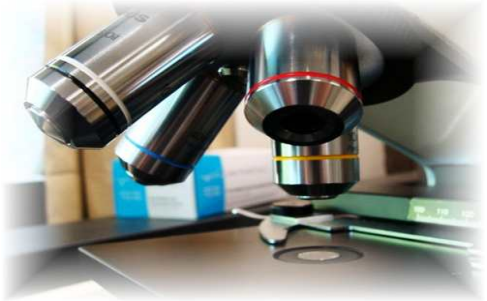

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• Science Prof Online (SPO) is a free science education website that provides fully-developed Virtual Science Classrooms, science-related PowerPoints, articles and images. The site is designed to be a helpful resource for students, educators, and anyone interested in learning about science.

• 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

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

Metabolism
The Transformation of Energy

- Cells either get their energy either by _____ or _____ _____.
- But a cell can't just use sunlight or nutrients to run cellular reactions.
- What type of fuel is needed to run a cell? _____

Cells Can't Eat Hamburgers

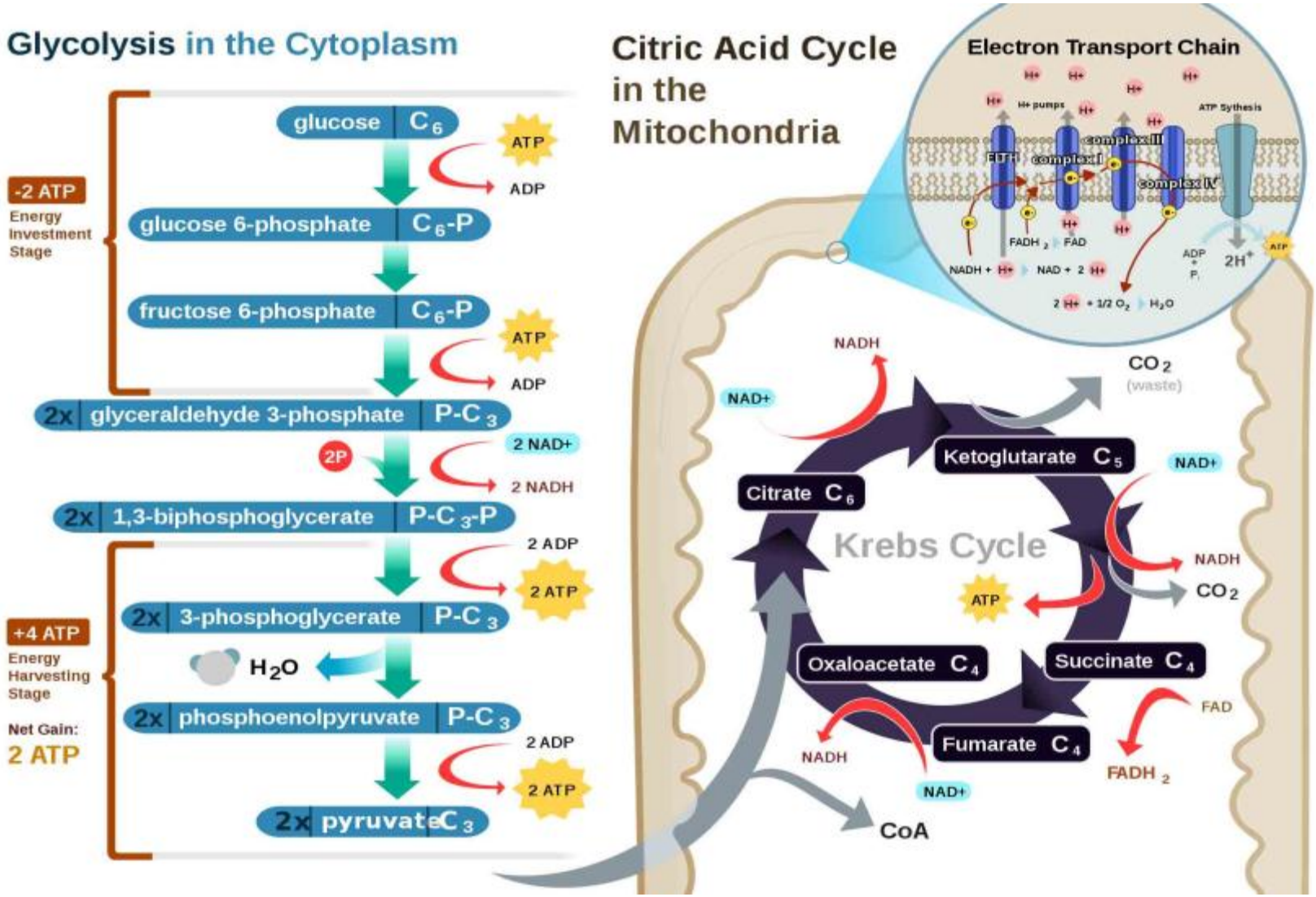
Image: Hamburger, Wiki

Cellular Respiration *is*
Carbohydrate Catabolism

- Organisms break down carbohydrates to create ATP for running cellular reactions.
- The monosaccharide _____ is used most commonly.
- Glucose catabolized by:
  - **Aerobic cellular respiration** → Results in complete breakdown of glucose to carbon dioxide, water and a lot of

  - **Anaerobic respiration & Fermentation** → Only partially breaks down glucose, into pyruvic acid and organic waste products and a little .

