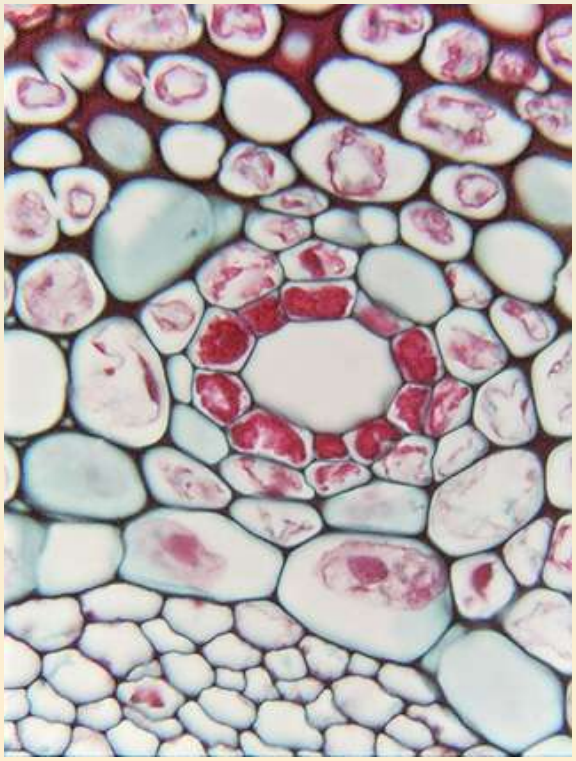
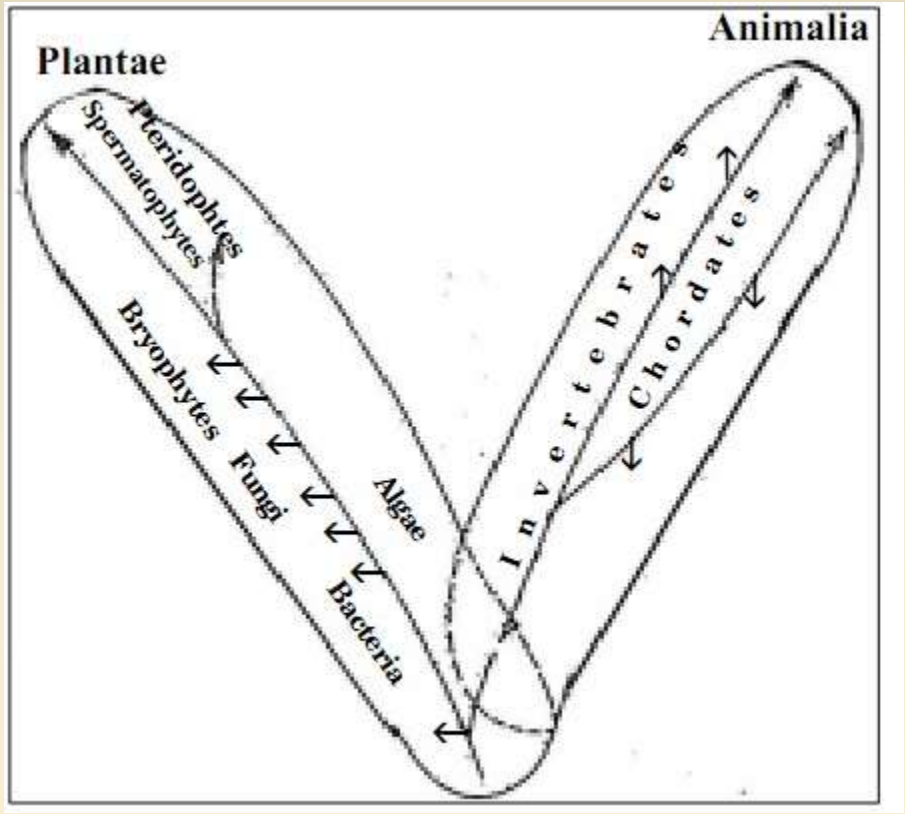
Basic Plant Biology
A Review



What is a plant?

Traditional View of Biology: Animals and Plants



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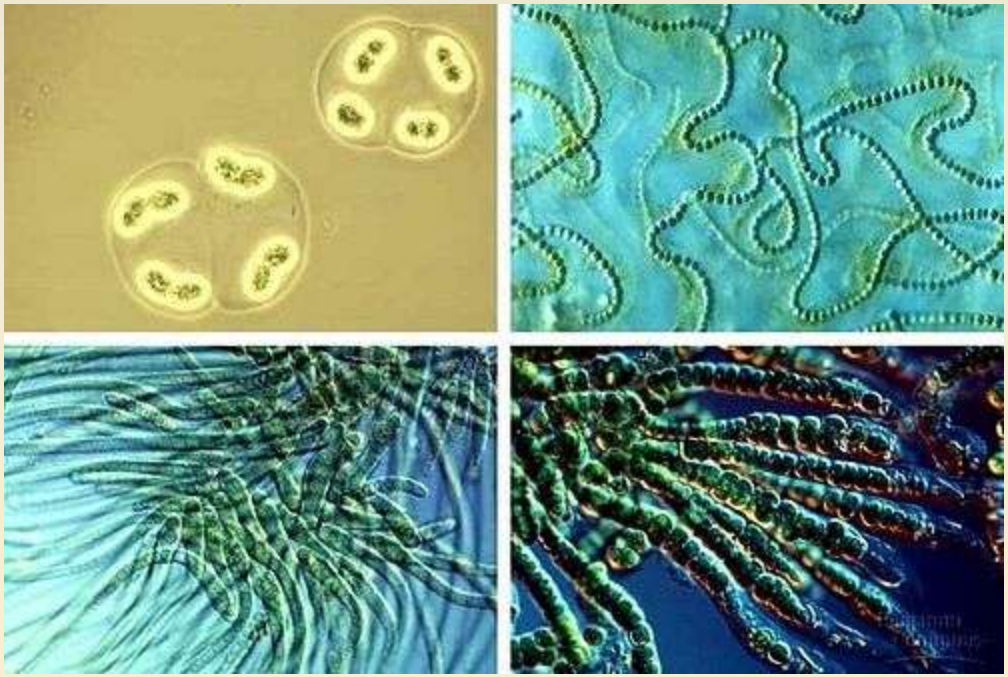
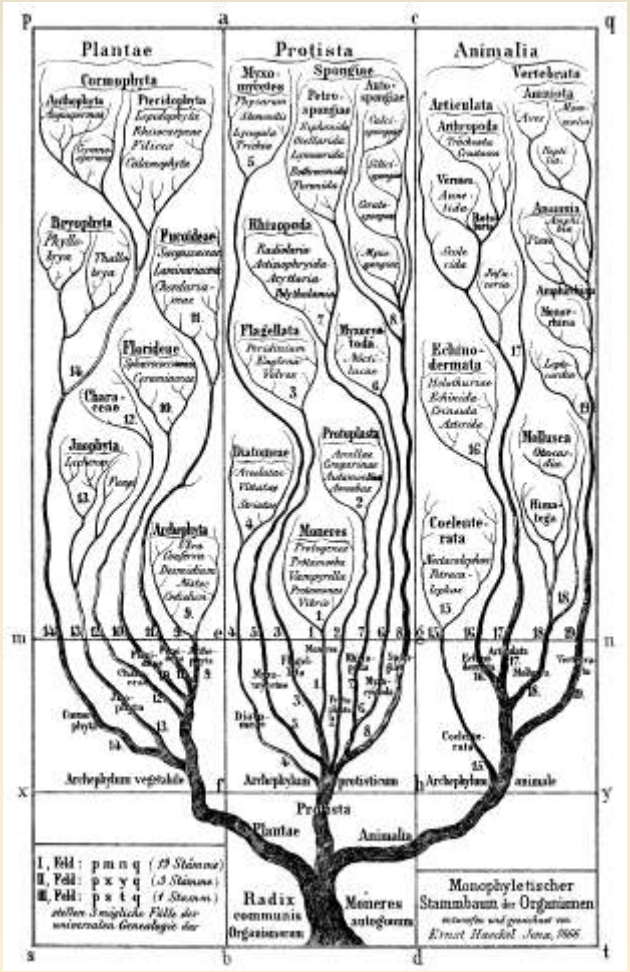
Problem: Microscopic Organisms (Bacteria, Fungi, Algae)





What is a plant?

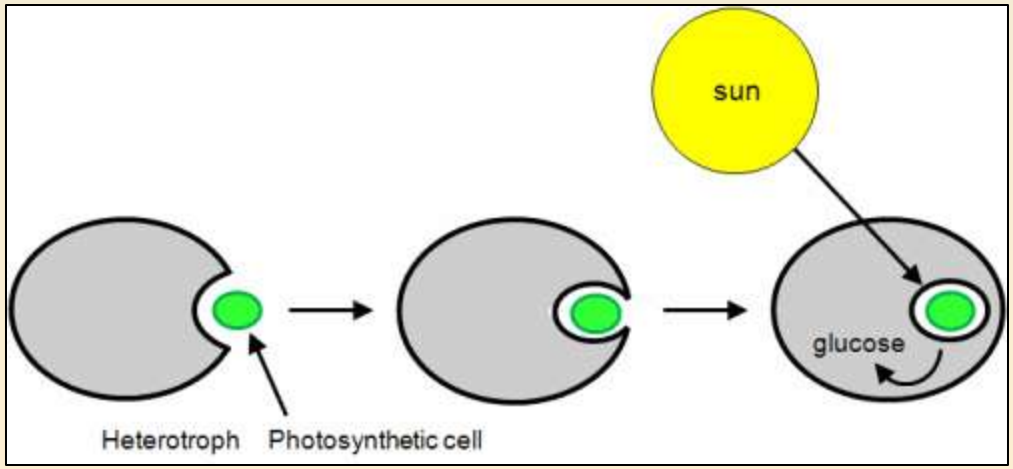
Traditional View of Biology: Animals and Plants

Problem: Microscopic Organisms (Bacteria, Fungi, Algae)

Complication:

Endosymbiotic origin of organelles (Lynn Margulis)

Membrane-bound structures in eukaryotic cells are derived from formerly free-living organisms that have become intimately symbiotic



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Further Information: DNA molecular phylogenetic information

1. Confirming evidence for endosymbiotic theory

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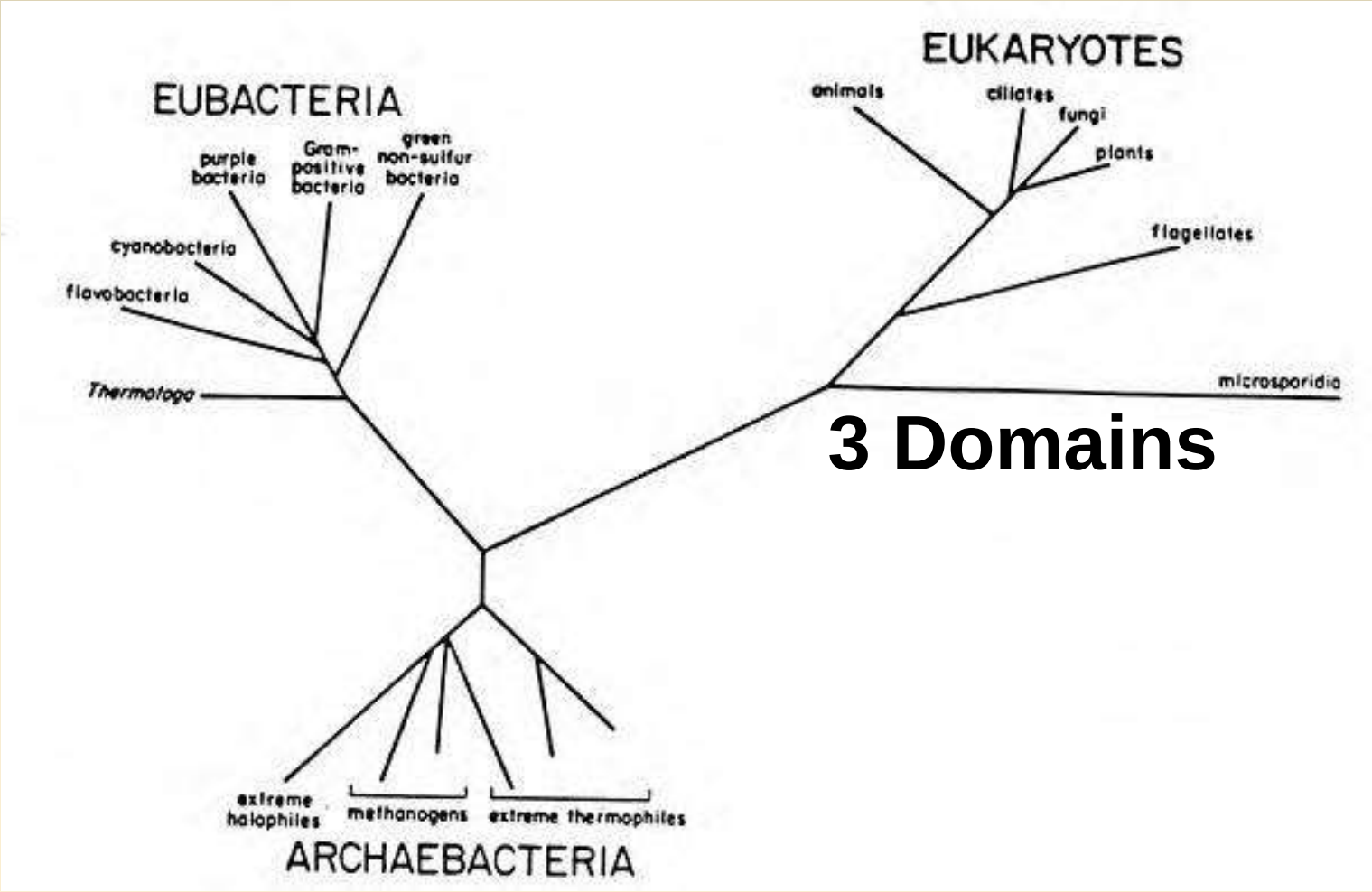
Further Information: molecular phylogenetic information

