Lecture2

Essential Chemistry for Biology

- Rain in the eastern United States can be more acidic than vinegar

TRACING LIFE DOWN TO THE CHEMICAL LEVEL

- Biology includes the study of life at many levels

Isotopes

- Isotopes are alternate mass forms of an element
- Radioactive isotopes
- Uncontrolled exposure to radioactive isotopes can harm living organisms by damaging DNA

–Example: the 1999 Tokaimura nuclear accident

Acids, Bases, and pH

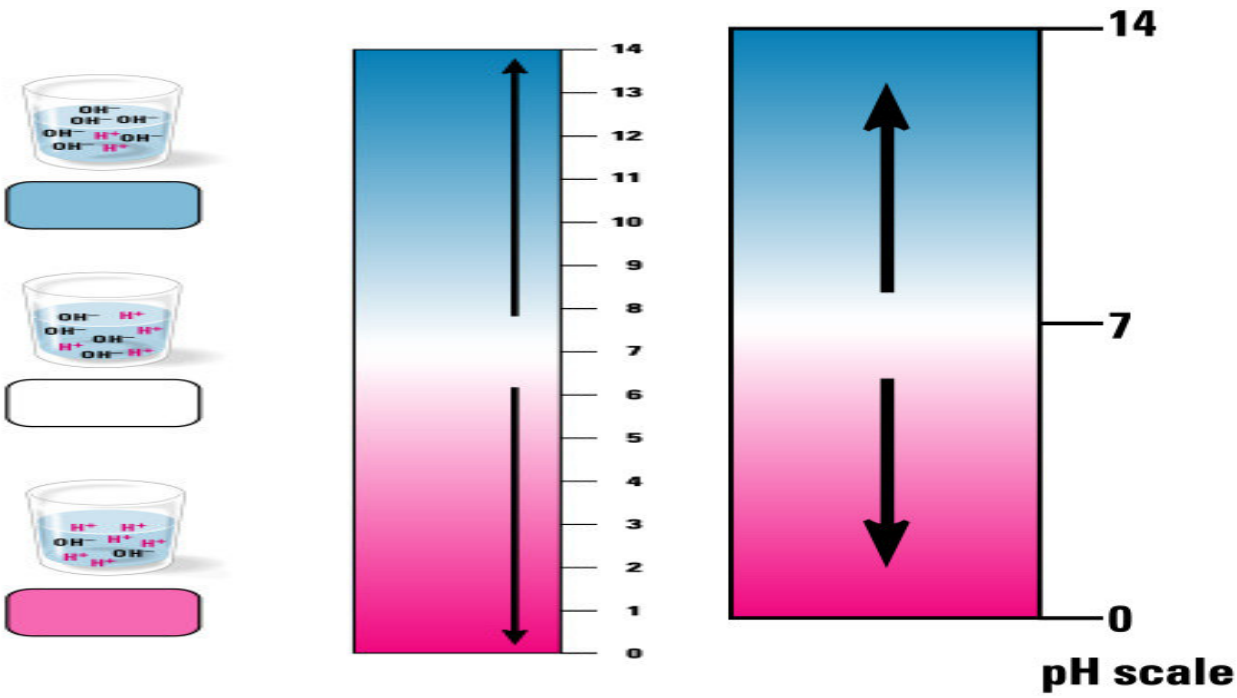
- Acid

–A chemical compound that donates H^+ ions to solutions

•Base

–A compound that accepts H^+ ions and removes them from solution

- To describe the acidity of a solution, we use the pH scale
- Buffers are substances that resist pH change
- Acids, Bases, and pH



CHAPTER 3

- A typical cell in your body has about 2 meters of DNA

Giant Molecules from Smaller Building Blocks

- On a molecular scale, many of life's molecules are gigantic
- Most macromolecules are polymers
- Organisms also have to break down macromolecules

BIOLOGICAL MOLECULES

- There are four categories of large molecules in cells

Carbohydrates

- Carbohydrates include

Lipids

- Lipids are hydrophobic

Proteins

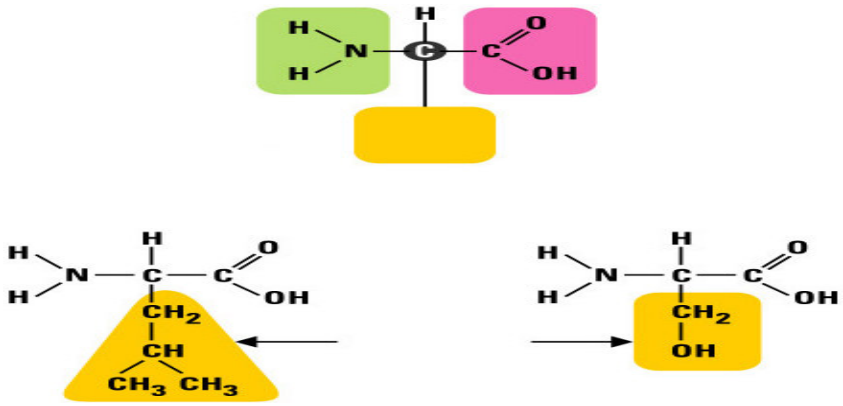
- A protein is a polymer constructed from amino acid monomers
- Proteins perform most of the tasks the body needs to function

–They are the most elaborate of life's molecules

- There are four basic types of proteins

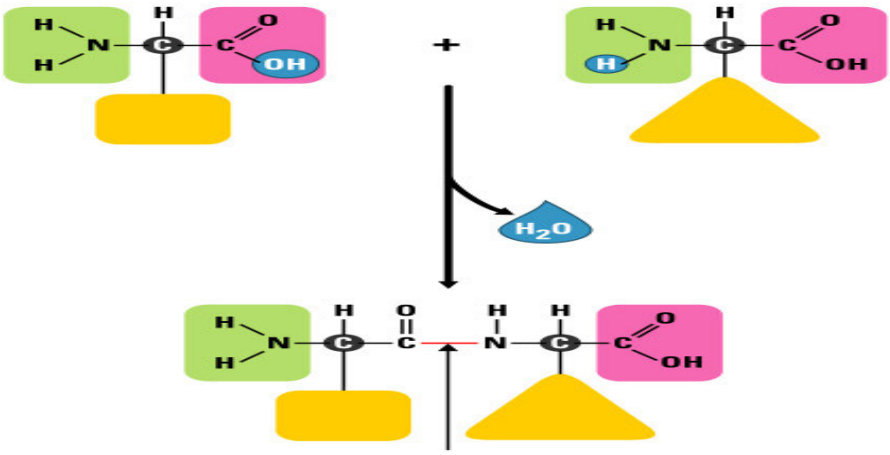
The Monomers: Amino Acids

- All proteins are constructed from a common set of 20 kinds of amino acids
- Each amino acid consists of
  –A central carbon atom bonded to four covalent partners
  –A side group that is variable among all 20



Proteins as Polymers

- Cells link amino acids together by dehydration synthesis
  -The resulting bond between them is called a peptide bond



- Your body has tens of thousands of different kinds of protein
  -The arrangement of amino acids makes each one different

- Primary structure
  -The specific sequence of amino acids in a protein

- A slight change in the primary structure of a protein affects its ability to function
  –The substitution of one amino acid for another in hemoglobin causes sickle-cell disease

Protein Shape

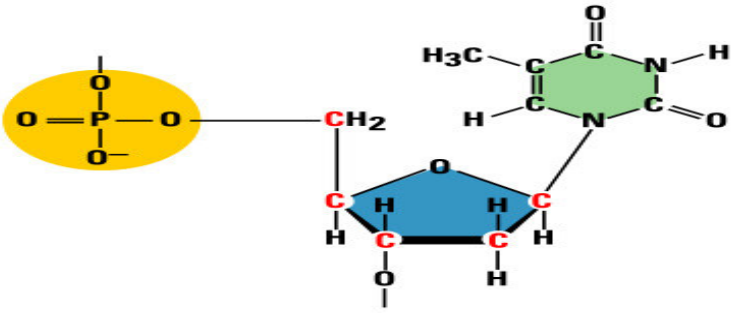
- Proteins have four levels of structure

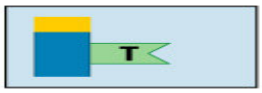
What Determines Protein Structure?

- A protein's shape is sensitive to the surrounding environment
  –Unfavorable temperature and pH changes can cause a protein to unravel and lose its shape
  –This is called denaturation

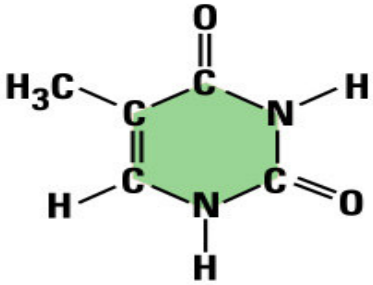
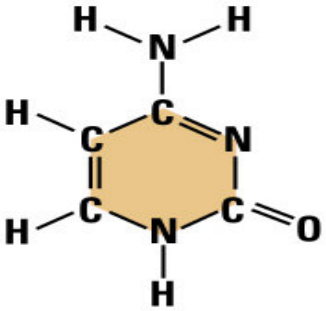
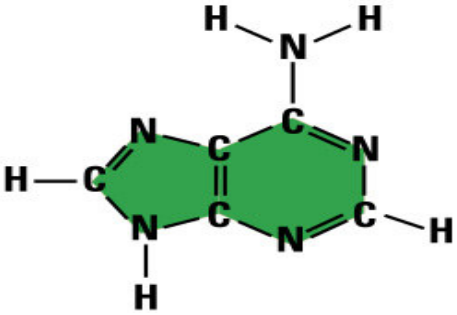
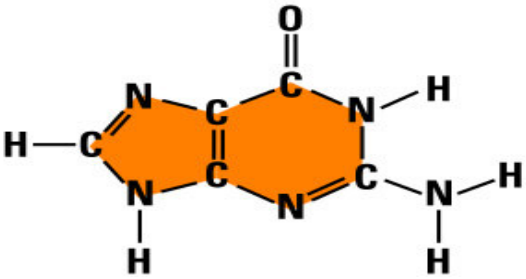
Nucleic Acids

- Nucleic acids are information storage molecules
  -They provide the directions for building proteins
- There are two types of nucleic acids
  –DNA, deoxyribonucleic acid
  –RNA, ribonucleic acid
- Nucleic acids are polymers of nucleotides

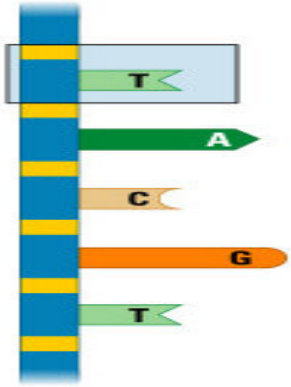




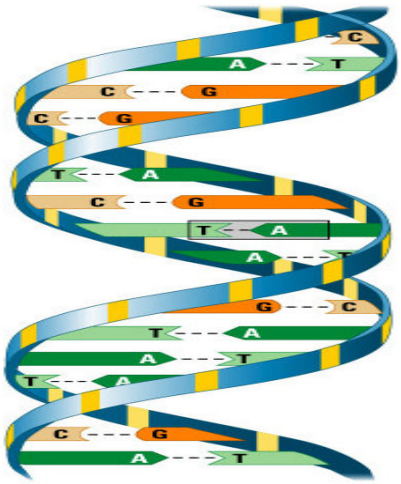
- Each DNA nucleotide has one of the following bases
  –Adenine (A)
  –Guanine (G)
  –Thymine (T)
  –Cytosine (C)

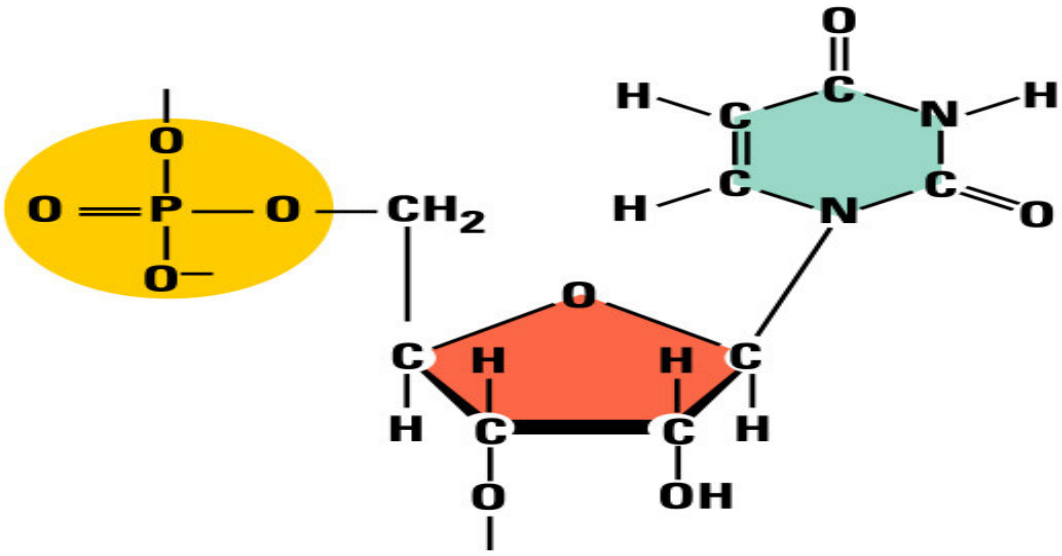
- Nucleotide monomers are linked into long chains
  –These chains are called polynucleotides, or DNA strands
  –A sugar-phosphate backbone joins them together



- Two strands of DNA join together to form a double helix



- RNA, ribonucleic acid, is different from DNA
  –Its sugar has an extra OH group–It has the base uracil (U) instead of thymine (T)



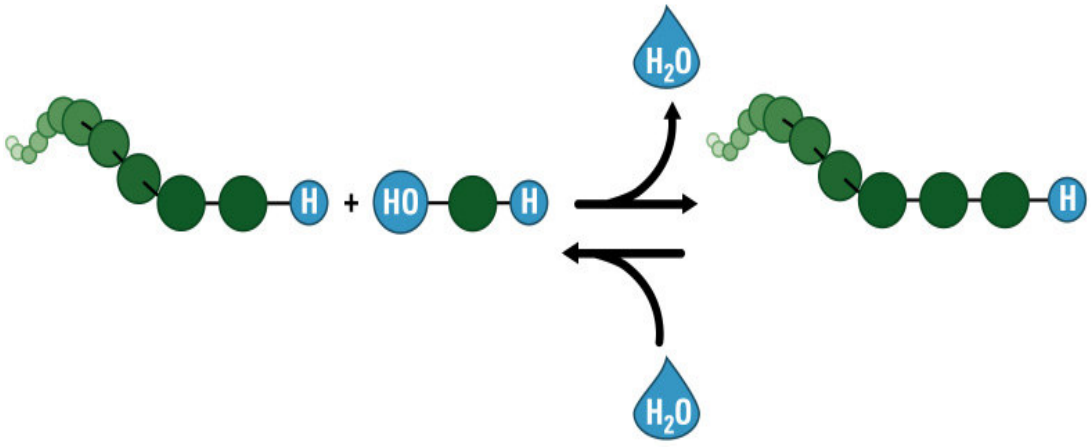
EVOLUTION CONNECTION:

DNA AND PROTEINS AS EVOLUTIONARY TAPE MEASURES

- Evolutionary relationships between organisms can be assessed
  –Molecular genealogy extends to relationships between species
  –Biologists use molecular analysis of DNA and protein sequences for testing evolutionary hypotheses

SUMMARY OF KEY CONCEPTS

- Giant Molecules from Smaller Building Blocks



- Biological Molecules

Biological macromolecule	Function	Monomer	Examples
Carbohydrates	Dietary energy; storage; plant structure	Monosaccharide	Monosaccharides: glucose, fructose. dissaccharides: lactose, sucrose. Polysaccharides: starch, cellulose.
Lipids	Long-term energy storage (for fats); hormones (for steroids)	Glycerol; Fatty acid; Components of a fat molecule	Fats, oils, steroids
Proteins	Enzymes, structure, storage, contraction, transport, etc.	Amino group; Carboxyl group; Side group; Amino acid	Lactase (an enzyme), hemoglobin
Nucleic acids	Information storage	Phosphate; Base; Sugar; Nucleotide	DNA, RNA

- Nucleic Acids