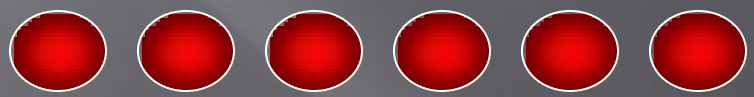
CARBOHYDRATES, LIPIDS, AND PROTEINS

Introduction

- **Macromolecule**
  - "Macro" = big
  - Definition: big ol' molecule
  - Carbs, lipids, and proteins are ALL members of this group
- **Polymer**
  - "Poly" = many
  - Definition: a macromolecule made of repeating units called "**monomers**" (mono = one)
  - Carbs, lipids, and proteins are ALL also members of this group



Polymer made of monomers

How to MAKE C/L/P's

- **Dehydration Synthesis**
  - "dehydration" = to remove water
  - "synthesis" = to make
  - Definition: the process of CREATING carbs, lipids, and proteins by removing water
  - Animation of this process
    - Dehydration Synthesis-Hydrolysis

How to BREAK C/L/P's

- Hydrolysis
  - "hydro" = water
  - "lysis" = to destroy
  - Definition: the process of DESTROYING carbs, lipids, and proteins by the addition of water
  - How our bodies break down the foods we eat into the monomers that make them up (only monomers can be absorbed)
  - Animation of this process:
    - Dehydration Synthesis-Hydrolysis

Carbohydrates

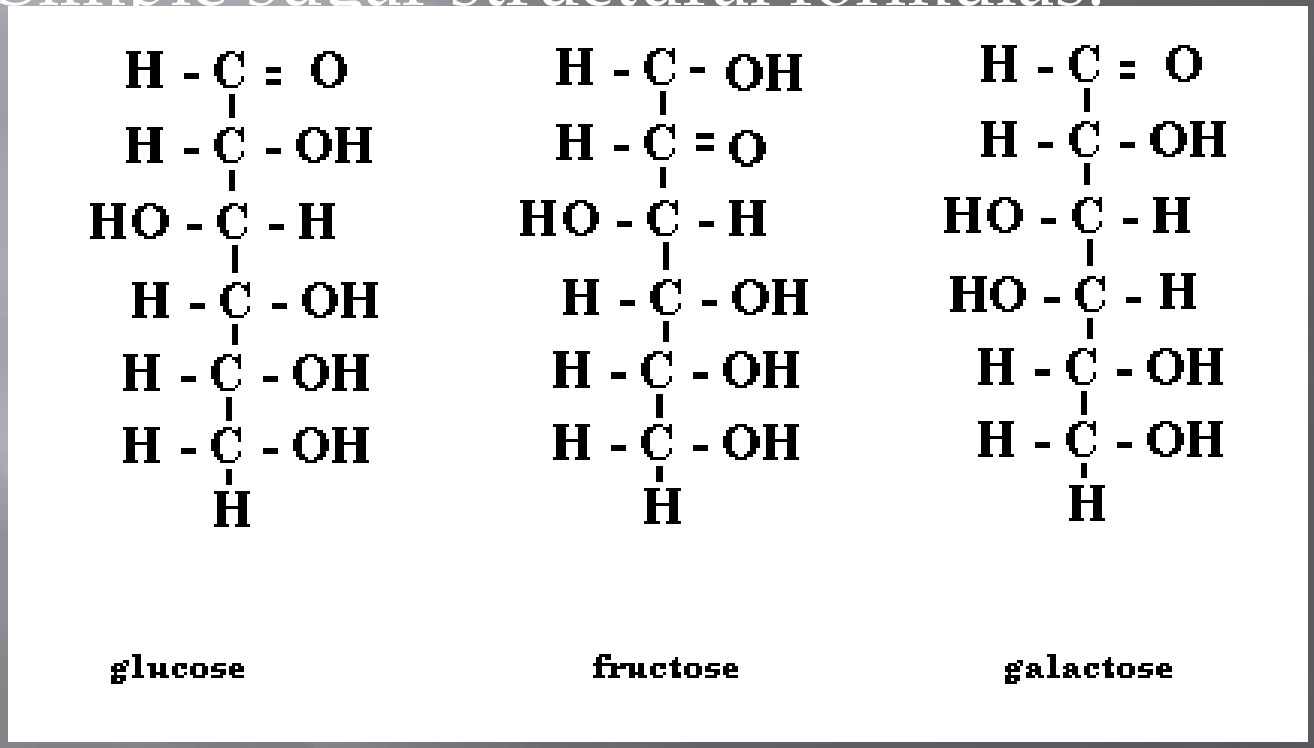
- Sources
  - Grain based foods
- **Chemical make-up**
  - carbo - contains C
  - hydrate – contains O and H (in 2:1 ratio like in water)
- Carbs are our main energy source (55%-65% of daily caloric intake)