1. Confirming evidence for endosymbiotic theory
2. Suggestion that life split early into at least 3 major lineages

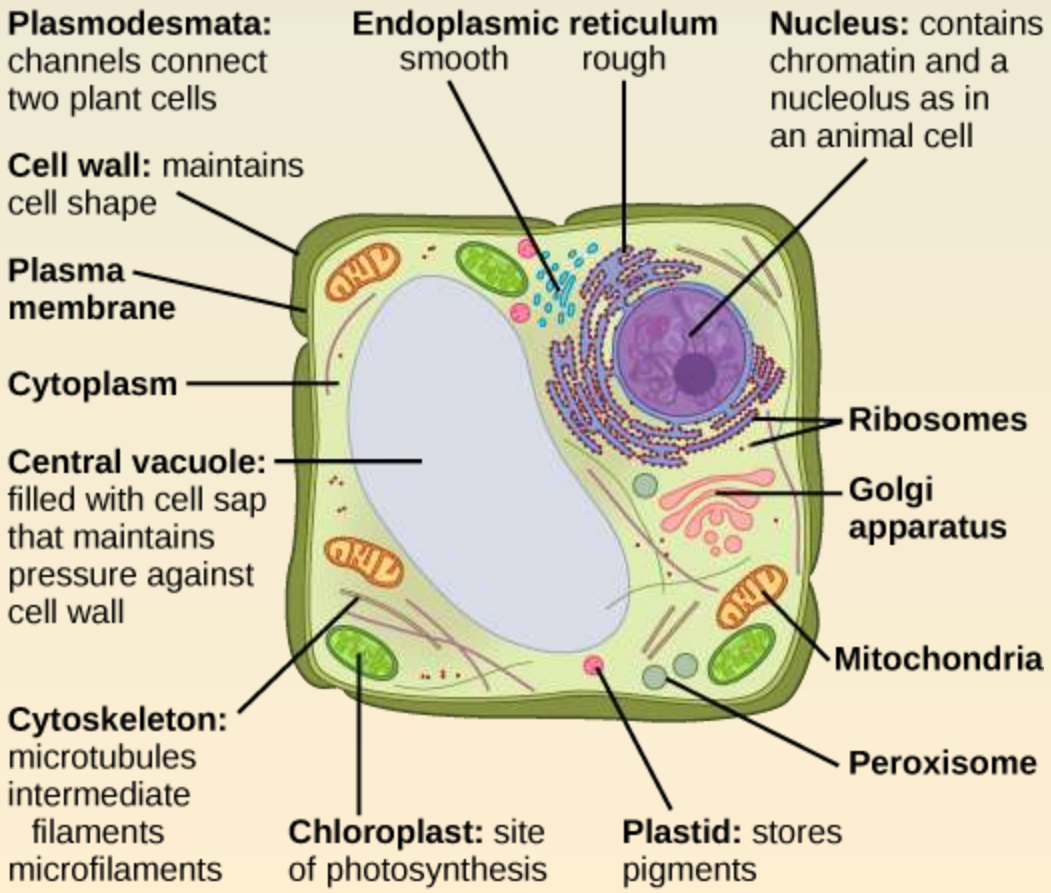
Carl Woese and the rRNA Tree of Life

Carl Woese
1980s
ssRNA
Sequences



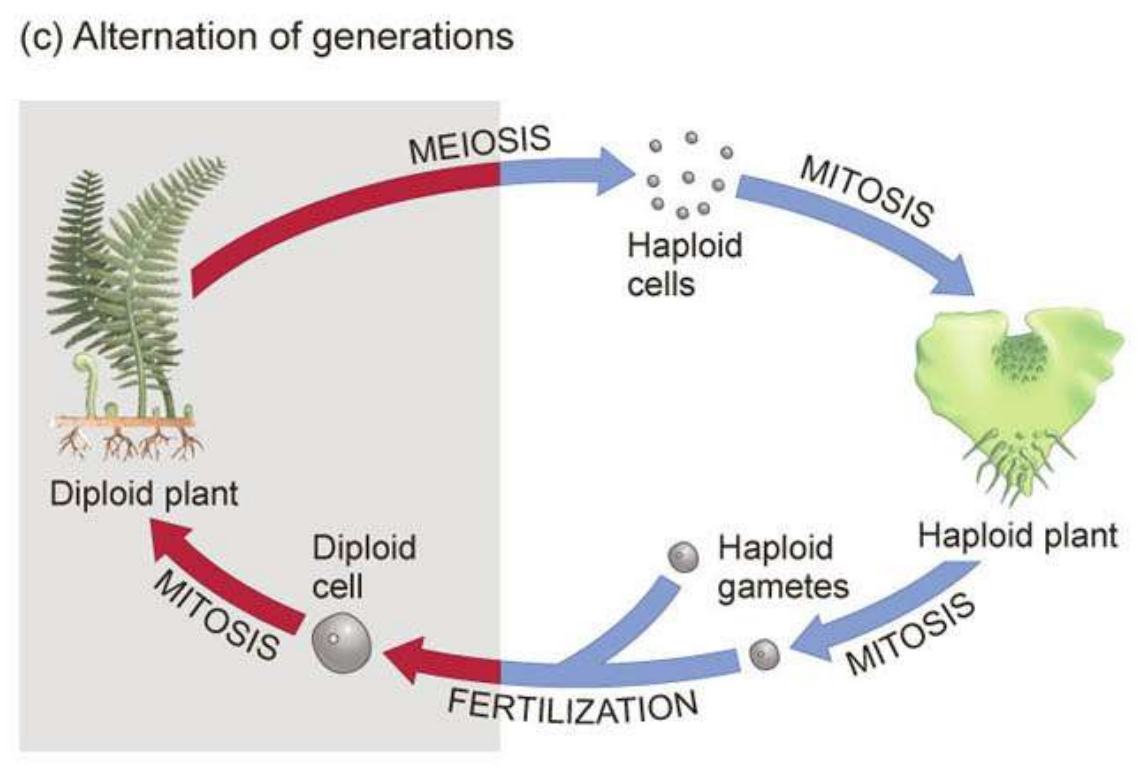
What is a Plant?

1. Eukaryotic - nucleus
2. Chloroplasts present
3. Cell wall with cellulose
4. Autotrophic – make own food

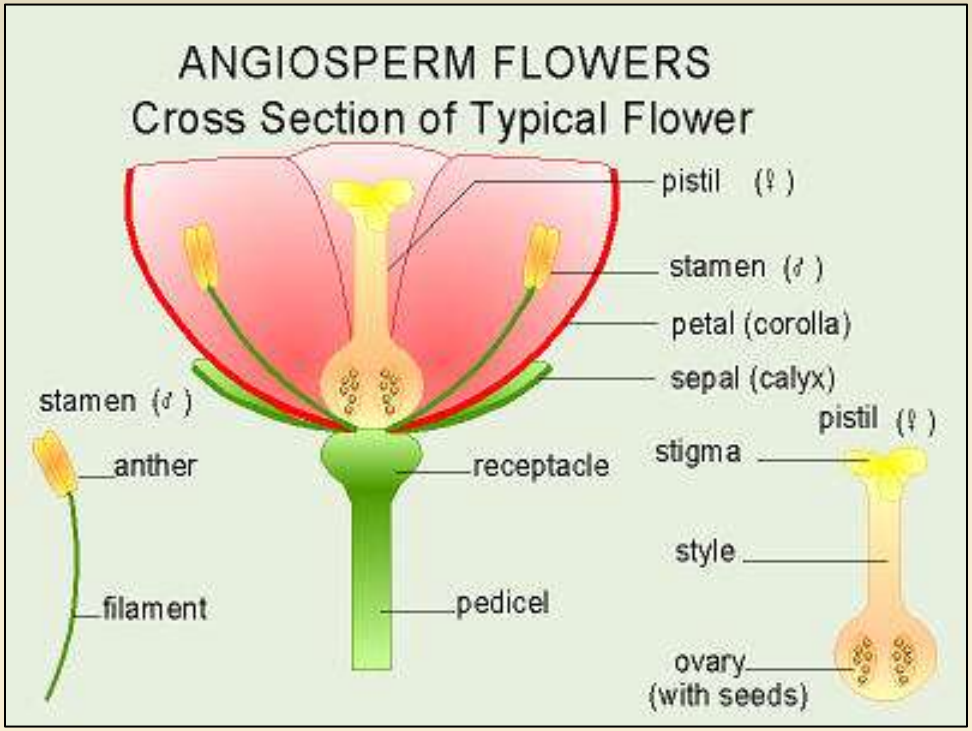


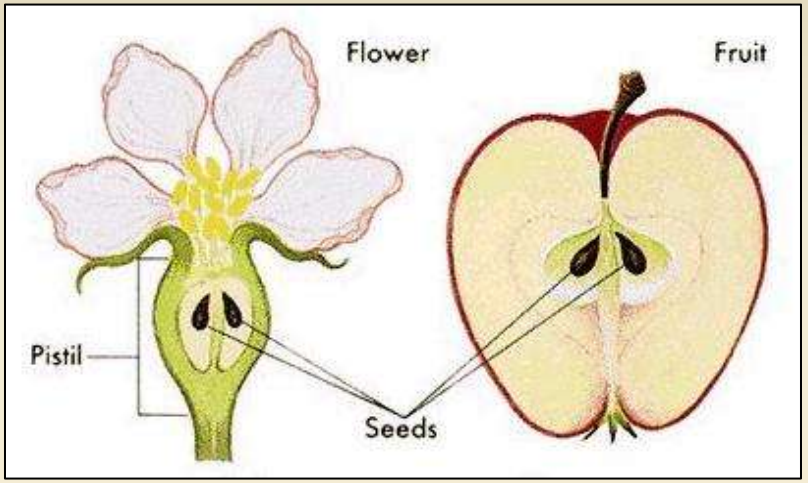
What is a Plant?

1. Eukaryotic
2. Chloroplasts present
3. Cell wall with cellulose
4. Autotrophic
5. Complex Life Cycle (alternation of generations)



Angiosperms - Flowering Plants
Flowers developed, Seeds enclosed by pistil, “fruit”





Monocots

Gyymnosperms – “naked seed” plants
Have no flowers or fruit, seeds borne naked

Ferns and Fern Allies

Vascular plants, but no flowers, no seeds

Reproduce by spores

Mosses and Liverworts - Bryophytes

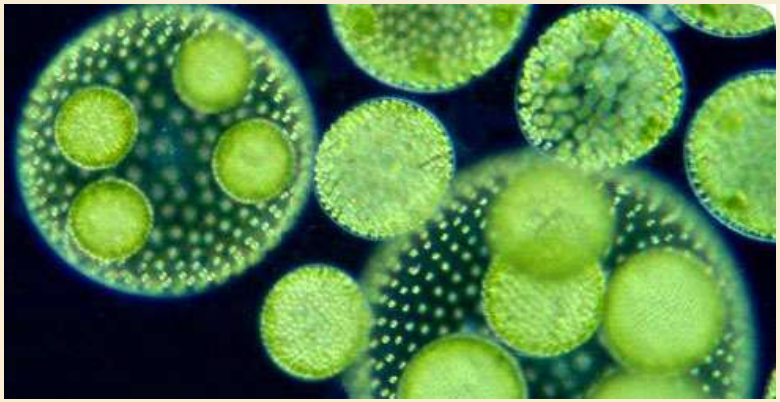
Lack true roots, stems and leaves

Require moisture for fertilization

Without vascular tissue; rely on diffusion of water

Dispersal by spores

Algae - Diverse, single-celled to complex seaweeds
Photosynthetic eukaryotes, green plants



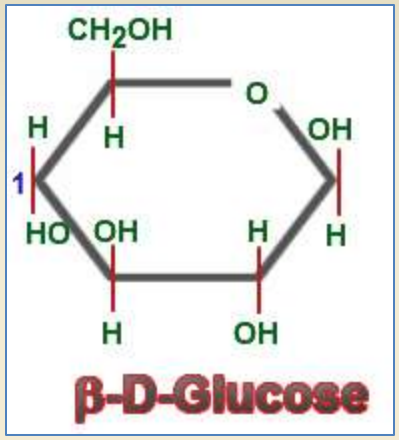
Fungi – not plants

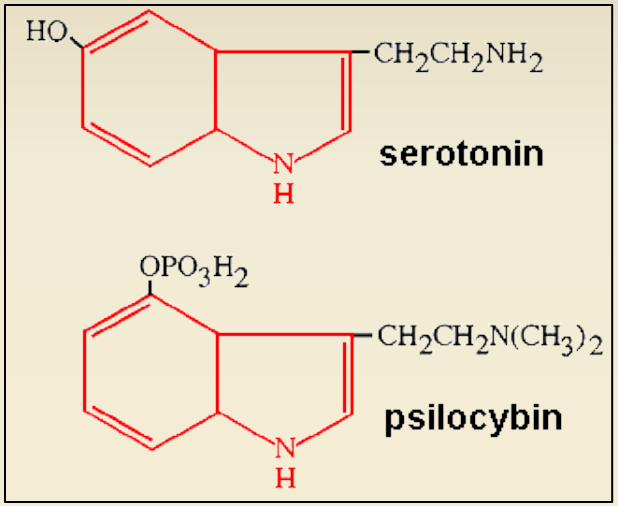
Non-photosynthetic eukaryotes, saprophytic,

Reproduce by spores, chitin cell walls (not cellulose)

Includes yeast

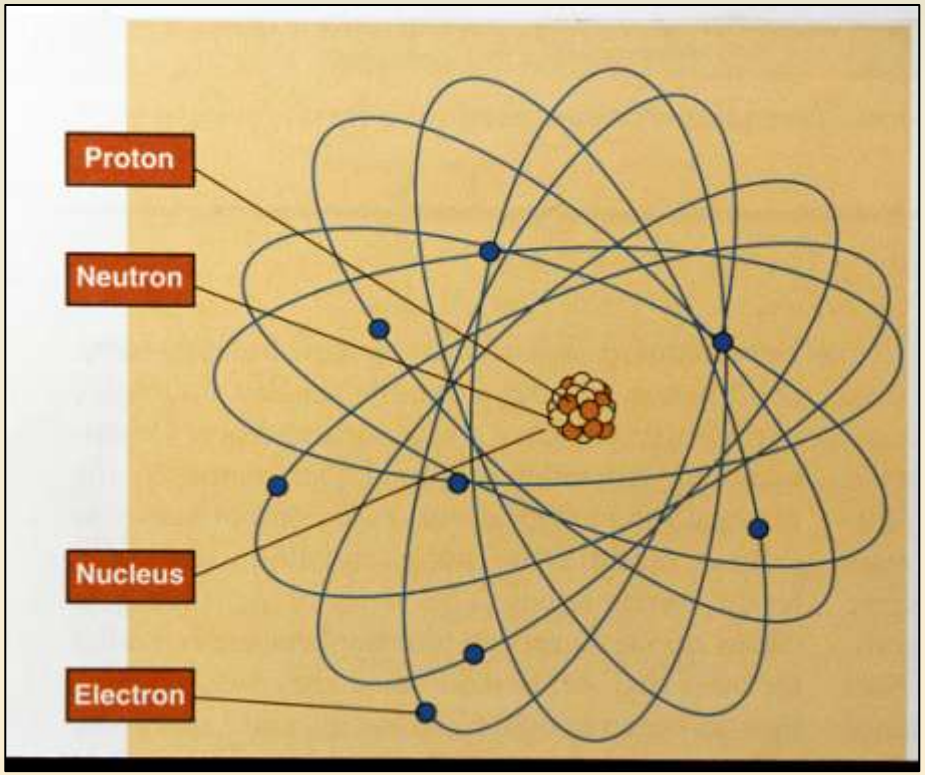
Basic Chemistry Review





Atoms

Atoms are the basic unit of chemistry.
They consist of 3 smaller things



- **Protons** - these are positively charged (+)
- **Electrons** - these are negatively charged (-)
- **Neutrons** - these have no charge

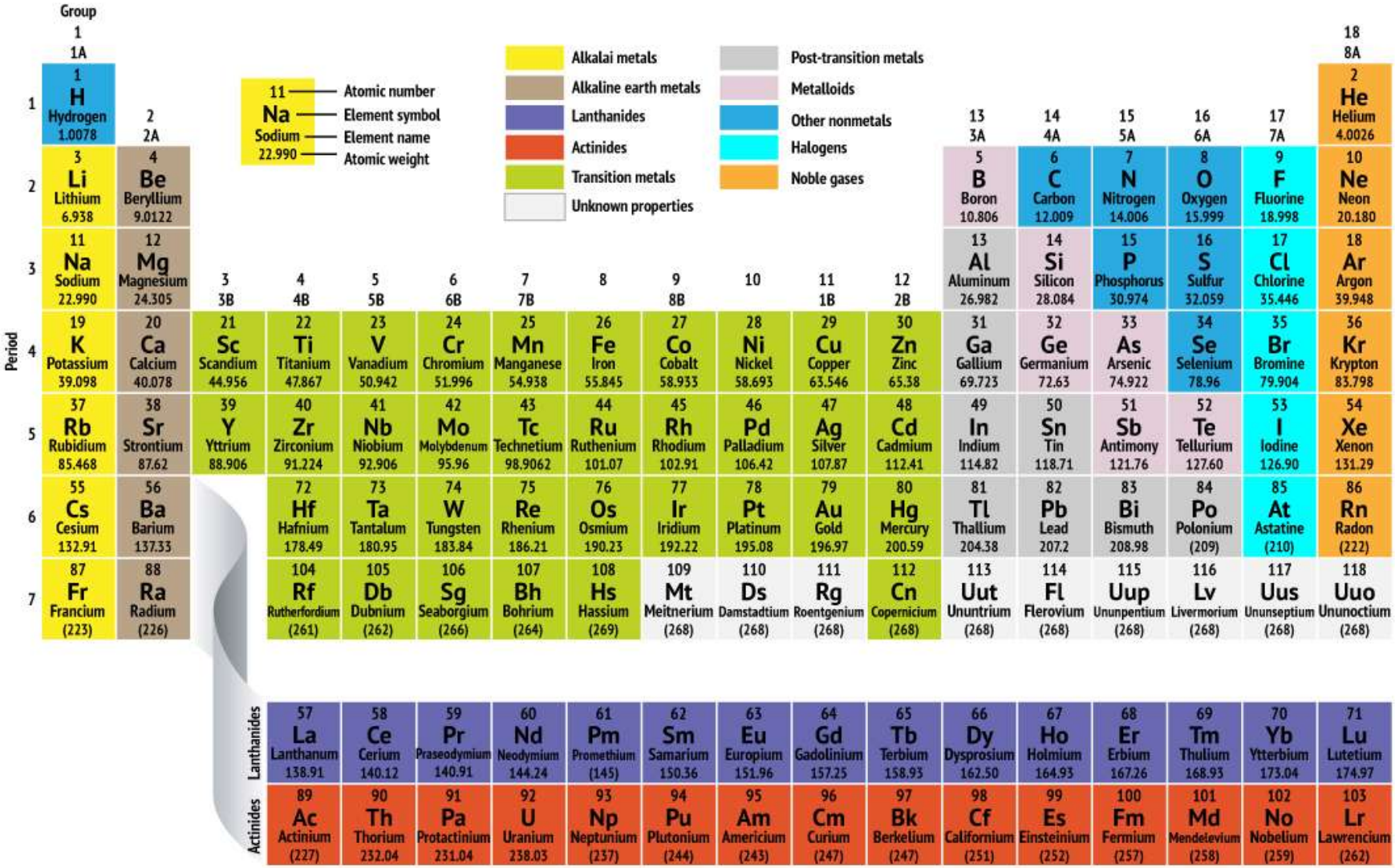
Elements

Pure substances, can't be broken down further

e.g. Silver, Copper, Magnesium, Iron

The universe is composed of approximately 100 types of atoms.
Each type of atom is referred to as an **element**.