Aerobic Cellular Respiration



From the Virtual Cell Biology Classroom on ScienceProfOnline.com

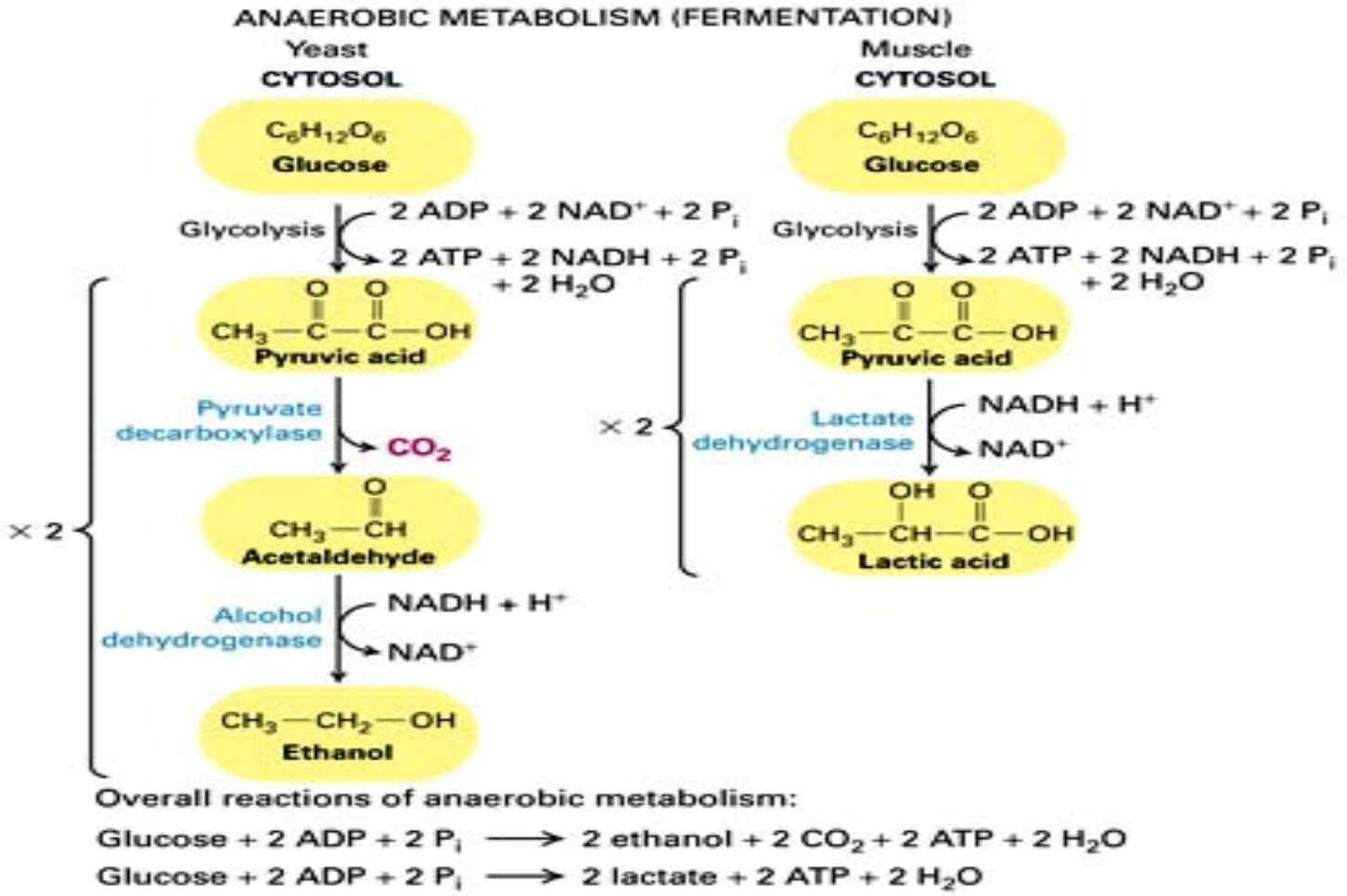
Images: Cellular Respiration, Regis Frey

What happens when oxygen is not available?

- Many anaerobic bacteria, and muscle cells that have run out of O2, can make ATP by using something other than oxygen as an electron acceptor
  (nitrate, sulfate and carbon dioxide).
- In anaerobic respiration, not all the ETC is used, so less ATP is produced.

- The ATP is produced during glycolysis.
- The additional steps of fermentation do not produce any additional ATP.
- Fermentation allows the breakdown of glucose to continue, followed by the oxidation of NADH, so that some energy to be recovered in the absence of oxygen.

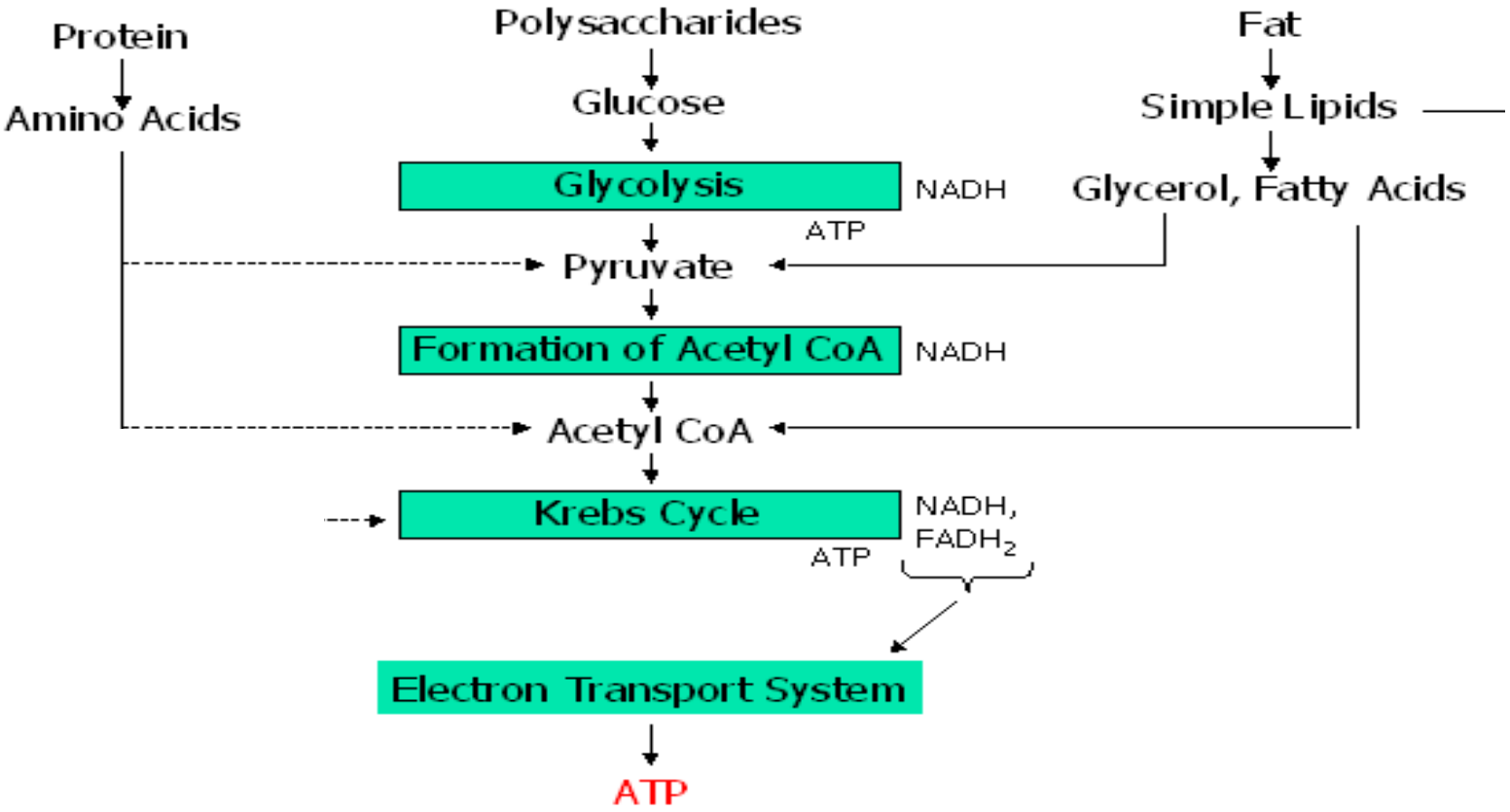
Fermentation



How do we metabolize proteins & fats?