Carbohydrates (cont.)

- Carbs are polymers made up of monomers
- What are the monomers (building blocks) of carbs?
  - Several names (all mean the same thing)
    - Monosaccharides
    - Simple sugars
  - Who are the simple sugars?
    - "-ose" = sugar
    - All have general formula – $C_6H_{12}O_6$
    - Ex. Glucose, galactose, fructose (are isomers of one another)

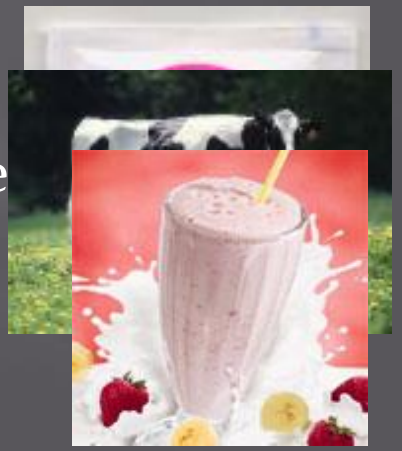
Carbohydrates (cont.)

- Simple sugar structural formulas:



Carbohydrates (cont.)

- **Disaccharides**
  - di = two
  - saccharide = sugar
  - Definition – double sugar made up of two simple sugars chemically combined
  - Introducing the disaccharides!
    - *Sucrose* (table sugar) = glucose + fructose
    - *Lactose* (milk sugar) = glucose + galactose
    - *Maltose* (malt sugar) = glucose + glucose



Carbohydrates (cont.)

- **Polysaccharides**
  - "poly" = many
  - "saccharide" = sugar
  - Definition – a carbohydrate made up of many simple sugars chemically combined together
  - Also called "complex carbohydrates"
  - Introducing the polysaccharides!
    - *1. Starch-* energy storage for plants.
      - Test for starch: Lugol's stain- turns starch purple
    - *2. Cellulose (fiber)*– contained within cell walls of plants (give structure)
    - *3. Glycogen* – energy storage for animals (mostly found in the muscle tissue)
    - *4. Chitin-* exoskeleton of some animals

Carbs

- How the body uses glucose from food:
  - 1. energy for life processes
  - 2. extra glucose: stored as glycogen for later use
  - 3. extra, extra glucose: stored as fat for MUCH later use

Energy from food

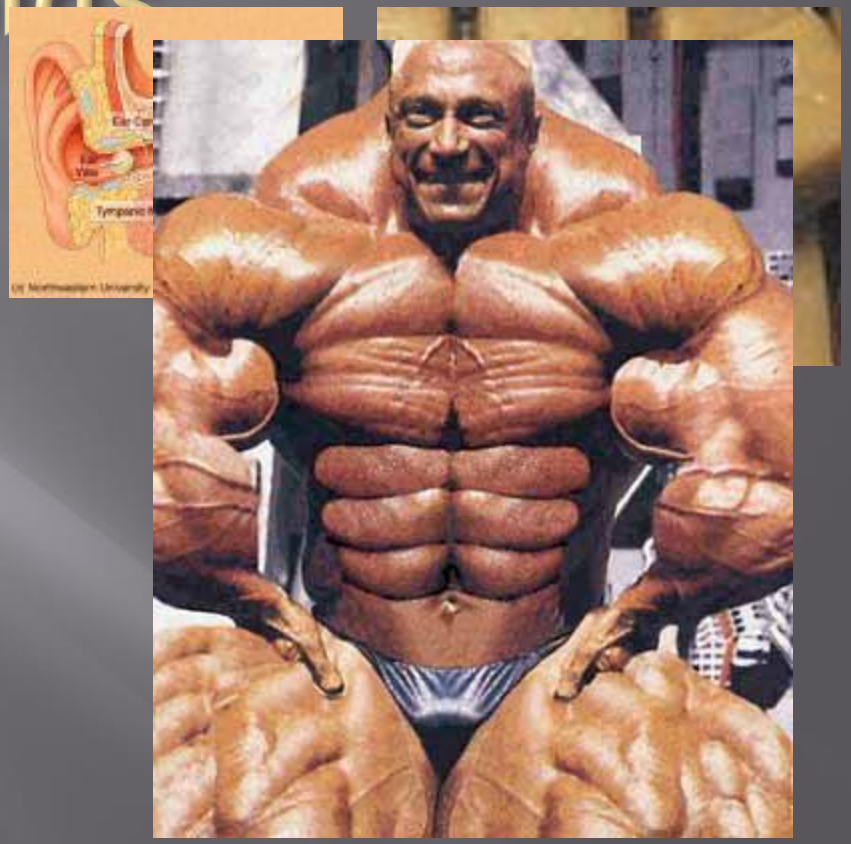
- How much energy does each macronutrient have?
- Calories: units of energy given off by a food

