Chapter 2
Foundations: The Cell

Introduction
There are trillions of cells in the body
Cells are the structural “building blocks” of all plants and animals
Cells are produced by the division of preexisting cells
Cells form all the structures in the body
Cells perform all vital functions of the body

Introduction
There are two types of cells in the body:
Sex cells
Sperm in males and oocytes in females
Somatic cells
All the other cells in the body that are not sex cells

The Study of Cells
Cytology
Study of cells
Common techniques used:
Light microscopy (LM)
Transmission electron microscopy (TEM)
Scanning electron microscopy (SEM)

The Study of Cells
Light Microscopy
Magnification up to 1000 times
Sometimes 2000 maximum

The Study of Cells
Transmission Electron Microscopy
Magnifies more than light microscopy

The Study of Cells
Scanning Electron Microscopy
Shows three-dimensional images

The Study of Cells
The diversity of the cells of the body
The following figure shows the proportion of cell size of the variety of cells in the body
Cellular Anatomy
The cell consists of:
- Cytoplasm
- Cytosol
- Organelles
- Plasmalemma
- Cell membrane

Cellular Anatomy
Anatomical structures of the cell
- Organelles
- Nonmembranous organelles
- Membranous organelles

Cellular Anatomy
Organelles of the cell
- Nonmembranous organelles
- Cytoskeleton
- Microvilli
- Centrioles
- Cilia
- Flagella
- Ribosomes

Cellular Anatomy
Membranous organelles
- Mitochondria
- Nucleus
- Endoplasmic reticulum
- Golgi apparatus
- Lysosomes
- Peroxisomes

Cellular Anatomy
Plasmalemma
A cell membrane composed of:
- Phospholipids
- Glycolipids
- Protein
- Cholesterol

Cellular Anatomy
Functions of the Plasmalemma
Cell membrane (also called phospholipid bilayer)
Major functions:
- Physical isolation
Regulation of exchange with the environment (permeability)
Sensitivity
Structural support

Cellular Anatomy
Membrane permeability of the plasmalemma
Passive processes
Diffusion
Osmosis
Facilitative diffusion

Cellular Anatomy
Membrane permeability of the plasmalemma
Active processes
Endocytosis
Phagocytosis
Pinocytosis
Receptor-mediated endocytosis

Cellular Anatomy
Plasmalemma: Active processes
Uses enzymes and carrier proteins
Ion pumps use energy to transport charged particles such as Na+, Ca2+, Mg2+, K+
An ion pump that moves two ions simultaneously in opposite directions is called an exchange pump.

Cellular Anatomy
Plasmalemma: Endocytosis
Phagocytosis: “cell eating”
Pinocytosis: “cell drinking”
Receptor-mediated endocytosis:
Ligands will bind specific molecules to the receptors thereby allowing only specific molecules to enter the cell

Cellular Anatomy
Nonmembranous Organelles (details)
The cytoskeleton consists of:
Microfilaments
Intermediate filaments
Thick filaments
Microtubules

Cellular Anatomy
Nonmembranous Organelles (details)
Microfilaments
Anchor cytoskeleton to integral proteins
Stabilize the position of membrane proteins
Anchor plasmalemma to the cytoplasm
Produce movement of the cell

Cellular Anatomy
Nonmembranous Organelles (details)
Intermediate filaments
Provide strength
Stabilize organelle position
Transport material within the cytosol

Cellular Anatomy
Nonmembranous Organelles (details)
Thick filaments
Found in muscle cells: involved in muscle contraction
Microtubules
Involved in the formation of centrioles, which are involved in cell reproduction

Cellular Anatomy
Nonmembranous Organelles (details)
Examples of microtubules
Centrioles
Cilia
Flagella

Nonmembranous Organelles (details)
Ribosomes
Free ribosomes: float in the cytoplasm
Fixed ribosomes: attached to the endoplasmic reticulum
Both are involved in producing protein

Cellular Anatomy
Membranous Organelles (details)
Double-membraned organelles
Mitochondria: produce ATP
Nucleus: contains chromosomes
Endoplasmic reticulum: network of hollow tubes
Golgi apparatus: modifies protein
Lysosomes: contain cellular digestive enzymes
Peroxisomes: contain catalase to break down hydrogen peroxide

Cellular Anatomy
Membranous Organelles (details)
Mitochondria
Consist of cristae
Consist of mitochondrial matrix
Produce ATP
Cellular Anatomy
Membranous Organelles (details)
Nucleus: control center of the cell
Nucleoplasm
Nuclear envelope
Perinuclear space
Nuclear pores
Nuclear matrix

Cellular Anatomy
Membranous Organelles: Nucleus
Chromosomes:
DNA wrapped around proteins called histones
Nucleosomes
Chromatin

Cellular Anatomy
Membranous Organelles (details)
Endoplasmic Reticulum (ER)
There are two types
Rough endoplasmic reticulum (RER)
Smooth endoplasmic reticulum (SER)

Cellular Anatomy
Membranous Organelles (details)
Rough endoplasmic reticulum
Consists of fixed ribosomes
Proteins enter the ER

Cellular Anatomy
Membranous Organelles (details)
Smooth endoplasmic reticulum
Synthesizes lipids, steroids, and carbohydrates
Storage of calcium ions
Detoxification of toxins

Cellular Anatomy
Membranous Organelles (details)
Golgi apparatus
Synthesis and packaging of secretions
Packaging of enzymes (modifies protein)
Renewal and modification of the plasmalemma

Cellular Anatomy
Membranous Organelles (details)
Lysosomes
Fuse with phagosomes to digest solid materials
Recycle damaged organelles
Sometimes rupture, thus killing the entire cell (called autolysis)

Cellular Anatomy
Membranous Organelles (details)
Peroxisomes
Consist of catalase
Abundant in liver cells
Convert hydrogen peroxide to water and oxidants

Cellular Anatomy
Membrane flow
This is the continuous movement and recycling of the cell membrane
Transport vesicles connect the endoplasmic reticulum with the Golgi apparatus
Secretory vesicles connect the Golgi apparatus with the plasmalemma

Intercellular Attachment
Examples of Intercellular Attachment:
Communicating junctions
Adhering junctions
Tight junctions
Anchoring junctions

The Cell Life Cycle
Cell reproduction consists of special events
Interphase
Mitosis
Prophase
Metaphase
Anaphase
Telophase
Cytokinesis
Overlaps with anaphase and telophase

The Cell Life Cycle
Cell reproduction (Interphase)
Everything inside the cell is duplicating
Consists of G1, S, and G2 phases
G1: duplication of organelles and protein synthesis
S: DNA replication
G2: protein synthesis

The Cell Life Cycle
Cell Reproduction (Mitosis)
Prophase
The first phase of mitosis
Metaphase
Paired chromatids line up in the middle of the nuclear region
Anaphase
Paired chromatids separate to opposite poles of the cell
Telophase
Two new nuclear membranes begin to form

The Cell Life Cycle
Cell Reproduction (Cytokinesis)
Cell membrane begins to invaginate, thus forming two new cells
Many times this phase actually begins during anaphase
This is the conclusion of cell reproduction