



Biology Keystone Exam Review Packet

2012 - 2013

1. Which characteristic is shared by all prokaryotes and eukaryotes?




- A. Ability to store hereditary information
- B. Use of organelles to control cell processes
- C. Use of cellular respiration for energy release
- D. Ability to move in response to environmental stimuli

All living things:

- Are made up of cells
- Have a universal genetic code
- Need a constant flow of energy
- Are capable of reproducing (on their own)
- Grow and Develop
- Have a level of organization (cells, tissue, organs, organ systems, organism)
- Respond to Stimuli

2. Living organisms can be classified as prokaryotes or eukaryotes. Which two structures are common to both prokaryotic and eukaryotic cells?

- A. Cell wall and nucleus
- B. Cell wall and chloroplast
- C. plasma membrane and nucleus
-  D. plasma membrane and cytoplasm

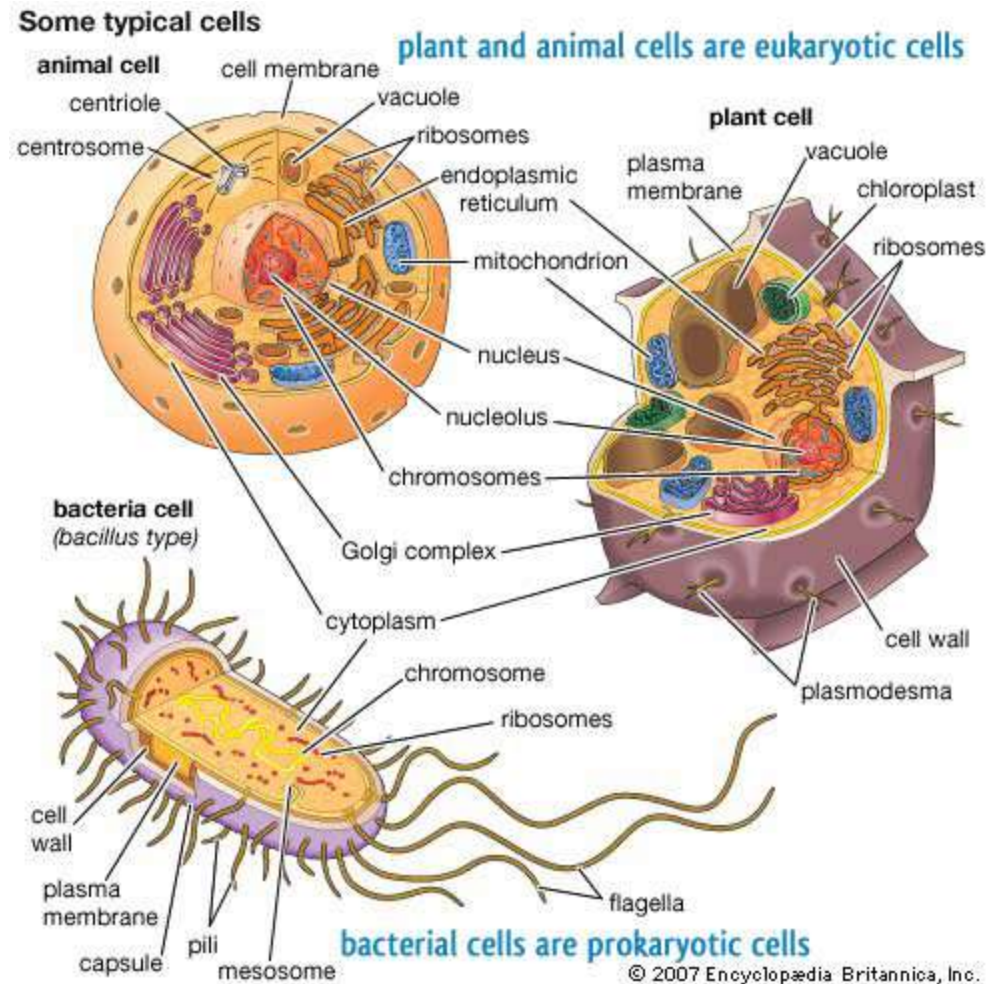
Prokaryotic vs Eukaryotic

Prokaryote

- Lack a nucleus and membrane bound organelles
- Have cytoplasm, plasma (cell) membrane, a cell wall, DNA and ribosomes
- Bacteria and Archae

Eukaryotes

- Have membrane bound organelles
- Have a true nucleus with a nuclear envelope
- Have a plasma membrane, cytoplasm, DNA, ribosomes, endoplasmic reticulum, golgi apparatus, nucleolus w/i the nucleus, vacuoles, a cell wall (in some) and other organelles.
- Protists, Fungus, Plants, Animals



3. Prokaryotic cells are generally much smaller than eukaryotic cells.

Part A: Identify a structural difference between prokaryotic cells and eukaryotic cells that is directly related to their difference in size.

3. Prokaryotic cells are generally much smaller than eukaryotic cells.

Part B: Based on structural difference, explain why prokaryotic cells can be much smaller than eukaryotic cells.

Prokaryotic cells lack membrane-bound organelles. Contain:

- Ribosomes
- DNA

Due to the lack of organelles, the total volume of the cell is smaller. Cells with organelles (eukaryotic) have the ability to metabolize materials and retain a larger size.

No specialization of function due to a lack of organelles. Enzymes within the cytoplasm carry out the metabolic functions of the cell

Eukaryotic cells contain membrane-bound organelles and organelles such as:

- Mitochondria
- Endoplasmic reticulum
- Vacuoles
- Lysosomes
- golgi apparatus
- Nucleus with DNA
- Nucleolus
- Ribosomes

Have a greater division of labor. Organelles are specialized.

Prokaryotic cells and eukaryotic cells both contain ribosomes, cytoplasm, a plasma membrane, and genetic material


3. Prokaryotic cells are generally much smaller than eukaryotic cells.

Part C: Describe one Similarity between prokaryotic cells and eukaryotic cells that is independent of size.

- **All cells contain:**

- genetic information in the form of DNA
- ribosomes(cell organelles) that translate nucleic acid (RNA) into protein
- a plasma membrane to create an internal environment and allows for the movement of materials from one side to another

4. Alveoli are microscopic air sacs in the lungs of mammals. Which statement best describes how the structure of the alveoli allows the lungs to function properly?

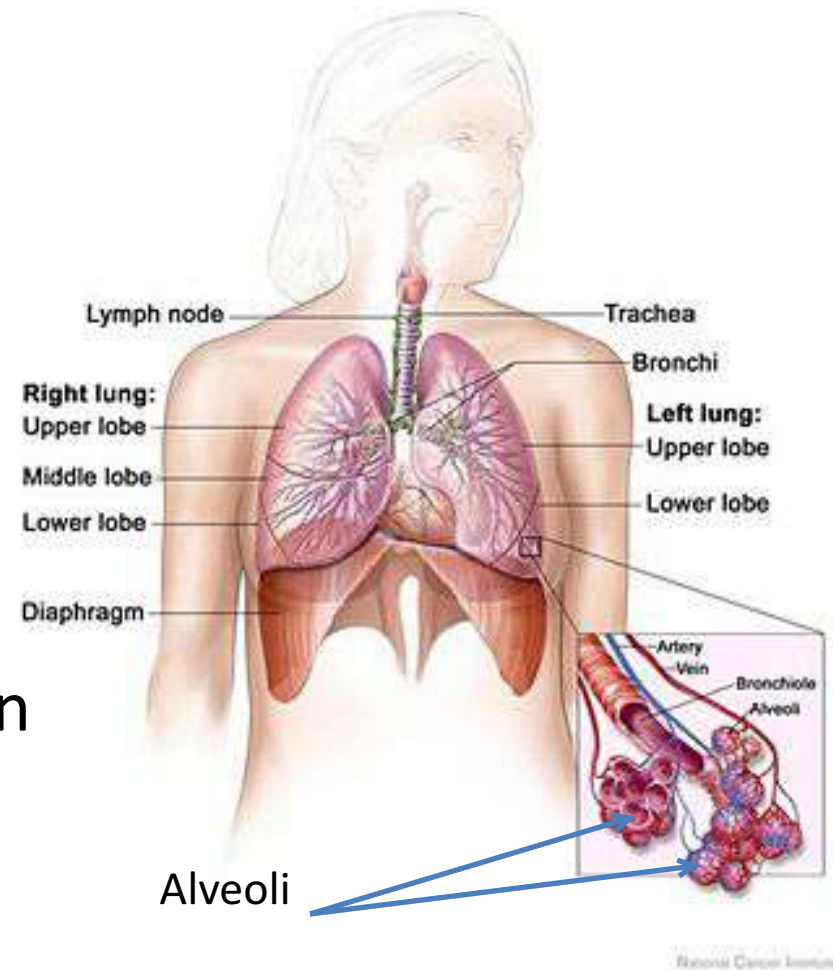
- A. They increase the amount of energy transferred from the lungs to the blood>
- B. They increase the flexibility of the lungs as they expand during inhalation.
- C. They increase the volume of the lungs, allowing more oxygen to be inhaled.
-  D. They increase the surface area of the lungs, allowing efficient gas exchange.

