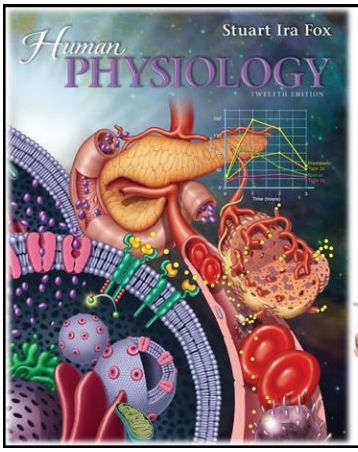
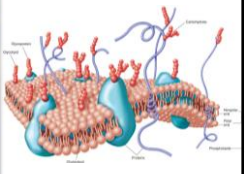


CHAPTER 3

Cell Structure and Genetic Control



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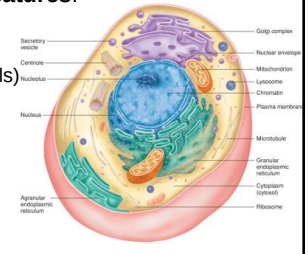
Chapter 3 Outline

- Plasma Membrane
- Cytoplasm and Its Organelles
- Cell Nucleus and Gene Expression
- Protein Synthesis and Secretion
- DNA Synthesis (Gene Expression)

2

The Cell

- Is the **basic unit** of structure and function in body
- Is a **highly organized** molecular factory
- Cells share **3 common features**:
  - Plasma membrane
  - Cytoplasm
  - Nucleus (not all mature cells)



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Plasma Membrane

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Plasma Membrane

- Phospholipid barrier between the intracellular and extracellular environments
  - Hydrophobic center of the double membrane restricts the movement of water, water-soluble molecules, and ions.
  - Many substances are selectively allowed to pass through protein channels.
  - Proteins and phospholipids are not trapped in the membrane but move laterally = fluid mosaic model.

5

Membrane Proteins

- **Integral proteins** – interact with the fatty acid tails.
  - *Transmembrane proteins* – span across the entire membrane.
- **Peripheral proteins** are embedded on just one side of the membrane.
- **Functions**:
  - Structural support
  - Transport
  - Enzymatic control of cell processes
  - Receptors for hormones and other molecules
  - "Self" markers for the immune system

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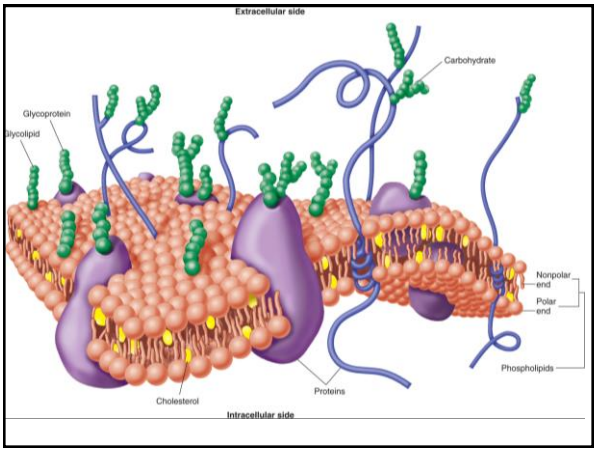

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Bulk Transport

- Way cells move large molecules and particles across plasma membrane
- **Phagocytosis** = Cell eating
- **Endocytosis** = Imports large compounds
  - Pinocytosis – Cell Drinking
  - Receptor Mediated endocytosis
- **Exocytosis** = Export products into the extracellular fluid

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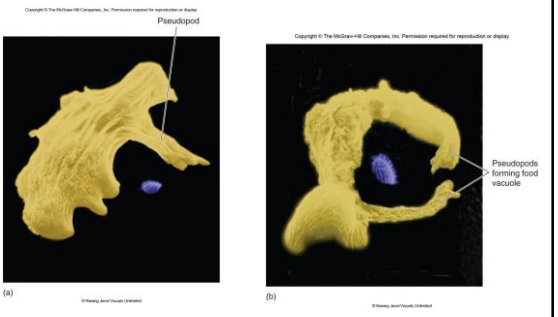
Phagocytosis



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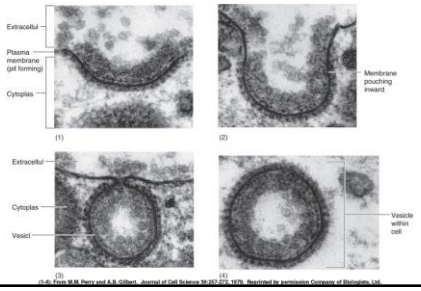
Receptor-mediated endocytosis

