

## Chapter 2

# The Cell: the Basic Unit of Life



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Cells

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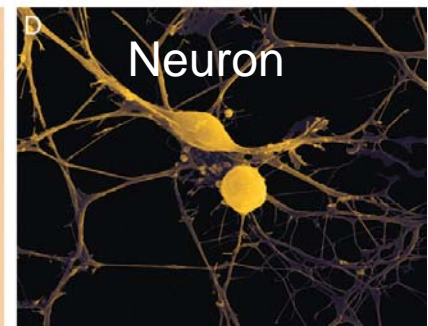
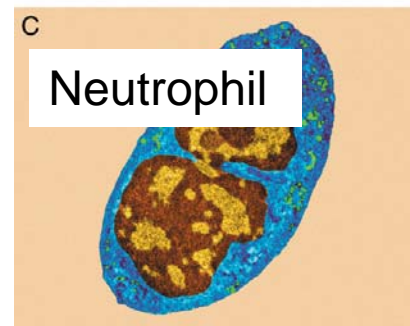
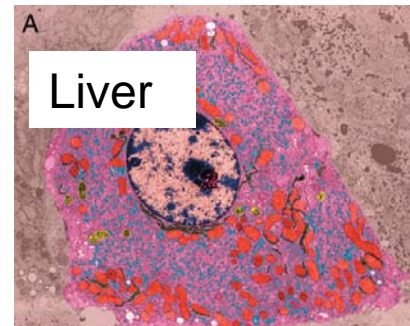
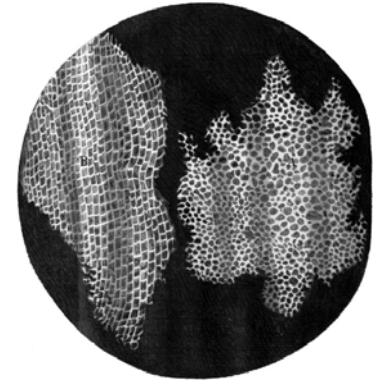
Cell Organization

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Two Fundamental Cell  
Types

# Cells

- Basic unit of living organism
- First named by Robert Hook in the 17<sup>th</sup> century
- Different types but the same essential properties
- Same building blocks: proteins, carbohydrates, fats, and nucleic acids

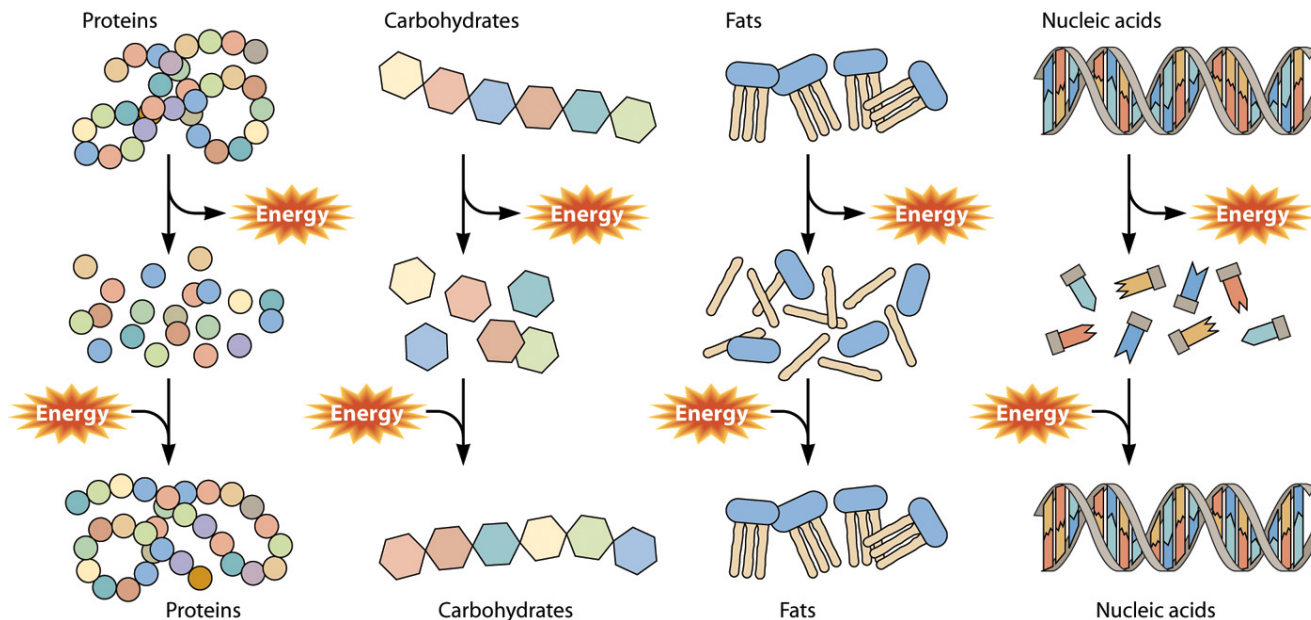


# Essential Functions of Living Cells 1

## ■ Growth

### ■ Metabolism

- Catabolism: breaking down large molecules to generate building blocks and energy
- Anabolism: Generation of large molecules using building blocks and energy