The Human Respiratory System

The alveoli increase surface area for gas exchange

The membranes of the alveoli are 1 cell thick. Oxygen and Carbon dioxide can easily be exchanged through the thin walls.

Typical human has ~ 700 million alveoli, accounting for an area of ~70 m² for gas exchange



5. Which statement best describes an effect of the low density of frozen water in a lake?

A. When water freezes, it contracts, decreasing the water level in a lake.

B. Water in a lake freezes from the bottom up, killing most aquatic organisms.

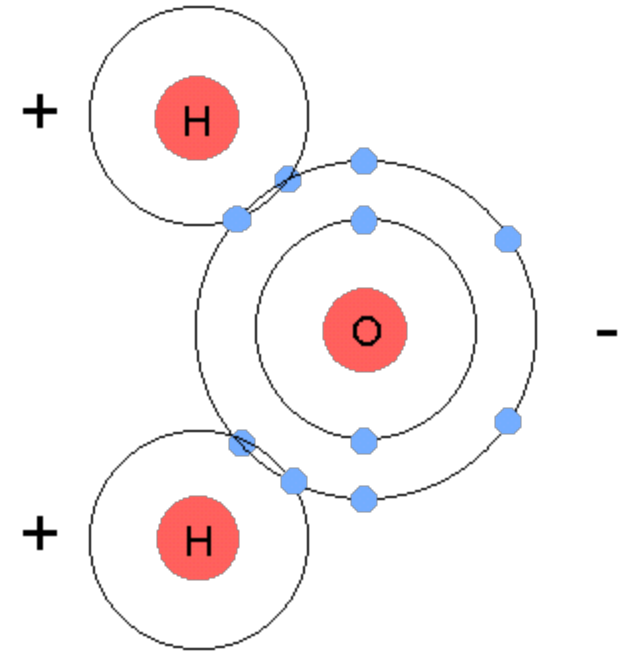


C. When water in a lake freezes, it floats, providing insulation for organisms below.

D. Water removes thermal energy from the land around a lake, causing the lake to freeze.

Properties of Water

1. Is a **polar covalent** molecule
2. Is the **Universal solvent** due to its polarity. Polar covalent compounds (like glucose) and ionic compounds (like salt) can easily go into solution in water.
3. Has a **high specific heat**. It is slow to heat up and also slow to cool down. This acts as an **insulator in living organisms** since the majority of their living tissue is water.
4. **When water freezes, it expands** and therefore floats. **Ice is less dense than water**. This provides an insulation to the organisms in the water. The water below will be at 4°C (if ice is above it)




6. Which statement correctly describes how carbon's ability to form four bonds makes it uniquely suited to form macromolecules?

A. It forms short, simple carbon chains.

B. It forms large, complex, diverse molecules.

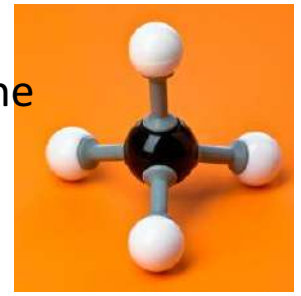
C. It forms covalent bonds with other carbon atoms.

 D. It forms covalent bonds that can exist in a single plane.

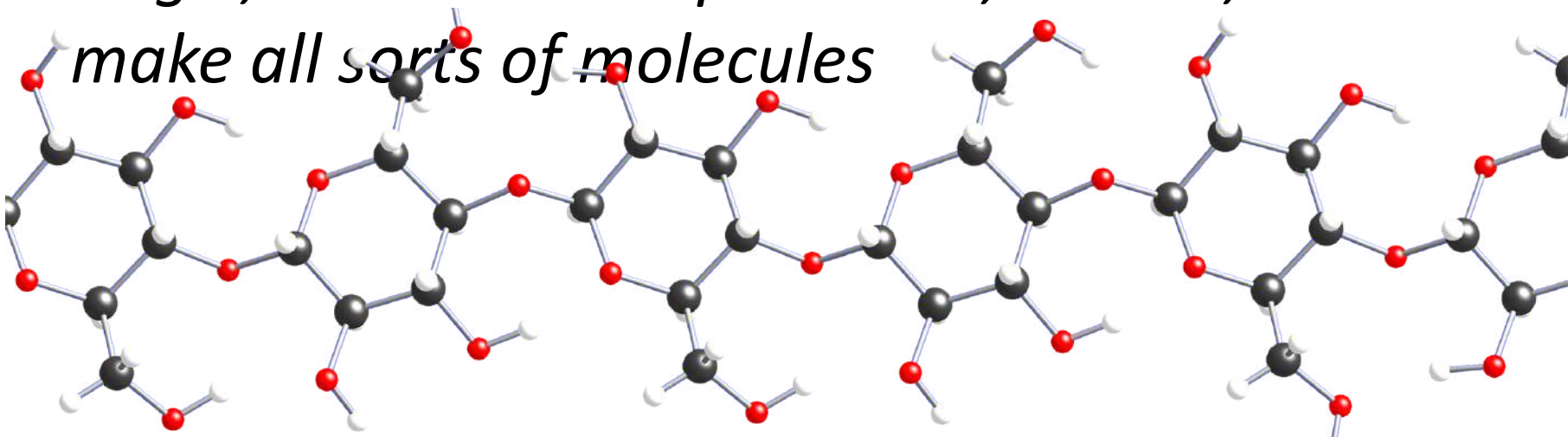


Carbon

Methane

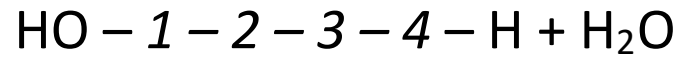
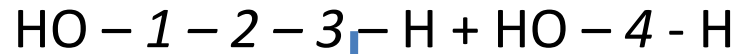


- Atomic number of 6.
 - 2 electrons in the 1st orbital and 4 remaining in the valence orbital.
 - 4 unpaired will form 4 covalent bonds
- *By bonding with other carbons in chains, rings, single, double and triple bonds, carbon, it can make all sorts of molecules*




7. Use the diagram below to answer the question.

Chemical Reaction

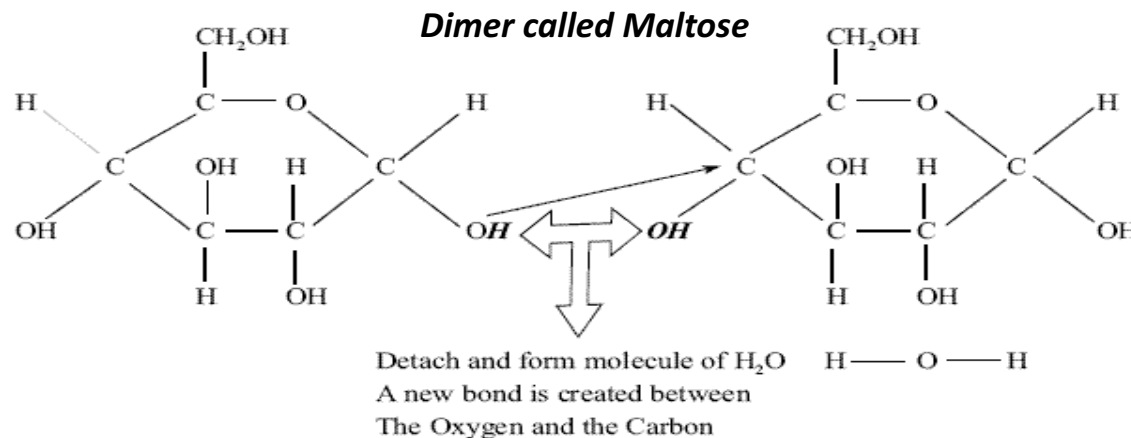
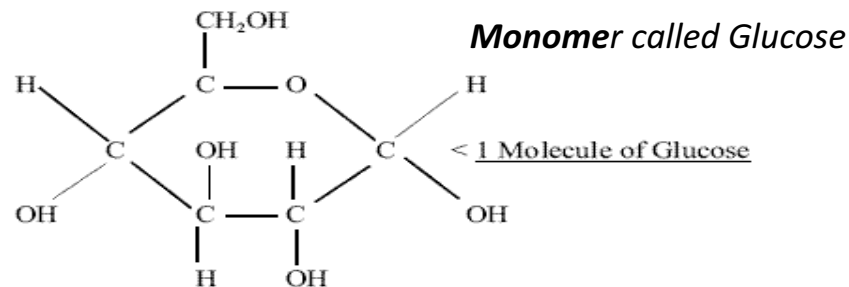


The diagram shows a reaction that forms a polymer from two monomers.

What is this type of reaction called?

- A. Glycolysis
- B. Hydrolysis
- C. Photosynthesis
-  D. Dehydration synthesis

- This is **dehydration synthesis**. During this type of reaction, a water molecule is removed (an -OH from one simple monomer and an -H from another to form a water molecule). This joins two monomers together to form a polymer. When adding another monomer to the dimer, another water molecule needs to be removed.



8. Carbohydrates and proteins are two types of macromolecules, which functional characteristic of proteins distinguishes them from carbohydrates?