- Carbs: 4 cal/gram
- Protein: 4 cal/gram
- Fat: 9 cal/gram

Lipids

- Dietary Sources
  - High fat sources
- **Chemical make-up**
  - Contains C, H, and O
- Lipids are our secondary energy source (mostly stored for use later)

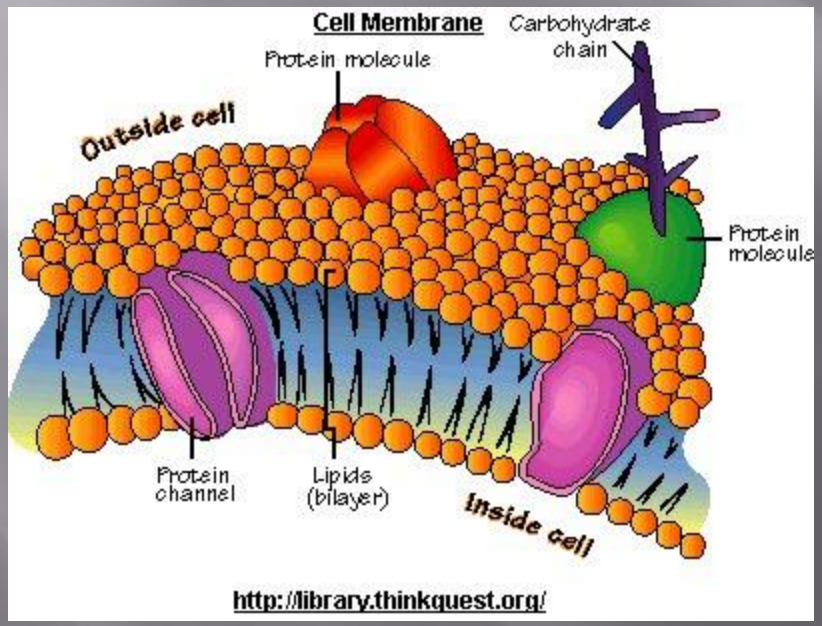
Lipids

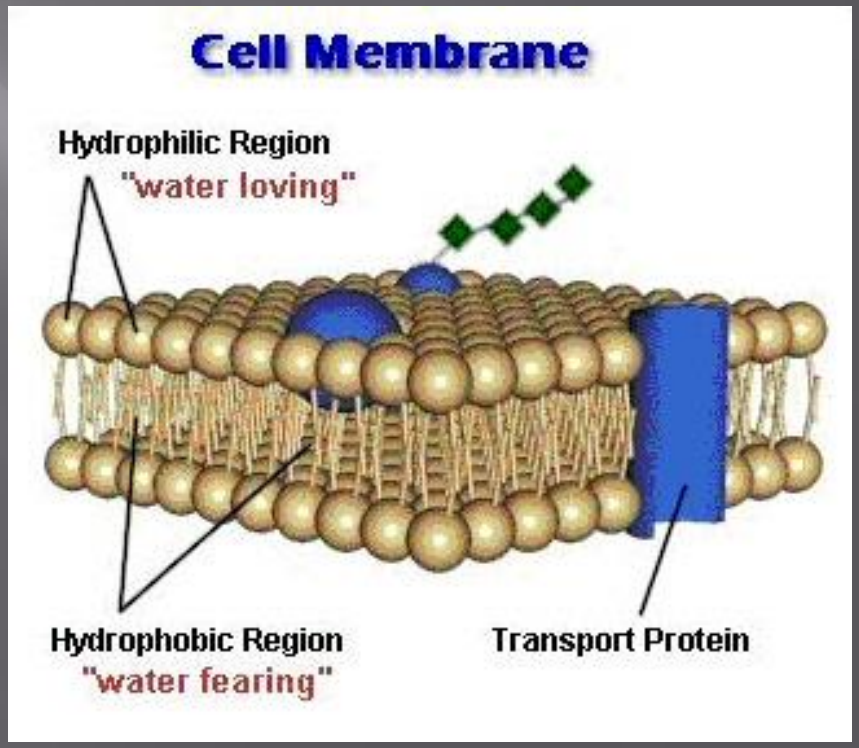


- Categories of lipids
  - Waxes
    - Ear wax
    - Bees wax
  - Steroids
    - Cholesterol
    - Hormones
  - Lecithin
    - Wraps nerve cells
    - Why is this important?
  - Fats/Oils
