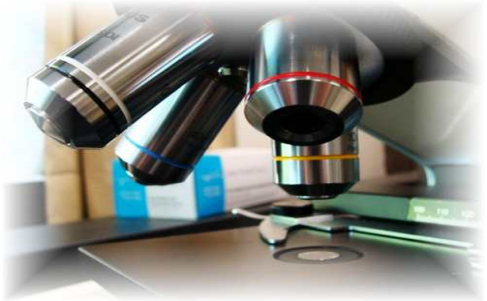

About Science Prof Online PowerPoint Resources

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• The SPO Virtual Classrooms offer many educational resources, including practice test questions, review questions, lecture PowerPoints, video tutorials, sample assignments and course syllabi. New materials are continually being developed, so check back frequently, or follow us on Facebook (Science Prof Online) or Twitter (ScienceProfSPO) for updates.

• Many SPO PowerPoints are available in a variety of formats, such as fully editable PowerPoint files, as well as uneditable versions in smaller file sizes, such as PowerPoint Shows and Portable Document Format (.pdf), for ease of printing.

• Images used on this resource, and on the SPO website are, wherever possible, credited and linked to their source. Any words underlined and appearing in blue are links that can be clicked on for more information. PowerPoints must be viewed in *slide show mode* to use the hyperlinks directly.

• Several helpful links to fun and interactive learning tools are included throughout the PPT and on the Smart Links slide, near the end of each presentation. You must be in *slide show mode* to utilize hyperlinks and animations.

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Image: Compound microscope objectives, T. Port

Metabolism:

Diet & Nutrition

Stuff We Need

_____nutrients:
- Carbohydrates
- Proteins
- Lipids

_____nutrients:
- Vitamins
- Minerals

…and, of course, **Water**

Image: Stilleben, painting dated 1613, oil on canvas, by Floris van Dyck

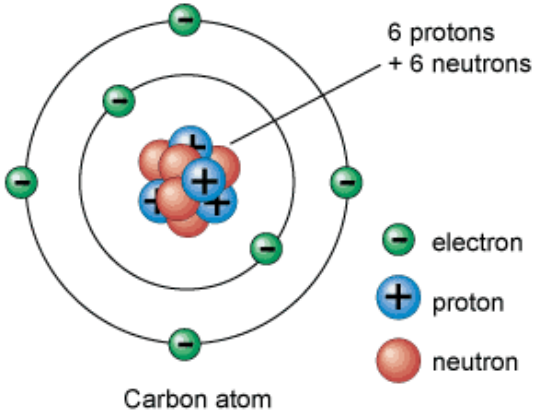
The Chemistry of Food ☺ (yummy!)

- Macronutrients: Three of the four types of major organic macromolecules we recognize as part of our diet: **Carbs, protein & lipids** (fats).
- Provide **energy** to fuel body's activities.
- And **raw materials** to build body's own molecules.

Image: Leo after pouring baby food on his head ☺, T. Port

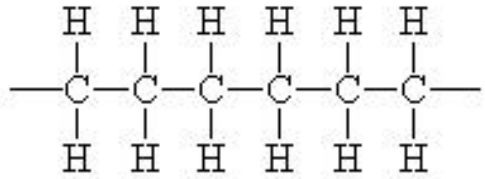
Carbon

Little Atom, Big Deal



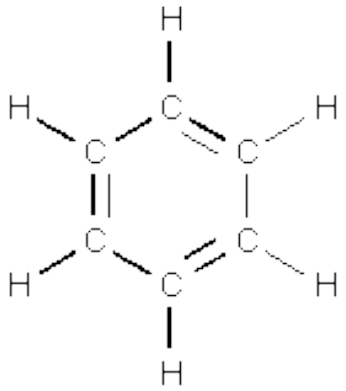
The chemical basis of life. Abundant in all known life forms.

Essential to complex organic macromolecules, because each carbon atom can form ____ bonds (usually involving hydrogen , oxygen and/or nitrogen).



Able to form polymers (big organic molecules).

- The atoms can bond with each other to form long chains.
- Sometimes the ends of these chains join together to form a ring.

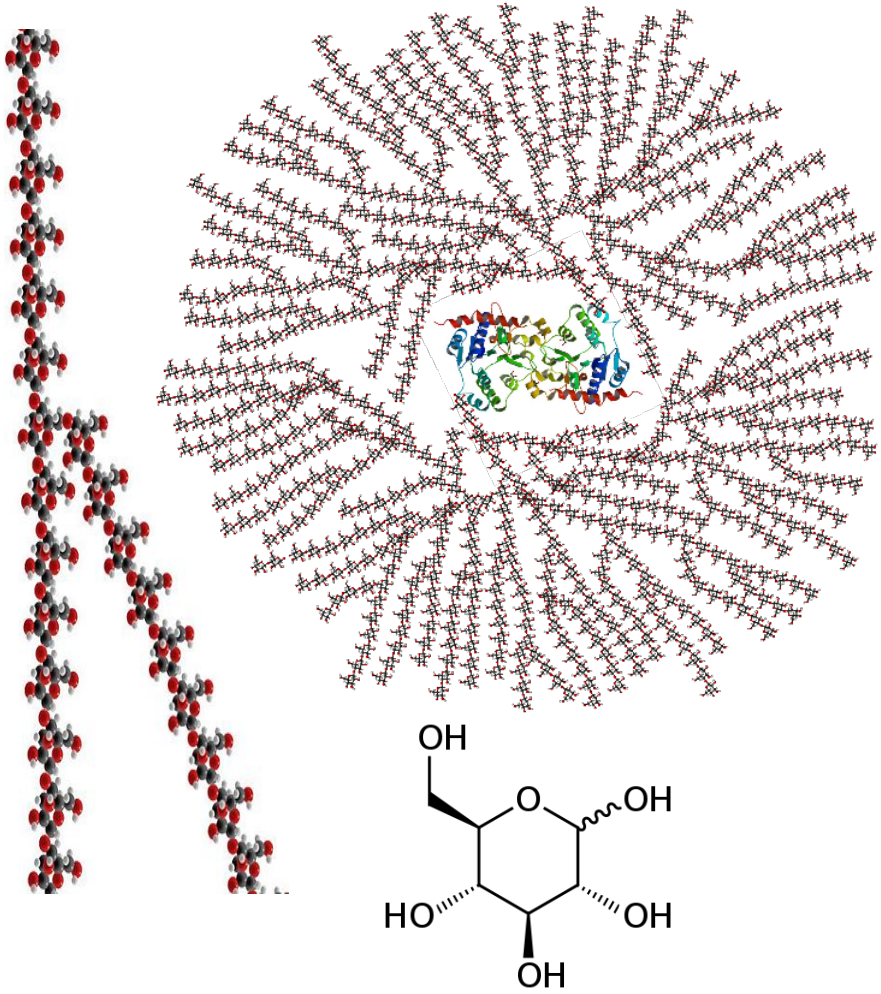


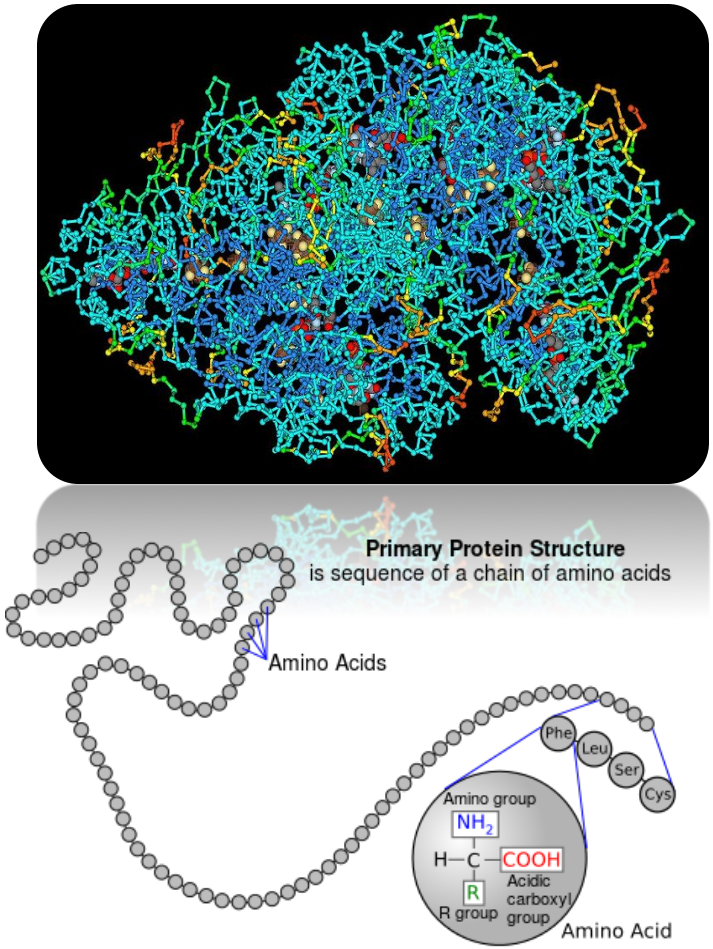
Double bonds form when atoms share two pairs electrons (two covalent bonds). Triple bonds = 3 shared pair of electrons.