1. Large amount of stored information

 **2. Ability to catalyze biochemical reactions**

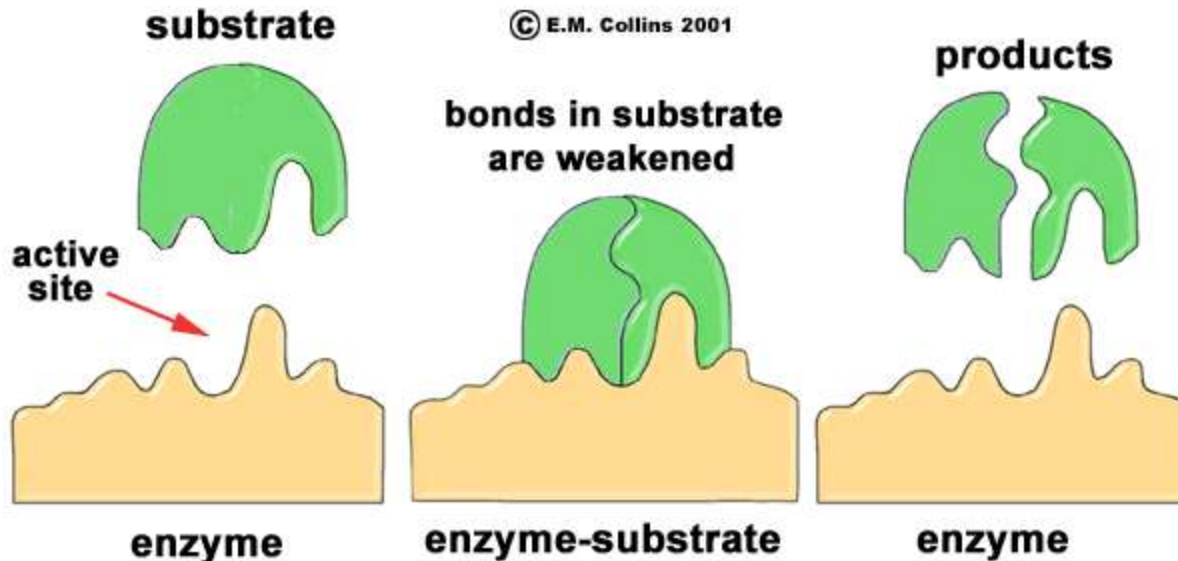
3. Efficient storage of usable chemical energy

4. Tendency to make cell membranes hydrophobic.

Enzymes

Enzymes are proteins, which are biological catalysts.

- They decrease activation energy, allowing a chemical reaction to happen in an organism's body at a suitable temperature and time rate*
- They enter into a reaction at an Active site to form an Enzyme/Substrate complex*

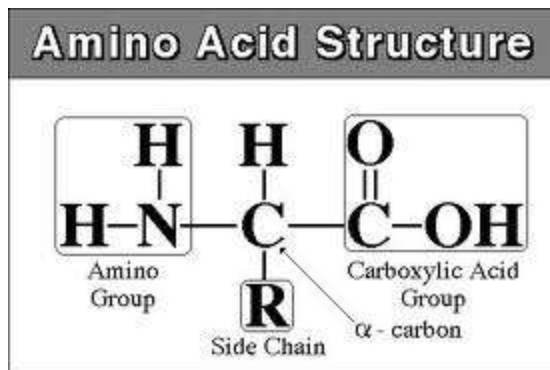


9. Proteins are a major part of every living cell and have many different functions within each cell. Carbohydrates also perform numerous roles in living things.

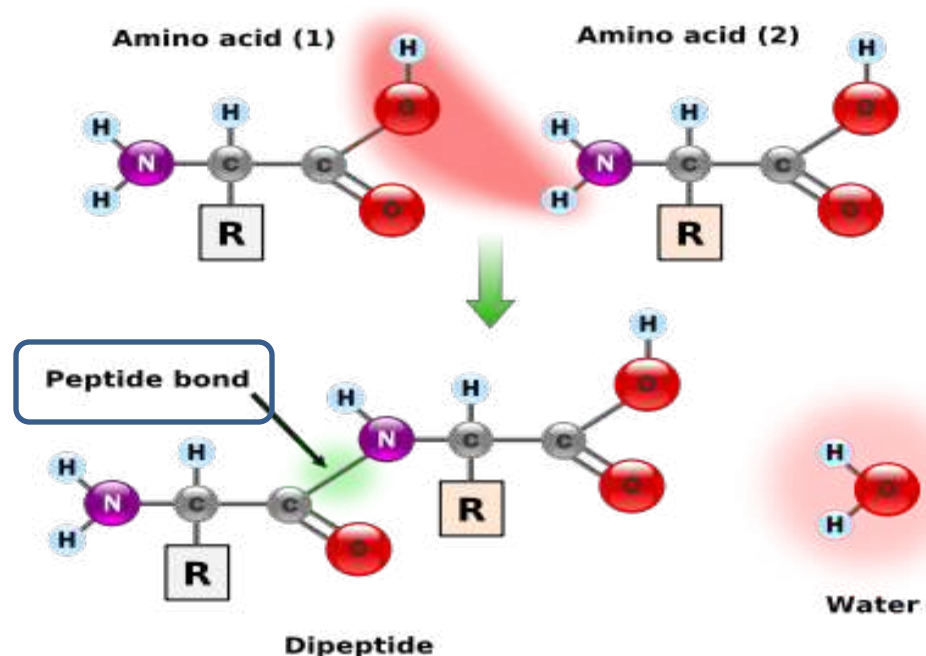
Part A: Describe the general composition of a protein molecule.

- *A protein is a polymer of amino acids. When amino acids are joined by dehydration synthesis (a process that removes water to form a chemical bond), they form **peptide bonds**.*
- *There are three main components of an amino acid, shown below.*

There are three main components of an amino acid, shown below.

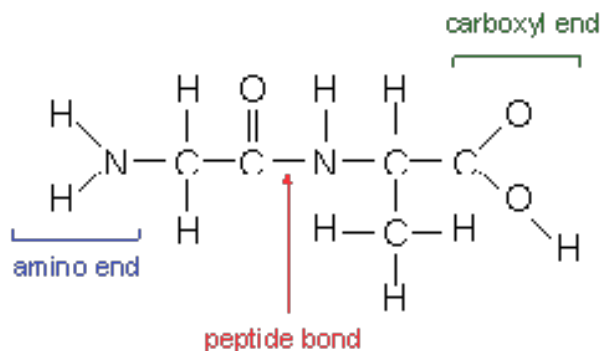


A dipeptide formed by the removal of water

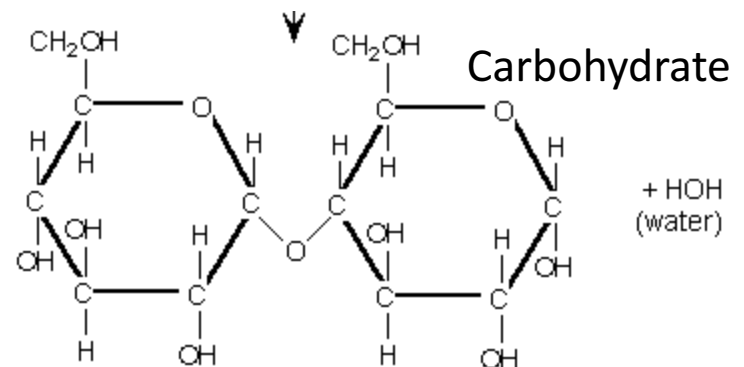


Part B: Describe how the structures of proteins differ from the structures of carbohydrates.

- Proteins are made up of the elements C,H,O, and N while carbohydrates only contain C,H, and O (elemental ratio of these three is 1:2:1)
- Carbohydrates do not contain peptide bonds formed during dehydration synthesis (also known as a condensation reaction)



Protein



Part C: Describe how the functions of proteins differ from the functions of carbohydrates.

- Carbohydrates are our essential energy molecules to be use almost immediately (simple sugars like glucose) or stored in the liver as glycogen.
- Proteins are building and regulatory compounds (such as hormones and enzymes). Muscles and cell membranes contain proteins

10.) Substance A is converted to substance B in a metabolic reaction. Which statement **best** describes the role of an enzyme during this reaction?

