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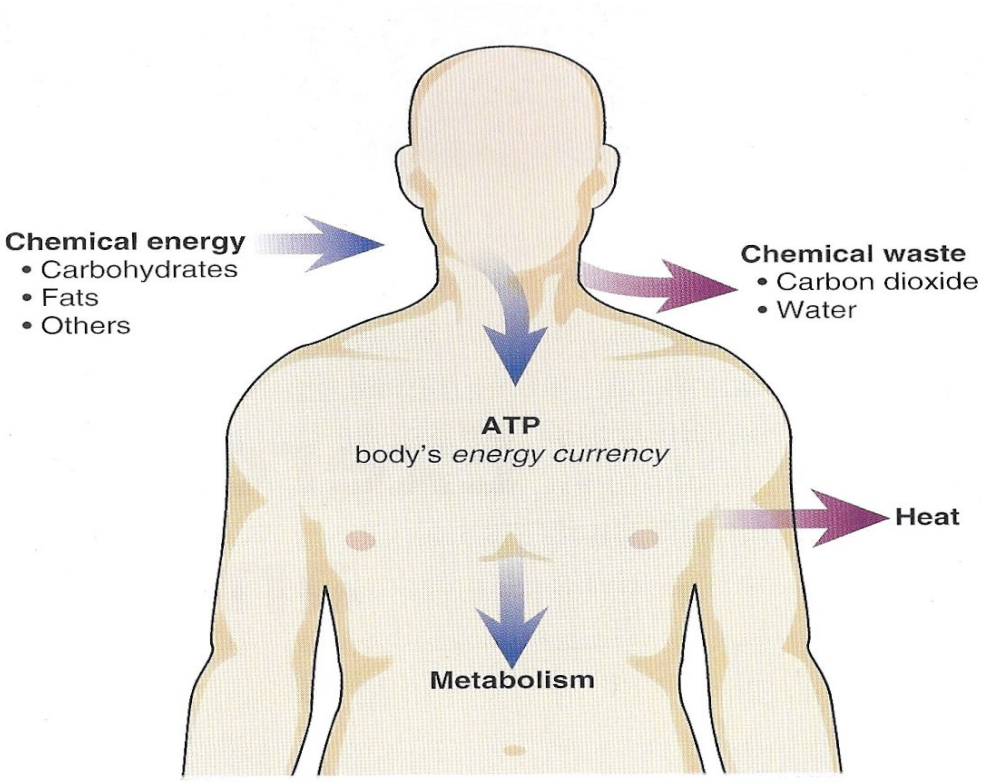
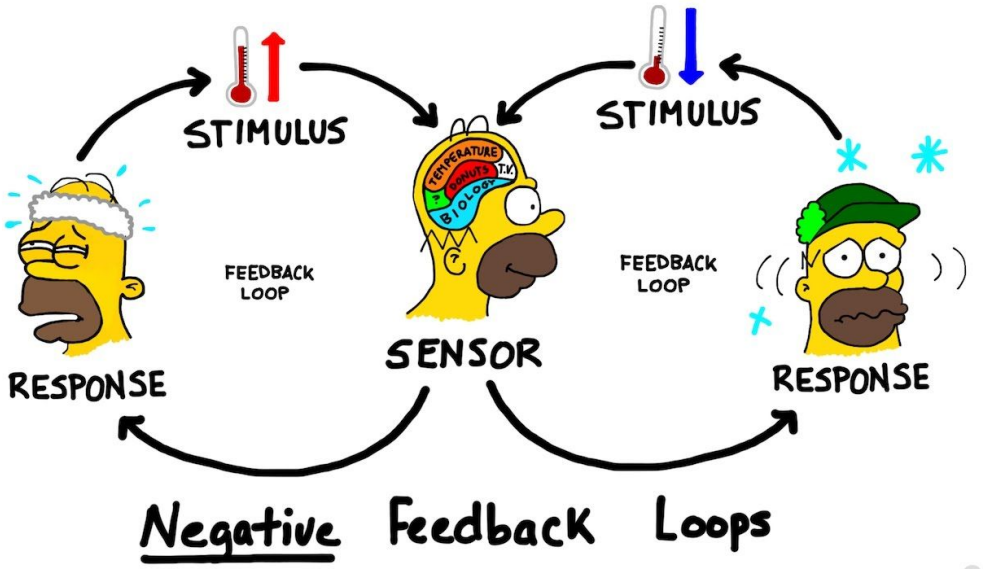
Chapter 1: Cells and Cell processes

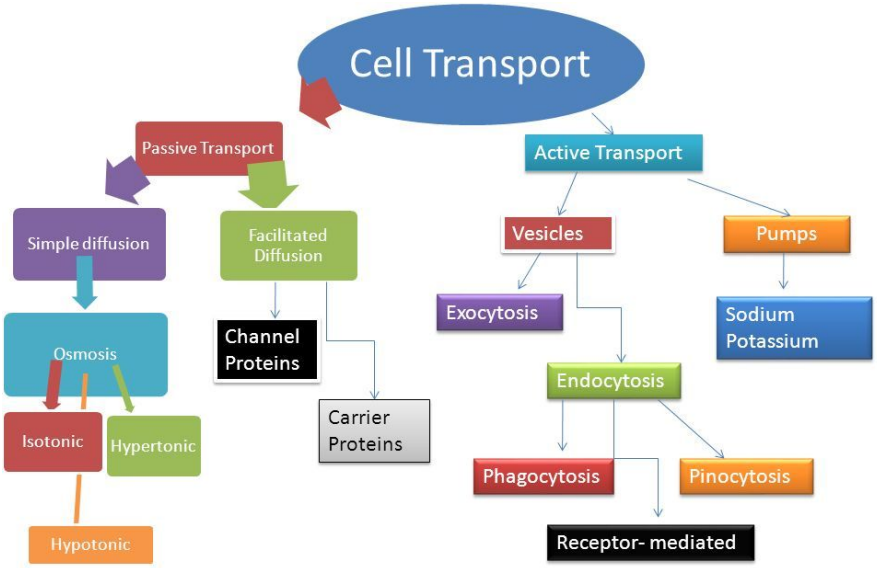


Bioenergetics

ATP also known by Adenosine Triphosphate, is a small soluble molecule that provides energy to reactions throughout the cell. For this reason, ATP is known as the “energy currency” of cells. ATP is continually produced and consumed in the cell. Without a constant supply of it, the cell would not be able to do various functions. The energy required to reassemble ATP is provided through cell respiration. This process breaks down organic molecules, like glucose, which is found in foods (It also uses oxygen, which then turns into carbon dioxide). Respiration takes place in 3 different stages and parts of the cell (all of which release a bit more of the chemical energy stored in glucose). The first stage is in the cytoplasm where Glucose molecules are broken down into smaller molecules. Oxygen is not needed in this process and only two molecules of ATP have been produced so far (from the energy of the glucose molecule). Then the second stage takes place in the matrix of the mitochondria (the powerhouse of the cell), where Enzymes in the matrix help break down the products of glucose, at the same time the carbon compounds of glucose turn into carbon dioxide. Finally in the third stage, still in the mitochondria, is where ATP is produced. During the first two stages hydrogen ions have been building up, and have been being stored in the matrix of the mitochondria. In the third stage, these Ions flow into the inner membrane of the mitochondria working as fuel for an enzyme called ATP synthase, which then synthesizes ATP from ADP and Phosphate. And as the ions exit the matrix, ATP is produced.

Photosynthesis is the process of converting light energy from the sun into chemical energy compounds such as glucose (a process that only happens in plants). Photosynthesis uses up carbon dioxide and water to produce oxygen, at the same time ATP is produced directly from this process and is stored in the form of glucose. With the help of cellular respiration, the glucose made by photosynthesis gives the plant energy which it can use to do various stuff as form cellulose (a molecule that strengthens the plant), be stored in a macromolecule such as starch for later use and to carry out chemical reactions. All of these reactions happen in Chloroplast, which are organelles in the cell that absorb sunlight in order for photosynthesis to happen. The stroma (the inner liquid) of the chloroplast surrounds stacks of “disks“ known as thylakoids which contain chlorophyll which is a pigment that captures sunlight. Photosynthesis has two stages. The first one is full of light dependant reactions; This leads to a chain of chemical reactions that harness energy, through chloroplasts, for the next stage to happen. In the second stage of photosynthesis no light is required, but products from the past stage are used to make glucose. This whole process of obtaining light and converting it into energy is called photosynthesis.



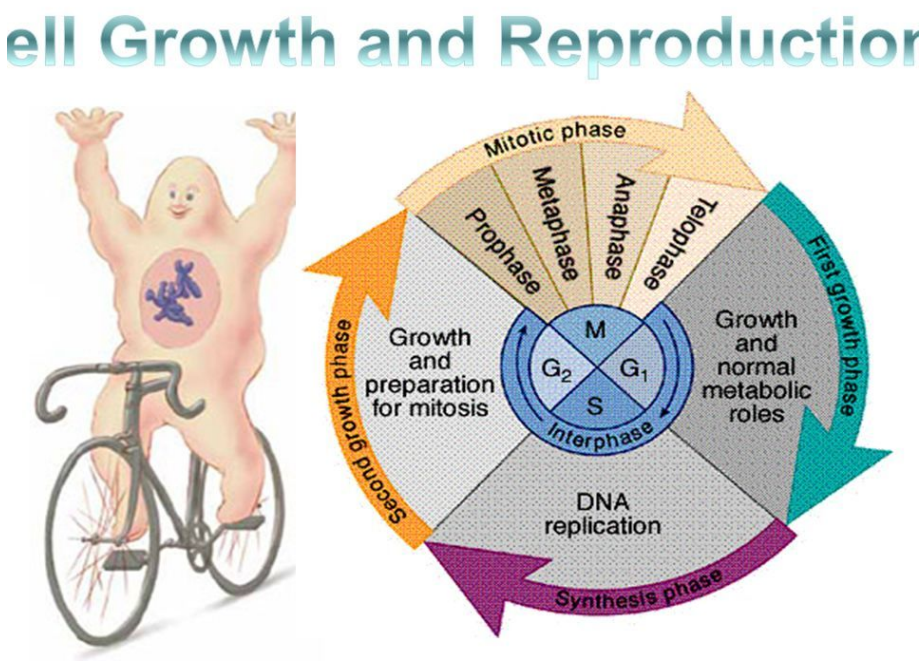


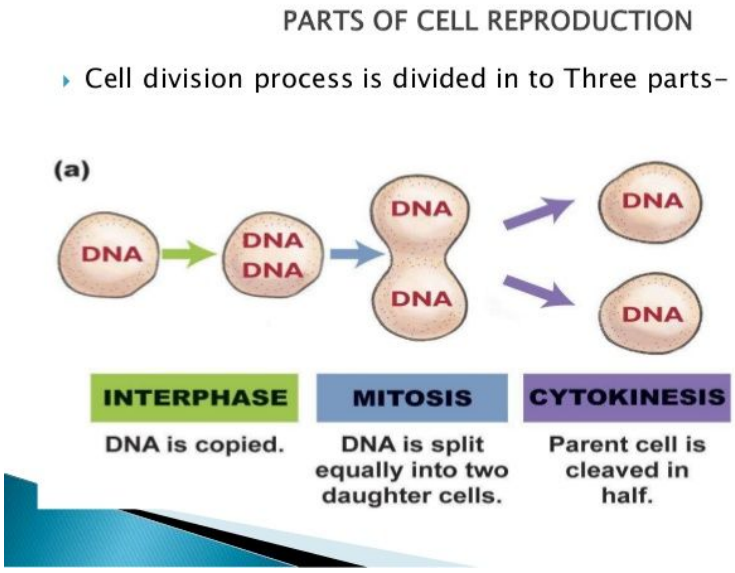
Homeostasis and transport:

Homeostasis is a mechanism in the body similar to that of a central heating and cooling system in a home. The process of changing the temperature in a room from hot to cold (or otherwise) happens in the body. The body must always remain at 98.6°F, for this to happen, The hypothalamus in the brain is the one that senses the temperature in the blood (inside) and signals body parts to release or restrain heat though various methods. Some methods can be Shivering, perspiration, dilation, etc. Perspiration cools the body through evaporative cooling, known as sweating. While Dilation happens in vanes, when they widen or shrink in order to heat the body. Osmoregulation is another mechanism of the body that helps regulate and balance water and solutes in bodies. This process helps by either signaling the body that it needs water through the feeling of being thirsty or through urinating excess water with very dilute urine. The body's cells require oxygen in order to carry out respiration and provide oxygen to the body, the way they do this is through alveoli in the lungs which are surrounded by capillaries. Gases exchange between the air inside the alveoli and the blood flowing through the capillaries achieving gas exchange. Blood glucose is another way the body maintains homeostasis. Blood glucose in the body requires around 90 mg / 100 ml of glucose. If there is too much in the body, the pancreas detects it and releases the hormone insulin, it causes cells of muscles, liver and other tissues to allow more glucose to cross the plasma membrane. The liver then converts this glucose into glycogen, bringing the blood glucose back to normal. When blood glucose is lower than 100 ml, the pancreas secretes glucagon, which breaks down the stored glycogen and release the glucose into the bloodstream. These processes make up homeostasis.

Passive transport moves material down its concentration gradient. It requires no energy input and stops once equilibrium is reached. However, some cells require a concentration gradient to

be created and maintained. This is done with the Plasma membrane which is a semi-permeable organelle in cells which lets small materials in but does not let large materials in either. Another example is through the phospholipid bilayer which is a layer in the cell that consists in two layers of phospholipids, arranged into “sheets” called bilayer. These “sheets” have a polar “head” and nonpolar “tails”. While the heads are hydrophilic the tails aren’t and this allows for water to pass through but very slowly. Other molecules like oxygen and glucose (bassically monosaccharides) can pass through the bilayer while big molecules like disaccharides and polysaccharides cannot. Other cells must take in or expel materials too large to fit through a membrane protein (another type of transport in the cell). When passive transport will not get the job done, cells resort to active transport, which requires energy in the form of ATP. This transport works with proteins and requires energy to work. It can go against the concentration gradient and let big molecules in with the help of proteins. Active transport also uses these membrane sacs called vesicles which transport materials through the cytoplasms and export proteins as well as other molecules.





Cell growth and reproduction:

Every multicellular organism begins with a single cell that then divides into two and then 4 and so on… Until a full body full of tissues and organs and trillions of cells is formed. Cell division continuous through life growing and repairing tissues as well as damaged cells. A cell pases through three main stages in its lifetime: Interphase, Nuclear Division and Cytokinesis. The longest of these being interphase as it by itself is divided into three stages. During Interphase a cell grows and prepares for cell division, An important stage of interphase is S (which stands for synthesis), because this is when a cell synthesises a copy of DNA. The form of nuclear division that produces most cells of a body is Mitosis, which produces an exact replica of the nucleus and all its chromosomes. The final stage of the cycle is cytokinesis, in which the original parent cell splits into two daughter cells. For a cell to form two identical daughter cells, it must duplicate its nucleus. If a parent cell has 46 chromosomes, each daughter cell must also have the same amount of chromosomes. This requires making a copy of DNA. Before DNA replication, it must produce an identical copy of a chromosome “arm”. Each “arm” is joined by a centromere - connecting two, making a sister chromatid. Now, DNA replication starts and is carried out by enzymes. At the beginning of this process, DNA helicase binds to a site of the double stranded DNA and begins separating the two strands. The pairing of new nucleotides follows complementary base pairing rules (A-T, C-G). As a result, one new strand came from the original and the other one newly synthesized. Mitosis is the duplication of the nucleus divided in four phases (Prophase, Metaphase, Anaphase and Telophase). At the end of mitosis, 2 new nuclei have formed. Finally in cytokinesis the two nuclei form into two new (daughter) cells.

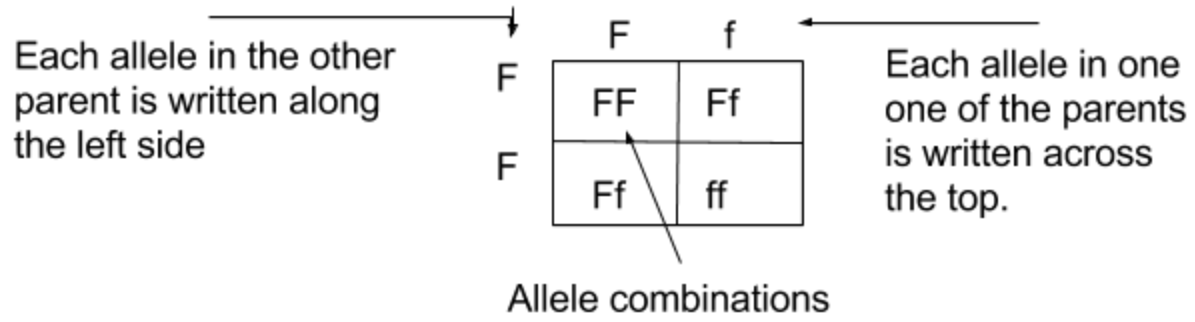
Miosis is a type of cell division that produces gametes (which hold one chromosome of each pair/ two Allele). An Allele is a version or “flavor” of a gene. Meaning one side of a gene - though they are two in a body. Meiosis produces gametes through two stages. It starts with a normal number of chromosomes due to S from the cell cycle. First, pairs of homologous chromosomes

are separated, with each daughter cell keeping one chromosome from each pair. The second stage (meiosis 2); Each replicated chromosome is separated in two. The daughter cells still have the normal number of chromosomes, but now the chromosomes are unreplicated. Crossing-over is the exchange of genetic material between homologous chromosomes (meaning one pair from the father, and one from the mother) which occurs early in Meiosis 1. Crossing-over "shuffles" genetic material so that each sister chromatid is different. In Meiosis two cell divisions take place, during each stage, it takes the same phases as Mitosis: prophase, metaphase, anaphase, and telophase but with slight variations. During the first stage of Meiosis everything ends up almost the same as Mitosis, however during Telophase 1 the two daughter cells will have half of the normal chromosome numbers. During Prophase two, chromosomes condense for a second time, and new spindles form to separate the nucleus again. During Metaphase two the spindles attach to the centrosomes of the sister chromatids. Then in Anaphase two the spindles shorten and the chromatids separate. Finally in Telophase 2, new nuclear membrane is formed and four daughter cells have been made.

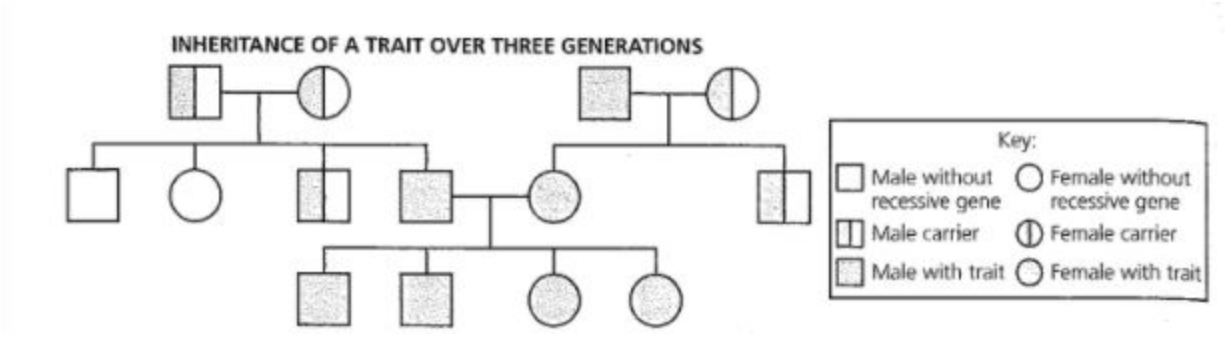
Genetics:

A gene is a region in a DNA that codes for a specific protein. Genes come in different versions, called Alleles. An organism's Allele and its environment determine the organism's traits. This can also be recalled to the Meiosis stages, though those were mainly gene changes from reproduction, while the changes we are going to talk about, are from your daily life. In most cases, traits are polygenic, meaning that they are determined by a number of different genes located on different chromosomes. More rarely, a single gene can determine a single trait. Just as there are different versions of a trait- there are different versions/ alleles of genes that can determine those traits. The gene that determines height in pea plants has two different alleles- one causing a tall phenotype and one causing a short one. A phenotype is the appearance of a trait. The body cells of most sexually reproductive organisms contain two alleles of each gene. An organism may have inherited two identical or different alleles for a gene. The combination of alleles in an organism's cells is its genotype. If a pea plant inherits two dominant alleles (expressed if individual inherits just a single copy of the allele) then, it expresses the dominant phenotype. If it inherits two recessive alleles (expressed if individual inherits two copies of the allele), it expresses a recessive phenotype. A recessive allele is expressed only if the individual inherits two copies of the allele. A heterozygous(different alleles) organism inherits one of each allele. Because dominant allele masks the effects of recessive allele, this organism will show the dominant phenotype. Remember that a gamete contains only one chromosome of each pair. Therefore, it contains one of the two alleles making up the organism's genotype.

To predict inheritance, scientists use Punnett squares to show the possible allele combinations and phenotypes of the offspring of a given set of parents. Punnett squares show the probability that each offspring will have a given genotype. This is a diagram of a Punnett square…



In this example, the probability that an offspring will be heterozygous is 50%. The probability that an offspring will be homozygous(same alleles) recessive is 25%, and the probability that each child of these parents will be homozygous dominant is 25%. Note that a Punnett square cannot be used to trace inheritance of a trait through multiple generations of related individuals. However, a pedigree chart can. In a pedigree, males are typically represented by squares and females are by circles. Shaded shapes indicate that the individual has the trait in question. Half-shaded shapes indicate the individual is a carrier of that trait but does not express the trait. A horizontal bar directly connecting two individuals represents a set of parents. A horizontal bar joining short vertical branches represents all the offspring of a set of parents.



Not all genes have one dominant and one recessive allele. Some alleles may show incomplete dominance, meaning that a heterozygous individual has a phenotype that differs from those with either homozygous genotype. The inheritance of flower color in snapdragons is an example of incomplete dominance. The allele R results in the red flower phenotype and the allele r results in white flowers. However, heterozygous flowers are pink, meaning that the phenotype is “in between”. Alleles may also show co-dominance, meaning that heterozygotes express both the dominant and recessive phenotypes, rather than a blend of the two. Some genes have more than two possible alleles. ABO blood type in humans is one example of a multiple-allele trait. Within the human population, there are three blood type allele I^A, I^B and *i*. Each person has only two of the possible three alleles. Instead of three possible genotypes, multiple alleles produce a larger number of genotypes. (The ABO blood type gene is also an example of an example of co-dominance).

In humans and many other animals, a single pair of chromosomes, called the set chromosoms, determines an individual’s sex. The human se chromosomes are the X chromosomes and the Y

chromosome. An XX individual is female, while an XY individual is male. The X chromosome is much larger, and contains many more genes, than the Y. Most genes on the X chrm. Determine traits that have nothing to do with being male or female. Males who have only one X chrm., therefore have only one allele of each of these genes. Traits governed by the genes on a sex chromosomes are called sex-linked traits. Non-sex chromosomes are called autosomes. Recessive sex-linked traits governed by genes in the X chromosome are observed more often in males than in females. This is how sex-linked traits happen.

Essential Questions

Cells and Cell Processes

a. Basic Biological Principles

Why are these basic principles so important ?

How can these basic principles improve procedures in the lab?

b. The Chemical Basis for Life

How is water important to the basic support of life on earth ?

What purpose does being uniquely formed benefit biological macromolecules ?

c. Bioenergetics: Photosynthesis and Cellular Respiration

Why are the roles of plastids and chloroplast fundamental to the function of the cell?

What is the role of ATP through any biochemical reaction ?

d. Homeostasis and transport

How does homeostasis benefit the body?

Why does the plasma membrane function as a regulatory Structure because of its shape?

a. Cell growth and Reproduction

What is the purpose of having checkpoints after each phase?

Why does DNA need to keep replicating?

b. Genetics *(Exceeding)*

Why does the recessive gene not show up if there's one recessive and one dominant?

How can you determine if a disease will be passed down from the parent to the child ?

c. Theory of Evolution *(Exceeding)*

What aspects have been found that point that everything alive today had a starting point from evolving to what they are now?

d. Ecology *(Exceeding)*

Why is the biosphere so important?

What aspects of oxygen and carbon dioxide keep the balance of life on planet earth?

Key terms

Cell- is the basic structural, functional, and biological unit of all known living organisms.
Atom- the basic unit of matter
Cell biology- The study of cells
Mitochondria- double membrane organelle found in all eukaryotic organisms
Cell membrane- protects cells from its surroundings.
Cytoskeleton- provides the cell with structural integrity, enables cell movement as well as molecular transport within thecell.
Microtubules- helps transport from the nucleus to the cytoplasm using motor proteins
Cellular transport- movement of materials across cell membranes.
Cell division- a parent cell divides into two or more daughter cells.
Cell cycle- cycle that helps the division and duplication of its DNA to make 2 daughter cells.
DNA- Carries the genetic instructions used in the growth, development, functioning and reproduction of all known living organisms.
Mitosis- apart of the cell cycle replicated chromosomes are separated into two new nuclei

Cells and Cell Processes

a. Basic Biological Principles

- What are Prokaryotic cells ?

1. are unicellular organisms that lack membrane bound organelles
2. Are something that membrane absorb energy from.

- What are Eukaryotic cells?

1. any organism whose cells have a cell nucleus and other organelles enclosed within membranes. Eukaryotes belong to the domain Eukaryota or Eukarya, and can be unicellular or multicellular organisms.
2. Helps the cytoplasm keep moving.

- What is the liquid surrounding the organelles in the cell

1.Cytoplasm
2.saliva
3.glucose
4.starch

- Give a brief description on what the cytoplasm is.

is that part of the cell between the cell membrane and thenuclear envelope. It is the jelly-like substance in a cell that contains the cytosol, organelles, and inclusions, but not including the nucleus.

- What's the difference between unicellular or multicellular?

Multicellular organisms need specialised organ systems, whereas all the life processes in a unicellular organism take place in that one cell.

b. The Chemical Basis for Life 6

- What is the pH level?

1. A measure of how acidic or basic a solution is
2. The center of the atom
3. To clean out the starch

- Give me a description on what is a Polar molecule.

A molecule with an unequal distribution of charge; that is, each molecule has a positive end and a negative end.

- What is Metabolism in your own words.

the sum of the chemical reactions that take place within each cell of a living organism and that provide energy for vital processes and for synthesizing new organic material

- True or false - Atoms of the same element that have different numbers of neutrons

1. True
2. False

- The purpose of a Covalent bond is ..

1. The force that holds together two atoms that share electrons (such as hydrogen sharing with oxygen in water)
2. The attraction of opposite charges between hydrogen and oxygen forms this weak bond

c. Bioenergetics: Photosynthesis and Cellular Respiration

- How is energy transformed during cellular respiration?

Energy enters cellular respiration as stored energy in glucose. It leaves cellular respiration as ATP. The goal of cellular respiration is to provide energy to be used by the cell. Changing from glucose to ATP allows the energy in glucose to be used by the cell.

- Explain what happens to energy during photosynthesis. How does energy enter into photosynthesis? In what form does it exist during photosynthesis?

Energy enters photosynthesis as light energy from the sun. During the light-dependent reactions, it is converted into chemical energy in the form of ATP and electron carriers. These molecules carry the chemical energy to the light-independent reactions, where it is stored as glucose.

- ribose, and phosphate group are apart of the ATP molecule so which one is missing?

1. Adenine
2. Stroma
3. thylakoid

- 3. Energy is released from an ATP molecule when:

1. a phosphate group is added
2. a phosphate group is removed
3. adenine bonds to ribose

- **Cellular Respiration produces _____ as a waste product**

a. CO_2

d. Homeostasis and transport- passive and active

- **What does the term homeostasis mean ?**

1. Ability to maintain a constant internal environment in response to environmental changes.
2. Is romantic attraction, sexual attraction or sexual behavior between members of the same sex or gender.
3. When a person's body temperature is low and the body begins to bring the temperature back up.

- **What is the difference between Diffusion & Osmosis?**

Diffusion refers to the movement of any chemical from one place to another, whereas osmosis exclusively refers to the movement of water across a membrane.

- **Define hypertonic:**

1. Is one where the concentration of solutes is greater outside the cell than inside it. (Solutes are the particles that are dissolved in a solvent, and together they form a solution.)
2. Is one in which the concentration of solutes is greater inside the cell than outside of it. Which means molecules can move through them, a process called osmosis.

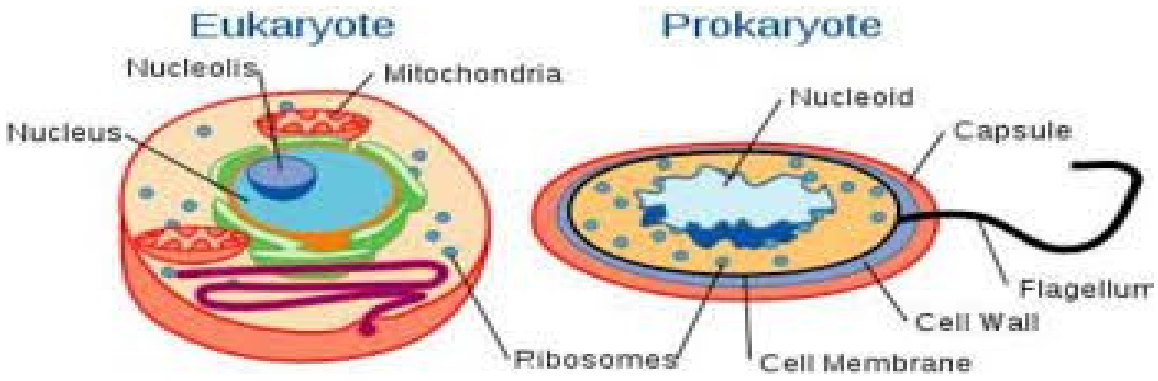
- **What is the function of the Cell membrane?**

1. Breaks down the food in your digestive system.
2. It cleanse the blood cell.
3. Is to protect the cell from its surroundings, controls the movement of substances in and out of cells and organelles.

Chapter 2: Continuity and Unity of Life

Basic Biological Principles:

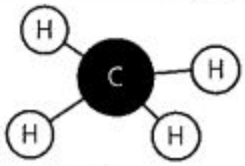
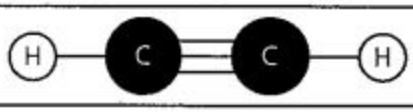
First the basic building block of life are cells. It is the smallest living unit on any organism. There are two main types of cells. They are Prokaryotic and Eukaryotic. Prokaryotic cells are unicellular organisms that lack membrane bound organelles. That means that their DNA is not contained in a nuclear membrane. Eukaryotic cells are more complex. Their DNA is within the nucleus, they are also larger than Prokaryotic cells. A cells body consists of a plasma/ cell membrane, which forms the outer layer of the cell. The cytoplasm which is made of mostly water fills the cells internal volume. DNA holds all the genetic information. Then finally the ribosome decodes the genetic information from the mRNA and assembles amino acids into proteins. Any organism is either unicellular or multicellular, and for these cells to operate they need to have homeostasis. Homeostasis is the process of maintaining the cell's levels of temperature, pH levels, solute concentration, and other conditions. If any of these levels get to low or too high the cell will deactivate. When cells deactivate they will not have an opportunity to develop. When cells develop they grow bigger and reproduce to make other cells. Unicellular and Multicellular either reproduce asexually or sexually.



The Chemical Basis for Life:

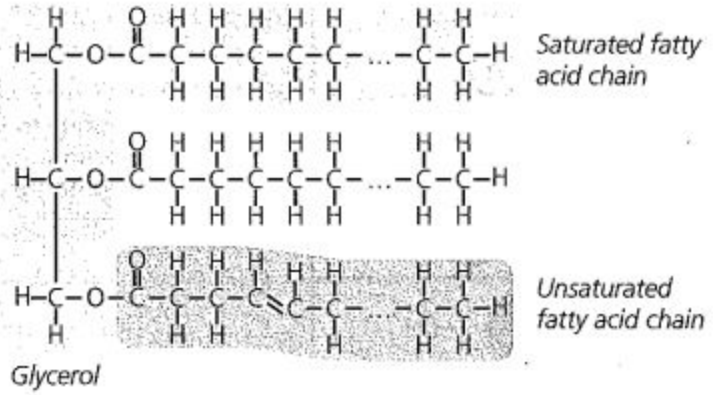
For the world to operate it needs water. Water at the molecular level has two hydrogen atoms and one oxygen atom. The atom are held together by covalent bonds. Covalent bonds occur when the atoms share electrons with each other. Even though the atoms share the electrons they may not share them equally. For example in water the oxygen atom pulls on the electrons more strongly than hydrogen atoms. This as being an uneven sharing water is described as a polar molecule. Another thing that is a key piece in the world is carbon. Pretty much all living things on earth are carbon based because this element forms the compounds that make up cells and organisms. A carbon atom is most stable when all four slots are filled covalent bonds may be single, double, and triple bonds. Carbon is unique in that a single atom can form up to four covalent bonds.

BONDS IN CARBON MOLECULES

Compound	Formula	Molecule
Methane	CH_4	
Carbon dioxide	CO_2	
Acetylene	C_2H_2	

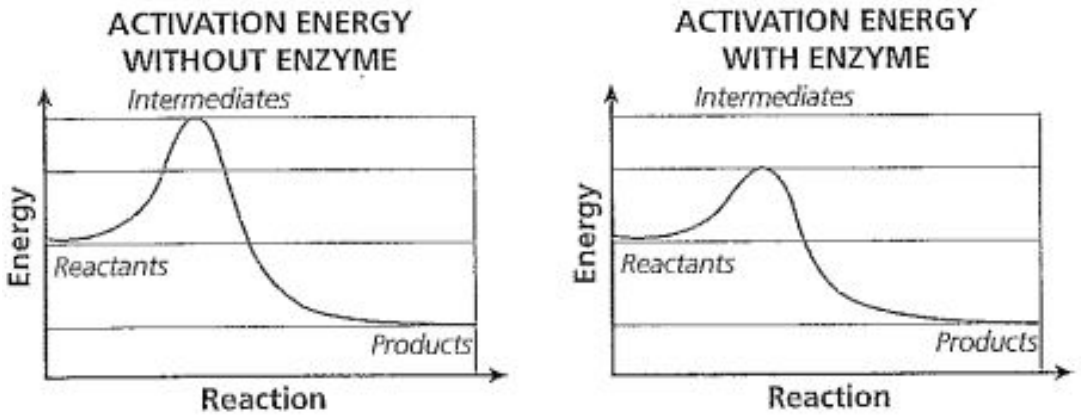
Lipids are another form of molecule. They include fat, oils, waxes, and sterols. They are nonpolar molecules which means they are not soluble in water. A fatty acid chain of carbon

atoms connected to each other by single or double bonds. Lipid molecules also consist of mostly carbon and hydrogen atoms as well.



This lipid molecule consists of glycerol attached to three fatty acid chains. Note the difference between the saturated and the unsaturated fatty acids.

Another big factor in the biological world are enzymes. Some proteins function as enzymes. Enzymes function as a catalase. Catalase are substances that speed up chemical reactions without being changed or used up. They cause reactions to occur at the rate of thousands of times per second. Enzymes work by lowering the activation energy of a chemical reaction. With a lower activation energy the reactants can be changed to products at a much faster rate.



Key terms

Proton- Positive subatomic particles in the nucleus of all atoms

Neutron- type of subatomic particle in the nucleus of all atoms except hydrogen; has mass but no charge.

Electron- Negatively charged subatomic particle. Electrons occupy orbitals around the atomic nucleus.

Ion- Atom having an unequal number of protons and electrons; it carries a positive or negative electric charge

Compounds- Molecule consisting of two or more elements in proportions that do not vary, as they can in mixtures.

Ionic bond- Ions interacting through the attraction of their opposite charges.

Hydrogen bond- A weak attraction that has formed between a covalently bonded hydrogen atom and an electronegative atom taking part in another covalent bond.

Temperature- Measure of molecular motion.

Evaporation- Process of conversion of a liquid to a gas; requires energy input.

pH scale- Measure of the H+ concentration of a solution. pH 7 is neutral.

Acid- Any water-soluble substance that releases hydrogen ions (H+) in water, yielding a pH below 7.0.

Molecule- Two or more covalently bonded atoms of the same or different elements.

Chemical bonds- A union between the electron structures of two or more atoms.

Continuity and Unity of Life

a. Cell growth and Reproduction

- How many chromosomes does Gametes?

1. 23
2. 100
3. 5

- In what part of the process is DNA is copied?

1. Prophase
2. Metaphase
3. Interphase

- If human cells consist of 46 chromosomes before mitotic division, how many cells would the child have?

1. 46
2. 23

3. 92

- Break down the process of Mitosis.

Mitosis is a process of nuclear division in eukaryotic cells that occurs when a parent cell divides to produce two identical daughter cells. During cell division, mitosis refers specifically to the separation of the duplicated genetic material carried in the nucleus.

- Compare and contrast the difference between Mitosis and meiosis.

Meiosis has two rounds of genetic separation and cellular division while mitosis only has one of each. In meiosis homologous chromosomes separate leading to daughter cells that are not genetically identical. In mitosis the daughter cells are identical to the parent as well as to each other.

b. Genetics *(Exceeding)*

- What is a gene ?

1. A piece of clothing
2. region in a DNA that codes for a specific protein

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c. Theory of Evolution *(Exceeding)*
d. Ecology *(Exceeding)*