CARBOHYDRATES, LIPIDS, AND PROTEINS
- **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
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$_6$H$_{12}$O$_6$
    - Ex. Glucose, galactose, fructose (are isomers of one another)
Carbohydrates (cont.)

- Simple sugar structural formulas:

  - Glucose: \( \text{H - C = O} \)
    \( \text{H - C - OH} \)
    \( \text{HO - C - H} \)
    \( \text{H - C - OH} \)
    \( \text{H - C - OH} \)
    \( \text{H - C - OH} \)
  
  - Fructose: \( \text{H - C = O} \)
    \( \text{H - C - OH} \)
    \( \text{HO - C - H} \)
    \( \text{H - C - OH} \)
    \( \text{H - C - OH} \)
    \( \text{H - C - OH} \)
  
  - Galactose: \( \text{H - C = O} \)
    \( \text{H - C - OH} \)
    \( \text{HO - C - H} \)
    \( \text{H - C - OH} \)
    \( \text{H - C - OH} \)
    \( \text{H - C - OH} \)
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
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
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
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
Dietary Sources
- High fat sources

Chemical make-up
- Contains C, H, and O

Lipids are our secondary energy source (mostly stored for use later)
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 liposome

- Monomers
  - 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

Long chain fatty acid

Long chain fatty acid

Triple alcohol

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
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
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
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
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
Proteins organized on four different levels

- Primary ($1^\circ$)
- Secondary ($2^\circ$)
- Tertiary ($3^\circ$)
- Quaternary ($4^\circ$)
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
General Structure for an Amino Acid

Key Carbon

Amine Group

Radical group = only part that changes in different AA’s

Carboxyl Group
Putting Together the Building Blocks

What process is used to build a Carb?

What process is used to build a protein?

Dehydration Synthesis

Water
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
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: