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Module 1: Cells and Cell Processes

Basic Biological Principles

Key Terms & Definitions

Homeostasis- The tendency toward a relatively stable equilibrium between interdependent elements, especially as maintained by physiological processes.

Eukaryote- An organism consisting of a cell or cells in which the genetic material is DNA in the form of chromosomes contained within a distinct nucleus.

Nucleus- the central and most important part of an object, movement, or group, forming the basis for its activity and growth.

Cell membrane-the semipermeable membrane surrounding the cytoplasm of a cell.

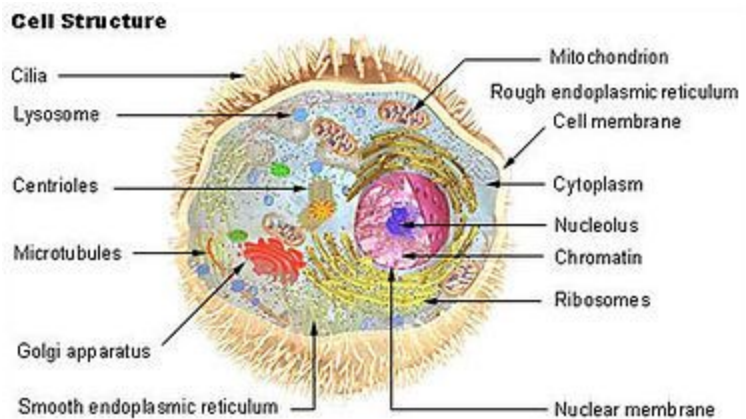
DNA-deoxyribonucleic acid, a self-replicating material present in nearly all living organisms as the main constituent of chromosomes. It is the carrier of genetic information.

Cell- the smallest structural and functional unit of an organism, typically microscopic and consisting of cytoplasm and a nucleus enclosed in a membrane. Microscopic organisms typically consist of a single cell, which is either eukaryotic or prokaryotic.

Organism-an individual animal, plant, or single-celled life form.

Molecule- a group of atoms bonded together, representing the smallest fundamental unit of a chemical compound that can take part in a chemical reaction.

Summary - Living things are made of units called cells, are based on a universal genetic code, obtain and use materials and energy, grow and develop, reproduce, respond to their environment, maintain a stable internal environment, and change over time. Living things are distinguished from nonliving things on the basis of seven characteristics: cells and organization, growth and development, obtains and use energy (metabolism), reproduction, universal genetic code, ability to change over time (evolution), and homeostasis. A cell is the basic unit of the structure and function of living things capable of performing all the activities of life.



Diagrams-

Practice!

- 3 Multiple choice

3. Which of the following characteristics of living things explains why birds fly south for the winter?

- A. Living things respond to their environment
- B. Living things maintain homeostasis
- C. Living things are made of cells
- D. Living things are based on a universal genetic code

5. Not all cells are alike. Which of the following is NOT a true statement about differences between cells?

- A. Cells come in many different shapes
- B. Different kinds of cells are different sizes
- C. Some cells have a nucleus and others do not
- D. Most cells have a membrane, but some do not

6. What is an organism?

- A. A form of life; an animal, plant, fungus, protist or bacteria
- B. The regulatory process in which an organism regulates its internal environment.
- C. An anatomical unit composed of tissues serving a common function.
- D. A permanent transmissible change of genetic material

Short Answers

What is homeostasis?

List the characteristics of life common to all living things?

The Chemical Basis for Life

Key Terms and definitions

Temperature: a measure of being hot and cold

Cohesion: the tendency of molecules of the same kind to stick to one another

Adhesion: the type of attraction that occurs between unlike molecules

Reactant: the starting substances for a chemical reaction and is read in a chemical equation

Product: the results or what come out in a chemical reaction and the outcome of a chemical equation

Chemical Reaction: a chemical reaction is a process that leads to the transform of one set of chemical substances to another.

pH scale: a scale that describes how acidic or a base solution is

Acid: are electrolytes that release hydrogen ions into water

Ion: is an atom or molecule with a net electric charge due to loss or gain of electrons

Ionic Bond: it is when a chemical bond involves attraction between two charged ions

Molecule: two or more atoms held by covalent bonds

Nucleus: the powerhouse of the cell and forming the basis for its activity and growth

Polar Molecule: a molecule that has a positive charge on one end and a negative charge on the other end

Atom: the basic unit of a chemical element

Protons: it is a particle with a positive charge

Neutrons: a charge electrically neutral

Electrons: a particle with a negative charge

Atomic Number: the number of protons unique to each element in an atom.

Element: atoms having the same number of protons in their atomic nuclei

Summary

There are many different things that go into the chemical bases of life. First we are going to start off with an atom. Atoms are made of protons, neutrons, and electrons. Protons have a positive charge. Neutrons have no charge and electrons have a negative charge. Electrons are the ones that orbit around the nucleus. Chemical reactions is a process that leads to the transform of one set of chemical substances to another. During a chemical reaction the atoms that are there in the reactants and create a product there are no new atoms made during that process. Here is how a chemical reaction works “reactants contact each other, bonds between atoms in the reactants are broken down and atoms rearrange and form new bonds to make the products”. Chemical reactions and atoms are the two basis for chemical life in a human body. You also have many other things that come into play when talking about this. That is acids and things that combine together. In your body there is pH scale and that determines how acidic or the base solution in your body is. Acids are electrolytes that release hydrogen ions into water. Since they have a positive charge to water they can combine with other things in the water. Which is like cohesion in which molecules tend to stick to one another.

Diagram

THE CHEMICAL BASIS OF LIFE

• COVALENT BOND

| Name (molecular formula) | Electron- shell diagram | Structural formula | Space- filling model |
|--------------------------------|-------------------------------|-------------------------------------|----------------------------|
| (a) Hydrogen (H_2) | | $H-H$ | |
| (b) Oxygen (O_2) | | $O=O$ | |
| (c) Water (H_2O) | | $O-H$ $ $ H | |
| (d) Methane (CH_4) | | H $ $ $H-C-H$ $ $ H | |

Practice!

- What is the difference between cohesion and adhesion?
 - Cohesion attracts two different molecules and adhesion attracts the same
 - Cohesion attracts the same and adhesion attracts unlike molecules
 - Both cohesion and adhesion attract unlike molecules
 - Both cohesion and adhesion attract the same molecules
- What is an atom made up of?
 - Protons, neutrons, electrons
 - Carbohydrates, lipids, neutrons
 - Electrons
 - Neutrons, and electrons
- What is in a chemical reaction?
 - Reactants and Products
 - Cohesion and Adhesion
 - Atoms and Electrons
 - Acid and Ion

Short Answers

- How is energy related to products and reactants of a chemical reactions?
- What occurs during a chemical reactions?

Bioenergetics: Photosynthesis and Cellular Respiration

Key terms and definitions

Cellular Respiration: the pathway in which cells release energy into chemical bonds of food molecules and that provide energy for our daily life.

Glycolysis:

Adenosine Triphosphate(ATP): soluble molecule that provides energy to reactions throughout the cell

Adenosine Diphosphate(ADP): An organic compound that is composed of adenosine and two phosphate groups

Photosynthesis: the process that converts light energy from the sun into chemical energy stored in compounds

Mitochondria: double membrane-bound organelle found in all eukaryotic organisms

Eukaryotic Cells: an organism that contains a nucleus surrounded by a membrane and whose DNA is bound together by proteins into chromosomes

Citric Acid Cycle: a cycle of enzyme-catalyzed reactions metabolism of carbohydrates, proteins, and fatty acids, and by which carbon dioxide is produced, oxygen is reduced, and ATP is formed

Chloroplasts: the organelles where photosynthesis takes place in eukaryotic cells, having two membranes that surround the stroma

Chlorophyll: green pigment that captures the energy in sunlight

Thylakoids: membrane that contains the chlorophyll in the chloroplasts of plant cells

Stroma- The fluid of the chloroplast surrounding the thylakoid membrane; involved in the synthesis of organic molecules from carbon dioxide and water; sugars are made in the stroma by the enzymes of the Calvin cycle

Stomata(stoma): A pore surrounded by guard cells in the epidermis of a leaf. When stomata are open, CO₂, enters a leaf, and water and O₂ exit.

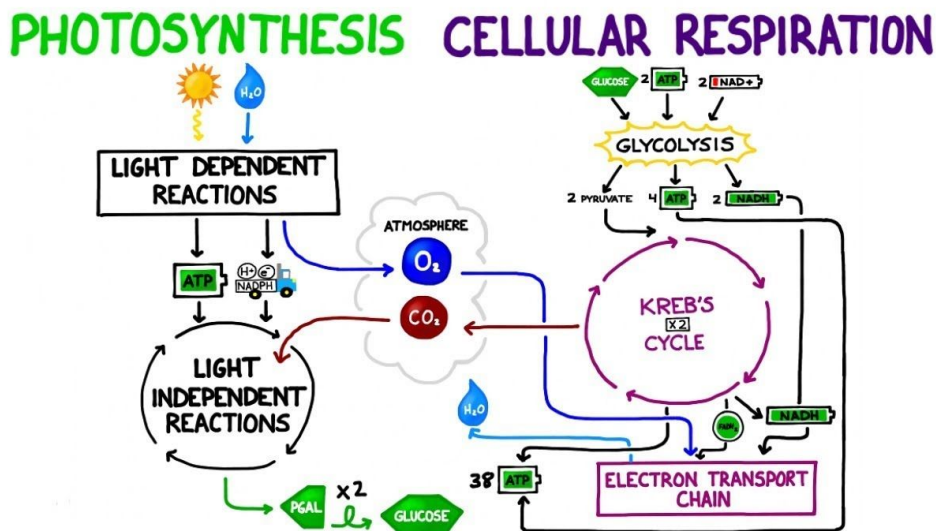
Light Dependent Reactions: The first step of the biochemical reaction in photosynthesis that require light energy that is captured by light-absorbing pigments (such as chlorophyll) to be converted into chemical energy in the form of ATP and NADP

Light Independent Reactions: The second step of the biochemical reaction in photosynthesis that does not require light to proceed, and ultimately produce organic molecules from carbon dioxide. The energy released from ATP (produced during the light reactions) drives this metabolic pathway.

Summary

Bioenergetics can consist of two main topics: Cellular Respiration and Photosynthesis. Both of these are similar in many ways. The products of one process are the reactants of the other. First there is photosynthesis, the process of converting light energy into chemical energy stored in compounds. Photosynthetic organisms use the energy in sunlight to produce glucose and oxygen from carbon dioxide and water. Having the net equation of $6\text{CO}_2 + 6\text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$. The glucose that's produced is then used in the process of cellular respiration. The equation and process for photosynthesis is the exact opposite for cellular respiration which is $\text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 \rightarrow 6\text{CO}_2 + 6\text{H}_2\text{O}$. In photosynthesis glucose is produced so that cellular respiration can use it to produce ATP. But in photosynthesis the glucose is turned back into carbon dioxide. While photosynthesis requires carbon dioxide and releases oxygen, cellular respiration requires oxygen and releases carbon dioxide. It is the released oxygen that is used by us and most other organisms for cellular respiration. We breathe in that oxygen, which is carried through our blood to all our cells. In our cells, oxygen allows cellular respiration to proceed. Cellular respiration works best in the presence of oxygen. Without oxygen, much less ATP would be produced.

Diagrams



Practice!

1. What is the main difference between cellular respiration and photosynthesis?

- a. They are the exact same
- b. Their processes are reversed
- c. Photosynthesis can produce glucose with oxygen.
- d. They consume and create the same substances (water, glucose, oxygen, and carbon dioxide) but in different ways.

2.If in respiration the net equation is consisted of two reactants glucose and oxygen in order to produce carbon dioxide and water, what is the net equation for photosynthesis?

- a. $C_6H_{12}O_6 + 6O_2 \rightarrow 6H_2O$
- b. $6CO_2 + 6H_2O \rightarrow \text{energy}$
- c. $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$
- d. $6CO_2 + 6H_2O + \text{energy} \rightarrow C_6H_{12}O_6 + 6O_2$

3. What product does photosynthesis make that is used in order for the process of cellular respiration to be done?

- a. ATP
- b. Glucose
- c. Carbon dioxide
- d. Water

Short Answers

4. Where does cellular respiration take place in a cell, and how does it ?

5.Explain the process for photosynthesis in which light dependent and light independent reactions are used.

Homeostasis and Transport

Key Terms & Definitions

Semipermeable membrane: a membrane that allows some substances to cross easily than others

Phospholipids: organic macromolecules

Hydrophilic: water-seeking

Hydrophobic: water-avoiding

Aquaporin: a protein channel with a hydrophilic center

Passive Transport: the movement of a substance across the plasma membrane without the requirement of energy

- Diffusion: the movement of molecules or ions down a concentration gradient
- Osmosis: the movement of water molecules from an area of higher concentration to an area of lower concentration
- Facilitated diffusion: the movement of molecules across the plasma membrane with the help of membrane proteins

Concentration gradient: a gradual difference of in the concentration of a substance

Active Transport: the movement of particles from an area of low concentration to an area of high concentration with the requirement of ATP (energy)

- Ion & Molecular Pumps: active transport mechanisms that use ATP to move materials against a concentration gradient
- Endocytosis: the process by which extracellular materials are taken into the cell by forming a membrane vesicle around it
- Exocytosis: the process by which substances are released from the cell into the extracellular environment via vesicles that fuse with the plasma membrane

Endosymbiosis: a theory that early eukaryotic cells were formed from simpler prokaryotes

Endoplasmic Reticulum (ER): a membrane-bound organelle that produces and transports materials for use inside and outside of a eukaryotic cell

- Rough ER has ribosomes and is involved in the production of proteins
- Smooth ER has no ribosomes and is involved in the transportation of lipids and hormones

Golgi apparatus: an organelle in eukaryotic cells that processes materials for release from the cell

Homeostasis: the process of maintaining a stable internal environment

Homeostatic mechanism: a method by which an organism regulates its internal environment

Summary

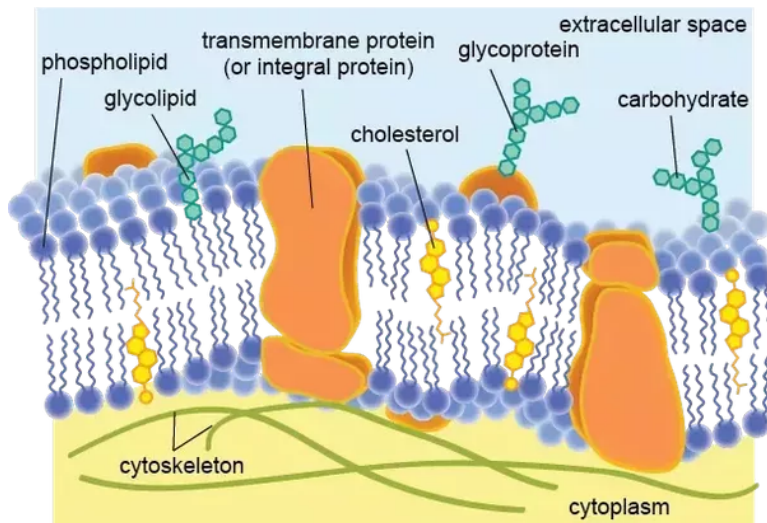
The cell membrane is surrounded by the cell's cytoplasm which controls what substance enters and exits. The term for this occurrence is semipermeable which means only certain substances are allowed to cross the membrane while other substances cannot. The plasma membrane is constructed into two layers of phospholipids called a bilayer. Every phospholipid has a hydrophilic "head" region and two hydrophobic "tails". The midsection of the bilayer is hydrophobic which determines what substances pass through the membrane. Only small and hydrophobic molecules pass through the membrane. The cell membrane has two forms of transportation in cell called active and passive transport. Active transport requires energy to move substances inside and outside of the cell while passive transport does not require energy to move substances. These two forms of transportation have three subtypes each. Passive transport includes diffusion, facilitated diffusion and osmosis. Active transport also includes pumps (ion and molecular), endocytosis and exocytosis. Within the cell are its membrane-bound organelles, the nucleus, endoplasmic reticulum (ER) and the Golgi apparatus. With these there organelles together, they create a transport and packaging system called the endomembrane system. While mRNA from the nucleus are transformed into the ribosomes of the rough ER and smooth ER synthesizing fatty acid and hormones, these substances from smooth and rough ER are packaged into vesicles which are taken to the Golgi apparatus to fuse with its membrane. The Golgi apparatus modifies the substances and begins to prepare for transportation toward the cell membrane.

Homeostasis maintains the body in a constant internal state. For In order to keep the body at its original state, the body is kept at at negative feedback loop which means that any change to

a system were to occur will cause the system to go back to its original state. Also, the hypothalamus area of the human senses and regulates the body's internal state. The body has four homeostatic mechanisms which are thermoregulation, osmoregulation, gas exchange, and the regulation of blood glucose.

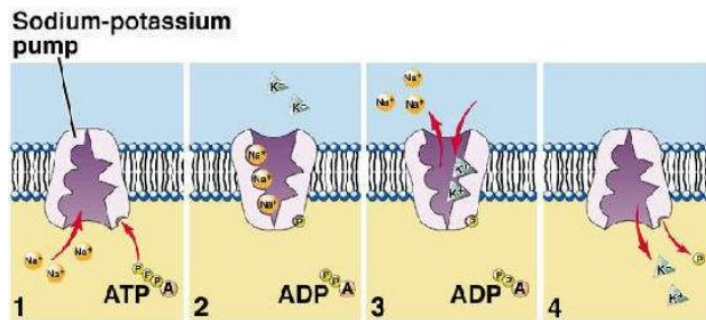
Diagrams

- Phospholipid Bilayer

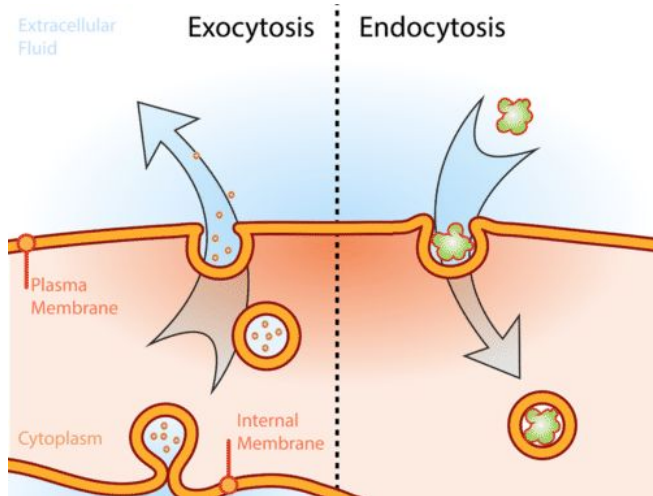


- Active Transport
- Ion & Molecular Pumps

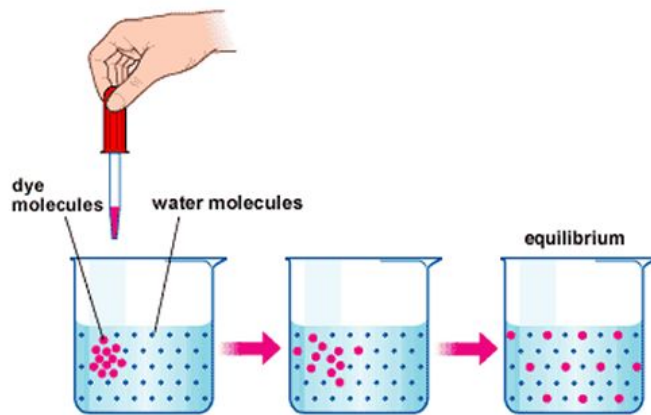
Sodium-Potassium Pump



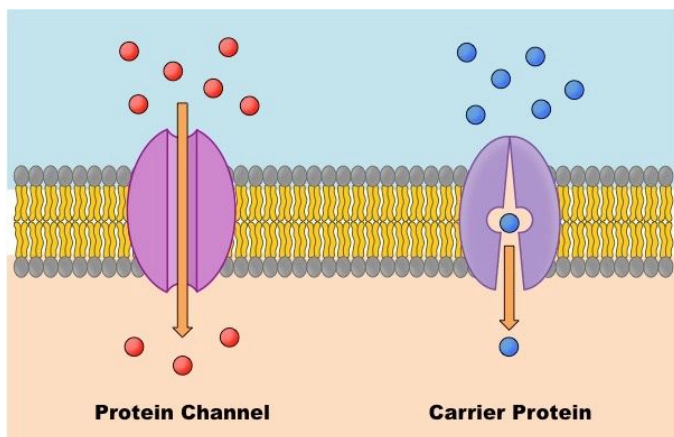
- Endocytosis and Exocytosis



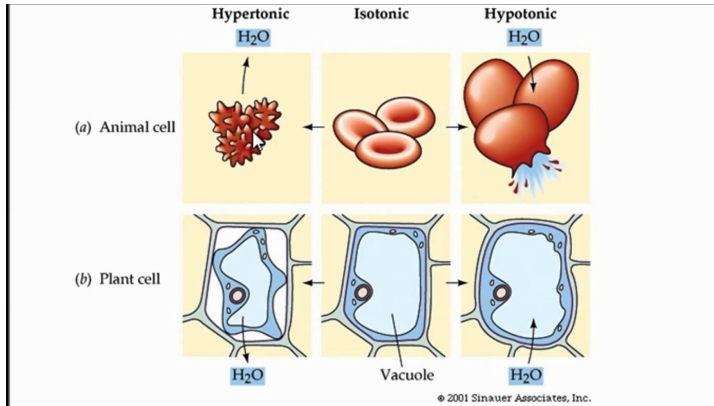
- Passive Transport
- Diffusion



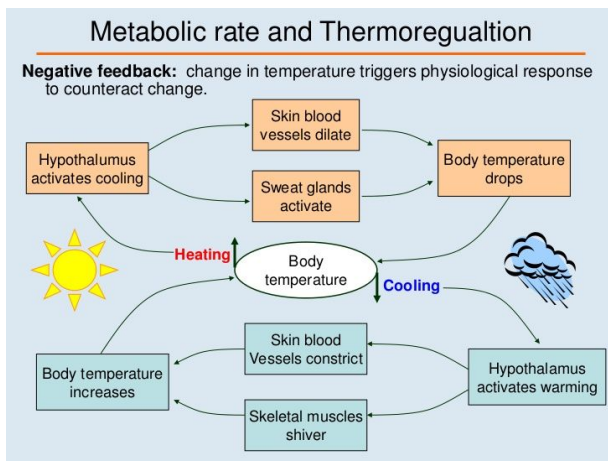
- Facilitated Diffusion



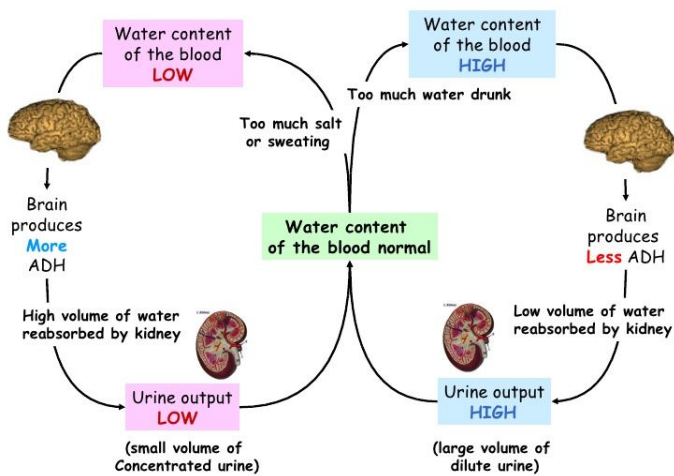
- Osmosis



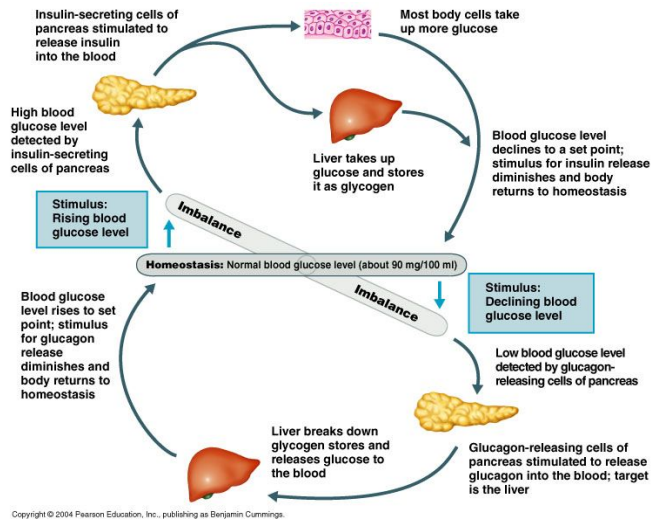
- Homeostasis
 - Thermoregulation



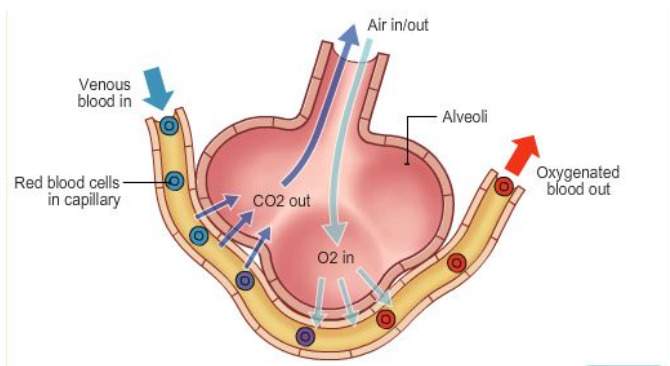
- Osmoregulation



- Blood Glucose Regulation



- Gas Exchange



Practice!

- Which of the following help keep the body at a constant temperature?
 - Thermoregulation
 - Osmoregulation
 - Diffusion
 - Gas Exchange

- Which membrane-bound organelle synthesizes hormones and fatty acids?
 - The nucleus
 - The Golgi apparatus
 - Smooth ER
 - Rough ER

- What part of the phospholipid bilayer causes it to semipermeable?
 - The head area
 - Carrier proteins

- c. The tails
 - d. Membrane proteins
4. When the body's temperature is too high, thermoregulation takes place. What causes the body to decrease its temperature?
 5. If there was an unknown diseases that prevents the body from regulating temperature, what happens to the body if it can't regulate temperature?

Module 2: Continuity and Unity of Life

Cell growth and Reproduction

Key Terms and Definition

Cell Division: the process by which a cell divides into two new daughter cells

Chromosome: is a DNA molecule with part or all the genetic material is store in it

Cell Cycle: a serious events that cells go through as they grow and divide

Interphase: it the longest phase of the cell cycle, the cell grows in the phase

Chromatin: to package to DNA in better and prevent damage from the DNA

Mitosis: it is the form of nuclear division that produces most cells in the body and produces the exact replica of the nucleus and all its chromosomes.

Cytokinesis: the final phase of the cell cycle during which the cytoplasm divides in two.

Prophase: first the stage mitosis when the genetic material condenses and duplicated chromosomes become visible.

Chromatid: a DNA strand in duplicated chromosomes

DNA replication: produces an exact of the genetic material in chromosome

Metaphase: during this phase spindle fibers attach to the centromere.

Asexual reproduction: reproduction without the fusion of reproductive cells

Sexual Reproduction: the process in where cells separate to form a new individual

Sister Chromatids: the identical are joined at the centromere

Semiconservative replication- means that each "new" double strand consists of one original strand and one newly assembled strand.

Prophase: the nuclear membrane begins to break down and the chromosomes become smaller. Centrioles move towards the poles of the cell.

Anaphase: the spindles shorten, they pull the sister chromatids apart, the chromatids from each pair move to opposite poles of the cell

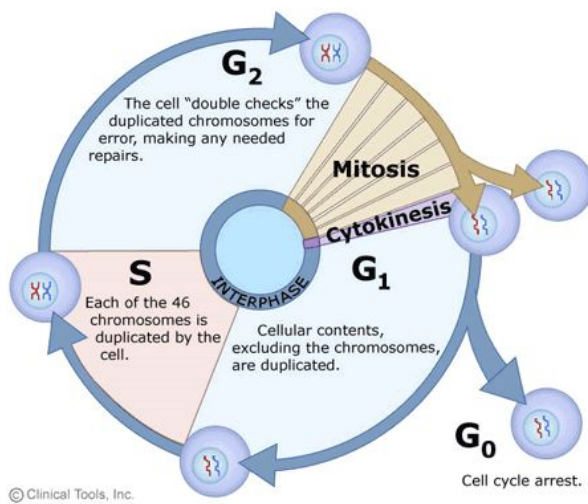
Telophase: new nuclear membranes form around the newly separated chromosomes. The chromosomes unwind becoming longer and thinner.

Enzymes: are catalysts for chemical that take place in the body.

Summary:

A cell goes through a lifecycle just as a regular human. Cells are the ones that make up who we are. A cell passes through three main stages of its life interphase, nuclear division, and cytokinesis. The first stop is interphase and during interphase the cell grows and prepares for cell division. One main stage in interphase is the S stage and it stands for synthesizes a copy of its DNA. The next stage is nuclear division that produces most cells of the body. Which then leads into mitosis which produces an exact replica of the nucleus and all its chromosomes. The chromosomes number stay the same in the two daughter cells that form after they divide. The two daughter cells must have an exact replica of the parent DNA in order for it to be complete. This is called DNA replication. The copies are still joined at centromere which is called sister chromatids until they are at nuclear division. The complementary base pairing base is A with T and C with G. In the final stage the two daughter cells are ready to separate and this is called cytokinesis in this process the cytoplasm, organelles, and the plasma membrane of a cell divide to form two daughter cells. Now you have come to the end of the cell cycle and how they are formed. These are the necessary steps to forming a complete cell.

Diagram



Practice!

1. What stage is the two daughter cells separated?

- A. Interphase
- B. Mitosis
- C. Anaphase
- D. DNA replication

2. What is Mitosis?

- A. The process of duplicating the nucleus of a eukaryotic cell?

- B. The process in which the cytoplasm organelles, and plasma membrane cell divide to form two daughter cells.
- C. The process of a cell life
- D. The process of producing an exact copy of the genetic material

3. If a parent has exactly 46 chromosomes how much does the daughter cells have?

- A. 5 chromosomes
- B. 57 chromosomes
- C. 46 chromosomes
- D. 45 chromosomes

Short Answers

1. What is the longest stage and what happens during that stage.
2. Why must a everything be copied in a cell before dividing into two daughter cells?

Answer Key

Module 1

● **Basic Biological Principles**

1. A
2. C
3. A
4. The regulatory process in which an organism regulates its internal environment.
5. responsiveness to the environment;
6. growth and change;

ability to reproduce; have a metabolism and breathe; maintain homeostasis; being made of cells; and passing traits onto offspring.

● **The Chemical Basis for Life**

1. B
2. A
3. A
4. When energy is absorbed chemical bonds are broken and when energy is released chemical bonds are formed so there is always a involve of change between products and reactants.
5. During a chemical reactions no atoms are created or destroyed. The reactants are broken down and atoms rearrange and form new bonds to make products.

● **Homeostasis and Transport**

1. A
2. C
3. C
4. When the body temperature is too high, the hypothalamus senses the body's temperature and the capillaries start to dilate in order to cools down the body.
5. If the human body cannot regulate temperature, the body will continue the dilation of capillaries.

● **Bioenergetics:photosynthesis and cellular respiration**

1. B
2. D
3. B

4. The mitochondria is where cellular respiration takes place. The reactions for cellular respiration occur on the inner membrane that has a high surface area which allows more reactions to take place at once.
5. Photosynthesis consists of two stages. The first stage consists of the light dependent reactions, sunlight energizing chlorophyll. This leads to chemical reactions that harness the energy necessary for the next stage which uses light independent reactions.

Module 2

● Cell growth and Reproduction

1. C
2. B
3. C
4. Interphase is the longest stage and during that stage the cell grows and reproduces the various proteins and gets the cell ready for division.
5. Everything must be copied before the cell divides because each daughter cell must have the exact same thing or the cell won't be right. If not one cell would be missing different important things.