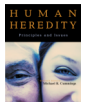
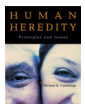
Chapter 2
Cells and Cell Division



Cells

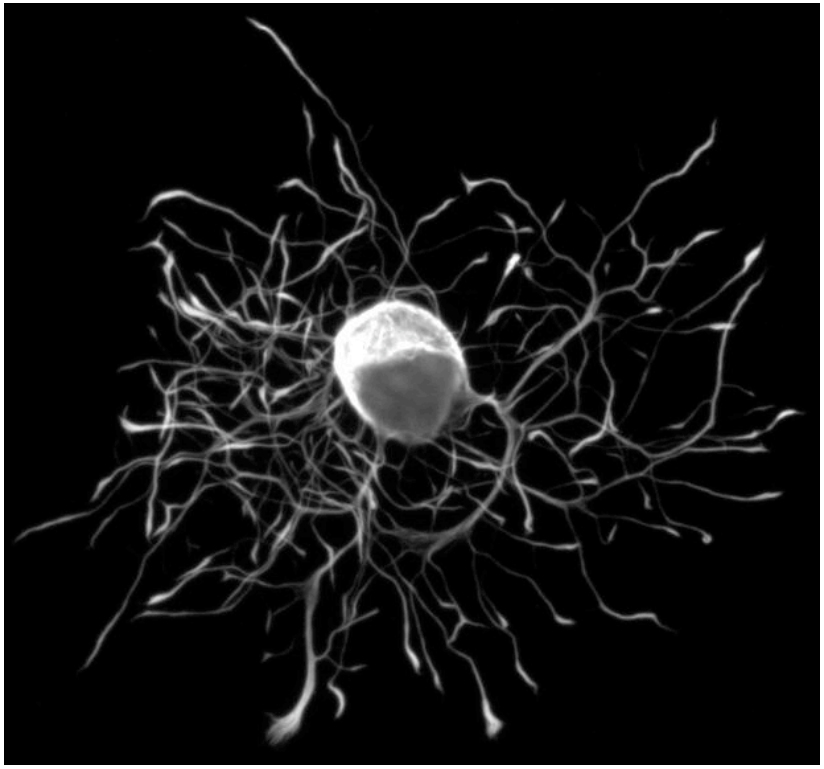
- The basic functional units of all living things

- Human cells vary widely but all have similar basic structure



Cells vary widely in morphology

Neuron



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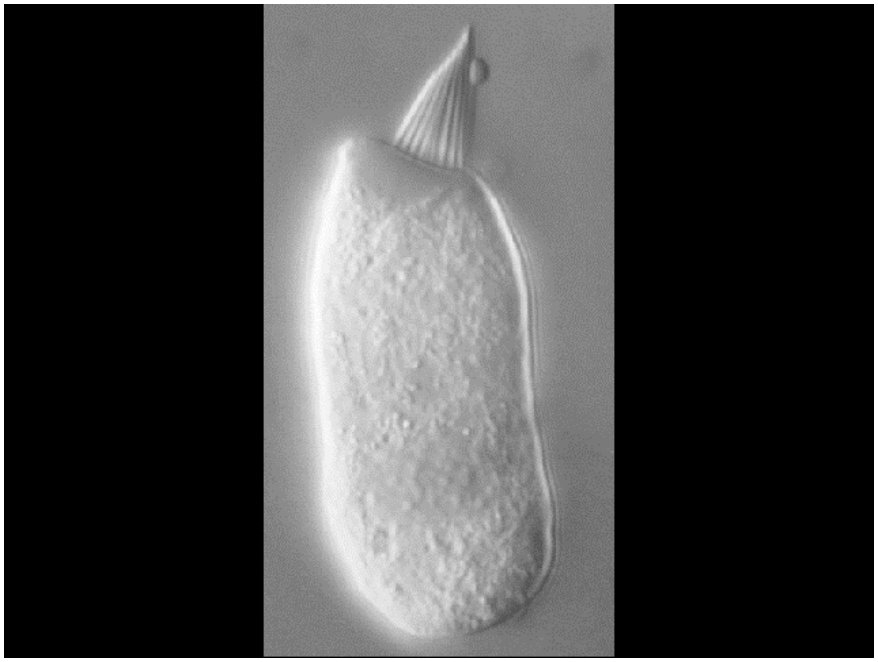
Hair cell



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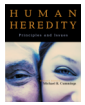
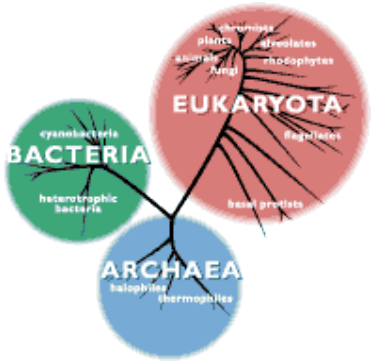


