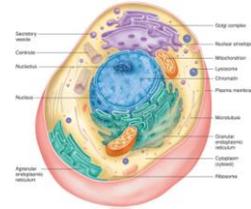


Chapter 3 Outline

- ▶ Plasma Membrane
- ▶ Cytoplasm and Its Organelles
- ▶ Cell Nucleus and Gene Expression
- ▶ Protein Synthesis and Secretion
- ▶ DNA Synthesis and Cell Division

Cell

- ▶ Basic unit of structure and function in body
- ▶ Highly organized molecular factory
- ▶ Has 3 main components: 1) [plasma membrane](#), 2) [cytoplasm](#) and 3) [organelles](#)

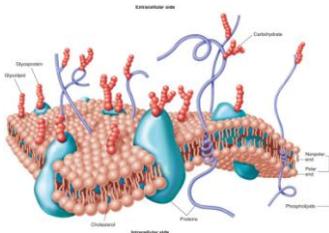


3-2

3-4

Plasma Membrane

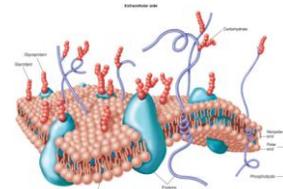
- ▶ Surrounds and gives cell form
- ▶ Selectively permeable
- ▶ Formed by a double layer of phospholipids
 - ▶ Which restricts passage of polar compounds



3-5

Plasma Membrane

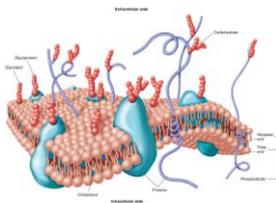
- ▶ **Proteins embedded within the membrane**
- ▶ **Peripheral and integral proteins**
 - ▶ Provide structural support
 - ▶ Serve as transporters, enzymes, receptors and identity markers



3-6

Plasma Membrane

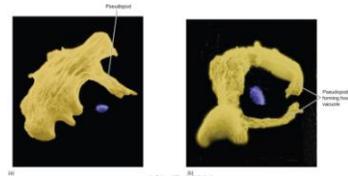
- ▶ Carbohydrates ([glycoproteins](#) & [glycolipids](#)) are part of outer surface
 - ▶ Impart negative charge to surface
 - ▶ Can serve as cell surface markers (antigens)



3-7

In and Out: Bulk Transport

- ▶ Large molecules and particles across plasma membrane
- ▶ Some cells use [phagocytosis](#) to take in particulate matter
 - ▶ e.g. white blood cells and macrophages



3-8

In and Out: Transport in Vesicles

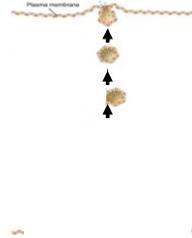
- › Vesicles are round sacs of membrane that surround stuff (Requires ATP)
- › **Endocytosis** = vesicles bringing something into cell



- Endocytosis:**
- receptor-mediated endocytosis
 - Pinocytosis – droplets of extracellular fluid

In and Out: Transport in Vesicles

- › Vesicles are round sacs of membrane that surround stuff (Requires ATP)
- › **Exocytosis** = vesicles release something from cell



Cell Surface Specializations

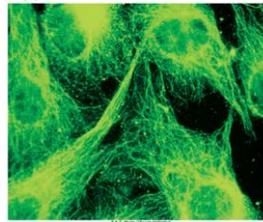
- › **cilia** vs. **Microvilli**



3-12

Cytoplasm and Cytoskeleton

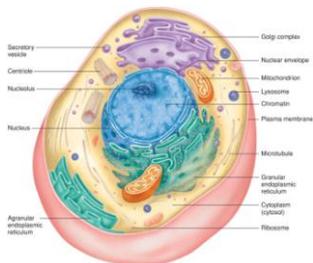
- › **2. Cytoplasm:** fluid-like **cytosol** plus **organelles**
- › **Cytoskeleton:** microfilaments and microtubules filling cytoplasm
 - › Gives cell its shape and structure
 - › Forms tracks upon which things are transported around cell



3-16

3. Organelles

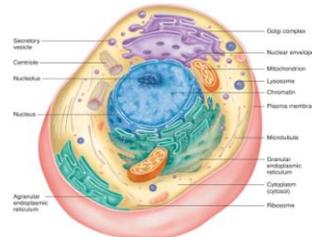
- › Cytoplasmic structures that perform specialized functions for cells



3-17

Lysosomes

- › **organelles containing digestive enzymes and matter being digested**
 - › Involved in recycling cell components
 - › Involved in programmed cell death



3-18

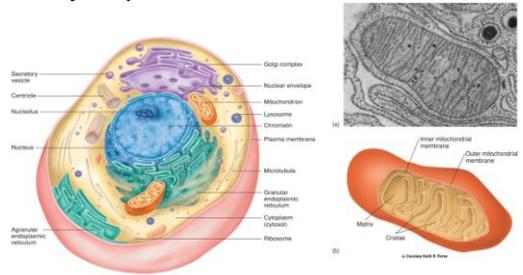
Peroxisomes

- ▶ Organelles containing oxidative enzymes
- ▶ H⁺ removed from toxic molecules – transferred to O₂.
- ▶ Peroxide is formed (H₂O₂)
- ▶ Catalase turns into Water and Oxygen
- ▶ Involved in detoxification in liver

3-19

Mitochondria

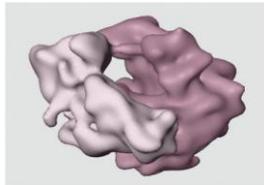
- ▶ Energy-producing organelles – ATP
- ▶ Can migrate
- ▶ Ability to reproduce themselves



3-20

Ribosomes

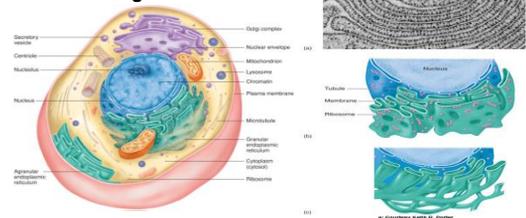
- ▶ Make proteins
- ▶ Where cell's proteins are synthesized
- ▶ Composed of 2 rRNA subunits
- ▶ Occur in cytosol (Free) and on Rough E.R.



3-21

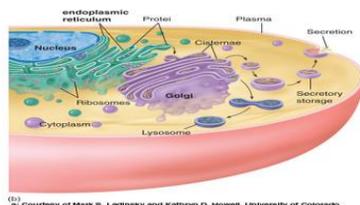
Endoplasmic Reticulum (ER)

- ▶ 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;
- ▶ Ca⁺ storage



Golgi Complex

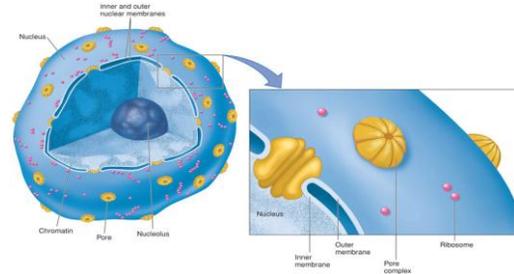
- ▶ Stack of flattened sacs
- ▶ Vesicles enter from ER, contents are modified, and leave other side
- ▶ Lysosomes and secretory vesicles are formed in Golgi complex



3-23

Nucleus

- ▶ Contains cell's DNA
- ▶ Enclosed by a double membrane nuclear envelope

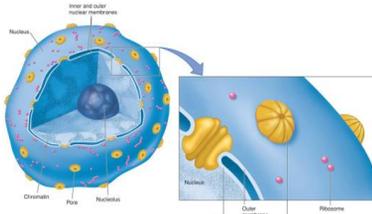


3-24

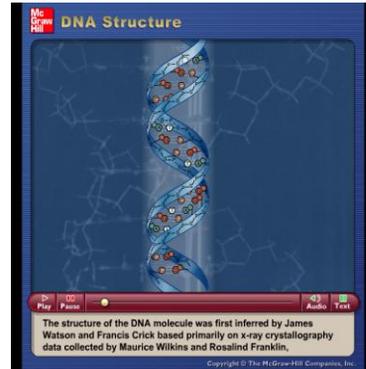
Nucleus

Nuclear pore complexes

- ▶ Small molecules can diffuse through pore
- ▶ Proteins, RNA must be actively transported



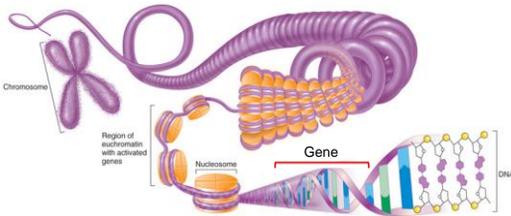
3-25



20

Chromatin

- ▶ Made of DNA and 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



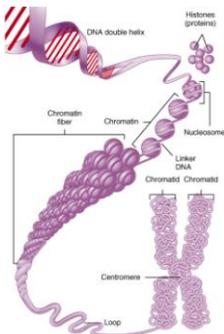
3-31

Genes

- ▶ Genes: segment of DNA that code for synthesis of a protein
- ▶ Genome refers to all genes in an individual or species
- ▶ How do we make proteins (gene expression)?
- ▶ Takes place in 2 stages
 - Transcription : when DNA sequence (gene) is turned into a mRNA sequence
 - Translation : when mRNA sequence is used to make a protein

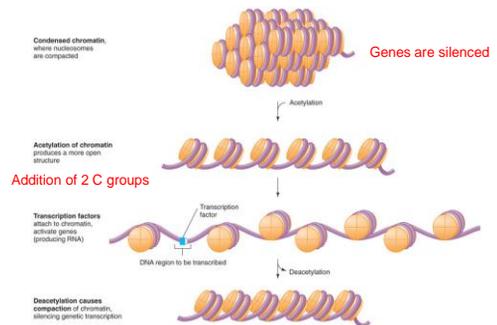
3-27

An Unraveled Chromosome



- One gene is several thousand nucleotide pairs long
- DNA in a human cell contains over 3 billion base pairs
- ~ 25,000 genes
- This is enough to code for at least 3 million proteins
- - make > 100,000 different proteins
- Only a little DNA used for protein synthesis

Chromatin



3-33

Protein Synthesis

- › DNA serves as master blueprint for protein synthesis
- › Genes are segments of DNA carrying instructions for a polypeptide chain (i.e., a protein)
- › Groups of 3 nucleotides on DNA are **TRIPLETS**
 - › Used to produce codons (3 nucleotides of RNA)
 - › Each codon specifies for an amino acid

DNA → RNA → Proteins

From DNA to Protein

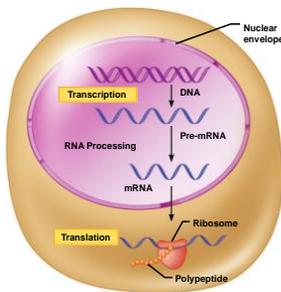


Figure 3.33

Four Types of RNA

1. Pre-mRNA – altered in nucleus to mRNA
2. Messenger RNA (mRNA) – carries genetic information from DNA to ribosomes
3. Transfer RNAs (tRNAs)
 - attaches to an amino acid
 - carries amino acid to mRNA
 - pairs with a codon of mRNA (translates)
 - attaches to other A.A.s
4. Ribosomal RNA (rRNA) – a structural & enzymatic component of ribosomes
 - made in nucleolus

Transcription

- › Transfer information from sense strand (coding strand) of DNA to make mRNA
 - i.e., mRNA will be the same as sense strand
- › **Transcription factor (chemical)**
 - › Loosens histones from DNA in the area to be transcribed
 - › Binds to **promoter** (a DNA sequence) specifying the start site of mRNA synthesis
 - › **RNA polymerase** binds to promoter and breaks H bonds of DNA

Transcription: RNA Polymerase

- › Enzyme that helps synthesis of mRNA
 1. Unwinds the DNA & breaks H bonds
 2. Adds complementary RNA nucleotides to the DNA template strand (anti-sense strand)
 3. Joins RNA nucleotides together to match DNA coding strand
 4. Reads termination signal to stop transcription

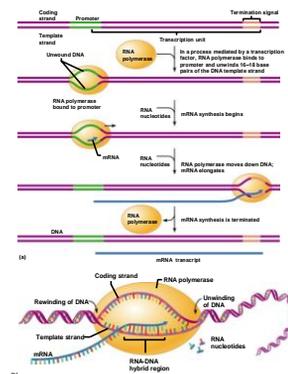
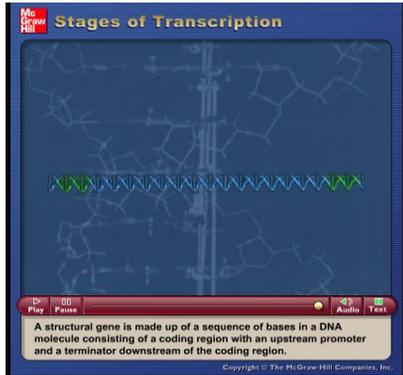


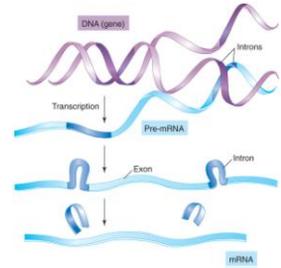
Figure 3.34



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Fixing pre-mRNA

- 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



3-38

From DNA to Protein

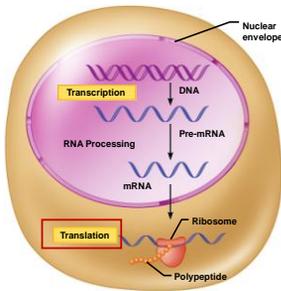


Figure 3.33

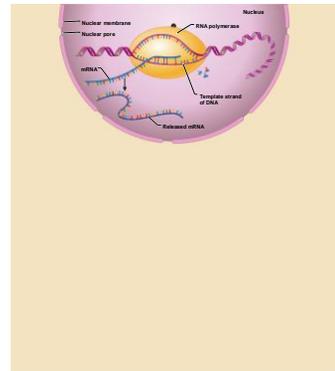


Figure 3.36

Polysome: mRNA binding to ribosome

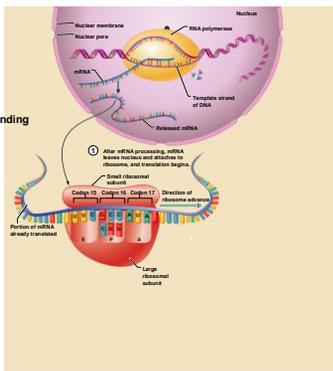


Figure 3.36

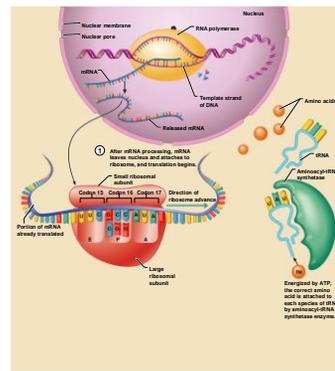


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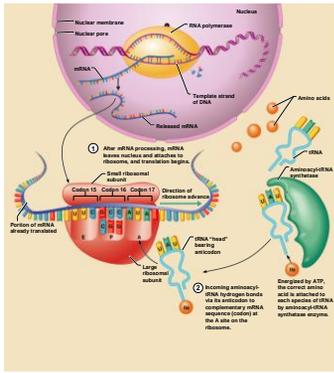


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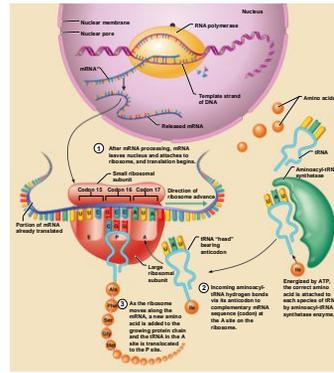


Figure 3.36

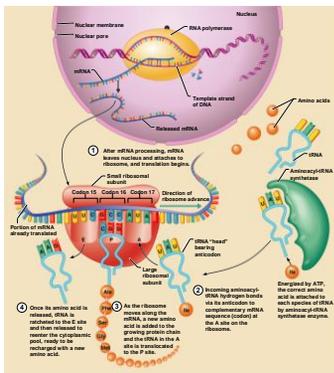
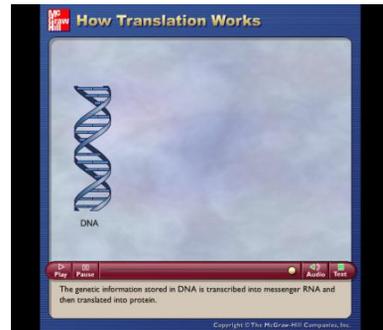


Figure 3.36



Information Transfer from DNA to RNA

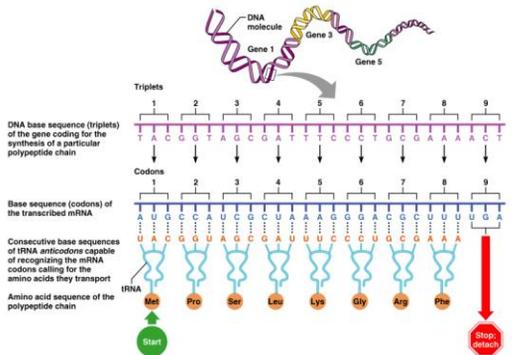
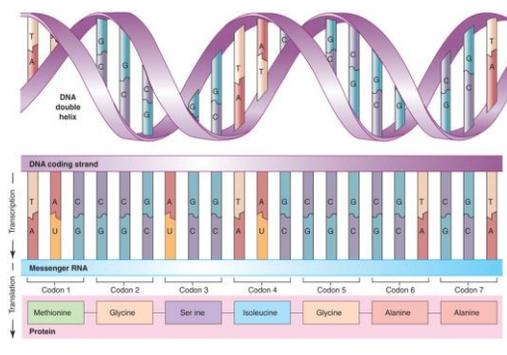
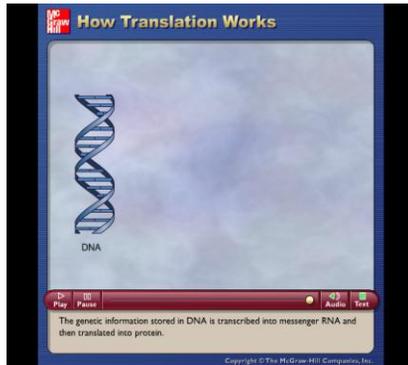


Figure 3.38

Protein Synthesis





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Genetic Code

- ▶ RNA codons code for amino acids according to a genetic code

		SECOND BASE				
		U	C	A	G	
FIRST BASE	U	UUU → Phe UUC → Phe UUA → Leu UUG → Leu	UCU → Ser UCC → Ser UCA → Ser UCG → Ser	UAU → Tyr UAC → Tyr UAA → Stop UAG → Stop	UGU → Cys UGC → Cys UGA → Stop UGG → Trp	U C A G
	C	CUU → Leu CUC → Leu CUA → Leu CUG → Leu	CCU → Pro CCC → Pro CCA → Pro CCG → Pro	CAU → His CAC → His CAA → Gln CAG → Gln	CGU → Arg CGC → Arg CGA → Arg CGG → Arg	U C A G
	A	AUU → Ile AUC → Ile AUA → Ile AUG → Met or start	ACU → Thr ACC → Thr ACA → Thr ACG → Thr	AAU → Asn AAC → Asn AAA → Lys AAG → Lys	AGU → Ser AGC → Ser AGA → Arg AGG → Arg	U C A G
	G	GUU → Val GUC → Val GUA → Val GUG → Val	GCU → Ala GCC → Ala GCA → Ala GCG → Ala	GAU → Asp GAC → Asp GAA → Glu GAG → Glu	GGU → Gly GGC → Gly GGA → Gly GGG → Gly	U C A G
		THIRD BASE				

Figure 3.35

RNA Synthesis

- ▶ A newly discovered type of RNA is involved in regulating gene expression
 - ▶ These perform [RNA interference \(RNAi\)](#) or [silencing](#)
 - ▶ Interfere with or silence expression of some genes
 - ▶ [siRNA](#) (short interfering RNA) and [miRNA](#) (micro RNA) molecules pair in varying degrees with different mRNAs
 - ▶ Thereby interfering with expression of those mRNAs
 - ▶ 1 miRNA may interfere with up to 200 different mRNAs

3-40