Excess amino acids can be used to synthesize _____, _____, and alpha ketogluterate, which enters the Krebs cycle.

The glycerol & fatty acids of fats can also be converted to pyruvate and Acetyl CoA and then enter cellular respiration.



Metabolism:

Diet & Nutrition

Stuff We Need

_____nutrients:
- Carbohydrates
- Proteins
- Lipids

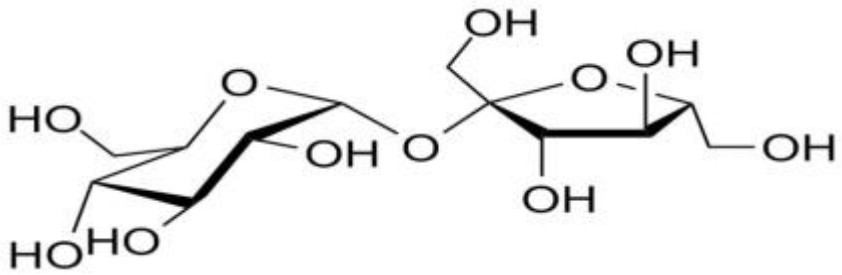
_____nutrients:
- Vitamins
- Minerals

…and, of course, **Water**

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

Carbohydrates - Organic Macromolecules

- "_____ hydrates"
- One carbon molecule to one water molecule (_____)n.
- **Saccharide** is a synonym for carbohydrate.
- The prefixes on the word "saccharide" relates to the _____ of the molecule (mono-, di-, tri- poly-).



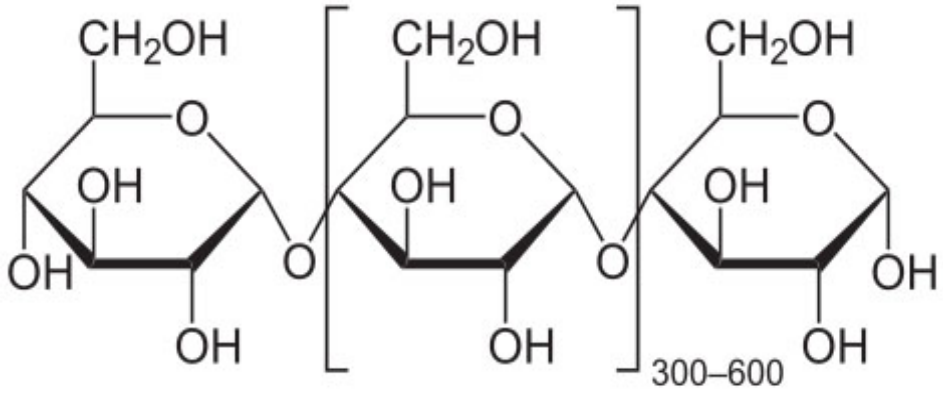
You probably know that chocolate cake is full of refined sugars…carbs. You may not know that boogers contain carbs as well. Boogers are dried-up mucus and dirty nose debris. Mucus is made mostly out of sugars and protein. Looks like this little guy is double dipping. Bon appetite!

Image: Sucrose, Wiki

Carbohydrates - Organic Macromolecules

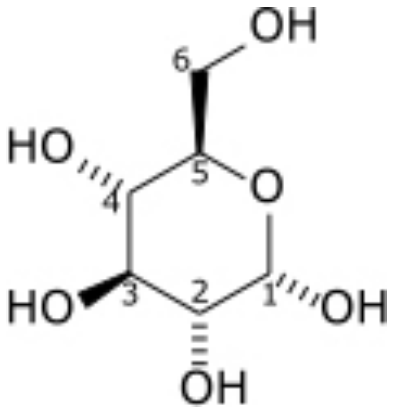
Monosaccharides

- ***Q:*** *What is a monosaccharide?*
- ***Q:*** *Name a monosaccharide.*



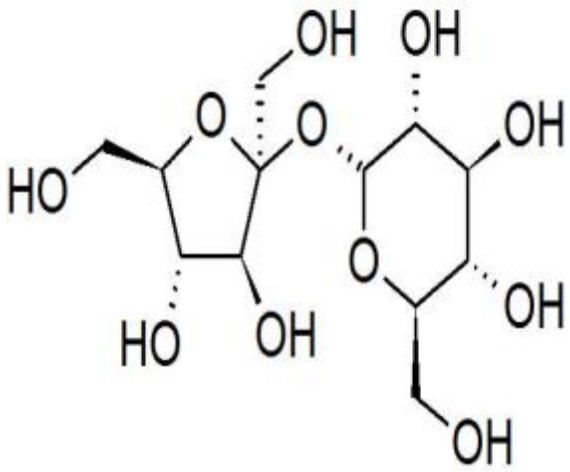
Disaccharides

- ***Q:*** *What is a disaccharide?*
- ***Q:*** *Name a disaccharide.*



Polysaccharides

- ***Q:*** *What is a polysaccharide?*
- ***Q:*** *Name a polysaccharide.*



Images: Glucose, Wiki; Sucrose, Wiki;, Starch, Wiki

From the Virtual Cell Biology Classroom on ScienceProfOnline.com

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.
- ***Q:*** *Lets list some complex carb and simple carb* ***food sources*** *on the board.*

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

Carbohydrates – Fiber

- Also called "bulk" or "roughage".
- Most are indigestible _____.
- There are two main types of fiber with different effects: **insoluble fiber** and **soluble fiber**.
- _____ improves elimination by increasing stool bulk, preventing constipation and decreasing risk of colon cancer.

- *Foods high in insoluble fiber*: legumes, whole grains, vegetables, fruits, nuts and seeds.
- _____ delays gastric emptying, slows absorption of glucose into the bloodstream and inhibits cholesterol absorption.
- *Good sources of soluble fiber* : Fruits, vegetables, oat bran, legumes, barley, nuts and seeds.
- The American Dietetic Association recommend 20 to 35 grams of total fiber each day. Most people get FAR LESS than this.

Proteins - Organic Macromolecules

Proteins are macromolecules, **polymers** composed of _____ called _____.

Amino acids contain a

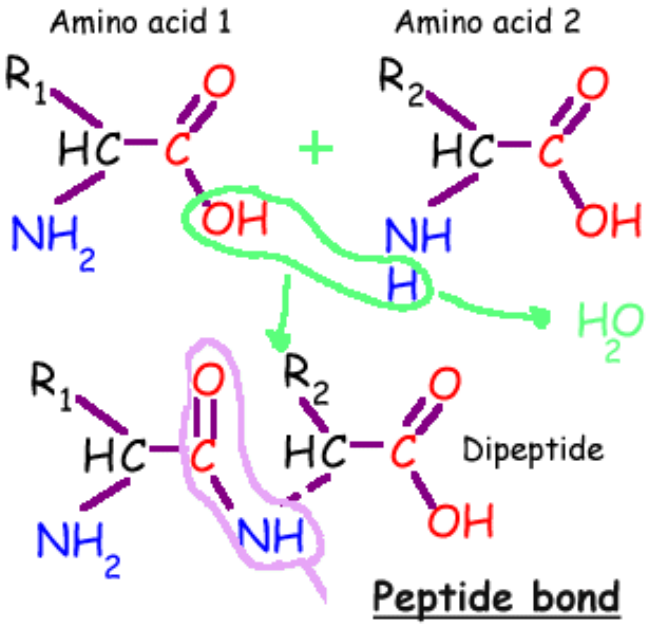
1. base amino group ($-NH_2$)
2. acidic carboxyl group (-COOH)
3. hydrogen atom

…all attached to same carbon atom (the a –carbon… alpha carbon).

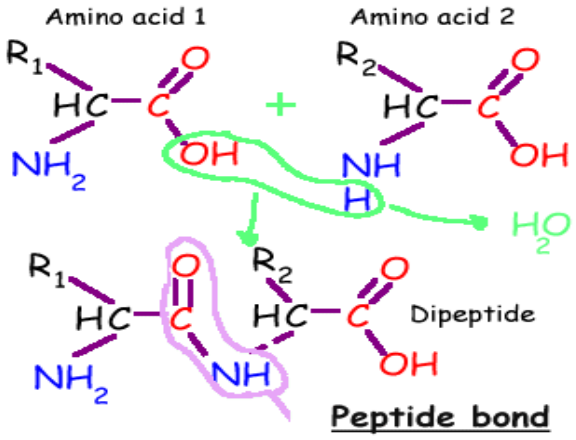
Fourth bond attaches a-carbon to a side group (--R) that varies among different amino acids.

There are hundreds, but most organisms use only 21 amino acids to build proteins.

Side groups important … affects the way a protein's amino acids interact with one another, and how a protein interacts with other molecules.



Proteins - Organic Macromolecules



Q: *What kind of bonds link amino acids together?*

Q: Do you think these bonds are … *ionic? covalent?*

A **dipeptide** is 2 amino acids linked together.

A **polypeptide**, more than two.