Prokaryotes/Eukaryotes

- Prokaryotes - bacteria - No nucleus

- Eukaryotes - contain nucleus



Cell architecture

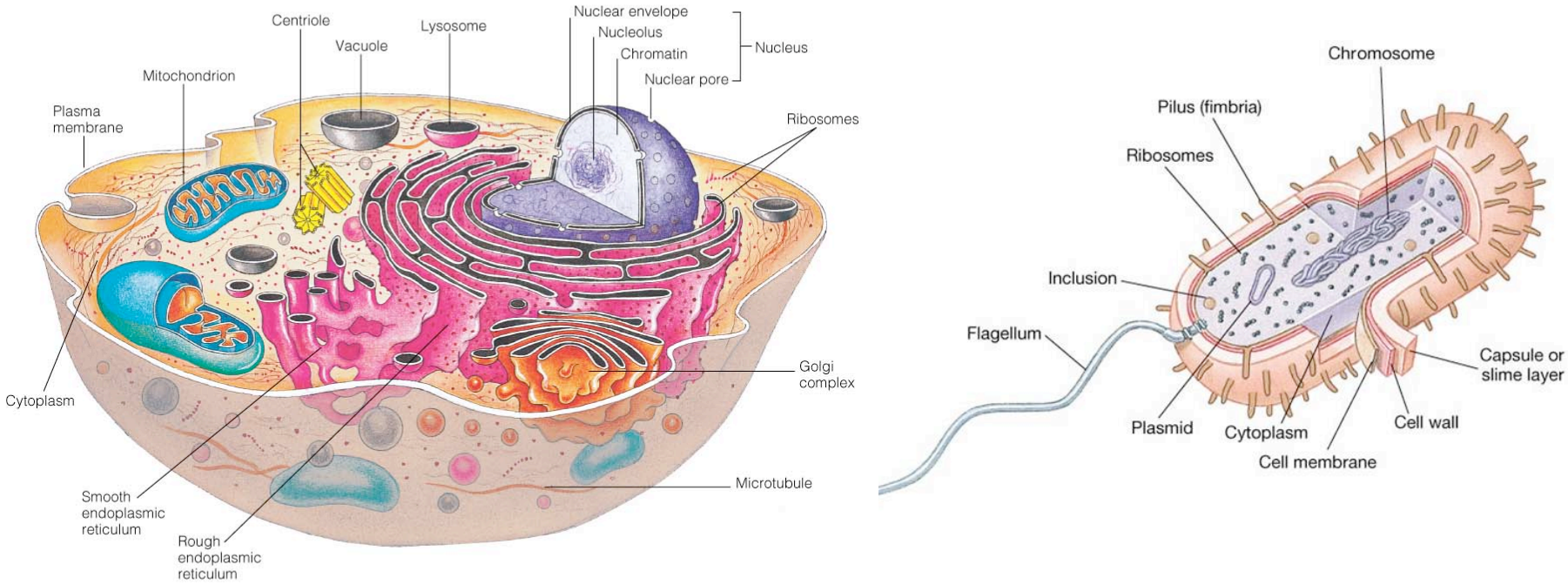
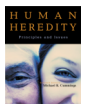


Fig. 2.1

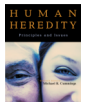
Human Cell Components

- 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

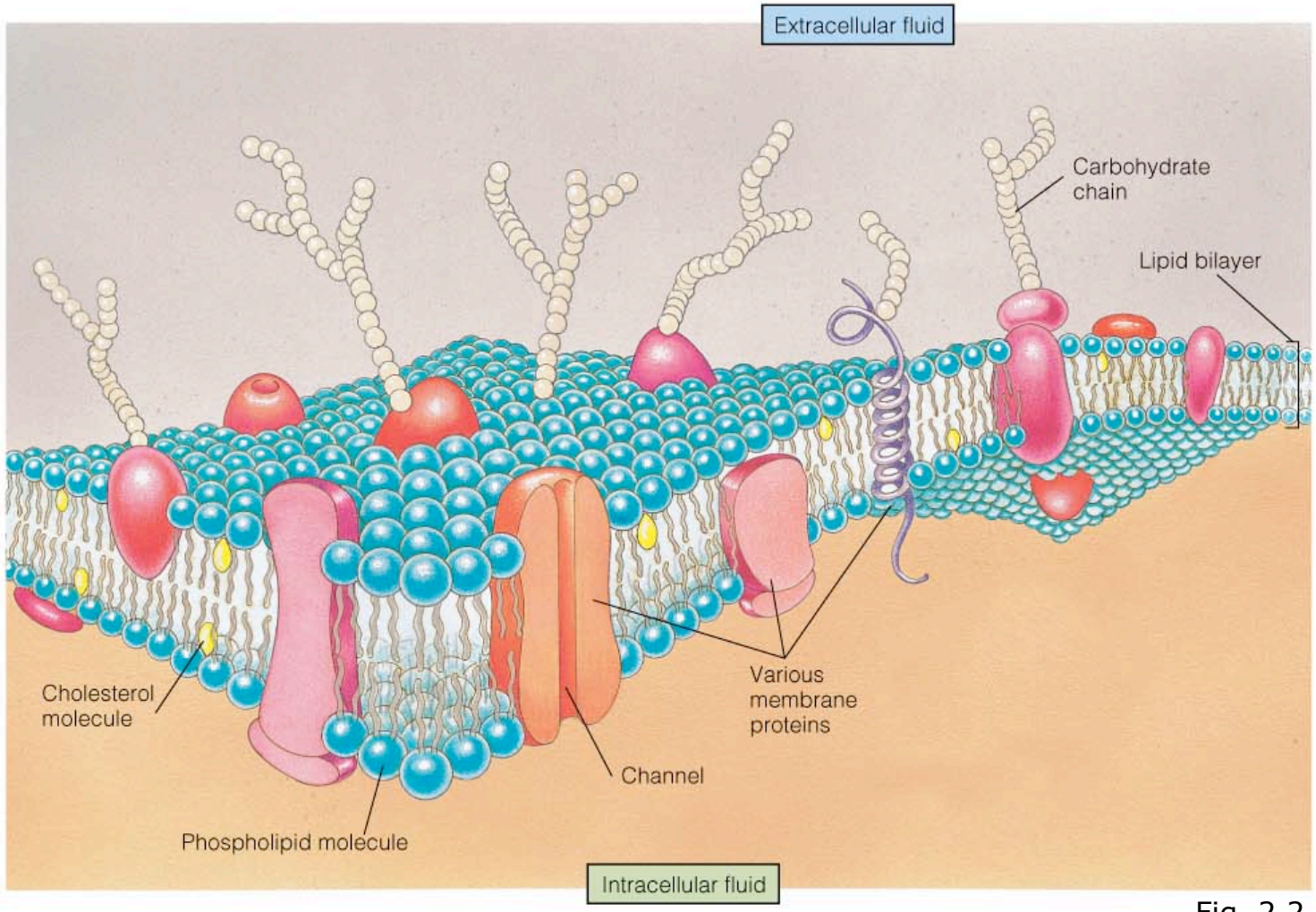
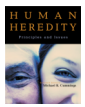