- Uses receptors to take in specific compounds
  - Including some viruses



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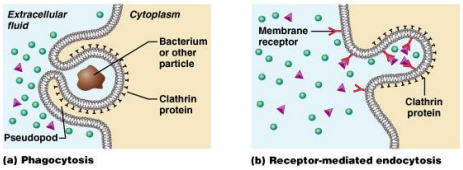

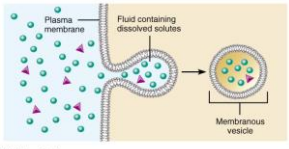

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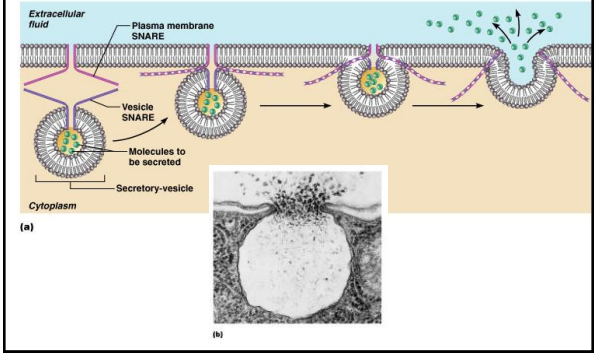
Exocytosis



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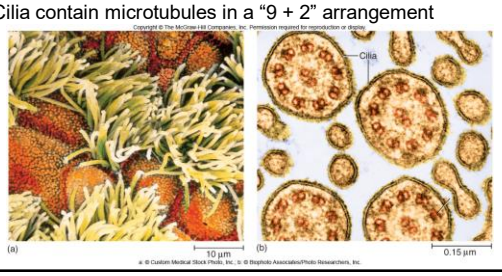
Surface Specializations

- Some epithelial cells have cilia projecting from surface
  - Hair-like structures that beat in unison
  - e.g. cilia line respiratory and reproductive tracts
  - Cilia contain microtubules in a "9 + 2" arrangement



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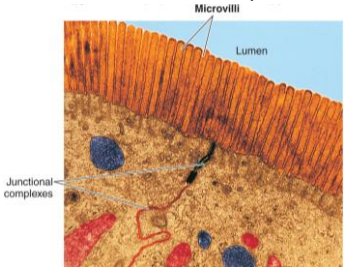
Surface Specializations

- Some epithelial cells have microvilli on surface to increase surface area for absorption
  - Finger-like structures that expand surface area



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Cytoplasm and Its Organelles

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Cytoplasm

- Material within a cell
- Includes:
  - Organelles
  - Cytosol
  - Cytoskeleton

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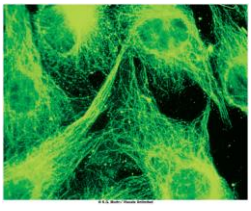
Cytoskeleton

- Latticework of **microfilaments** and **microtubules** filling cytoplasm
  - Gives cell its shape and structure
  - Forms tracks upon which things are transported around cell



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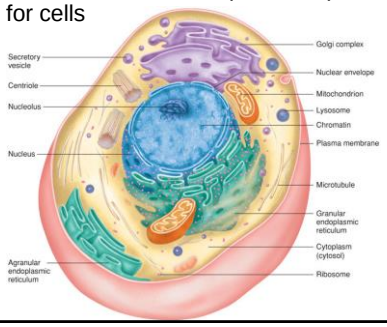
Organelles

- Are cytoplasmic structures that perform specialized functions for cells



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Lysosomes

- Are vesicle-like organelles containing digestive enzymes and matter being digested
  - Involved in recycling cell components
  - Involved in programmed cell death - **Apoptosis**

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Peroxisomes

- Are vesicle-like organelles containing oxidative enzymes
  - Involved in detoxification in liver
  - Help to breakdown hydrogen peroxide

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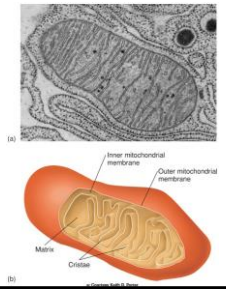
Mitochondria

- Are energy-producing organelles
- Believed to have originated from symbiotic bacteria



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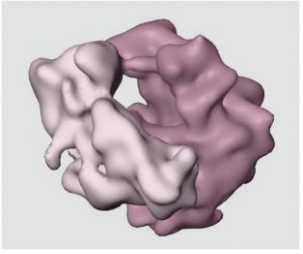
Ribosomes