Periodic Table of the Elements



SOURCES: National Institute of Standards and Technology, International Union of Pure and Applied Chemistry

KARL TATE / © LiveScience.com

Organic vs. Inorganic

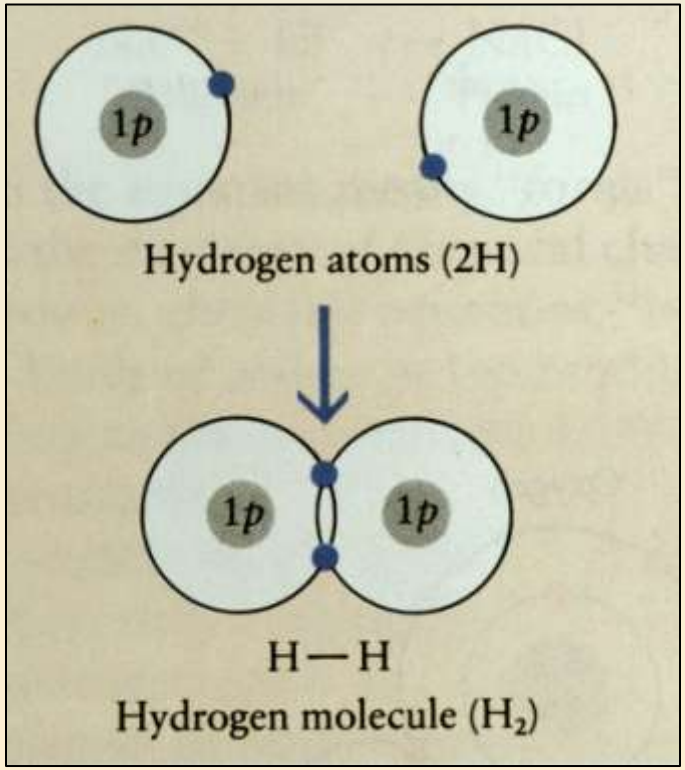
Organic molecules contain Carbon, inorganic molecules do not.

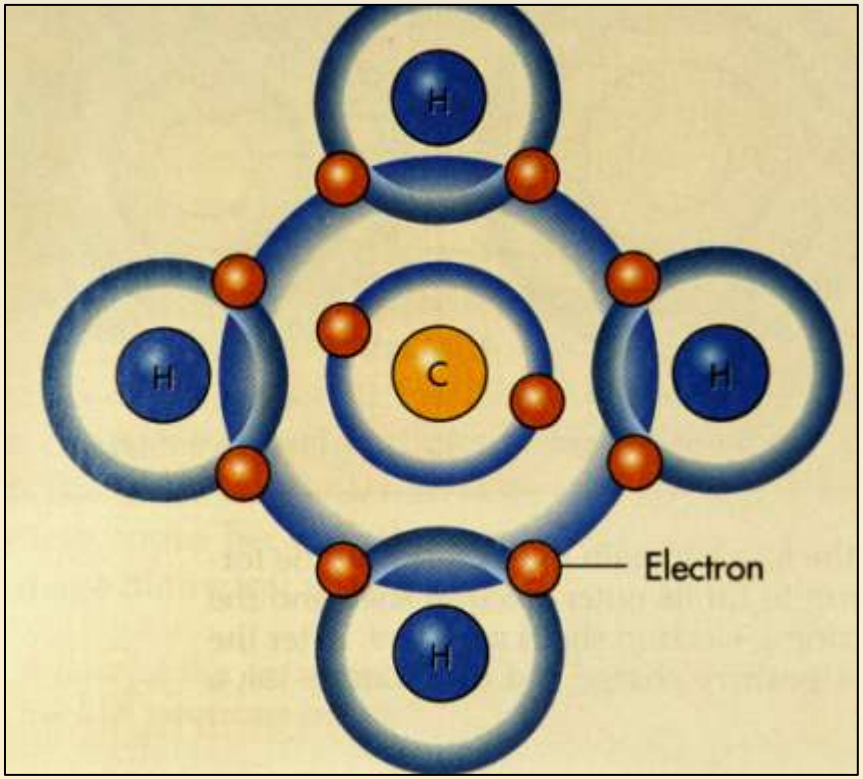
- CH_4 is the formula for methane, it is organic.
- NaCl is the formula for common table salt, it is inorganic.

Chemical Bonding

Covalent

These ***strong*** bonds form when two atoms ***share electrons***.



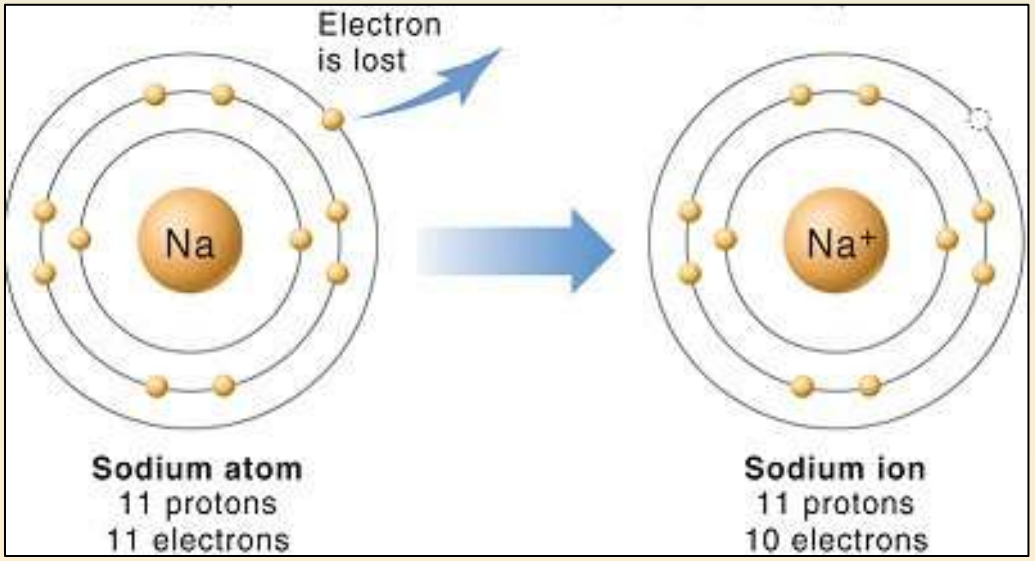


Chemical Bonding

Ions

Sometimes atoms gain or lose electrons. These atoms are then called ions.

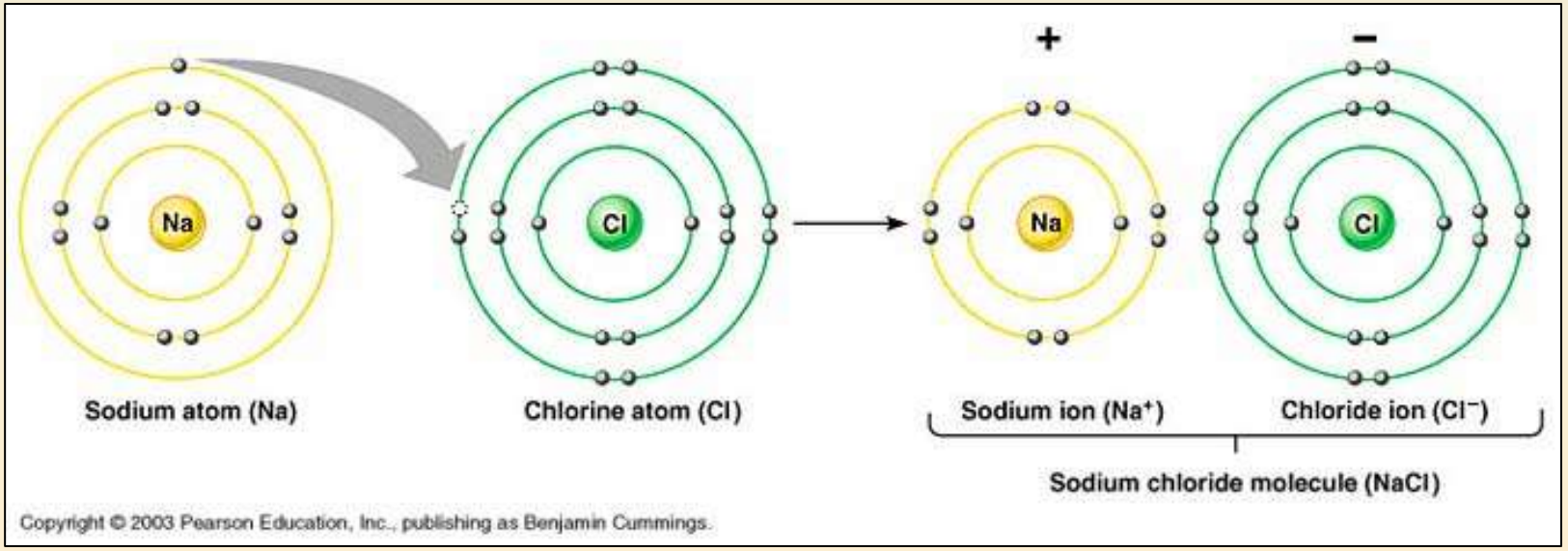
- **Positive Ion** - Occurs when an atom ***loses an electron*** (negative charge) it has more protons than electrons.
- **Negative Ion** - Occurs when an atom ***gains an electron*** (negative charge) it will have more electrons than protons.



The following image shows Na ***losing*** an electron and Cl ***gaining*** an electron

Thus the Na becomes Na+

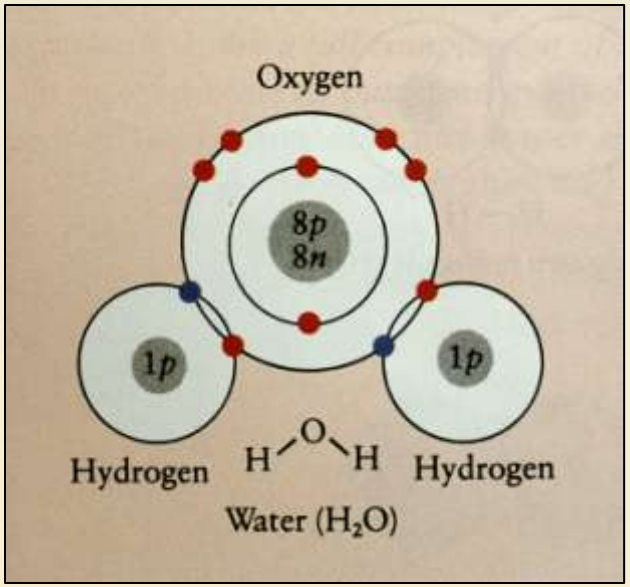
The Cl becomes Cl-

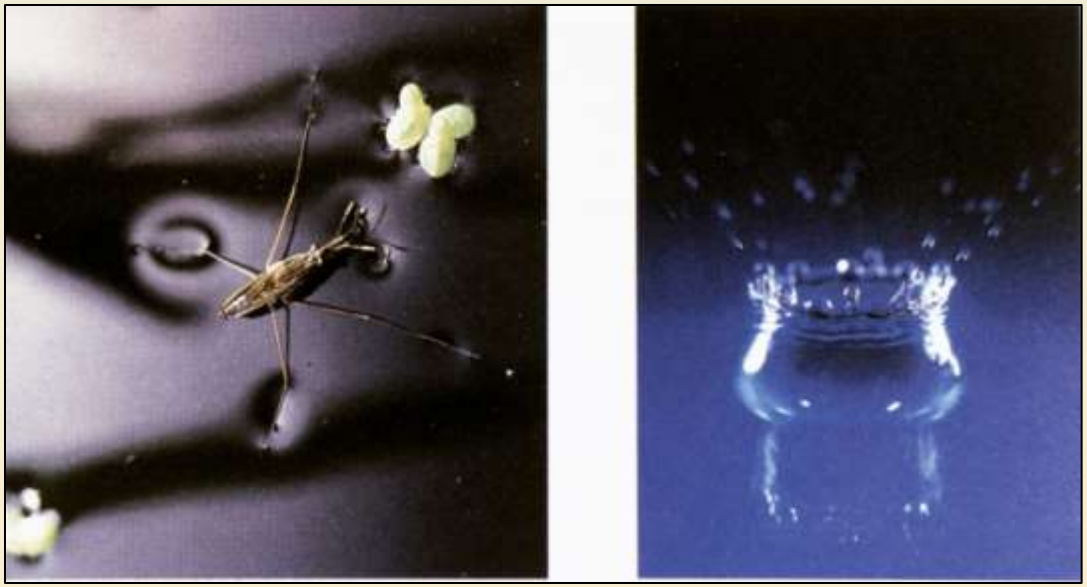


Hydrogen Bond

Weakest bond between atoms.. When the electrons are not equally shared; one atom of the molecule becomes partly negative and the other then becomes partly positive. Positive and negative are attracted to each other.

This is especially common between water molecules.





Polar and Nonpolar Substances

Since the water has opposite charges on different parts of the same molecule we call it Polar.

- A **Polar substance** has charges that can interact with the charges in water. Therefore Polar molecules are said to be Hydrophilic too (water loving).
- A **Nonpolar substance** then lacks any charges and will not be able to interact with water. Nonpolar molecules are said to be Hydrophobic (water hating).

Macromolecules

- Carbohydrates
- Lipids
- Proteins
- Nucleic Acids

Carbohydrates

Carbohydrates

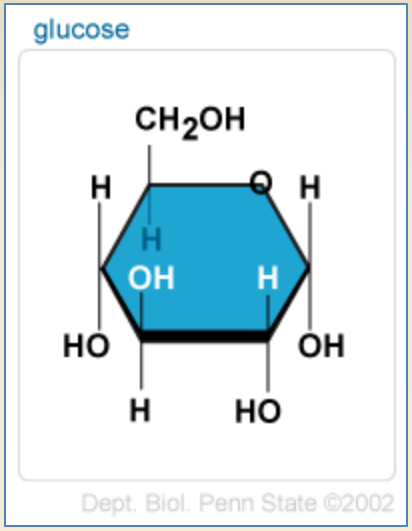
- **Carbohydrates** are composed primarily of carbon, hydrogen and oxygen and used primarily by living things as a source of energy and for structure.

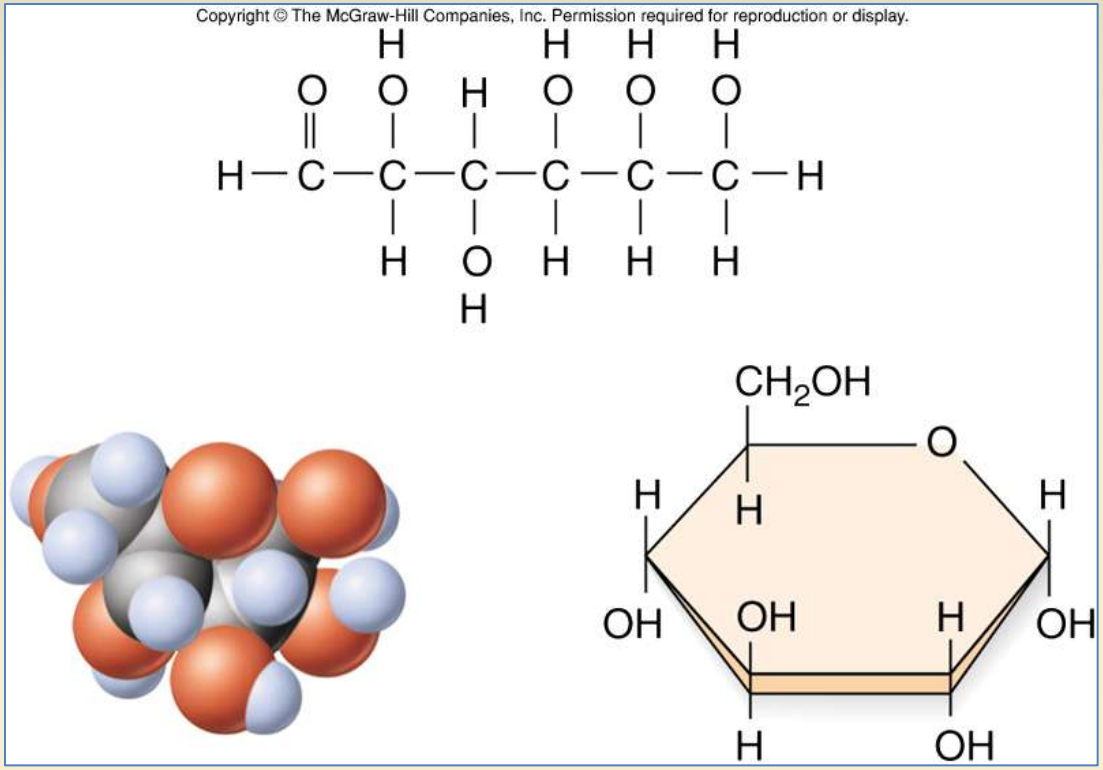
- The simplest carbohydrates are sugars called **monosaccharides**. An example of a monosaccharide is the sugar glucose, formula $C_6H_{12}O_6$.

