardenofeaden.blogspot.com/

Carrot Family Herbs

Celery
Parsley
Cilantro
Dill
Fennel
Oil canals in leaves

Source: http://ucanr.edu/

Laurel Family Herbs

Bay leaf

Avocado leaf

Sassafras

Bay Laurel

Source: http://www.thegardenpages.com/

Sassafras

Source: http://www.fcps.edu/islandcreekes/ecology/sassafras.htm

Carrot Family Spices

Coriander

Celery

Cumin

Dill

Fennel

Caraway

Small dried fruits

Cabbage Family Spices

Mustards

Wasabi

Horseradish

Mustard Seed
Source: http://www.cookinglight.com/

Wasabi
Source: http://www.thewasabicompany.co.uk/

Making “mustard”

Soak seeds

Enzyme activation

Grind and mix

Add acid (vinegar)

Bread

Flat/Unleavened breads

- Grains ground with water and cooked
- More palatable, transportation advantage

Image: http://www.indianfoodsite.com/breads_indian_paratha.htm

Image: http://www.cepolina.com/bread_Muslim_unleavened.html

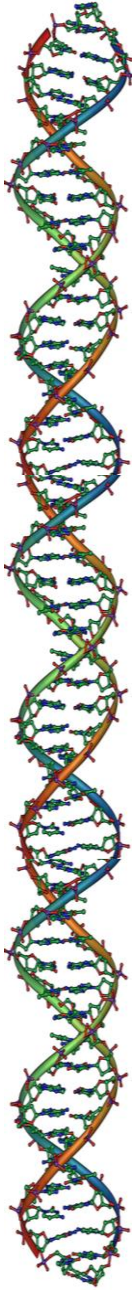
Unleavened Breads

Tortillas

Lavash

Matzah

Thin and often cracker-like



“Leavening”

Chemical or Biological

Forming and trapping gas

Chemical Leavening

Carbonates + Acid = $CO_2(g)$

- Relatively fast gas formation
- Little other character
- “Quickbreads”
- “Soda bread”
- Cakes

Images: http://www.bellaonline.com/articles/art65628.asp
http://www.diabetesselfmanagement.com/recipes/Breads/
http://www.salon.com/2010/08/12/irish_soda_bread_how_to_make_quickbreads/

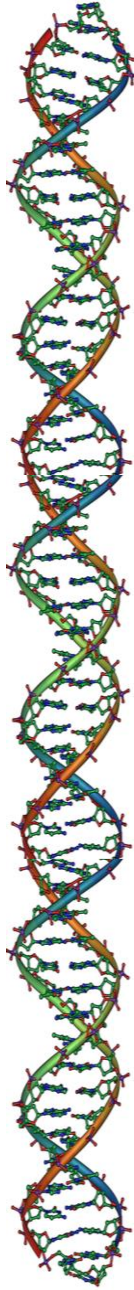
How much CO_2(g)?

1 Tablespoon Baking Soda =

25g $NaHCO_3$(s)

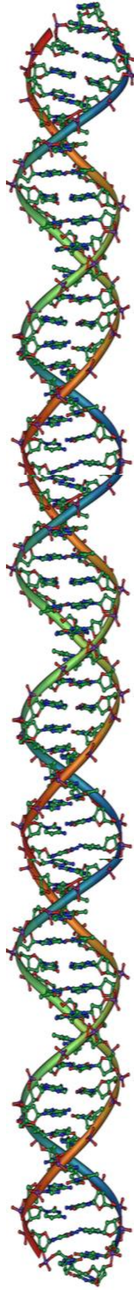
Can produce ~7L of CO_2(g)

7L = 1.9 gallon

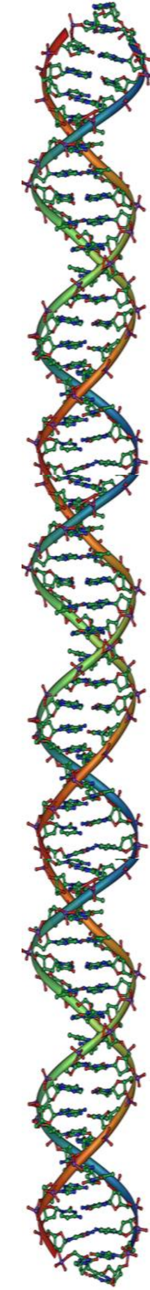


Trapping the gas

- Need a network of large molecules
- Protein!
- Gluten = long protein chains
  - Glutenins link together, form gluten
  - Disulfide bonds = strong
  - Longer glutens = chewier bread
  - Kneading…



Modifying Gluten



Flour type – high protein (↑ gluten)

Oxidizing substances (↑ gluten)

"Wet" dough (↑ gluten)

Lots of kneading/mixing (↑ gluten)

Salt (↑ gluten)

Sugar (↓ gluten)

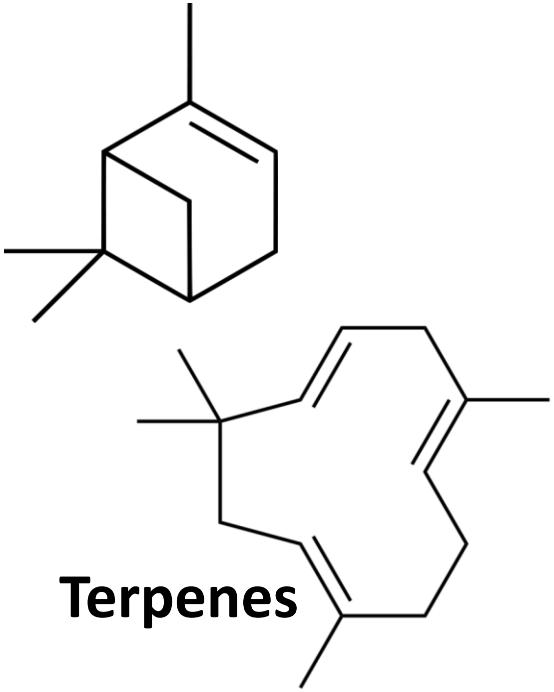
Fats & Oils (↓ gluten)

Acid (↓ gluten)

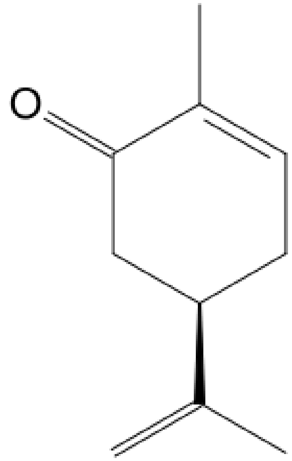
END DAY 26

Content

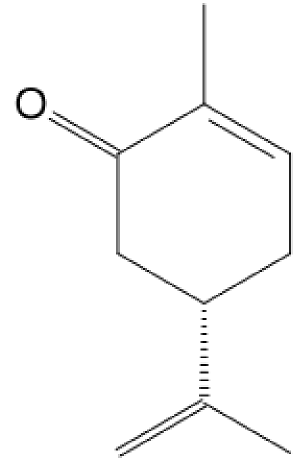
From Last Time:



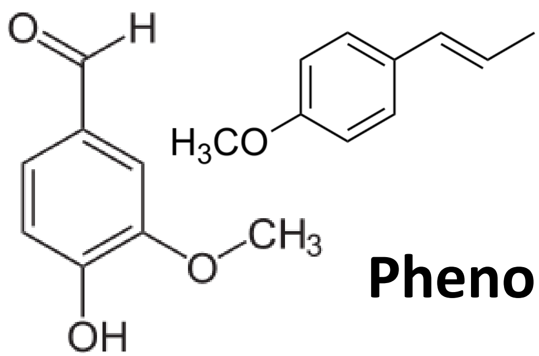
Terpenes



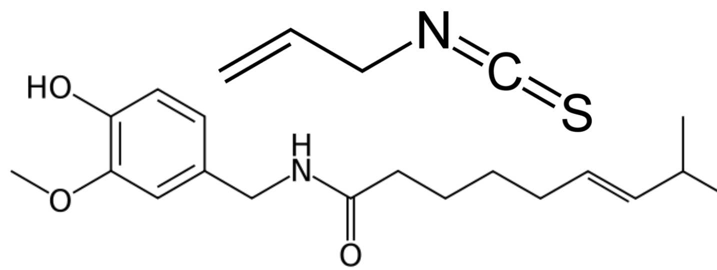
(R)-carvone
(spearmint)



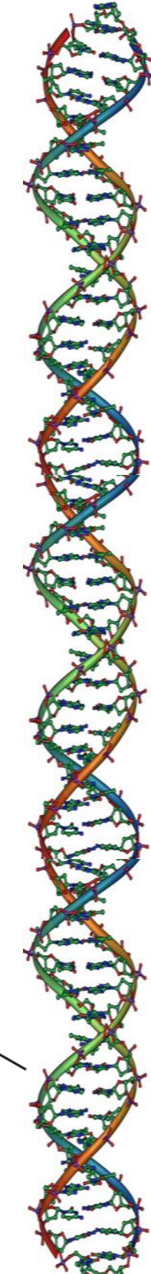
(S)-carvone
(caraway)



Phenolics



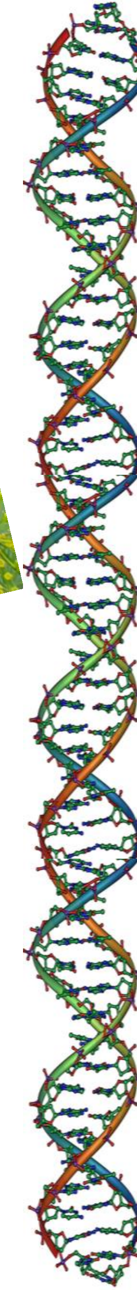
Pungents



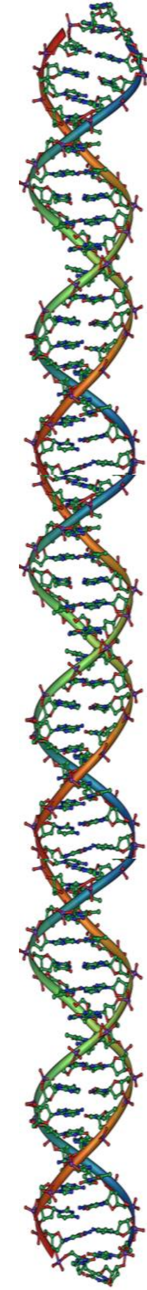
END DAY 25

Content

From Last Time:



Yeast



Ubiquitous microorganism

Many "yeasts"

Aerobic:

$$C_6H_{12}O_6 + 6\ O_2 \rightarrow 6\ CO_2 + 6\ H_2O$$

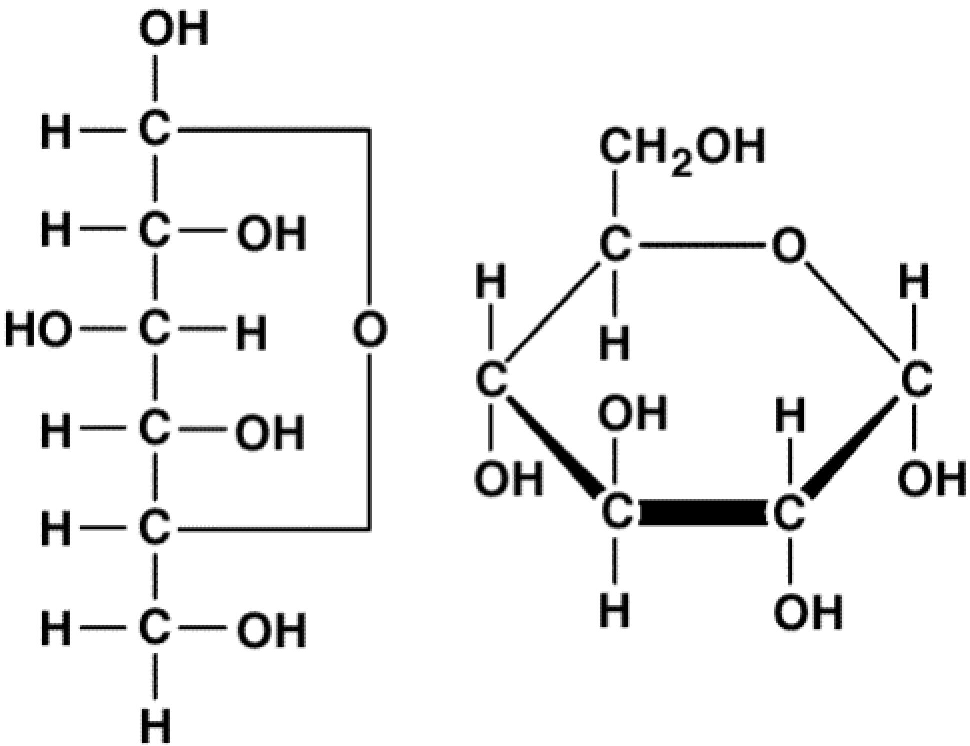
Yeast:

$$C_6H_{12}O_6 \rightarrow 2\ CO_2 + 2 \text{ alcohol molecules}$$

(simplified...)

Aerobic

Aerobic digestion = “burning”



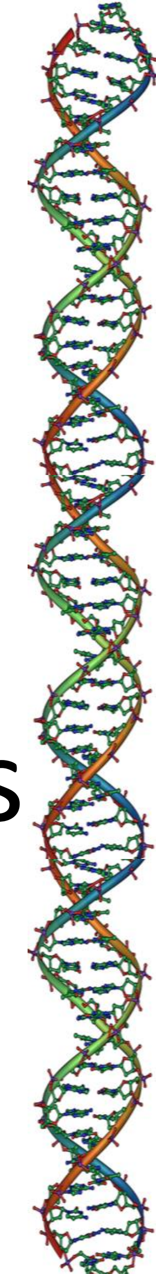
Glucose

6 carbons

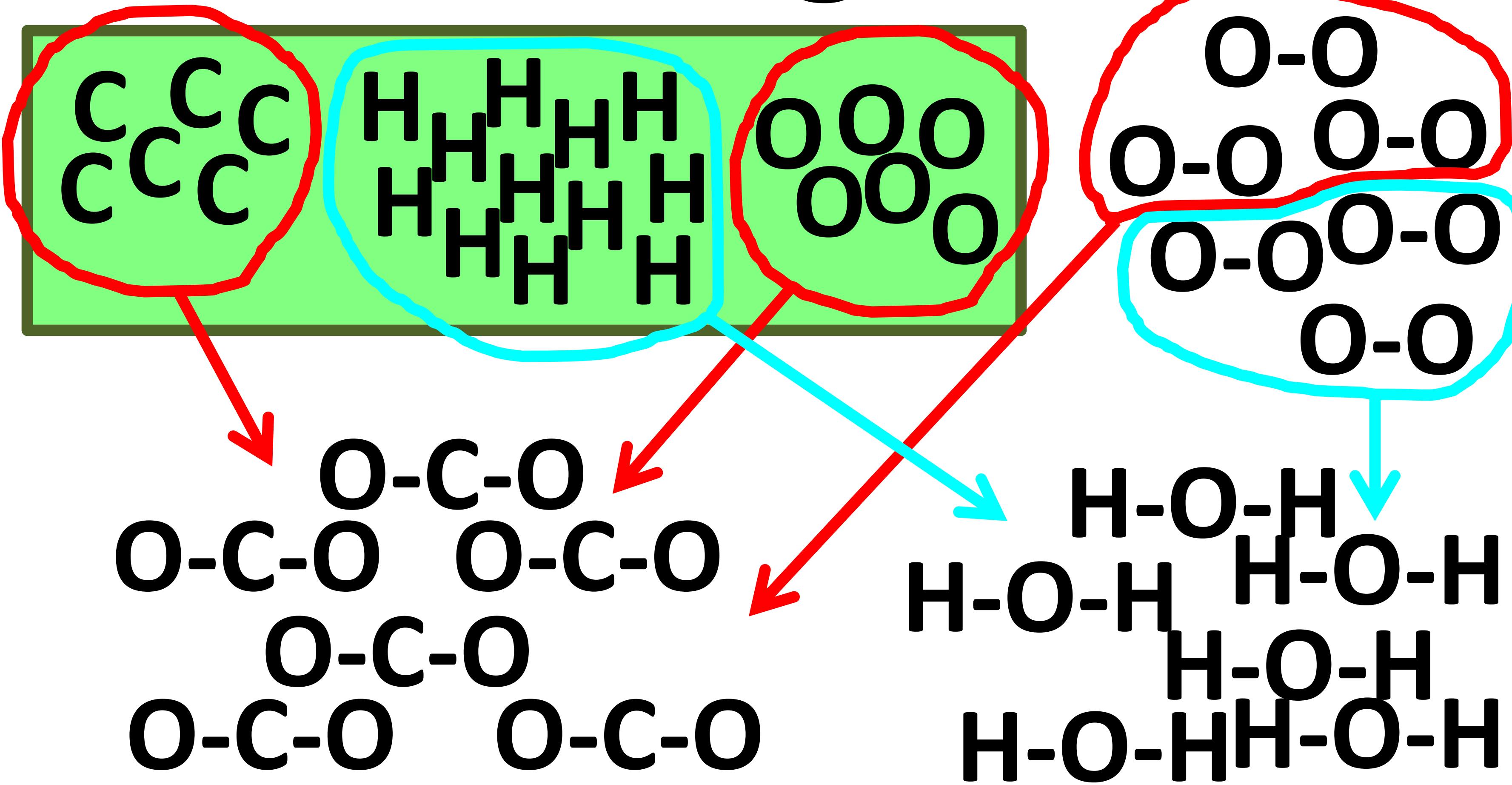
12 hydrogens

6 oxygens

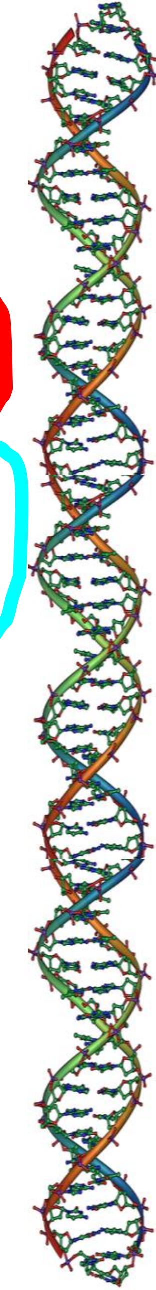
Source: http://imgarcade.com/1/c6h12o6-molecule/



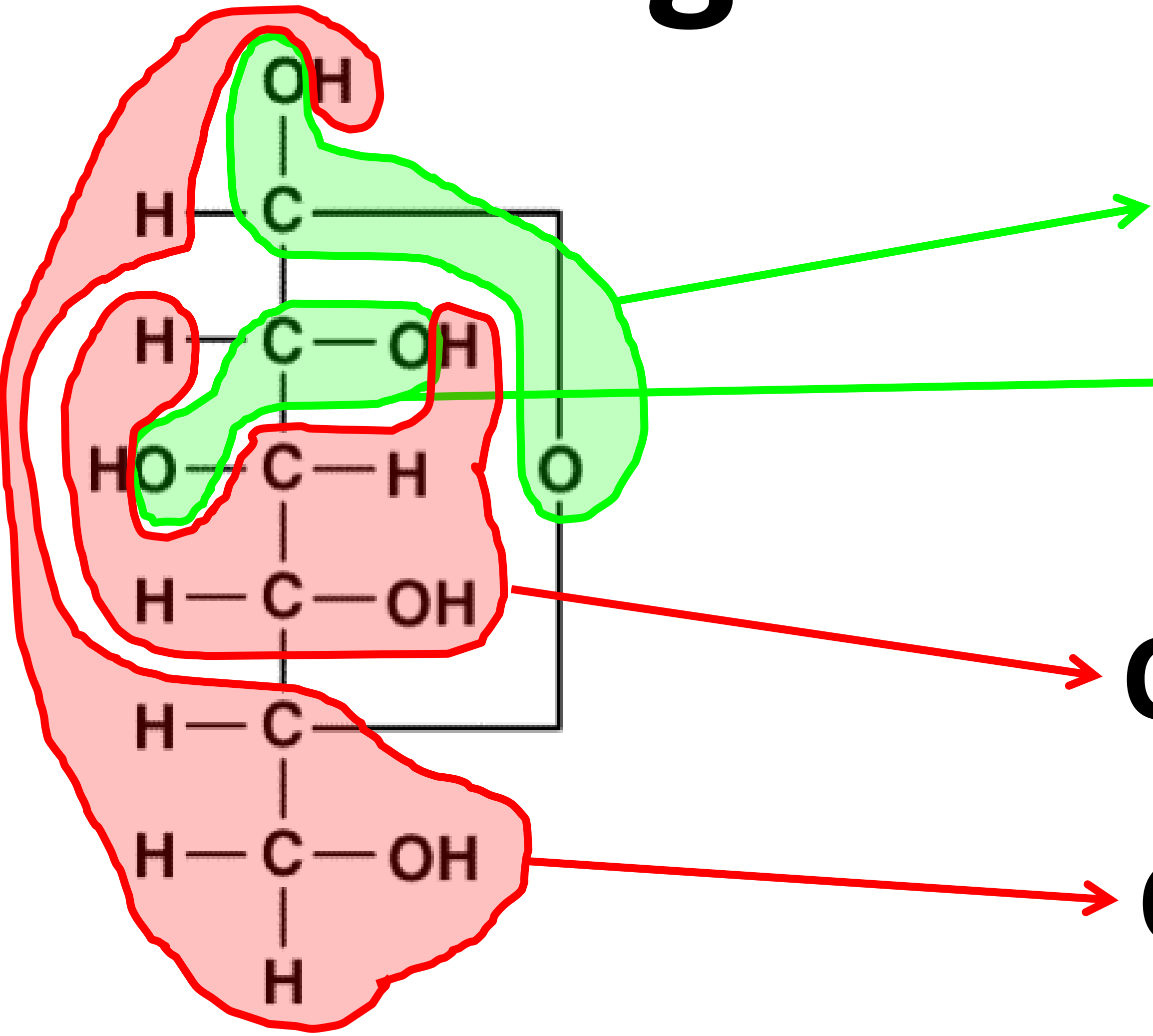
Aerobic "Digestion"



$$C_6H_{12}O_6(s) + 6\ O_2(g) \rightarrow 6\ CO_2(g) + 6\ H_2O(l)$$



Yeast Digestion



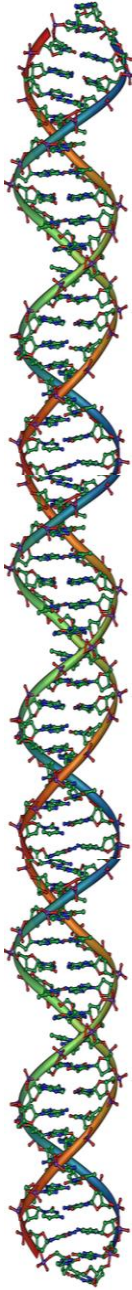
O-C-O

O-C-O

C_2H_5OH

C_2H_5OH

Source: http://imgarcade.com/1/c6h12o6-molecule/



Yeast leavening

Slower

Other flavors develop

Continuous yeast culture

- “New kitchen” syndrome

“friendship breads”

Amount of Gas…

Gas changes volume with amount

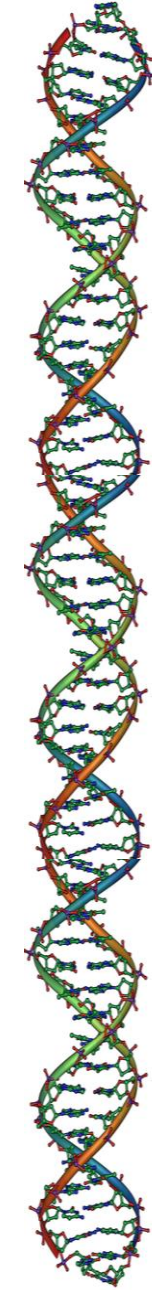
Avogadro's Law

$$\text{Volume} \propto \text{Amount}$$

$$V \propto n$$

$$V = kn$$

$$V / n = k$$



Temperature…

Gas changes volume with temp.

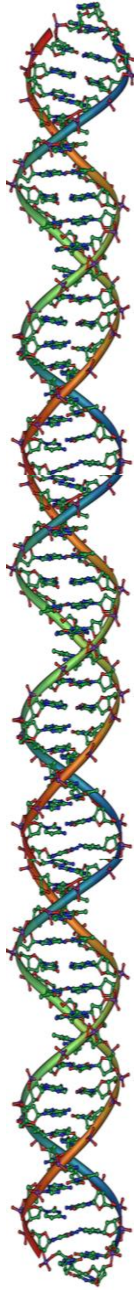
Charles' Law

$$\text{Volume} \propto \text{Temperature}$$

$$V \propto T$$

$$V = kT$$

$$V / T = k$$



Bread Structure

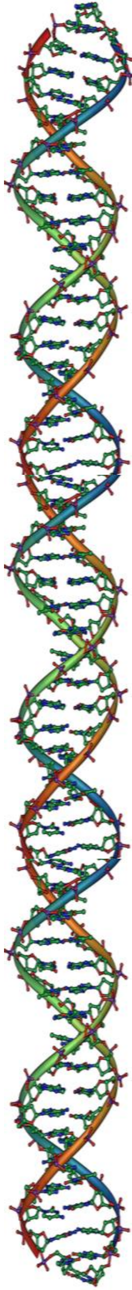
Glutens form a network to trap CO_2

Wheat flour is mostly starch…

Recall meringues set by heat…

Albumin proteins for a network

Sugar reinforces when water is removed



Gluten and Starch

When baked, starch granules absorb water, swell, and "set"

Starch pops bubbles

Steam escapes

Image: http://www.seriouseats.com/2011/06/the-food-lab-the-science-of-no-knead-dough.html

Modifying Gluten

Flour type – high protein (↑ gluten)

Oxidizing substances (↑ gluten)

"Wet" dough (↑ gluten)

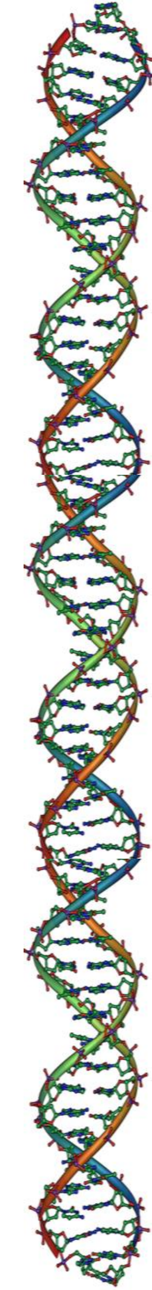
Lots of kneading/mixing (↑ gluten)

Salt (↑ gluten)

Sugar (↓ gluten)

Fats & Oils (↓ gluten)

Acid (↓ gluten)

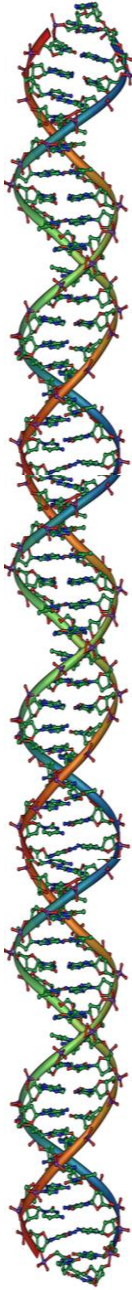


Baking – Charles' Law

How big do bubbles get?

