Biology

Ward/Prater

**Unit 3: Cells and Energy**

**Section 1( LT 1-7)=TBL Quiz 1**

**LT1: I can discuss important scientists in the History of the Cell:**

**Antonie Von Leeuwenhoek (Lay-Van-hook)-1600’s**. Built more than 500 microscopes. He was a loner who never took an apprentice. He took more than 100 years for another individual to make recreate a microscope half as good as the ones he built.

**Robert Hook-1665**-After observing a cork cell, he observed that he reminded him of Monk’s quarters in a monastery and coined the term “cell” to represent the basic unit of life.

**Matthias Schleiden(Shli-den)**-1838-German botanist who concluded that all plants were made of cells

**Theodor Schwann**-1839-German scientist who concluded that all animals were made of cells

**Rudolph Virchow (Fear-co)**-1855, a German physician who studied cell reproduction concluded his research with this: “where a cell exists, there must have been a pre-existing cell” or All cells come from pre-existing cells.

**CELL THEORY**

The work of all of these scientists (**Hooke, Schleiden, Schwann, and Virchow)**

is summarized in what we know as the Cell Theory, which states:

1. **All living things are made of cells. (Hooke, Schleiden, Schwann)**
2. **Cells are the basic units of structure/function in all things(Hooke, Schleiden, Schwann)**
3. **New cells are only produced from pre-existing cells. (Virchow)**

**Lynn Margulis-**1970-An American female scientist working at UCLA (wife to Carl Sagan) who studied mitochondria and thought they resembled bacteria. She discovered that mitochondria contained their own DNA. One of her colleagues discovered that chloroplasts contained their own DNA. With this data, she developed the Endosymbiotic Theory.

**Endosymbiotic Theory-**Theory those bacteria with mitochondria and bacteria with a chloroplast that made its own food developed a symbiotic relationship where the chloroplast made food for both of them and mitochondria did respiration for the both of them. They became so dependent on each other that they began to divide together and eventually swallowed the other and they become the first Eukaryotic Cell

**LT2: I can analyze the similarities and differences among eukaryotic and prokaryotic cells and also plant and animal cells.**

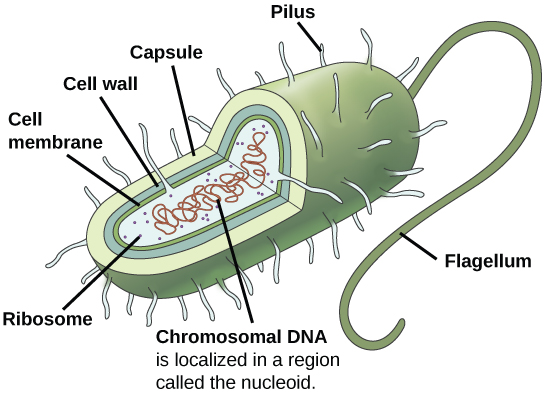
There are two basic types of cells: Prokaryotic and Eukaryotic.

**Prokaryotic Cell-(**Prefix Pro means before and kary means of the center)-Cells that DO NOT have a true NUCLEUS. Even though the genetic material is in a central location, a MEMBRANE DOES NOT SURROUND IT.

Prokaryotic cells do have a few organelles like ribosomes and flagella. However, they have NO MEMBRANE-BOUND ORGANELLES (organelles enclosed in a membrane)! MAKE NOTE THAT THEY DO HAVE A CELL WALL made of PEPTIDOGLYCAN!

The ONLY examples of Prokaryotic cells that we know exist are BACTERIA!

Example: Prokaryotic Bacteria



**Eukaryotic Cell-** (Prefix Euk means true and kary means of the center)-Cells that HAVE A TRUE NUCLEUS SURROUNDED by a NUCLEAR MEMBRANE.

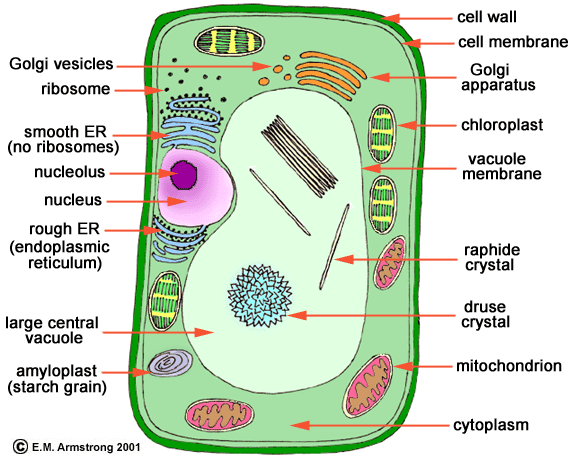
Eukaryotic cells have SEVERAL MEMBRANE ORGANELLES and tend to be LARGER than prokaryotic cells.

Examples: Both Plant and Animal Cells are Eukaryotic even though that each have their own unique cell parts.

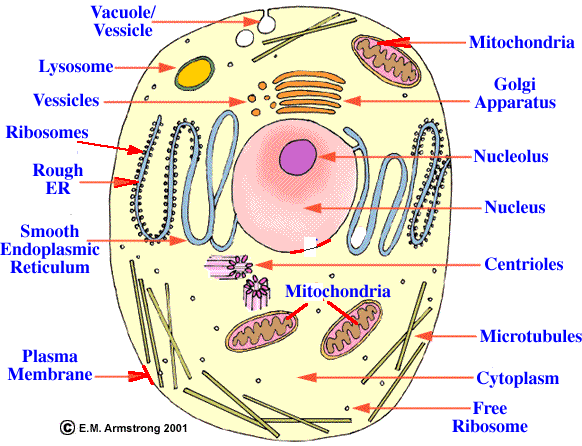
Plant cells-have a cell wall made of cellulose which prevents the thin layered cells from taking on too much water and bursting. and plastids that capture light (like chloroplasts) to do photosynthesis

Animal cells-have centrioles that are used in mitosis (cell division) and some have cilia flagella for movement

Example of a Plant Cell below



Example of Animal Cell Below



**LT: 3- I can describe the functions of all major cell organelles**

|  |  |
| --- | --- |
| **Cell organelle** | **Description** |
| Cell wall | Rigid membrane around the cell that provides strength and support; Found in all types of cells EXCEPT ANIMAL or animal-like cells |
| Plastids | Roles is to carry out the process photosynthesis; includes chloroplasts, leukoplasts, and chromoplasts found in plant cells and some bacterial cells |
| Vacuoles | Storage chambers within the cell for food or water |
| Vesicle | Small storage sac that holes finished proteins that are enclosed in a lipid bilayer just like the cell membrane; |
| Cell membrane | Structure that surrounds the cell and regulates what enters and leaves the cell; All CELLS have a CELL MEMBRANE. Only SOME have an extra layer called a CELL WALL on the outside of the membrane! |
| Golgi Apparatus (Complex) | Flattened sacs for Prepares and packages proteins either for use within the cell or for shipment out of the cell |
| Mitochondria | Double-Membrane structure Nicknamed the “powerhouse of the cell”, the mitochondria is the site of cellular respiration, the location of energy production in the cell |
| Microfilaments & Microtubules | Fibers and tubes of protein that help move internal cell parts (like sliding robots, these structure call for movement of organelles) |
| Rough Endoplasmic Reticulum (RER) | A region of ER that is covered with bumpy looking dots of ribosomes. Ribosomes make proteins and the RER is the site of production and assembly of amino acids into protein This bumpy appearance is the reason for the term “rough”. |
| Smooth Endoplasmic Reticulum (SER) | Looks like the RER, without the bumpy dots; the SER is where lipids and important hormones are synthesized for the cell; \*Hormones can be lipid based or protein based |
| Nucleolus | Seen as a dark spot on the nucleus, its job is to make ribosomes for the cell in subunits which leave the nucleus through nuclear pores |
| Nucleus | The headquarters of operation within a cell |
| Nuclear envelope | Double-Membrane; Surrounds the nucleus and controls what enters and leaves the nucleus |
| Ribosomes | Found attached to the RER (Attached Ribosomes) or floating in the cytoplasm (Free Ribosomes), they MAKE PROTEIN |
| Centrioles (animal cells only) | Short tubes that help to separate chromosomes during Mitosis or Meiosis in animal cells |
| Lysosomes | Structures that contain digestive enzymes for breaking down substances; they often fuse with a vesicles to break down protein stored there. |
| Cilia | Short, hair-like extensions used for movement; mostly in animal cells or animal-like Protists and some bacteria; Cilia usually go all around the outside of the cell |
| Flagella | Long, whip-like extensions on the surface of the cell for movement; They are usually few in number and come in pairs.  (Sperm cells swim have flagella!) |
| Cytoplasm | Semi-liquid portion of the cell where all others organelles and the cytosol are located |
| Cytosol | Liquid-like substance that is composed of water, proteins, and dissolved ions that makes up the cytoplasm |
| Chromatin | Another name for **DNA** located within the **nucleus** of the cell |

**LT: 4 I can explain how all cell organelles work together to make and use proteins.**

Steps:

1. DNA contains the recipe to make proteins.

2. The nucleus commands the cell to copy the DNA into a form that contain leave the nucleus called the mRNA or messenger RNA. (The messenger is a like the DNA with a few little differences)

3. The mRNA carries the recipe for proteins out of the nucleus and to the cell part known as the ribosome.

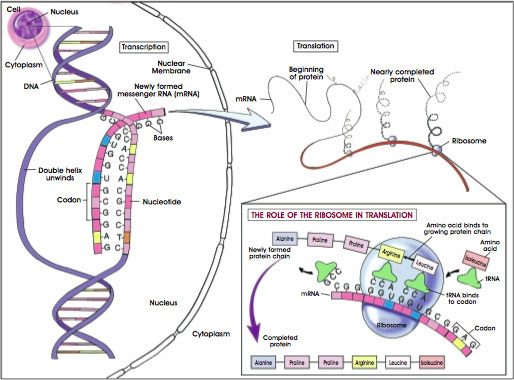
4. MRNA molecule binds to the ribosome on the lower side

5. mRNA bound to the ribosome sends a signal for the tRNA (transfer RNA) to bring down the amino acids needed to make the protein. The upper side of the ribosome is where the amino acids are linked together to make protein.

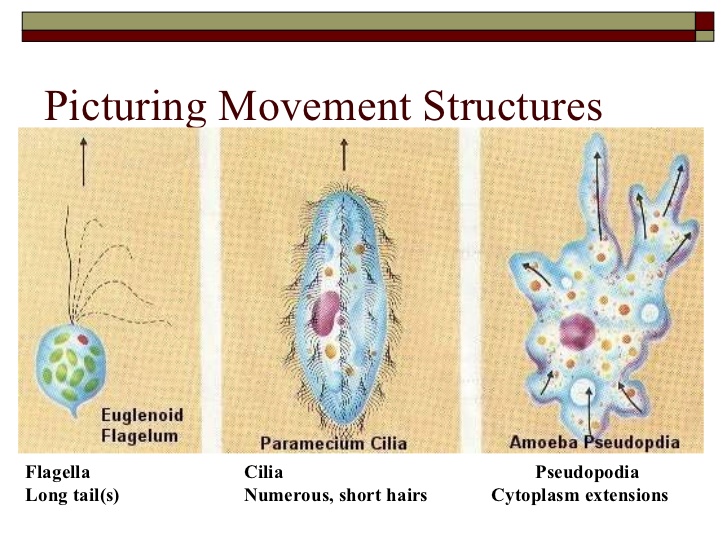
6. The ribosome hook together the amino acids together to make the protein. Remember ribosomes are either Free or Bound to the RER.

7. Some finished proteins move the Golgi Apparatus (Complex) where they’re sorted and packaged into a transport or storage vesicle. The proteins themselves have markers on the surface which allows the cell to know which storage vesicle they belong in.

8. Packaged proteins are contained inside sorted vesicles. The vesicles fuse with the cell membrane and proteins are released from the cell!



**LT: 5 I can distinguish between cilia and flagella**



Unicellular organisms use several methods to move from one location to another: Cilia, flagella, and pseudopodia.

**Cilia**-There are two groups of cilia: motile and non-motile.

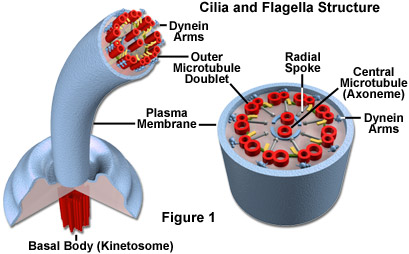
Non-motile Cilia (Primary Cilia)-Found on almost every eukaryotic cell. Research suggests that primary cilia may play a role in controlling cell growth, transmitting cellular information, and recognizing chemical signals

Motile Cilia are numerous on the cell surface for movement. Motile means used for movement Ex. paramecium can have 4,000!

Either motile or non-motile cilia are part of every eukaryotic cell. Important examples include cilia in our lungs that clear mucus, cilia in our inner ear to coordinate balance, and cilia in the female reproductive tract to move eggs down the fallopian tubes, cilia in our eyes distinguish light waves.

**Flagella**-are long, whip-like projections that are used for motion in cells; typically longer and fewer in number than cilia and almost always are in pairs 2, 4, 6. Ex. Green algae have 2 flagella.

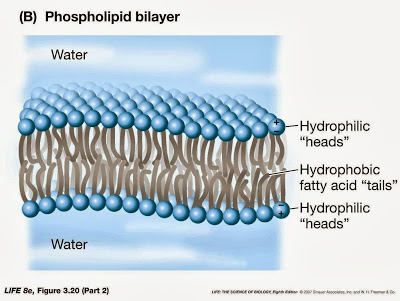
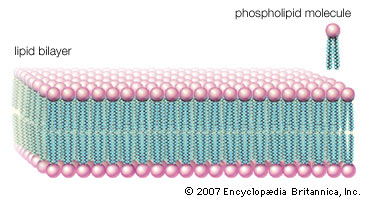
Human sperm cells have flagella\*



**Pseudopodia** extremely flexible regions of cell membrane that are finger-like that allow and organism to stretch themselves in any direction or shape. Ex. include amoeba. - (pseudo means false and podia means feet)

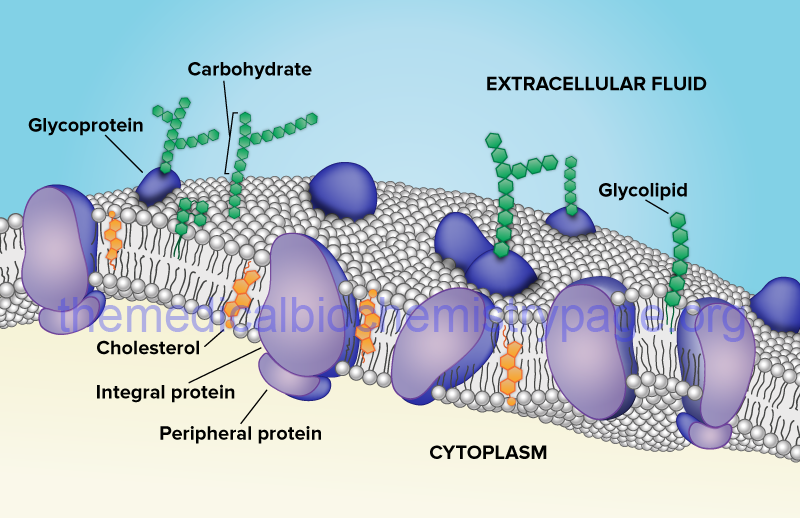
**LT: 6 I can explain how the cell membrane controls movement of substances both into and out of the cell and within the cell.**

Phospholipid Bilayer of the Cell Membrane below



Heads of the bilayer-made of phosphate and found on the outside of the cell membrane, the head region is hydrophilic. This means that they let water pass across.

Tails-made of fatty acids (lipids). Oils and fats are lipids. Everyone knows that oil and water do not mix. The tail region of the bilayer is hydrophobic. This means that water CAN NOT PASS!



The purpose of the Cell Membrane is to regulate the movement of materials into and out of the cell.

The cell membrane **is semi-permeable or selectively permeable**. This means that only certain substances can go through the membrane.

The **proteins** found on the surface serve to **recognize certain molecules** that need to get across the membrane.

**What can’t pass through?** Large or charged molecules cannot pass directly through the **phospholipid bilayer**.

**Movement Across the Cell Membrane**

Important terms in movement across a membrane is concentration and equilibrium.

Concentration-mass of solute dissolve in a given volume of solution (water)

**With the Concentration Gradient**-means movement from side where a substance is in high concentration towards a side where it is in low concentration or H🡪L.

Equilibrium-when the concentration of a solution is the same on the inside and outside of the membrane

**LT7: I can explain how the cell membrane maintains homeostasis.**

**Hormones**-are chemical messengers that regulate some body functions in multicellular organisms. One function of hormones is to help maintain homeostasis.

* Control the movement of oxygen into cells and removal of carbon dioxide from cells
* Maintain internal temperature of organisms
* Regulate fluid level

**Individual Cells**-Move fluids and nutrients in and out regulated by their semi-permeable cell membrane. This also helps to maintain homeostasis.

**Section 2 (LT 8 only)=TBL Quiz 2**

**LT8: I can describe types of cell transport: osmosis, diffusion, facilitated diffusion, and active transport.**

**Two categories of Movement Across the Membrane; Passive and Active Transport**

**Passive Transport**-molecules move spontaneously through a membrane from high to low concentration. Without using energy.

How does this work? If two substances are present in unequal concentrations on either side of a membrane, and the substance isn’t too large or charged to cross the membrane, it will move toward the area of lowest concentration until the two sides are in equilibrium

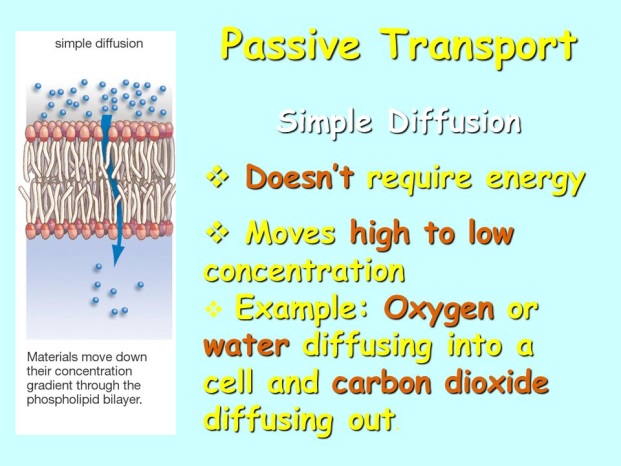
Permeable-allows the substance to cross the membrane

Impermeable-the membrane will not allow the substance to cross the membrane

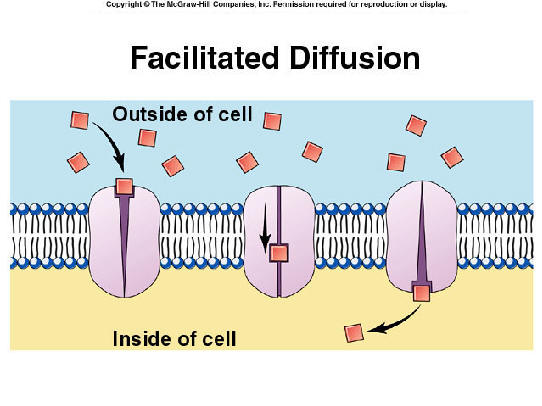
Semi or selectively permeable-only certain things can pass across the membrane

**Three kinds of Passive transport:**

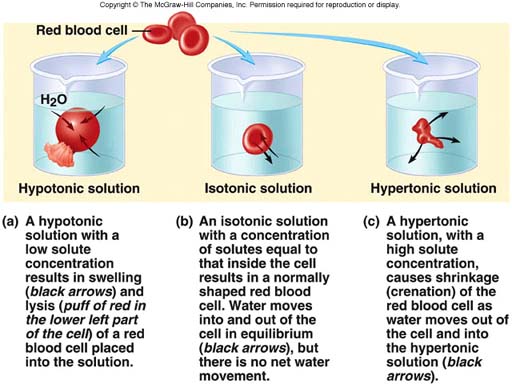
1. **Diffusion**-Process by which substances move directly through the cell membrane from high to low concentration.



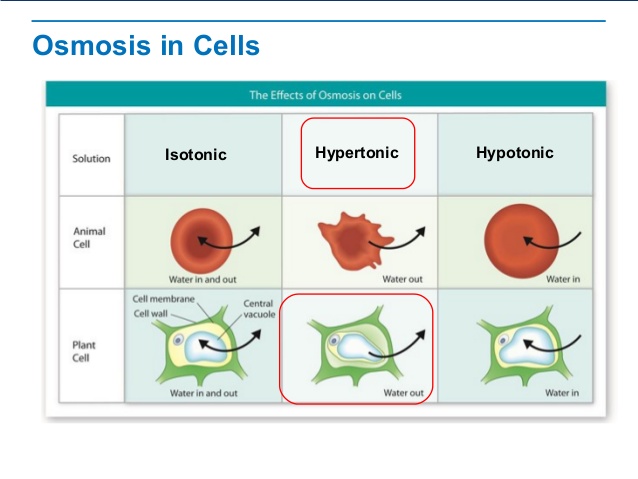
2. **Facilitated Diffusion**-Movement of substances from high to low except that MUST move through a PROTEIN CHANNEL. Large molecules like glucose and ~~charged molecules~~ sometimes move across in this manner.



3. **Osmosis**-Diffusion of water across a membrane from the high water concentration side to the low water concentration side. Osmotic pressure is created due to differences in concentration on two sides of a membrane of substances that the membrane is impermeable to.



The hypertonic side (high solute side) of the membrane will be hypotonic water side (less water. The hypotonic side (low solute side) of the membrane will be the hypertonic water side (high water concentration side).



Plasmolysis-cell membrane shrinks away from the cell wall in a plant cell when placed in a hypertonic (salty or sugar) solution!

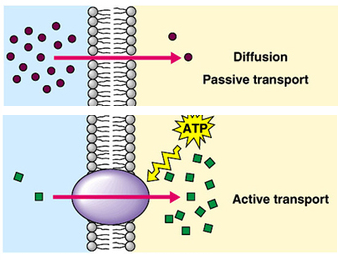
Real-Life examples of Diffusion: Kidney dialysis, preserving food such as salt-cured or sugar-cured (hypertonic) meats by drawing water out of the cell.

**Active Transport**

**Active transport-**movement of a material from a lower concentration to an area of higher concentration. This is against the concentration gradient. Active transport REQUIRES ENERGY TO MOVE SUBSTANCE LOW TO HIGH!

Carrier proteins-proteins embedded in the phospholipid bilayer that is specifically shaped to accommodate the type of molecule they carry. The fit together like a lock and key.

Where do cells get the energy for Active transport? ATP molecules!



**Processes that require Active transport include:**

1. ATP opens the protein channel for a carrier molecule bring across a specific molecule

**Bulk (large items like proteins or whole cells) transport:**

2. **Endocytosis**-cell membrane folds itself forming a vesicle around a substance and pulls it into the cell. Requires ATP

Endocytosis including **phagocytosis** (cellular eating), **pinocytosis** (cellular drinking), and **receptor mediated endocytosis** (receptor protein on the surface recognizes a substance and opens the membrane

3. **Exocytosis**-removal of large amounts of material from a cell by force. Requires ATP

**LT: 9 I can identify the cellular sites of anaerobic and aerobic respiration;**

**LT: 10 I can compare reactants and products for each process and account for how aerobic respiration produces more ATP per monosaccharide.**

**Aerobic Respiration-**cellular respiration that occurs in the **mitochondria** of the cell; Oxygen must be present**. The processes occurs in 3 phases**

**REQUIRES OXYGEN!**

**Cellular Respiration Equation**

**C6H12O6 + 6 O2🡪6CO2 +6H2O energy (Takes place in the mitochondria)**

**Can make 36-38 ATP’s!**

**1. Glycolysis-**Glucose is broken in half into two 3 carbon molecules called Pyruvic Acid or Pyruvate. This happens in the **cytoplasm.** The energy released from breaking the glucose bond produces 2 ATP and gives off some high-enrgy electrons that are given to NAD+(carrier molecule) forming NADH

**Products:** 2 pyruvic acid molecules, 2 ATP’s and 2 NADH

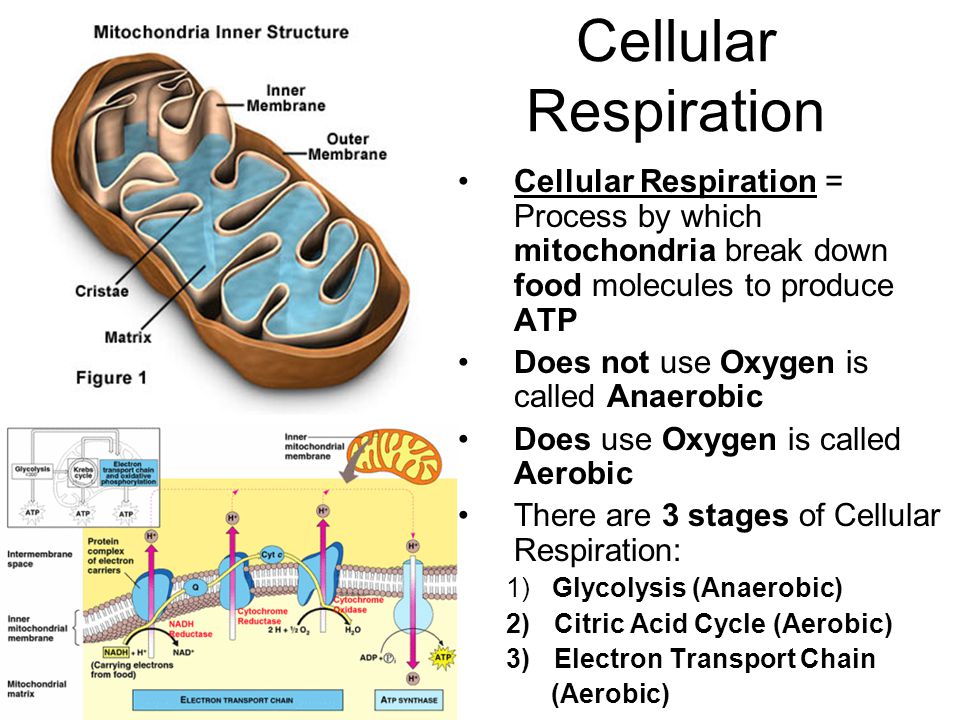
2. **Krebs Cycle**-2 Pyruvic Acid molecules enter the matrix of the **mitochondria** along with oxygen. They are converted to Citric Acid. (Some books call the Krebs Cycle the Citric Acid Cycle). Krebs Cycle produces more ATP and some GTP (another energy molecule) and more NADH is formed

Products:CO2, citric acid is given off as a by-product; ATP, NADH, GTP

3. **Electron Transport Chain**-The NADH releases hydrogen ions and high-energy electrons picked up during glycolysis and the Krebs Cycle. The energy from these is used to make large quantities of ATP. The electrons are transferred like dominoes through a series of carrier proteins. The final electron acceptor is oxygen (this is why we need to breathe oxygen) which forms a water molecule. (This process happens in the folds of the mitochondria called the cristae.)

**By-product is H2O**

**Product: 36-38ATP**



**Anaerobic Respiration or Fermentation**

**Anaerobic respiration-**process by which sugar is broken down to produce ATP in the absence of oxygen. Glycolysis occurs just like in aerobic respiration but once Pyruvic Acid is formed,

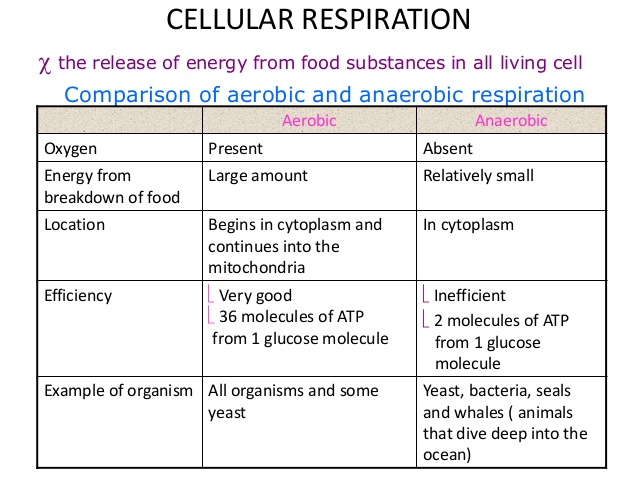
fermentation occurs to make just enough energy to regenerate glycolysis. This happens in the cytoplasm

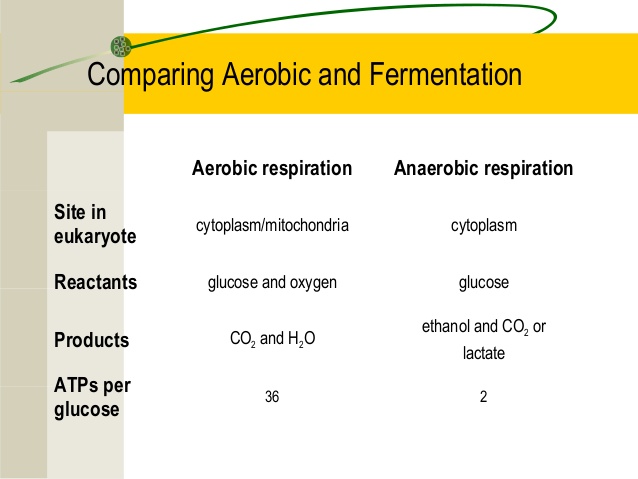
**Lactic Acid Fermentation**- Pyruvic acid is converted into lactic acid, releasing NAD+ the electron carrier needed to start glycolysis again. Only produces a net of 2 ATP’s!

Ex. Human muscle cells, fungi (yeast), some bacteria carry out anaerobic respiration via lactic acid fermentation

**Alcoholic Fermentation**-Pyruvic acid is converted into ethanol (ethyl alcohol), C2H5OH and NAD+, the electron carrier needed to start glycolysis again. Only produces a net of 2 ATP’s

Comparing Aerobic to Anaerobic Respiration





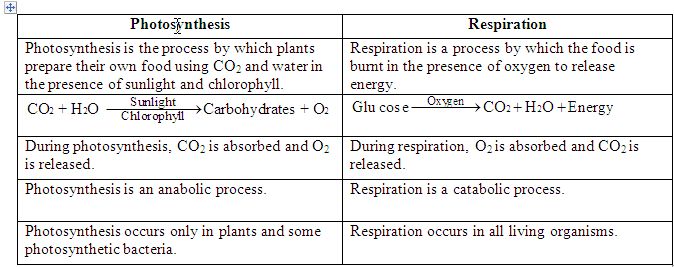
**LT: 11 I can describe how organisms use the energy made by the processes of photosynthesis and respiration.**

All organisms must be able to obtain and convert energy to carry out life functions. **Photosynthesis** is one way that organisms can trap energy from the environment and convert it into a source of energy.

**Cellular respiration** is a way that organisms can break down energy sources to carry out life’s process. Photosynthesis takes place in plants, protists, algae and some bacteria. Cellular respiration takes place in all eukaryotic cells and some prokaryotic cells

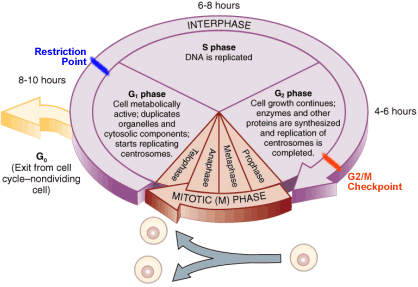
Photosynthesis-Process where plants, algae, or cyanobacteria absorb sunlight and convert CO2 and H20 into glucose.

6CO2 + 6H2O🡪C6H12O6 + O2 Inside the chloroplast



**LT: 12 I can describe the basic process of mitosis and explain why it must occur**

**Cell Cycle Diagram**



**Interphase-Consists of G1, S, and G2 of the cell cycle.**

G1-Cell grows in size

S-DNA (chromosomes) are copied

G2-Continued growth of the cell, enzymes and other proteins are produces, and centrosomes are produced, **duplicates organelles**

**Mitosis (M)-The cell copies itself and (nucleus) divides into two cells that are identical cells called daughter cells, identical to the parent cell**. Since the two daughter cells have the same number of chromosomes as the parent cell they are said to have (diploid) or 2n chromosome number.

Mitosis happens in **somatic cells**. Somatic cells are all cells in an organism EXCEPT sex cells (sperm and egg)

Since only 1 parent is required and exact copies of the original cell are made, this is asexual reproduction.

Why do cells divide by mitosis? To grow or repair cells

**Stages of Mitosis Division**:

**Prophase**-The nucleus organizes the chromatin material into thread-like structures called chromosomes

**Metaphase**-The chromosomes attached at the centromeres line up at the center of the cell

**Anaphase**-Chromosomes separate at the center and are pulled toward either end of the cell. A nuclear membrane forms around the chromosomes.

**Telophase**-Chromatin again forms from the chromosomes, and a cell membrane begins to grow around the center between the two new nuclei

Phases of Mitosis