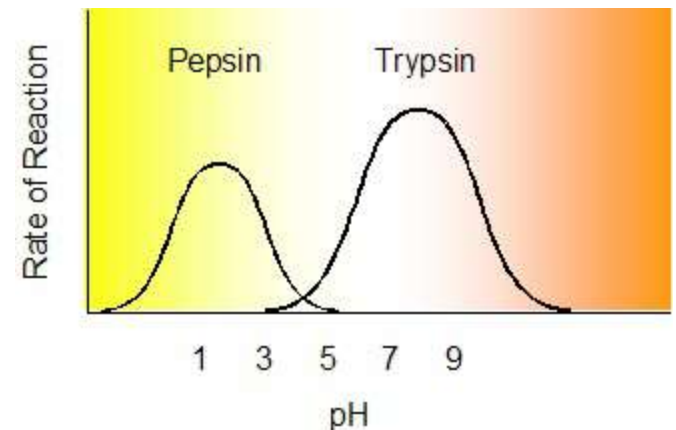
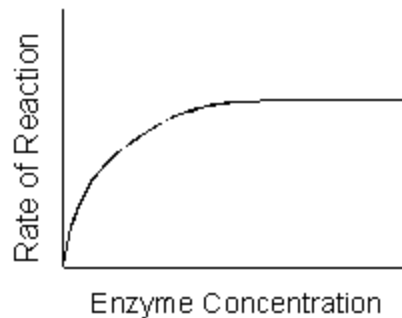
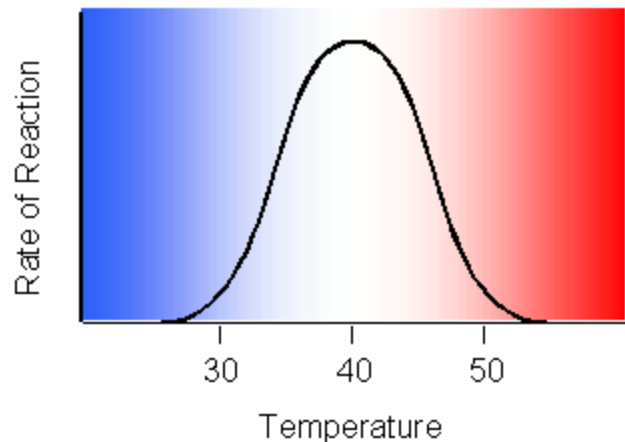
A.) It adjusts the pH of the reaction medium.

B.) It provides energy to carry out the reaction

C.) It dissolves substance A in the reaction medium

D.) It speeds up the reaction without being consumed.

- Enzymes are organic catalysts which regulate the rate of a reaction. They allow reactions to take place under conditions that will not damage a cell.
- Enzymes are reusable. They do not break down under normal conditions.
 - Regulated by temperature, concentration and pH.




11.) A scientist observes that, when the pH of the environment surrounding an enzyme is changed, the rate the enzyme catalyzes a reaction greatly decreases. Which statement **best** describes how a change in pH can affect an enzyme?

- Think of an enzyme like a puzzle piece or a key. If extreme heat is added to it, it will burn or melt, changing its shape. The area where the enzyme reacts with the substrate is called the active site. If the active site is altered, it can no longer function
- This change in shape is called denaturing.
- See graphs on prior page for clarification

12.) Using a microscope, a student observes a small, green organelle in a plant cell.
Which energy transformation **most likely** occurs first within the observed organelle?

A.) ATP to light

 B.) light to chemical

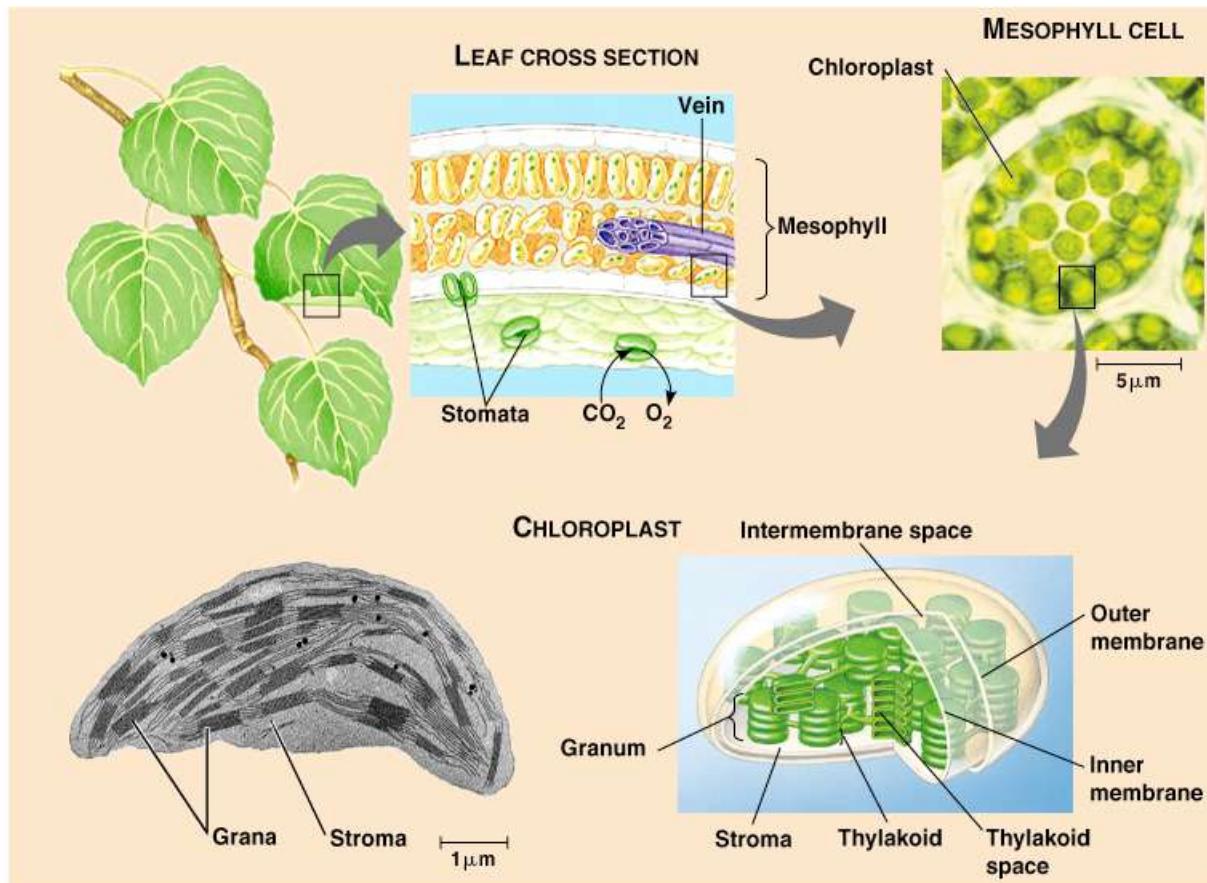
C.) heat to electrical

D.) chemical to chemical

Photosynthesis

Is the process whereby organisms convert light energy into chemical bond energy of glucose

- It occurs in the Chloroplasts of plant cells



13.) Photosynthesis and cellular respiration are two major processes of carbon cycling in living organisms. Which statement correctly describes one similarity between photosynthesis and cellular respiration?

A) Both occur in animal and plant cells.

B) Both include reactions that transform energy.

C) Both convert light energy into chemical energy.

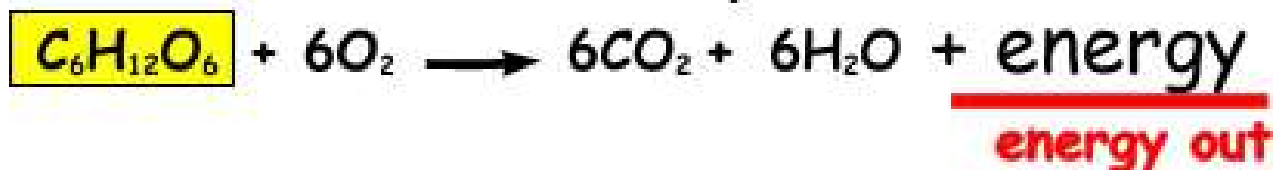
D) Both synthesize organic molecules as end products.

—

photosynthesis



aerobic respiration



Photosynthesis vs Respiration

- Think of Photosynthesis like baking a cake. The plant takes raw material (CO_2 and H_2O) and uses light energy to make Glucose (and releases O_2 in the process)

Respiration is the process whereby organisms break down glucose to provide energy to all life processes

Breaks down glucose (sometimes with O_2 and others without it), transfers energy to a small energy transferring compound called ATP

- Think of Respiration like burning the cake. Energy is released from the bonds of glucose to be stored as ATP.

All plants (photosynthetic organisms) undergo both Photosynthesis (only in the presence of light) and Respiration (all of the time)

All living organisms must go through respiration 24/7

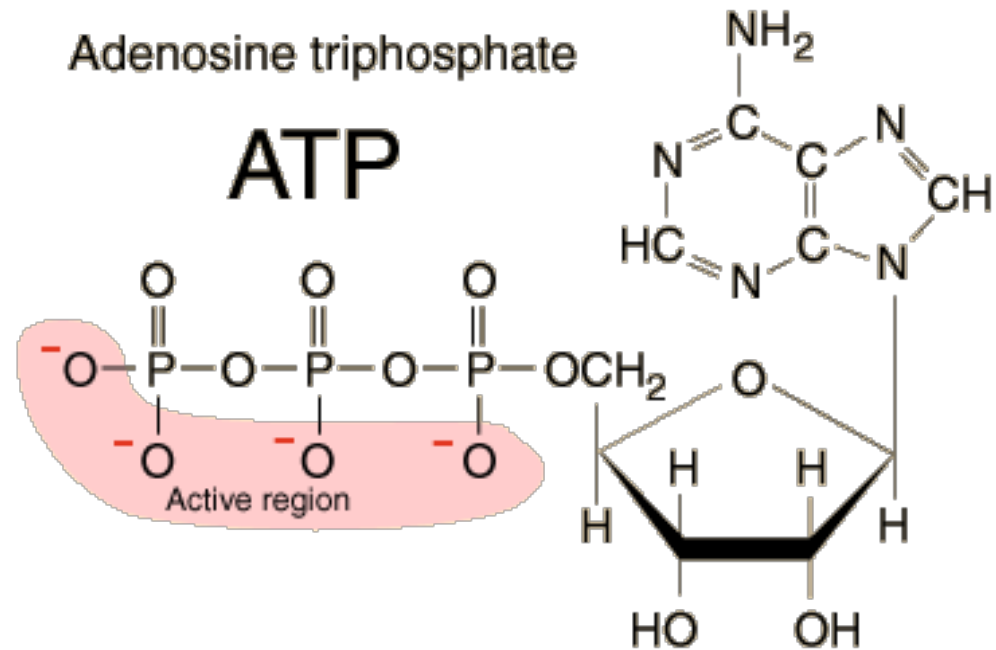
14.) A protein in a cell membrane changed its shape to move sodium and potassium ions against their concentration gradients. Which molecule was **most likely** used by the protein as an energy source?

A) ATP

B) ADP

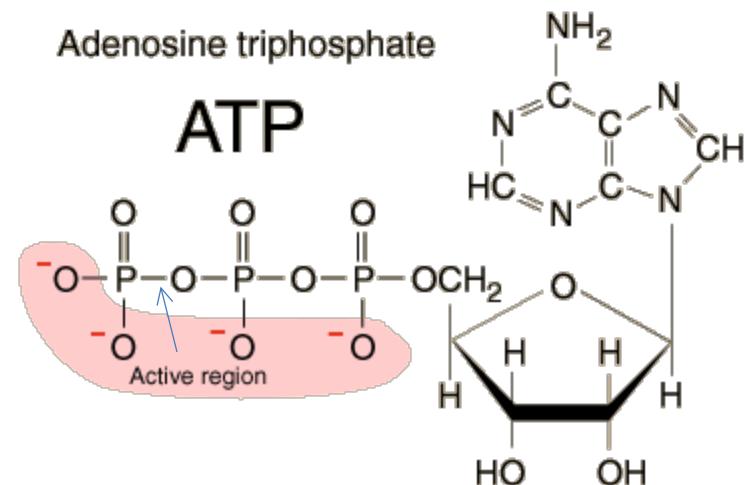
C) Catalase

D) Amylase

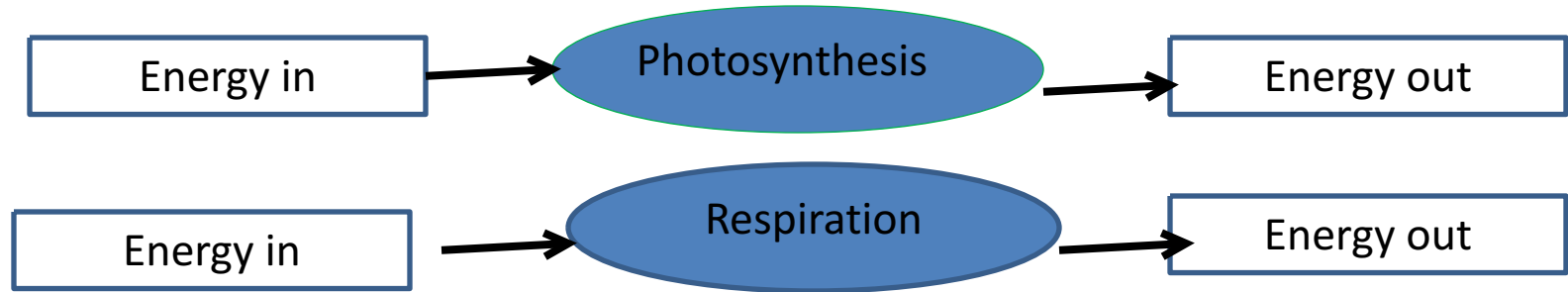


ATP – Temporary energy storage molecule

ATP is a readily usable form of chemical energy. By breaking off the 3rd phosphate (ATP = adenosine **tr**iphosphate), energy is released to allow reactions to happen, such as changing the shape of a protein



15.) Use the diagrams below to answer the question.



- **Part A:** Complete the chart below by describing energy transformations involved in each process.

Process	Energy Transformations
Photosynthesis	<i>CO₂ and H₂O are transformed using the energy from sunlight to create C₆H₁₂O₆ and O₂. The captured and used energy is stored in the chemical bonds of glucose (C₆H₁₂O₆)</i>
Cellular Respiration	<i>O₂ and C₆H₁₂O₆ are broken down with a small amount of invested energy to form CO₂ + H₂O and a large amount of ATP which is the energy storage molecule of living things</i>

Part B : Describe how energy transformations involved in photosynthesis are related to energy transformations involved in cellular respiration.

- *They are, in essence, the reverse of each other. The products of photosynthesis become the reactants for cellular respiration, and the opposite is true.*
- Again, one bakes the cake and the other one breaks it down to release the energy



16.) Carbon dioxide and oxygen are molecules that can move freely across a plasma membrane. What determines the direction that carbon dioxide and oxygen molecules move?

A) Orientation of cholesterol in the plasma membrane.

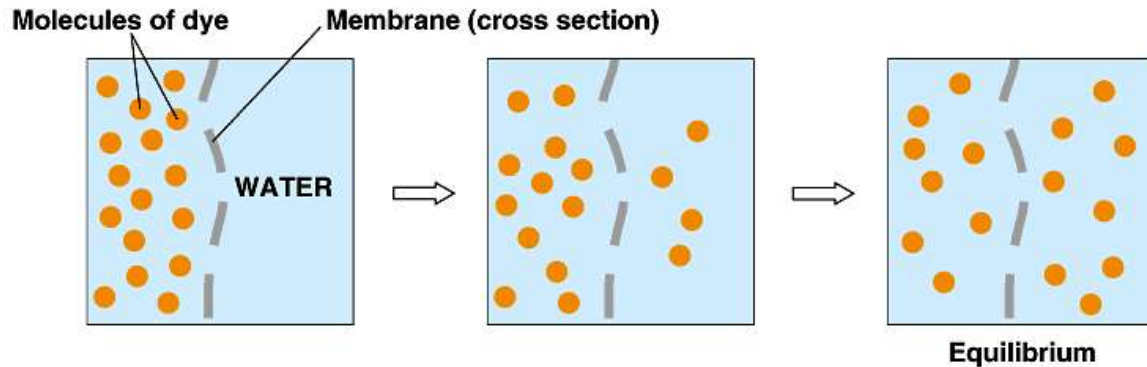
 B) Concentration gradient across the plasma membrane.

C) Configuration of phospholipids in the plasma membrane.

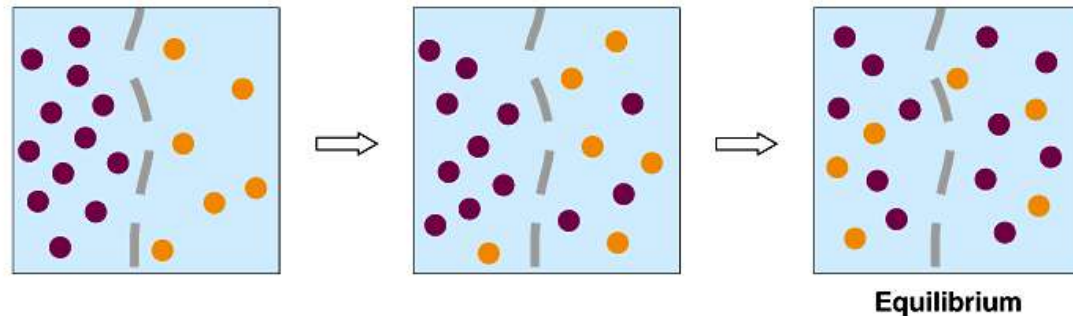
D) Location of receptors on the surface of the plasma membrane.

Transport through a membrane by Diffusion

- *Diffusion is the movement of molecules from an area of high concentration to that of a lower concentration*
- *If the concentration of CO_2 or O_2 is too high on one side of the membrane, then the molecules would not freely be able to move from an area of high concentration to an area of low concentration*



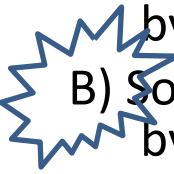
(a) Diffusion of one solute



(b) Diffusion of two solutes

17.) A sodium-potassium pump within a cell membrane requires energy to move sodium and potassium ions into or out of a cell. The movement of glucose into or out of a cell does not require energy. Which statement **best** describes the movement of these materials across a cell membrane?

A) Sodium and potassium ions move by active transport, and glucose moves by osmosis.

 B) Sodium and potassium ions move by active transport, and glucose moves by facilitated diffusion.

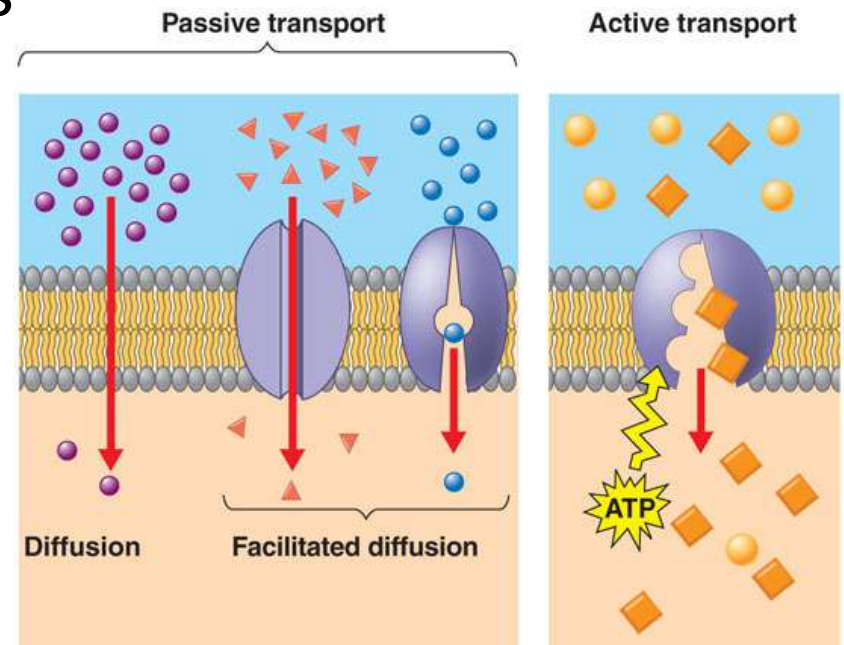
*Due to the fact that they are highly charged molecules (and “hate” the nonpolar cell membrane and can’t pass through it) **and** are trying to move against a concentration gradient (from low → high), sodium and potassium ions require a protein and energy to move across the cell membrane. Glucose is a large enough molecule (and polar), so it needs the ‘help’ of a protein to move it along (facilitated diffusion)*

C) Sodium and potassium ions move by facilitated diffusion, and glucose moves by osmosis.

D) Sodium and potassium ions move by facilitated diffusion, and glucose moves by active transport.

Types of Transport across a membrane

- **Passive** – by diffusion or osmosis (if water)
 - No energy is needed.
 - Driven by concentration gradient
- **Facilitated Diffusion** – movement across a membrane with the help of carrier proteins
 - No energy is needed
 - Still driven by the concentration
- **Active transport** – energy is needed to go from an area of low concentration to a more concentrated area



18.) Some animals can produce a potassium ion concentration inside their cells that is twenty times greater than that of their environment. This ion concentration gradient is maintained by the plasma membrane

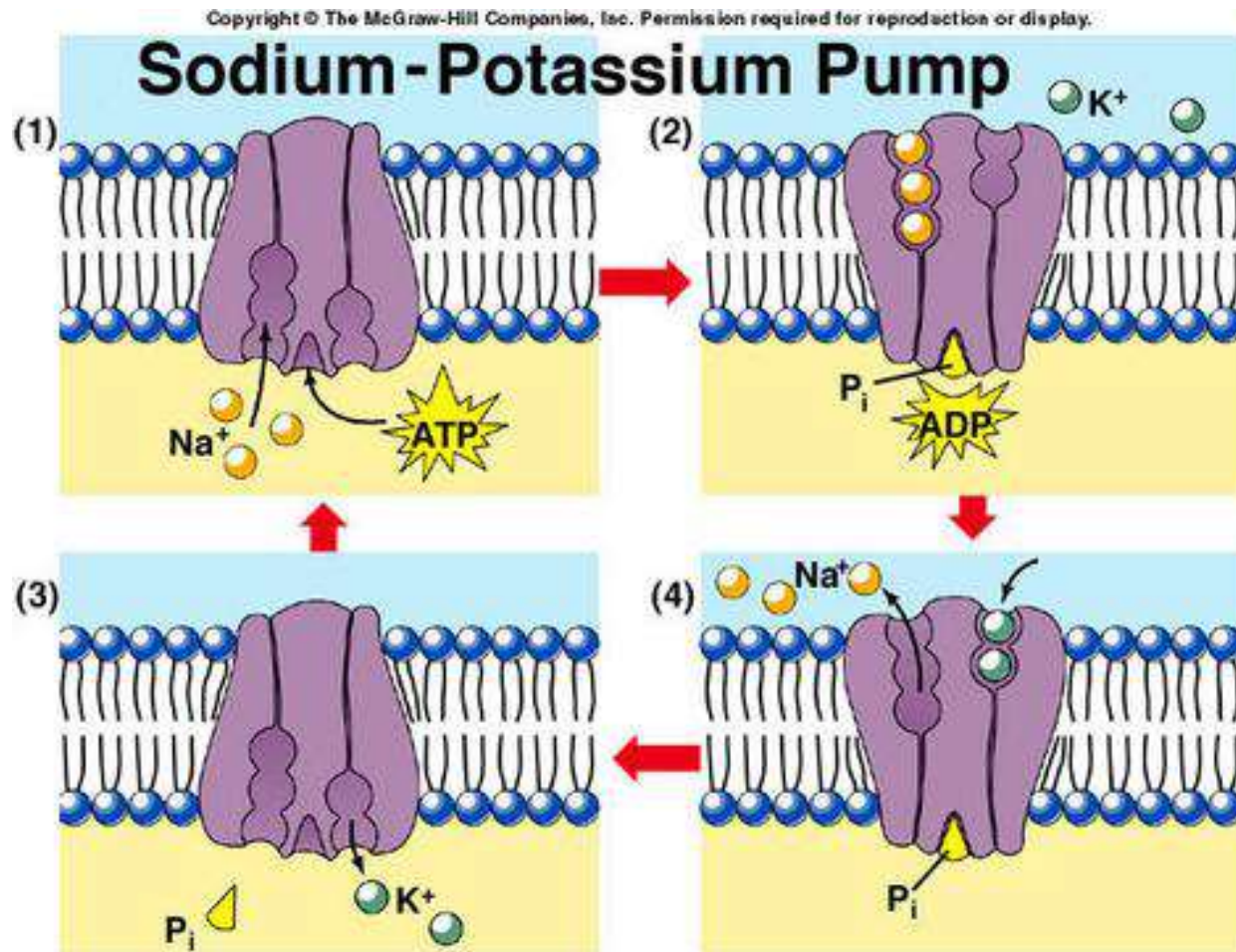
- **Part A:** Identify the process in the cell membrane that produces this difference in concentration.

*The process is **active transport** (needs energy).*

- **Part B:** Explain the process that occurs as the cell produces the ion concentration gradient.

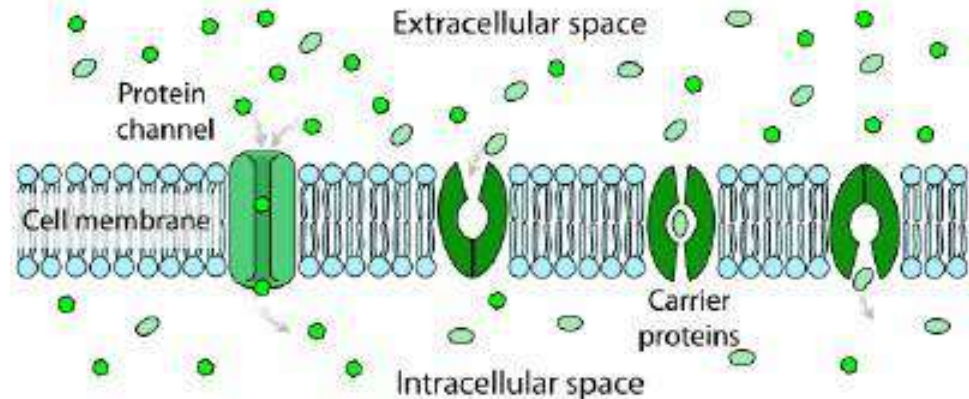
*There are specialized proteins in the cell membrane that act like “pumps with a toll”. These **pumps use ATP** (small packets of energy) to power their transport of Na^+ out of a cell, and K^+ into the cell. Because different numbers of **sodium ions** and **potassium ions** are pumped back and forth, it creates an **electrical gradient where one side of the cell is more positive than the other side***

Sodium-Potassium Pump




Part C: Compare the process of potassium ion transport to another mechanism that moves material across the plasma membrane.

- Active transport is **specific** and also **uses energy**, which is the key distinction, as opposed to facilitated diffusion which is also **specific** to a molecule (or ion) but does **not require energy**. An example would be glucose is too big to pass through the cell membrane on its own, but can do so the with help of a specific protein.