Images: Carbon, Universe Today Website

Polymers

Big molecules that are made of many similar units (monomers).



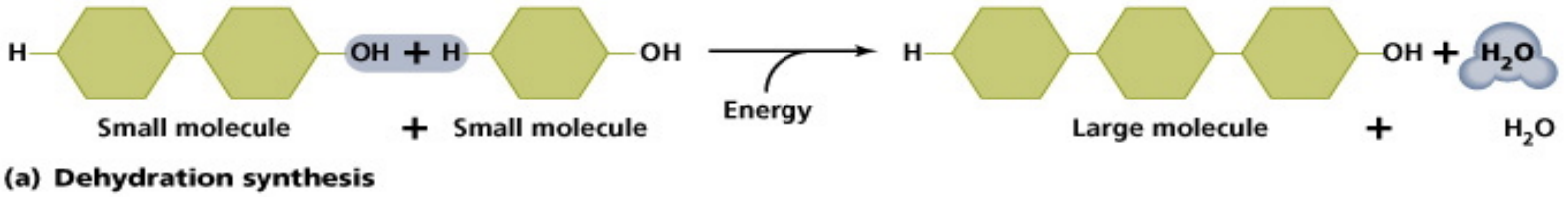


Images: Part of a Glycogen Molecule, Wiki; Glycogen diagram, Wiki; Glucose chemical structure, Wiki; Protein Molecule, Wiki; Primary structure of protein, Wiki

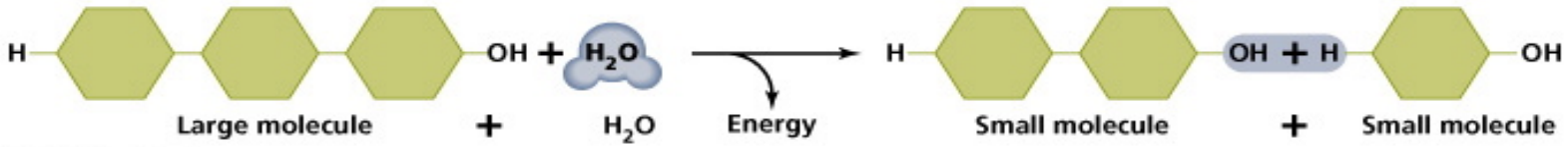
Polymers Can be Built and Broken Down Through Dehydration and Hydrolysis Reactions

Dehydration reaction: Building the polymer.

- Polymer = long chain of subunits called monomers.
- Reconnect monomers by covalent bonds
- a.k.a. Condensation reaction
- Energy input required.
- Aided by enzymes.



(a) Dehydration synthesis



(b) Hydrolysis

Hydrolysis: Breaking the polymer.

- Covalent bond is broken between subunits.
- Releases energy
- Aided by enzymes

Building and Breaking Down Molecules

Anabolic Reaction

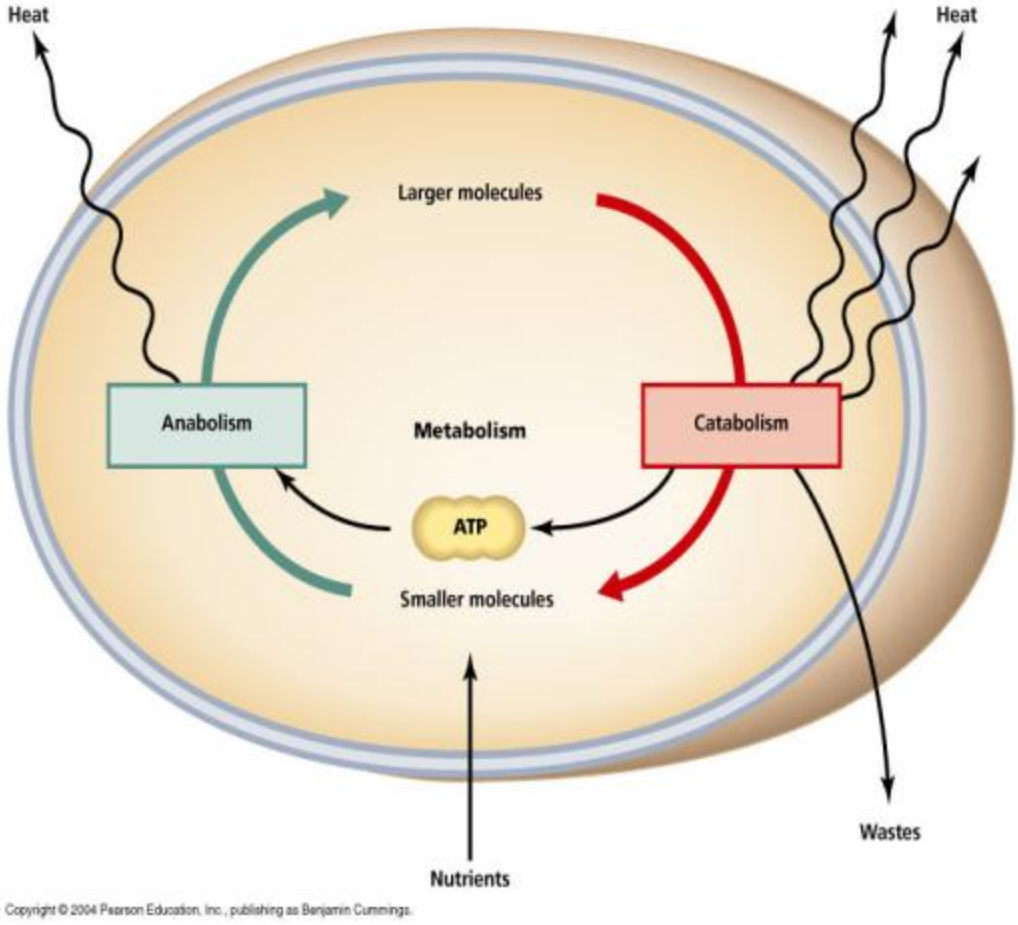
(anabolism)

The phase of metabolism in which simple substances are **synthesized** into the complex materials of living tissue.

Catabolic Reaction

(catabolism)

The metabolic **break down** of complex molecules into simpler ones, often resulting in release of energy.



3 of the 4 macromolecules commonly occur on Nutrition Labels, and are the major components in our diet.

Sample Label for Macaroni and Cheese

Start Here

Limit these Nutrients

Get Enough of these Nutrients

Footnote

Nutrition Facts

Serving Size 1 cup (228g)
Servings Per Container 2

Amount Per Serving

Calories 250	Calories from Fat 110
	% Daily Value*
Total Fat 12g	18%
Saturated Fat 3g	15%
Trans Fat 1.5g	
Cholesterol 30mg	10%
Sodium 470mg	20%
Total Carbohydrate 31g	10%
Dietary Fiber 0g	0%
Sugars 5g	
Protein 5g	
Vitamin A	4%
Vitamin C	2%
Calcium	20%
Iron	4%

* Percent Daily Values are based on a 2,000 calorie diet. Your Daily Values may be higher or lower depending on your calorie needs:

	Calories:	2,000	2,500
Total Fat	Less than	65g	80g
Sat Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Quick Guide to % DV

5% or less is low
20% or more is high

Q: Which organic macromolecule that is part of our diet is not present on food labels?

Images: Nutrition Label, Wiki

Study Table of Organic Macromolecules

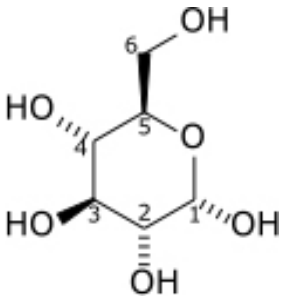
(We will fill this in as we go through the rest of the lecture.)

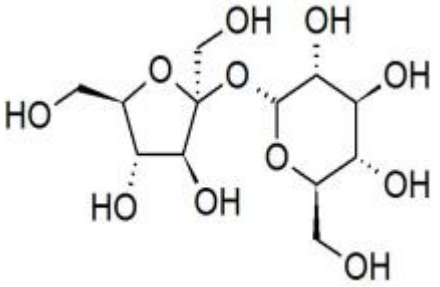
Macromolecule (polymer)	**Made of what type of monomer?**	**Is there another name for this polymer?**	**What are the main elements in this macromolecule?**	**Examples**
1.				
2.				
3.				
4.				