- Monosaccharides can bond together to form larger carbohydrates called **polysaccharides**. An example of a polysaccharide is starch as is found in potatoes or pasta.

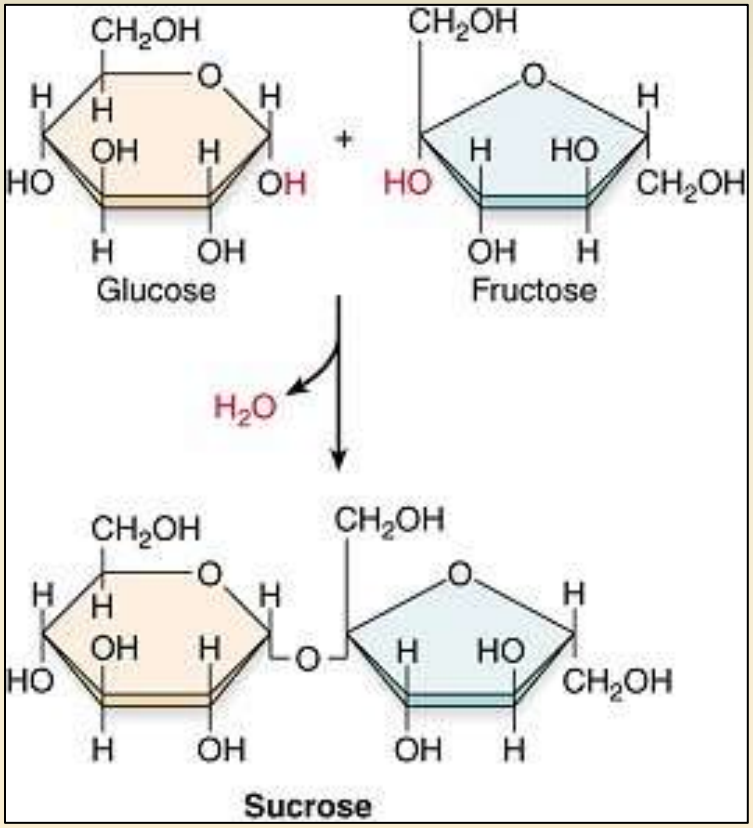
Monosaccharides - Glucose

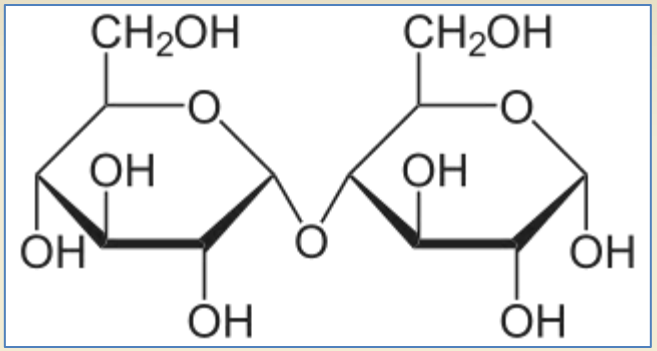
formula C6H12O6





Disaccharides - two carbohydrates linked together; ie. sucrose, maltose

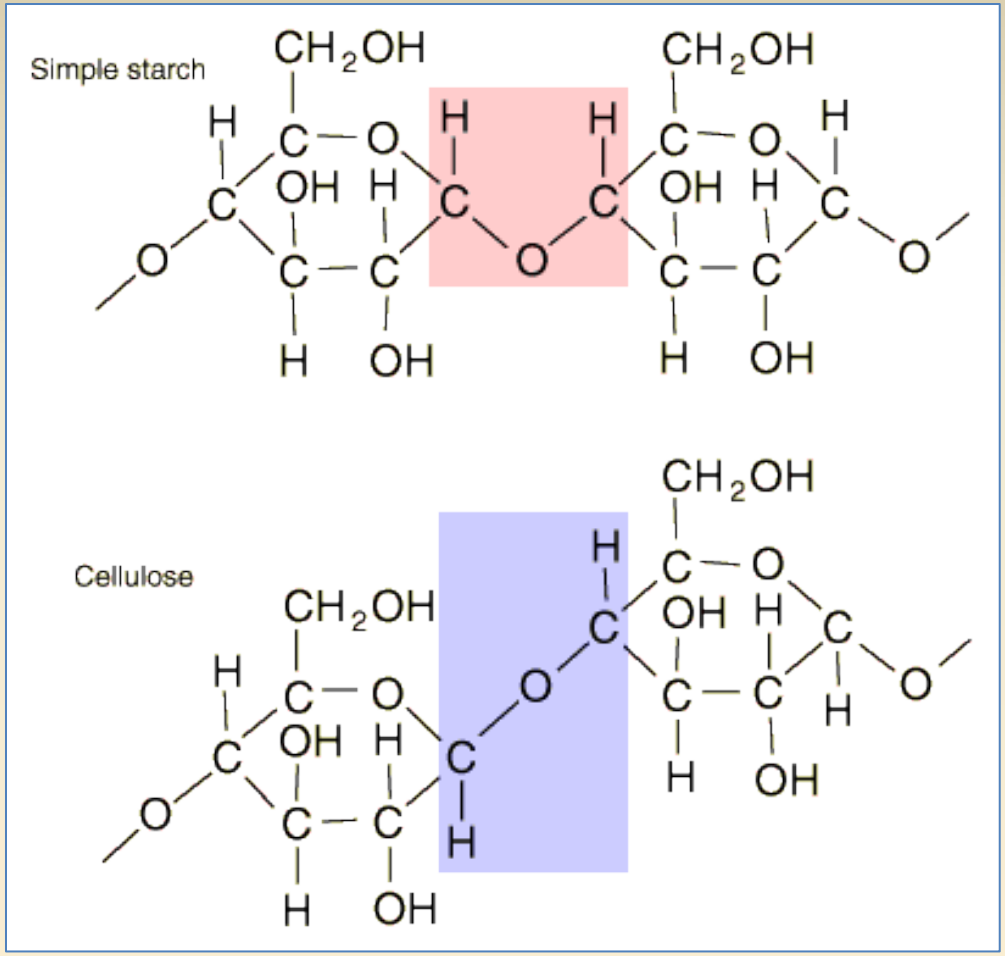




Maltose

Beer is brewed from malted barley

Starch and Cellulose

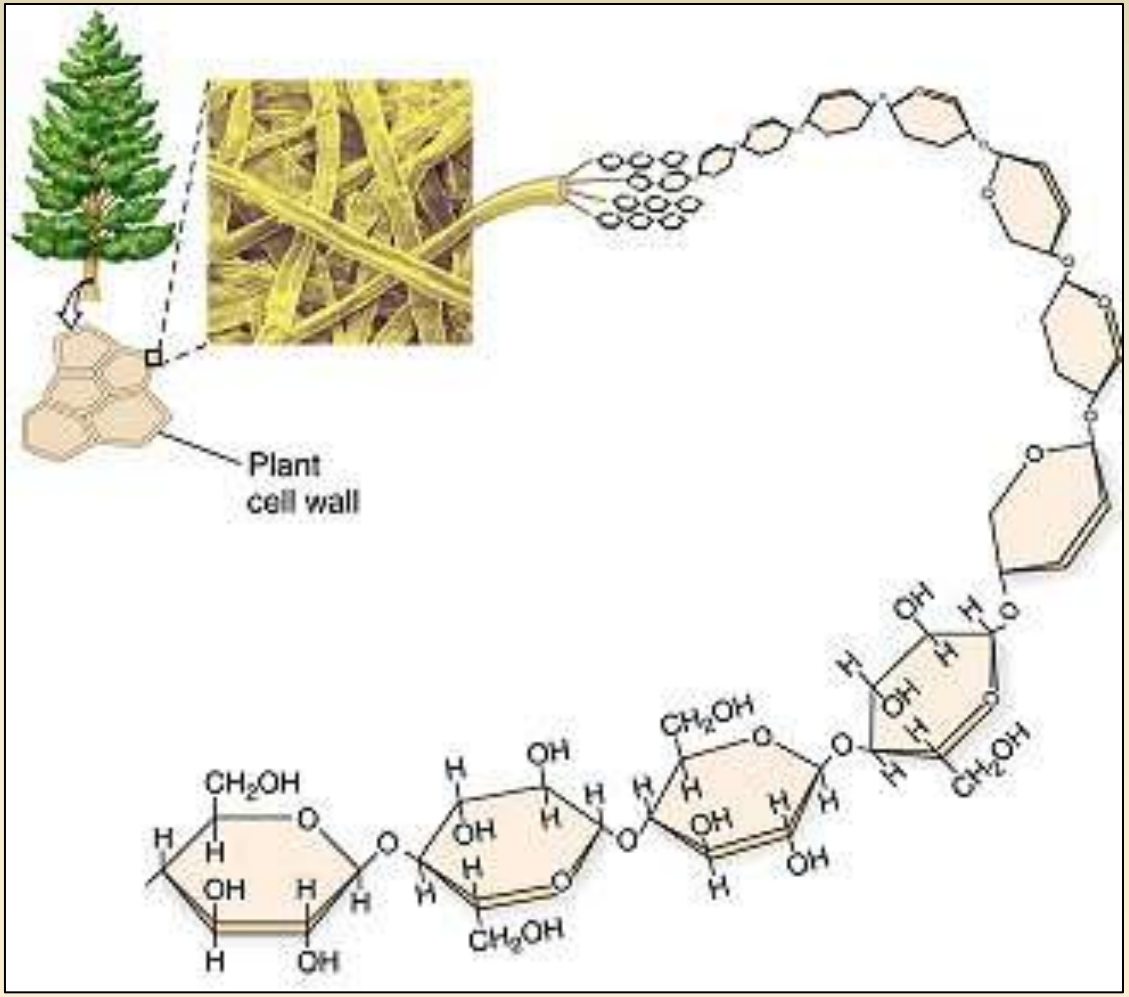


- differ in how the carbohydrates are linked together, two slightly different types of bonds are used.
- makes them different enough that one you can easily digest while the other is not digested at all by humans.

Polysaccharides

Cellulose

- the most common organic compound on Earth
- Wood, paper
- Food additive

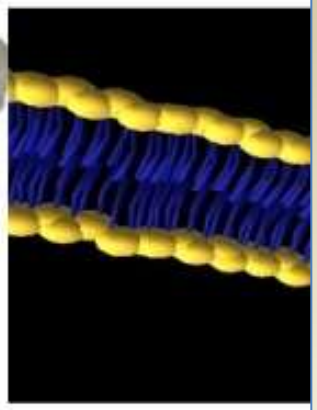


Lipids

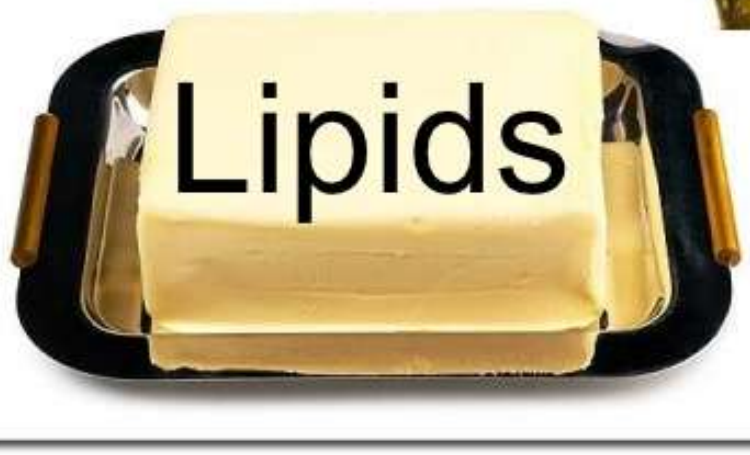
- store extra energy and insulate the body.
- cell membranes, myelin sheaths, and certain hormones.
- from animal fat and vegetable oils.

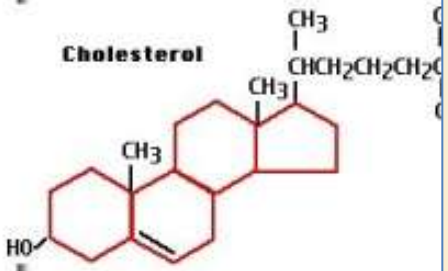

Cholesterol Free
Mazola
CORN OIL


Crisco
ALL-VEGETABLE SHORTENING
Crisco
50% LESS SATURATED FAT THAN BUTTER
NET WT 16 OZ (1 LB)