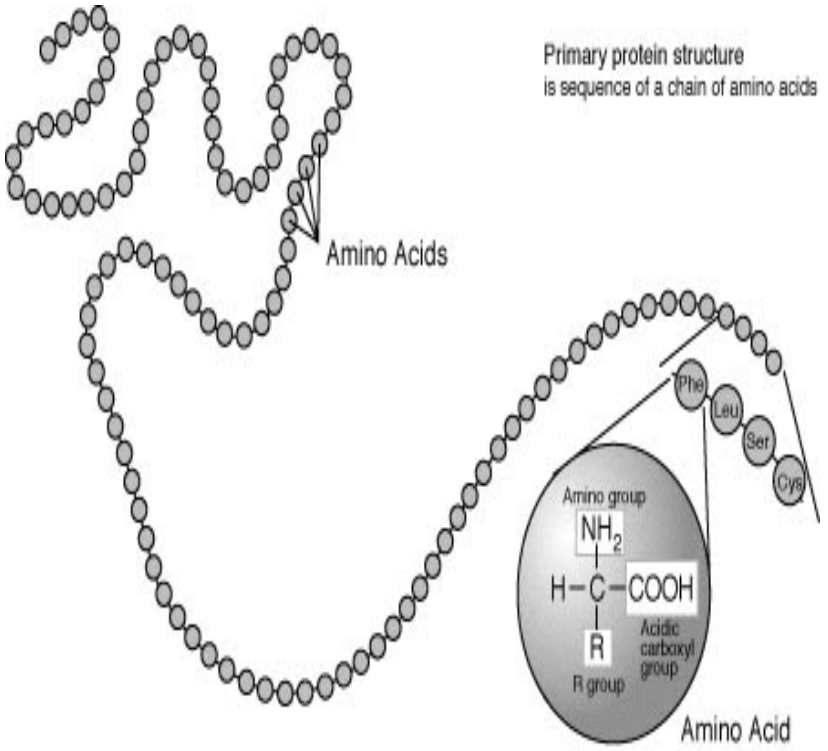


Image: Protein Primary Structure, Wiki

Protein Structure

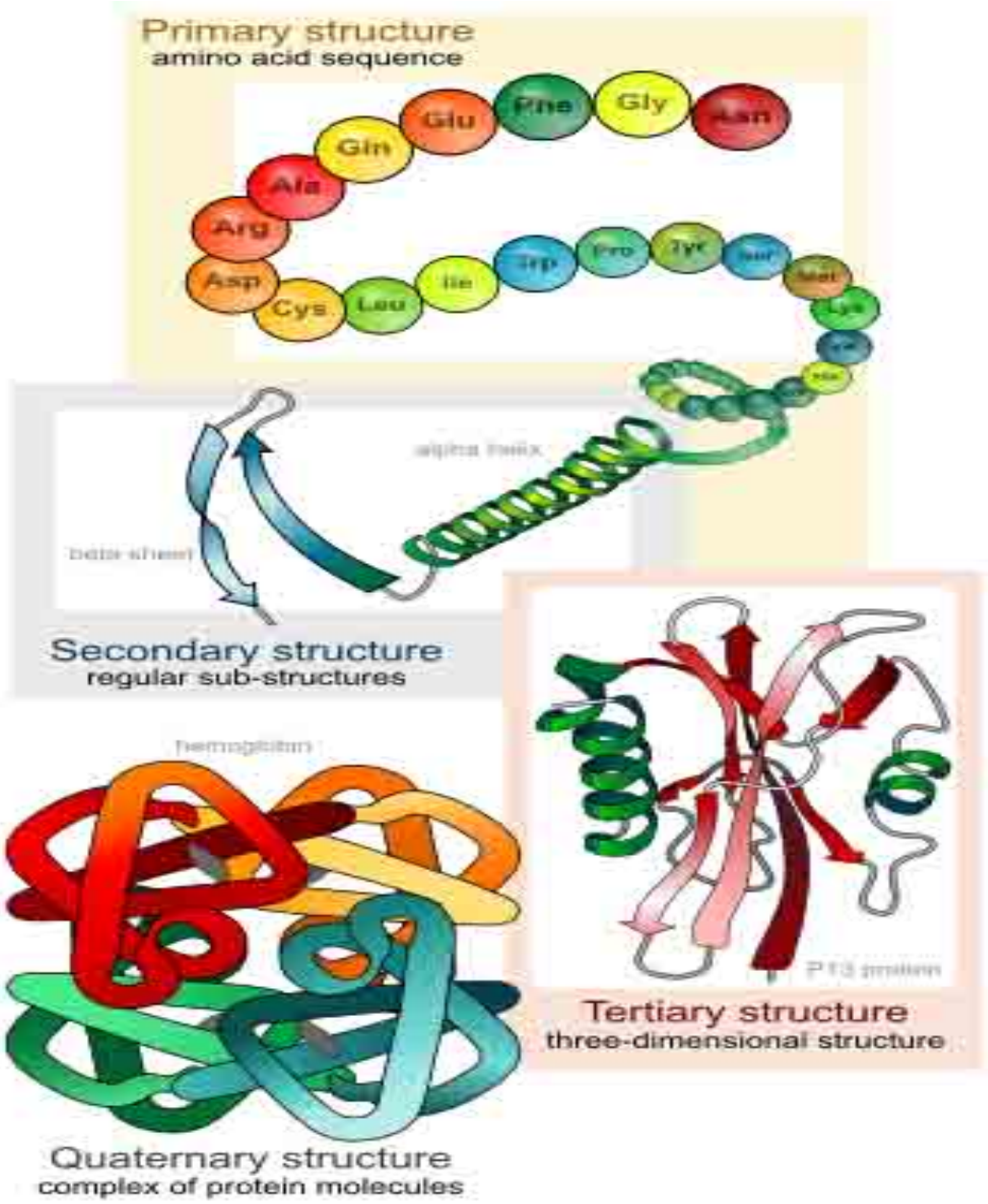


Image: Levels of protein structure, M Ruiz

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*

Lentils, a vegetable protein, Paul Goyette; Roasted chicken, Viperx, Wiki

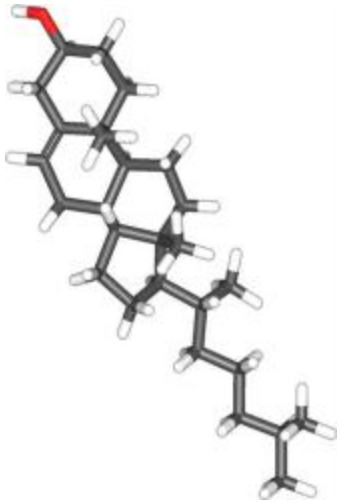
Lipids - Organic Macromolecules

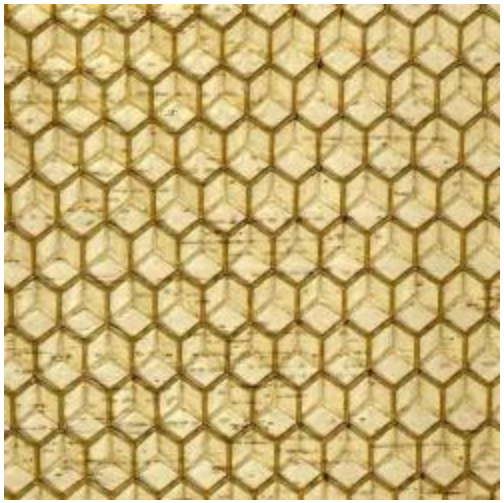
Fats, Phospholipids, Waxes & Steroids

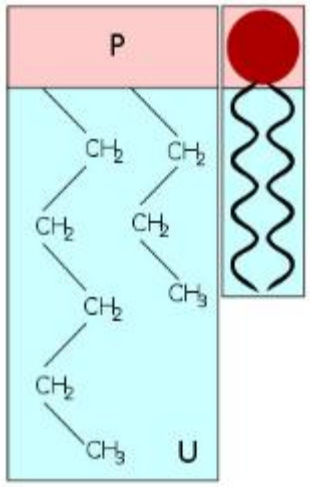
Hydrophobic macromolecules…insoluble in water.

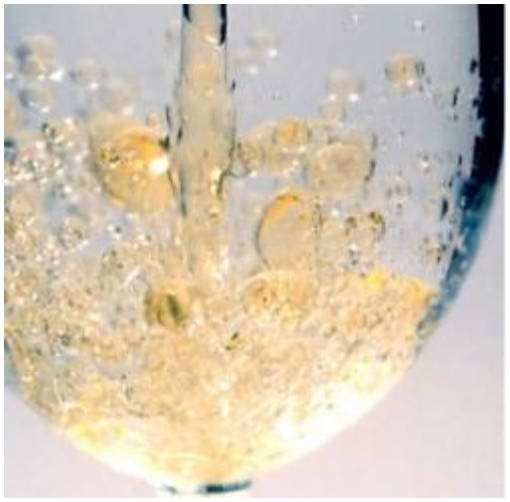
Not attracted to water because …

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



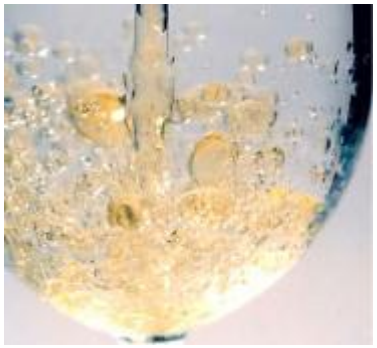






Images: Cholesterol, Wiki; Phospholipid Structure, Bryan Derksen. Wiki Honeycomb, Wikii; Oil & Water, Kidipede