    - Animal fat- solid at room temperature
    - Plant oils- liquid at room temperature

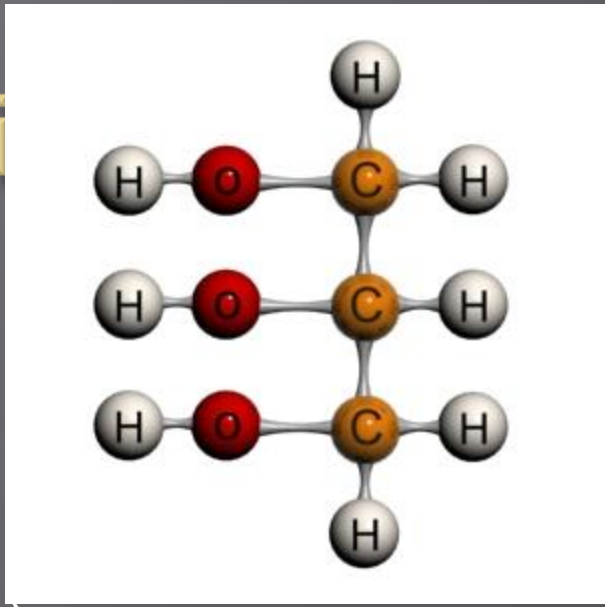
Uses of Lipids

- Long-term energy storage
- Production of cell membranes





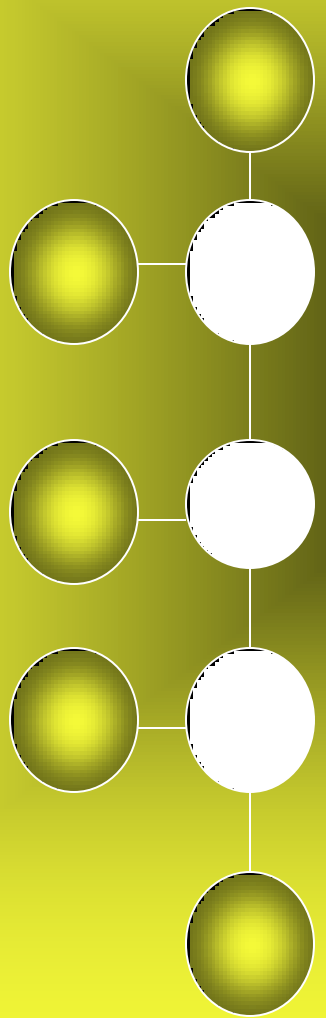
How to build a li



- Monomers — Draw this ----→
  - Glycerol
    - Three carbon alcohol
  - Long chain fatty acids (carbon chain)
    - Several different types
      - Saturated, unsaturated, polyunsaturated
- Created by…
  - DEHYDRATION SYNTHESIS
- Broken down by…
  - HYDROLYSIS