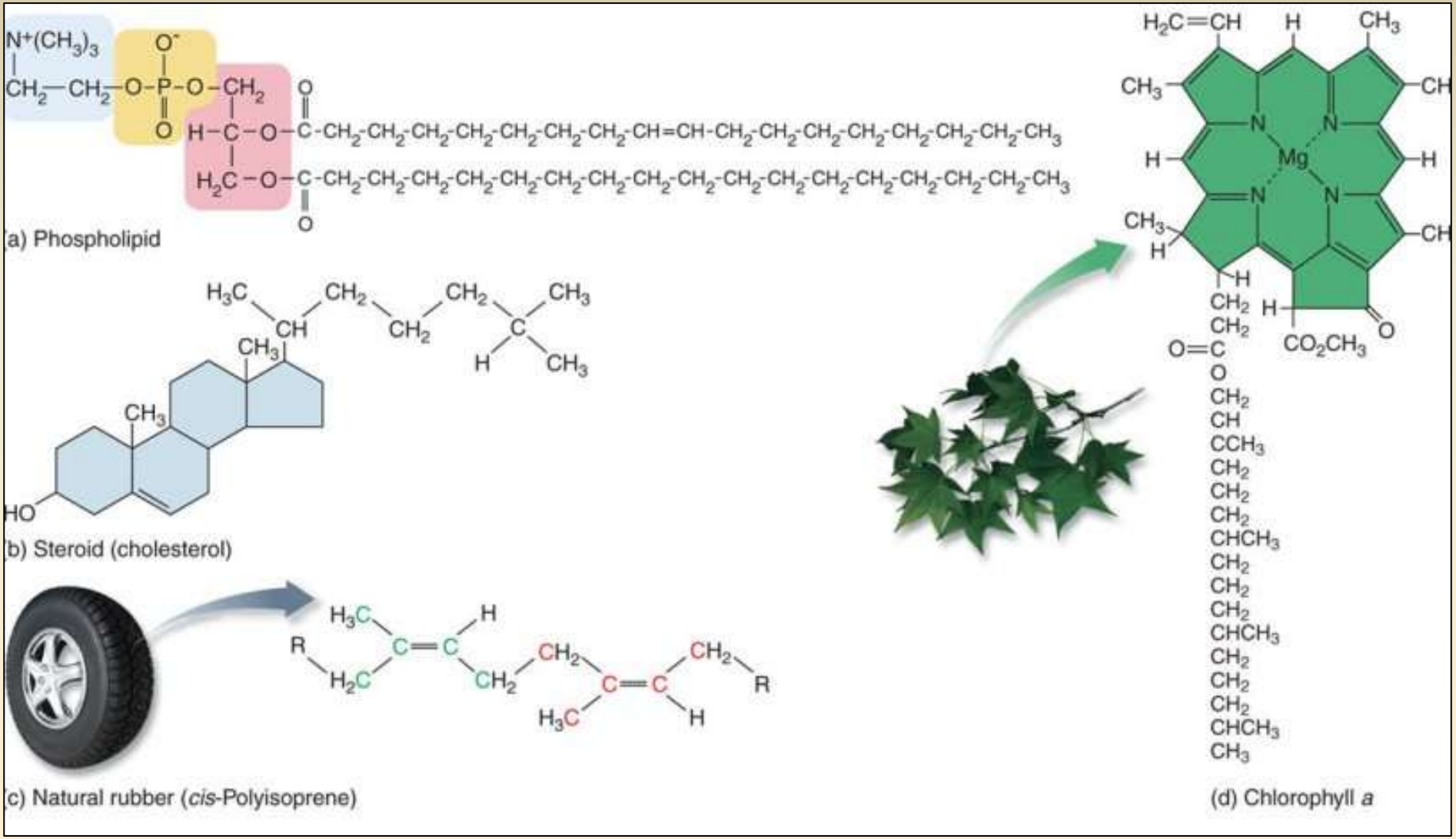



Soap Cake


Lipids

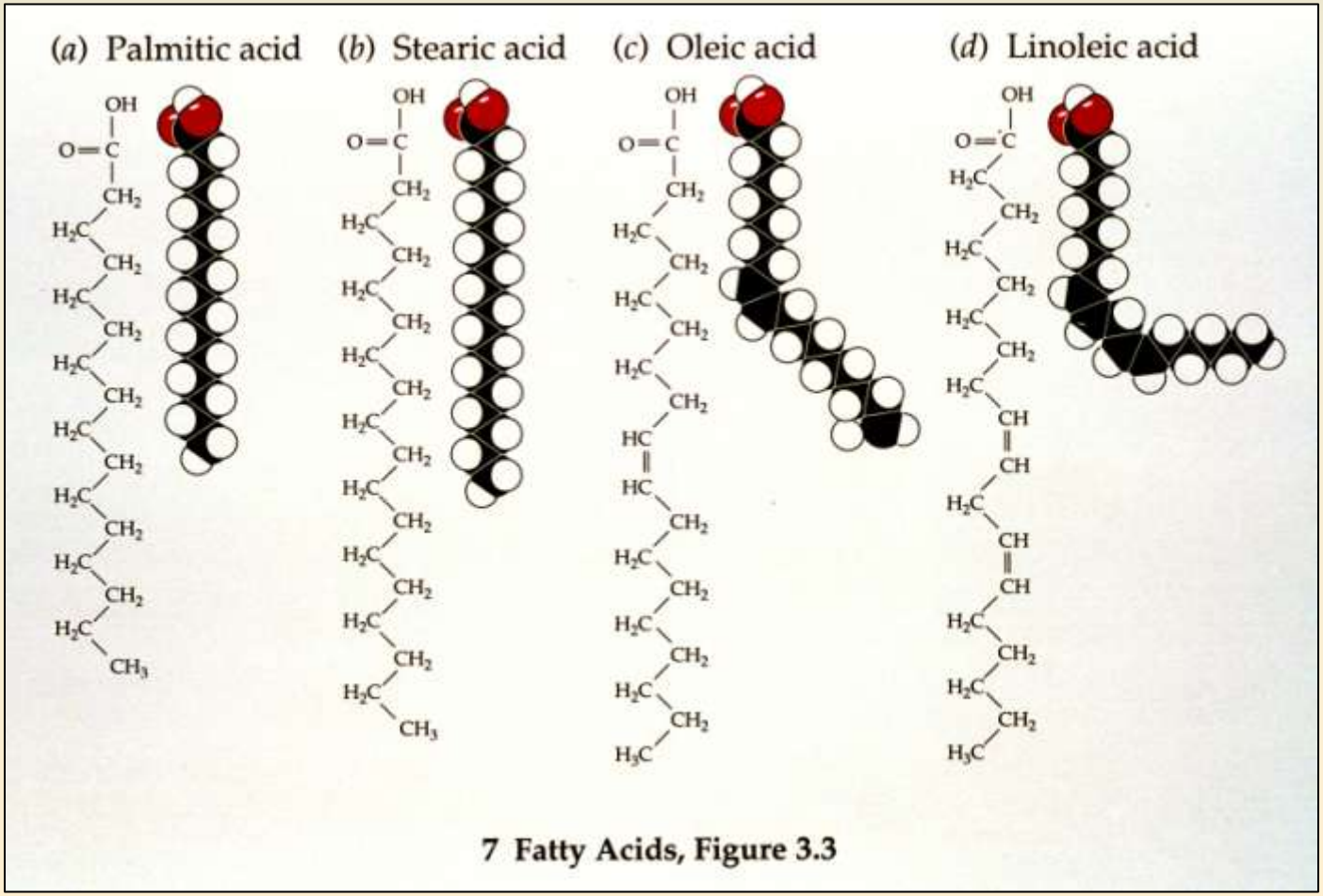

Cholesterol
CH3
CHCH2CH2CH2
CH3
CH3
HO

Lipids


(a) Phospholipid
(b) Steroid (cholesterol)
(c) Natural rubber (*cis*-Polyisoprene)
(d) Chlorophyll *a*

Fatty acids

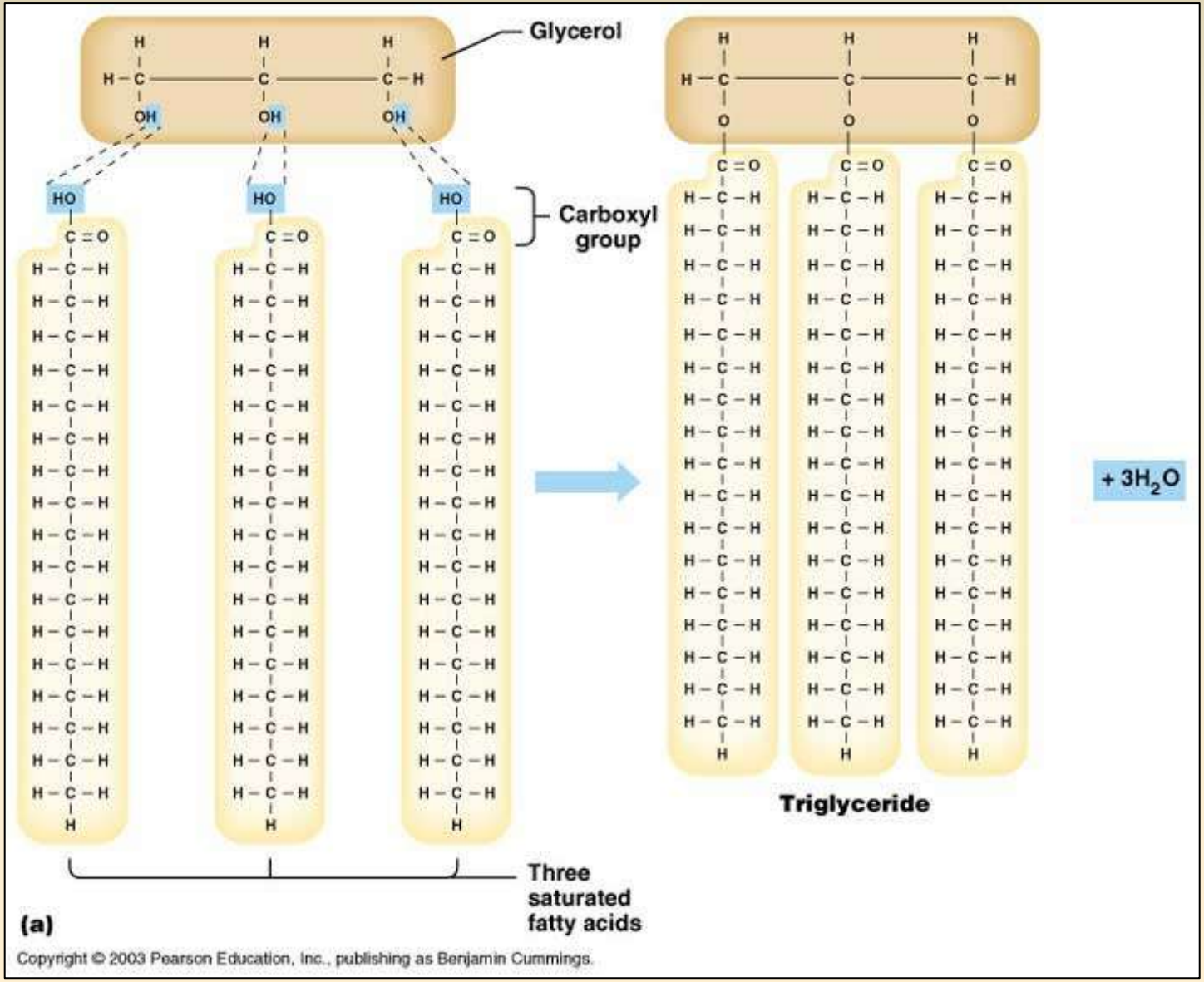
- Long neutral carbon chains (C-C-C-C-C-C-C-C-C-C-C-C-C-C) with carboxyl group at one end.
- They come in many different lengths, get many different fatty acids.
- They are non-polar, so they clump together in water (oil and water don't mix.)



7 Fatty Acids, Figure 3.3

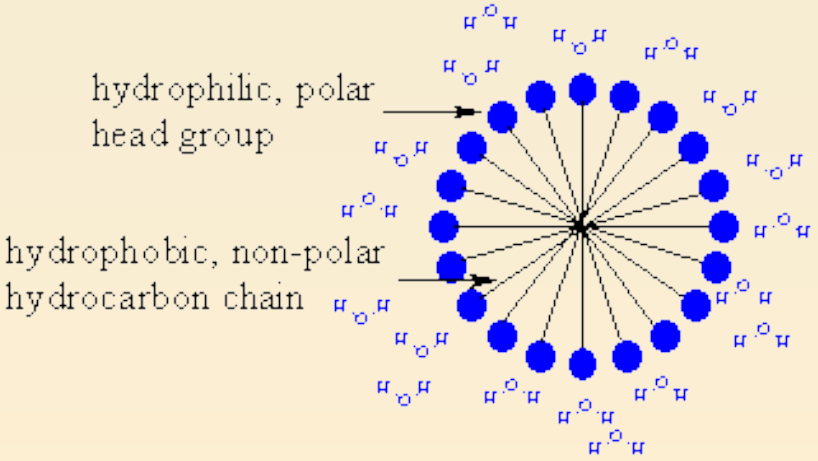
Triglycerides

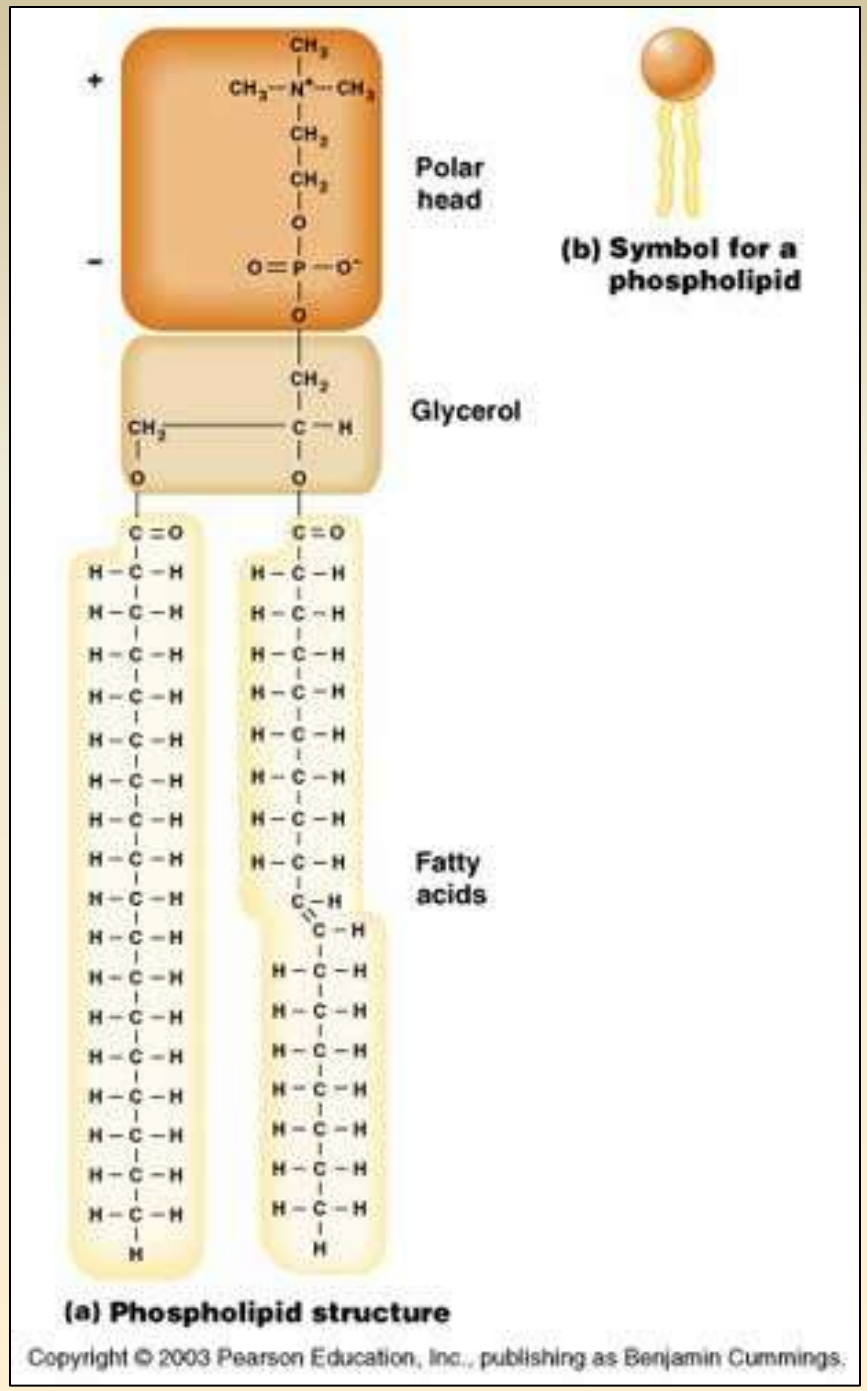
Three fatty acids linked by **glycerol**.



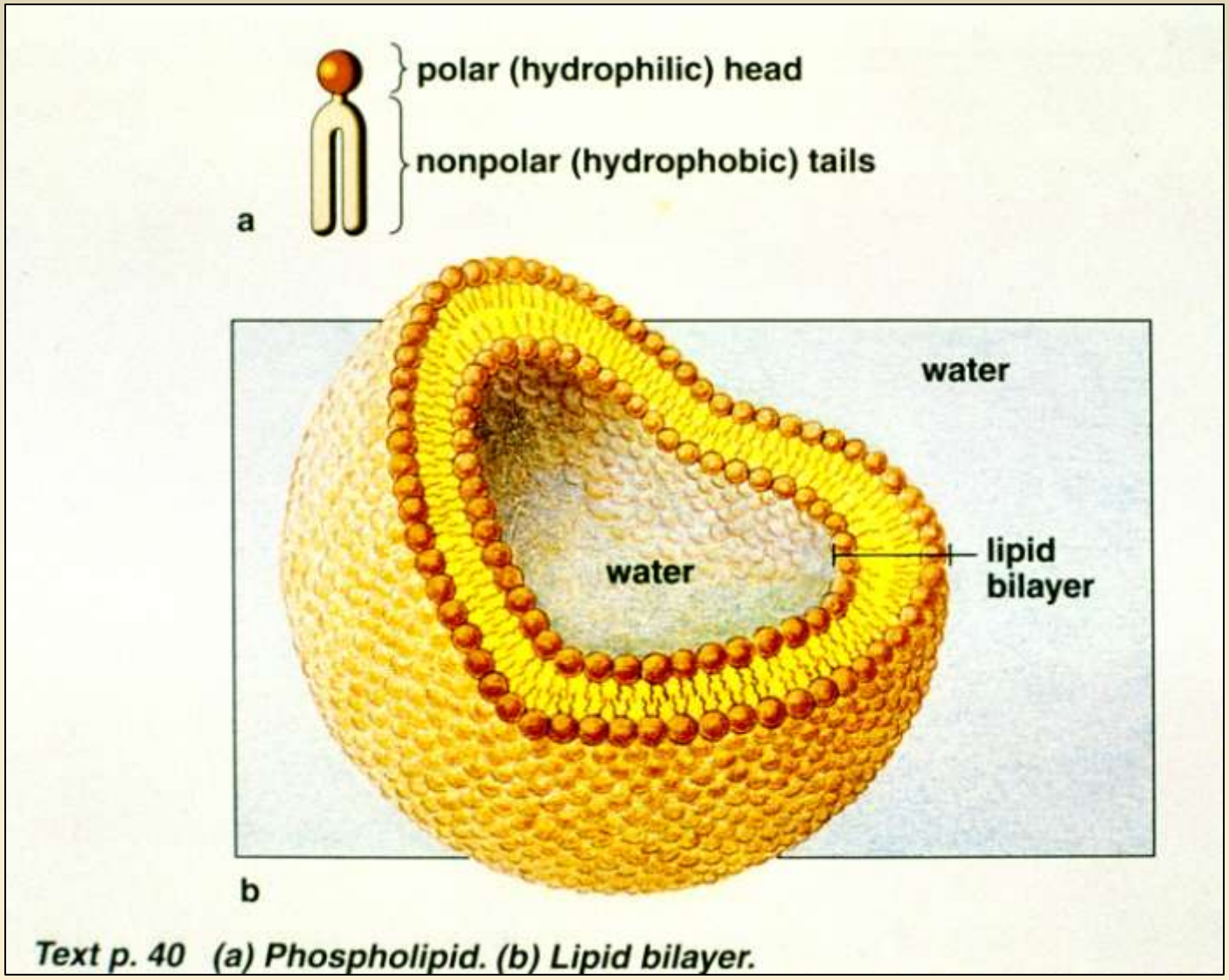
Phospholipids - remove one fatty acid from a Triglyceride and add a Phosphorous instead.

- organize themselves in water in unique ways.
- partly non-polar (long tails) and partly polar (the phosphorous end.)



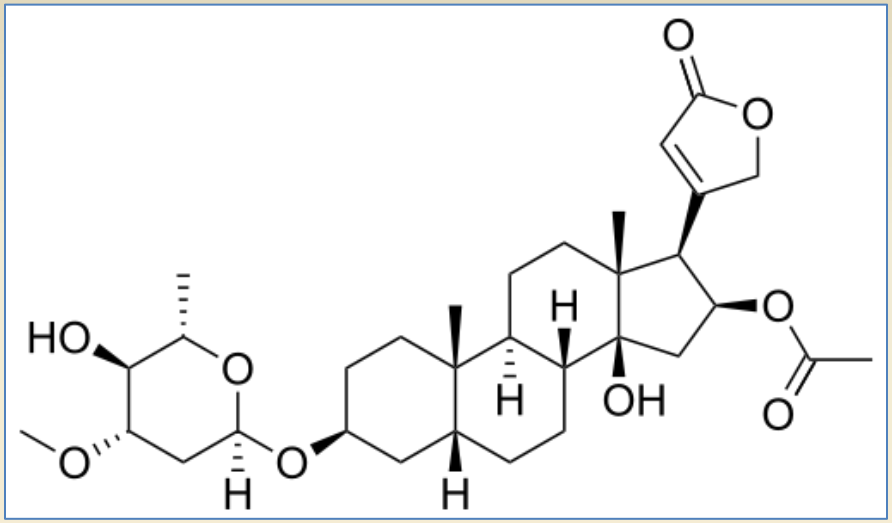


Phospholipids form a **Bilayer** or a **Micelle** (round ball) in water
Phospholipids are used to construct cell membranes

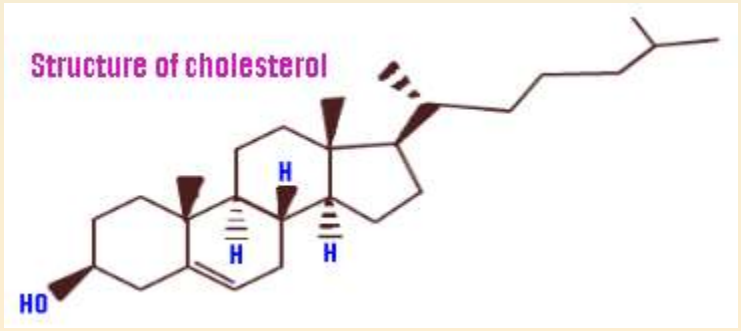


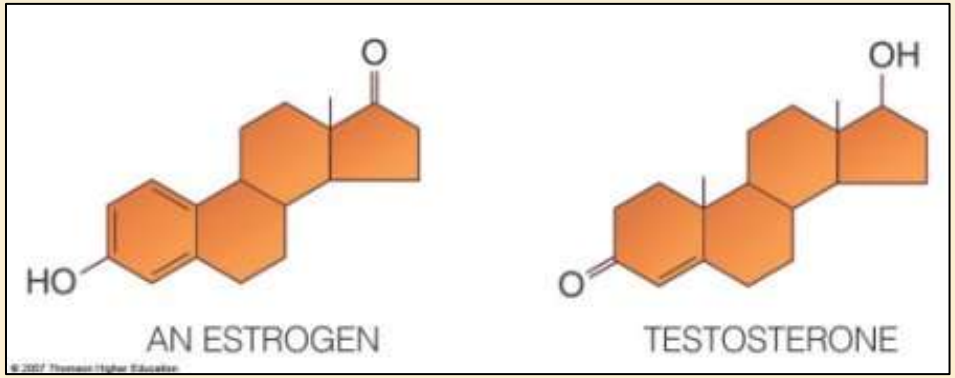
Text p. 40 (a) Phospholipid. (b) Lipid bilayer.

Steroids – lipids



Oleandrin
a toxic cardiac glycoside from
Nerium oleander

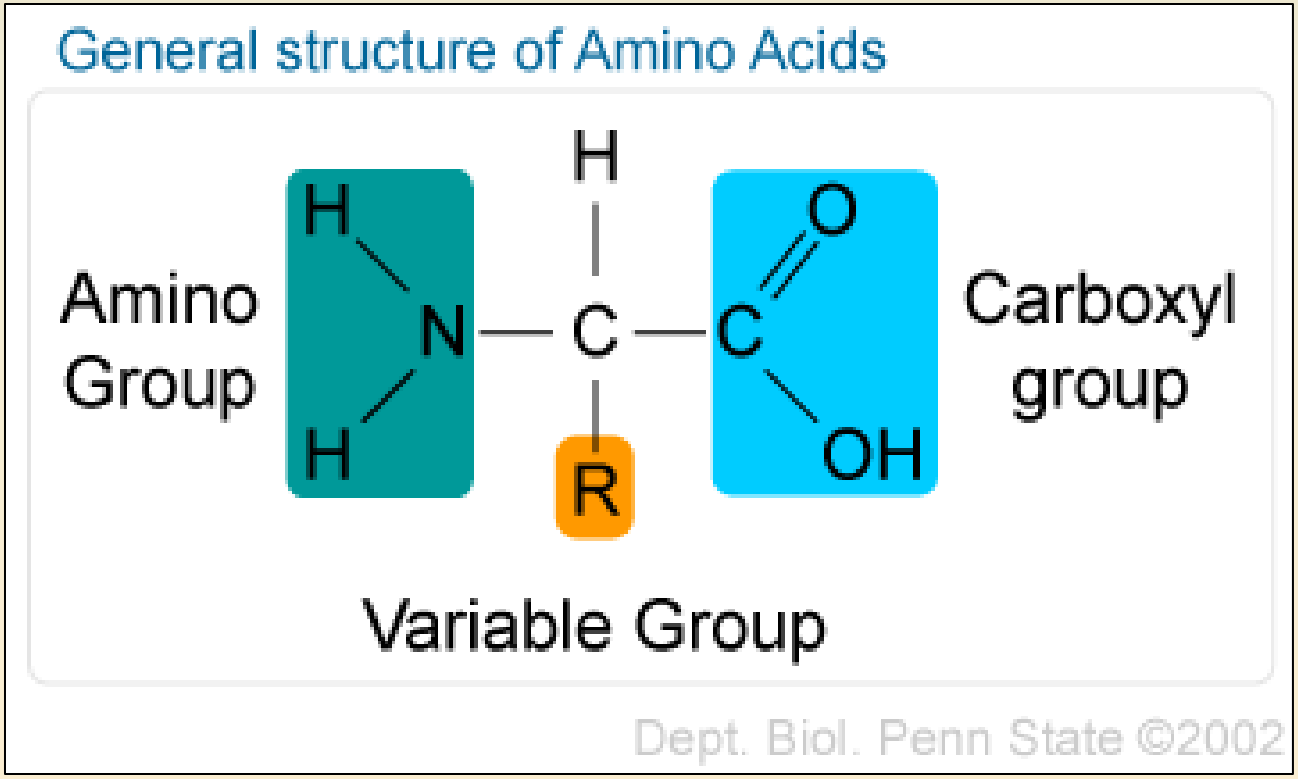




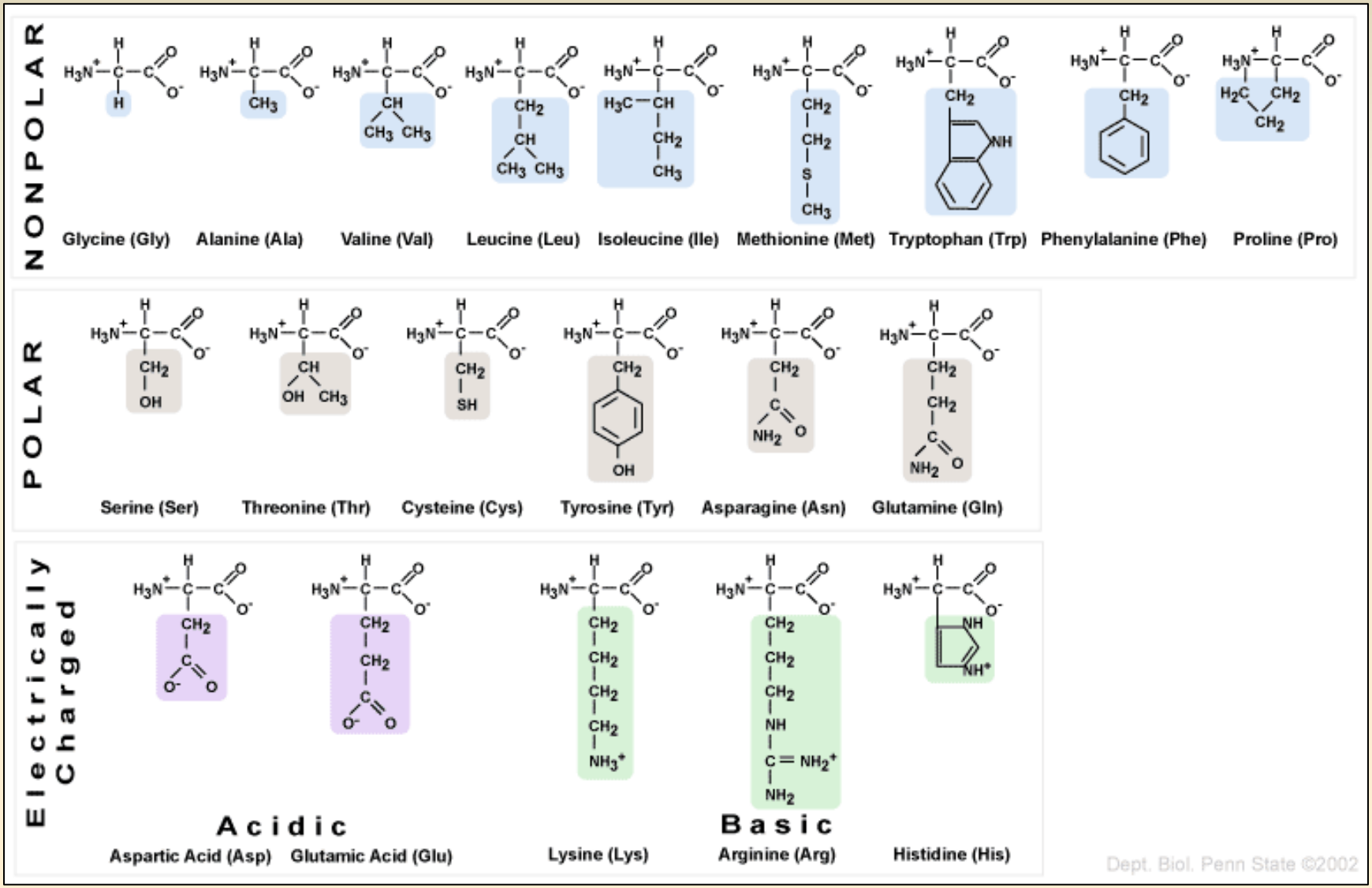
Proteins

Proteins

Proteins are made by building long chains of **amino acids**.
The Amino acid structure looks like this:



The R side chain is attached to central Carbon.
Each R side chain has a different structure to it
Twenty different types of side chains (20 amino acids)

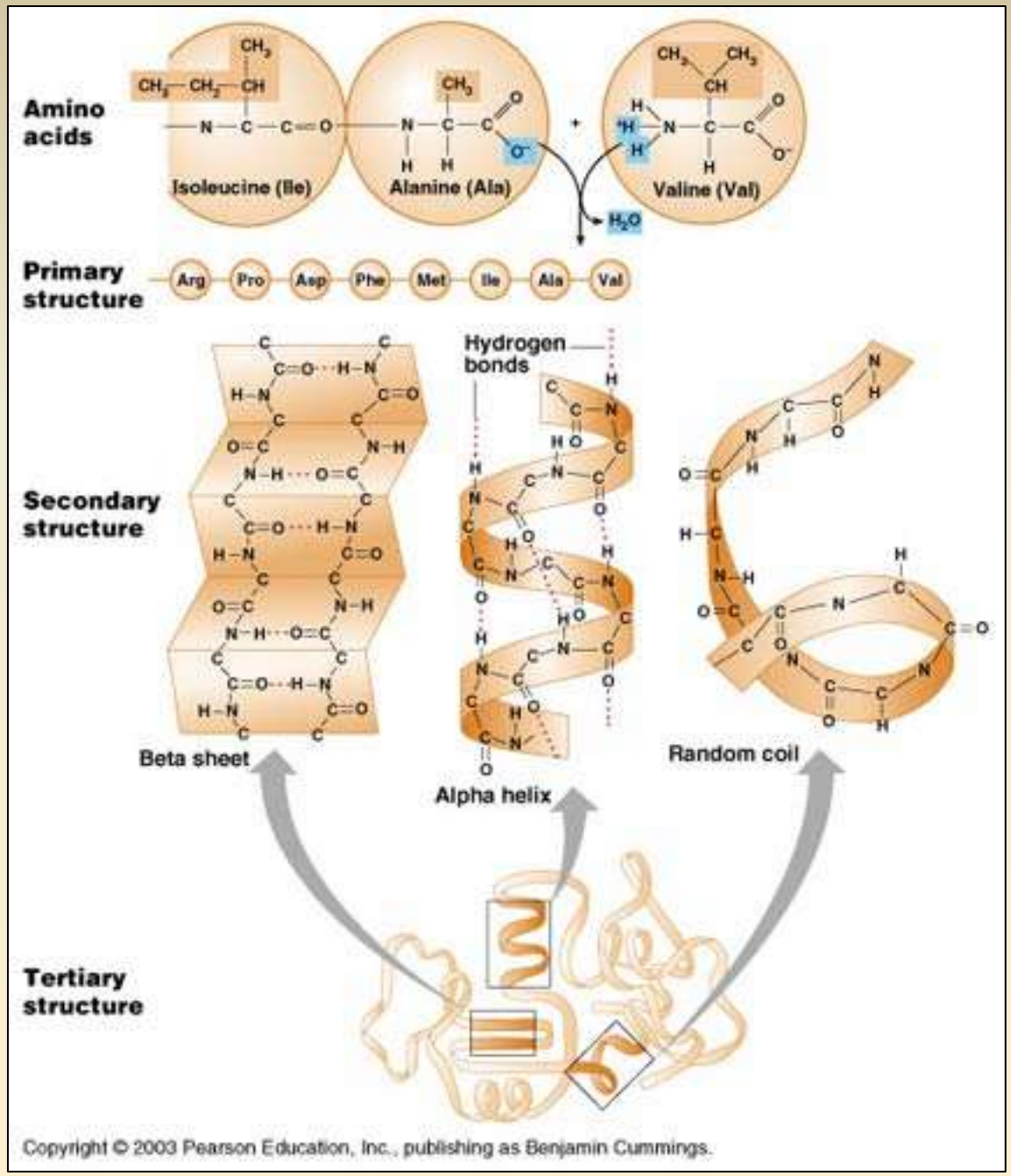


Four Levels of protein structure

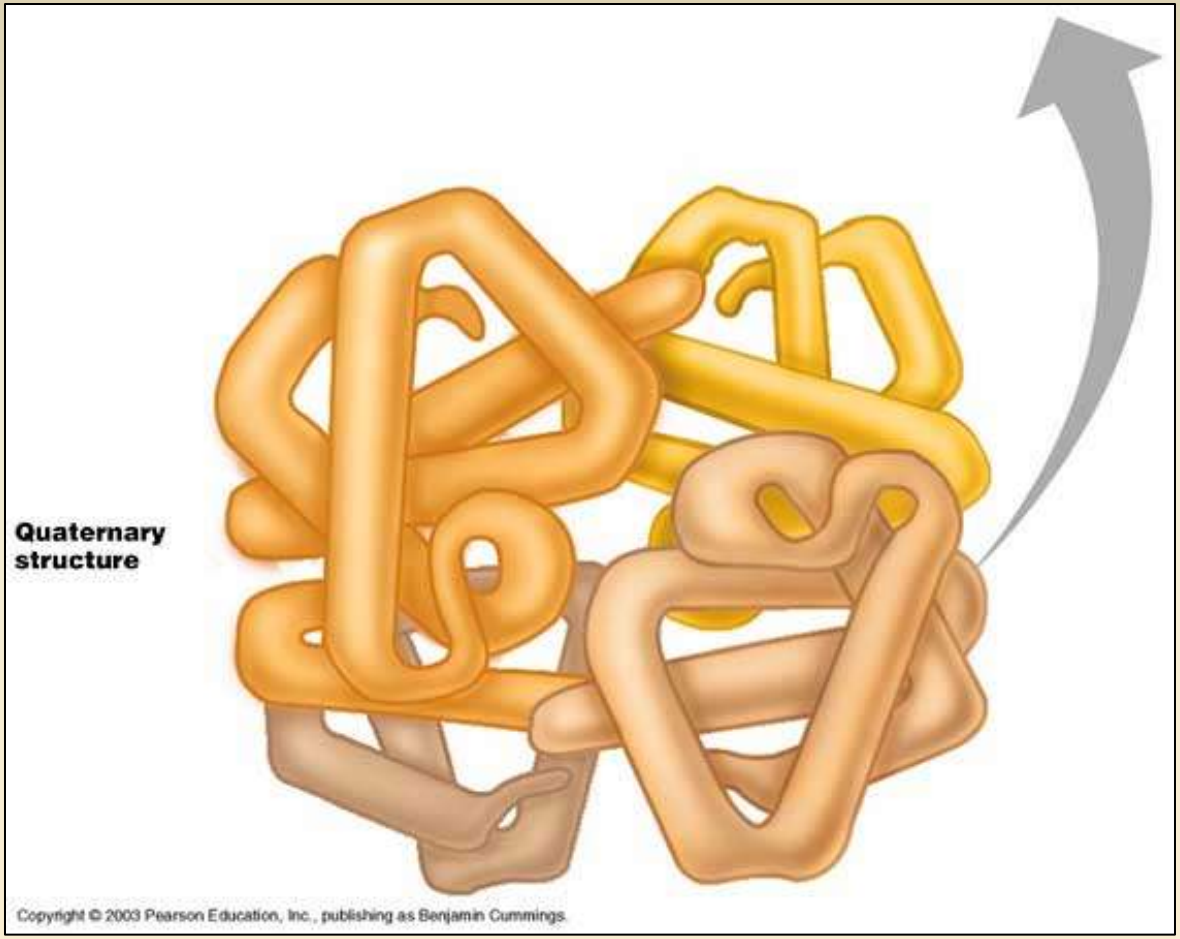
Primary - exact sequence of amino acids before folding.

Secondary - simple folding create simple structures.

Tertiary - folding results in complex 3D structures



Quaternary - multiple 3D subunits organized into a bigger structure

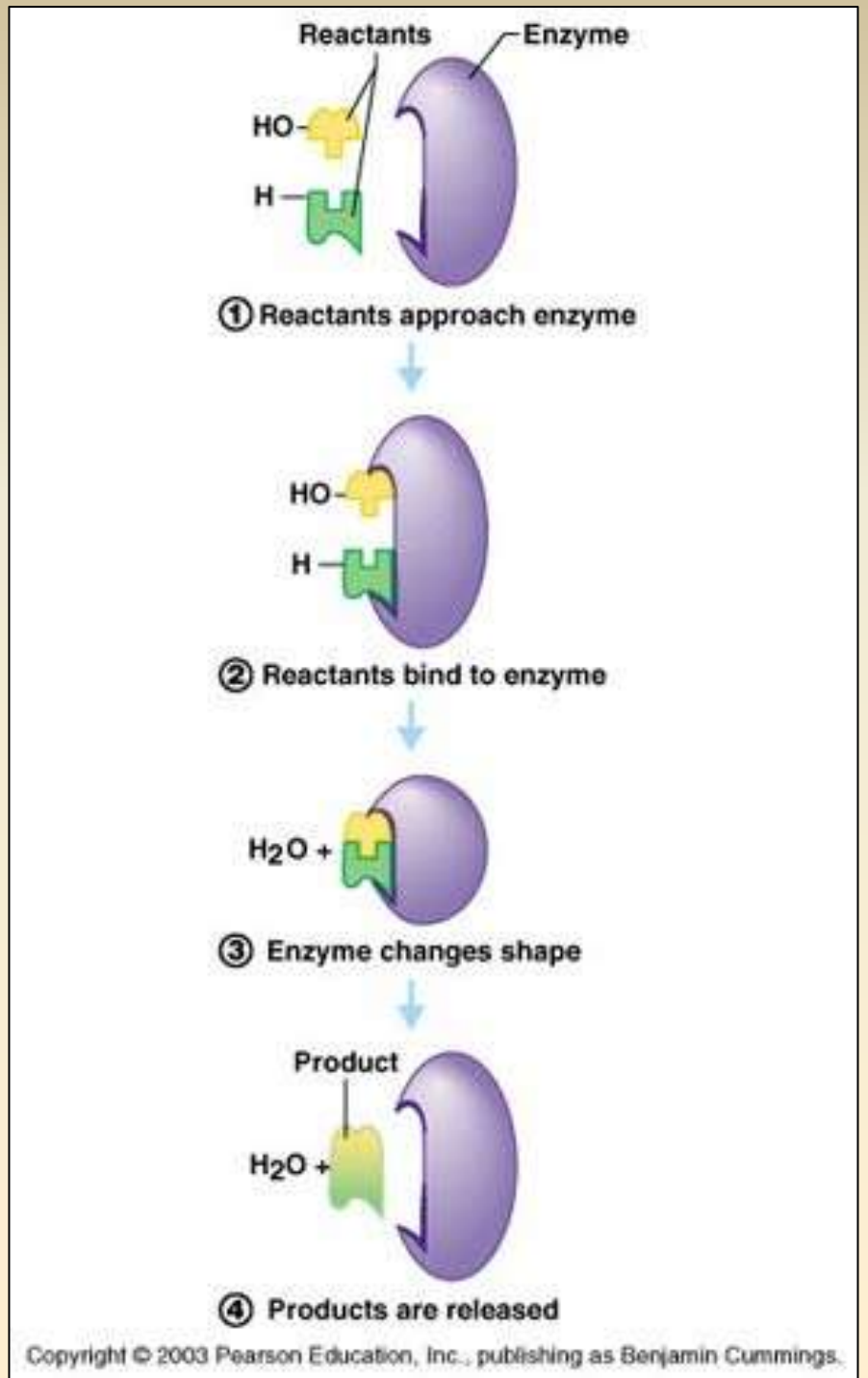


- Proper protein function depends on correct 3D structure.
- Any change in the specific primary structure can cause the protein to fold differently.
- A different shape can lead to a different function (or lack of proper function).

Enzymes

Proteins specifically shaped to carry out special functions in cells:

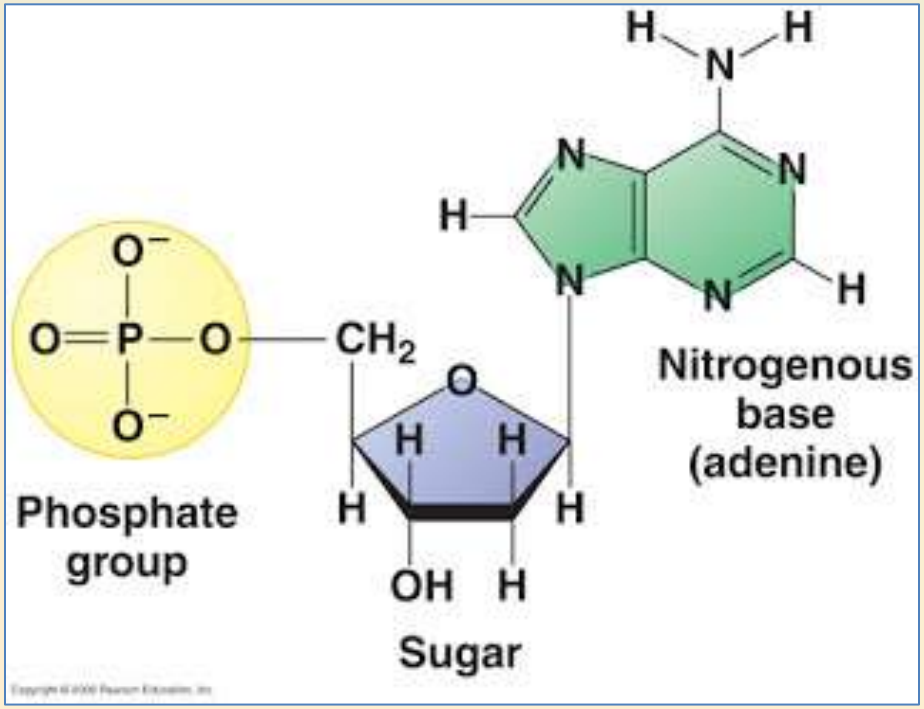
- They accelerate the rate of chemical reactions necessary for life.
- Enzymes take a **Substrate** and convert it into a new Product
- Each specific reaction needs a specific enzyme.
- Any changes in their shape will effectively stop chemical reactions.

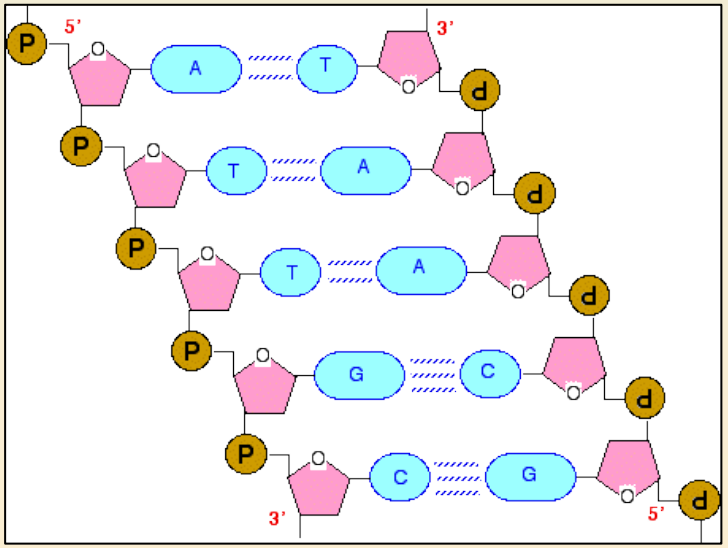


Nucleic Acids

One nucleotide has 3 parts:

- **Sugar** (pentose, a 5 carbon sugar)
- **Base** (A, G, C, T, U)
- **Phosphorous**





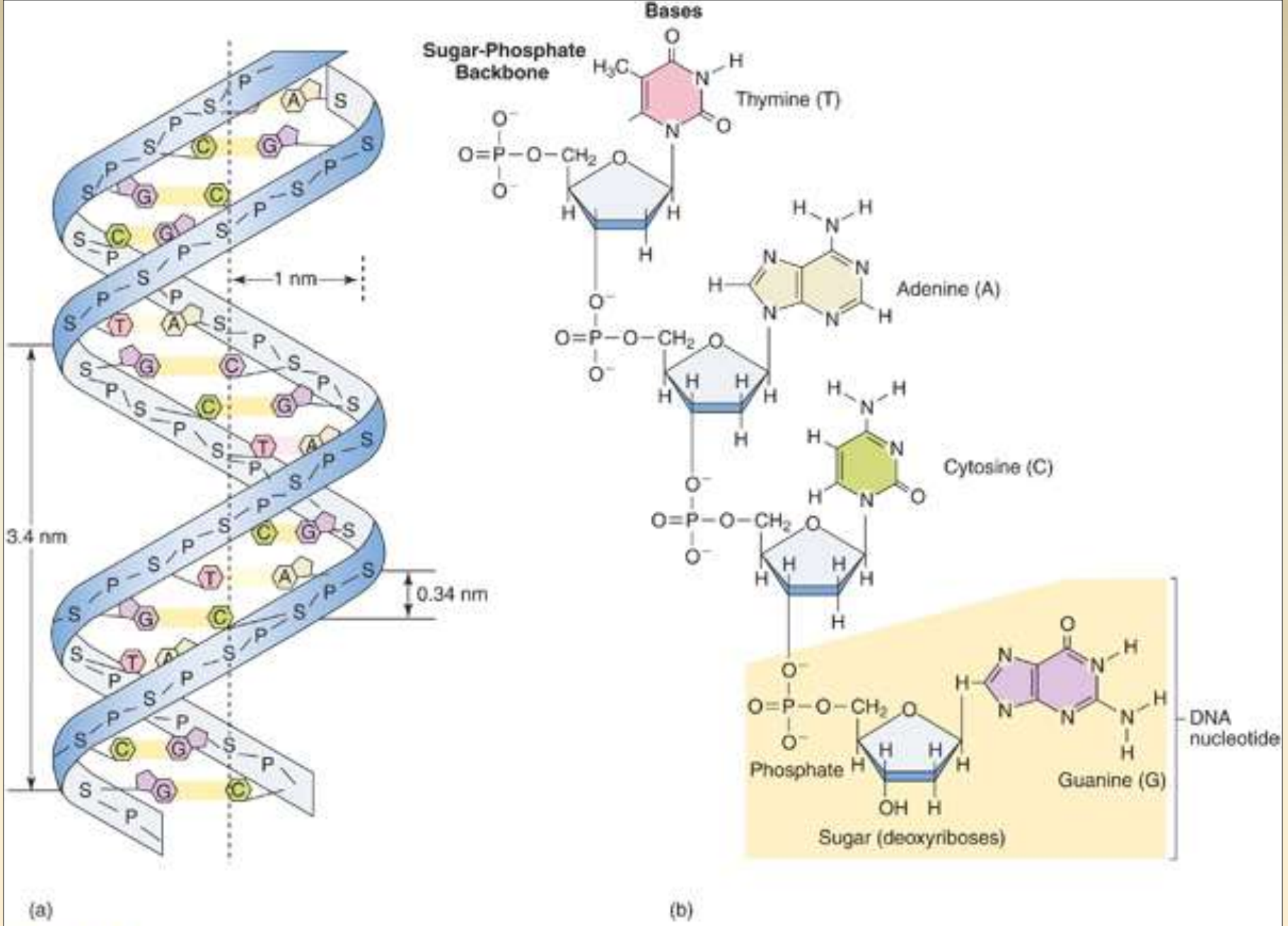
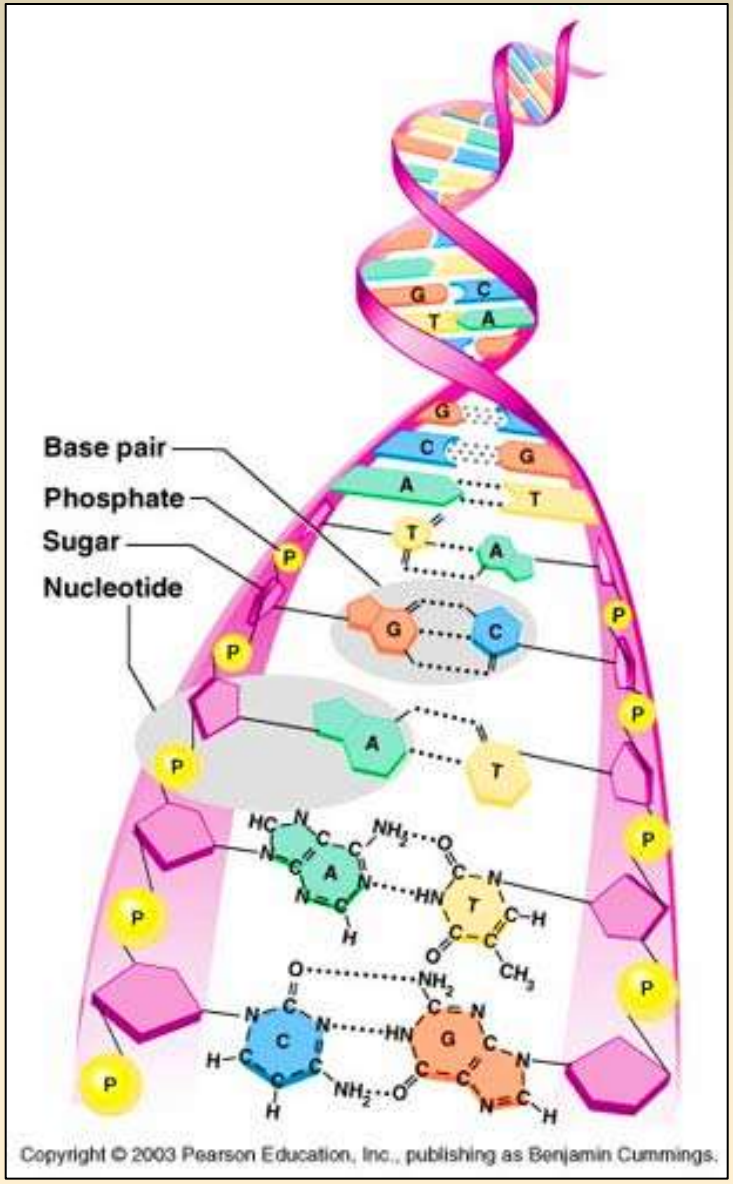


Figure 1.9 DNA molecule. (a) The double helix with the sugar-phosphate backbone making up the sides and the paired nitrogenous bases the interior. (b) Structures of the nucleotides (sugar, phosphate, and base) that make up the DNA molecule.

DNA Structure

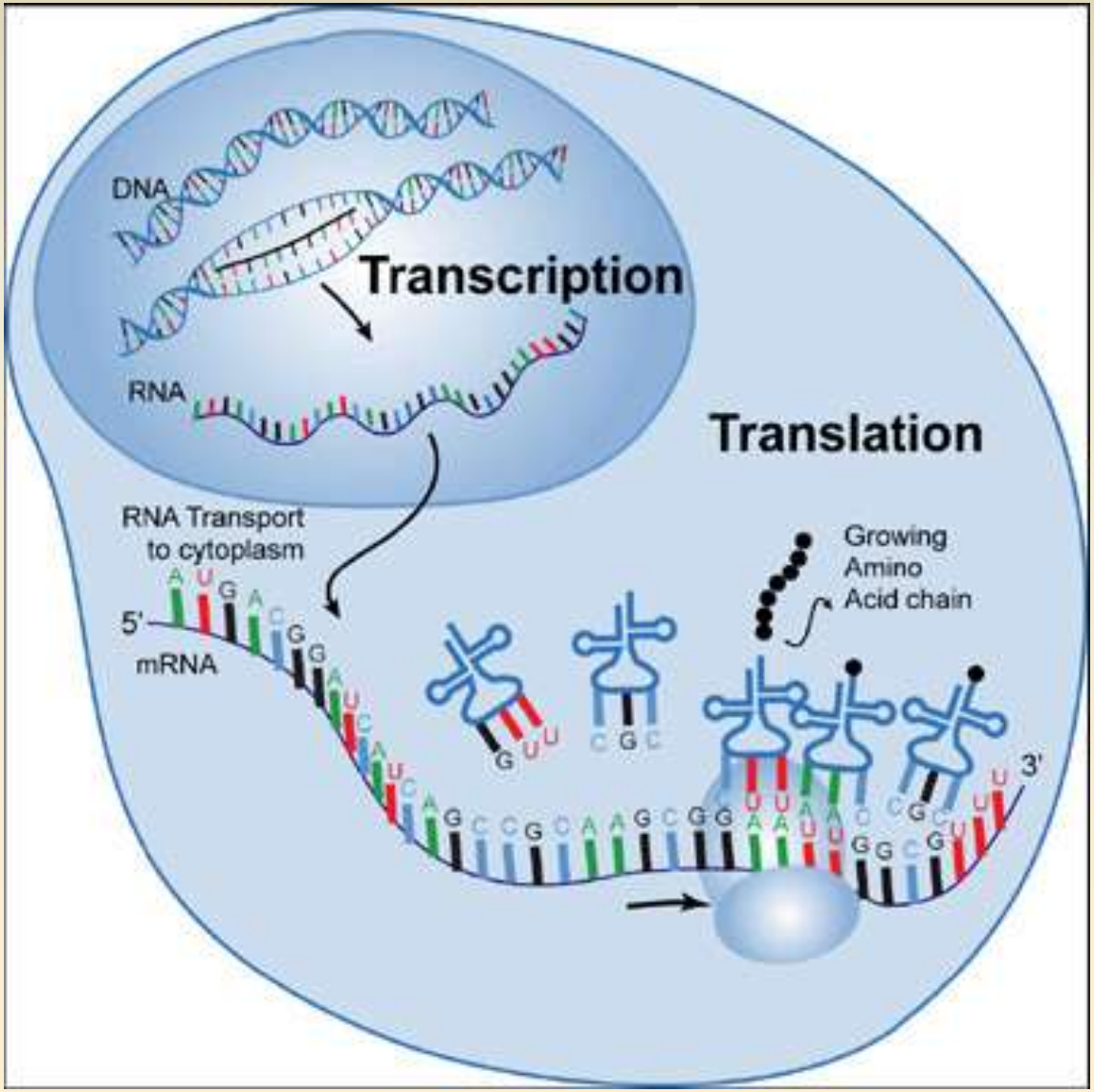
- Double helix
- Paired strands are linked by bases
  - Adenine (“A”)
  - Cytosine (“C”)
  - Guanine (“G”)
  - Thymine (“T”)

  – A must bond with T
  – G must bond with C



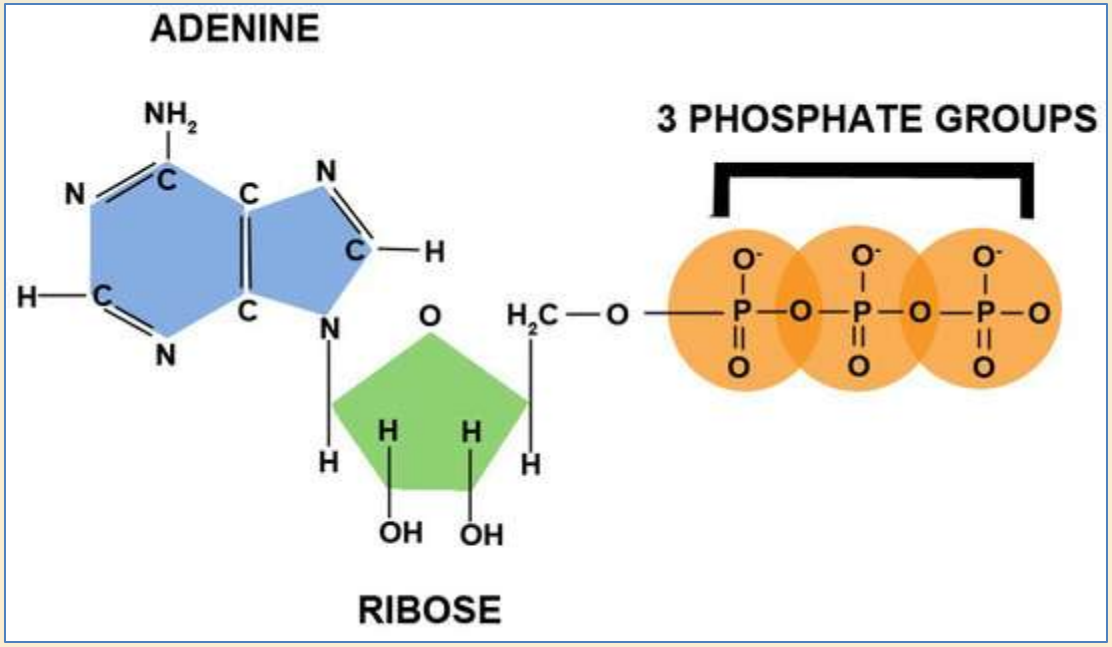
Transcription: DNA => RNA

Translation: RNA => Protein (enzymes)



ATP – adenosine triphosphate

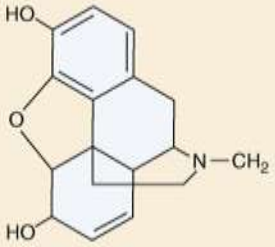
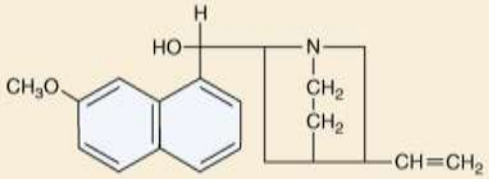
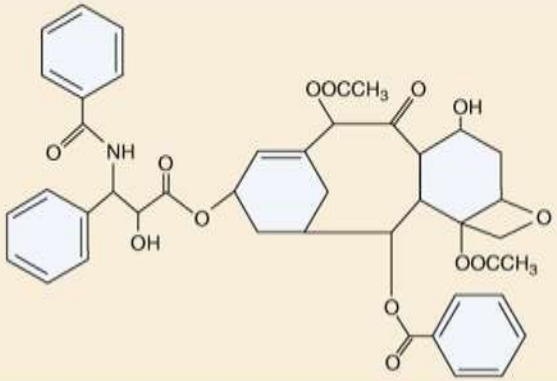
- Needed when cells require energy.
- Energy from sunlight is stored in ATP molecules and is used just like a rechargeable battery .
- Once energy is released, ATP is converted to an **ADP (adenosine di-phosphate)**.



Energy currency of metabolism

Secondary Compounds

Table 39.1 Secondary Metabolites

Compound	Source	Structure	Effect on humans
Morphine (alkaloid)	 Opium poppy *Papaver somniferum*		Narcotic pain killer
Quinine (alkaloid)	 Quinine bark *Cinchona officinalis*		Antimalarial drug
Taxol (terpenoid)	 Pacific Yew *Taxus brevifolia*		Anticancer drug

Secondary Compounds

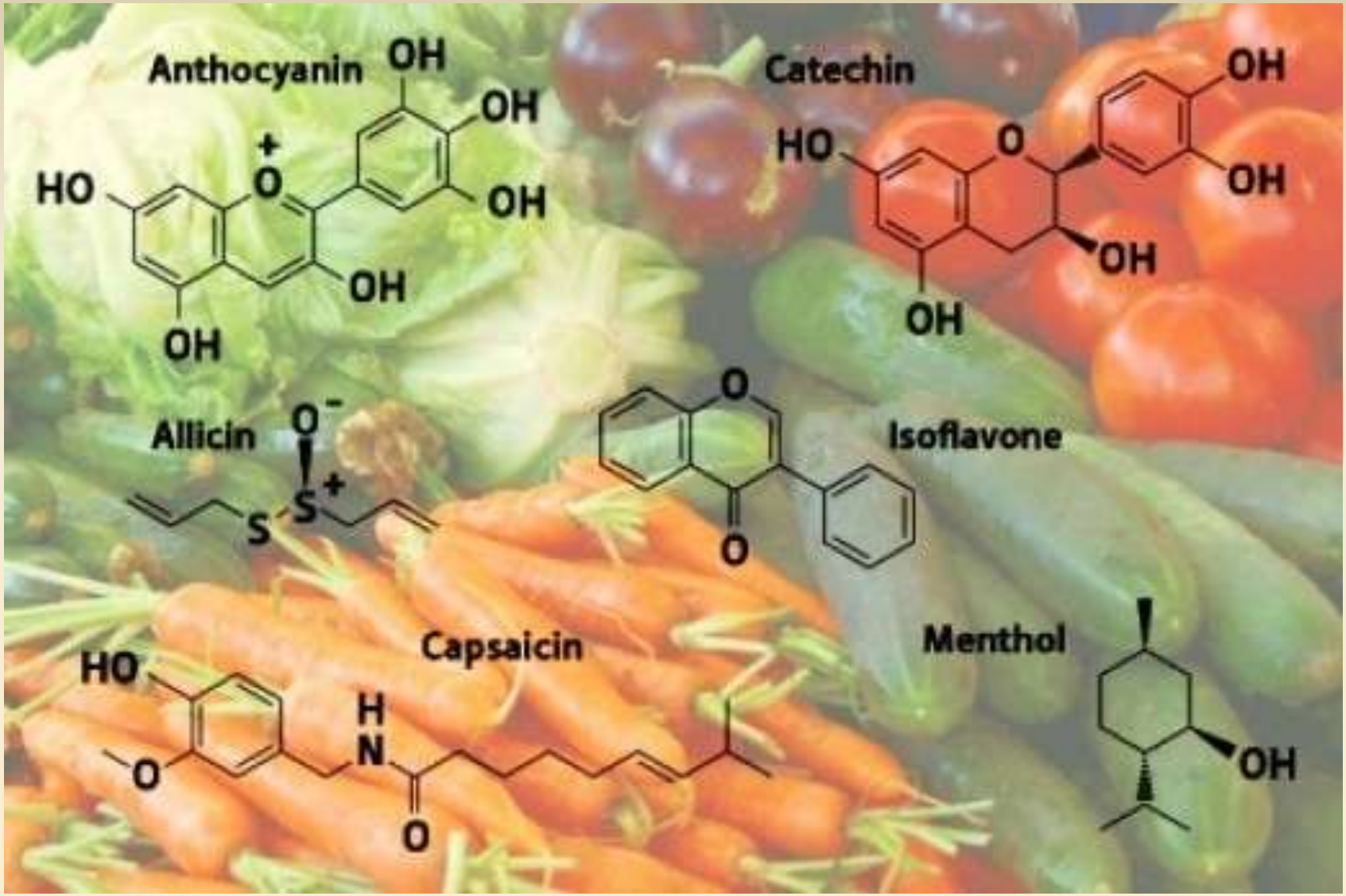
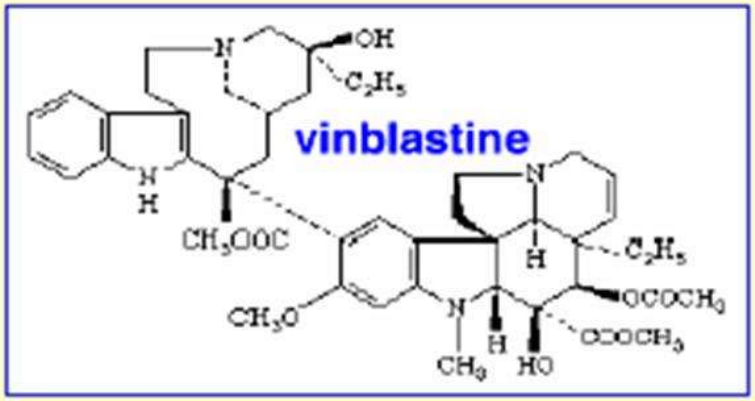


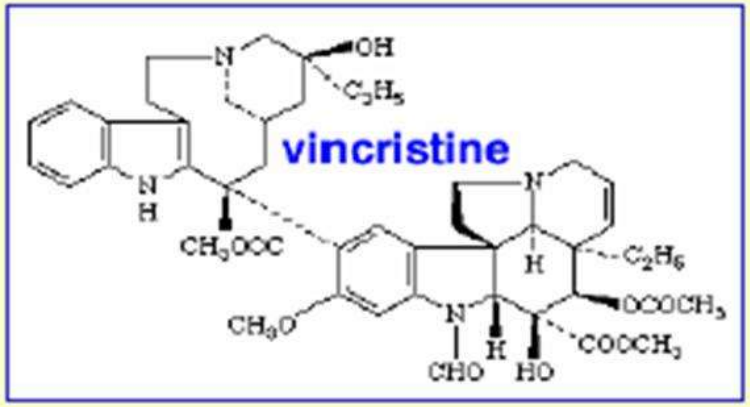
Table 1.A Commonly Occurring Secondary Products

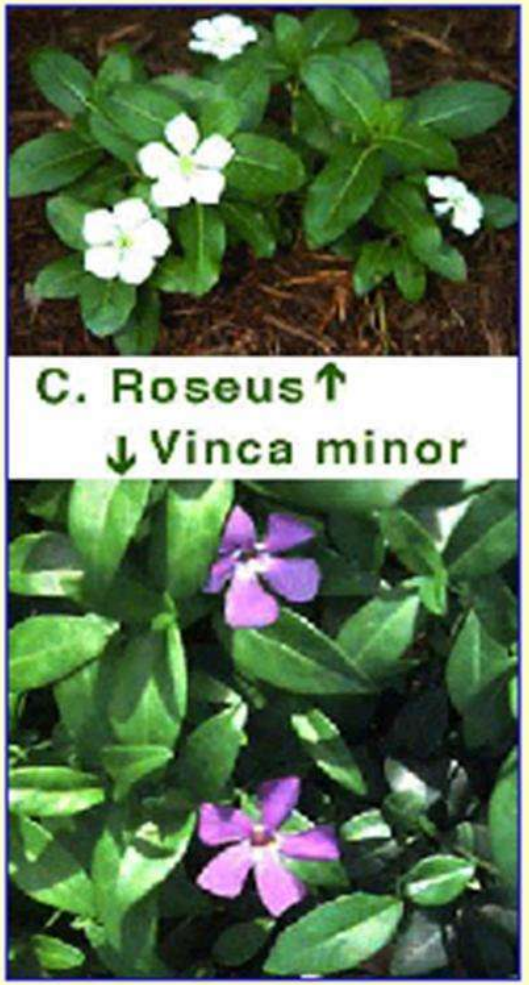
Class of Compound	Examples	Use by Humans	Chapter
Terpenes	Essential oils	Herbs and spices/flavor	Chapter 17
	Essential oils	Perfumes and incense	Chapter 5
	Taxol	Chemotherapy	Chapter 19
Phenolics	THC	Hallucinogen/glaucoma treatment	Chapter 20
	Urushiol	Allergen	Chapter 21
Glycosides	Cassava—cyanogenic glycosides	Starchy staple	Chapter 14
	Yam—saponin	Starchy staple/source of steroids	Chapter 14
	Digitoxin	Heart medication	Chapter 19
Alkaloids	Caffeine	Stimulant	Chapter 16
	Ephederine	Stimulant/decongestant	Chapter 19
	Quinine	Treatment for malaria	Chapter 19
	Morphine	Pain relief, psychoactive	Chapter 20
	Cocaine	Anesthetic/psychoactive	Chapter 20
	Mescaline	Hallucinogen	Chapter 20

Alkaloids

Vinblastine & Vincristine are Alkaloids







End