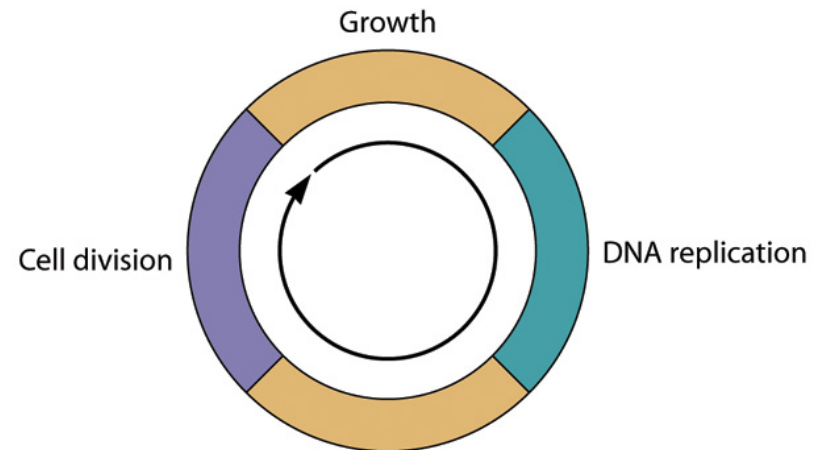
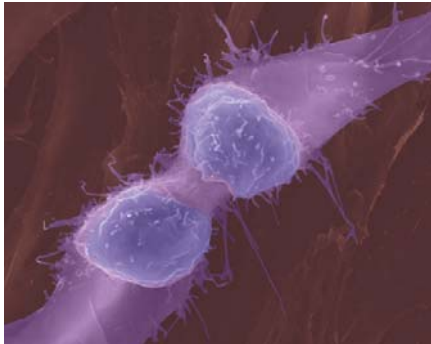


# Essential Functions of Living Cells 2

## ■ Reproduction

### ■ Cell cycle

- Cyclical process of cell growth and division
- Daughter cell must receive a correct copy of genetic material  
→ DNA replication before cell division



Cell cycle

# Essential Functions of Living Cells 3

- Maintenance of internal environments
  - Use energy to maintain the internal environments
    - Unique molecules
      - Specific proteins, DNA etc.
    - Molecules also exit outside but with different concentrations
      - Water, salts, sugar etc.



Amoeba

# Essential Functions of Living Cells 4

- Response to external environments
  - Sense a change in their environment
  - Respond
    - Maintaining osmotic homeostasis
    - Bacterial chemotaxis
    - Release of digestive enzymes from stomach cells



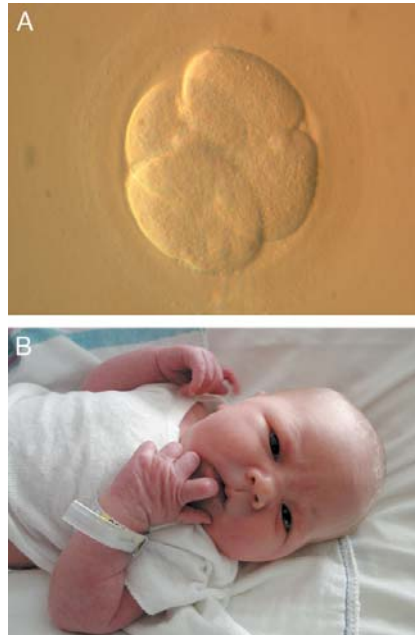
# Essential Functions of Living Cells 5

- Communication with each other
  - Between cells in an organism
    - e.g. Nerve cell and muscle
  - Between single cell organisms
    - e.g. Mating of yeast cells, quorum sensing of bacteria



