

Two Basic Types of Cells

- Prokaryotic- bacteria
 - larger than eukaryotic cells
 - lacks a nucleus but has a nucleoid (a region of coiled DNA)
- DNA is in direct contact with rest of cells contents
 - Cell wall- a rigid complex structure that protects the cell and helps to maintain its shape
 - Some have a sticky outer coat called a capsule that further protects the cell and helps to adhere the cell to surfaces
 - Some have projections
- Pili- short projections that aid in adhesion
- flagella- used to propel through the liquid environment
- Eukaryotic- all other forms of life

Human Cell

Plant Cell

Generalized Cell

Three parts

- Plasma (cell) membrane- the limiting membrane that separates the outer from the internal cell environment
- Cytoplasm- all the cellular contents between the plasma membrane and the nucleus
 - cytosol- the thick semifluid portion of the cytoplasm
- Organelles- the highly organized structures in the cytoplasm that are specialized for particular functions.

Organelles

- Membranous organelles- surrounded by one or two layers of unit membrane
 - Nucleus
 - Mitochondria
 - Lysosomes
 - Peroxisomes
 - Endoplasmic reticulum
 - Golgi complex
- Non membranous organelles- not membrane bound
 - Ribosome
 - Centrosome
 - Centrioles
 - Basal bodies

Organelles

Provides separate chemical environments for the various specialized reactions of the cell

Nucleus

- largest structure in the cell
- called the control center because it contains the genetic material
 - chromatin- loosely dispersed DNA associated with protein
 - chromosomes- condensed DNA strands

Karyotype

Nucleus (cont.)

- nuclear contents bound by a membranous sac called a **nuclear envelope** (double layered membrane)
- studded with ribosomes- place of protein synthesis
- nuclear pores- provide communication with cytoplasm
- continuous with endoplasmic reticulum
- contains nucleolus- unenclosed area composed of protein, DNA, where ribosomes are manufactured

Endoplasmic Reticulum

- a system of membranous flattened sacs (cisterns) dispersed throughout the cytoplasm
- Two types- Rough and smooth
- Rough endoplasmic reticulum
- studded with ribosomes on the outer surface
- makes more membrane and processes secretory proteins manufactured by the ribosomes
- membrane continuous with the nuclear envelope

Endoplasmic Reticulum

- Smooth endoplasmic reticulum
- network of interconnected tubes void of ribosomes
- continuous with rough ER
- site of fatty acid, phospholipid, and steroid synthesis
- in certain cells the enzymes within the smooth ER inactivates or detoxifies various chemicals (i.e., alcohol, pesticides, carcinogens)

Ribosome

- Small granules composed of ribosomal RNA and protein
- sites of protein synthesis
- are scattered throughout the cytoplasm and attached to ER
- composed of 2 subunits

Golgi Complex

- a system of stacked flattened sacs (cisterns) with expanded areas at their ends
- has golgi vesicles that cluster along the expanded edges of the cisterns
- is the “shipping and receiving” dock for newly synthesized lipids and proteins
- packages them into transport (secretory) vesicles that release the products to the external of the cell

Lysosomes

- membrane enclosed sacs formed the golgi complex that contains powerful digestive enzymes
- used to foreign substances and organisms
- digest old organelles (autophagy) for recycling
- capable of digesting the cell (autolysis)
- enzymes can also be used external to the cell in injury repair

Peroxisomes

- Resemble lysosomes but contain different enzymes

- Peroxisomes, kill bacteria, neutralize free radicals, breaks down fatty acids, and detoxify alcohol and other drugs.
- In the course of detoxification and the destruction of microorganisms, they produce hydrogen peroxide (H_2O_2)
- Contain catalase, an enzyme that breaks down hydrogen peroxide which is dangerous to the cell

Mitochondria

- The powerhouse of the cell because of its function in energy production
- Consist of two membranes
 - outer membrane- smooth
 - inner membrane- arranged in folds (cristae) where ATP is generated
- Center core called matrix
- Found throughout the cytoplasm of all cells, especially in cells that expend a lot of energy (i.e. muscle, liver..etc.)

Cytoskeleton

- A supportive meshwork of fine fibers that provide structural support for the cell
- three main types of fibers
 - microfilaments - helical rodlike globular protein (actin) structures involved in contraction in muscle cells and provide support, shape, and assist in locomotion in nonmuscular cells

Cytoskeleton (cont.)

- intermediate filaments- fibrous ropelike protein structures that serve as reinforcing rods for bearing tension and for anchoring certain organelles

Microtubules

- straight hollow tubes composed of globular proteins called tubulins
- provide anchorage of organelles and act as tracks along which organelles can move within the cytoplasm
- guide the movement of chromosomes in cell division
- the structural basis for flagella and cilia

Cilia and Flagella

Both consist of microtubules surrounded by cytosol and enclosed by plasma membrane

- Cilia- short numerous appendages used for locomotion and the movement of substances along the surface of the cell
- Flagella- longer, generally less numerous appendages used for locomotion (sperm)

Cilia and Flagella

- These motile appendages are constructed by basal bodies (kinetosomes), which also function as centrioles.
- The basal body is located at the base of each filament, anchoring it to the cell and controlling its movement.
- Cilia and flagella have the same structure. The only difference is that the flagella are longer.

Cilia and Flagella

- Axoneme- structural basis for ciliary movement
- Consist of an array of thin protien cylinders called microtubles
- There are two centrally microtubules surrounded by a ring of nine microtubule pairs (9+2 structure)

–Dynein arms-a motor protein who's movement causes cilia to bend

Cilia In The Lungs

- Sweeps dust and germ laden mucous from the lung passageways to the throat to be swallowed.
- Cigarette smoke slows down and then stops the action of cilia.

Centrosome and Centrioles

- Centrosome- a dense area of cytoplasm near the nucleus that is involved in mitosis
- Centrioles- a pair of structures composed of microtubules arranged in right angles that are located in the centrosomes.
- Has an unknown function in mitosis
- involved in the formation of flagella and cilia

Plasma Membrane

- Composed of two parallel rows of phospholipids called a phospholipid bilayer.
- Contains two types of membrane proteins
- integral- penetrate through the membrane
- form channels that have pores through which certain substances move in and out of the cell.
- transporters (carriers) that move substances from one side of the membrane to the other.
- Receptors (recognition sites) which identify and attach various molecules (i.e. hormones, antibodies.. etc.).
- cell identity markers-glycoproteins and glycolipids that enable the cell to recognize self and foreign.
- peripheral - loosely attached to the exterior or interior surface of the membrane

Functions of the Plasma Membrane

- Shape and protection

Functions of the Plasma Membrane

- Communication- occurs via receptors and second messengers
 - Enzymes in the membrane break down signaling molecules to halt action
- #### Signal Transduction Pathway (Second Messenger)

Functions of the Plasma Membrane

- Maintains the electrochemical Gradient

Functions of the Plasma Membrane

- Selective permeability- regulation of the entry and exit of materials
- depends on various factors
- lipid solubility- substances that dissolve in lipids easily pass across membrane.
- size- most large particles cannot pass. A few small molecules pass (CO₂, H₂O, O₂).
- charge- impermeable to ions
- presence of channels and transporters-

Control of Channel Proteins

- Channel gates open and close in response to three types of stimuli
- Ligand-regulated gates**- respond to chemical messengers
- Voltage-regulated gates**- respond to changes in electrical potential (voltage) across the plasma membrane
- Mechanically regulated gates**- respond to physical stress on a cell such as stretch and pressure

Glycocalyx

- Consist of the carbohydrate moieties of the membrane glycolipids and glycoproteins and the adhesion molecules that enables cells to adhere to each other

- Chemically unique in everyone but identical twins**

- Allows the body to distinguish self from non self**

Glycocalyx

Cell Adhesion Molecules (CAMs)

- Adheres cells to one another and to extracellular matrix
- Cells do not grow or survive unless they are mechanically linked to the extracellular matrix.
- Acceptions- blood cells, cancer cells

Movement of Materials Across Plasma Membrane

- Passive processes (or transport)- cell does not expend energy
- Active processes (or transport)- cell expends energy

Movement of Materials Across Plasma Membrane

Movement of Materials Across Plasma Membrane

- Passive processes (transport)-
- affected by
- concentration
- Temperature
- Molecular weight
- Membrane surface area
- Membrane permeability
- pressure exerted by gravity or other forces
- simple diffusion
- concentration gradient- the difference between low and high concentration
- equilibrium- when molecules are evenly distributed

Passive Processes (cont.)

- facilitated diffusion- when substances are allowed to cross the cell membrane with the help of integral proteins

Movement of Water Across the Cell Membrane

- Water crosses cell membranes by two routes:
- by diffusion through the lipid bilayer
- and through water channels called **aquaporins**.

Osmosis

- The special case of the diffusion concerning the movement of water across a selectively permeable membrane

- Osmotic Pressure- The force created by the tendency of water to move

- measured by the amount of pressure that stops osmosis

Measuring Osmotic Concentration

- Osmole- one mole of dissolved particles

- Osmolality- the number of osmoles of solute per kilogram of water

- Osmolarity- the number of osmoles of solute per liter of solution

- Ex: 1 M NaCl = 2 osm/L

1 M CaCl₂ = 3 osm/L

Effects of Blood Cell in Various Tonicity of Solutions

Filtration

- The movement of solvents and dissolved substances across a selectively permeable membrane by gravity or mechanical pressure (low pressure to high pressure)

Active Processes

- The movement of substances across the cell membrane with the expenditure of energy

Three Kinds of Membrane Carriers

Uniport

- Carries only one molecule at a time

Symport

- Carries two or more solutes through a membrane simultaneously in the same direction (cotransport)

Antiport

- carries two or more solute in opposite directions (countertransport)

Sodium Potassium Pump

- Half of the bodies calories consumed each day are used by the Na/K pump

- Regulation of cell volume

- Heat production- when cold, thyroid hormone causes increased production of Na/K pumps

- Maintenance of membrane potential

Sodium Glucose Transport Protein

- Used in the kidneys to salvage glucose from the urine.

- Na/K pump removes excess Na from cell

Active processes (cont)

- Endocytosis- process of bring things into the cell.

- Exocytosis- process of expelling things from the cell.

Active Process (cont.)

- Endocytosis- a portion of the cell membrane encloses the substance and brings it into the cell.

- Phagocytosis (cell eating)- projections of the plasma membrane (psuedopods) surround a large particle and brings it into the cell.

Exocytosis

Cellular Environment

- Intracellular fluid (ICF, cytosol)- fluid inside the cells.

- Extracellular fluid (ECF) - fluid outside the cell

- interstitial fluid- fills the spaces between the cells

- plasma- fluid in blood vessels

- lymph- fluid in lymphatic vessels