Lipids - Organic Macromolecules



Fats

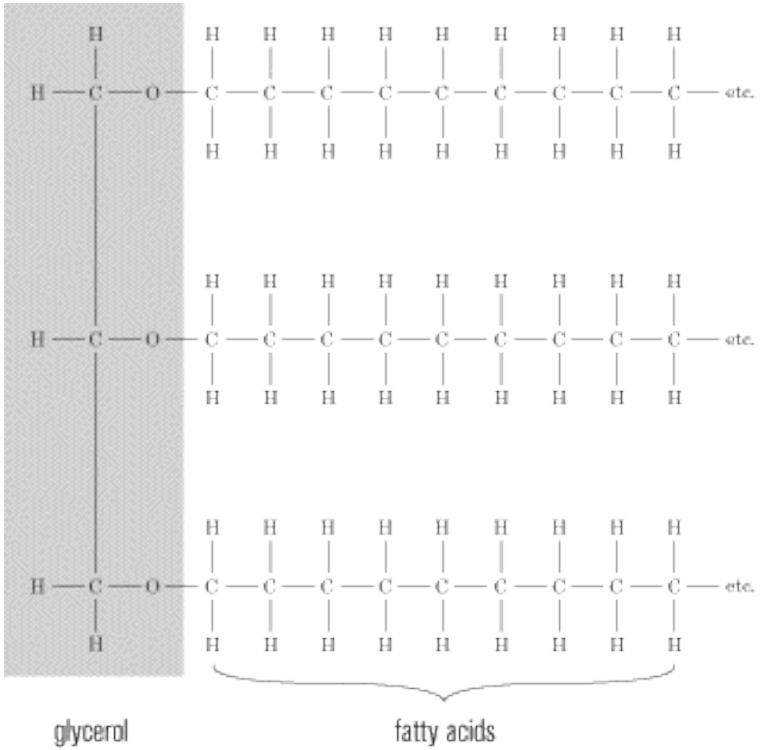
Fats and oils are made from two kinds of molecules:

- _____

(a type of alcohol)

- _____

(triglycerides)

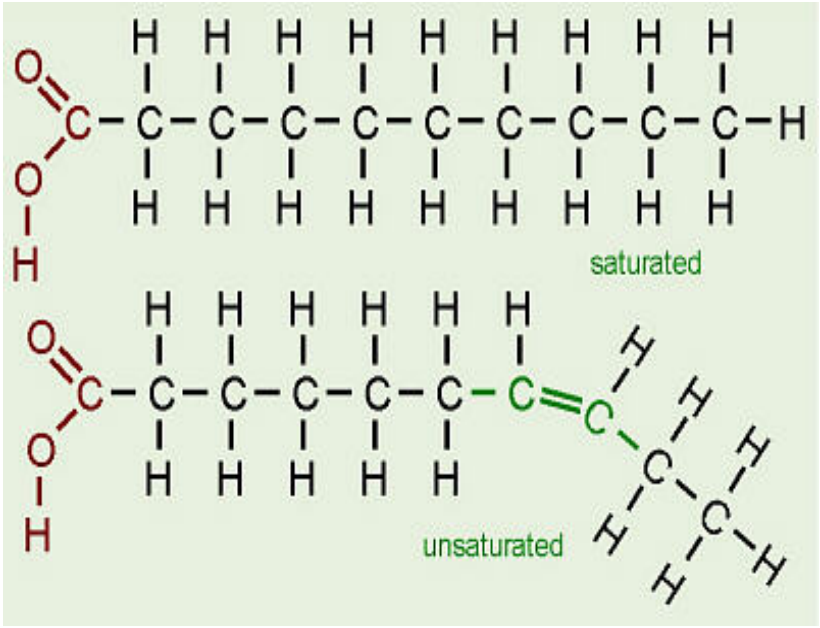


Images: Oil & Water, Kidipede

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., and 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

Lipids - Phospholipids

- Phospholipids are a major component of all cell membranes.
- Most phospholipids contain a diglyceride, a phosphate group, and a simple organic molecule such as choline.
- The diglyceride tails are _____, but phosphate group end is _____.
- So phospholipids are soluble in both water and oil.
- Tails from both layers facing inward and the heads facing outward = phospholipid _____.

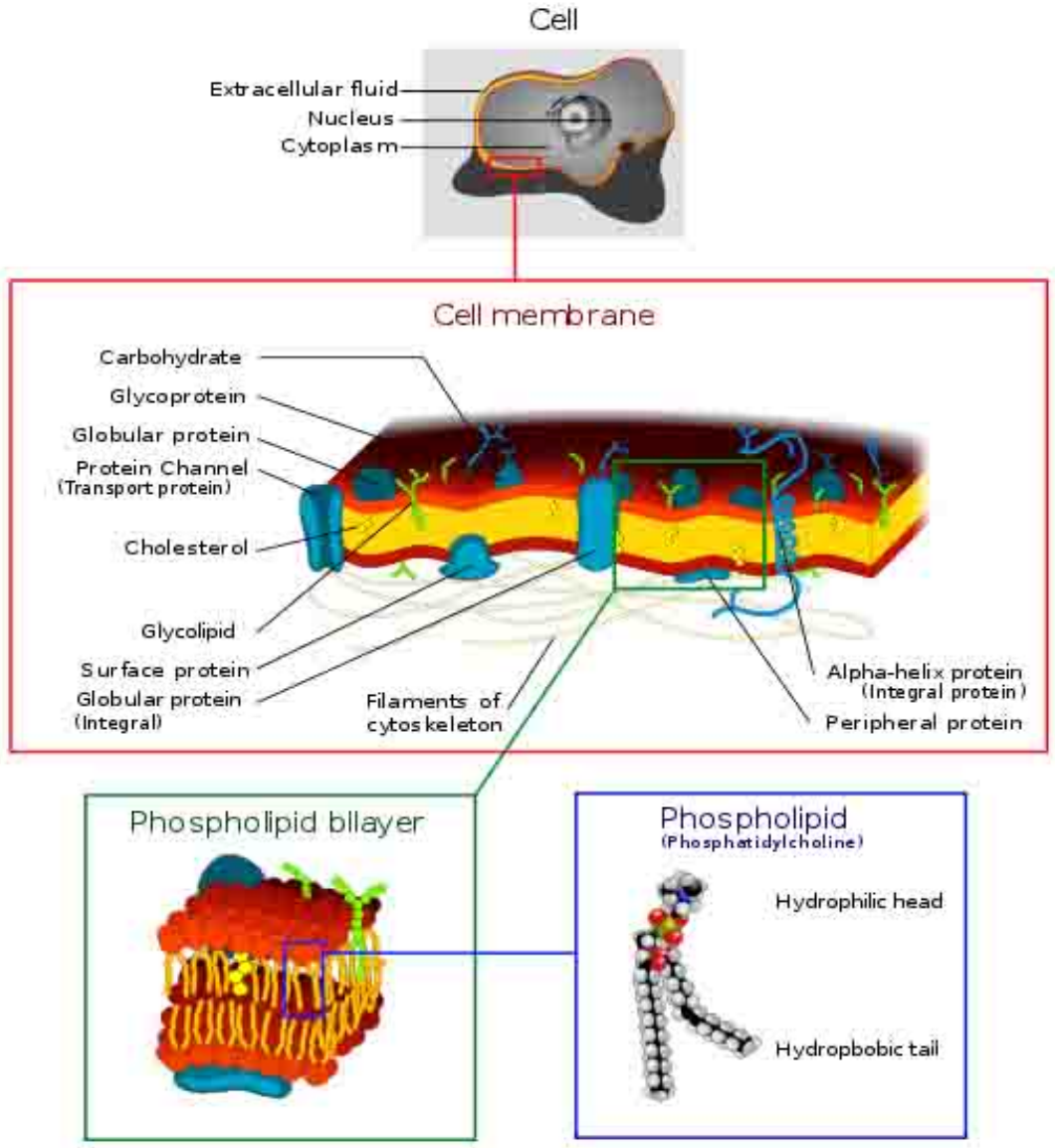


Image: Cell Membrane, Wiki;

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.

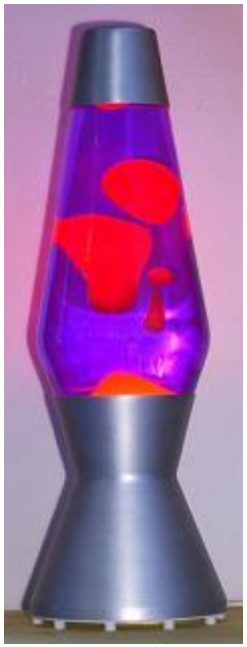
  For example, lecithin keeps the cocoa and cocoa butter in a candy bar from separating.

  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.

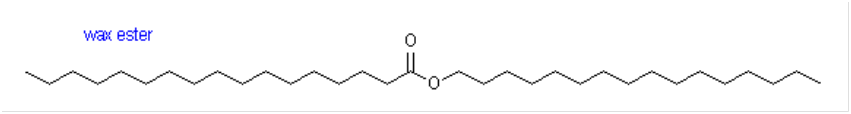
Steamed and salted, edamame (soybeans) is yummilicious; as addictive as potato chips, but much healthier! Protein, carbs and healthy fats all in one food item.

Image: Edamame, Tammy Green

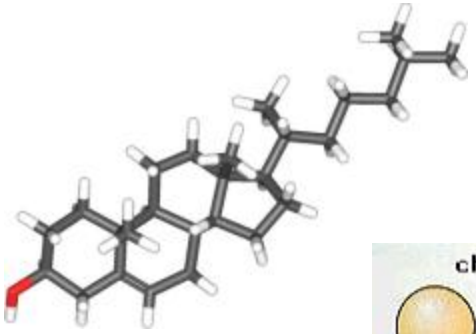
Lipids - *Waxes & Steroids*



Waxes



- Do not have a hydrophilic head: so completely water insoluble.
- Many plants, especially those found in warm climates, produce waxes to reduce dehydration.



Steroids

- The central core of a cholesterol molecule (4 fused rings) is shared by all steroids,
- Cholesterol is precursor to our sex hormones and Vitamin D.
- Our cell membranes contain _____ (in between the phospholipids) to help keep membrane "fluid" even when exposed to cooler temperatures.

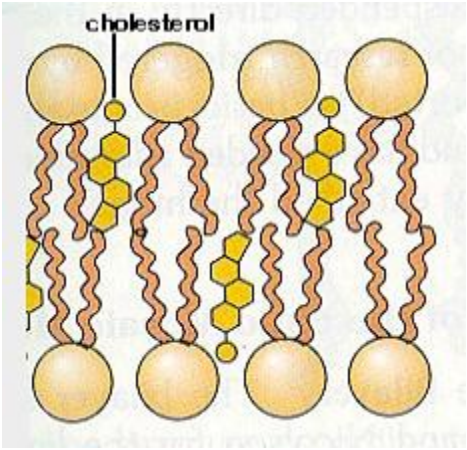


Image: Lava Lamp, Wiki; Cholesterol molecule, Wiki; Phospholipids & Cholesterol, Cytochemistry.net

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?

_____ calories per gram.

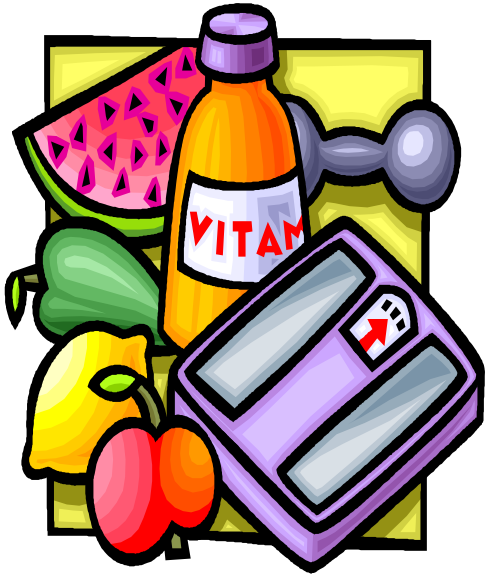
But different drinks have different strengths of alcohol.

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).