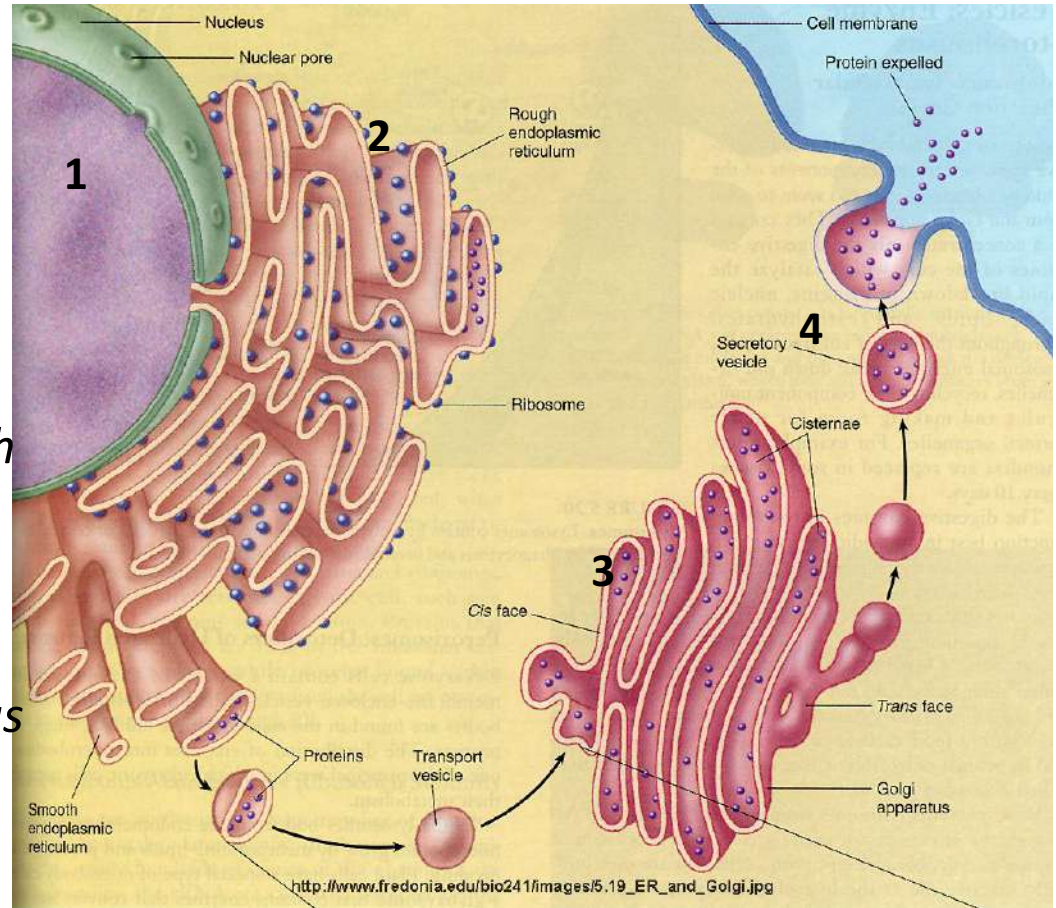
19.) The rough endoplasmic reticulum and Golgi apparatus work together in eukaryotic cells. What is one way that the rough endoplasmic reticulum assists the Golgi apparatus?

1. It assembles nucleic acids from monomers.
2. It breaks down old damaged macromolecules.
- 3. It packages new protein molecules into vesicles.
4. It determines which protein molecules to synthesize.

Protein Synthesis

Proteins are code for by genes on DNA.

- 1. mRNA “reads” the gene and carries the message to the ribosomes either free in the cytoplasm or attached to the endoplasmic reticulum (Rough endoplasmic reticulum if they have ribosomes on them)*
- 2. At the ribosomes on the RER, DNA’s message gets uncoded and Proteins are produced (with the help of tRNA transferring amino acids (the building units of proteins) to the ribosomes)*
- 3. The proteins produced will be transport to the Golgi apparatus which will package the proteins and*
- 4. export proteins to the cell or other cells.*

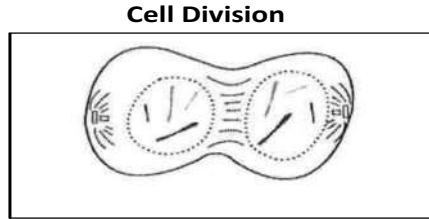


20.) Which example is an activity that a fish most likely uses to maintain homeostasis within its body?

- A.) Using camouflage to avoid predators.
- B.) Feeding at night to regulate body temperature.
- C.) Moving to deeper water to regulate metabolic wastes
- D.) Exchanging gases through its gills to regulate oxygen levels.

O₂ is needed for cellular respiration to provide energy for the organism. At the gills, O₂ and CO₂ are exchanged. If CO₂ is present, the amount of O₂ will change to stay regulated.

21.) Use the illustration below to answer the question.



Which statement best describes the phase of the cell cycle shown?

This diagram is showing the formation of two cells

- A. The cell is in prophase of mitosis because the number of chromosomes has doubled.
- B. The cell is in prophase I of meiosis because the number of chromosomes has doubled.
- C. The cell is in telophase of mitosis because the cell is separating and contains two copies of each chromosome.
- D. The cell is in telophase of meiosis because the cell is separating and contains two copies of each chromosome.

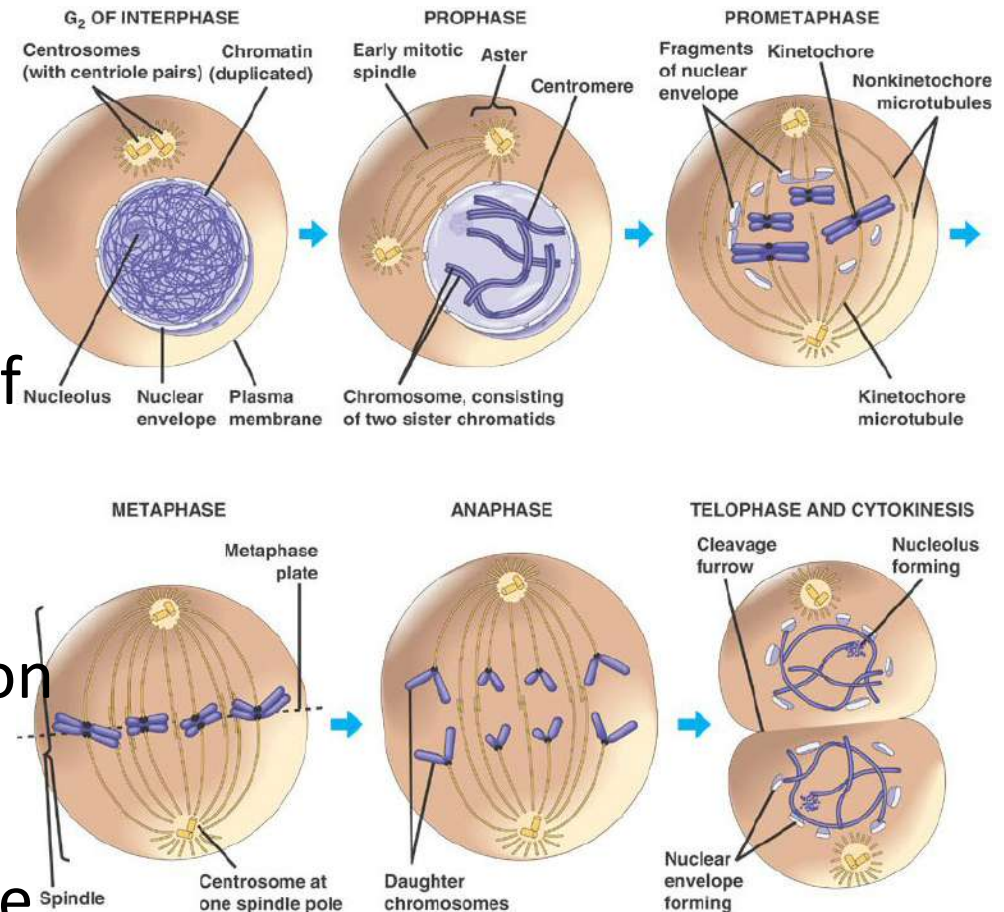
At the end of meiosis, you would see 4 genetically different cells with only one copy of each chromosome (here you see 2 cells, and each has 2 matching "sticks" in it)

Cell Division (Mitosis)

Cell division results in two identical *daughter cells*.

The process of cell divisions occurs in three parts:

- **Interphase** - duplication of chromosomes and preparing the nucleus for division
- **Mitosis** – organized division of the nucleus into two identical nuclei
- **Cytokinesis**- division of the cell and cellular contents into two identical daughter cells
- [Animation](#)



22.) Mitosis and meiosis are processes by which animal and plant cells divide. Which statement best describes a difference between mitosis and meiosis?