Assume a 1mL bubble @20°C heating up to 65°C

Race between expanding gas & stiffening gluten



Steam in Baking

Phase changes

Steam transfers heat better

Keeps surface elastic longer

Glossy crust

Image: http://tlc.howstuffworks.com/home/wash-and-dry-with-steam.htm

Stale…

Changes in the starch

Gel loses water, crystallizes

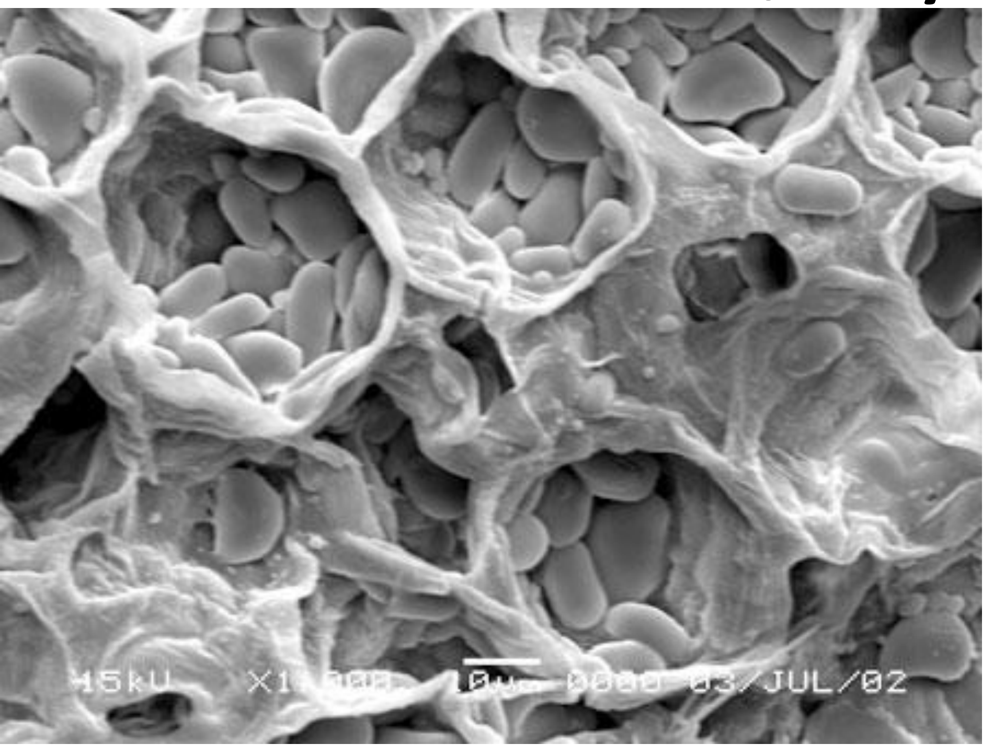


Image: http://www.aroid.org/gallery/held/starch_grains.php

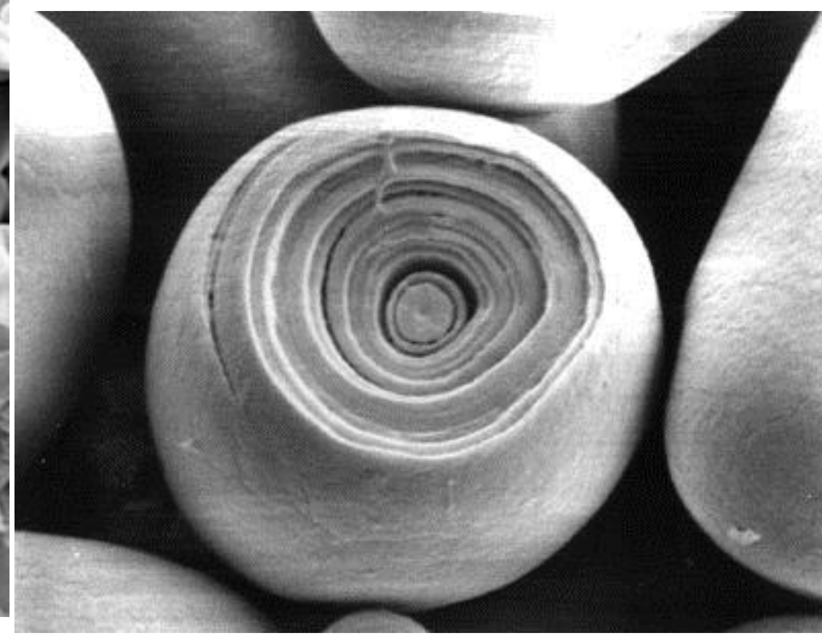


Image: http://sciencegirlsrock.wordpress.com/2011/05/30/women-of-outstanding-achievement/

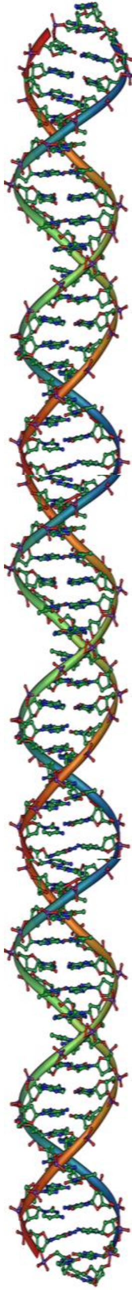
Science to the rescue!

Stale bread can be "fixed"

Consider the food molecules

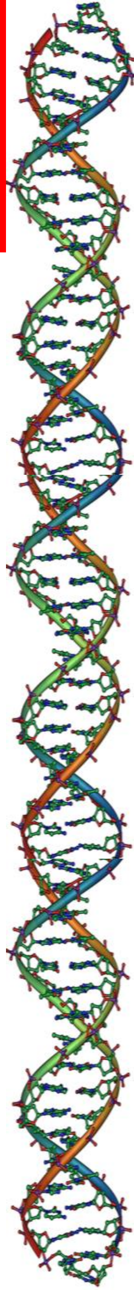
Starch – need to re-gel

- Heat
- Storage conditions



END DAY 26

Content



From Last Time:

Basic Bread

Ingredients:

3/4 cup warm water

1 package active dry yeast

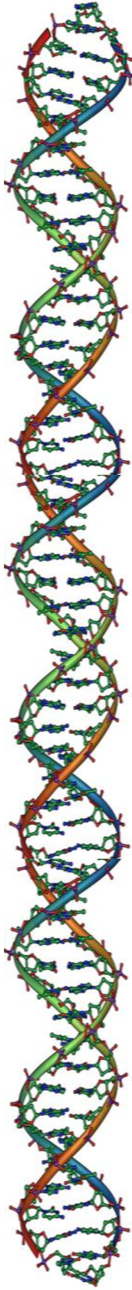
1 tsp salt

1-1/2 tbsp sugar

1 tbsp vegetable shortening

1/2 cup milk

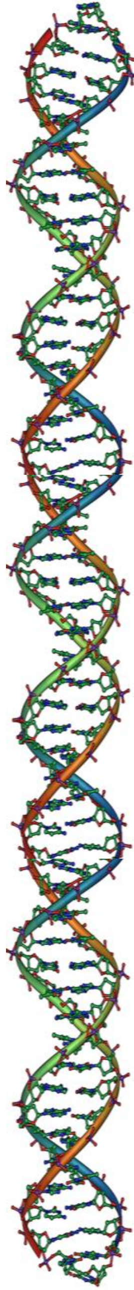
3 cups flour, approximately



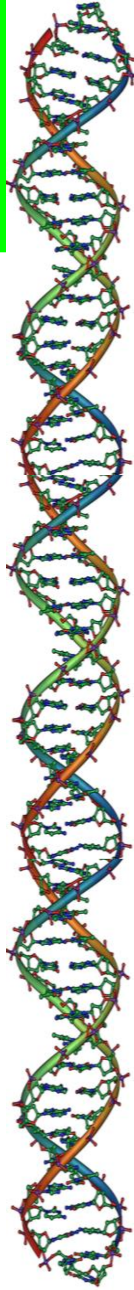
Recipe: http://breadbaking.about.com/od/yeastbreads/r/1loafbread.htm

