Chapter 2
Cells and Cell Division
Cells

• The basic functional units of all living things

• Human cells vary widely but all have similar basic structure
Cells vary widely in morphology
Prokaryotes/Eukaryotes

- Prokaryotes - bacteria - No nucleus
- Eukaryotes - contain nucleus
Cell architecture

Fig. 2.1
Human Cell Components

• Plasma membrane
• Cytoplasm
• Membrane-bound nucleus
• Organelles
Plasma Membrane

- Double-layered
- Dynamic and active
- Selectively permeable
- Regulates the exchange of materials
- Contains molecules important in identity
Plasma Membrane

Fig. 2.2
Plasma Membrane Molecules

- Molecules in and on plasma membrane give cell molecular identity
- Number and type of molecules genetically controlled
- Have many functions including transport, receptors, blood type, and compatibility of organ transplants

- **Cystic fibrosis** is a genetic disorder associated with a change in a protein that makes up the chlorine channel of the cell membrane (CFTR)
Cystic Fibrosis affects a membrane channel

http://www.humanillnesses.com/original/images/hdc_0001_0001_0_img0072.jpg

http://prometheus.mse.uiuc.edu/research/cysticFibrosis/CFTRdiagramLarge.gif
Endoplasmic Reticulum

- Form channels in the cytoplasm
- Network of membranes
- Protein folding, processing, and preparation for transport
- Rough ER
  - Contains ribosomes and site of protein synthesis
Endoplasmic Reticulum

Fig. 2.3
Golgi Apparatus

- Clusters of flattened membranes
- Sort, modify, and package proteins in the cell
- Golgi produce lysosomes
  - Contain hydrolytic enzymes

Fig. 2.4
Genetic Diseases that Affect Lysosomal Function

- Gaucher disease
  - Lack enzyme to break down membranes
  - Treated with recombinant DNA enzyme

- Tay-Sachs - mutation in hexosaminidase A

- Pompe disease
Mitochondria

- Site of cellular respiration and ATP production
- Contain their own DNA
- Mutations of mitochondrial DNA cause a number of genetic disorders

Fig. 2.5
Mitochondrial Eve
Nucleus

- Largest organelle
- Enclosed by a double-layered membrane
- Pores allow communication between nucleus and cytoplasm
- Contain
  - Nucleoli that synthesize ribosomes
  - Chromosomes
Nucleus

Fig. 2.6a
Human Chromosomes

- DNA and associated proteins are organized into chromosomes

- Humans have 22 pairs of **autosomes** and XX or XY
  - Females XX
  - Males XY

**sex chromosomes**
Mitosis Functions in Growth and Cell Replacement

- Cells from adults can divide only about 10–30 times

- Cell division is tightly controlled; Blood cells and neurons

- Disorders of altered cell cycle control: cancer
The Cell Cycle

Mitosis

- Produces **identical** daughter cells
- It must be accurate for cells to function properly
- Continuous process but divided into
  - Prophase
  - Metaphase
  - Anaphase
  - Telophase
Interphase

- **Gap 1** – many cytoplasmic organelles are constructed; cell almost doubles in size

- **Synthesis** – DNA chromosomes replicate and form 2 sister chromatids attached at the centromere

- **Gap 2** – more cell growth

Fig. 2.8a
One chromosome (unreplicated)

One chromosome (replicated)

A chromatid

Its sister chromatid

Centromere

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Prophase

- Chromosomes coil
- Nuclear membrane breaks down
- Spindle fibers form

Fig. 2.8b
Prophase into Metaphase

Late Prophase

Prometaphase

Fig. 2.8c

Fig. 2.8d
Metaphase

- Chromosomes line up on the midline
- Spindle fibers attach to centromeres
Anaphase

• Centromeres divide
• Spindle fibers shorten
• Sister chromatids separate and move to opposite poles

Fig 2.8f
Telophase

- Cell elongates
- Nuclear membrane reforms
- Chromosomes uncoil
- Spindle disappears

Fig. 2.8g
Cytokinesis

- Division of the cytoplasm
- Cleave furrow forms at equator of the cell
- Constriction tightens by contraction of filaments
- Cell is divided into two identical cells

Fig. 2.11
Cytokinesis in frog egg

Credit: © Dr. David Phillips/Visuals Unlimited

Two **Identical** Daughter Cells

Interphase

Fig. 2.8h
Guess the stage
Mitosis