# Understandings:

**1. Explain molecular biology.**

- This is the study of biological processes at its smallest level, looking at component parts. The idea is to understand small parts first and then combine it. 2015 Nobel Prize in chemistry about DNA reparation is a form of molecular biology (biology and chemistry are heavily intertwined indeed). After that, emergent properties may explain the system as whole. DNA reparation may explain how we age and the mechanisms of cancer.

**2. Explain why carbon is found everywhere in organic compounds.**

- Carbon is not that abundant ($15^{th}$ in the world), but the good thing is that it can form covalent bonds, 4 very stable ones in fact (covalent bonds are strong hence stable). This leads to complexity and variety of carbon compounds. Bonds can be with all sorts of elements, and it can be from single to triple bonds!

Organic chemists will understand how amazing carbon is.

**3. Classify carbon compounds.**

- We need to know four basic ones.

Carbohydrates are also known as sugar. They are made of carbon and oxygen with hydrogen in the same ratio as in water, hence the name carbo*hydrate*.

Lipids are a wide range of molecules that are insoluble in water. They are made of carbon, oxygen, hydrogen and sometimes phosphor (phospholipid bilayer).

Proteins are compounds made of amino acids. They are made of carbon, oxygen, hydrogen, nitrogen, and an R group (more on this later).

Nucleic acids are compounds made of nucleotides. They are made of carbon, oxygen, hydrogen, nitrogen and phosphor. These are further classified into ribonucleic acid and deoxynucleic acid (one less oxygen).

Some additional main carbon compounds are alcohol, hydrocarbons, carboxylic acids and amines.

**4. Define metabolism.**

- Metabolism is the sum of all reactions in an organism. Even the simplest prokaryotes have 1000s of reactions, so imagine in humans!

What we do is that we divide metabolism into two parts. One that builds up new molecules and one that breaks down.

**5. Define anabolism.**

- Anabolism is the reaction of synthesis from simple molecules to macromolecules by condensation. Hence these reactions need energy, usually in the form of ATP.

Some examples of anabolic processes are protein synthesis, DNA synthesis, photosynthesis, etc.

**6. Define catabolism.**

- This is catastrophic! (My teacher taught me that). It breaks down large molecules into simpler ones by hydrolysis. These require water, and release energy when the molecules are broken. Basically, organisms store energy in chemical bonds, so when we want to use them, we break them.

Examples are digestion and respiration.

## Applications and skills:

**1. State that compounds produced in organisms may be synthesized artificially, such as urea.**

- Before, up to 1700s, people strongly believed that organic compounds could not be synthesized artificially except the organ itself, hence the name organic compound. This is known as vitalism, vita meaning life. However, in 1720s, Friedrich Wöhler synthesized urea artificially, and contributed with a strong argument against vitalism. Now urea is used as fertilizers.

The reactions were $2NH_3 + CO_2 \rightarrow CH_6N_2O_2$ (ammonium carbamate) and then

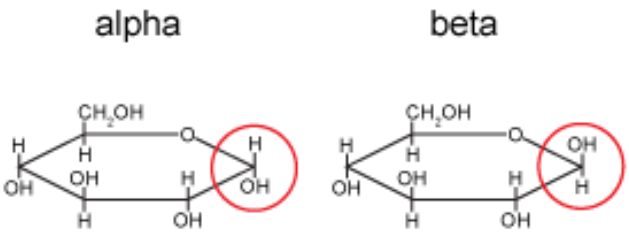
$CH_6N_2O_2 \rightarrow CH_4N_2O + H_2O$ which is urea and water.

**2. Be able to draw glucose, ribose, saturated fatty acid and generalized amino acid.**

-

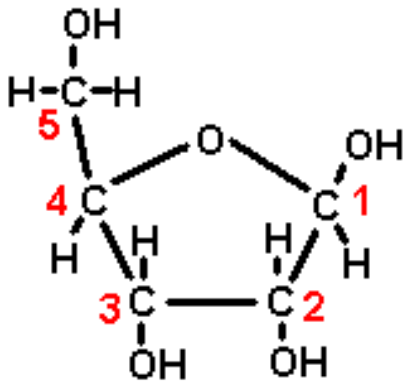
Formula is $C_6H_{12}O_6$.

Remember that there are many types of glucose. The example shown is alpha and beta D-glucose. Alpha D-glucose would have swapped location of OH and H in C1. The way to remember Alpha glucose is the shape OH and H forms an A shape in Alpha. Get it?



Formula for ribose is $C_5H_{10}O_5$.

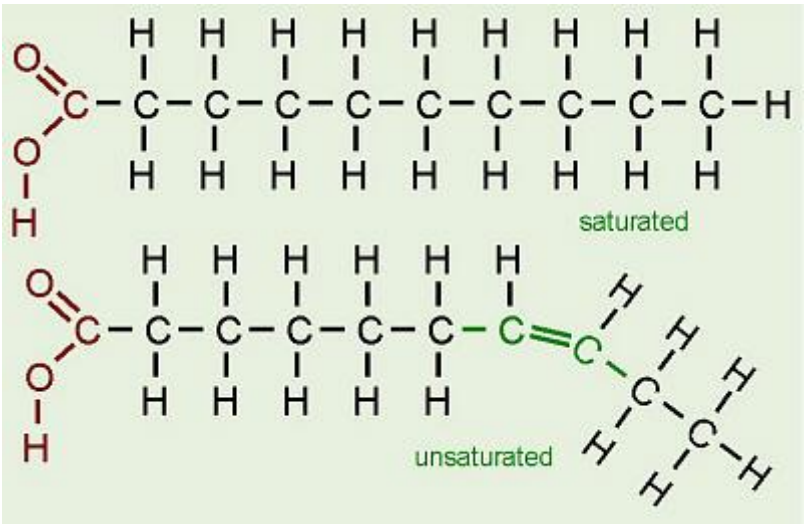
The shape is a pentagon unlike glucose, which is a hexagon.



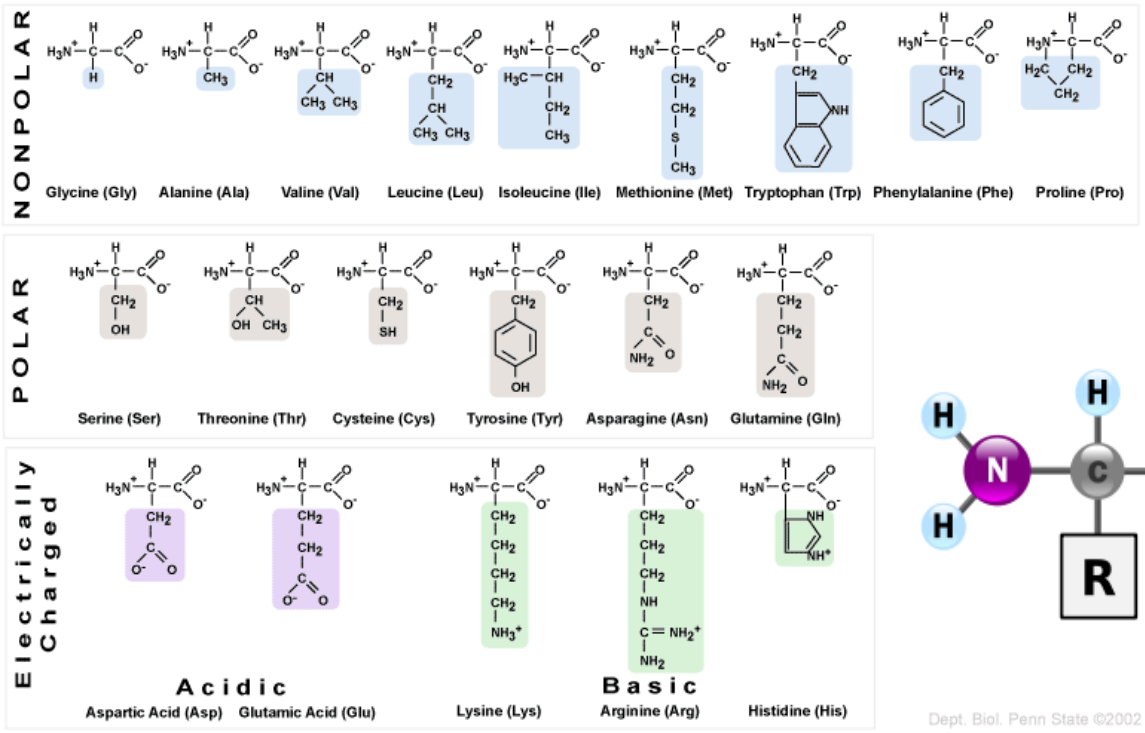

Saturated fats only have single bonds. Unsaturated fats can polymerize due to its double bond(s).

Fatty acids always have a carboxylic group and methyl group in each end.

These are unbranched, and the formula can vary. The middle $CH_2$ is usually from 14-20.



There are many types of amino acids, but the generalized form is shown to right. It contains an amine group, a carboxyl group, and the middle part with an R, radical, that varies. A set of them is shown to left.







Dept. Biol. Penn State ©2002

**3. Identify the essential biochemical (carbohydrate, lipid, protein) from molecular diagrams.**

- Think that carbohydrates and lipids always only contain carbon, hydrogen and oxygen.

As mentioned, carbohydrates have their hydrogen and oxygen in the ratio as water.

Lipids have a proportionally small amount of oxygen.