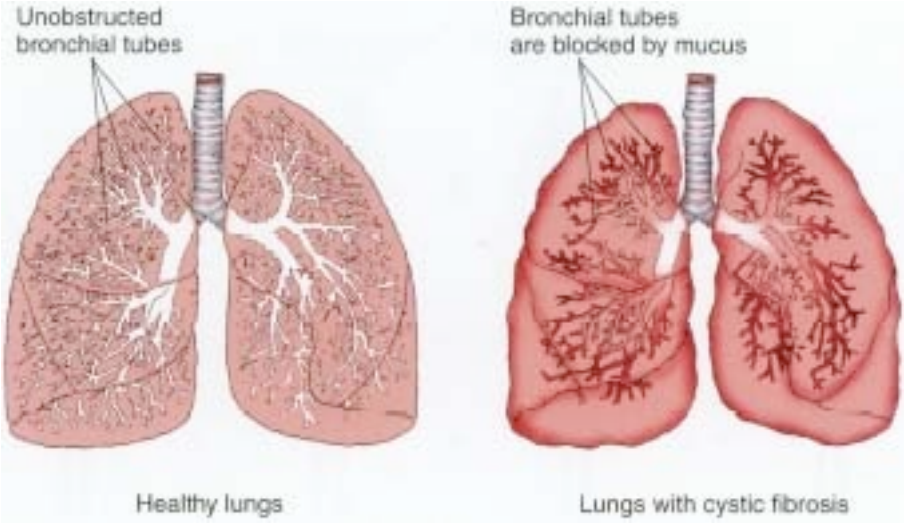
Fig. 2.2

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)

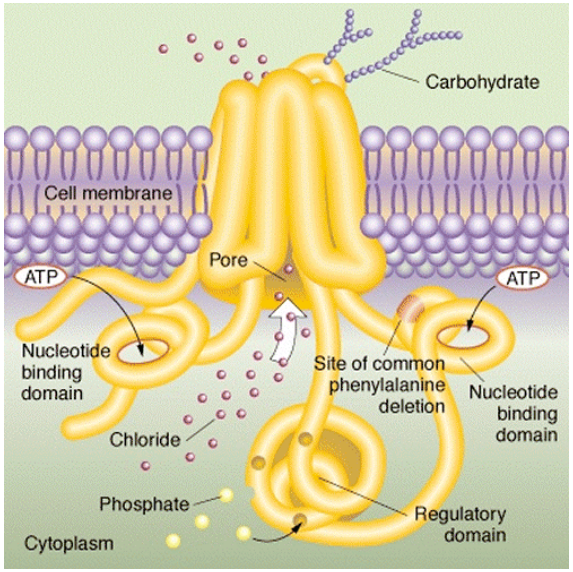


Cystic Fibrosis affects a membrane channel

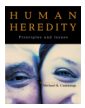


http://www.humanillnesses.com/original/images/hdc_0001_0001_0_img0072.jpg

CFTR

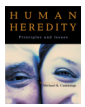


http://prometheus.mse.uiuc.edu/research/cysticFibrosis/CFTRdiagramLarge.gif



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

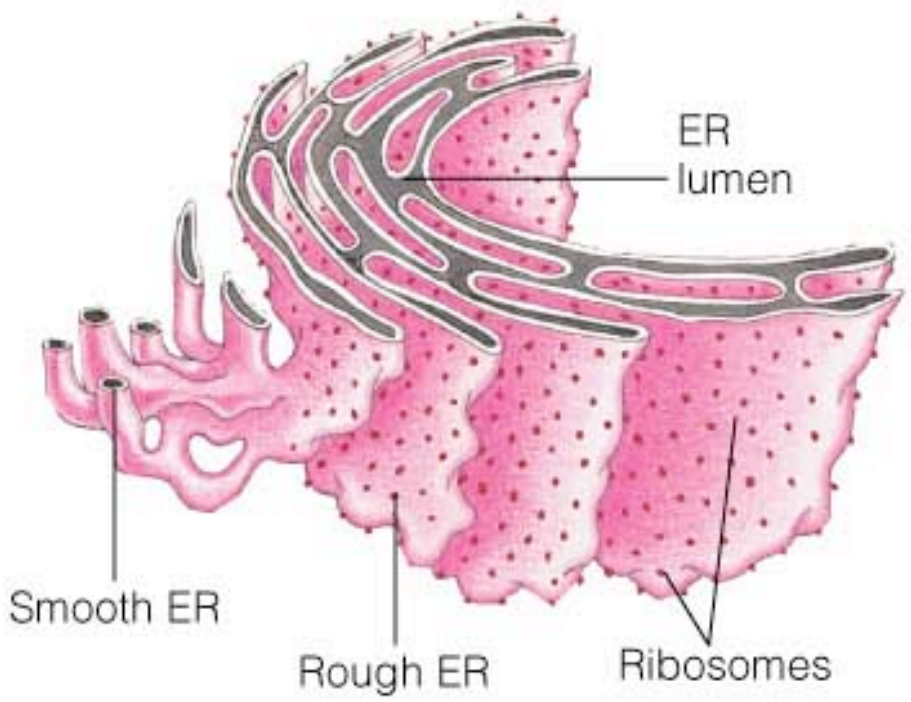


Fig. 2.3

Golgi Apparatus

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

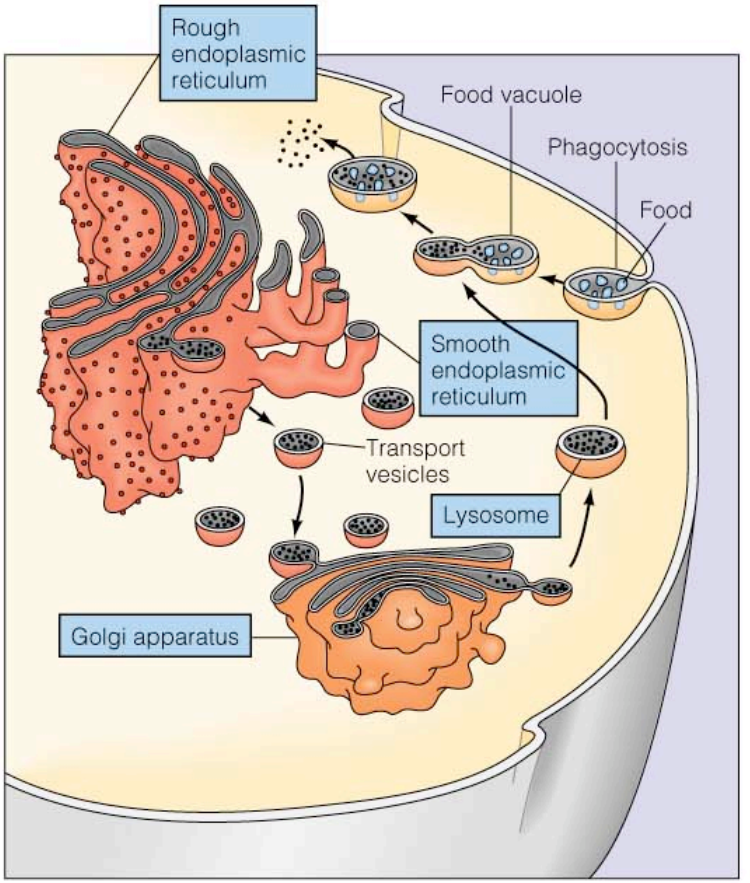
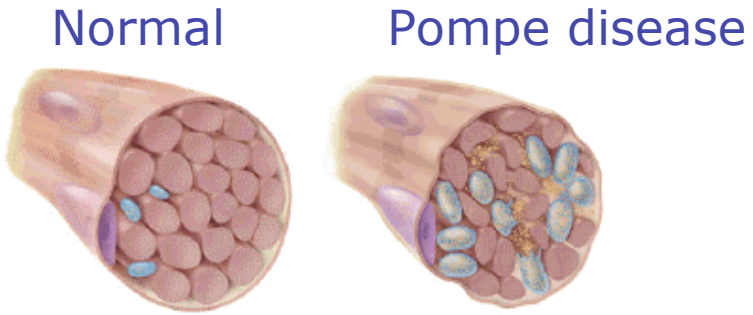
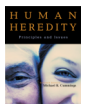


Fig. 2.4

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

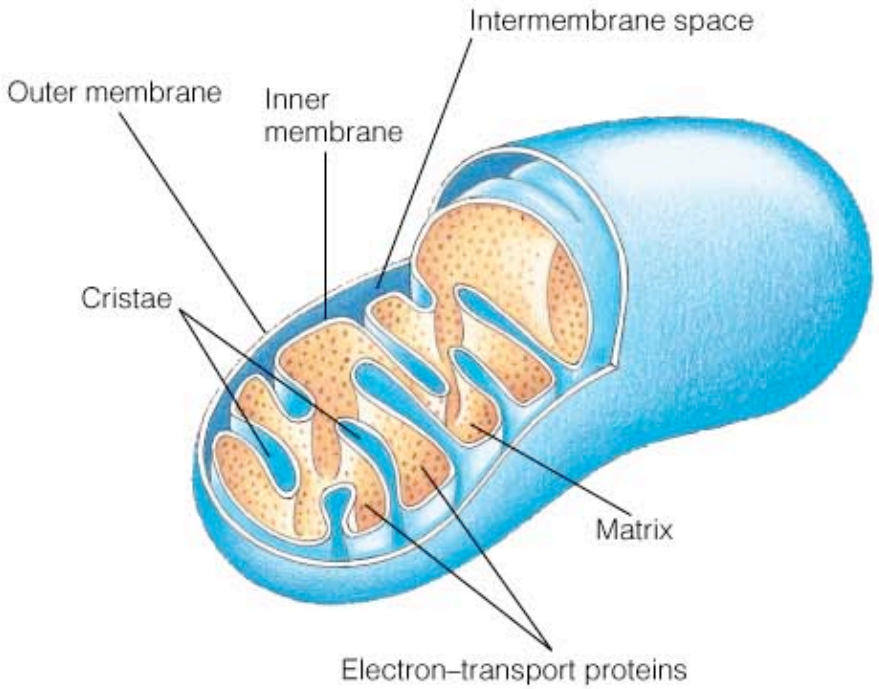
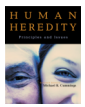
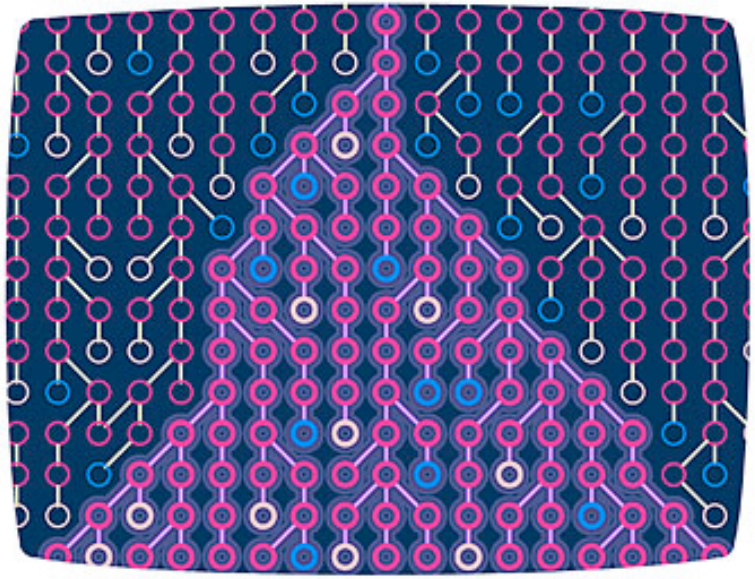
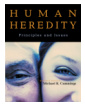


