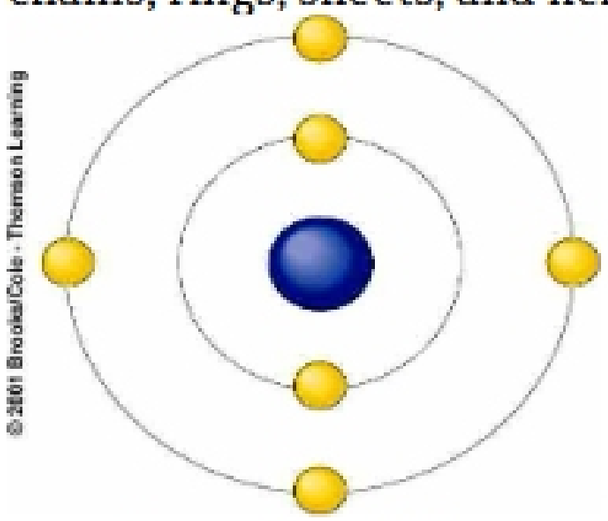
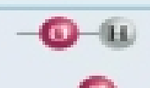
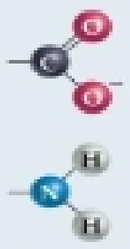
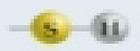
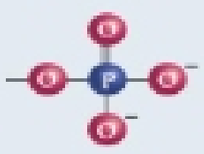
Chapter 3:

Why is carbon so important in biological molecules?

- Organic/inorganic molecules and functional groups
    - **Organic**: consisting of a carbon skeleton bonded to hydrogen atoms
    - **Inorganic**: carbon dioxide and all molecules without carbon
    - The carbon atom is very versatile
    - Has *4 electrons in outermost shell*
    - ***CAN hold up to 8 electrons in outer shell***
        - Therefore, a carbon atom can become stable by forming up to four covalent bonds with up to 4 atoms
        - So, organic molecules can assume complex shapes, including branched chains, rings, sheets, and helices
        - 

- **Function groups**: determine the characteristics and chemical reactivity of the molecules
    - Less stable than the carbon backbone and more likely to participate in chemical reactions
    -

Table 3-1 Important Functional Groups in Biological Molecules

Group	Structure	Properties	Found in
Hydroxyl		Polar; involved in dehydration and hydrolysis reactions	Sugars, starches, nucleic acids, alcohols, some acids, and steroids
Carbonyl		Polar; tends to make parts of molecules hydrophilic (water-soluble)	Sugars, some hormones, some vitamins
Carboxyl		Acidic; the negatively charged oxygen may bond H^+, forming carboxylic acid (—COOH); involved in peptide bonds	Amino acids, fatty acids
Amino		Basic; may bond an additional H^+, becoming positively charged; involved in peptide bonds	Amino acids, nucleic acids
Sulfhydryl		Forms disulfide bonds in proteins	Some amino acids; many proteins
Phosphate		Acidic; links nucleotides in nucleic acids; energy-carrier group in ATP (this ionized form occurs in cellular environments)	Nucleic acids, phospholipids

How are organic molecules synthesized?

- Small organic molecules (called **monomers**) are joined together to form longer molecules (called **polymers**)

- Monomers are joined together through **dehydration synthesis** (or **CONDENSATION RXN**), resulting in the *loss* of a water molecules from the reacting molecule

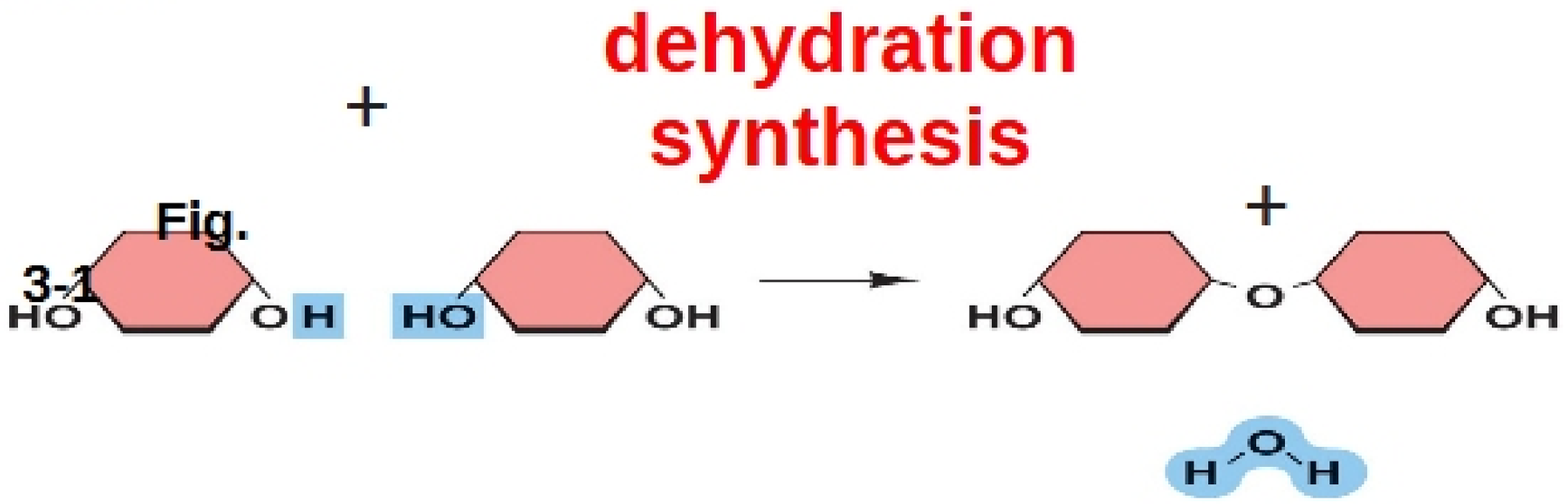


Fig. 3-1

- Polymers are broken apart through **hydrolysis** ("water cutting")
  - *Water is broken into H and OH* and is used to *break* the bond between monomers
  -

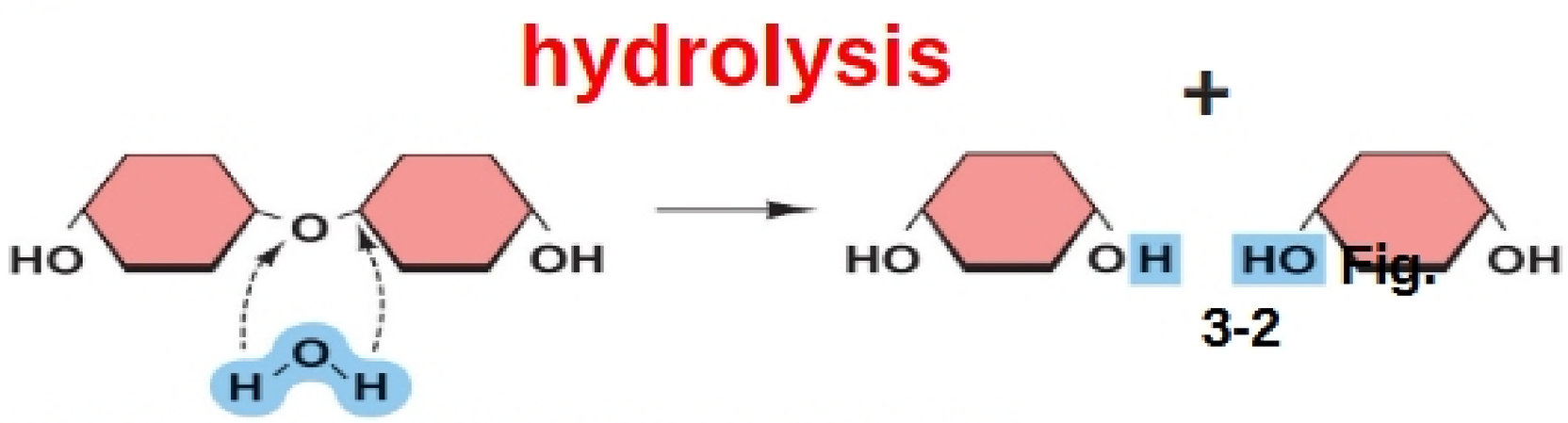


Fig. 3-2

- All biological molecules fall into one of four categories
  - Carbohydrates
  - Lipids
  - Proteins
  - Nucleotides/nucleic acids

What are carbohydrates?

- **Carbohydrate** molecules are composed of C. H. and O in ratio of 1:2:1
  - If a carbohydrate consists of just one sugar molecule, it is a **monosaccharide**
  - Two linked monosaccharides form a **disaccharide**
  - A polymer of many monosaccharides is a **polysaccharide**
  - Important energy sources for most organisms
  - Most small carbohydrates are water-soluble due to the polar OH functional group
- There are several monosaccharides with slightly different structures
  - Example: monosaccharides
    - *Glucose ($C_6H_{12}O_6$): the most common in living organisms*
      - Sugar dissolving in water
    - Fructose: "fruit sugar" found in fruits, corn syrup, and honey
    - Galactose: "milk sugar" found in lactose
    - Ribose and deoxyribose (found in RNA and DNA)

- Disaccharides consist of two monosaccharides linked by dehydration synthesis
  - *Disaccharides are two-part sugars*
    - They are *used for short-term energy storage*
    - When energy is required, they are broken apart into their monosaccharide subunits by hydrolysis
  - Examples of disaccharides:
    - **Sucrose** (table sugar)**:** *glucose +fructose*
    - **Lactose** (milk sugar): *glucose + Galactose*
    - **Maltose** (malt sugar): *glucose + glucose*
- Polysaccharides are chains of simple sugars
  - **Starch:** an energy-storage molecule in plants, formed in roots and seeds
  - **Glycogen**: an energy-storage molecule in animals, found in liver & muscles
  - Both are polymers of glucose molecules

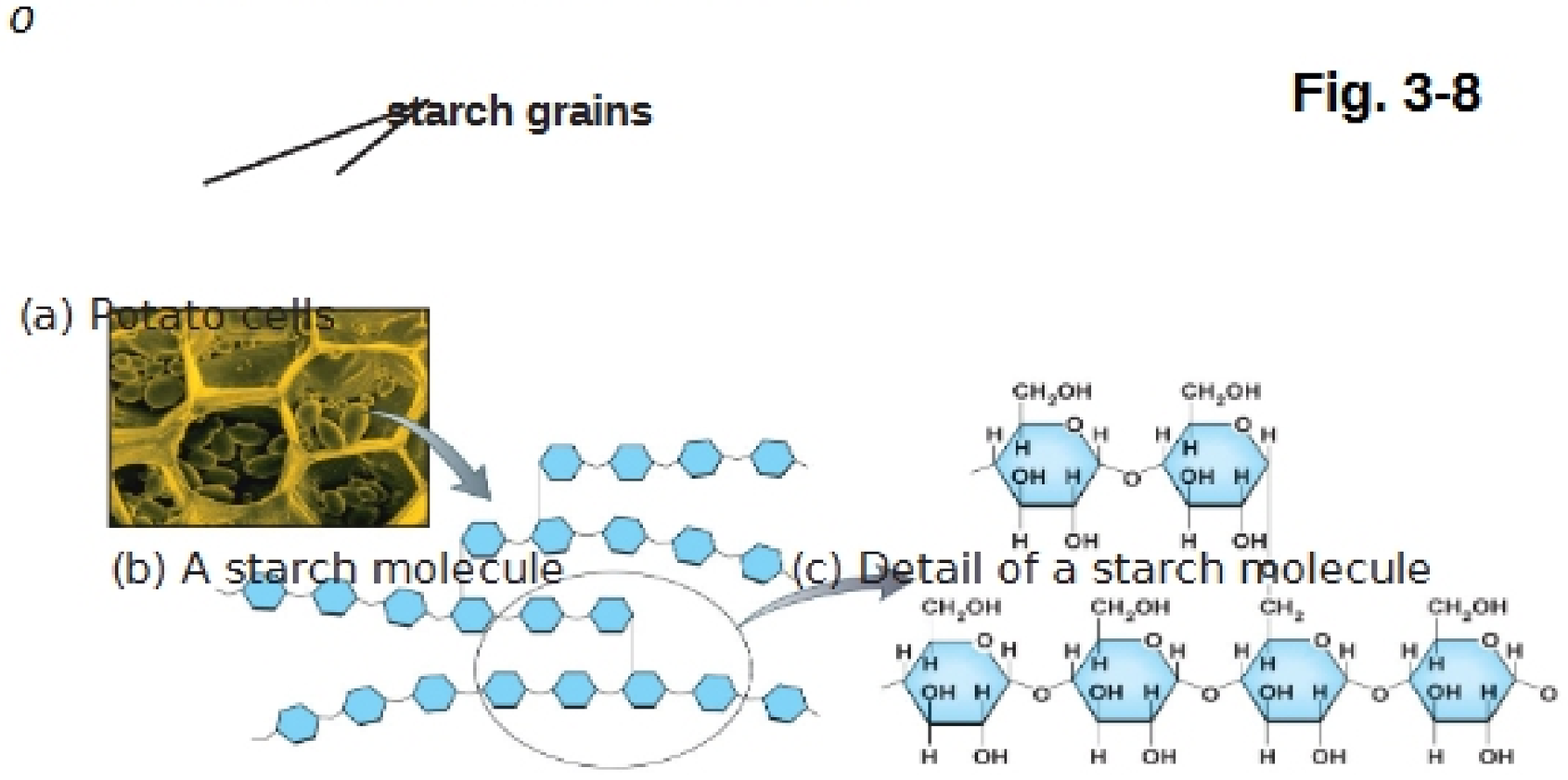


Fig. 3-8

  - Many organisms use polysaccharides as a structural material
  - **Cellulose** (a polymer of glucose) is one of the most important structural polysaccharides
    - Found in cell walls of plants
    - Indigestible for most animals
    - *Chemical formula for starch and cellulose is the same but they are very different*
    - Starch (easily digested) vs. cellulose (indigestible for most animals)