

# Basic Biology Concepts

# Basic biology concepts

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- Chemical composition of life
- Cell, cell contents, and cellular functions
- Energy and metabolism
- Application of biology for environmental engineering

# Chemical composition of life

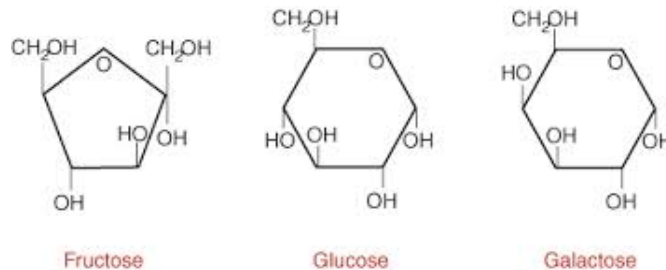
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- Major elements: C, H, O, N, S, P
- Major classes of [macro]molecules:
  - carbohydrates
  - nucleic acids
  - protein
  - lipids

# Carbohydrates

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- Energy source, building materials for cells
- Monomers, dimers, polymers
  - Monosaccharides: building blocks

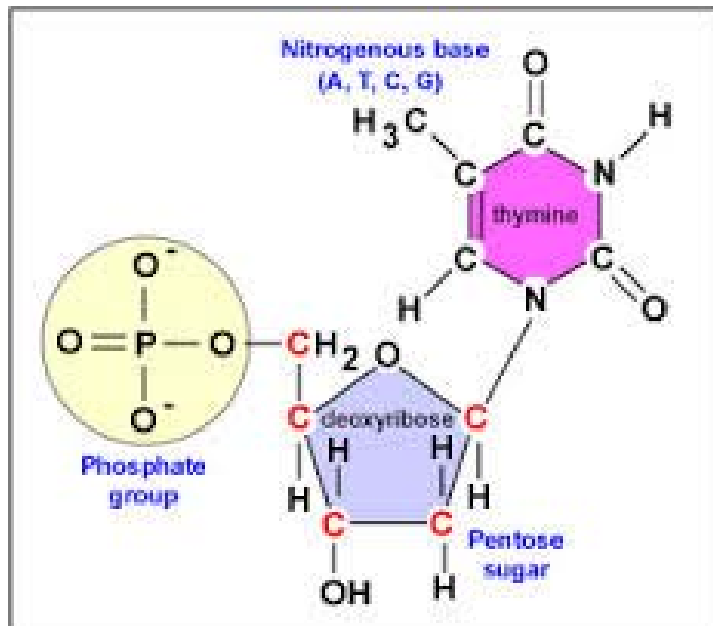


- Disaccharides: sucrose, lactose, maltose
- Polysaccharides: 100s – 1000s of monosaccharides

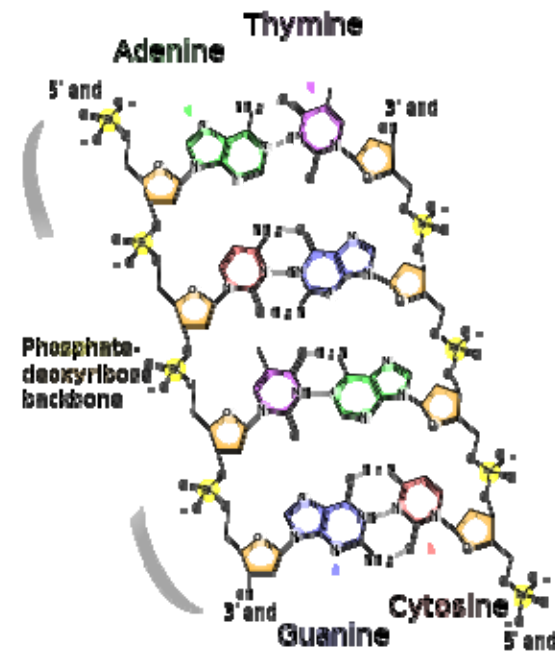
# Nucleic acids

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- Store and transmit hereditary information
- Monomers: nucleotides / polymers: DNA & RNA



Nucleotide for DNA



Structure of a DNA

# DNA vs. RNA

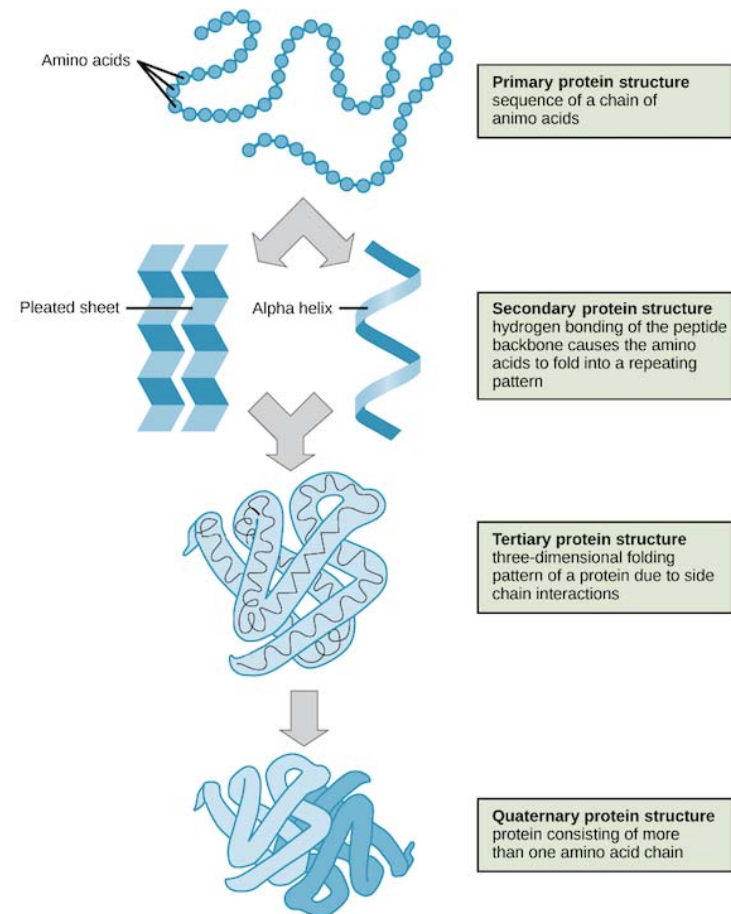
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	<b>DNA (deoxyribonucleic acid)</b>	<b>RNA (ribonucleic acid)</b>
Sugar	deoxyribose	ribose
Strand	double-stranded	single-stranded
Base	adenine (A), thymine (T), guanine (G), cytosine (C)	adenine (A), uracil (U), guanine (G), cytosine (C)
Function	long-term storage of genetic information; transfer genetic information to other cells and new organisms	transfer the genetic code from the DNA to ribosomes to make proteins

# Proteins

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- Affect almost all cellular functions (enzymes, immunoglobulins, hemoglobins, etc.)
- Structural support of organisms
- Monomers: amino acids (20) / polymers: polypeptides



<http://khanacademy.org>

# Lipids

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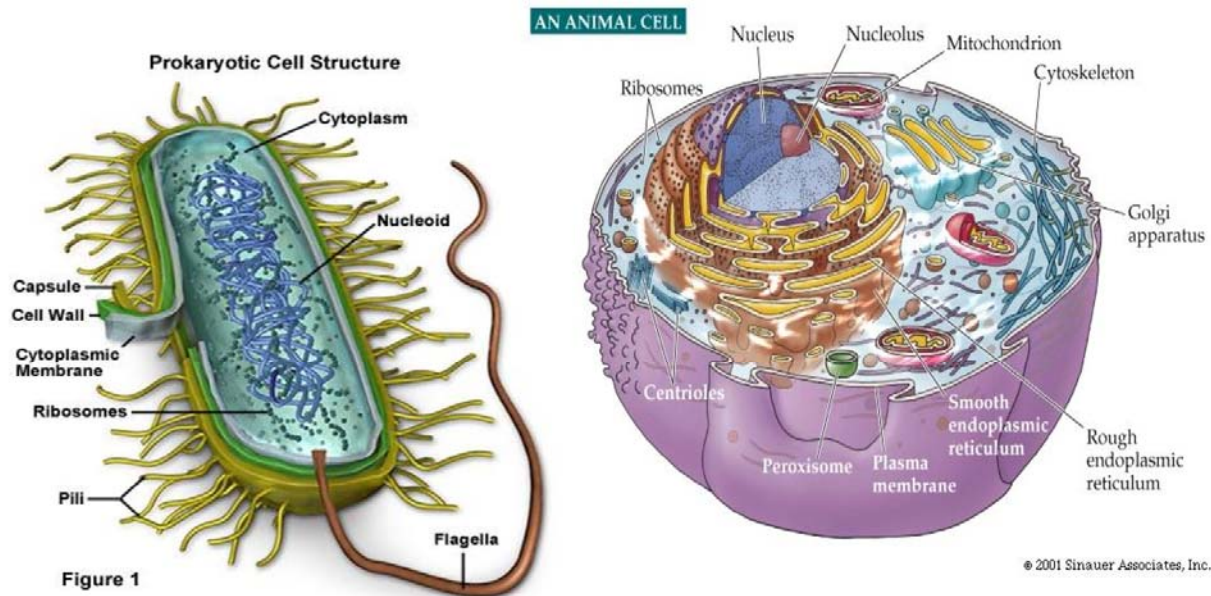
- Not polymeric (no monomers, dimers, polymers)
- Various structures
- Common characteristic: hydrophobic (repulsion of water)
- Fats, phospholipids, and steroids
  - fats: store energy
  - phospholipids: major component of cell membranes
  - steroids: signaling (ex: steroid hormones)



# The cells

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- Prokaryotes vs. Eukaryotes: absence/presence of a nucleus



*Davis & Masten (2014)*

# Composition of a cell

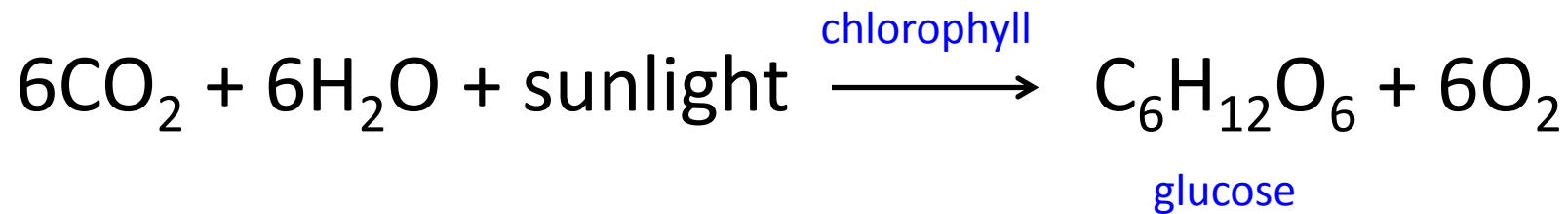
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- Cell membrane
  - separates the interior of the cells from outside
  - exhibit selective permeability to control material movement in & out of a cell
- Nucleus: contains chromosomes (eukaryotic cells)
- Ribosomes: synthesize proteins
- Mitochondria: produce ATP
- Cell wall: give rigidity to a cell (prokaryotes/plant cells)

# Energy and metabolism

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- Photosynthesis: convert energy from sunlight into chemical energy



# Energy and metabolism

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- Metabolism: life-sustaining chemical transformations within cells of living organisms
  - catabolism: process to break down molecules into smaller units to generate energy (ATP)
  - anabolism: process to construct macromolecules from smaller molecules (consumes ATP)

# Biology for environmental engineering

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- Water quality (rivers, lakes, oceans..)
  - self-purification of natural water environments: contaminants are degraded by microorganisms
  - oxygen depletion: if excessive amount of organic contaminants are present, microorganisms consume most of dissolved oxygen in water → fish kills!
  - algae problems (algal bloom – excessive algal growth)

# Biology for environmental engineering

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- Wastewater treatment
  - biological wastewater treatment: use abilities of microorganisms to degrade/transform organic substances
  - main player: bacteria



# Biology for environmental engineering

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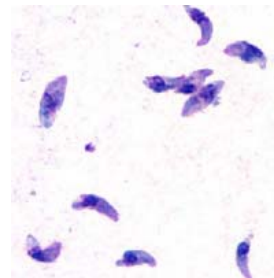
- Drinking water treatment
  - prevent waterborne diseases
  - types of disease-causing organisms: bacteria, protozoa, viruses, helminth
  - removal process: filtration & disinfection



Norovirus



*Vibrio cholerae*



*Toxoplasma gondii*



# Biology for environmental engineering

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- Detoxification of hazardous chemicals
  - use microorganisms (mostly bacteria) to detoxify hazardous chemicals in soils, sediments, and groundwater
  - ability to deal with newly generated chemicals



# Reading assignment

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- Textbook 89-117, 133-136