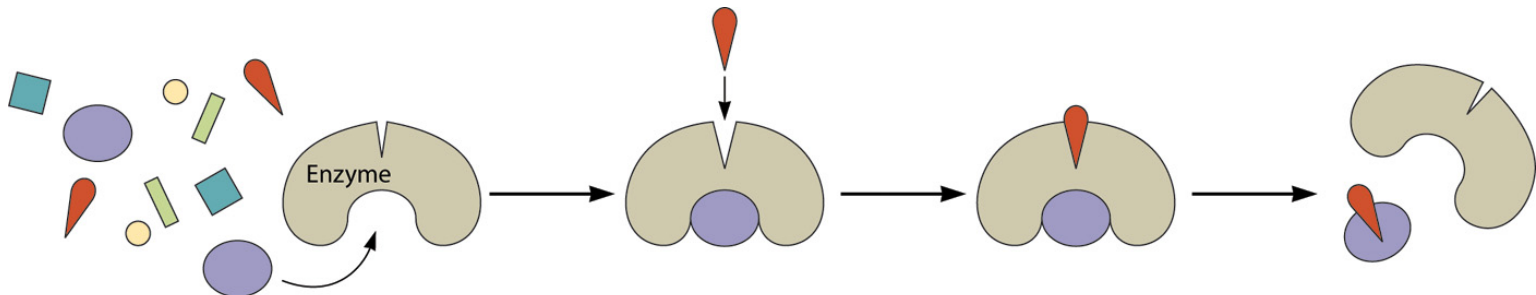
# Essential Functions of Living Cells 6

- Differentiation in multicellular organisms
  - Cells differentiate to cells with specific functions
  - Specific cells organize into different tissues and organs



# Common Cellular Processes

- Constant supply of energy
  - Need energy for all the cellular activities
  - Energy source
    - Sun: photosynthetic plant or bacteria
    - Food and Chemicals
- Chemical reactions
  - Enzymes: protein catalyst accelerating chemical reactions

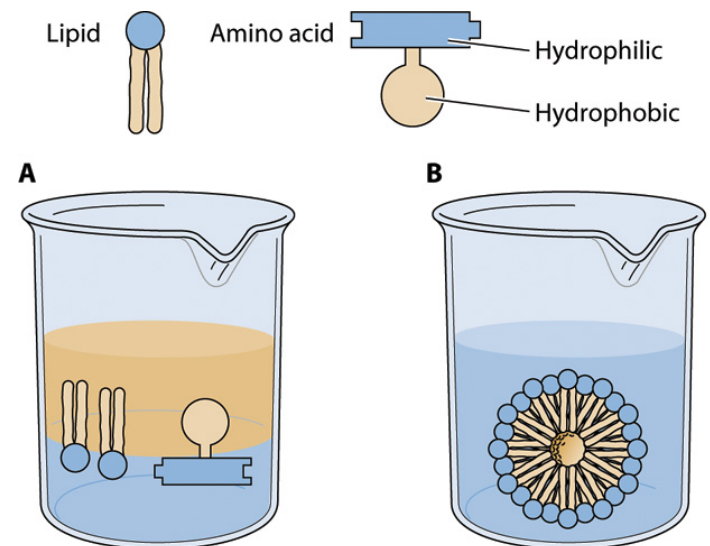


# Common Cellular Processes

- Cell processes occur in a series of small steps
  - Pathway: a process consisting of a series of steps
- Regulation of processes
  - Regulation of various processes by regulation of protein-protein and protein-DNA interactions
  - Cell cycle, blood sugar levels, blood pressure, body water balance etc.

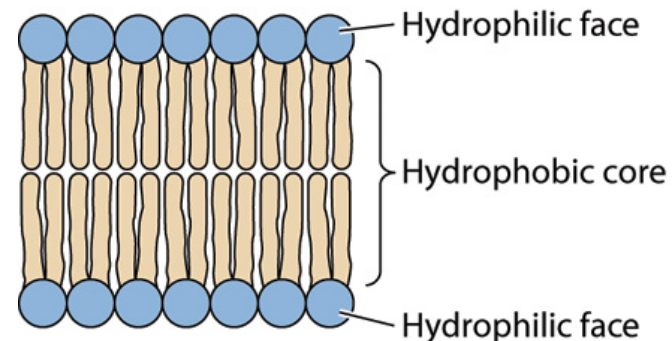
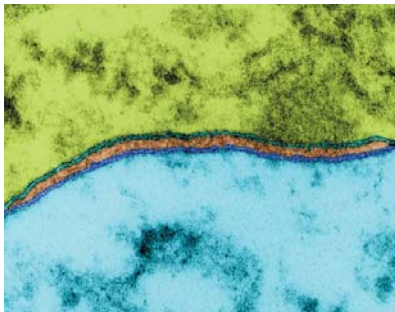
# Cell Organization

- Interaction of molecules with water
  - Important factor for determining the molecular organization within a cell
  - Hydrophilic (water soluble) or Hydrophobic (water insoluble)
    - Congregation of hydrophilic parts with other hydrophilic parts
    - Congregation of hydrophobic parts with other hydrophobic parts
- Binding of molecules
  - Specificity of molecular bindings determines cellular processes
  - Binding: fitting between molecules
    - Depends on shape and chemical properties (charge)



