

1.1 INTRODUCTION, STRUCTURE - FUNCTION + CELL THEORY

Complementarity: form (anatomy) determines function (physiology) = better understanding of human body

↳ Anatomy: structure of body parts + relation to one another (concrete)

↳ Physiology: how body parts work/ carry life-sustaining function, explained through knowledge of anatomy

Reductionism (scientific method): understand the nature of complex things by reducing to the interaction of its parts

- Macroscopic (visible to the eye) vs. microscopic (not visible, too small)

Structural Organization of the Human Body

Atoms: > H forged by nuclear fusion of stars, > Fe formed by supernova

Ex: inorganic [H₂O, C, O₂, CO₂, NaCl] & organic [amino acid, lipids, sugars]

Cells: fundamental structural/functional unit

Smallest units of life, vary in size/shape → maintain/ perpetuate life

New cells come from preexisting cells (multicellular)

Tissues: groups of similar cells with common functions

4 different types of tissues: epithelial, muscle, connective, nervous

Organs: discrete structure composed of at least 2 (usually 4) types of tissues, specialized functional center for specific activity (i.e. diffusion of nutrients/oxygen)

- 75 different types of organs, 5 essential organs [heart, brain, lungs, kidneys, liver]

Organ System: groups of organs working together to accomplish a common purpose (ex: cardiovascular system: heart + blood + veins/ arteries)

Requirement for life = water + energy + suitable environment

Eukaryotes: all complex cells, almost all multicellular organisms

- Contains a nucleus, enclosed in double membrane separating genetic material
- Endomembrane system: variety of membrane-bound structure
- 1st Eukaryotic cell - evolved from engulfed prokaryotic by phagocytosis that was left undigested - prokaryote gained new functionality (became supplemental to primary cell) → photosynthesis, aerobic respiration
- Unique biochemical pathways (group of proteins universal to eukaryotes)
 - Compose cytoskeleton, transcription machinery, membrane sorting system, nuclear pore, enzyme

Organelles: keep cell alive (func.), exceedingly complex

Signal transduction (cross plasma membrane)

Information Flow (in-out, out - in)

Organelles	Structure	Function
Plasma Membrane	Double layer of phospholipids with embedded cholesterol & proteins (may pass through lipid bilayer/ protrude one face), sugar attached to most facing proteins + some lipids	External cell barrier, transmembrane proteins are receptors for chemical messages (e.g. hormones, neurotransmitters), as transport proteins & in cell-to-cell recognition, maintains resting potential (required for excitable cells to function)

Cytoplasm:

Structure: region between nuclear & plasma membranes, consists of fluid cytosol (contains dissolved solutes, organelles (metabolic machinery of cytoplasm) & inclusions (stored nutrients, secretory products, pigment granules))

Function:

Mitochondria:

Structure: rodlike, double-membrane structures, inner membrane folded into cristae (projections)

Function: site of ATP synthesis; powerhouse of the cell

Ribosomes:

Structure: dense particles with 2 subunits - composed of ribosomal RNA & protein, free or attached to rough ER

Function: sites for protein synthesis

Rough Endoplasmic Reticulum (ER):

Structure: membranous system enclosing cistern (cavity) & coiling through cytoplasm, externally studded with ribosomes

Function: In the cistern, proteins have sugar groups attached & bound in vesicles for transport to Golgi apparatus + other sites, external face synthesizes phospholipids

Smooth Endoplasmic Reticulum (ER):

Structure: membranous system of sacs & tubules, free of ribosomes

Function: site of lipid + steroid (cholesterol) synthesis, lipid metabolism, drug detoxification, Ca²⁺ storage

Golgi Apparatus:

Structure: stack of flattened membranes & associated vesicles close to the nucleus

Function: packages, modifies & segregates proteins for secretion, inclusion in lysosomes, incorporations into plasma membrane, modifies carbohydrates on proteins

Peroxisomes:

Structure: membranous sacs + catalase & oxidase enzymes

Function: enzymes detoxifies # of toxic substances, catalase (most important enzyme) breaks down hydrogen peroxide

Lysosomes:

Structure: membranous sacs + acid hydrolases

Function: sites of intracellular digestion

Microtubules:

Structure: cylindrical structure composed of tubulin proteins

Function: supports cell, maintains shape, involved in intracellular & cellular movements, form centrioles & cilia & flagella (if present)

Intermediate Filaments

Structure: protein fibers, varying composition

Function: stable cytoskeletal elements, resist mechanical forces acting on the cell

Microfilaments

Structure: fine filaments composed of protein actin

Function: muscle contraction + other types of intracellular movements, help form cell's cytoskeleton

Centrioles:

Structure: paired cylindrical bodies - composed of 9 triplets of microtubules

Function: (part of centrosomes) organize microtubule network, form the spindle & asters (during mitosis), form bases of cilia & flagella (basal bodies)

Cilia:

Structure: short cell-surface projection - cilium (sing.) contains 9 pairs of microtubules surrounding a central pair

Function: coordinates movement = unidirectional current that propels substance across cell surfaces

Flagellum:

Structure: long cell-surface projection - contain 9 pairs of microtubules surrounding central pair(ex: sperm tail)

Function: propels the cell

Microvilli:

Structure: tubular extensions of plasma membrane - contains bundle of actin filaments

Function: increase SA for absorption

Nucleus:

Structure: largest organelle, surrounded by nuclear envelope - fluid nucleoplasm, nucleoli & chromatin

Function: control center of the cell, transmits genetic information & provides instructions for protein synthesis

Nuclear Envelope:

Structure: double-membrane pierced by pores, outer membrane continuous with ER

Function: separates nucleoplasm from cytoplasm & regulates passage of substance + nucleus

Nucleolus:

Structure: dense spherical (non-membrane bounded) bodies - ribosomal RNA + proteins

Function: site of ribosomal subunit manufacture

Chromatin:

Structure: granular, threadlike material - DNA & histone proteins

Function: DNA constitutes the genes

Fluorescent Microscope: fluorescent small molecules (antibodies) - identify visualization of small structure under fluorescent molecules

Fixed, non-living or living cells

Quantitative information on cellular events

Inner Life of Cell:

- Macrophages (WBC) look for foreign invaders & ingest + break them down → presenting foreign proteins on its surface
- Helper T-cells sample (until it's matches with foreign proteins), activates massive reproduction of right cytotoxic T-cells
 - B cells produce antibodies to help fight infection