- Are protein factories
  - Where cell's proteins are synthesized
  - Composed of 2 protein subunits + rRNA



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Endoplasmic Reticulum (ER)

- A system of membranes specialized for synthesis or degradation of molecules
  - Rough ER contains ribosomes for protein synthesis
  - Smooth ER contains enzymes for steroid synthesis and inactivation

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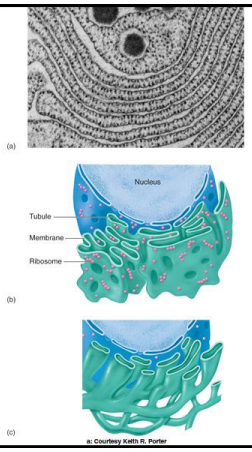

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Golgi Complex

- Is a stack of flattened sacs
- Vesicles enter from ER, contents are modified, and leave other side
- Lysosomes and secretory vesicles are formed in Golgi

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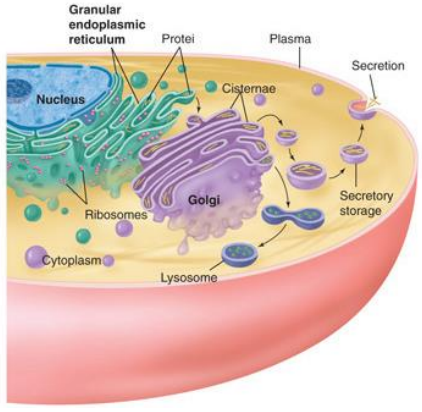

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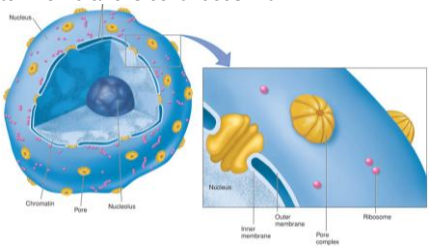
Nucleus

- Contains cell's DNA
- Enclosed by a double membrane nuclear envelope
  - Outer membrane is continuous with ER



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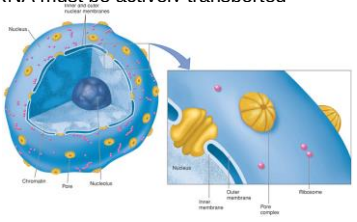
Nucleus

- Nuclear pore complexes fuse inner and outer membranes together
  - Small molecules can diffuse through pore
  - Proteins, RNA must be actively transported



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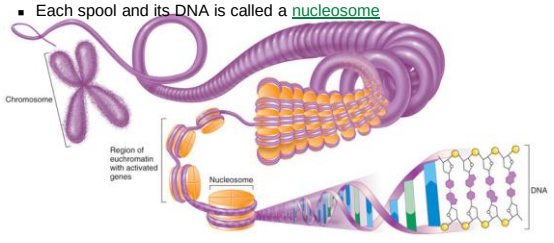
Chromatin

- Is made of DNA and its associated proteins (=histones)
- Histones are positively charged and form spools around which negatively charged DNA strands wrap
  - Each spool and its DNA is called a nucleosome



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Chromatin

- Euchromatin is the part of chromosomes active in transcription
  - Light in color
- Heterochromatin is highly condensed region where genes are permanently inactivated

30

Nucleoli

- Each nucleus contains 1 or more dark areas called nucleoli
  - These contain genes actively making rRNA

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Gene Expression

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Gene Expression

- A Process by which the Genes in our DNA are converted into a protein.
- Genes are lengths of DNA that code for proteins.

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Gene Expression

- Takes place in 2 stages:
  - Transcription occurs when DNA sequence in a gene is turned into a mRNA sequence
  - Translation occurs when mRNA sequence is used to make a protein

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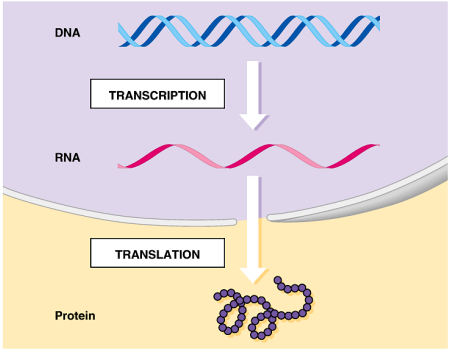
How are genes used?