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

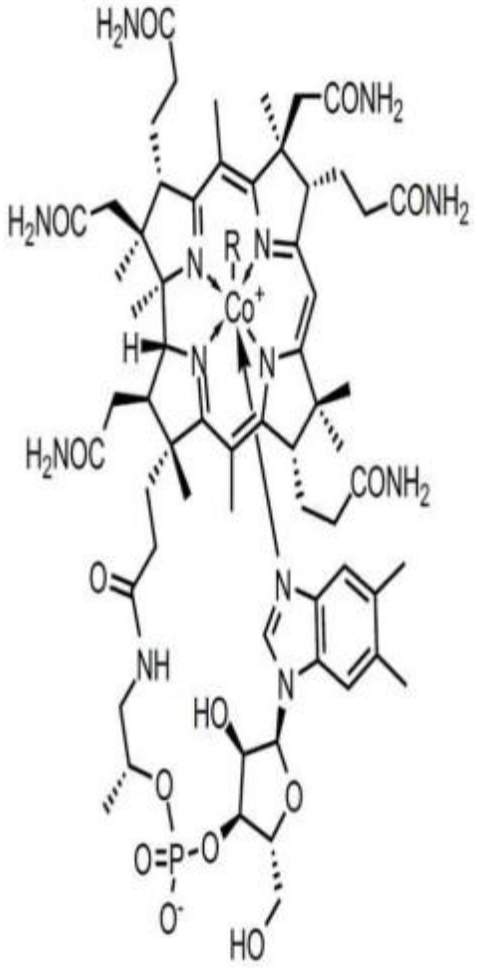
VITAMIN - B_{12}

- 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 cobalamin (B12). Wiki

MINERALS - Magnesium

- Magnesium plays an important role in the **production** and **transport of** _____.
- It is also important for the **contraction** and **relaxation of muscles**.
- Magnesium is involved in the **synthesis of** protein, and it **assists certain** enzymes in the body.
- Over 300 enzymes require magnesium ions for their catalytic action, including all enzymes using or synthesizing ATP, or those that use other nucleotides to synthesize DNA and RNA.
- Human magnesium deficiency is common, with only approximately 32% of the United States meeting the RDA.
- Low levels of magnesium in the body have been associated with development of illnesses such as asthma, diabetes, and osteoporosis.

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

WATER

- All 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 ***catalysis*** of 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).
- ***Q:*** *What are some reactions that we have discussed in class that involve water?*

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:

Smart Links

- Metabolism: Diet & Nutrition Main Page on the Virtual Cell Biology Classroom of Science Prof Online.
- Cellular Respiration animation by Jay Phelan, "What is Life? A Guide to Biology", W. H. Freeman & Co.
- "The Body Machine" music video by School House Rock.
- "Sugar, Sugar" a song by The Archies.
- Food Molecules video from HowStuffWorks, a Discovery company.
- "Do You Want Fries With That?" song by Tim McGraw.

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

Metabolism Project

See the ScienceProfOnline Virtual Cell Biology Classroom: **Metabolism & Nutrition Lecture** for a printable Word .doc of this project.

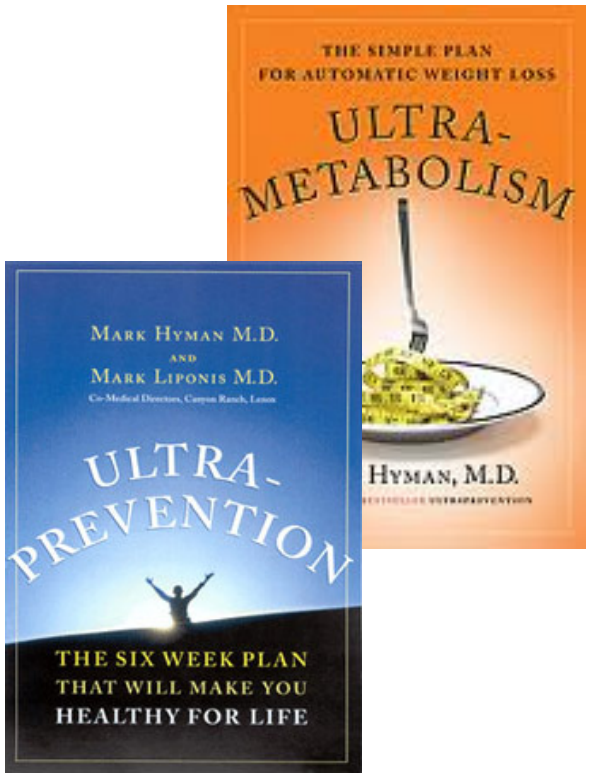
OPTION 1

Macromolecules and Exercise

This is the most difficult assignment for earning full points, and students often choose this option so that they don't have to read a book. I expect very detailed and complete answers to all components of this assignment. Missing and incomplete answers will result in missing and incomplete points.

As a finished product, this Option 1 assignment should be several pages long, and have required several hours to complete (in addition to the time spent recorded what you ate for 3 days).

Here's specifically what you have to do…

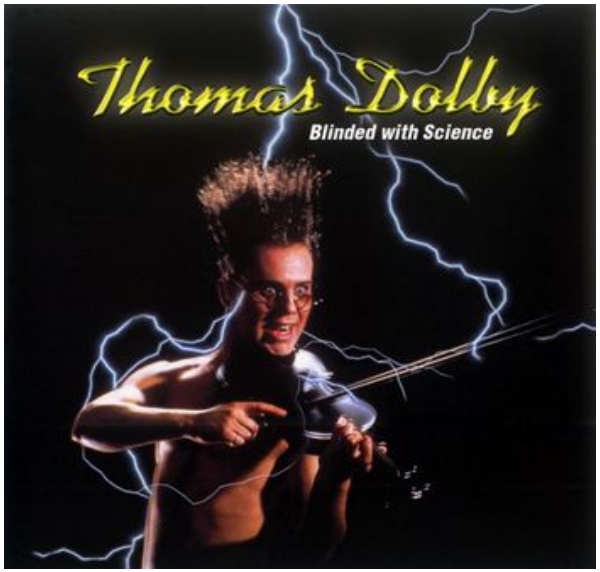


OPTION 2 & OPTION 3

The Most Awesome Book Report You'll Ever Do!

There are two popular books, by Harvard MDs. The books are full of very useful knowledge for those entering the field of Health Care. They provide a scientific and entertaining explanation of how our bodies work and how the choices we make in diet and lifestyle impact our health on a cellular level. Options 2 & 3 relate to reading one of these books and writing a report.

Here's specifically what you have to do…

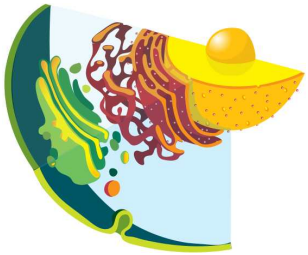


Are you feeling blinded by science?

Do yourself a favor. Use the…

Virtual Cell Biology Classroom *(VCBC)* !

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



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

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