Fats, Carbs, and Proteins

Lipids



Long chain fatty acid

Triple alcohol

Long chain fatty acid

Long chain fatty acid

Glycerol

Types of fats

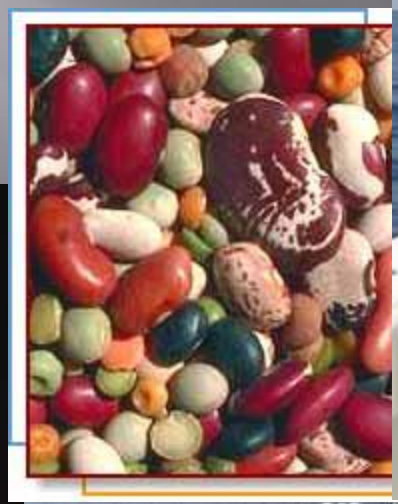
- Saturated fats
  - Fats that have all of their carbons filled with hydrogens
  - NO double bonds in long chain fatty acid
- Unsaturated fats
  - Fats that don't have all of their carbons filled with hydrogens
  - Must contain a double bond line in long chain fatty acids
- Which ones are more healthy?
  - Unsaturated

PROTEINS

The most important compound in your body!!!!

Dietary Sources

- Beef
- Chicken
- Fish
- Nuts
- Beans



Chemical make-up of proteins

- Chemical make-up of carbs?
  - C, H, O
- Chemical make-up of lipids?
  - C, H, O
- Chemical make-up of proteins?
  - C, H, O, N and sometimes S

Function of Proteins

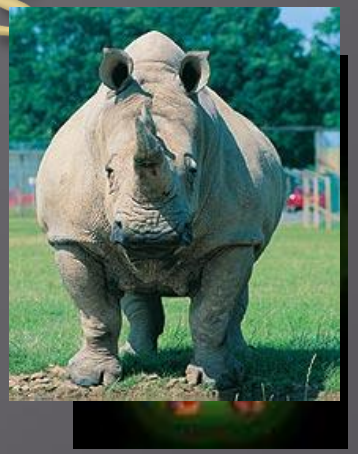
- Main function of carbs?
  - Primary source or short term energy
- Main function of lipids?
  - Secondary source or long term storage, insulation, cell membrane structure
- Main function of proteins
  - Growth
  - Repair

Two main types of proteins

- Structural- build things
- Globular- travel through the body independently

Structural proteins

- Muscle tissue
  - Actin and myosin fibers
- Keratin
  - Hair
  - Nails
  - Rhino horn
- Collagen
  - Connective matrix
  - Keeps skin smooth (breaks down as you get older)



Globular Proteins

- Hemoglobin
  - O_2 binds with use of iron to carry oxygenated blood around the body
- Insulin
  - Opens muscles to allow glucose to enter
  - Controls glucose levels in the bloodstream
- Antibodies
  - Help fight infection in the body
  - Produced by white blood cells

Globular proteins (cont.)

- Enzymes
  - Also called organic catalysts
  - Reduce activation energy of a reaction
    - Lowers amount of energy needed to start reaction
    - Helps reaction go faster

Structure of proteins

- Consist of monomers called amino acids
  - 20 different types of amino acids make up all proteins
  - 8 are "essential" amino acids
    - Means that your body can't produce them naturally
- Contains C, H, O, N, and S (only one amino acid contains S)
- Built just like every other organic compound!
  - Dehydration synthesis
- Broken down just like every other organic compound!
  - Hydrolysis

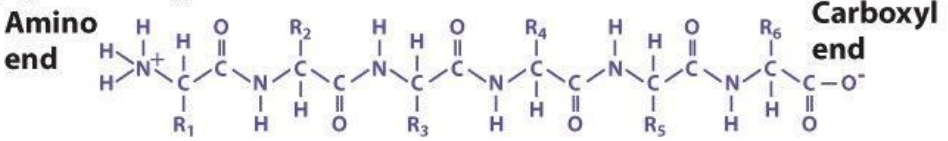
Structure of Proteins (cont)

