Types of Biomolecules

- **Carbohydrates**
  - Monosaccharides (glucose and fructose)
  - Disaccharides (maltose, lactose, and sucrose)
  - Polysaccharides (starch and cellulose)
- **Amino Acids** and **Proteins**
- **Triglycerides**
- **Steroids**

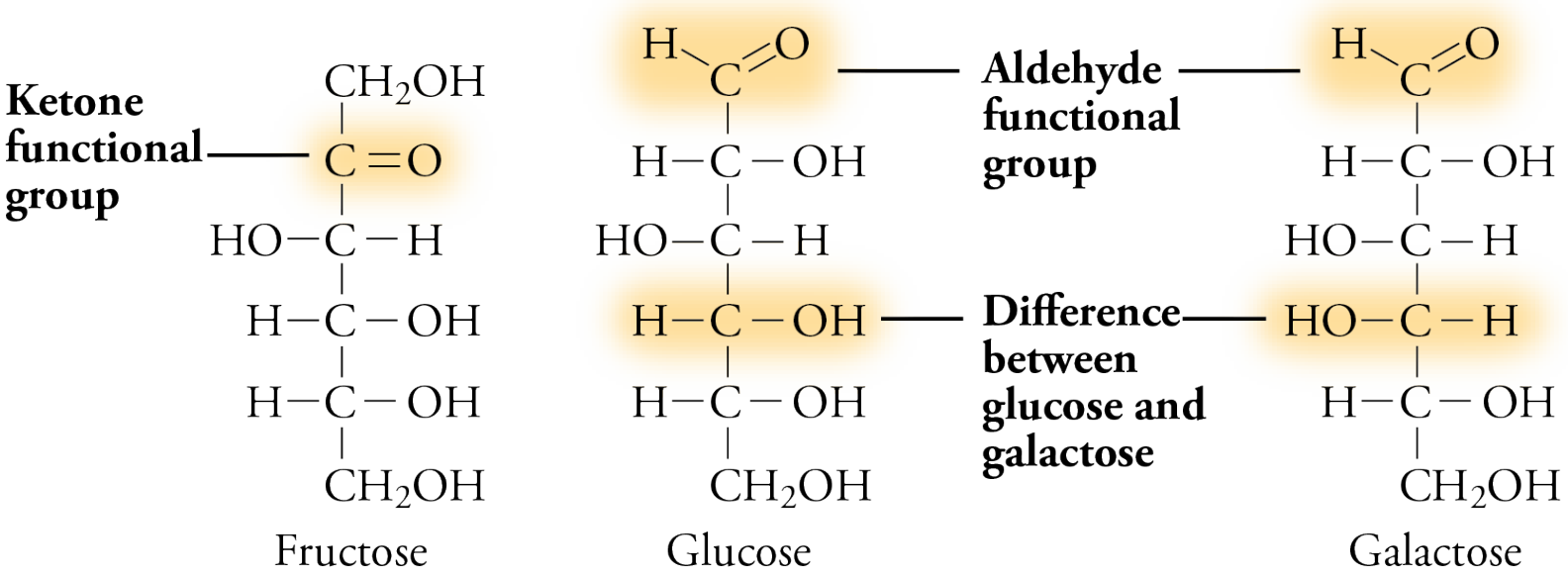
Substances in Food

- Our food is a mixture of many different kinds of substances, but the energy we need to run our bodies comes from three of them:
  - digestible carbohydrates (the source of 40%-50% of our energy),
  - protein (11%-14%),
  - and triglycerides (the rest).

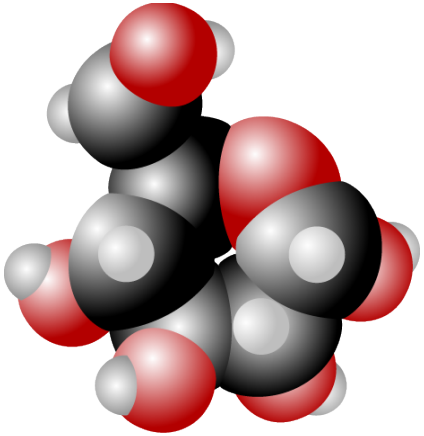
Carbohydrates

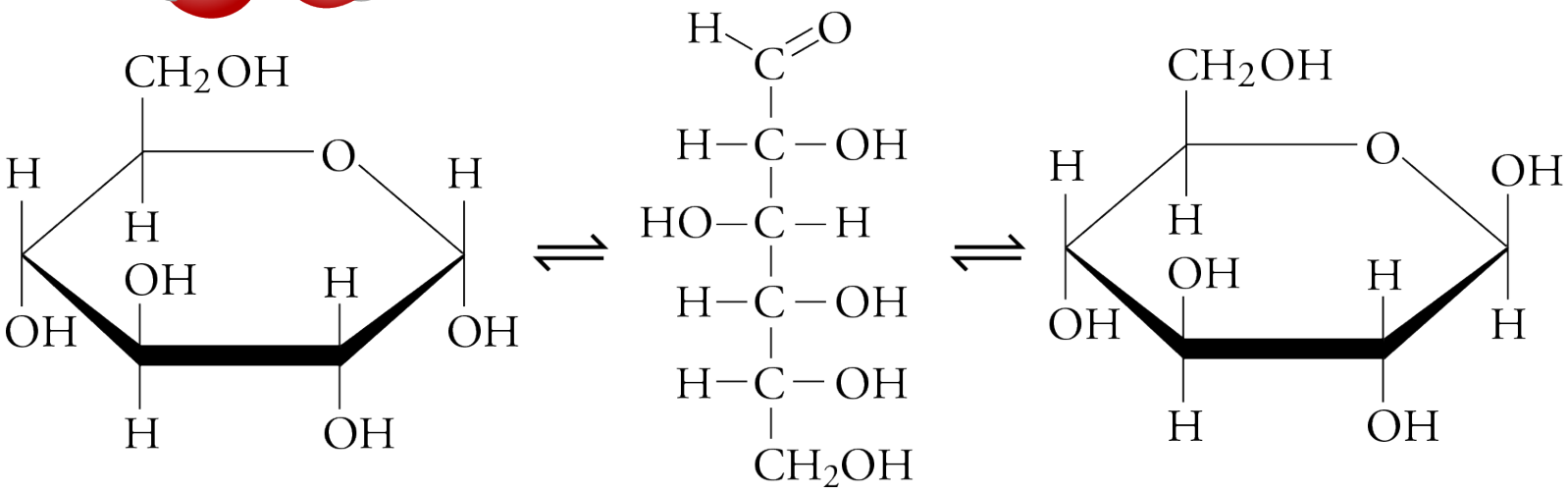
- Carbohydrate is a general name for sugars, starches, and cellulose.
- They are also be called saccharides.
- Sugars are monosaccharides or disaccharides, and starches and cellulose are polysaccharides.
- The most common monosaccharides are glucose, fructose, and galactose, which are isomers with the formula $C_6H_{12}O_6$.

Monosaccharides



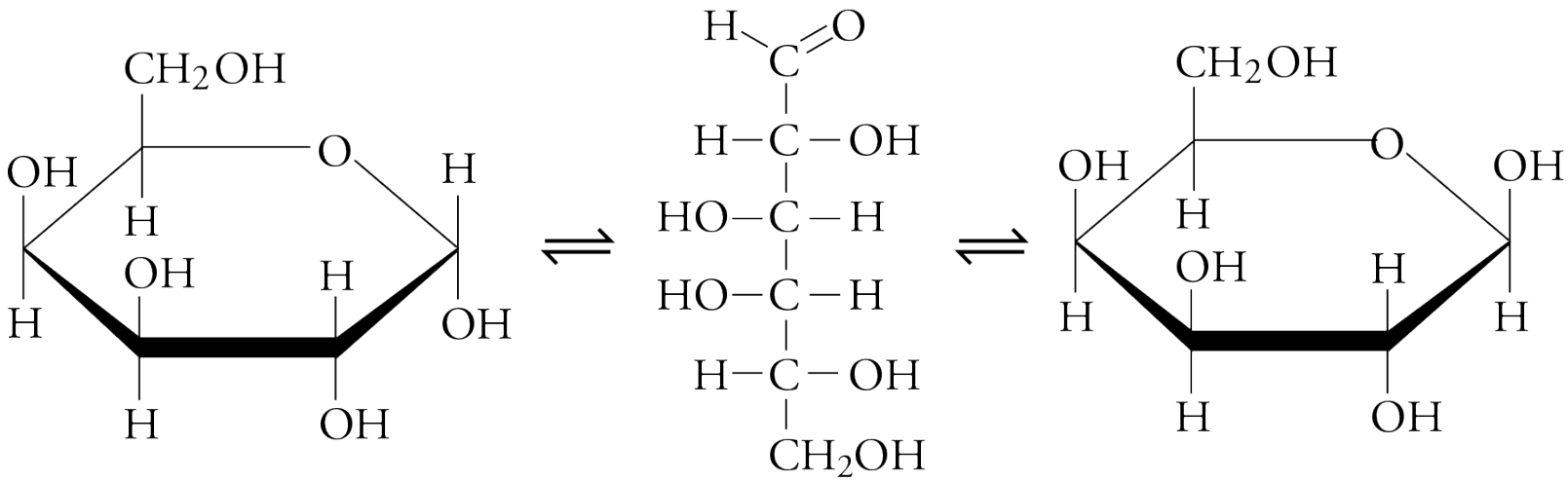
Glucose





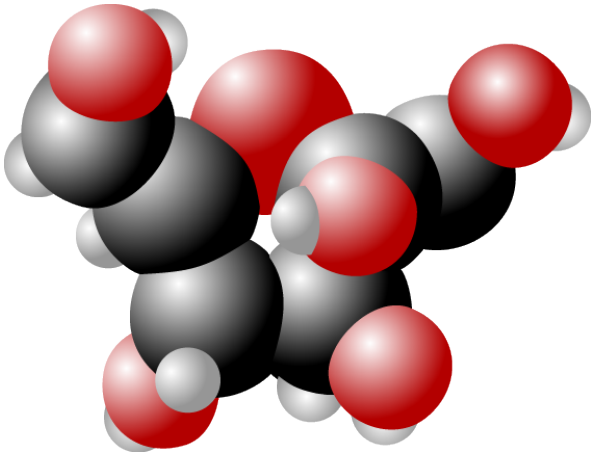
glucose

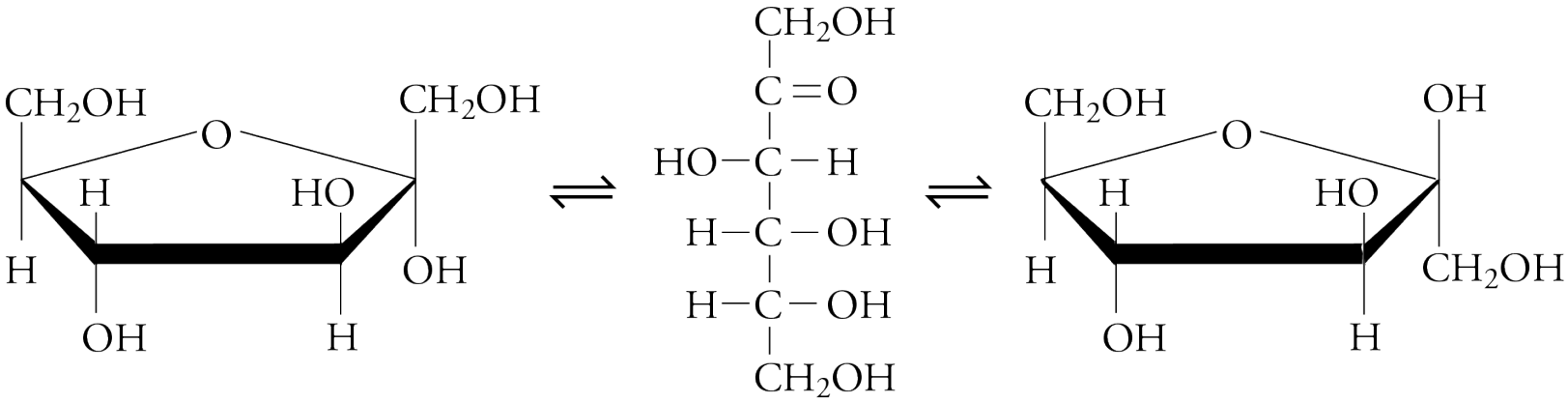
Galactose



galactose

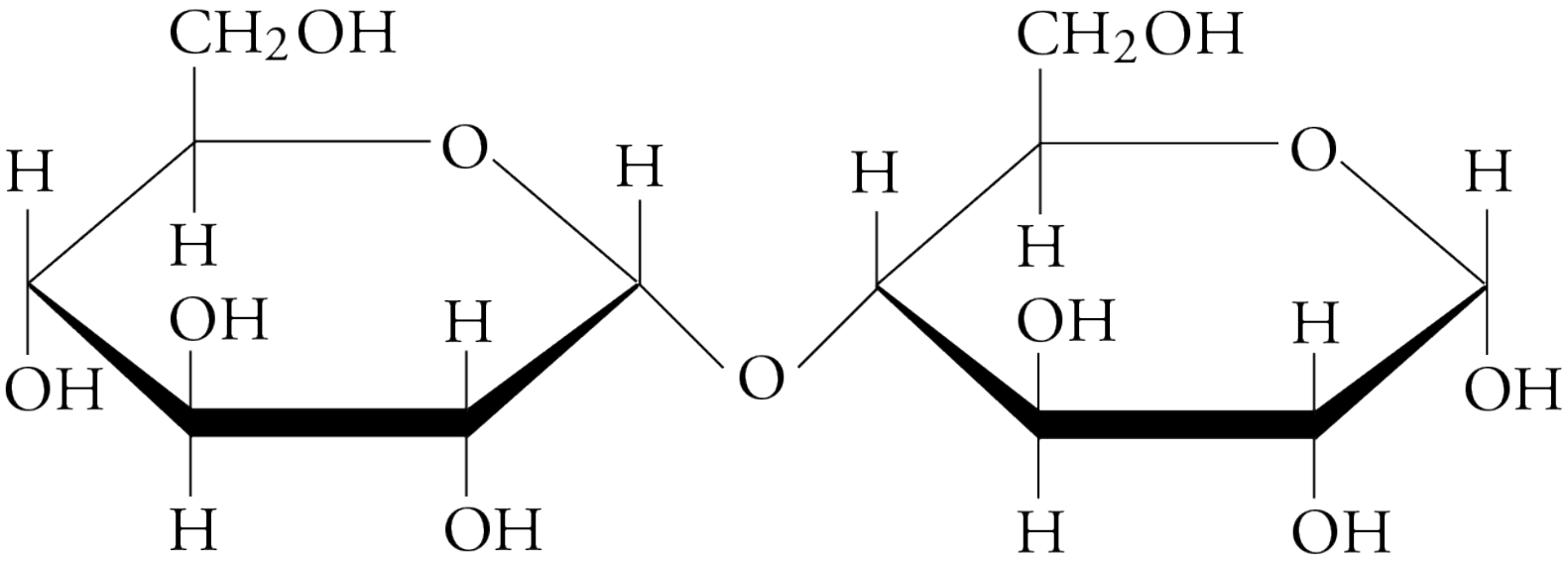
Fructose





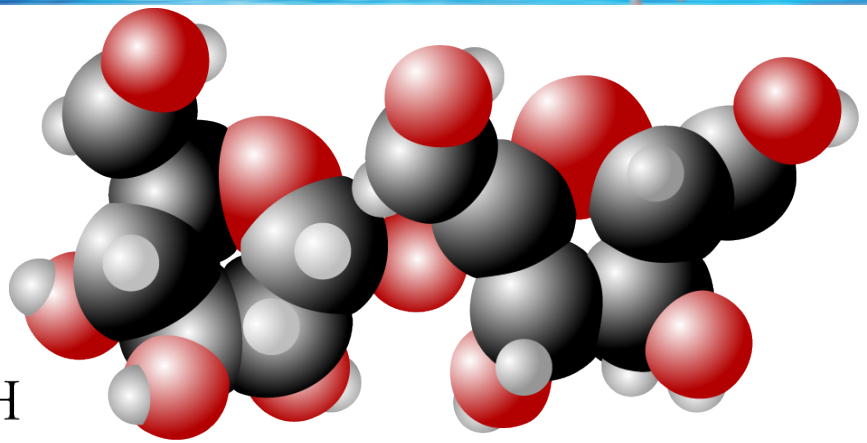
Fructose

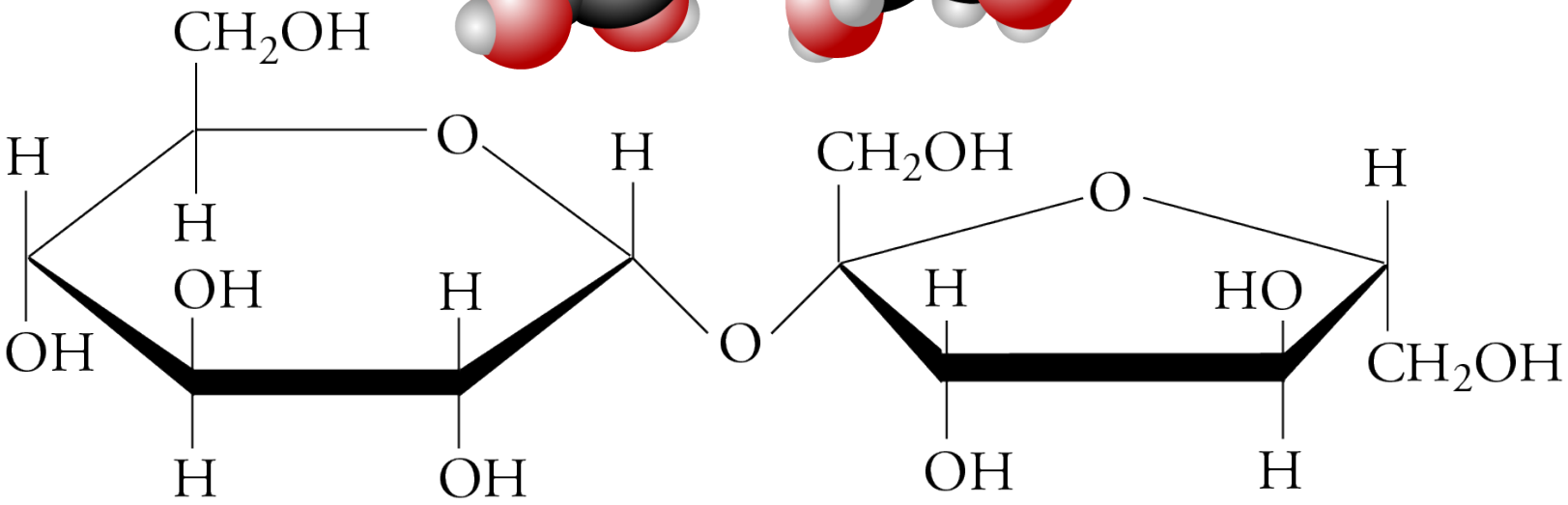
Maltose



Maltose (glucose and glucose)

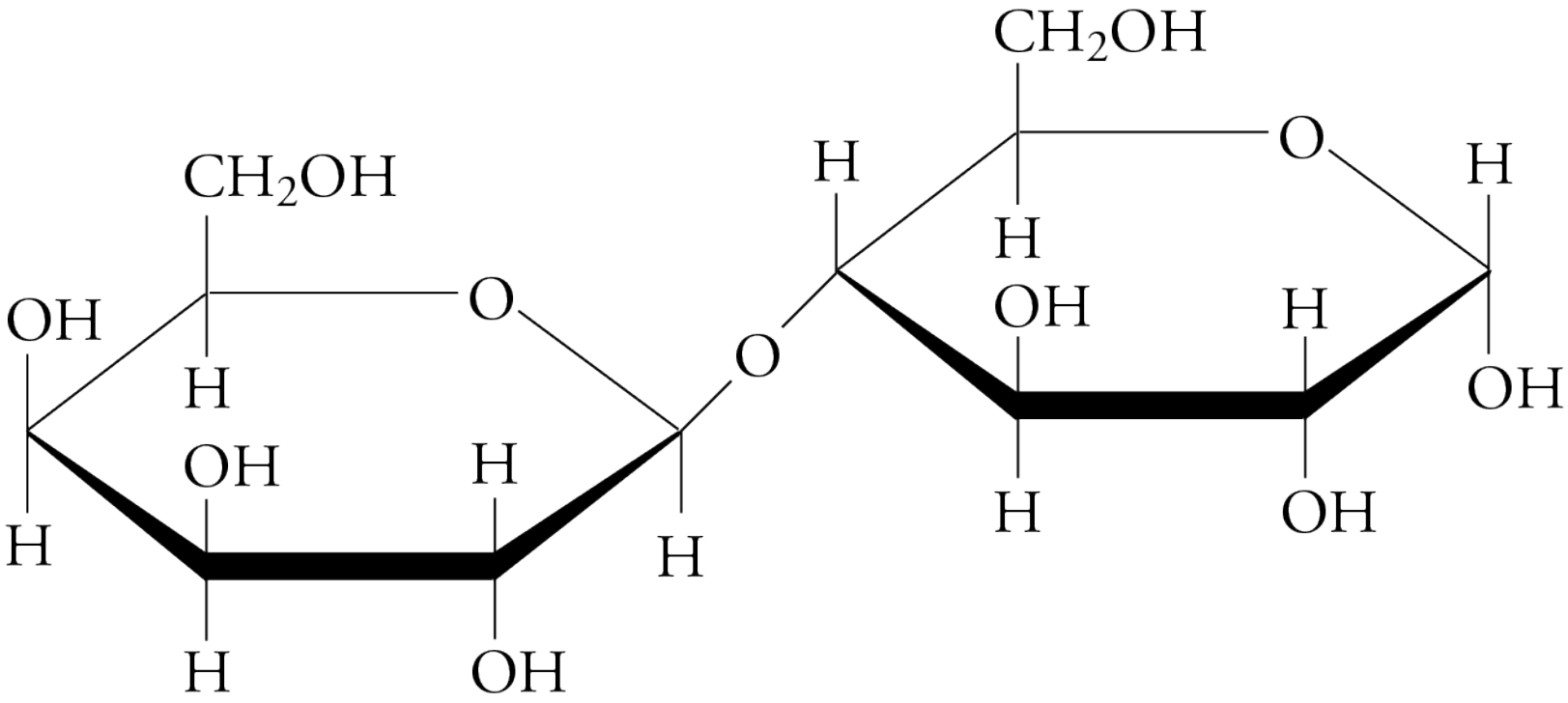
Sucrose





Sucrose (glucose and fructose)

Lactose



Lactose (galactose and glucose)

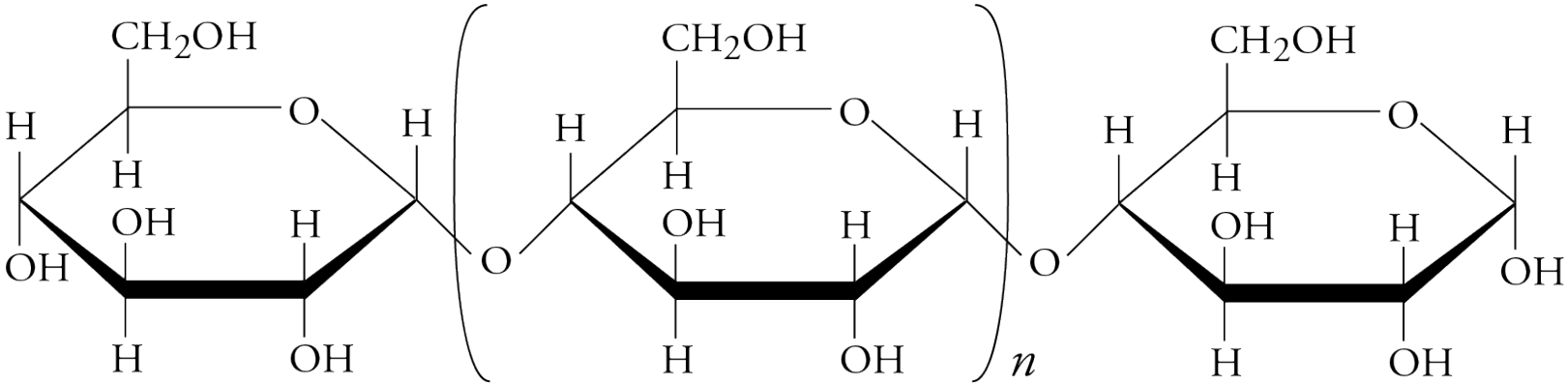
Polysaccharides

- Starches are polysaccharides (polymers) composed of long chains of glucose molecules (monomers) linked together by alpha linkages.
  - **Polymers** are large molecules composed of simpler repeating units called **monomers**.
- Cellulose is a polysaccharide composed of long chains of glucose molecules linked together by beta linkages.

Plant and Animal Starches

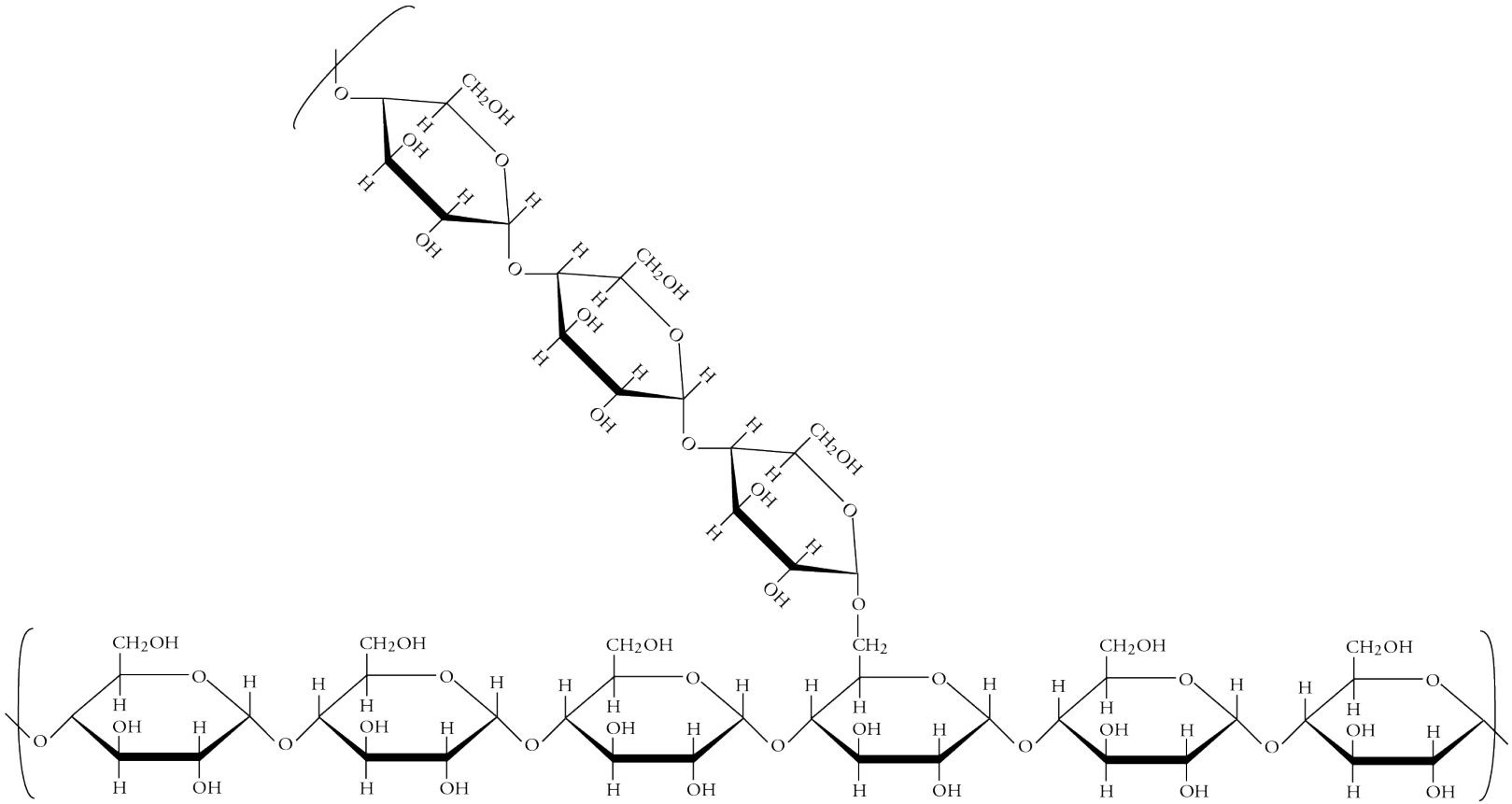
- Plant Starch
  - Amylose with long straight chains of glucose molecules.
  - Amylopectin with long chains of glucose molecules with periodic chains of glucose molecules coming off as branches from the straight chains.
- Animal Starch (Glycogen)
  - Similar to amylopectin but with generally shorter and more frequent branches.

Amylose

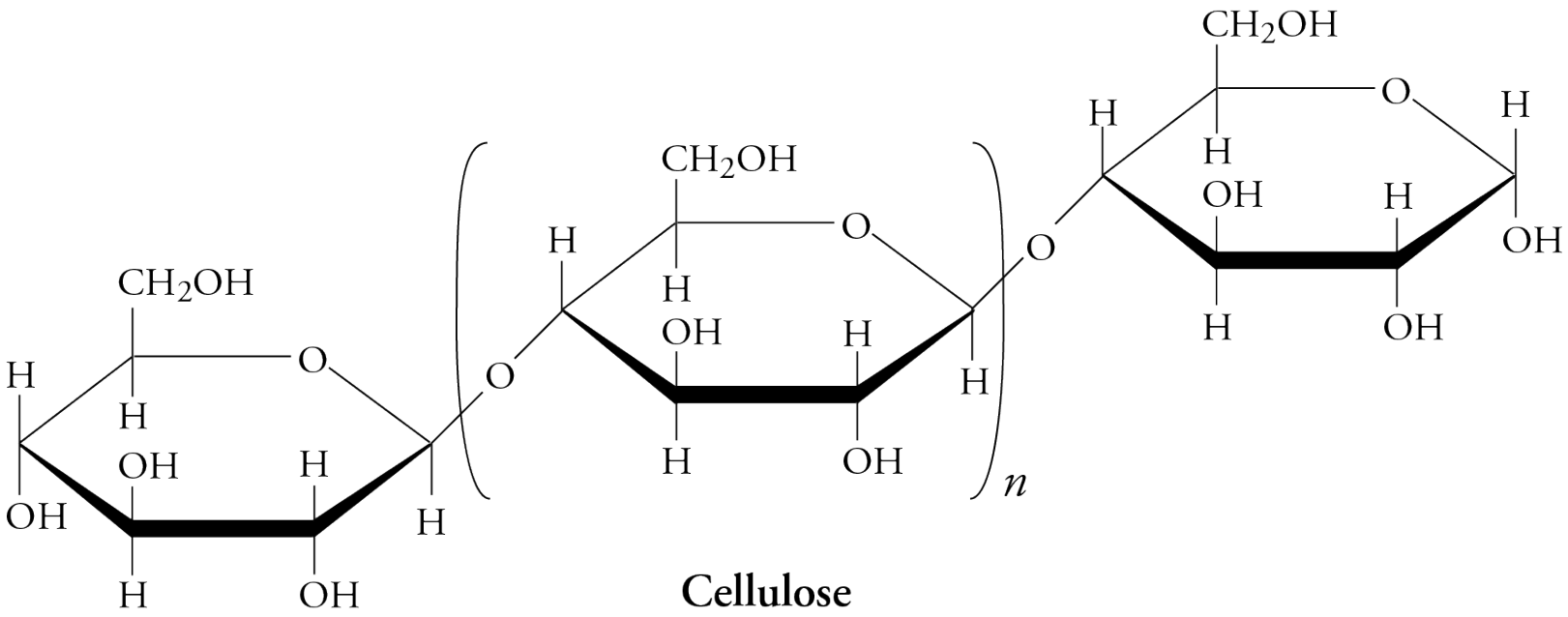


Amylose

Amylopectin or Glycogen



Cellulose

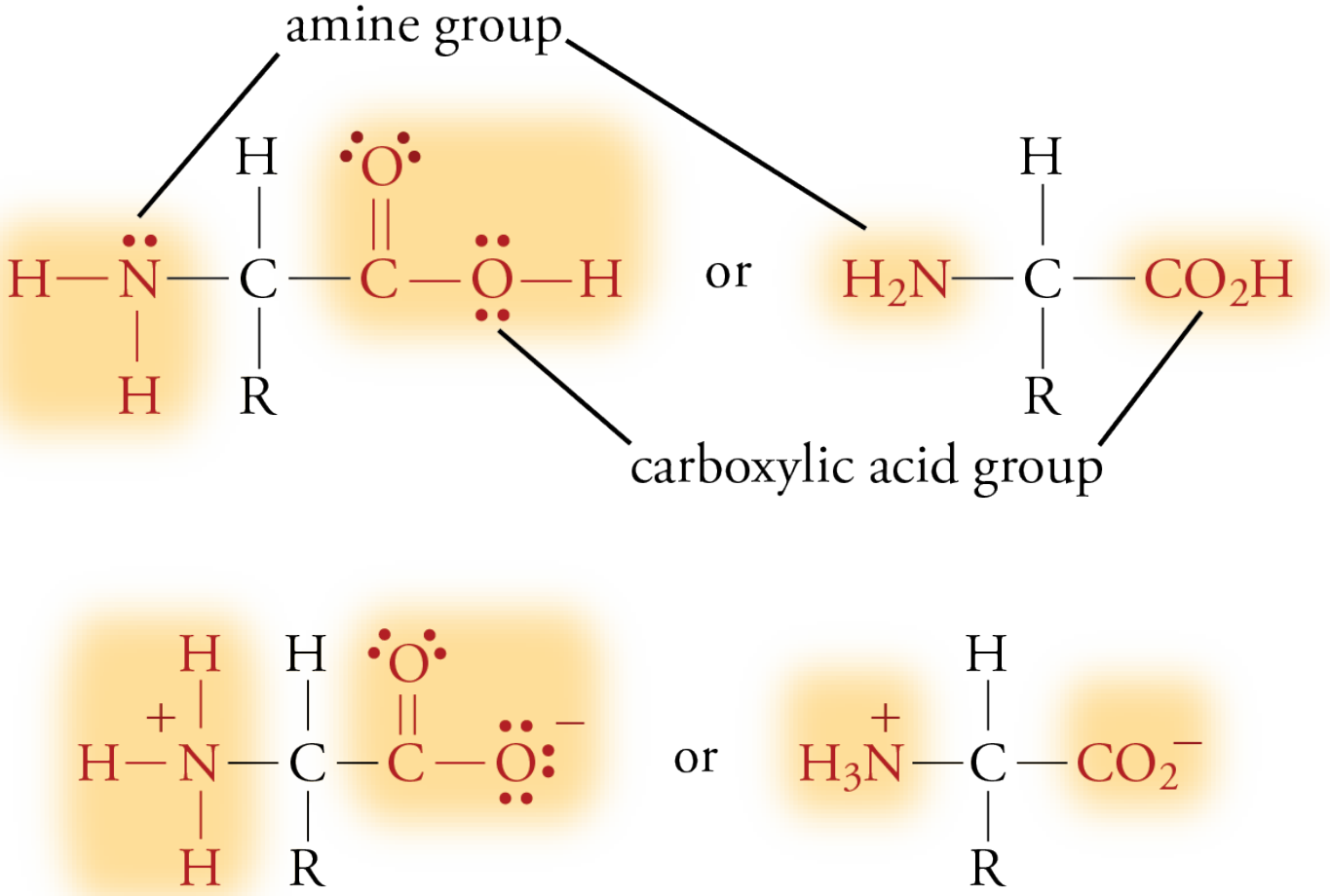


Cellulose

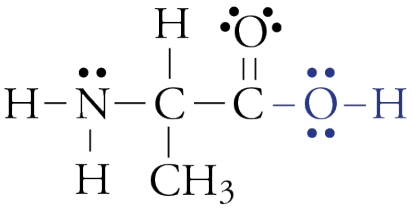
Amino Acids

- Amino acids are the building blocks of proteins.
- There are hundreds of amino acids in nature, but only 20 of them are important for producing proteins.
- Each amino acid has an amine group and a carboxylic acid group separated by a carbon.
- One amino acid differs from another by a side chain connected to the central carbon.

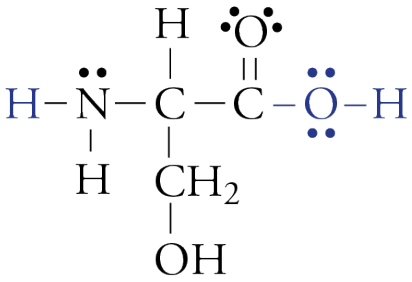
Amino Acids



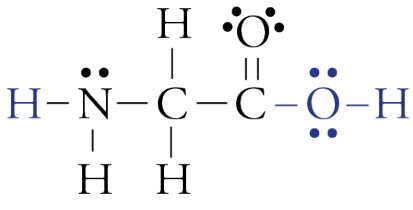
Alanine, Serine, Glycine, and Cysteine



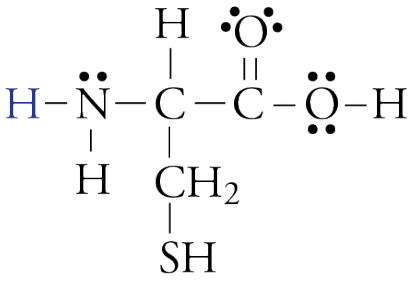
Alanine (Ala)



Serine (Ser)



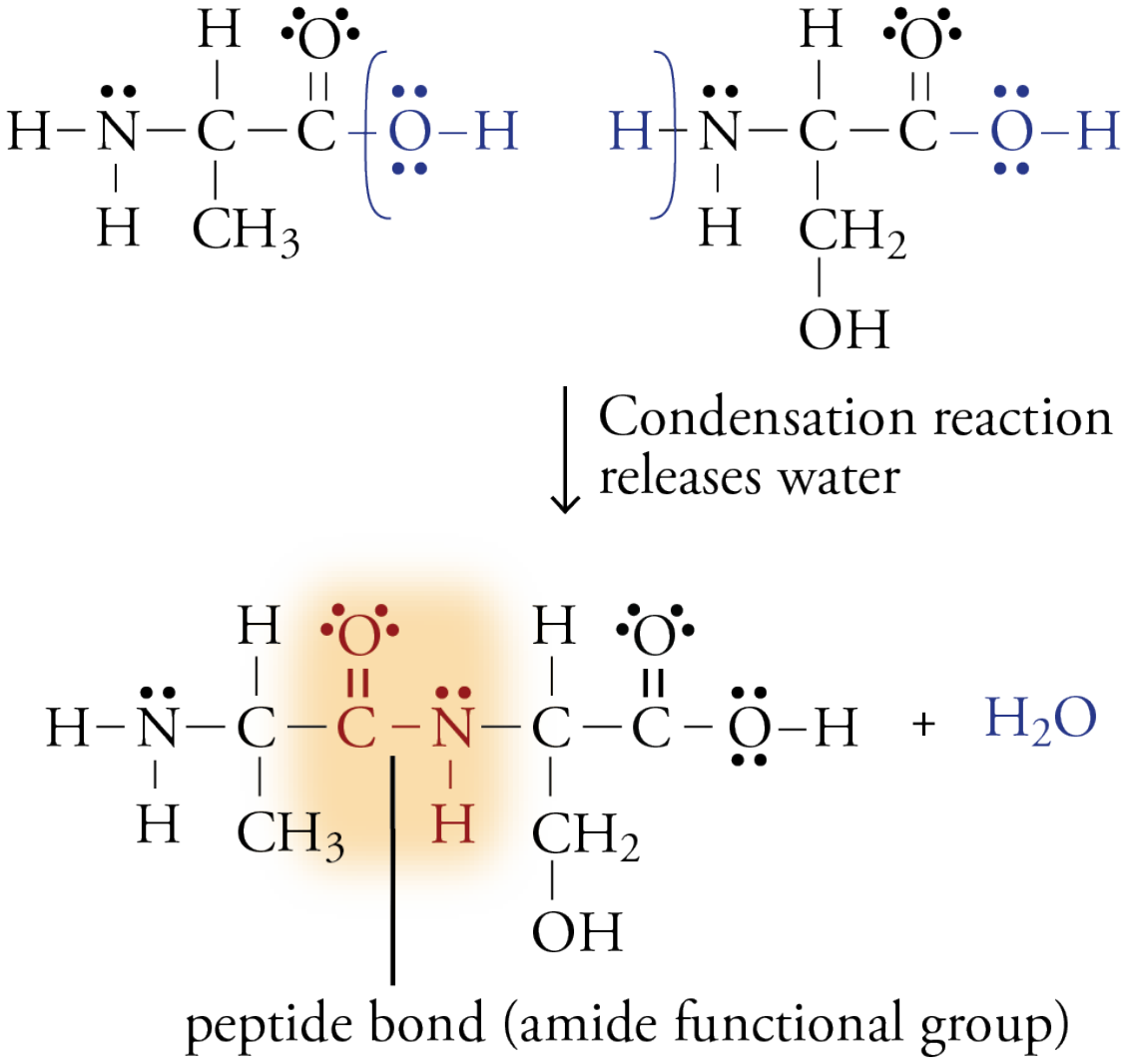
Glycine (Gly)



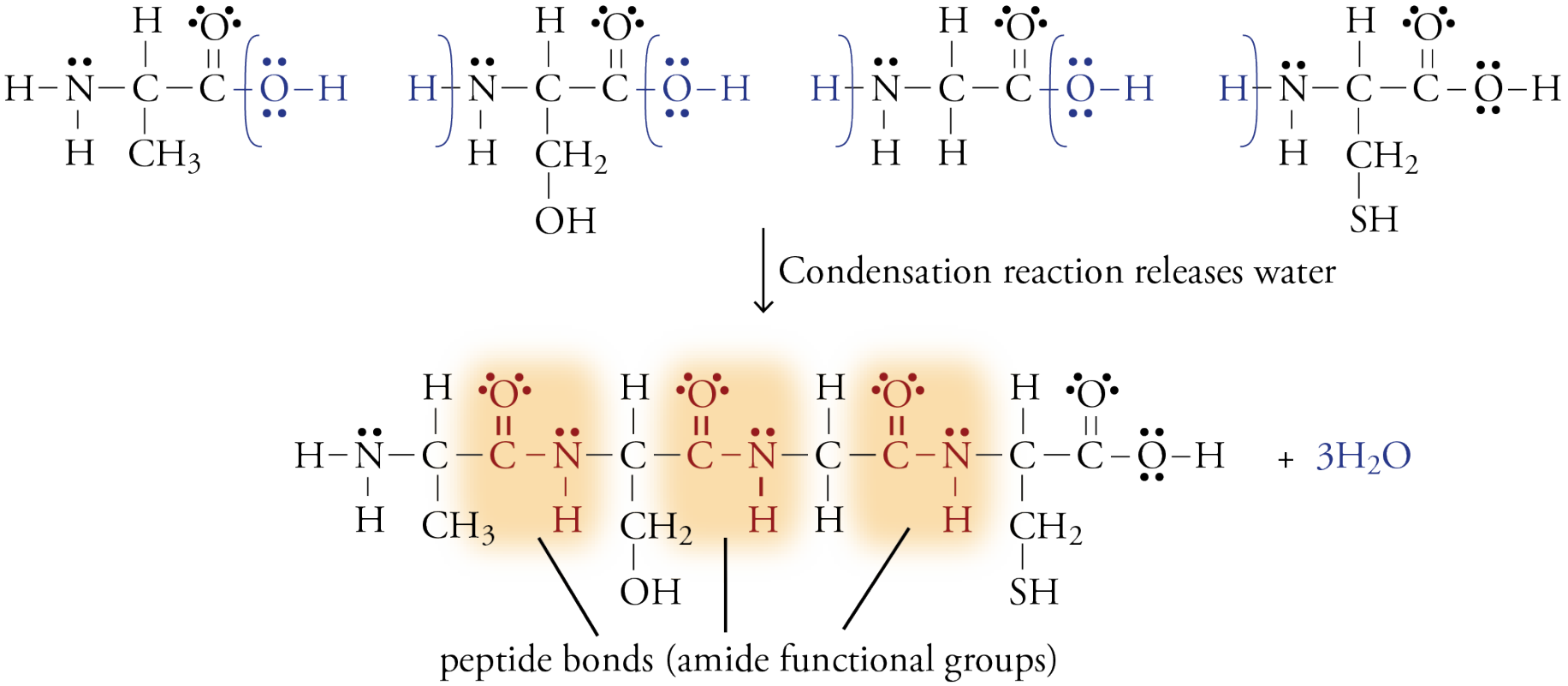
Cysteine (Cys)

Protein Formation

- The amine group of one amino acid can react with the carboxylic group of another amino acid to form an amide group and link the amino acids together.
- In proteins, this amide linkage is called a peptide bond.



Formation of Ala-Ser-Gly-Cys



Polypeptides and Proteins

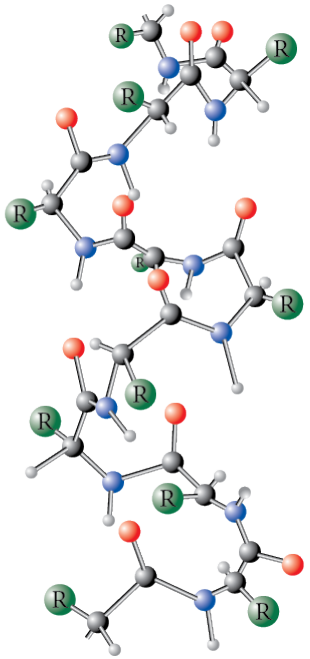
- A chain of amino acids linked by peptide bonds would be called a **polypeptide** or often just a peptide.
- If the polypeptide has more than about 50 amino acids, we called it a **protein**.

Primary and Secondary Protein Structures

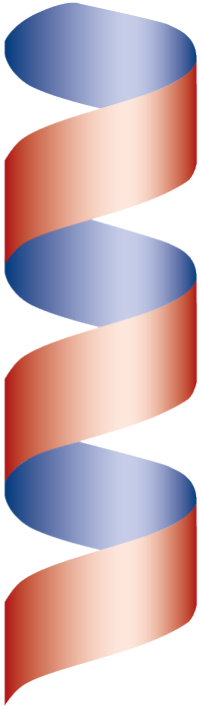
- ***Primary Structure*** = the sequence of amino acids in the protein
- The arrangement of atoms that are close to each other in the polypeptide chain is called the ***secondary structure*** of protein.
  - Three types
    - α-helix
    - β-sheet
    - irregular

α-helix – Secondary Structure

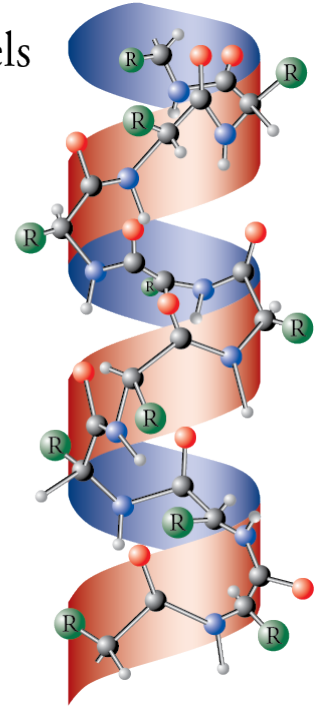
Ball-and-stick model of a portion of the α-helical secondary structure of a protein molecule



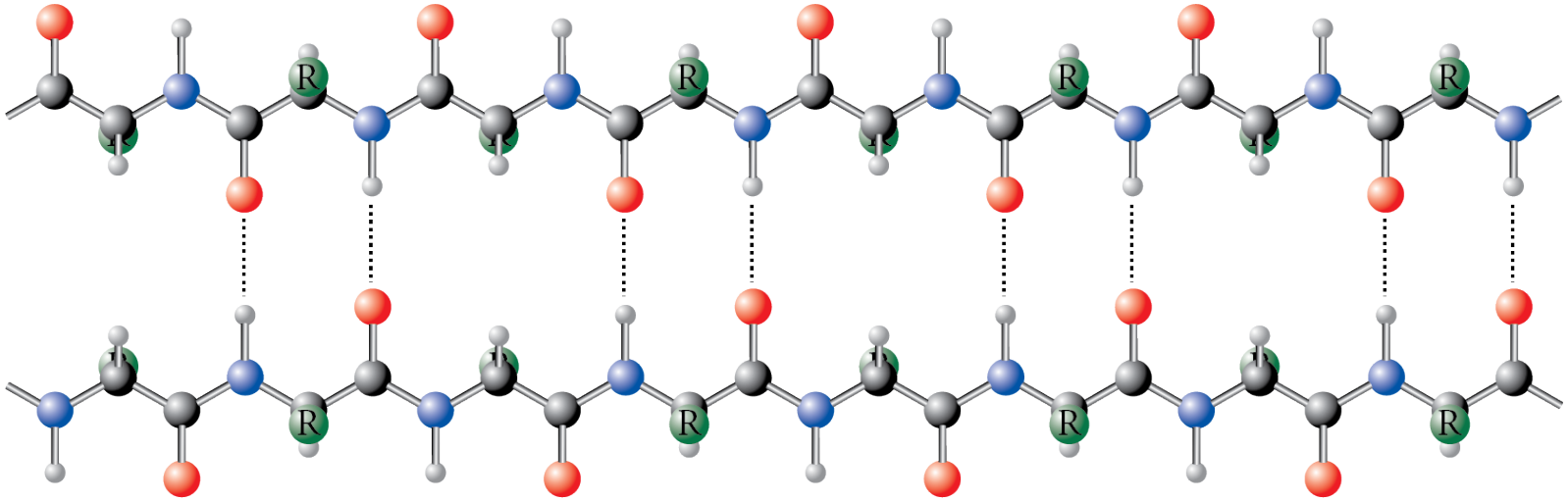
This ribbon model shows the general arrangement of atoms in a portion of the α-helical secondary structure of a protein molecule.



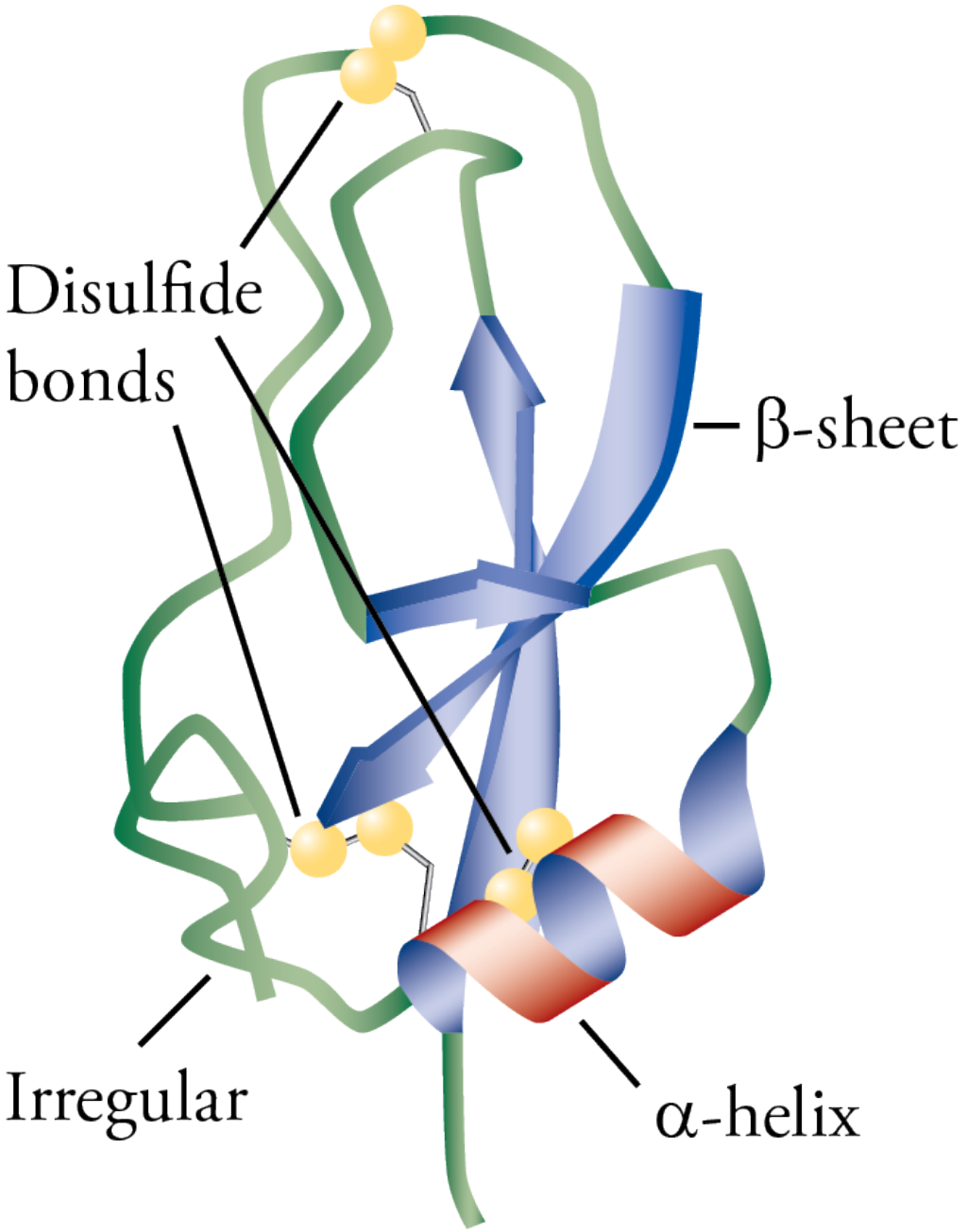
The two models superimposed



β-Sheet Secondary Structure



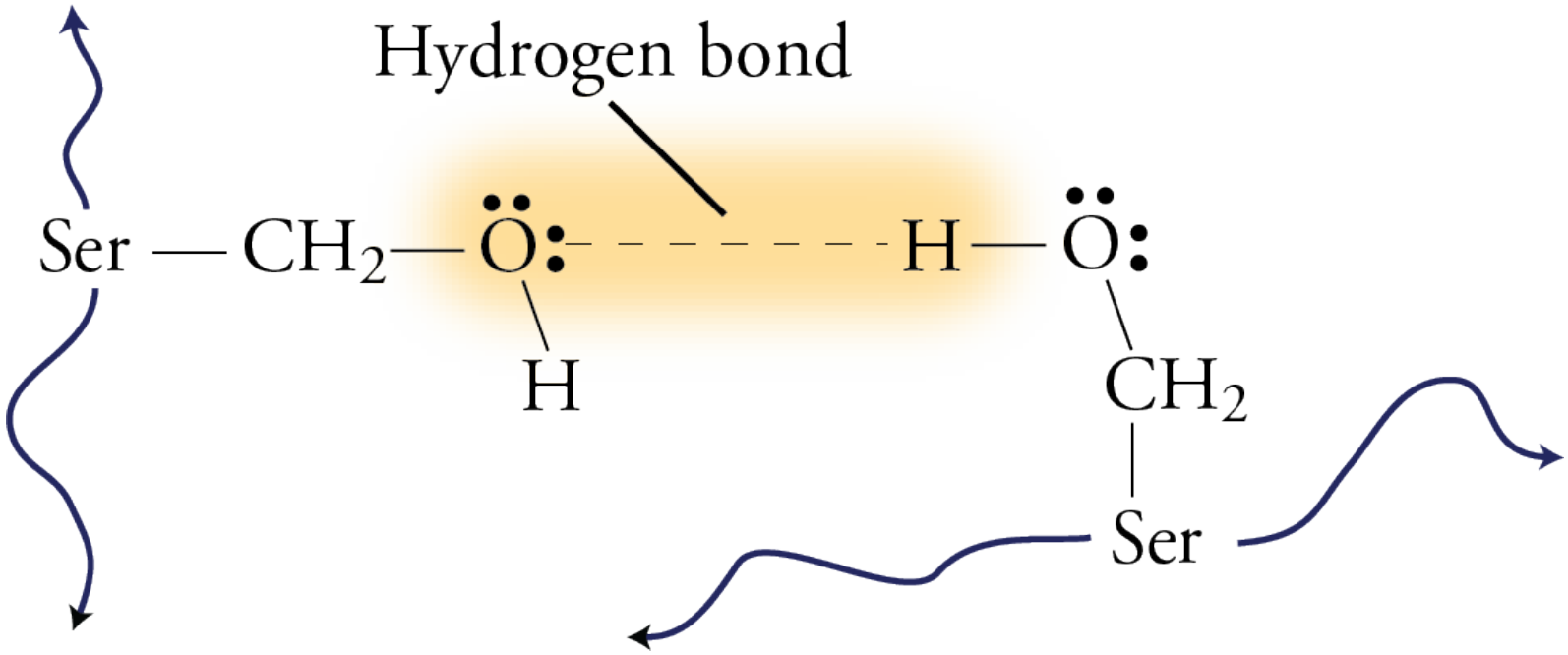
The Ribbon Structure of the Protein BPTI



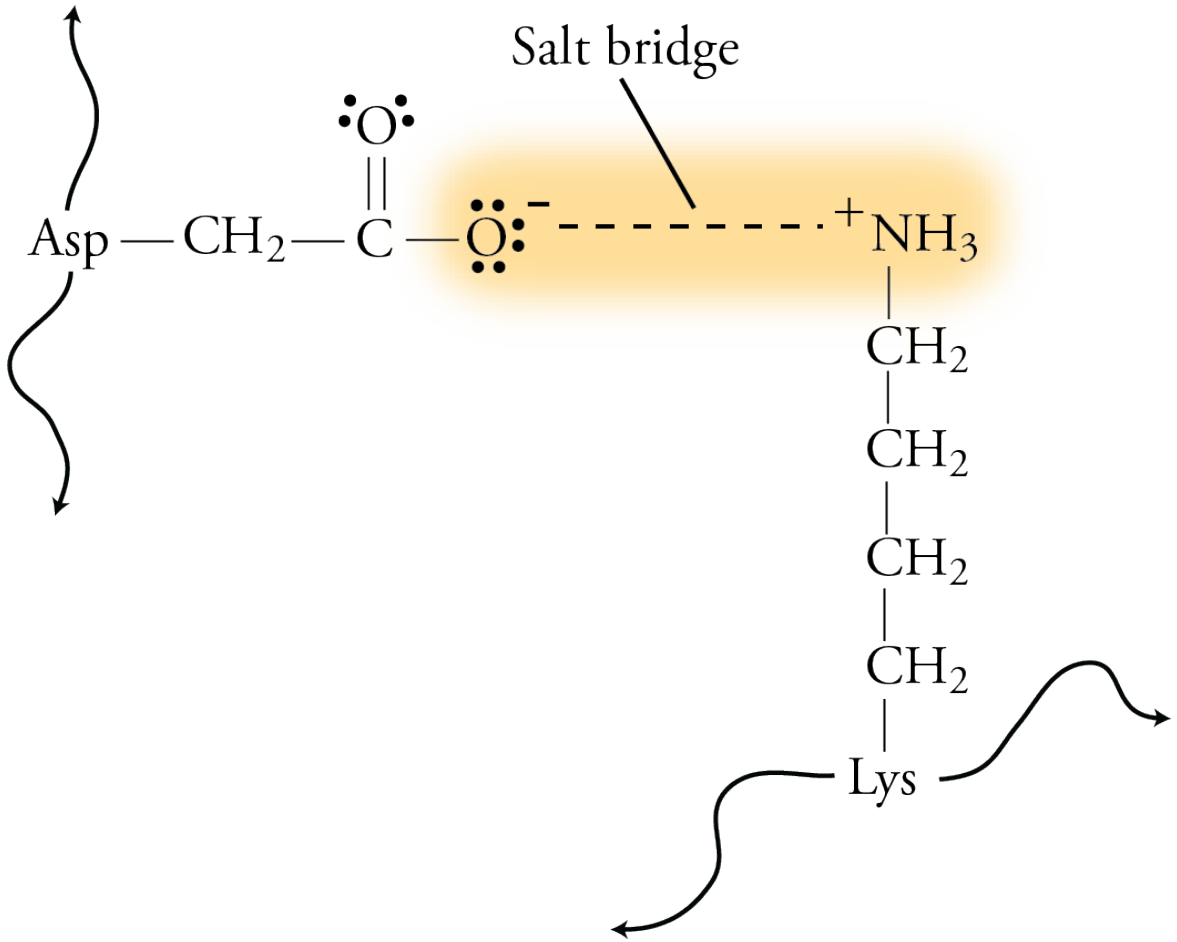
Tertiary Protein Structure

- The very specific overall shape of the protein called its ***tertiary structure***.
- The protein chain is held in its tertiary structure by interactions between the side chains of its amino acids.
  - Hydrogen bonds
  - Salt bridges
  - Disulfide bonds

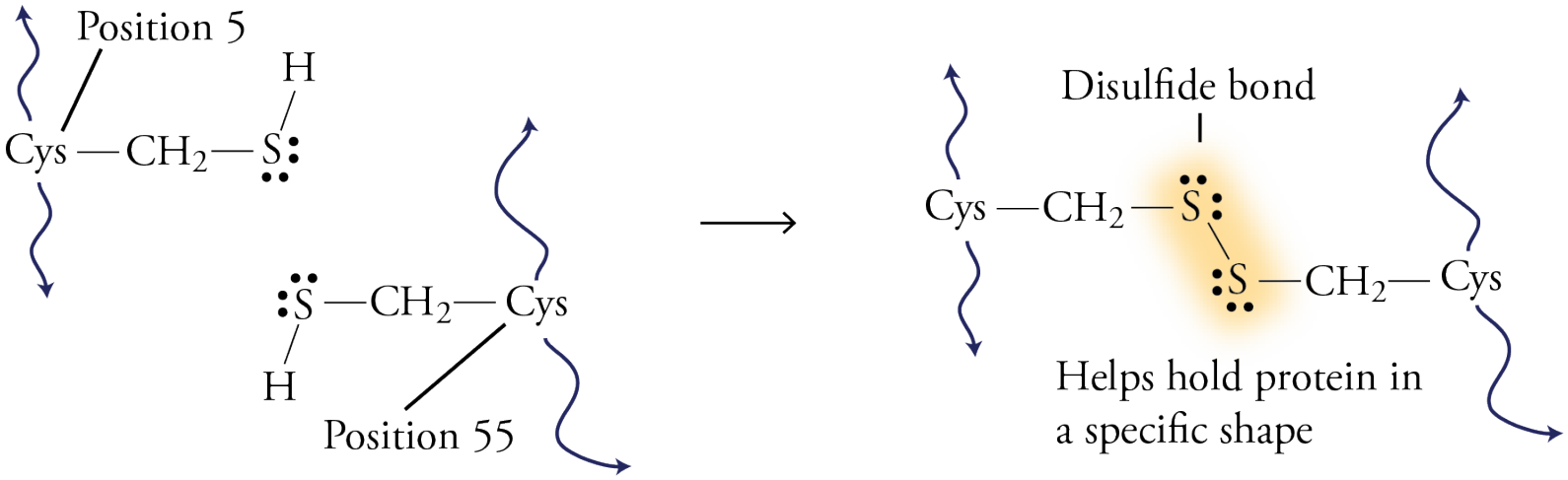
Hydrogen Bonding in Proteins



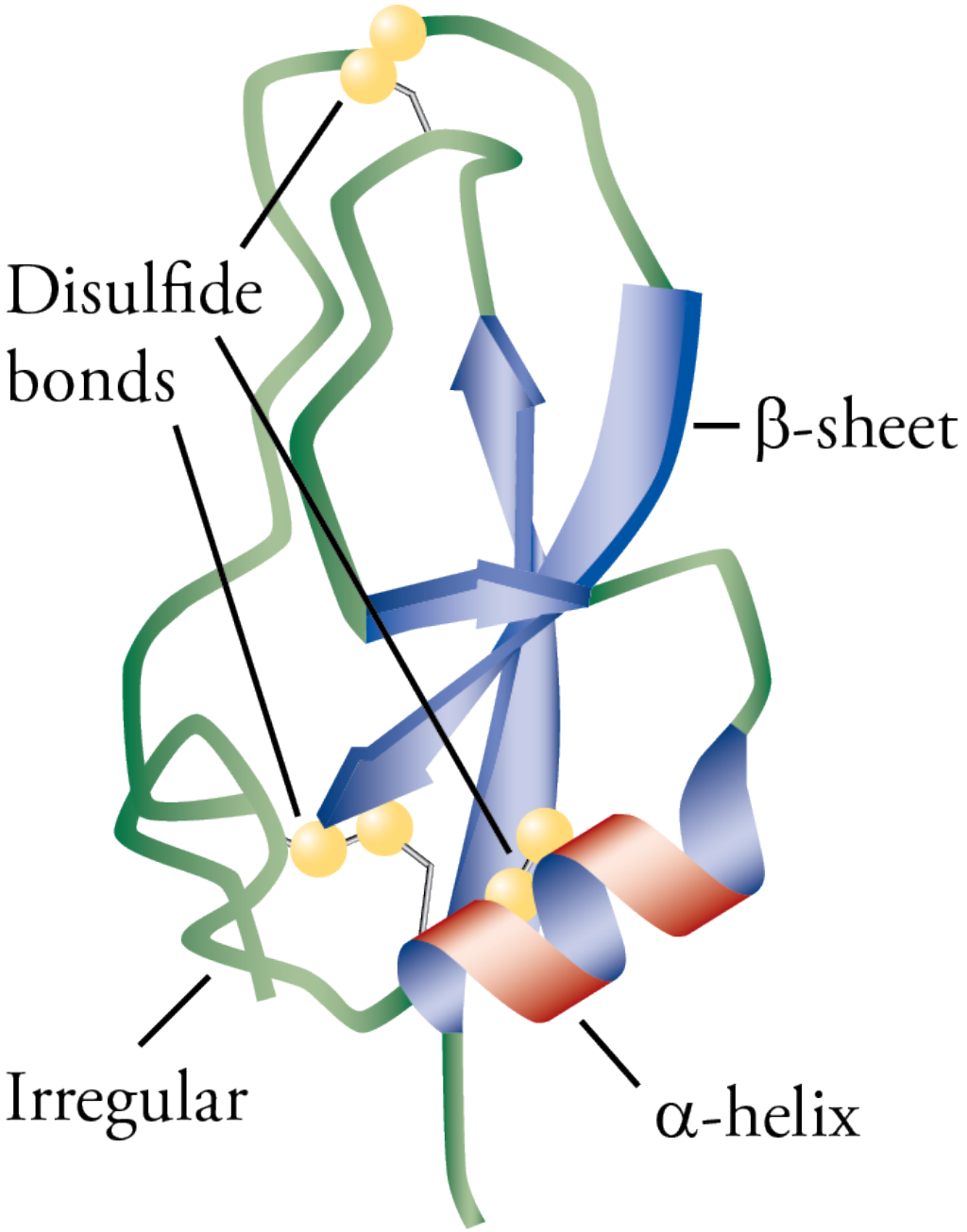
Salt Bridge in Proteins



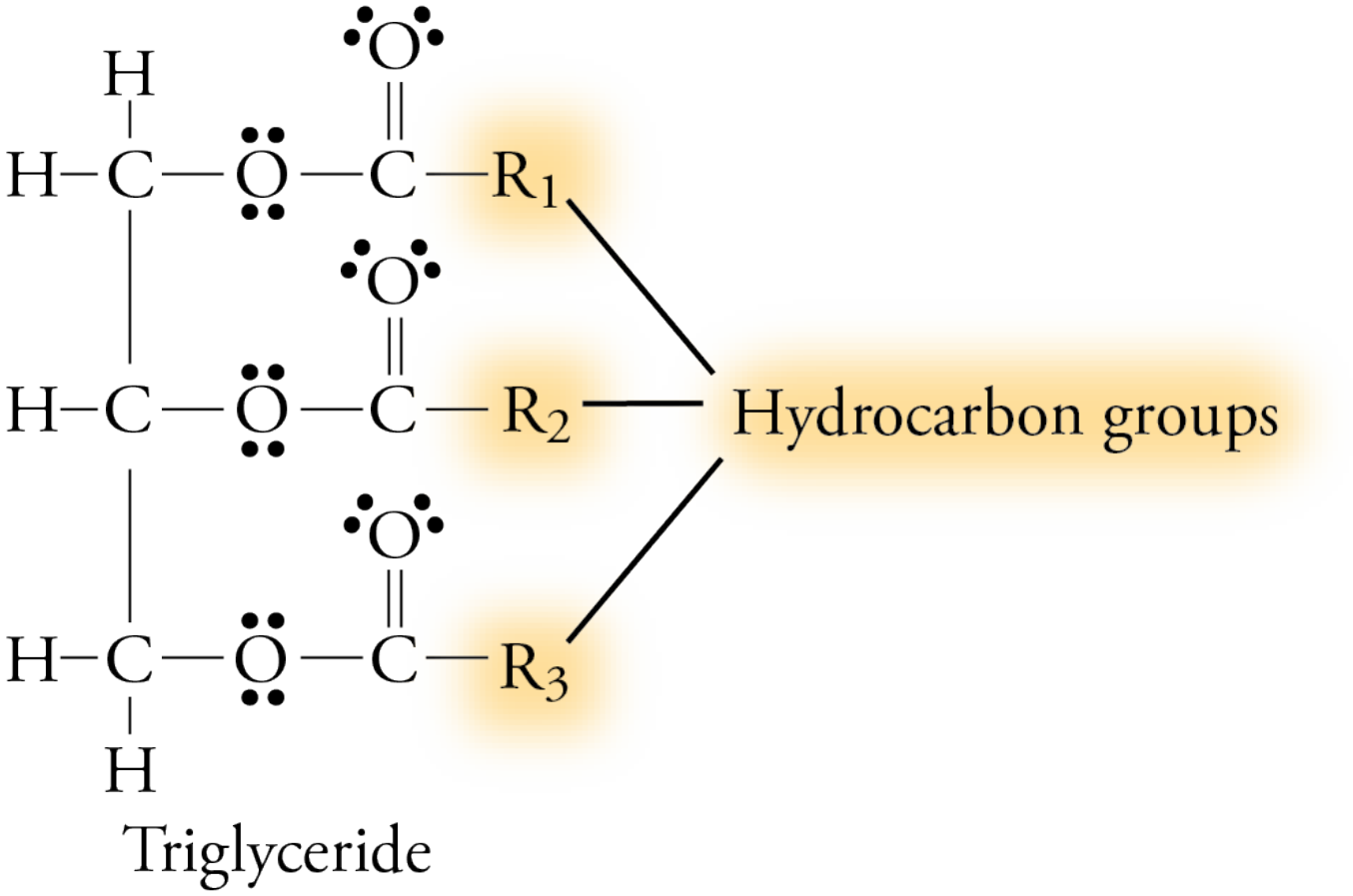
Disulfide Bonds in Proteins



The Ribbon Structure of the Protein BPTI

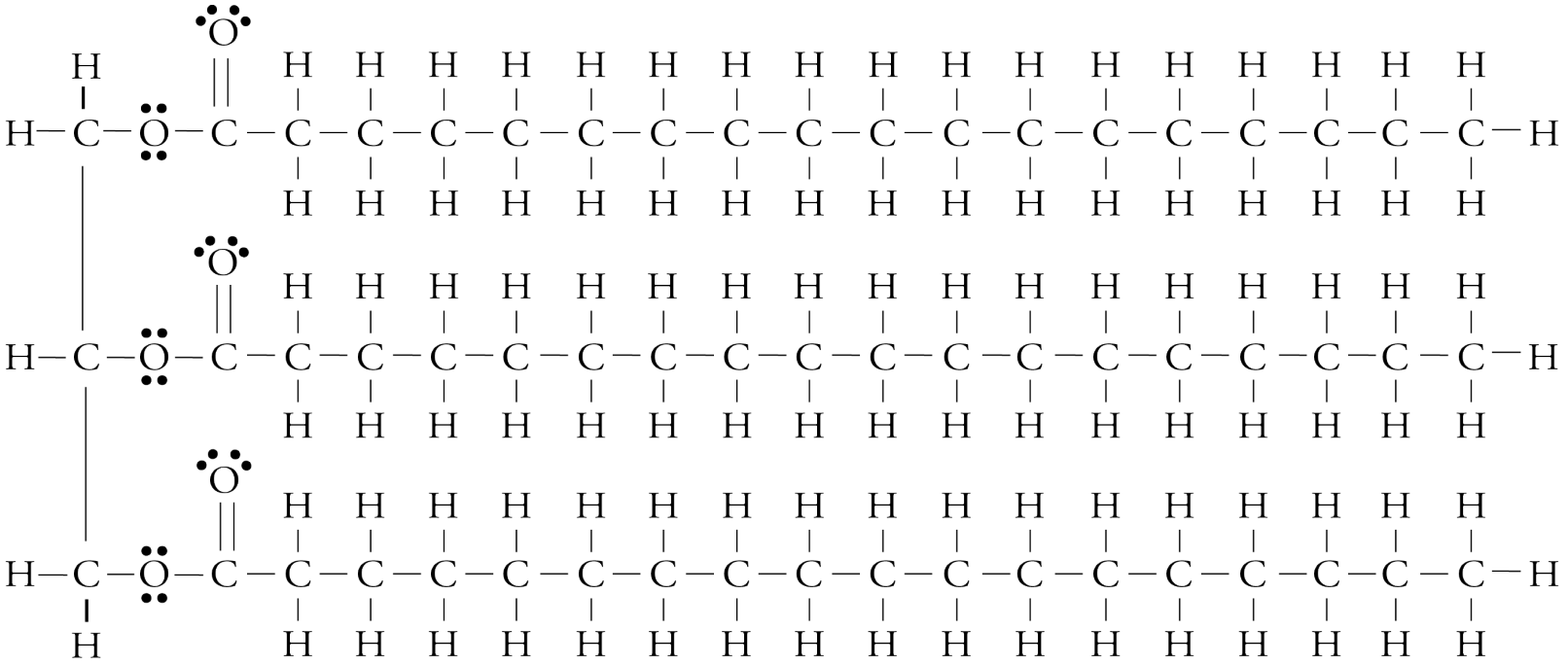


Triglycerides (Fats and Oils)

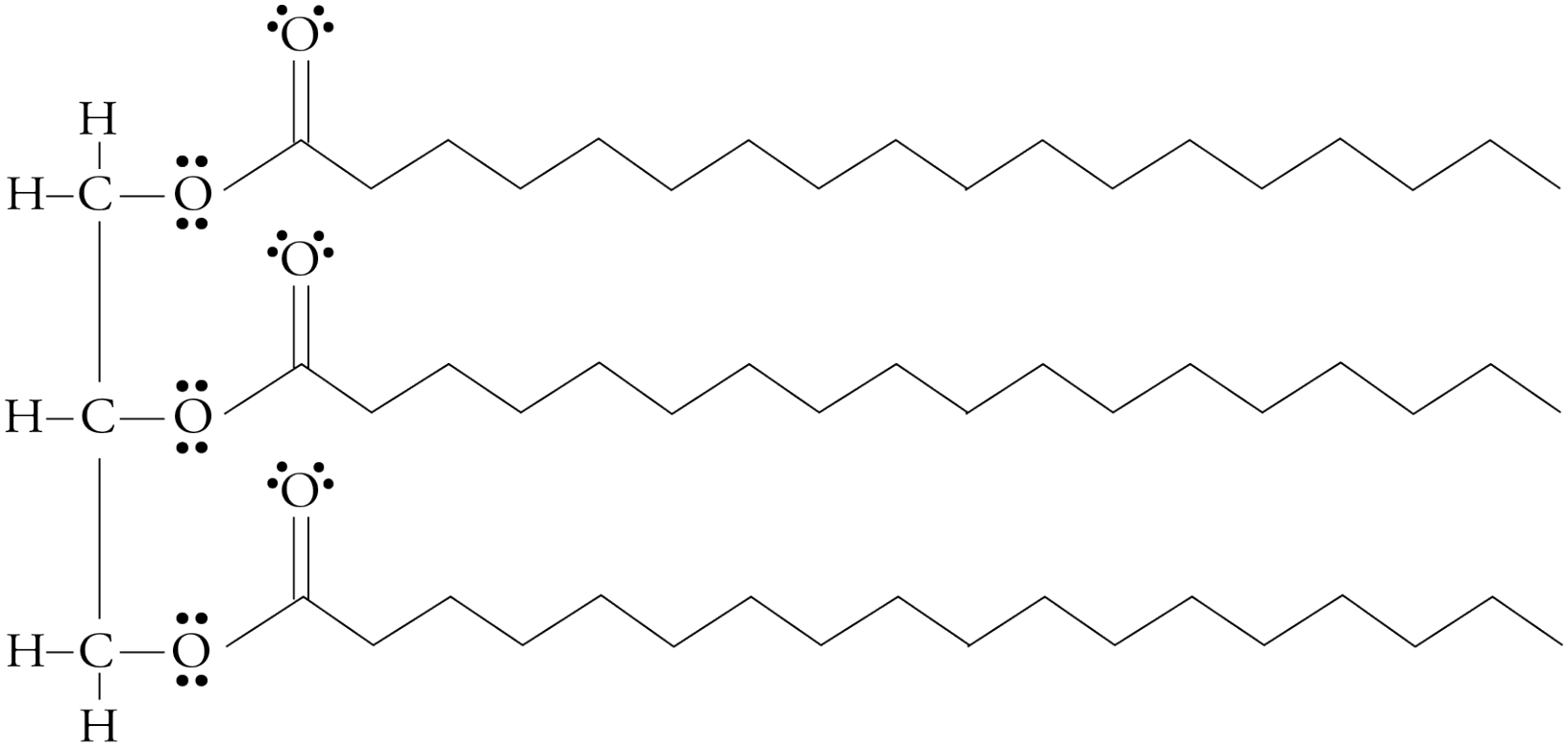


Triglyceride

Saturated Triglyceride - Tristearin

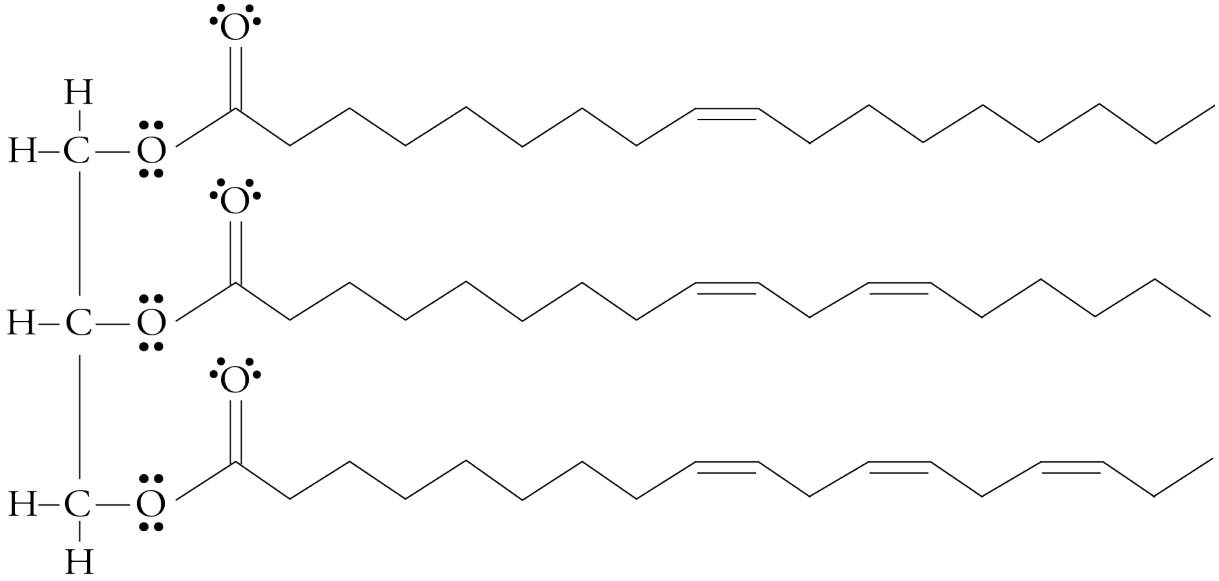


Tristearin – Line Drawing



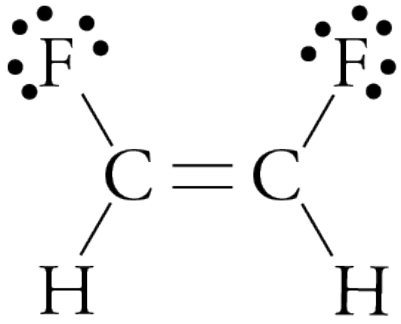
Unsaturated Triglyceride

Liquid triglycerides are rich in carbon-carbon double bonds.

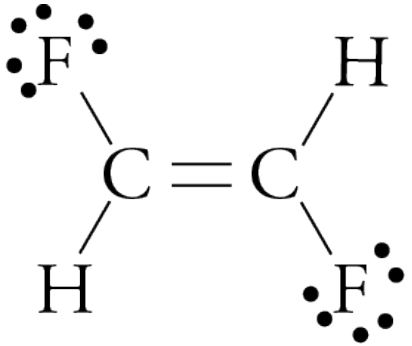


Cis and Trans

- When there is a double bond between two carbon atoms and when like groups are on different carbon atoms and the same side of the double bond, the arrangement is called ***cis***.
- When the like groups are on opposite sides of the double bond the arrangement is called ***trans***.

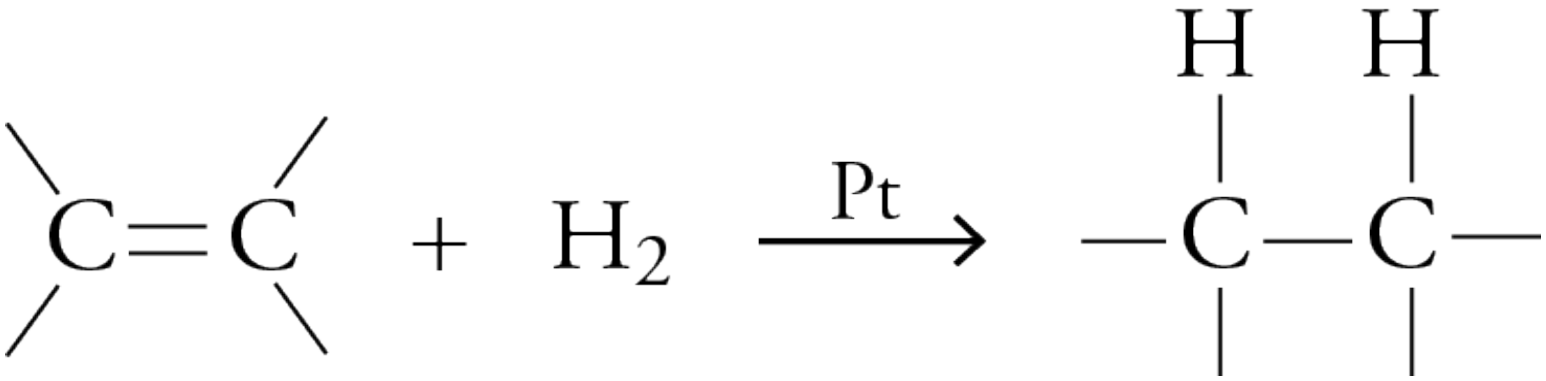


cis-1,2-difluoroethene

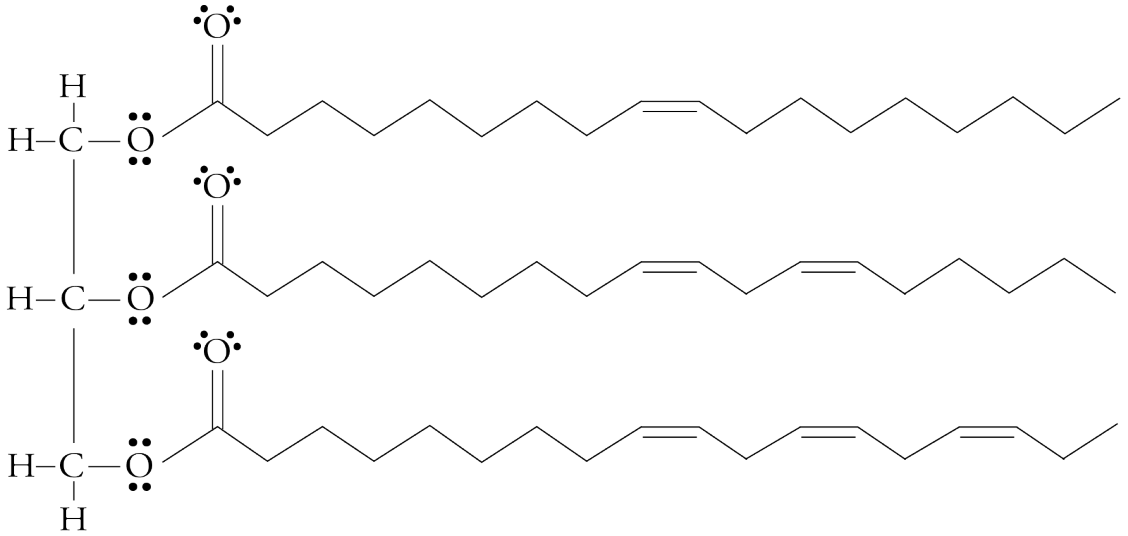


trans-1,2-difluoroethene

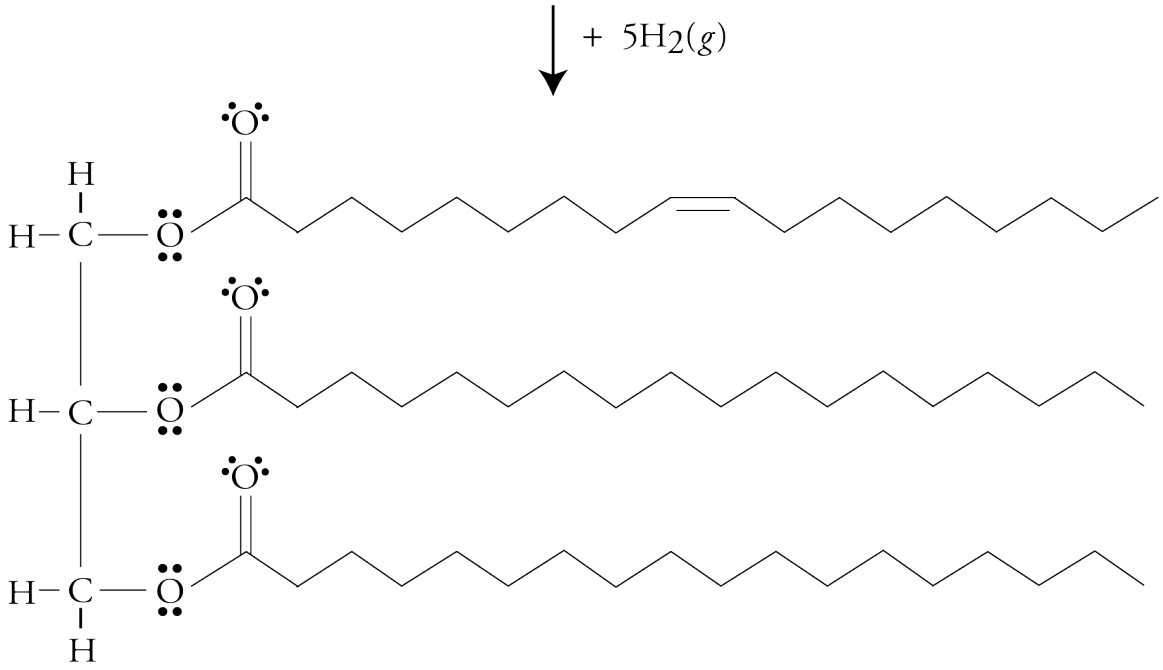
Hydrogenation



Hydrogenation - Example



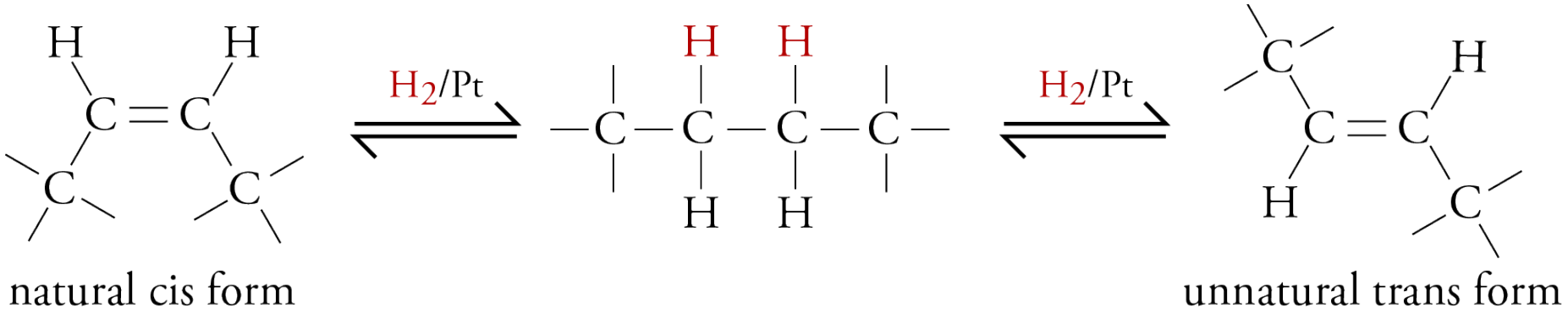
Typical vegetable oil molecule - liquid unsaturated triglyceride



Typical molecule in margarine - solid partially hydrogenated triglyceride

Trans Fats

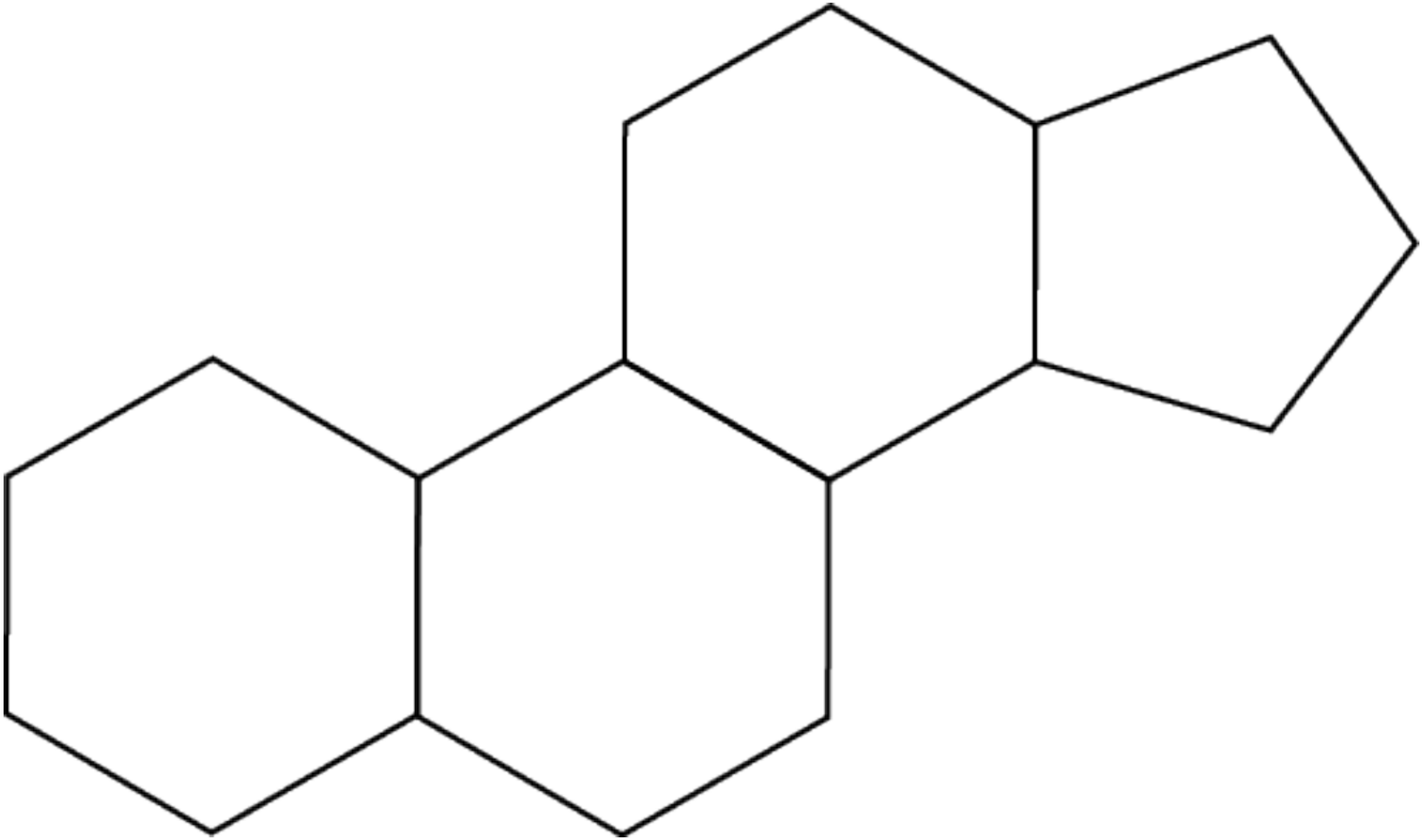
- Natural unsaturated triglycerides have the groups attached to the double-bonded carbon atoms in the cis arrangement.
- Hydrogenation is reversible.
- When the double bond is reformed, it is more likely to form the more stable trans form than the less stable cis form.
- Therefore, partially hydrogenated vegetable oils contain trans fats, which are considered to be damaging to your health.



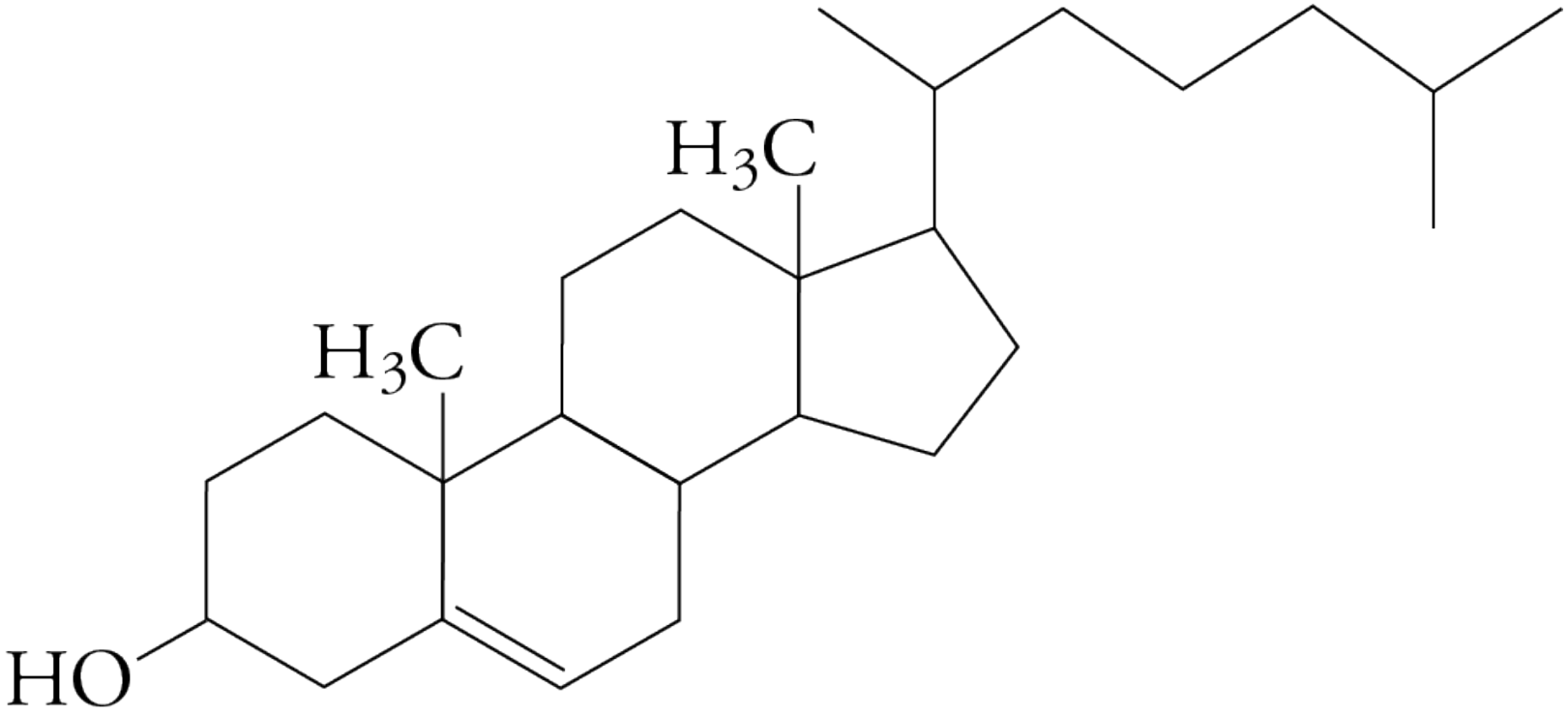
natural cis form

unnatural trans form

Steroid Skeleton



Cholesterol



cholesterol

Testosterone Formation