Fig. 2.5



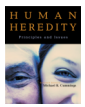
Mitochondrial Eve





Nucleus

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



Nucleus

nucleolus

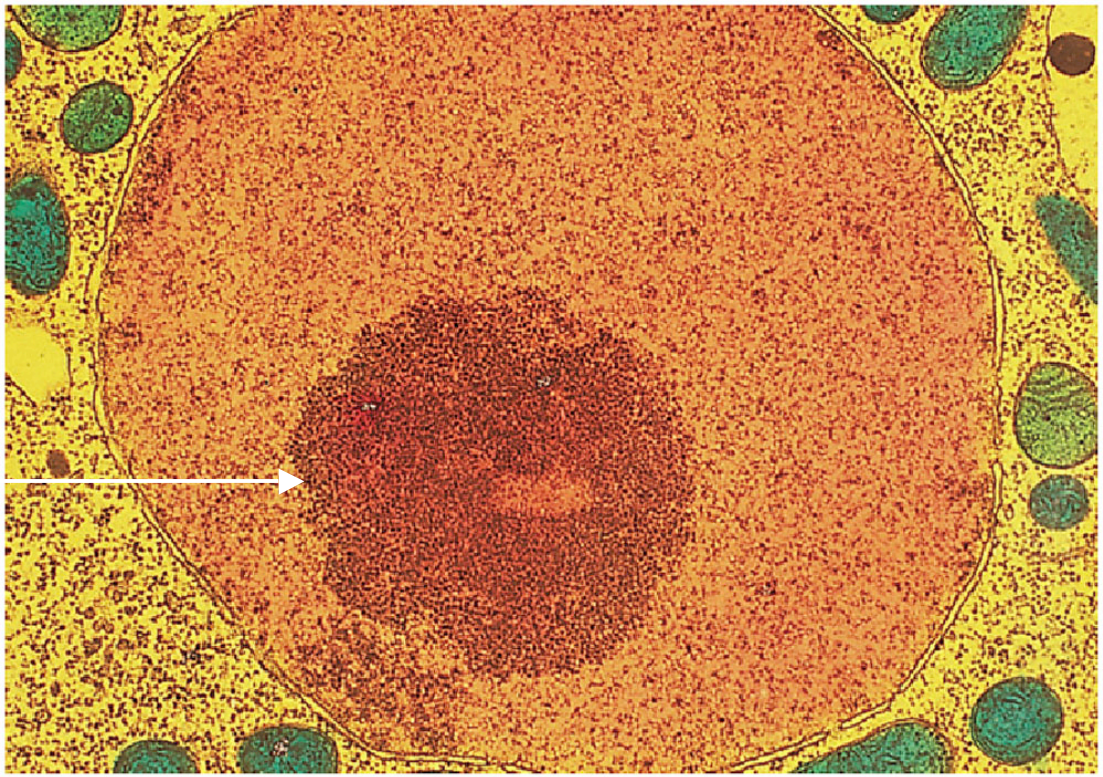
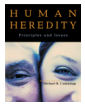


Fig. 2.6a

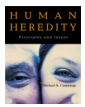


Human Chromosomes

- DNA and associated proteins are organized into chromosomes

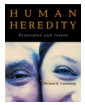
- Humans have
  - 22 pairs of autosomes and XX or XY
    - Females XX
    - Males XY

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

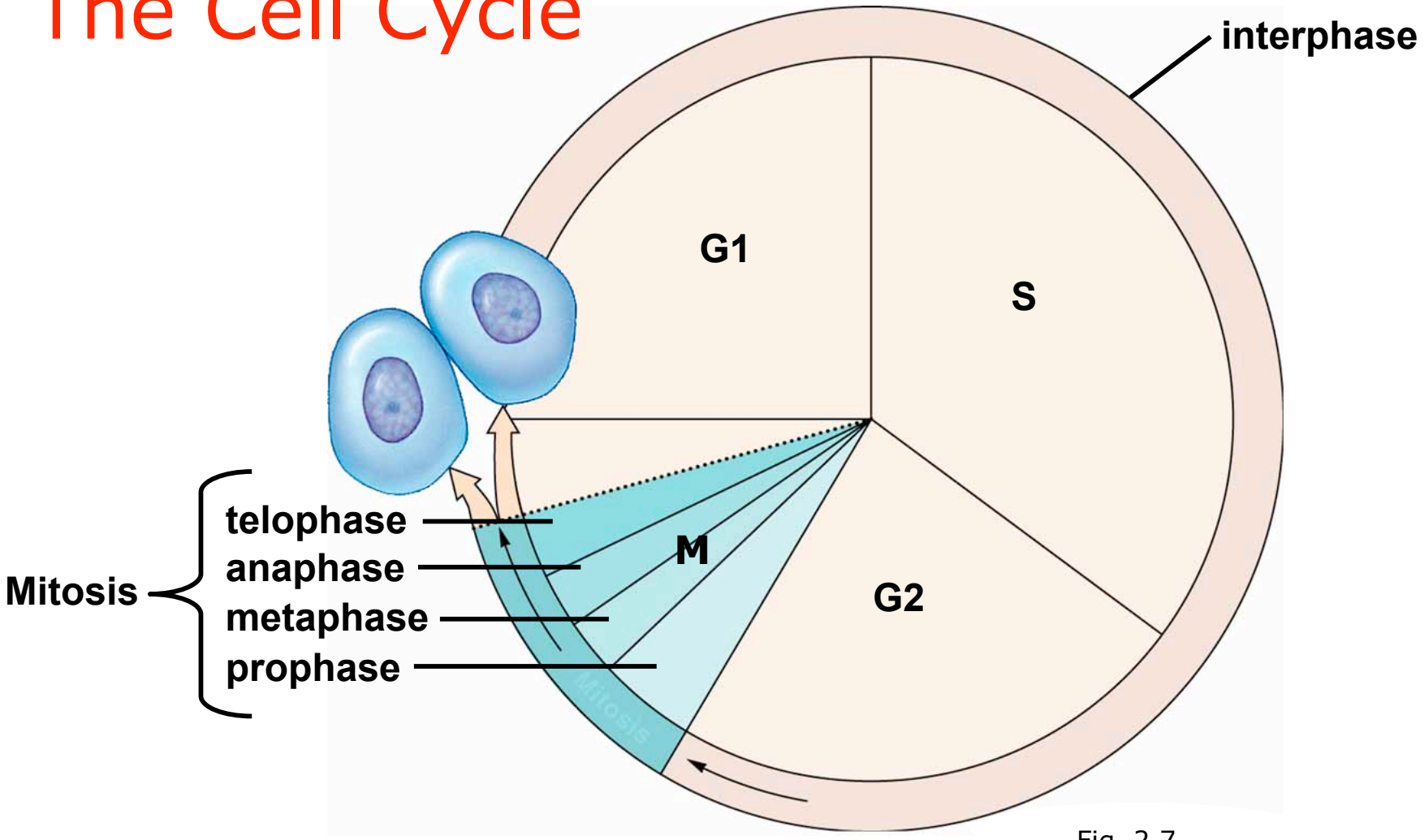
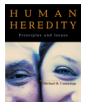