- Proteins organized on four different levels
  - Primary (1°)
  - Secondary (2°)
  - Tertiary (3°)
  - Quaternary (4°)

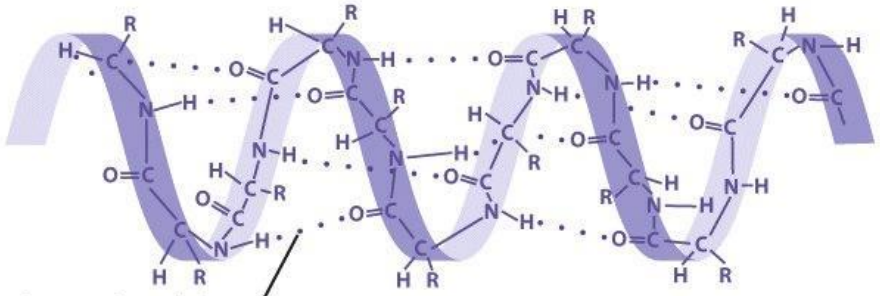
Structure of Proteins (cont)

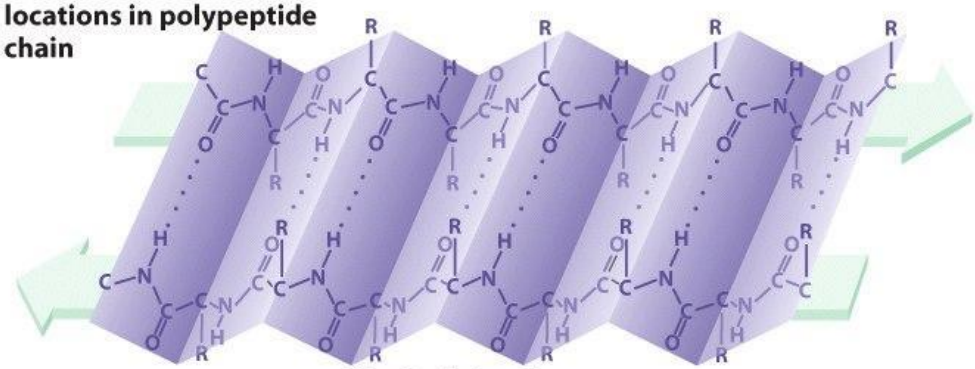
- Primary (1°)
  - Unique sequence of amino acids
- Secondary (2°)
  - Alpha helix
    - Amino acid sequence coils up with use of H bonds
  - Beta sheet
    - Amino acid sequence "pleats" with use of H bonds
- Tertiary (3°)
  - Alpha helix and beta sheets fold onto one another to form a "subunit"
- Quaternary (4°)
  - Subunits bond together

(a) Primary structure

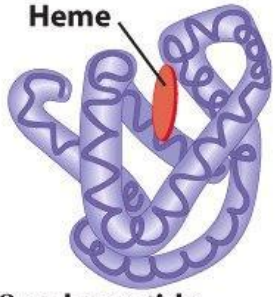


(b) Secondary structure

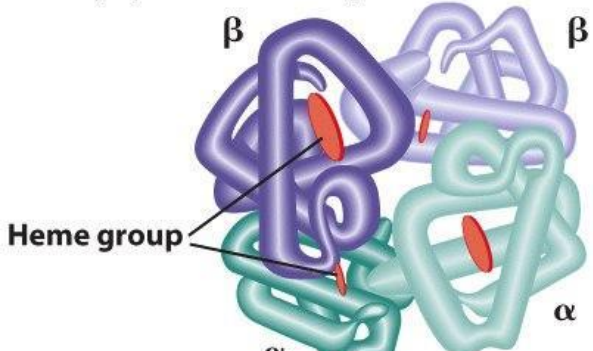




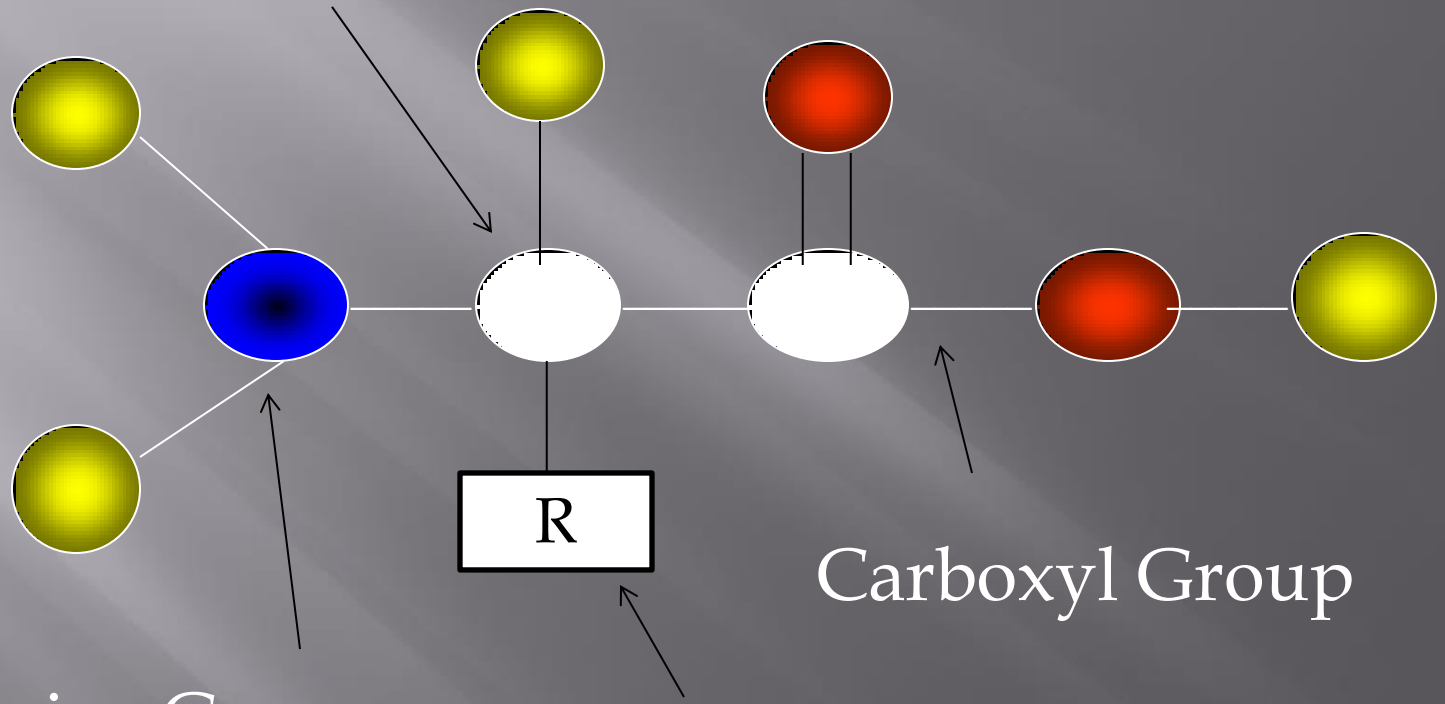
(c) Tertiary structure



(d) Quaternary structure



General Structure for an Amino Acid



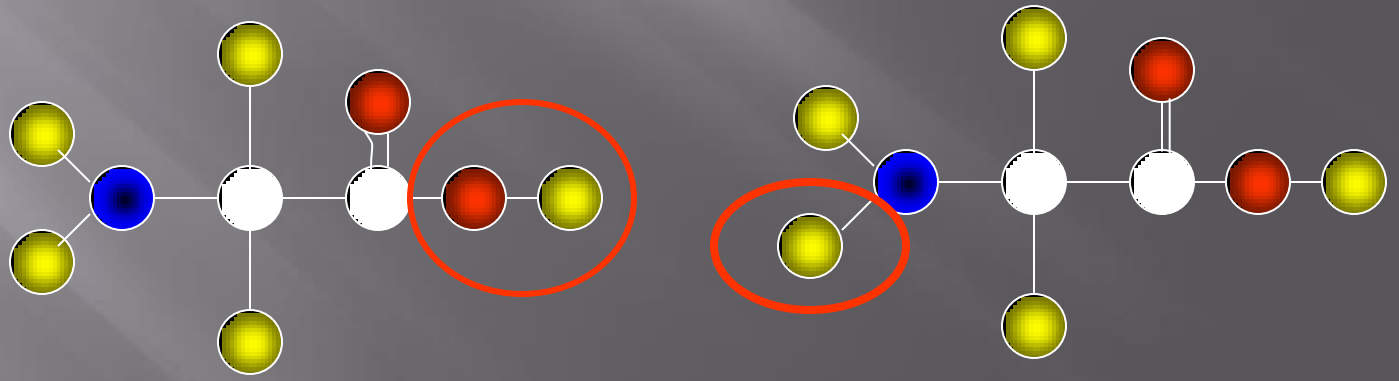
Putting Together the Building Blocks

What process is used to build a Carb?

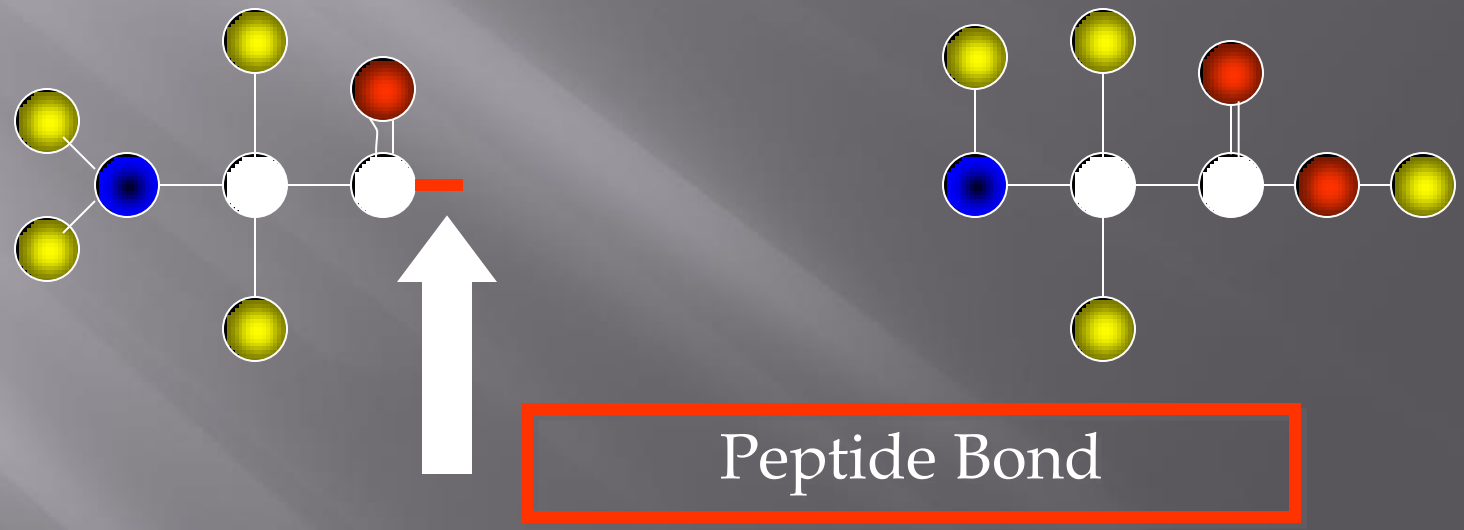
What process is used to build a protein?

water

Dehydration Synthesis



Putting Together The Building Blocks (cont)



Two characteristics of a peptide bond

a. Carbon – nitrogen bond

b. Double bonded oxygen on carbon atom

Enzyme terms to know

- **Enzyme** = protein that speeds up (reduces activation energy) of a process
- **Substrate** = substance enzyme interacts with
- **Enzyme-substrate complex** = joining together of substrate and enzyme
- **Active site** = open face of enzyme to which the substrate attaches

"Lock and Key"

- Enzymes work in a "lock and key" relationship
  - Active site of enzyme is shaped to connect with very SPECIFIC substrates
  - If the shapes don't fit, the enzyme can't do its job
  - After the joining of the substrate and enzyme, substrate (and NOT enzyme- the enzyme must stay the same so it can be used again) is changed in some way to help speed up reaction

Denaturation

- When bonds of active site break the shape of a protein
- Makes them unable to do their jobs correctly
- Can happen for many reasons: