

METABOLISM

There are two main objectives in metabolism:

- Making Energy
- Metabolizing biomolecules (anabolism and catabolism) let us look first at making energy

Before we study the details of metabolism, we must review the structure and functions of the four major classes of biomolecules.

FOUR CLASSES OF BIOMOLECULES (ALL ORGANIC MOLECULES)

1) CARBOHYDRATES 2) LIPIDS 3) PROTEINS 4) NUCLEIC ACIDS

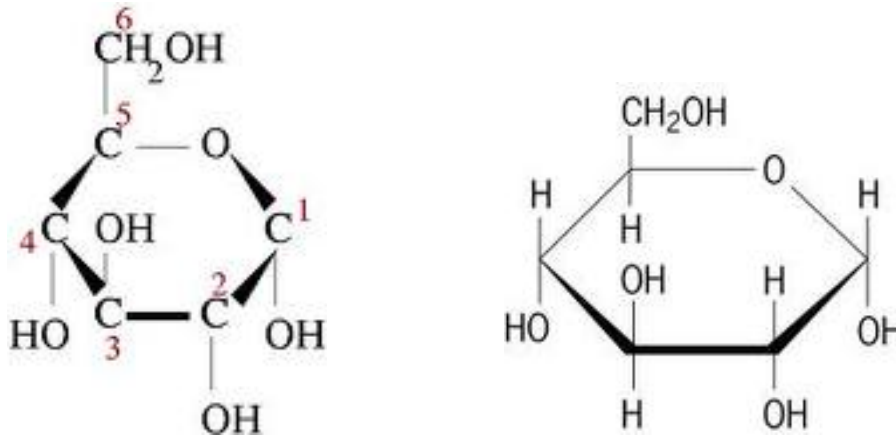
1) **Carbohydrates**

During photosynthesis, water (H_2O) is combined with Carbon from the CO_2 in the air to form CARBO, HYDRATES (when you drink water you get “hydrated”). Adding water to carbon hydrates the water.

1. Carbohydrates (carbon-water) are the most abundant organic compounds (things made of carbon and hydrogen and often some oxygen) on Earth.

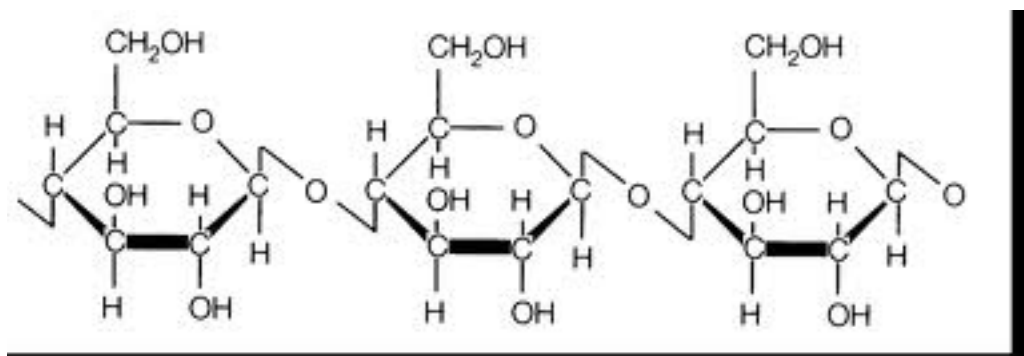
Carbohydrates have carbon and the two elements of water (H and O).

The simplest carbs are single sugar molecules called monosaccharides. A common single sugar is glucose. Glucose is called a ring structure...guess why?



The left formula shows the carbons. The right formula represents most of the carbons as corners in the drawing. Note that the condensed formula for glucose is $C_6H_{12}O_6$

When many sugars are bonded together they are called polysaccharides. Cellulose (plants are mostly cellulose) is the most common polysaccharide (a very big carbohydrate) by weight. Cellulose is a polymer of glucose monomers. Cellulose functions as a structural support molecule in plants but is a food source for many primary consumers and herbivores.



The most common carbohydrate or monosaccharide in mammals is glucose (from the Greek word glukus meaning sweet), which has the chemical formula $C_6H_{12}O_6$.

2. LIPIDS (FATS AND OILS)

- include fats, oils, waxes, steroids, and phospholipids. They function as energy storage, as waterproof coatings, and as chemical messengers.

There are many kinds of lipid molecules

BUT ALL LIPIDS:

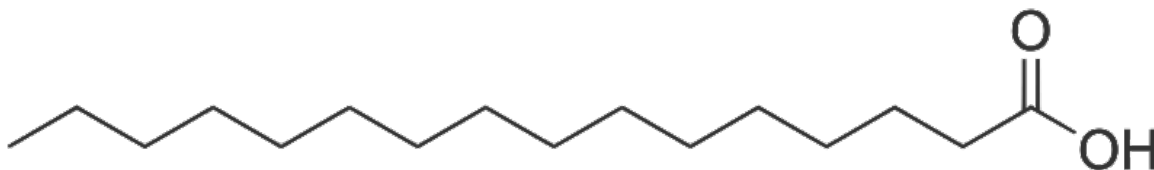
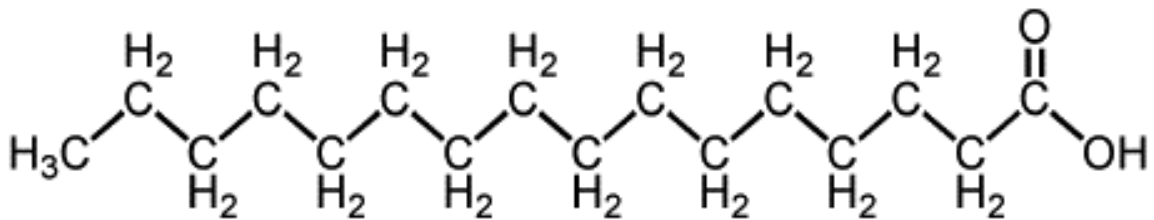
-DO NOT dissolve well in water but DO dissolve in oil

-They are mostly non-polar

(LIKE DISSOLVES LIKE !!! Birds of a feather flock together)

- are made of carbon atoms strung together often in long chains with an acid at the end so these very common lipids are called fatty acids. Palmitic acid is the most common fatty acid.

PALMITIC ACID $C_{16}H_{32}O_2$



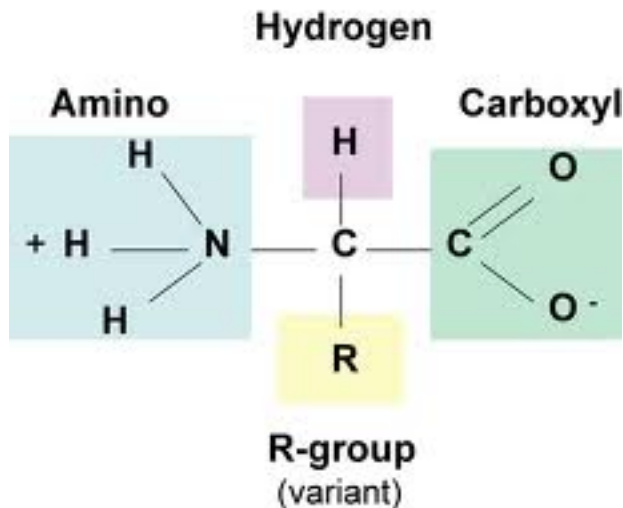
hydrocarbon tail HATES WATER

acid part LIKES WATER

3. Proteins (polypeptides)

Proteins consist of long chains of amino acids, the building blocks of proteins. All amino acids are based on having an amino group and an acid group.

Amino Acid Structure



Proteins have many roles in cells (and between cells). They include, but are not limited to:

1. **Structural proteins** such as keratin. Keratin is a protein in the shape of a long fiber. It is tough and strong. Hair, fingernails, fur, and the outer layers of animal skin are made mostly of keratin.
2. **Enzymes** make chemical reactions occur quickly. An example of an enzyme is the protein called amylase. Amylase is found in human saliva and helps digest starch. Starch is a carbohydrate made of a string of glucose molecules.
4. **Hormones** - chemical messengers such as insulin stimulate cells to absorb glucose.
5. **Transport proteins** - carry other substances from one place to another. Hemoglobin is a large protein that transports oxygen throughout the body. Transferrin is a protein that transports iron in the body.

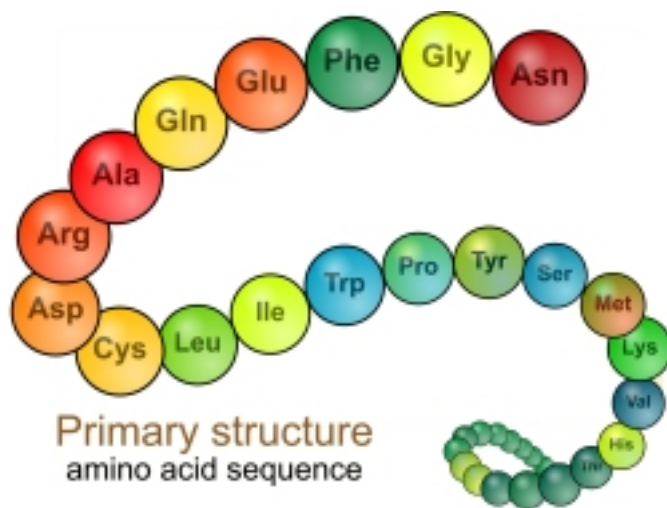
There are 20 different amino acids that we use in our bodies to build the thousands of different proteins we need for life. There are ~10 amino acids (essential amino acids) that we must have in our diet because we cannot make them in metabolism. Proteins differ in the number and order of these amino acids. We might think of amino acids as words in a

sentence with a language that has only 20 words. If we can have sentences over 800 words long, you can see that the amount of different proteins is endless.

Insulin, a hormone that regulates how our bodies use sugar and lipids, is a small protein of about 56 amino acids long. Hemoglobin is much larger and is about 600 amino acids long. Transferrin is about 1500 amino acids long.

When we digest protein from what we eat we break the protein down into individual amino acids. Our metabolism then build those amino acids back into proteins our bodies need.

If we represented amino acids as colored balls, a protein of about 75 amino acids might have the following starting structure (primary shape).

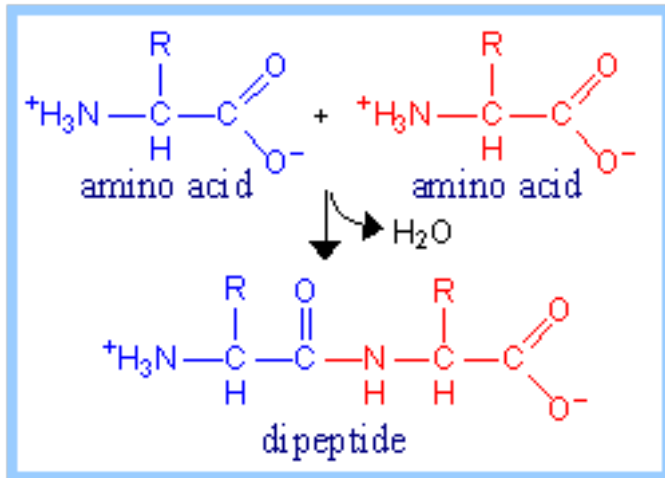


The three letter symbols are the abbreviations for the various amino acids. Asn for asparagine, Gly for glycine, Phe for phenylalanine...etc.

Protein Structure - proteins have four levels of organization (see Figures in Text below)

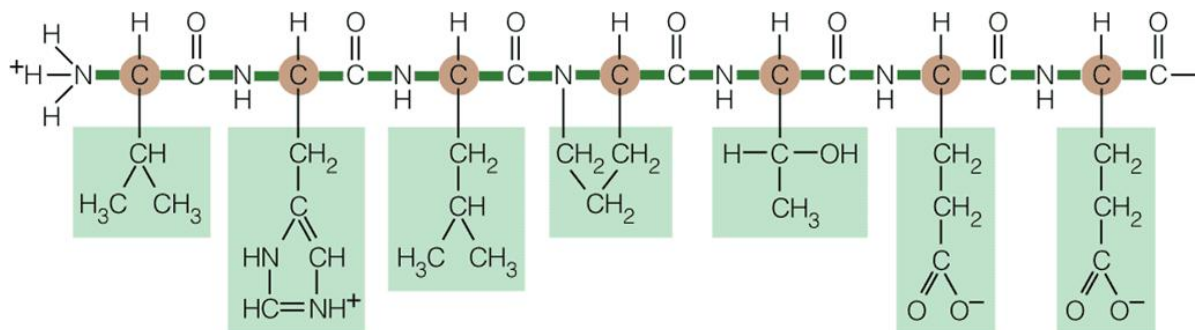
1. **Primary structure** - simply the order of amino acids in a polypeptide strand.

amino acids are joined by a peptide bond...a type of covalent bond.



Many amino acids joined are called a polypeptide or protein.

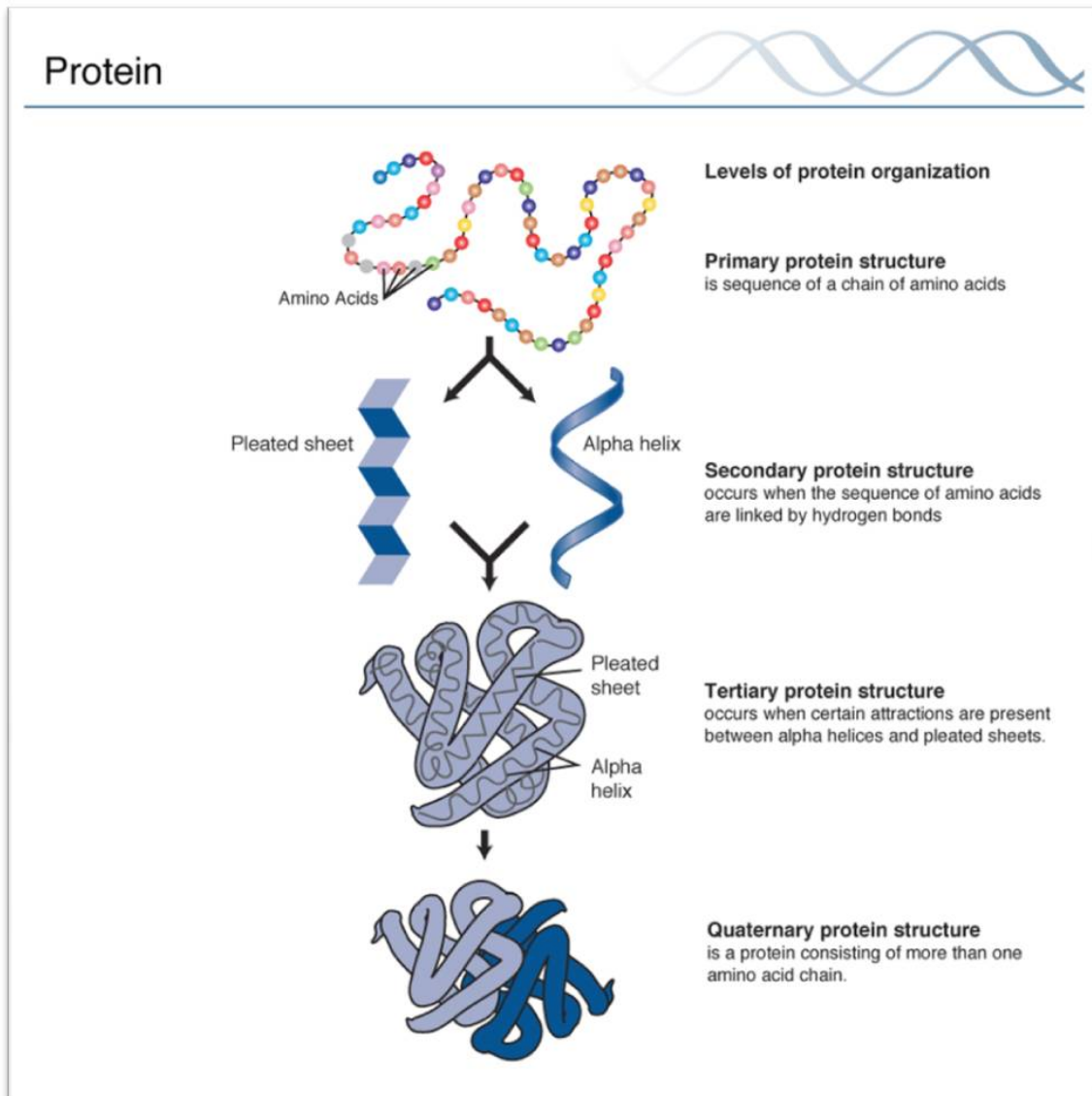
© 2003 Brooks/Cole – Thomson Learning



2. **Secondary structure** - regions of localized bending resulting in a) an alpha helix and/or b) pleating (like an accordion) called beta sheets give proteins their secondary structure. Weak hydrogen bonds cause this structure.

3. **Tertiary structure** - the three-dimensional folding of the entire polypeptide chain.

4. **Quaternary structure** - the fitting together of two or more polypeptide chains, thus forming a functional protein.



Organisms have evolved to use a special short-term energy molecule ATP that drives most of the organisms needs for energy...such as muscle contraction, thinking, and most cellular mechanisms such as making DNA.