Title

Content



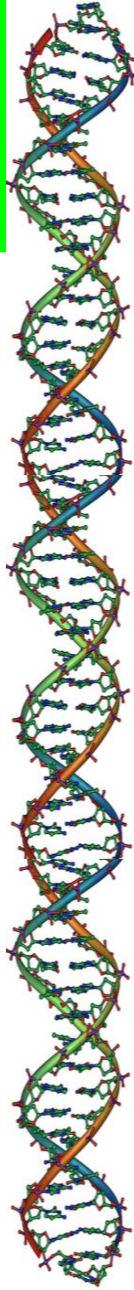
TOPIC BEGIN



Breads and Doughs

TOPIC BEGIN

Exam 1 review

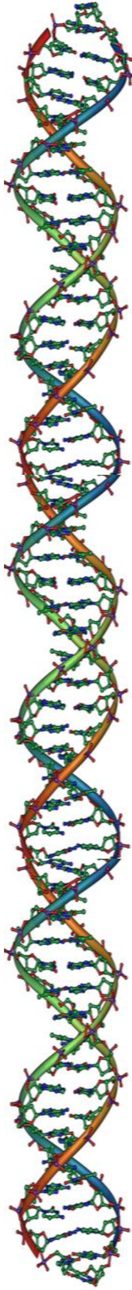


From Last Time:

Exam 1 Results & Feedback:

- Average = 68%
- Number of questions?
- Level of questions?

Will be posted to D2L soon…



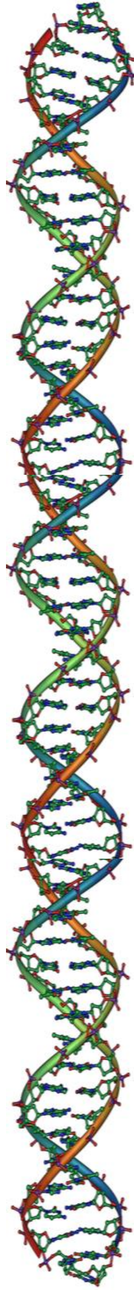
Grades right now…

How D2L lists them…

What does your score mean?

- 1st exam is almost always low
- ***<u>If</u>*** grades based just on this exam:
  - 100.0-86.00% = A
  - 85.99-72.00% = B
  - 71.99-60.00% = C
  - 59.99-50.00% = D

Real grade ranges will be higher



Exam details

Fill in your Scantrons correctly

Write on the exam

Use the information in other questions to help yourself

Answer all questions

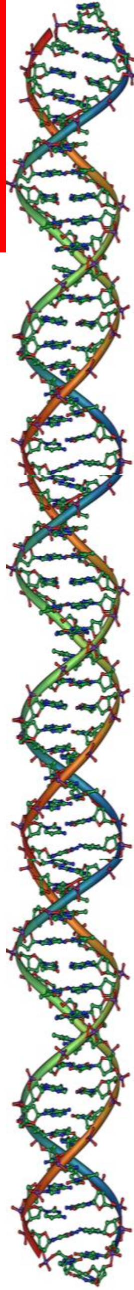
END DAY XX

Content

From Last Time:

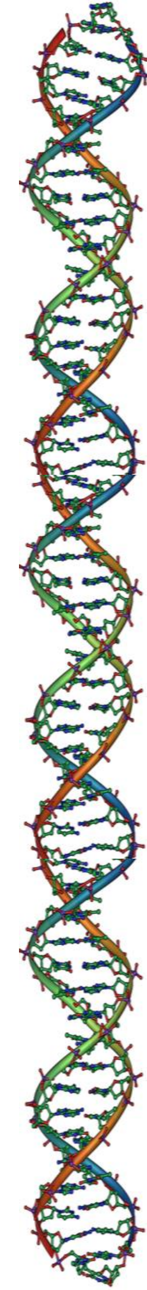
END DAY XX

Content



From Last Time:

What is food made of?



Water

Inorganic components

Salts, minerals

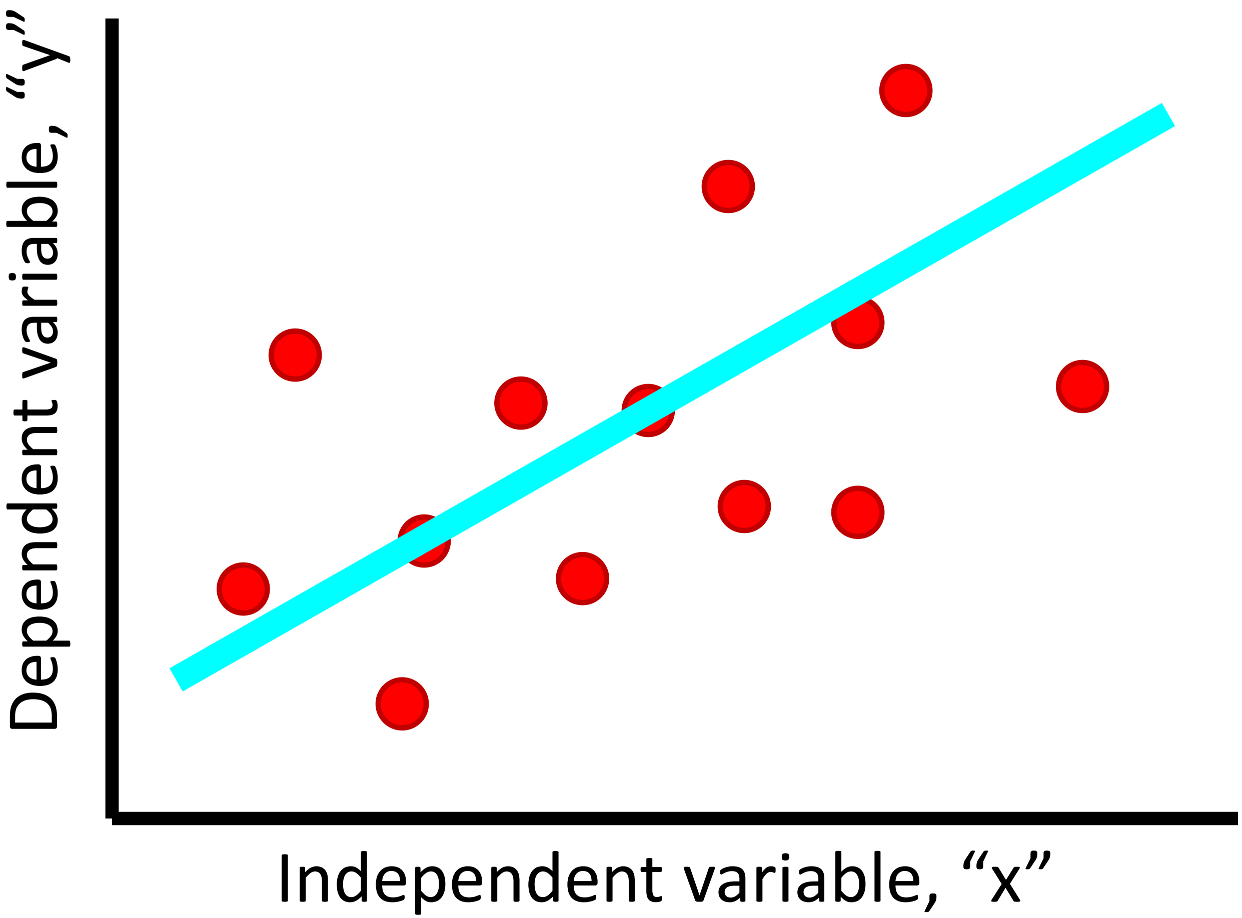
“Small” Organic Molecules

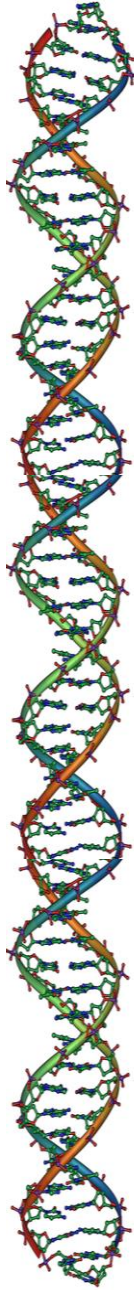
Vitamins, metabolites

Macromolecules

Lipids, proteins, carbohydrates

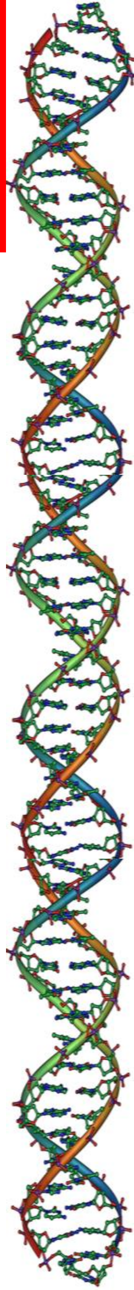
Making graphs





END DAY XX

Content



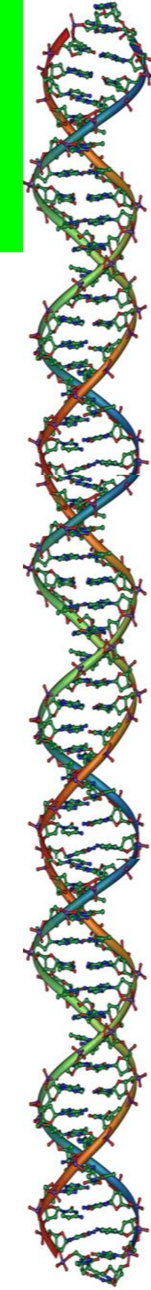
From Last Time:

END DAY XX

Content

From Last Time:

TOPIC BEGIN



Exam 2 review

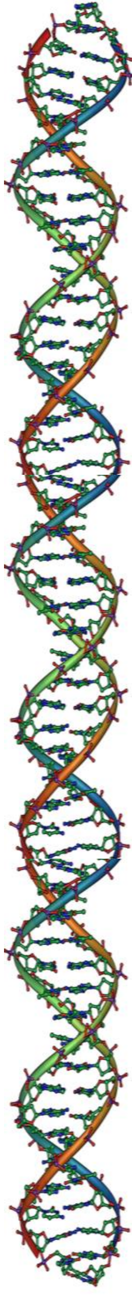
Exam 2

Know your Dragon ID#

Pencil(s)!

Filling out Scantron…

Write on exam book!



Exam 2

Cheese

- As with most food preparations, mostly an accident!

Milk curdled by acid ***<u>and</u>*** rennet

Rennet/chymosin

- Shaves kappa-casein off micelles
- Forms network

Exam 2 – Bacteria

- Acidifying
  - Mesophilic (lactococi)
  - Thermophilic (lactobaccilli, streptococci)
- Aging – flavor & aroma
  - Digest fats and proteins
  - Liberate CO2 (propionibacteria)

Exam 2 - Molds

- Blue Molds
  - Inside the cheese
  - Break down fats
- White Molds
  - Surface
  - Break down proteins

Exam 2

Cheesemaking

Tasting

Storing

Cooking

Exam 2

Eggs

Composition/Biology

Fresher vs. Older

Chickens

Exam 2

- Whip It!
- Whites/albumen
  - Chemistry of disulfide bonds
  - Cream of tartar
  - Setting albumen foams
- Yolks

Exam 2

Custard's Last Stand…

Evaluating a recipe

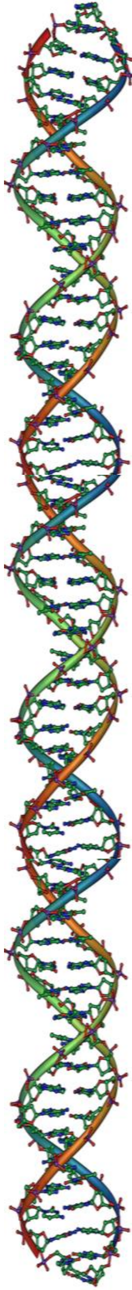
Molecular components

Methods of heat management

Exam 2

Specific Heat Capacity

Phase changes



Questions?

No, really, are there any questions?

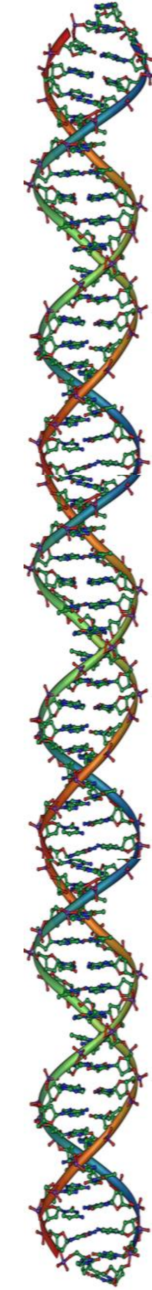
Exam 2

Average = 113 points = 75%

Class so far…

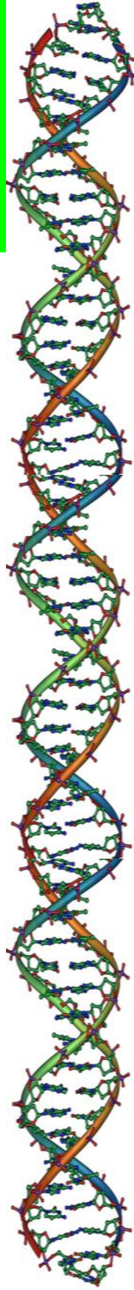
Average = ~74%

If grades were assigned right now, cutoffs in syllabus would be adjusted down slightly.



TOPIC BEGIN

Study Skills, other help



Study skills

Not always developed pre-college

College-level classes

- Less in-class time
- More outside time
- More outside distractions
- Fewer “pulse and position points”
- More responsibility

Study skills

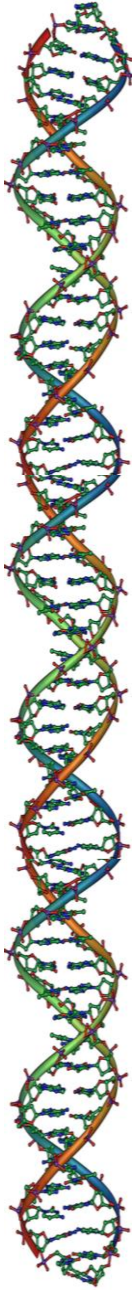
Time management

Schedule time to study/review

- 1-2 hours per hour in class is reasonable
- Location, location, location
- Find what works for you

Flash cards work for some classes!

Taking notes



SQ3R

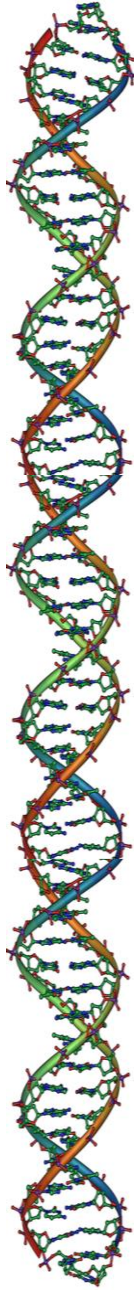
Survey

- Skim headings, key words, etc
- Look at figures, tables
- “Testing the waters”

SQ3R

Question

- Before reading in detail, write down a few questions you think will be answered
- Do this by section – small is OK
- Gives you something to look for (focus)
- “Engaged reading”



SQ3R

Read

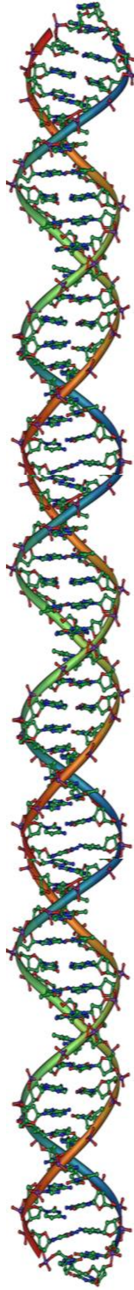
- Answer your questions (or revise)

Recite

- Yes, out loud.
- Study groups – discussion

Review

- After the whole reading
- Again, note cards are useful



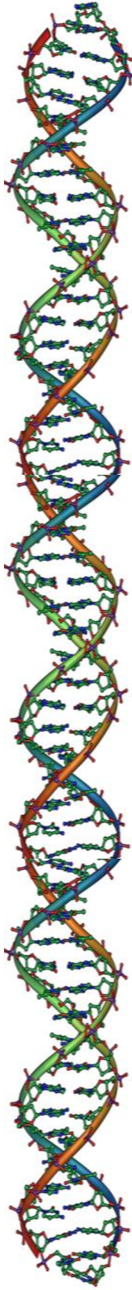
Using a “method”

SQ3R isn’t perfect

Good start for a web search…

Many other methods

Find aspects that work for ***you***.



Exploring a Recipe

- Custard – The Basics
  - A network of egg proteins
  - Delicate, not rubbery
- Science!
  - Identify variables
  - Predict their effect
  - Test, revise, re-test

Two custards…

Custard is milk and eggs

- Often sweetened (sugar/maple syrup/etc)
- Other flavors – vanilla/nutmeg/lemon

Custard #1

Very simple custard:

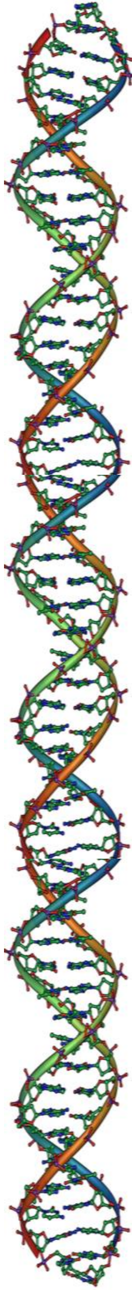
BAKED EGG CUSTARD

4 eggs
2 1/2 c. milk
1/2 c. sugar (or to taste)
Vanilla
Nutmeg

Place all ingredients in a saucepan. Beat together. (The secret of this custard is to beat gently until everything is just thoroughly mixed). Heat the mixture until hot, but not boiling. Place in baking dish, sprinkle more nutmeg over the top if desired and bake in a 325°F oven for 40 minutes.

Image: http://www.cooks.com/rec/view/0,1816,150185-234200,00.html

Custard #2



BAKED VANILLA CUSTARD

3 eggs, slightly beaten
1/4 c. sugar
1/4 tsp. salt
1/2 to 1 tsp. vanilla
2 c. skim milk, scalded
Ground nutmeg for garnish

Combine first 4 ingredients, beating well. Gradually add milk, stirring constantly. Pour into 6 (6 ounce) custard cups. Sprinkle with nutmeg.

Place custard cups in a large baking pan; pour hot water into pan to a depth of 1 inch. Bake at 325 degrees for 40-45 minutes or until knife inserted halfway between center and edge of cup comes out clean. Remove cups from water and cool. Chill thoroughly.

Image: http://www.cooks.com/rec/view/0,1913,146188-227200,00.html

The Ingredients

Compare ratios

BAKED EGG CUSTARD

4 eggs
2 1/2 c. milk
1/2 c. sugar (or to taste)
Vanilla
Nutmeg

BAKED VANILLA CUSTARD

3 eggs, slightly beaten
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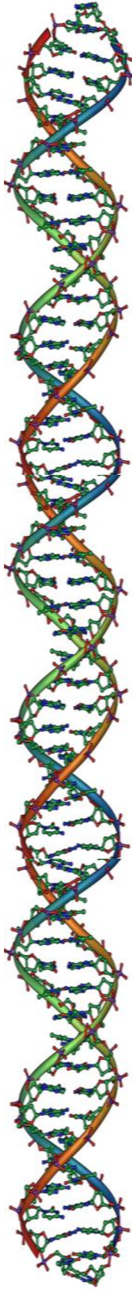
Ground nutmeg for garnish



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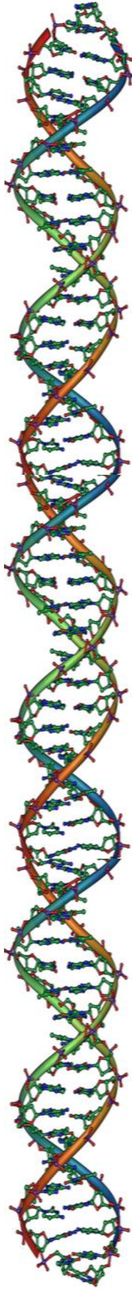
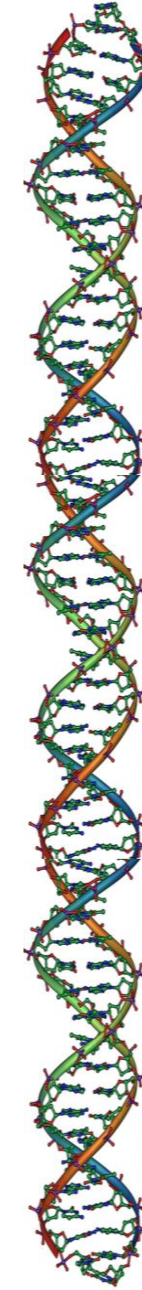


Heat Management



Mixtures can have complex behavior

"Albumin" is a class of proteins

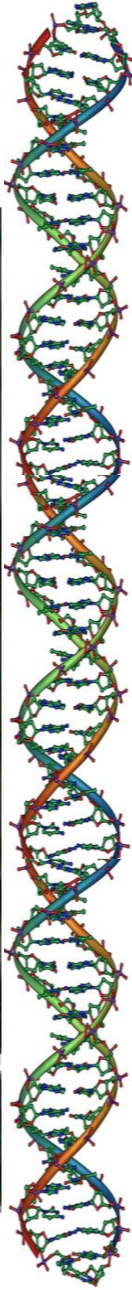
Casein vs. Whey proteins

Mixtures of fats

Eggs & Scalded Milk

Tempered "Custard"

In water baths…



Scrambled Eggs

Procedure

D2L discussion - optional

Assignment to hand in

Must be typed

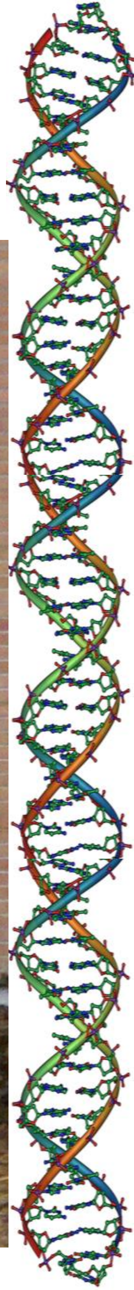
Answer all questions

Due Monday by 2pm

Turning In Papers

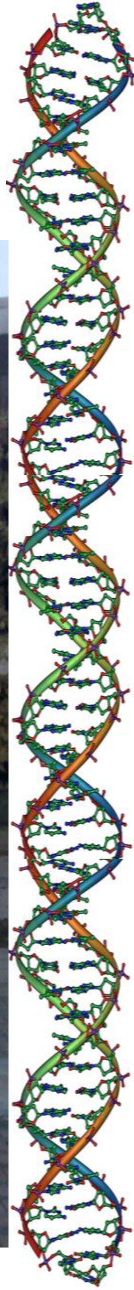
Science of Cooking – BCBT100
Summer 2016 - Bodwin

Turning In Papers



Science of Cooking – BCBT100
Summer 2016 - Bodwin

Turning In Papers



Science of Cooking – BCBT100
Summer 2016 - Bodwin

Turning In Papers

Turning In Papers

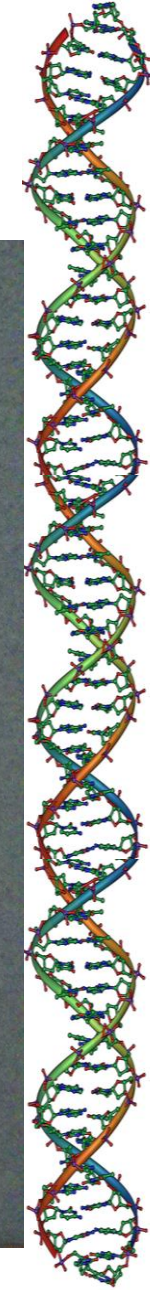
Science of Cooking – BCBT100
Summer 2016 - Bodwin

Turning In Papers

Science of Cooking – BCBT100
Summer 2016 - Bodwin

Turning In Papers

Turning In Papers

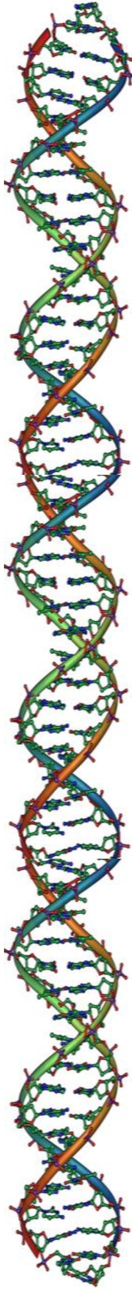


Title

Content

Title

Content



END DAY XX

Notes…

Exam XX

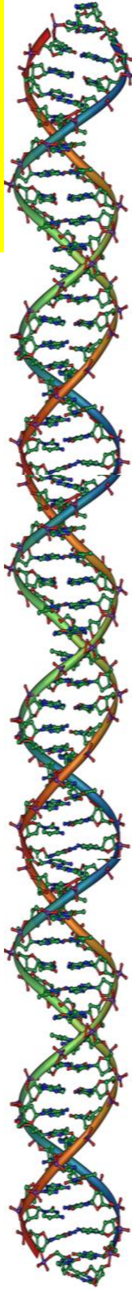
Number of takers =

Max score = XXX/150

Average score = XXX/150

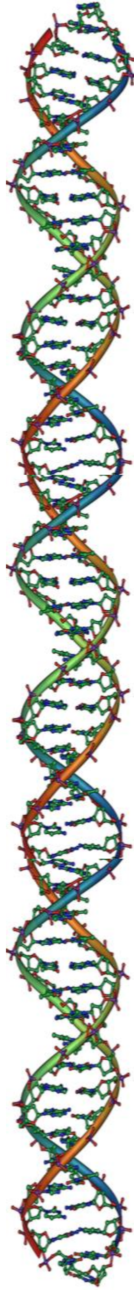
Min score = XXX/150

Standard Deviation =



From Last Time:

Review bits…



Temperature Conversions

Fahrenheit (historically)

- 0°F = Salt water freezing (colligative)
- 32°F = Water freezing
- 96°F = “blood heat”

Celsius (historically)

- 0°C = Water freezing
- 100°C = Water boiling

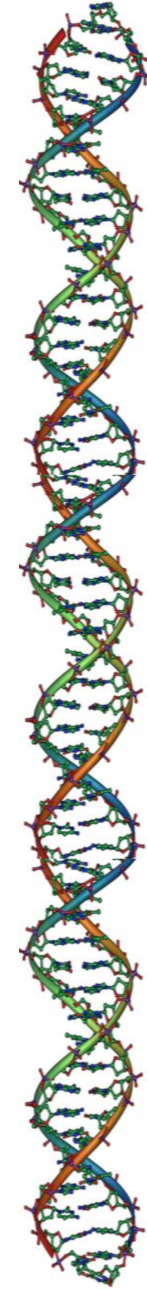
Adjustments over time…

Do the math

What is “body temperature”?

Absolute Scales

- Kelvins
  - 1K = 1°C
  - “Zero” really means “zero”
  - 0°C = 273.15K
- Rankine (rarely used)
  - 1°R = 1°F
  - “Zero” is absolute zero
  - 0°F = ??°R



Temp!

Scales

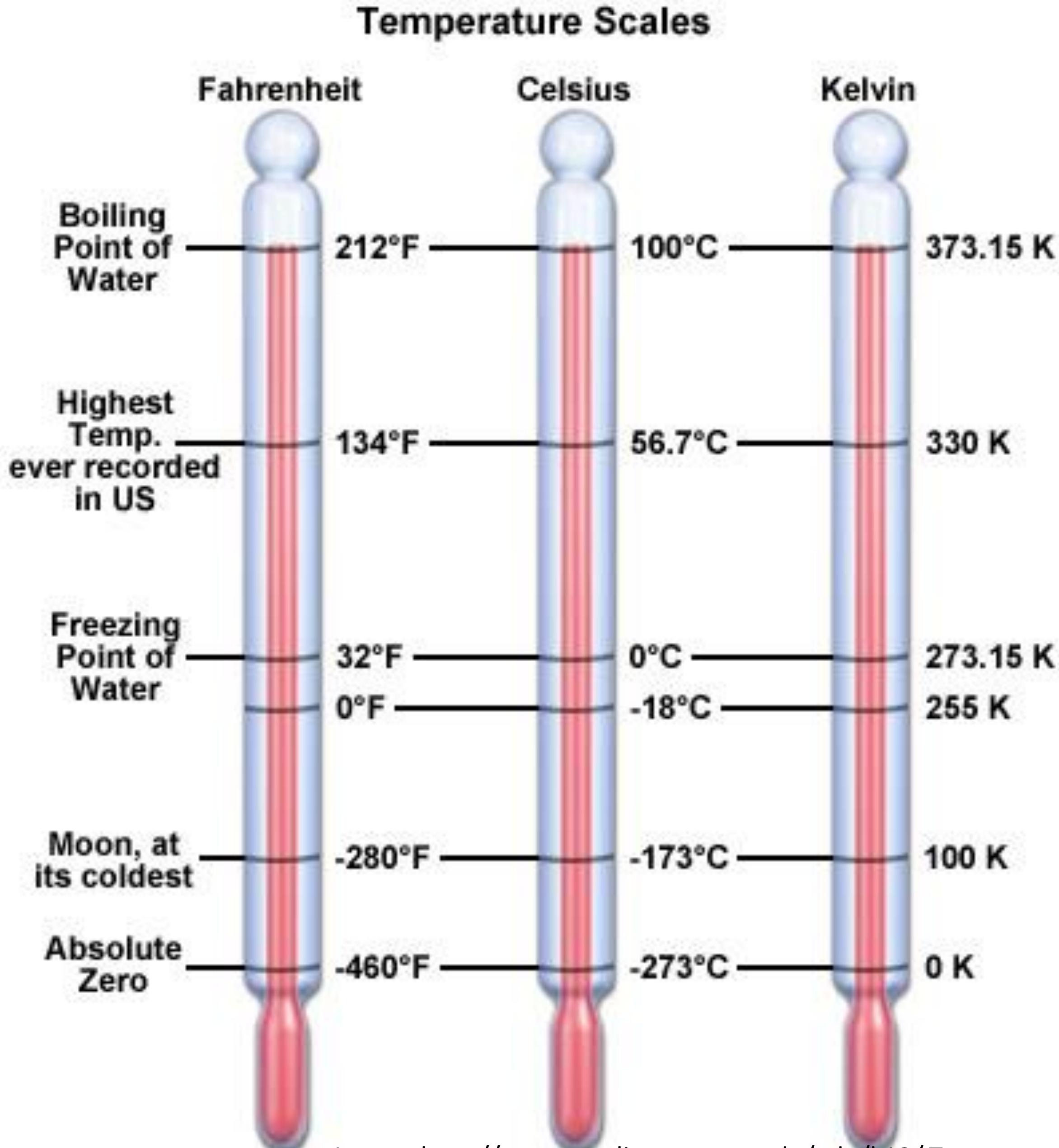


Image: http://www.nc-climate.ncsu.edu/edu/k12/.Temperature

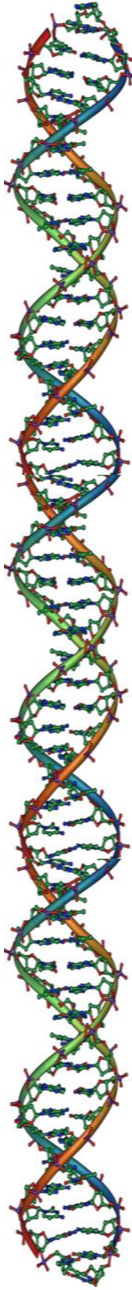
From Last Time:

Exam 2 Scores & Feedback:

Average = 72%

Lab 1 Scores in D2L (average = 20)

Always answer "why".



END DAY 17

Content

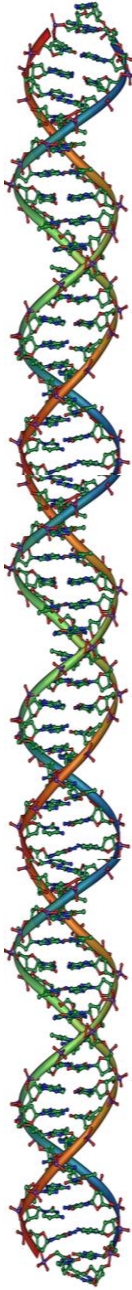
Making & Using Graphs

Why graph?

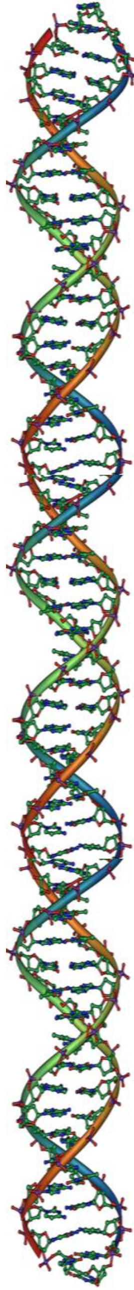
Easier to visualize data

Easier to see trends

A picture paints 1000 words…



Making & Using Graphs



Axis formatting

- Use the full axis
- Equal spacing

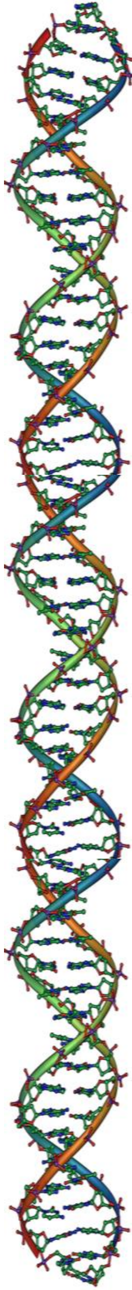
Choosing “x” and “y”

- x = you “control”
- y = you observe

Making & Using Graphs

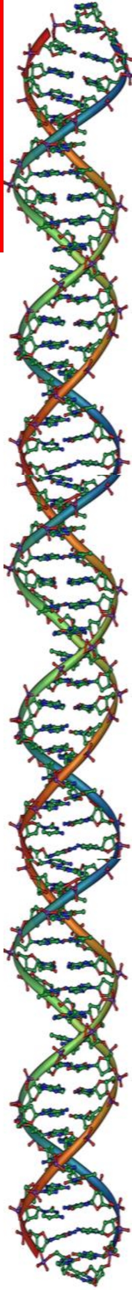
Interpreting graphs

Linear relationships



END DAY 16

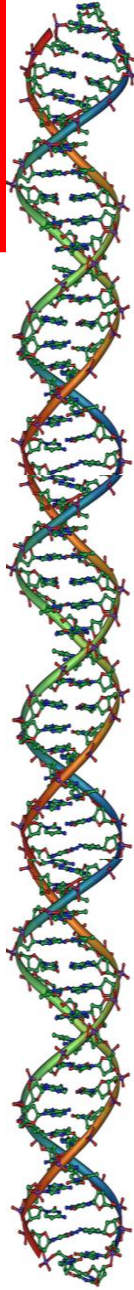
Content



END DAY 18

TECHNICAL DIFFICULTIES

I tripped a breaker in the media station in LH104 so we did a little activity on colligative properties (boiling point) and good experimental design



From Last Time: