Objectives

- **The student will be able to define cell and describe its three major regions and the general function of each.**
- **The student will be able to describe the cell membrane and its chemical composition and relate it to its functions.**
- **The student will be able to list and describe the different membrane transport processes both active and passive.**
- **The student will be able to list and describe the structure and function of the following: Nucleus, nuclear membrane, nucleolus, chromatin, mitochondria, ribosomes, endoplasmic reticulum, Golgi apparatus, lysosomes, peroxisomes, sytoskeletal elements, centrioles.**
- **The student wil be able to discuss the phases of the cell life cycle and describe the key events of each phase.**
- **The student will be able to describe the process of DNA replication, its importance, when and why it occurs.**
- **The student will be able to define gene and explain the two phases of protein synthesis.**
- **The student will be able to define and describe the roles of DNA, mRNA, tRNA, and rRNA in each of the phases of protein synthesis.**

What are the principal parts of the cell?

The principal parts are 3:

1. Plasma or cell membrane thqat separates the internal components of the cell from the outside of the cell.
2. Cytosol that is a semifluid intracellular fluid containing many dissolved and suspended substances including the organelles.
3. Organells that are highly organized structures with characteristic shapes and highly specialized functions.

What is the cell membrane made of?

The cell membrane is made of proteins and lipids (phospholipids). There are more lipid moledcules than protein that are either integral or peripheral proteins, and may be in the form of glycoproteins.

Explain the Fluid Mosaic Model of cell membrane structure.

Proteins float among the phospholipis "like Ice on water". The phospholipid bilayer has its hydrophobic ends facing each other, and the hydrophilic ends facing the outside or the inside of the cell. The phospholipids and proteins can move sideways within the bilayer.

Help with MITOSIS !!!

Ok Mitosis has four phases:

1. Prophase - chromatin fibers shorten and coil into chromosomes, nucleoli and nuclear envelope disappear, centrioles move to opposite poles of the cell, and mitotic spindle appears
2. Metaphase - centromeres of chomatid pairs line up on the metaphase plate of the cell
3. Anapase - centromeres divide and identical sets of chromosomes move to opposite poles of the cell
4. Telophase the opposite of Prophase! Nuclear envelope reappears, chromosomes uncoil, nucleoli reappears and the mitotic spindle disappears.

Explain the 3 types of RNA.

1. mRNA is produced from sense strand of DNA via transcription and carries the code for making a particular protein from the nucleus to the ribosome in the form of codons
2. rRNA makes up the ribosome and is produced in the nucleolus. It moves along the mRNA strand ot "read" the directions for making the protein

3. tRNA is the one that transports the specific AA from the cytoplasm to the ribosome. It places AA in proper sequence by matching its anticodon to the appropriate codon on the mRNA

Simple diffusion vs Osmosis

Both are passive types of movements. Simple diffusion involves the net movement of solute molecules from an area of higher solute concentration to an area of lower concentration. Osmosis involves the movement of water across a semipermeable membrane from an area of higher water concentration to an area of lower water concentration.

Cells: The Living Units

Cell Theory

The cell is the basic structural and functional unit of life

Organismal activity depends on individual and collective activity of cells

Biochemical activities of cells are dictated by subcellular structure

Continuity of life has a cellular basis

Structure of a Generalized Cell

Plasma Membrane

Separates intracellular fluids from extracellular fluids

Plays a dynamic role in cellular activity

20% of all membrane lipid is cholesterol

Fluid Mosaic Model

Double bilayer of lipids with imbedded, dispersed proteins

Bilayer consists of phospholipids, cholesterol, and glycolipids

Glycolipids are lipids with bound carbohydrate

Phospholipids have hydrophobic and hydrophilic bipoles

Functions of Membrane Proteins

Transport

Enzymatic activity

Receptors for signal transduction

Intercellular adhesion

Cell-cell recognition

Attachment to cytoskeleton and extracellular matrix

Membrane Junctions

Tight junction – impermeable junction that encircles the cell

Desmosome – anchoring junction scattered along

the sides of cells

Gap junction – a nexus that allows chemical substances to pass between cells

Membrane Junctions: Tight Junction

Membrane Junctions: Desmosome

Membrane Junctions: Gap Junction

Passive Membrane Transport: Diffusion

Simple diffusion – nonpolar and lipid-soluble substances

Diffuse directly through the lipid bilayer

Diffuse through channel proteins

Facilitated diffusion

Transport of glucose, amino acids, and ions

Transported substances bind carrier proteins or pass through protein channels

Diffusion Through the Plasma Membrane

Passive Membrane Transport: *Osmosis*

Occurs when the concentration of a solvent is different on opposite sides of a membrane

Diffusion of water across a semipermeable membrane

Osmolarity – total concentration of solute particles in a solution

Tonicity – how a solution affects cell volume

Effects of Solutions of Varying Tonicity

Isotonic – solutions with the same solute concentration as that of the cytosol

Hypertonic – solutions having greater solute concentration than that of the cytosol

Hypotonic – solutions having lesser solute concentration than that of the cytosol

Passive Membrane Transport: Filtration

The passage of water and solutes through a membrane by hydrostatic pressure

Pressure gradient pushes solute-containing fluid from a higher-pressure area to a lower-pressure area

Active Transport

Uses ATP to move solutes across a membrane

Requires carrier proteins

Primary active transport – hydrolysis of ATP

phosphorylates the transport protein causing conformational change

Sodium-Potassium Pump

Types of Active Transport

Secondary active transport – use of an exchange pump (such as the Na^+-K^+ pump) indirectly to drive the transport of other solutes

Symport system – two substances are moved across a membrane in the same direction

Antiport system – two substances are moved across a membrane in opposite directions

Vesicular Transport

Transport of large particles and macromolecules across plasma membranes

Exocytosis – moves substance from the cell interior to the extracellular space

Endocytosis – enables large particles and macromolecules to enter the cell

Phagocytosis – pseudopods engulf solids and bring them into the cell's interior

Fluid-phase endocytosis – the plasma membrane infolds, bringing extracellular fluid and solutes into the interior of the cell

Receptor-mediated endocytosis – clathrin-coated pits provide the main route for endocytosis and

transcytosis

Non-clathrin-coated vesicles – caveolae that are platforms for a variety of signaling molecules

Cytoplasm

Cytoplasm – material between plasma membrane and the nucleus

Cytosol – largely water with dissolved protein, salts, sugars, and other solutes

Cytoplasmic organelles – metabolic machinery of the cell

Cytoplasmic Organelles

Specialized cellular compartments

Membranous

Mitochondria, peroxisomes, lysosomes, endoplasmic reticulum, and Golgi apparatus

Nonmembranous

Cytoskeleton, centrioles, and ribosomes

Mitochondria

Ribosomes

Granules containing protein and rRNA

Site of protein synthesis

Free ribosomes synthesize soluble proteins

Membrane-bound ribosomes synthesize proteins to be incorporated into membranes

Endoplasmic Reticulum (ER)

Rough (ER)

External surface studded with ribosomes

Manufactures all secreted proteins

Responsible for the synthesis of integral membrane proteins and phospholipids for cell membranes

Smooth ER

Tubules arranged in a looping network

Catalyzes the following reactions in various organs of the body

In the liver – lipid and cholesterol metabolism, breakdown of glycogen and, along with the kidneys, detoxification of drugs

In skeletal and cardiac muscle – storage and release of calcium

Golgi Apparatus

Stacked and flattened membranous sacs

Functions in modification, concentration, and

packaging of proteins

Transport vessels from the ER fuse with the cis face of the Golgi apparatus

Proteins then pass through the Golgi apparatus to the trans face

Secretory vesicles leave the trans face of the Golgi stack and move to designated parts of the cell

Lysosomes

Spherical membranous bags containing digestive enzymes

Digest ingested bacteria, viruses, and toxins

Degrade nonfunctional organelles

Breakdown glycogen and release thyroid hormone

Breakdown bone to release Ca^{2+}

Secretory lysosomes are found in white blood cells

Endomembrane System

Peroxisomes

Membranous sacs containing oxidases and catalases

Detoxify harmful or toxic substances

Neutralize dangerous free radicals

Free radicals – highly reactive chemicals with unpaired electrons (i.e., O_2^-)

Cytoskeleton

Microtubules

Dynamic, hollow tubes made of the spherical protein tubulin

Determine the overall shape of the cell and distribution of organelles

Microfilaments

Dynamic strands of the protein actin

Attached to the cytoplasmic side of the plasma membrane

Braces and strengthens the cell surface

Function in endocytosis and exocytosis

Intermediate Filaments

Tough, insoluble protein fibers with high tensile strength

Resist pulling forces on the cell and help form desmosomes

Centrioles

Cilia

Nucleus

Contains nuclear envelope, nucleoli, chromatin

Gene-containing control center of the cell

Contains the genetic library with blueprints for nearly all cellular proteins

Dictates the kinds and amounts of proteins to be synthesized

Nuclear Envelope

Selectively permeable double membrane barrier containing pores

Encloses jellylike nucleoplasm

Outer membrane is continuous with the rough ER and is studded with ribosomes

Pore complex regulates transport of large molecules into and out of the nucleus

Nucleoli

Dark-staining spherical bodies within the nucleus

Site of ribosome production

Chromatin

Threadlike strands of DNA and histones

Arranged in fundamental units called nucleosomes

Form condensed, barlike bodies of chromosomes in mitosis

Cell Cycle

Interphase

Growth (G_1), synthesis (S), growth (G_2)

Mitotic phase

Mitosis and cytokinesis

Interphase

G_1 (gap 1) – metabolic activity and vigorous growth

G_0 – cells that permanently cease dividing

S (synthetic) – DNA replication

G_2 (gap 2) – preparation for division

DNA Replication

DNA helices begin unwinding

Helicase untwists the double helix and exposes complementary strands

Each nucleotide strand serves as a template for

building a new complementary strand

DNA polymerase covalently adds complementary nucleotides to the template

Since DNA polymerase only works in one direction:

A continuous leading strand is synthesized

A discontinuous lagging strand is synthesized

DNA ligase splices together the short segments of the discontinuous strand

This process is called semiconservative replication

Cell Division

Essential for body growth and tissue repair

Mitosis – nuclear division

Prophase

Metaphase

Anaphase

Telophase

Cytokinesis – division of the cytoplasm

Protein Synthesis

DNA serves as master blueprint for protein synthesis

Genes are segments of DNA carrying instructions for

a polypeptide chain

Triplets of nucleotide bases form the genetic library

Each triplet specifies coding for an amino acid

From DNA to Protein

Roles of the Three Types of RNA

Messenger RNA (mRNA) carries the genetic information from DNA in the nucleus to the ribosomes in the cytoplasm

Transfer RNAs (tRNAs) bound to amino acids base pair with the codons of mRNA at the ribosome to begin the process of protein synthesis

Ribosomal RNA (rRNA) is a structural component of ribosomes

Transcription: RNA Polymerase

An enzyme that oversees the synthesis of RNA

Unwinds the DNA template

Adds complementary ribonucleoside triphosphates on the DNA template

Joins these RNA nucleotides together

Encodes a termination signal to stop transcription

Overview of Transcription

Initiation of Translation

A leader sequence on mRNA attaches to the small subunit of the ribosome

Methionine-charged initiator tRNA binds to the small subunit

The large ribosomal unit now binds to this complex forming a functional ribosome

Polypeptide Chain Elongation

Genetic Code

RNA codons code for amino acids according to a genetic code

Information Transfer from DNA to RNA

DNA triplets are transcribed into mRNA codons by RNA polymerase

Codons base pair with tRNA anticodons at the ribosomes

Amino acids are bonded at the ribosomes to form polypeptide chains

Start and stop codons are used in initiating and ending translation