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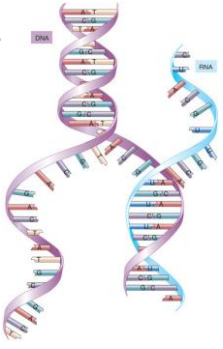
RNA Synthesis

- Only one strand of DNA contains the gene and is transcribed
  - Its bases pair with complementary RNA bases to make mRNA
    - G pairs with C
    - A pairs with U
- RNA polymerase detaches when hits a "stop" sequence



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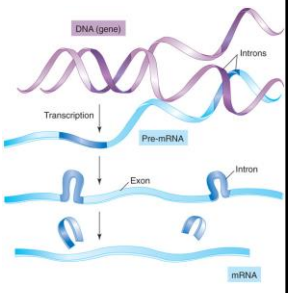
RNA Synthesis

- Pre-mRNA is much larger than mRNA
  - Contains non-coding regions called introns
  - Coding regions are called exons
  - In nucleus, introns are removed and ends of exons spliced together to produce final mRNA



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RNA Synthesis

- Human genome has <25,000 genes
  - Yet produces >100,000 different proteins
  - 1 gene codes for an average of 3 different proteins
    - Accomplished by alternative splicing of exons
      - This allows a given gene to produce several different mRNAs

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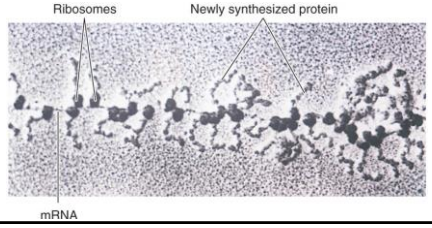
Protein Synthesis

- Occurs one amino acid at a time according to sequence of base triplets in mRNA
- In cytoplasm, mRNA attaches to ribosomes where translation occurs



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Protein Synthesis

- Ribosomes read 3 mRNA bases (a triplet) at a time
  - Each triplet is a codon, which specifies an amino acid
  - Ribosomes translate codons into an amino acid sequence that becomes a polypeptide chain

Table 3.2 Selected DNA Base Triplets and mRNA Codons

DNA Triplet	RNA Codon	Amino Acid
TAC	AUG	"Start" (Methionine)
ATC	UAG	"Stop"
AAA	UUU	Phenylalanine
AGG	UCC	Serine
ACA	UGU	Cysteine
GGG	CCC	Proline
GAA	CUU	Leucine
GCT	CGA	Arginine
TTT	AAA	Lysine
TGC	ACG	Threonine
CCG	GGC	Glycine
CTC	GAG	Glutamic acid

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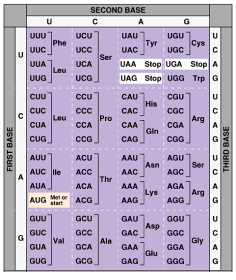
The Genetic Code



AGGCUAUGGGUACUUCCCUCGUGUAGAAAGAC

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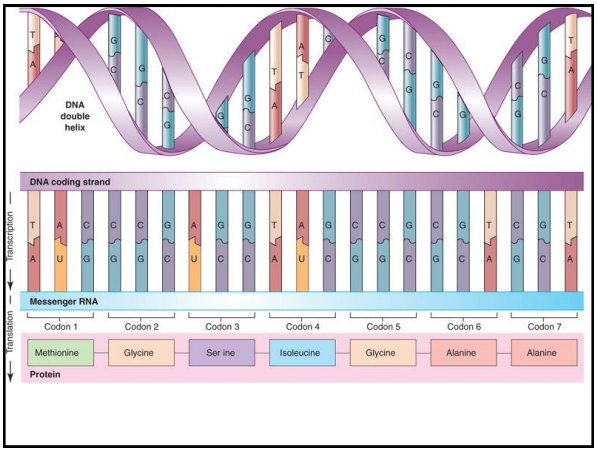

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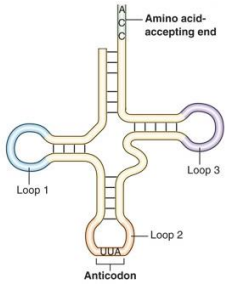
tRNA

- **Anticodon** – Region of tRNA that contains the complementary seqence to a specific mRNA codon
- Each tRNA carries the amino acid specified by its anticodon



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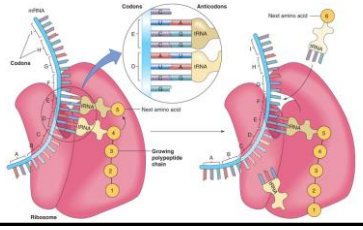
Protein Synthesis

- In a ribosome, anticodons on tRNA bind to mRNA codons
- Amino acids on adjacent tRNAs are brought together and linked enzymatically by peptide bonds
  - This forms a polypeptide; at a stop codon it detaches from ribosome



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