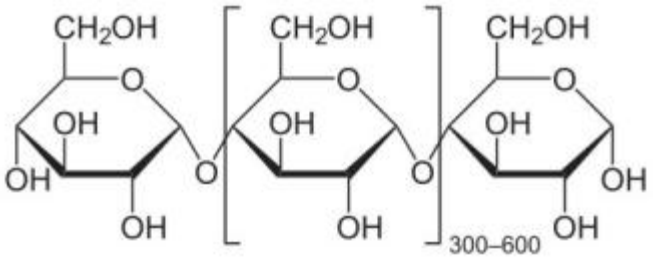
Organic Molecules - Carbohydrates

Monosaccharides

- **single** sugars (one molecule)
- simplest
- **glucose*, fructose







Disaccharides

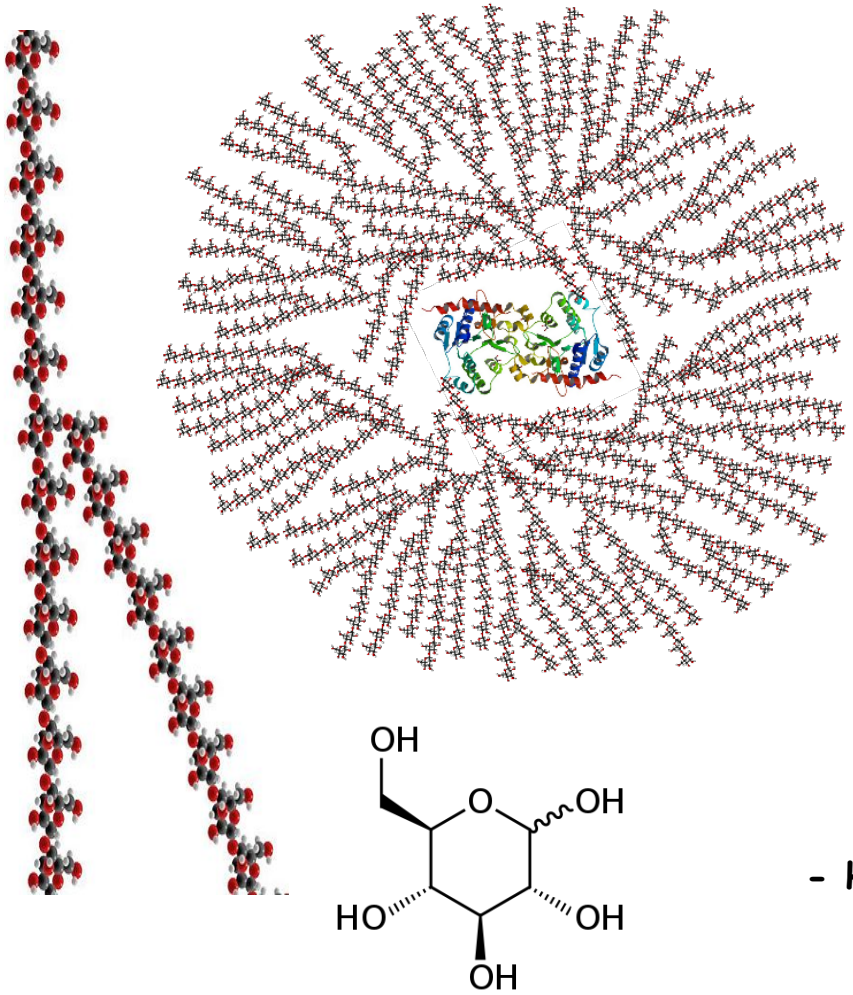
- **double** sugars
- combination of two monosaccharides
- * **sucrose** = glucose + fructose
- * **lactose** = glucose + galactose

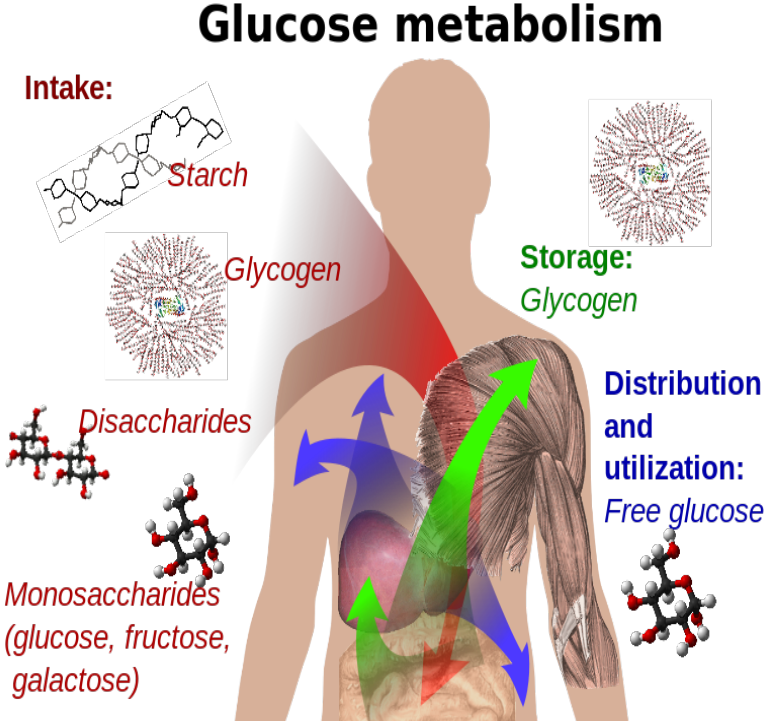
Polysaccharides

- macromolecules; **polymers** composed of several sugars
- can be same monomer (many of same monosaccharide) or mixture of monomers
- **food storage** carbohydrates: ***glycogen*** (animals) ***starch*** (plants)
- **structural** carbs: ***chitin*** (animals), ***cellulose*** (plants)

Glycogen

Carbohydrate polymer that we use to store sugar energy.





- **Subunits are glucose monosaccharides**

- **Humans and other vertebrates store glucose as glycogen in the liver and muscles**

Images: Part of a Glycogen Molecule, Wiki; Glycogen diagram, Wiki; Glucose chemical structure, Wiki; Glucose metabolism, Wiki

Carbohydrates - Nutrition

- Present in fruits, vegetables and grains… essentially in plant matter…and low amounts in dairy.
- _____ carbs are **not** bad for you. They should be the type of food you eat the **most** of *(45 – 65% of your daily food intake).*
- Complex carbs more nutrient-rich and harder for your body to break down. They enter blood stream more slowly, and include **fiber**.
- Highly processed, refined carbs *(such as sucrose)* are like "pre-chewed" food, so are very easily digested. They quickly enter blood stream, and can cause levels of the hormone _____ to spike.
- Consuming too many refined carbs can increase your risk of Type 2 diabetes.

Image: Vegetables, Gpics, Wiki; Grains, USDA; Fruits, Bill Ebbesen

Protein Structure

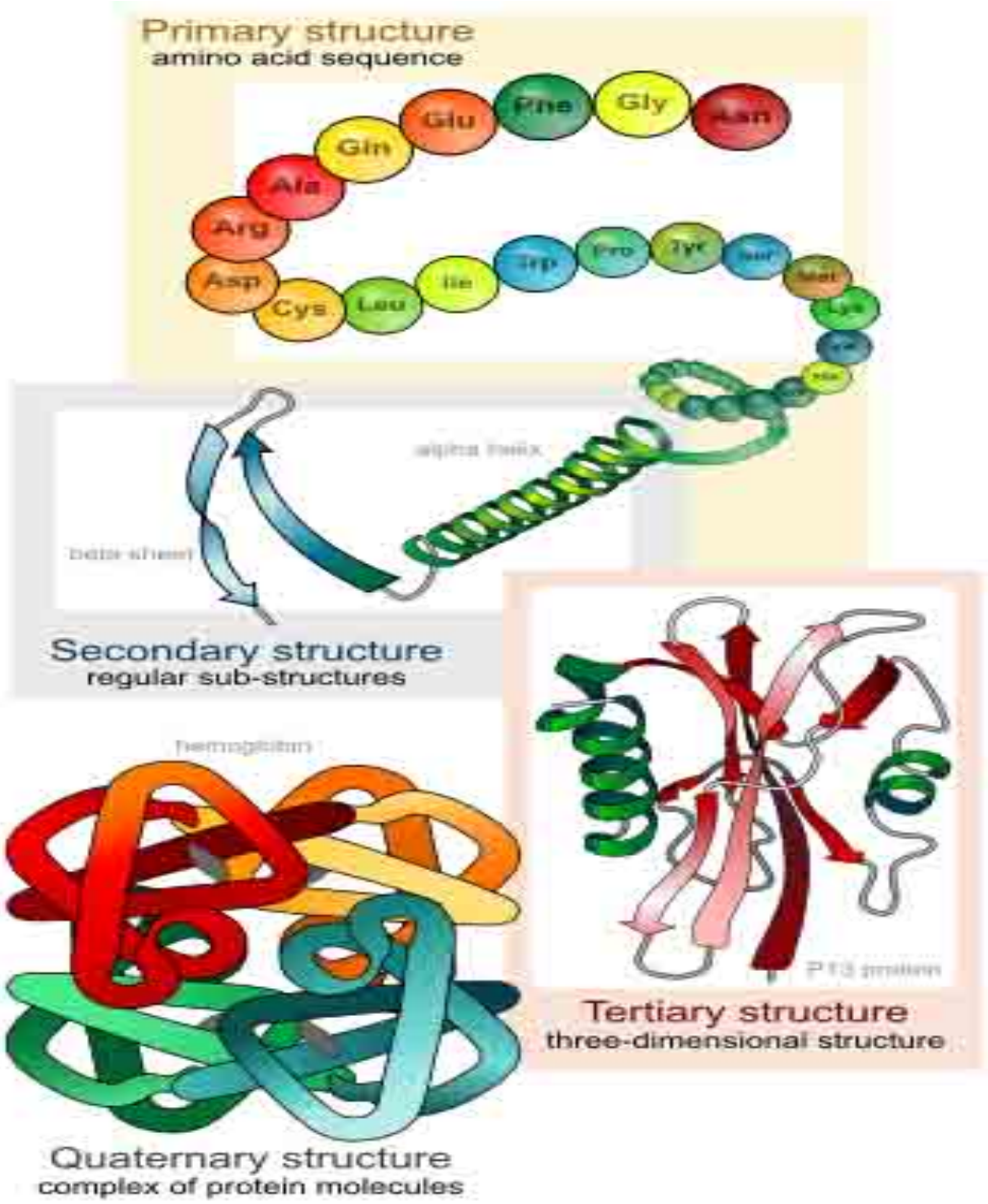
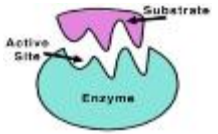


Image: Levels of protein structure, M Ruiz

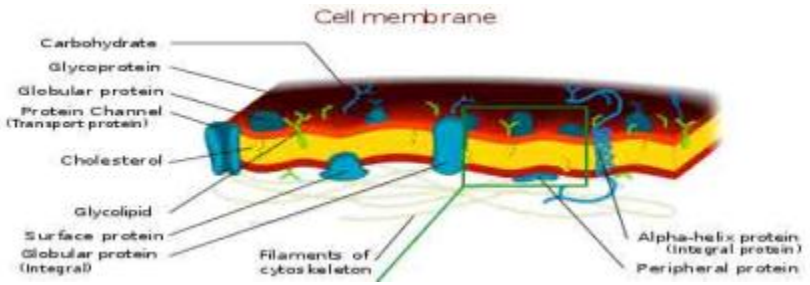
Organic Molecules - Proteins



Complex organic macromolecules fundamental to living cells.

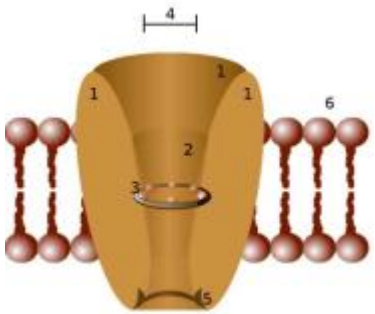
Composed of one or more chains of amino acids.

Proteins perform many functions in cells, including:



1. Structural

• Components in cell walls, membranes, and within cells themselves.

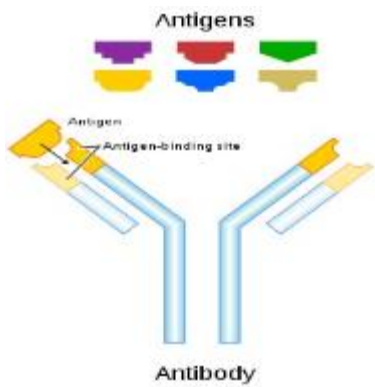


2. Enzymes

• Chemicals that speed up a chemical reaction.
• The catalysts in cells are called enzymes.

3. Regulation

• Some regulate cell function by stimulating or hindering either the action of other proteins or the expression of genes.



4. Transportation

• Some act as channels and "pumps" that move substances into or out of cells.

5. Defense

• Antibodies = proteins that defend your body against microorganisms
• Some bacteria produce proteins (bacteriocins) that kill other bacteria.

Images : Cell Membrane, Wiki; Channel Protein, Wiki; Antibody, Wiki

From the Virtual Biology Classroom on ScienceProfOnline.com

Proteins - Dietary

- _____ **Proteins** = contain all *essential amino acids* necessary for good health
- _____ **Proteins** = are missing some of the *essential amino acids* necessary for good health
- Essential Amino Acids = can't be synthesized by the human body
- Percentage of daily food intake that should be protein: 10 – 35%.
- The amount of protein that a person actually requires on a daily basis is quite small, approximately 0.8 gram per pound of body weight, depending on level of physical activity. *(That means, for example, that 150# person needs about 120 grams or 4.25 oz of protein daily.) – USDA*

Images: Lentils, a vegetable protein, Paul Goyette; Roasted chicken, Viperx,

Organic Molecules – Nucleic Acids

Nucleic acids (both RNA and DNA) are macromolecules; polymers made up of monomers called **nucleotides**.

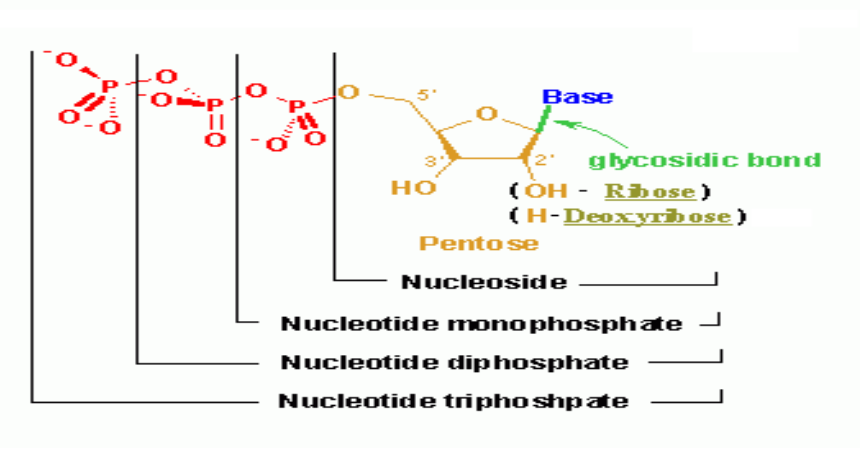
Nucleic acids **deoxyribonucleic acid** (DNA) and **ribonucleic acid** (RNA) = genetic material of cells.

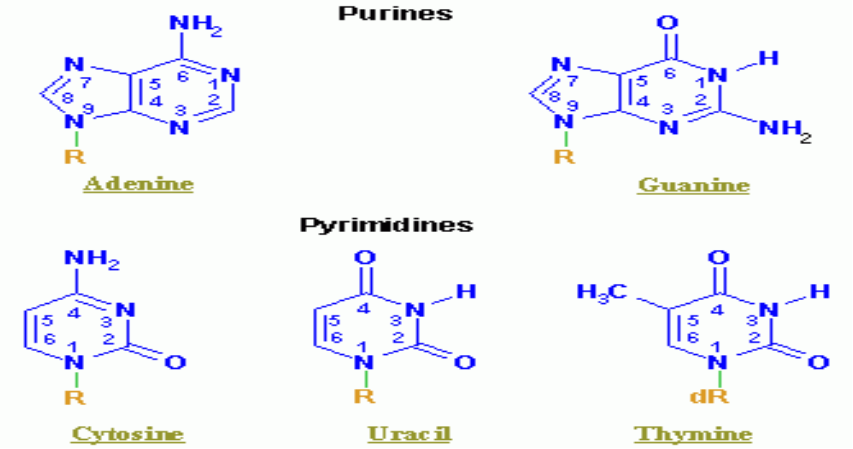
Names derived from type of **sugar** contained within molecules = **ribose**

Nucleotides

Each monomer of nucleic acid is a **nucleotide** and consists of 3 portions:

- a **sugar**
- one or more **phosphate**
- one of five cyclic **nitrogenous bases**
  - +adenine, guanine (double-ringed purines)
  - + cytosine, thiamine or uracil (single-ringed pyrimidines)





From the Virtual Biology Classroom on ScienceProfOnline.com

Image: Nucleotide Structure, Wikipedia

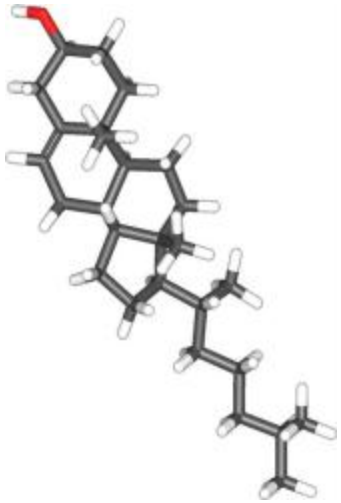
Organic Molecules – Lipids

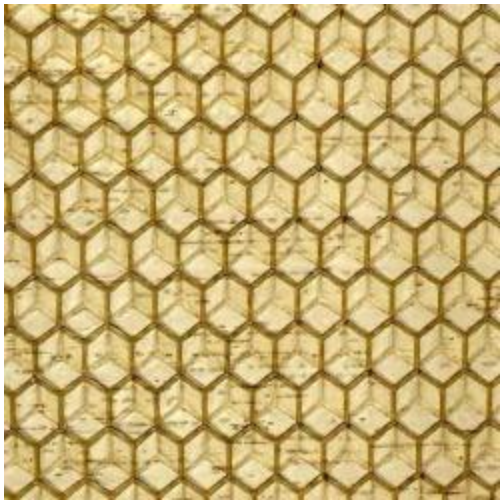
(Fats, Phospholipids, Waxes & Steroids)

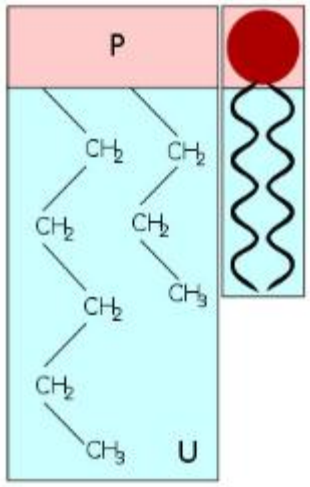
Hydrophobic macromolecules…insoluble in water.

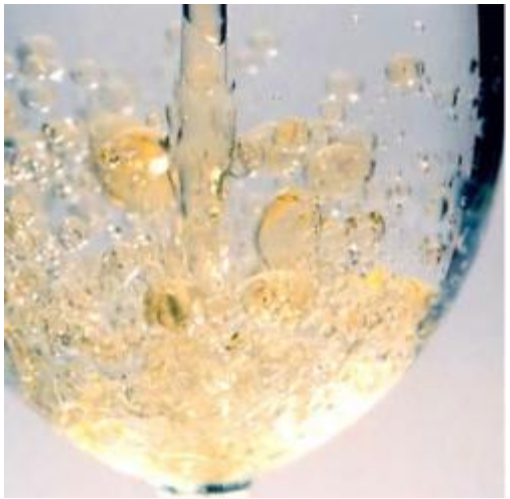
Not attracted to water because …

non-polar covalent bonds linking carbon & hydrogen aren't attracted to the *polar bonds of water.*







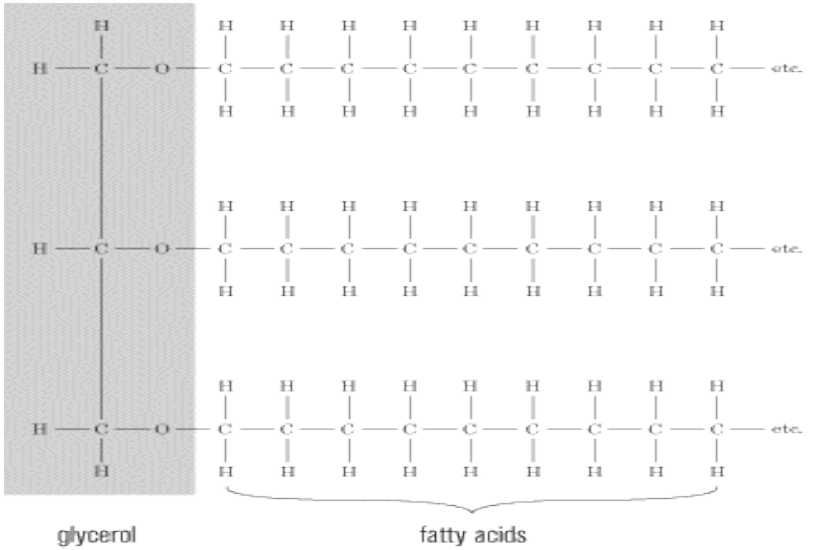


Images: Cholesterol, Wiki; Phospholipid Structure, Bryan Derksen. Wiki Honeycomb, Wikii; Oil & Water, Kidipede

Lipids - Dietary Fats

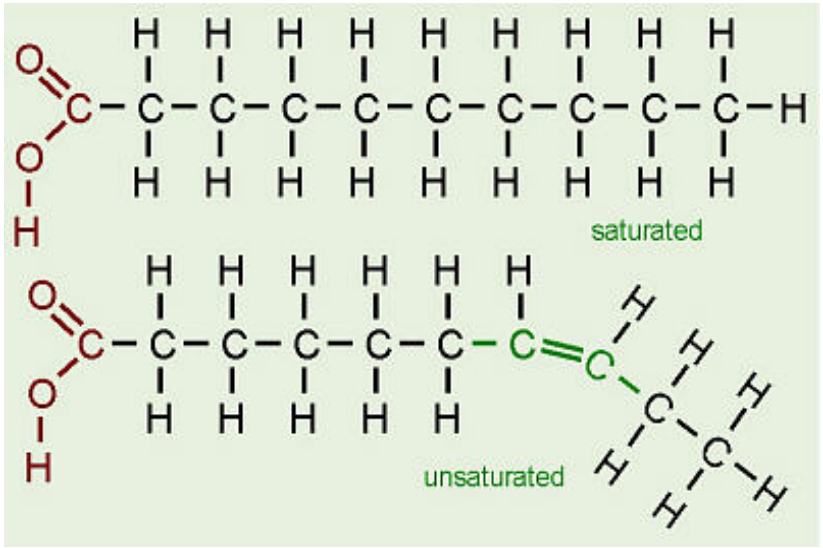
Saturated fats

- Mostly from animal sources.
- Single bonds between the carbons in their fatty acid tails (all carbons are bonded to max number of hydrogens possible).
- Hydrocarbon chains fairly straight and packed closely together … so _____at room temperature.



Unsaturated fats (oils)

- Mostly from plant sources.
- Have double bonds between some carbons in the hydrocarbon tail, causing bends or "kinks" in shape.
- Kinks in hydrocarbon tails, so unsaturated fats can't pack closely together … _____ at room temp.



Lipids – Dietary Fats

- We typically refer to them all as "Fats", but remember, fats are only one of several molecules known as lipids.

- Phospholipids, steroids and true fats play an important role in human nutrition, should get no more than 30% of calories from fats. The type of fat consumed is very important!

- _____ fatty acids (EFAs) are fats that the body can't make, but needs to take in from outside sources.

- There are two families of EFAs: omega-3 and omega-6. Fats from each of these families are essential, as the body can convert one omega-3 to another omega-3, for example, but cannot create an omega-3 from scratch.

- When the EFAs were discovered in 1923, they were designated Vitamin F. In 1930, further research showed that the two EFAs are better classified with the fats than with the vitamins.

Olive oil has both omega 3 and omega 6 EFAs

Organic Molecules – Lipids

*(Fats, **Phospholipids**, Waxes & Steroids)*

Phospholipids

- Phospholipids are a major component of all cell membranes.
- Most phospholipids contain a diglyceride as the tail, and a phosphate group for head.
- Hydrocarbon tails are **hydrophobic**, but phosphate heads are **hydrophilic**.
- So phospholipids are soluble in both water and oil.
- Tails from both layers facing inward and the heads facing outward = **phospholipid bilayer**.

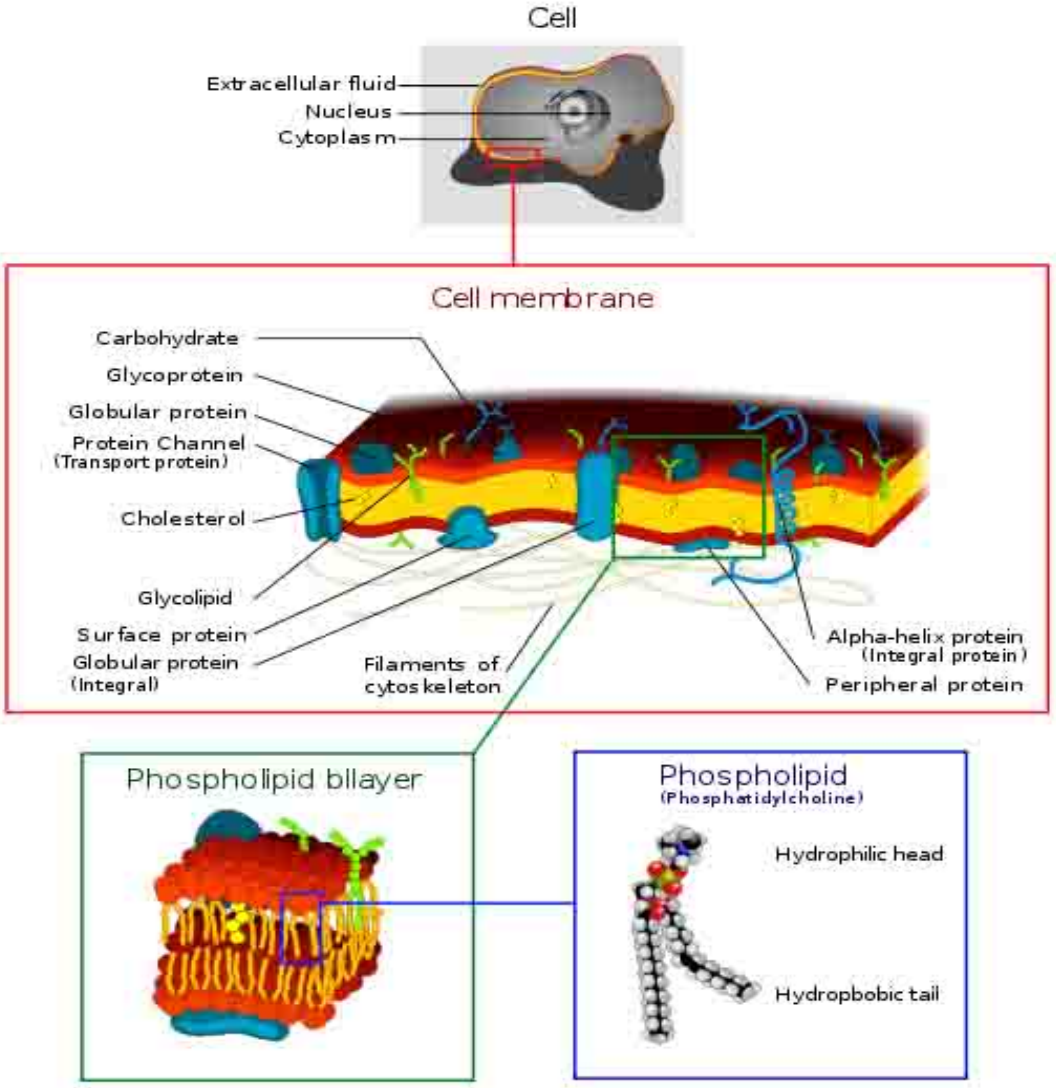


Image: Cell Membrane, Wiki;

Phospholipids - Dietary

- Because they are polar *(hyprophobic and hydrophilic parts)* phospholipids can act as an emulsifier in foods, enabling oils to dissolve in water.
- _____, which is made of phospoholipid, is used in cooking sprays and as a food emulsifier.

  For example, lecithin keeps the cocoa and cocoa butter in a candy bar from separating.

  Originally discovered in egg yolk, and today commercially extracted from soybeans, but widely present in animal and plant tissues.
- Remember, if we are eating cells, we are eating phospholipids.

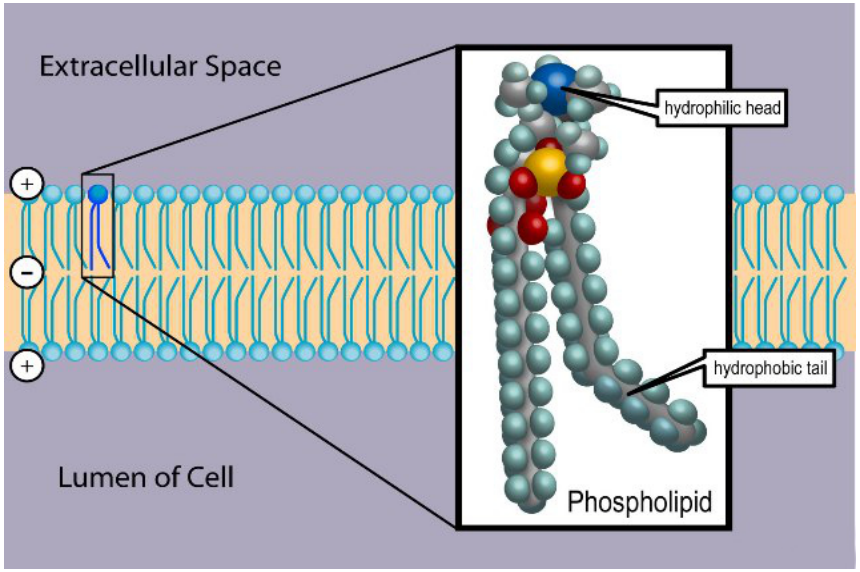


Image: Phospholipid, Wikipedia

Calories (really Kilocalories)

Q: What is a calorie?

Carbohydrates have _____ calories per gram.

Fiber, a type of less-digestible carb has _____ calories per gram.

Proteins have _____ calories per gram.

Fats have ____ calories per gram.

How many calories are in alcohol?

7 calories per gram.

But different drinks have different strengths of alcohol.

So you can calculate the calories in any alcoholic drink that you consume with the following calculation:

1.6 x alcohol % x oz in a glass

To learn more about alcohol and your health, see the "Rethinking Drinking" website by the NIAAA (National Institute on Alcohol Abuse and Alcoholism).

The Chemistry of Food ☺ (yummy!)

- Micronutrients: Our diet must also include **essential nutrients** that our bodies cannot manufacture but are needed for biological function, such as:
  - Vitamins
  - Minerals

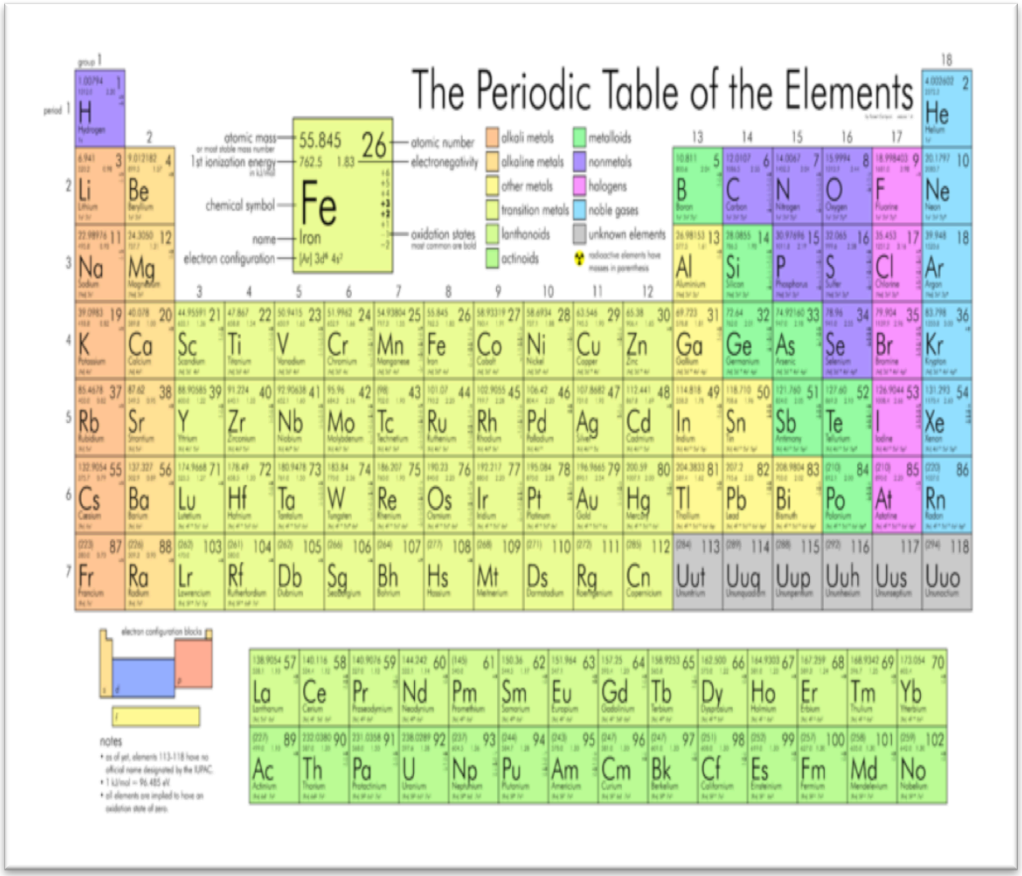
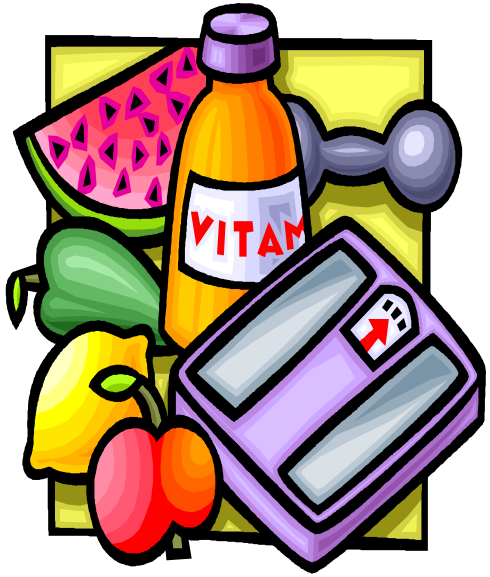


Image: Periodic Table of Elements, Wiki

VITAMINS - Micronurteints



- _____ _____ usually not produced by the body, but essential in minute amounts for metabolism.

- Do not serve as a source of energy, but some help facilitate many metabolic reactions as _____.

- *Example*: B vitamins

  - Eight water-soluble vitamins that play important roles in cell metabolism.

  -Once thought to be a single vitamin, referred to as Vitamin B (much like how people refer to Vitamin C or Vitamin D).

  - Later research showed that they are chemically distinct vitamins that often coexist in the same foods.

  - Supplements containing all eight B vitamins are generally referred to as a vitamin B complex. Individual B vitamin supplements are referred to by the specific name of each vitamin (e.g. B1, B2, B3).

Images: B vitamin caplets, Ragesoss

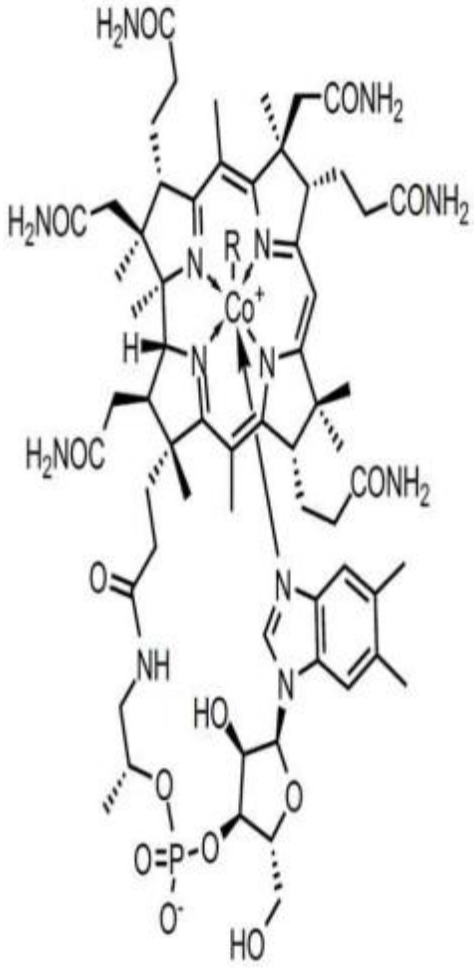
VITAMIN - B_{12}

- Largest and most complex of all the vitamins.
- **Sources of B_{12}**: Only bacteria can synthesize. Present in animal products such as meat, poultry, fish (including shellfish), and to a lesser extent, dairy. Vegans need to take supplements.
- Involved in many aspects of our health. Required for proper red blood cell formation, neurological function, and DNA synthesis.
- 10-15% of people are believed to be deficient in this vitamin.
- **B_{12} and Depression**

  Observational studies have found as many as 30% of patients hospitalized for depression to be deficient in vitamin B_{12}.

  A recent cross-sectional study of 700 community-living, physically disabled women over the age of 65 found that vitamin B_{12} deficient women were twice as likely to be severely depressed as non-deficien women.

  The reasons for the relationship between vitamin B_{12} deficiency and depression are not clear.



Learn more about Vitamin B12 from the website of the Office of Dietary Supplements, National Institutes of Health.

Image: Molecular structure of Vitamin B12, Wiki

MINERALS - Micronutrients

Minerals are chemical elements present in our diet.

EXAMPLE: Magnesium

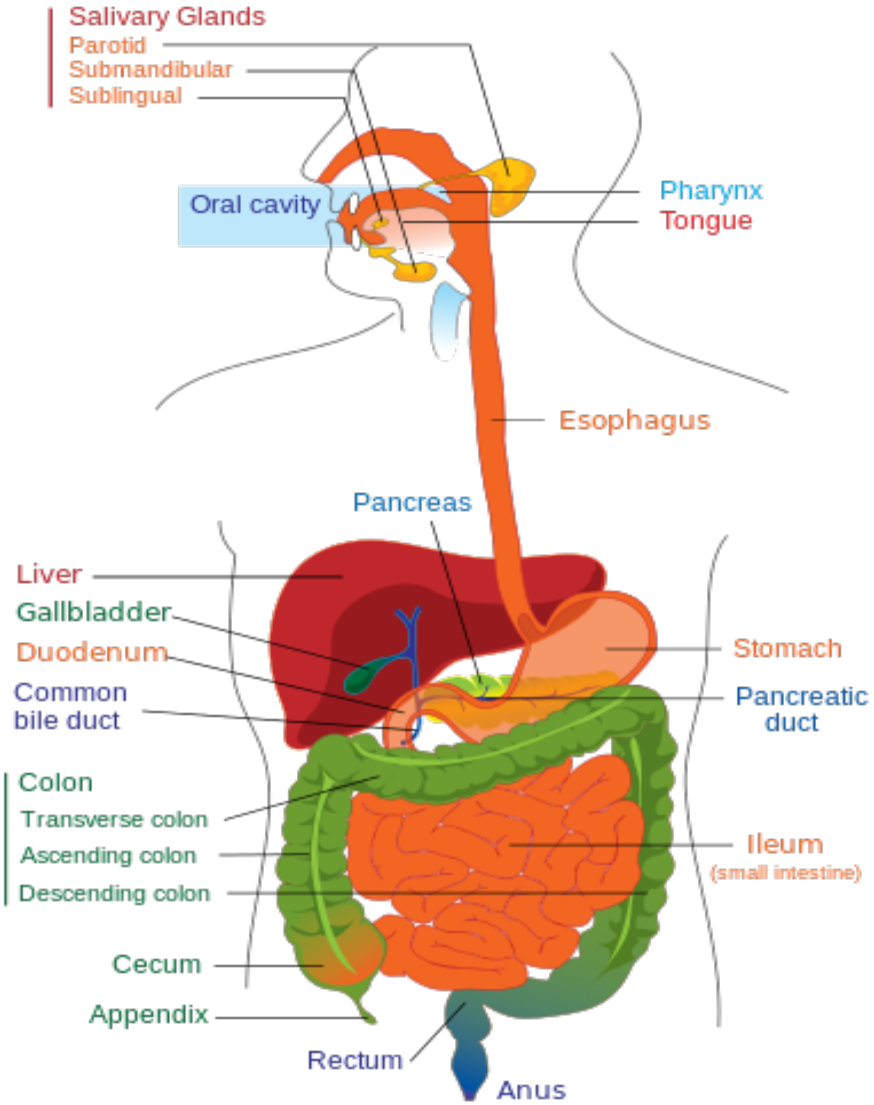
- Magnesium plays an important role in the **production** and **transport of** ENERGY.
- It is also important for:
  - the **contraction** and **relaxation of muscles**.
  - the **synthesis of** protein.
  - **assisting certain** enzymes in the body.
- Over 300 enzymes require magnesium ions for action, including all enzymes using or synthesizing ATP, or those that use other nucleotides to synthesize DNA and RNA.
- Human magnesium deficiency is common (~32% of those in US meet RDA).
- Magnesium supplements can help you poop!

Images: Magnesium crystals, Warut Roonguthai; Food sources of Magnesium, Peggy Greb

WATER

- Chemical reactions of living things take place in water.
- Many types of metabolic wastes can only be eliminated from body when dissolved in water.
- The *break down* of many materials requires water.
- You may be able to survive weeks without food, but wouldn't last more than a few days without water.
- Human body ~ 65% water (even dense tissue like bone is 33% water).
- Food provides ~ 20% of total water intake. Remaining 80% from water and other beverages.
- Institute of Medicine advises men consume roughly 3.0 liters (~ 13 cups) total beverages daily & women consume 2.2 liters (~ 9 cups).

Digestion



- **Compartmentalized breakdown of foods**
  - Enzymes
  - Stomach acid
- **How we get nutrients from the outside to the inside.**
- **Smaller units are absorbed and carried by the bloodstream to the cells of our body.**

Image: Digestive system diagram, Wiki

Digestive System (a.k.a. gastrointestinal tract & GI tract)

Digestion involves the breakdown of food into smaller components that can be absorbed by the body.

Process of digestion has many stages::

- *Oral cavity:* Secretion of saliva (which contains digestive enzyme amaylase) helps produce a soft, moist bolus of food that can pass down the esophagus.
- *Esophagus*: Passageway from oral cavity to stomach.
- *Stomach:* Gastric juice and enzymes help break down food.
- *Small Intestine*: Most digestion takes place in the small intestine where nutrients are absorbed.
    - *Gallbladder:* Where bile (a fluid produced by the liver) is stored before release into small intestine to emulsify fats.
    - *Pancreas:* Both an endocrine (hormone secreting) and a digestive organ. Secretes pancreatic juice with enzymes that help with digestion and absorption of nutrients in small intestine.
- *Large Intestine/Colon*: Water and some minerals are reabsorbed back into the blood. Colon is where most of the bacteria in the GI tract live.
- *Rectum & Anus:* Waste products of digestion are defecated

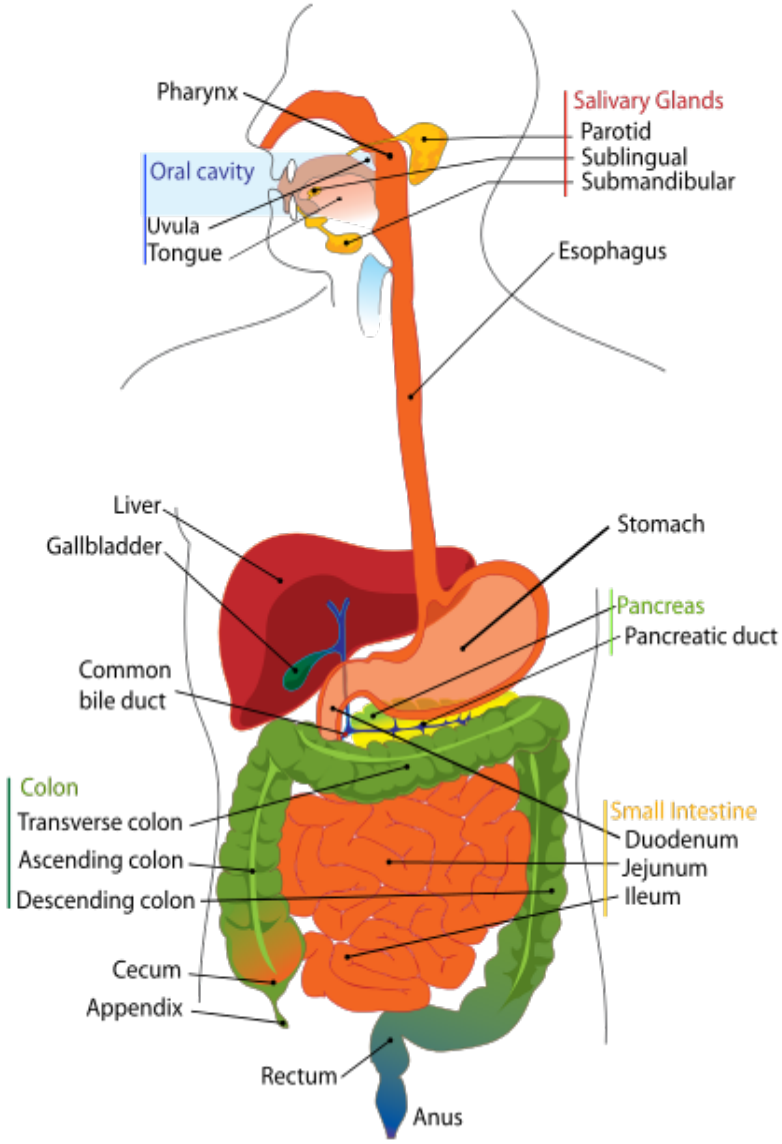
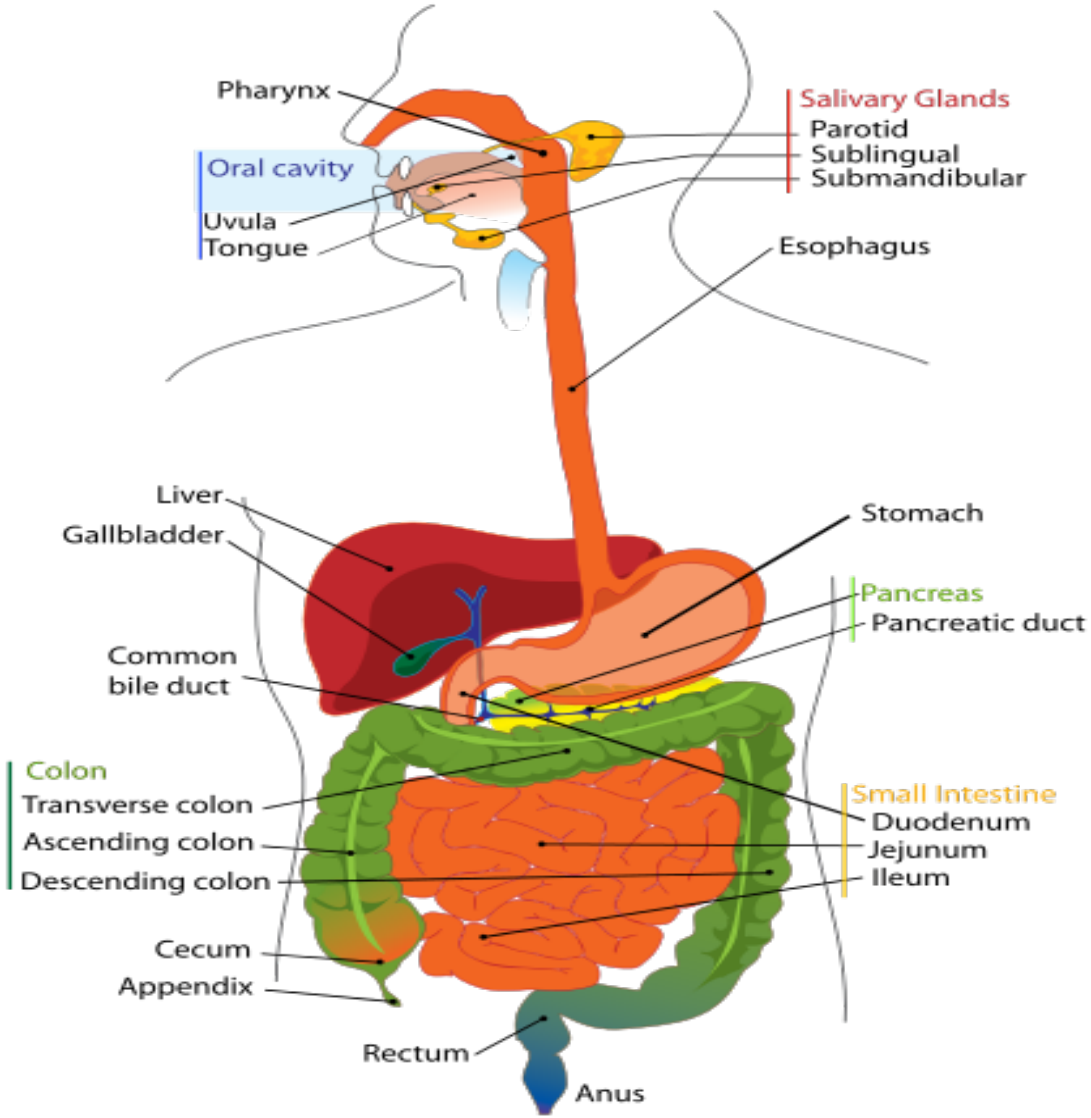


Image: Digestive System, Wiki

Study Table of Enzymes & Digestion

	Enzymes involved? Which?	What's happening?		Protein y/n	Carbs y/n	Fat y/n
mouth			*digested?*			
			absorbed?			
esophagus			*digested?*			
			absorbed?			
stomach			*digested?*			
			absorbed?			
small intestines			*digested?*			
			absorbed?			
large intestine			*digested?*			
			absorbed?			

Digestive System (a.k.a. gastrointestinal tract & GI tract)



WATCH THIS!

Digestive Enzymes

Food Moving Through Digestive System

Digestive System: Part 1 & Part 2 from Crash Course Biology

Image: Digestive System, Wiki

Confused about what to eat?

- Eat more fresh food!
- Eat local food when you can!
- Complex carbs, balanced wit protein and healthy fats.
- Reduce animal fats and refined sugar.

Image: Edamame, Tammy Green

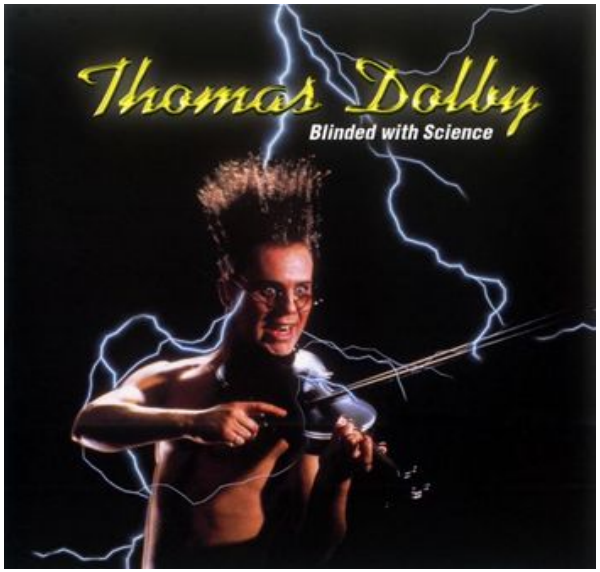
Confused?

Here are links to fun resources that further explain nutrition:

- "The Body Machine" music video by School House Rock.
- Food Molecules video from HowStuffWorks, a Discovery company.
- NuVal: A simple number that give you a "snapshot" of the nutritional Value of various food items.
- "Alphabutt" song by Kimya Dawson

(You must be in PPT slideshow view to click on links.)

Smart Links

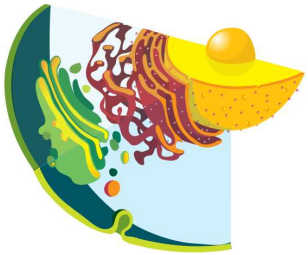


Are you feeling blinded by science?

Do yourself a favor. Use the…

Virtual Biology Classroom *(VBC)* !

The VBC is full of resources to help you succeed, including:



- practice test questions
- review questions
- study guides and learning objectives
- PowerPoints on other topics

You can access the VBC by going to the Science Prof Online website
www.ScienceProfOnline.com

Images: Blinded With Science album, Thomas Dolby; Endomembrane system, Mariana Ruiz, Wiki