Fig. 2.7

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

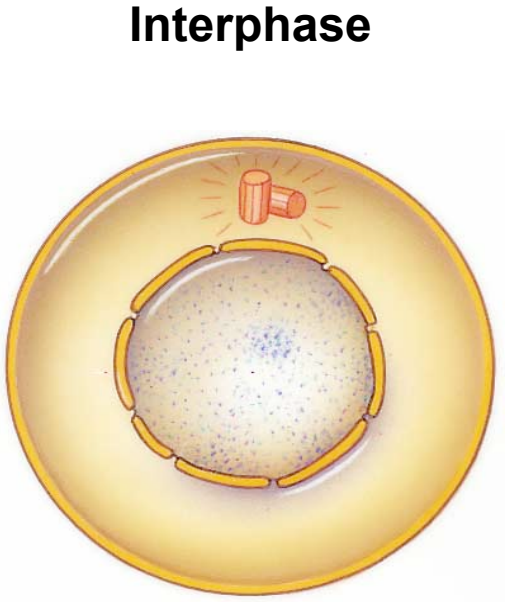
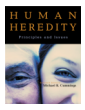
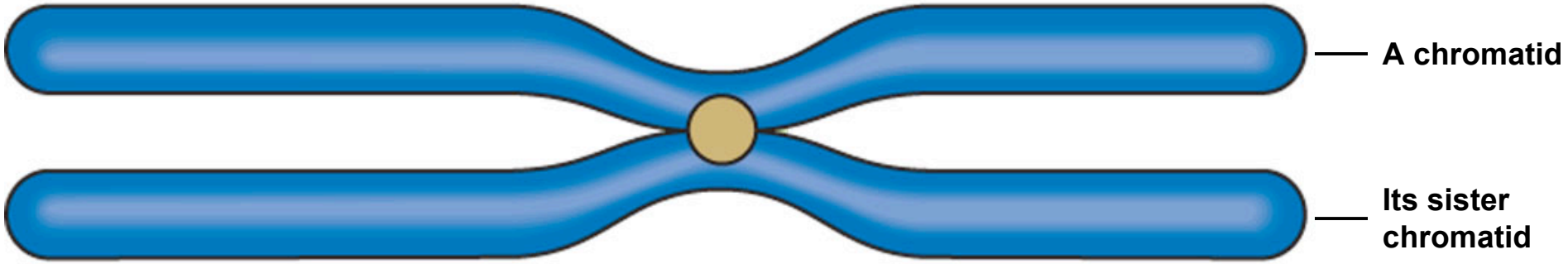


Fig. 2.8a



One chromosome (unreplicated)

One chromosome (replicated)



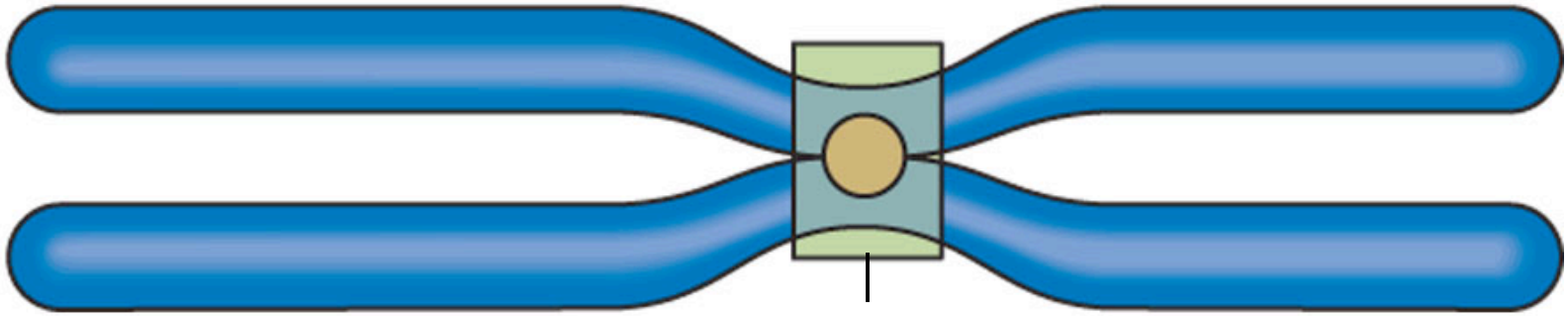
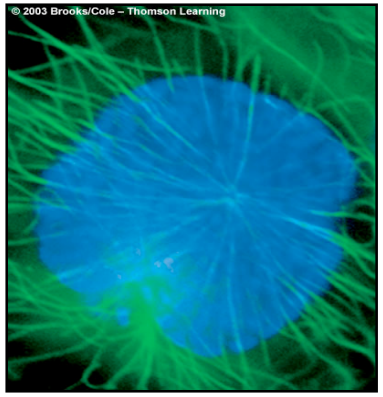


Fig. 2-9, p.28

Prophase

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



Prophase

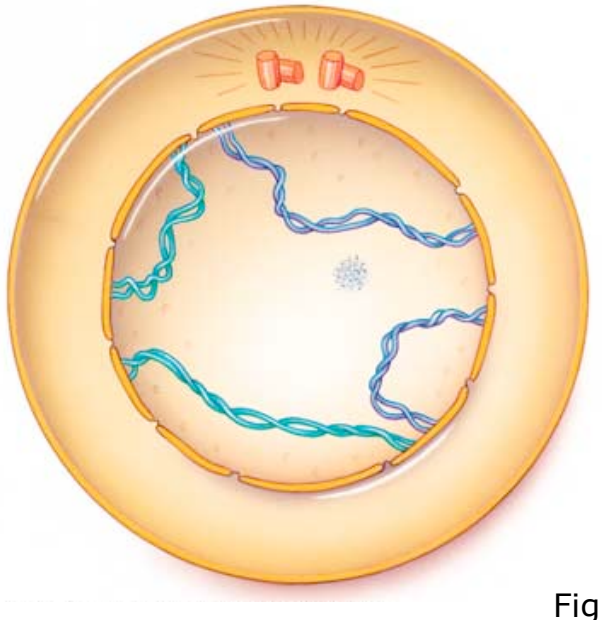
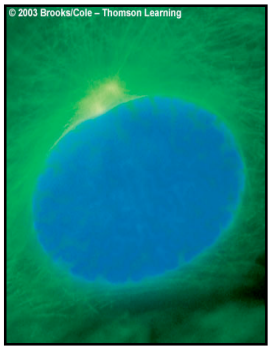
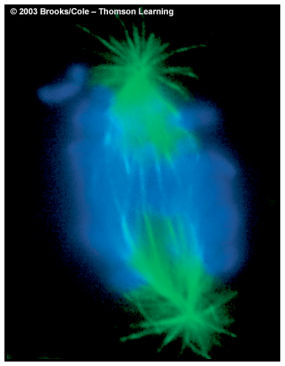


Fig. 2.8b

Prophase into Metaphase



Late Prophase



Prometaphase

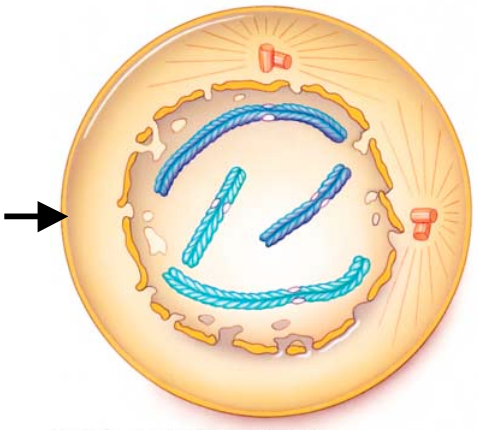


Fig. 2.8c

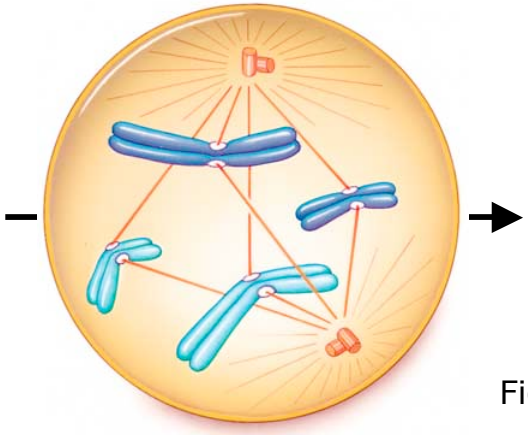
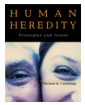
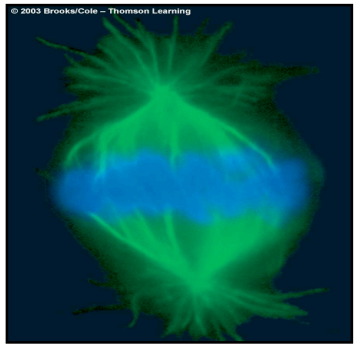


Fig. 2.8d



Metaphase

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



Metaphase

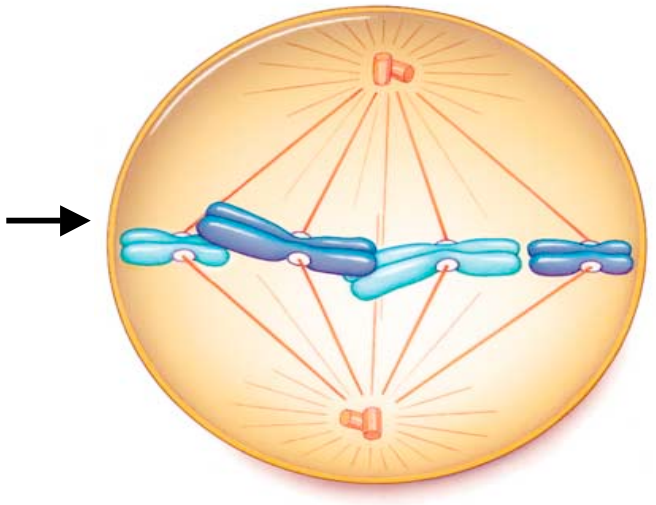
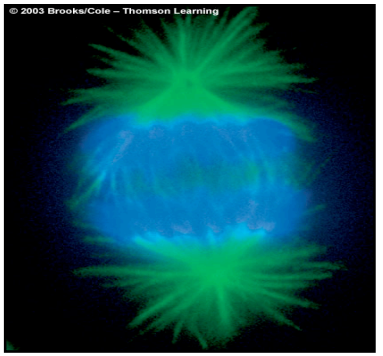


Fig. 2.8e

Anaphase

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



Anaphase

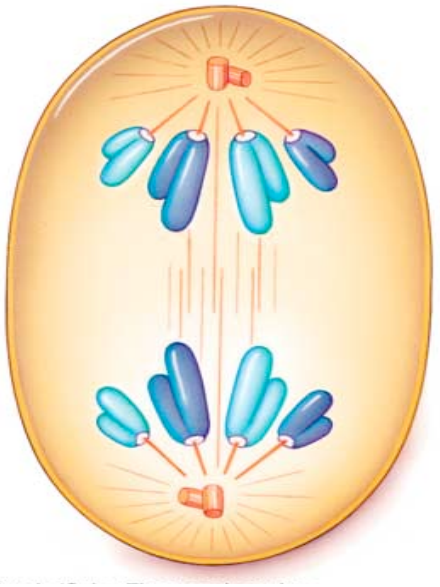
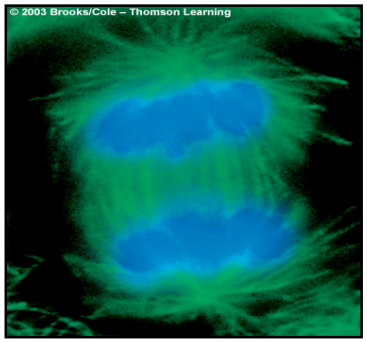


Fig 2.8f

Telophase



Telophase

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

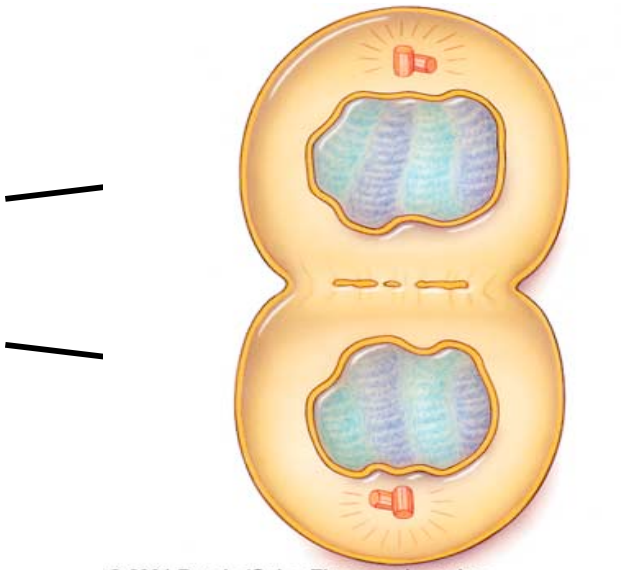


Fig. 2.8g

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

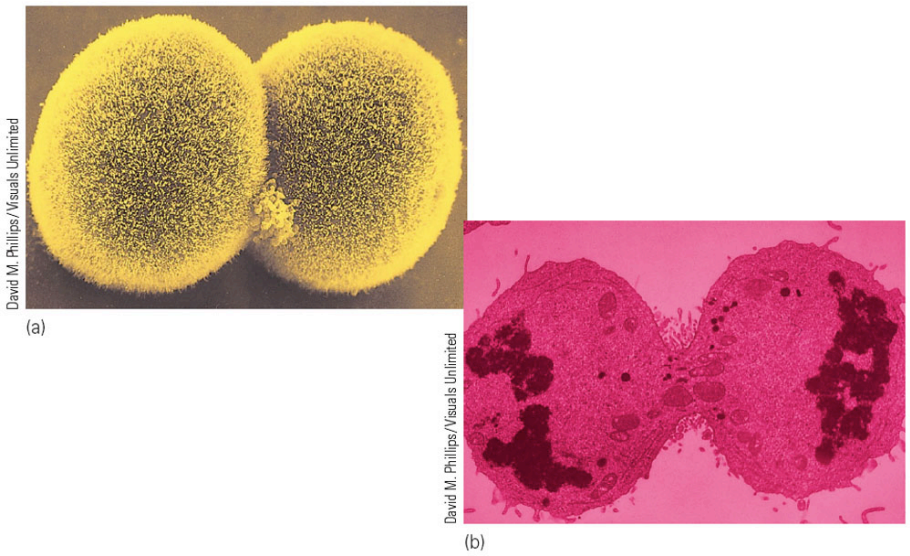


Fig. 2.11

Cytokinesis in frog egg

Credit: © Dr. David Phillips/Visuals Unlimited

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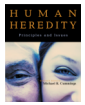


Two **Identical** Daughter Cells

Interphase

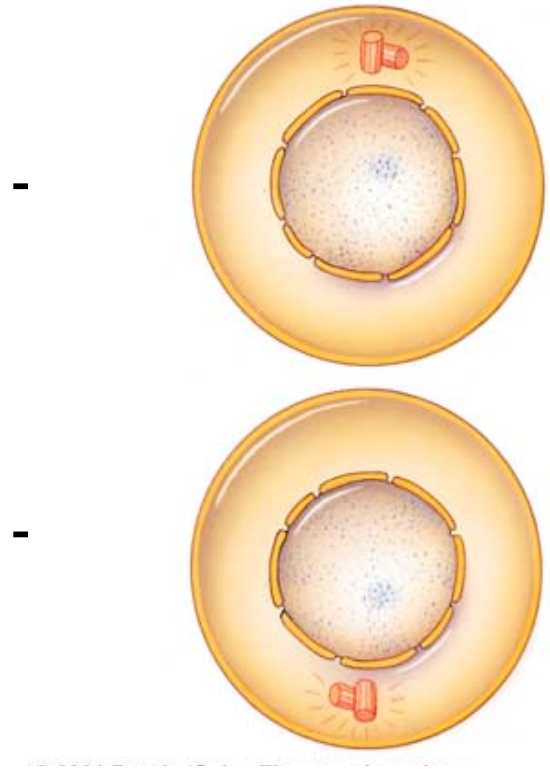
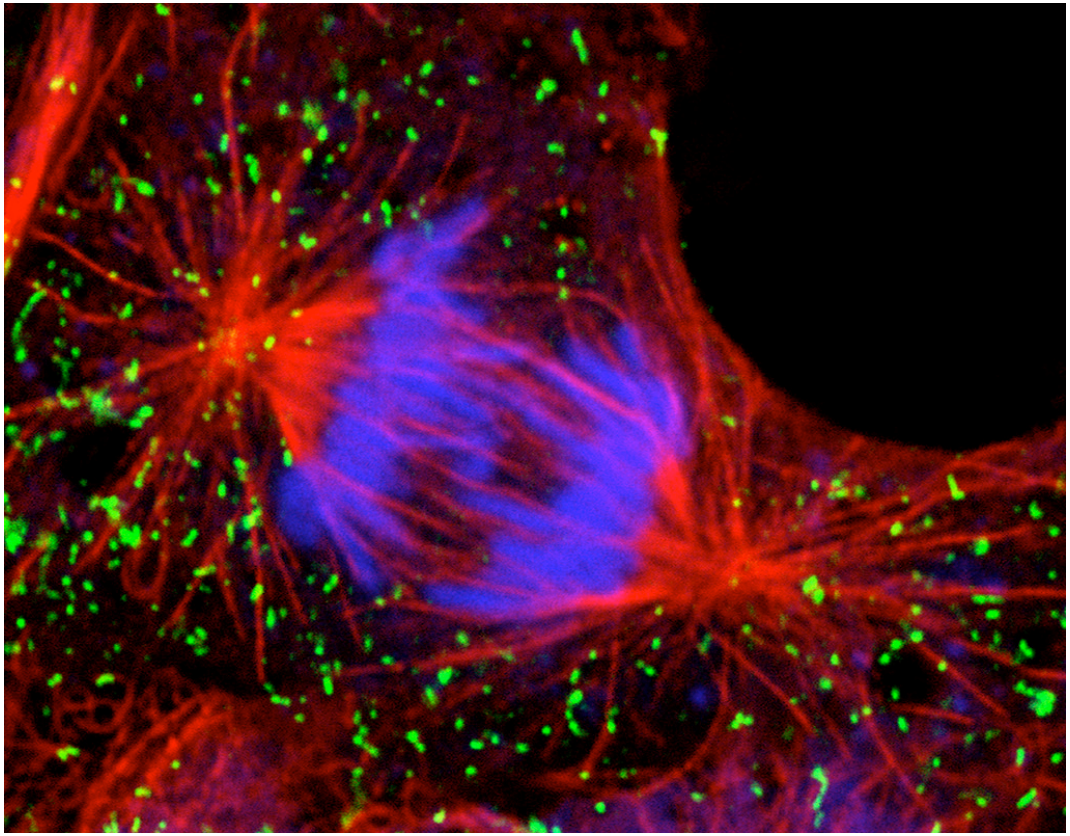


Fig. 2.8h

Guess the stage



Credit: © Thomas Deerinck/Visuals Unlimited

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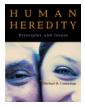

Mitosis