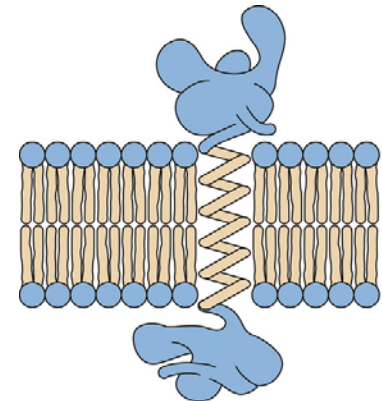
# Cellular Membranes I

- Provide structural organization
  - Lipid bilayer with hydrophobic core and hydrophilic face
  - Plasma (cell) membrane: Hydrophobic barrier between inside (cytoplasm) and outside of the cell
  - Internal membranes
    - Nucleus
    - Endoplasmic reticulum, Golgi apparatus
    - Mitochondria
    - Chloroplast



# Cellular Membranes II

- Control molecular transport across the membrane
  - Free diffusion
    - Small, electrically neutral or slightly charged molecules ( $\text{CO}_2$ ,  $\text{O}_2$ , water)
  - Transport through membrane-bound channels and transporters



# Two Fundamental Cell Types

## ■ Prokaryotic cells

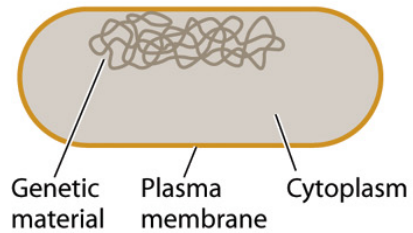
- Prokaryote (pro; before, karyon: kernel or nucleus)
- No nuclear membrane
- Small (0.2-2  $\mu\text{m}$ ), mostly single-celled organisms
  - Eubacteria : common bacteria, e.g. *E.coli*, blue-green algae
  - Archaea (Archaeobacteria)

## ■ Eukaryotic cells

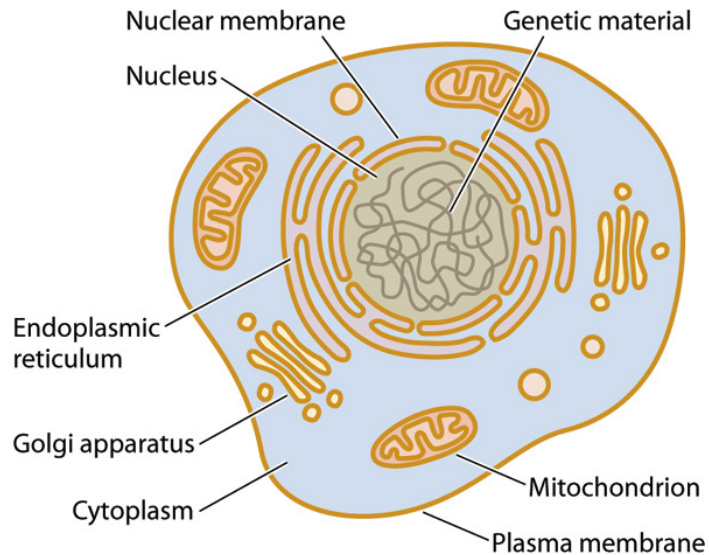
- Eukaryote (well-formed nucleus)
- Nuclear and internal membranes  $\rightarrow$  organelles
- Larger than prokaryotes (10-100  $\mu\text{m}$ )
  - Single-celled: yeast, green algae, amoebae
  - Multicellular: fungi, plant, animal

# Two Fundamental Cell Types

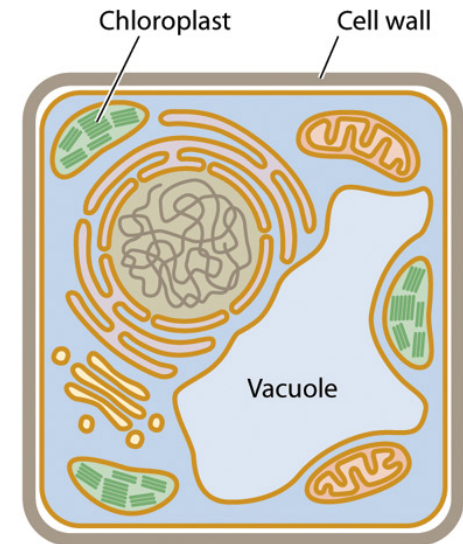
**A. Prokaryotic cell**



**B. Eukaryotic animal cell**



**C. Eukaryotic plant cell**





# Viruses

- No independent reproduction
  - Genetic material (DNA or RNA)
  - Proteins (Capsid)
- Host specificity
  - Bacteria (bacteriophages), human etc
- Tissue specificity