A. Meiosis is a multi-step process.

Both processes have multiple steps (prophase, metaphase, anaphase, and telophase, but meiosis has two sets of these stages with slight differences than the mitosis versions)

B. Mitosis occurs only in eukaryotic cells.

Mitosis occurs in prokaryotic and eukaryotic cells

C. Meiosis is used in the repair of an organism.

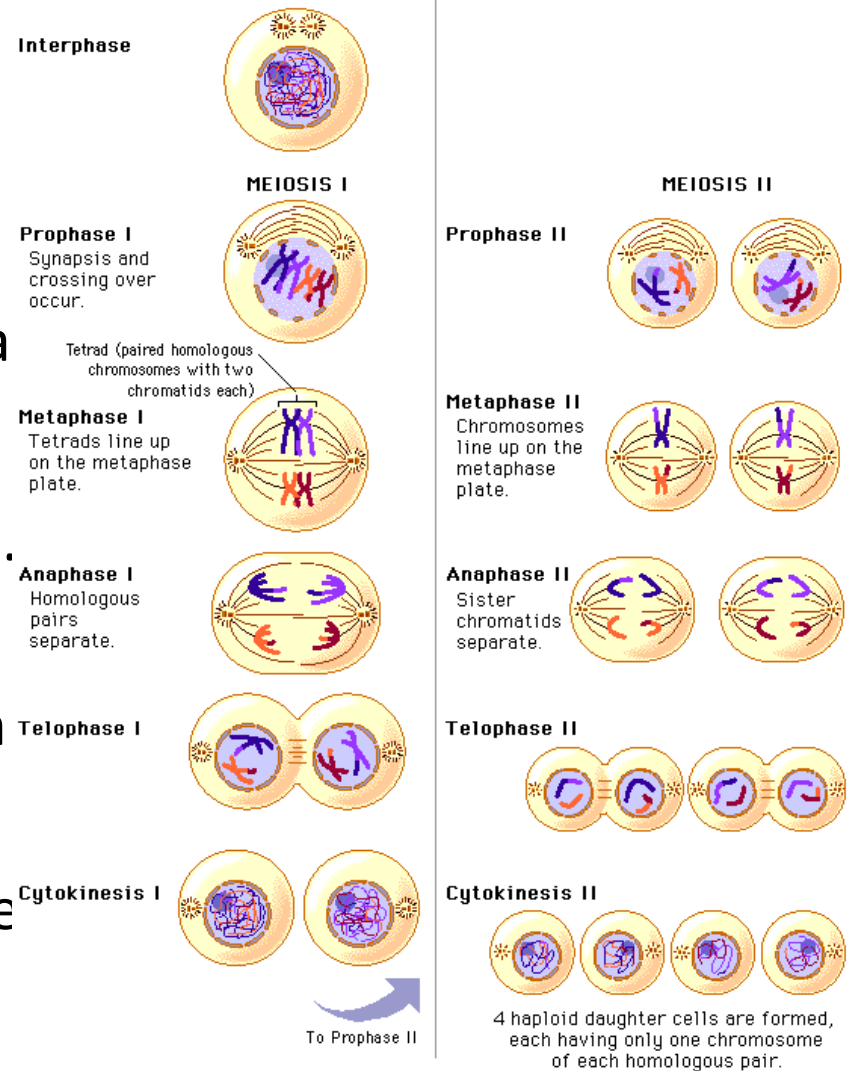
Mitosis is the process used to repair an organism by creating more of the same type of cell (for example, to heal a cut on the leg)

 D. Mitosis produces genetically identical daughter cells.

Meiosis produces genetically different cells as a result of crossing over and chromosome shuffling

Meiosis

- Meiosis occurs during the formation of sex cells (sperm and egg). It is necessary so that the sex cells only have half the number of chromosomes (23 in us) so that at fertilization, the normal chromosome number is returned (46 in us)
- Meiosis involves two divisions. It begins with the replication of the chromosomes, divides up the cell into two cells, then divides again (without replication) into 4 genetically different sex cells with half the normal number of chromosomes

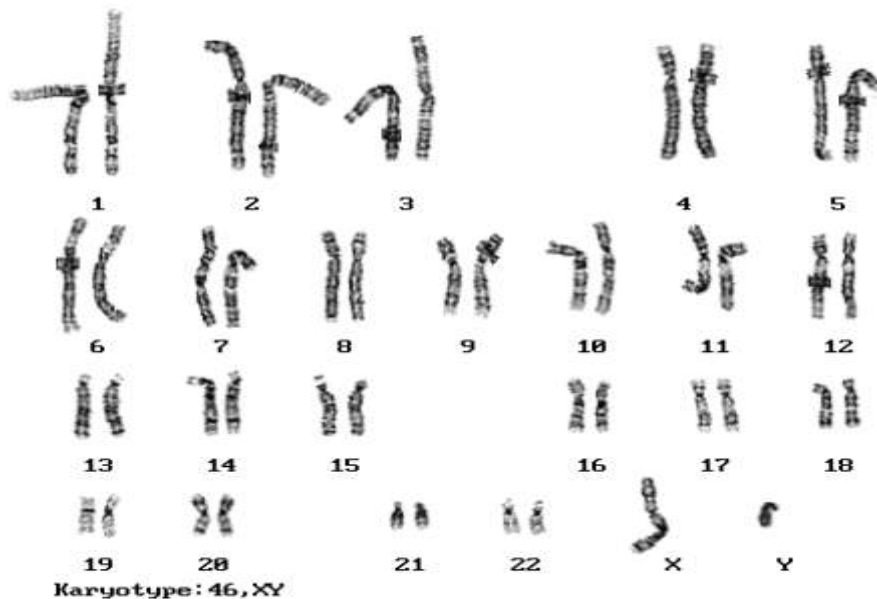
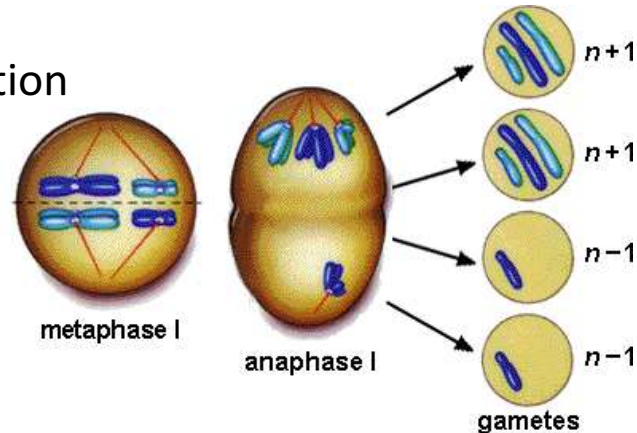


23.) Patau syndrome can be a lethal genetic disorder in mammals, resulting from chromosomes failing to separate during meiosis.

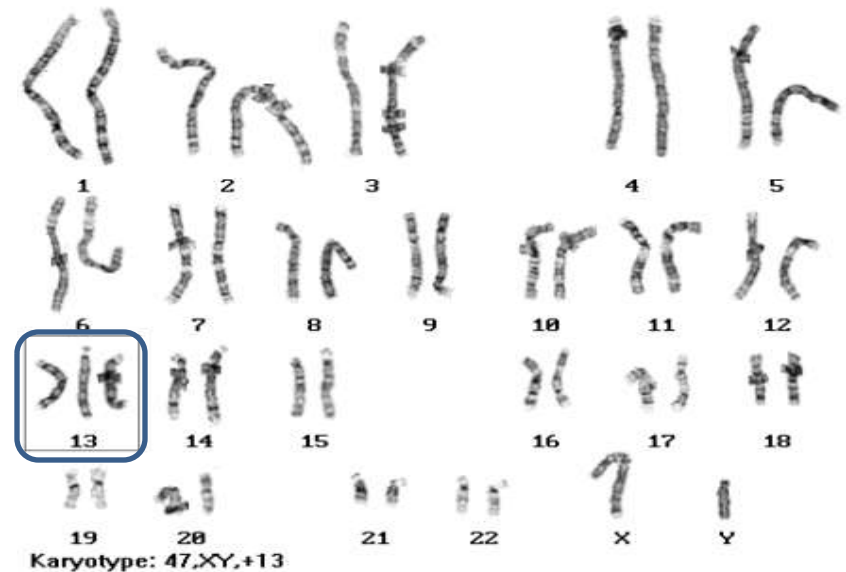
- **Part A:** Identify the step during the process of meiosis when chromosomes would **most likely** fail to separate.
- *Most likely **chromosomes would fail to separate during anaphase I or Anaphase II**. In anaphase, chromosomes (anaphase I) or sister chromatids (anaphase II) are supposed to separate, or move AWAY from each other. This is called Nondisjunction.*
- **Part B:** Describe how chromosome separation in meiosis is different from chromosome separation in mitosis.
- *During meiosis cells and the genetic material **is divided twice** (the first set of division is meiosis I and the second set is meiosis II). In mitosis, the cell and chromosomes divide once.*

Nondisjunction and Patau's syndrome

Nondisjunction



Karyotype of a normal male



Karyotype of a Patau's male (notice chromosome #13 has three chromosomes instead of two)

MITOSIS

Prophase

Duplicated chromosome
(two sister chromatids)

Metaphase

Chromosomes
positioned at the
metaphase plate

Anaphase
Telophase

Sister chromatids
separate during
anaphase

$2n$

Daughter cells
of mitosis

$2n$

MEIOSIS

Parent cell
(before chromosome replication)

$2n = 6$

Chiasma (site of
crossing over)

MEIOSIS I

Prophase I

Tetrad formed by
synapsis of homologous
chromosomes

Tetrads
positioned at the
metaphase plate

Metaphase I

Homologues
separate
during
anaphase I;
sister
chromatids
remain together

Anaphase I
Telophase I

Haploid
 $n = 3$

Daughter
cells of
meiosis I

MEIOSIS II

Daughter cells of meiosis II

Sister chromatids separate during anaphase II

n

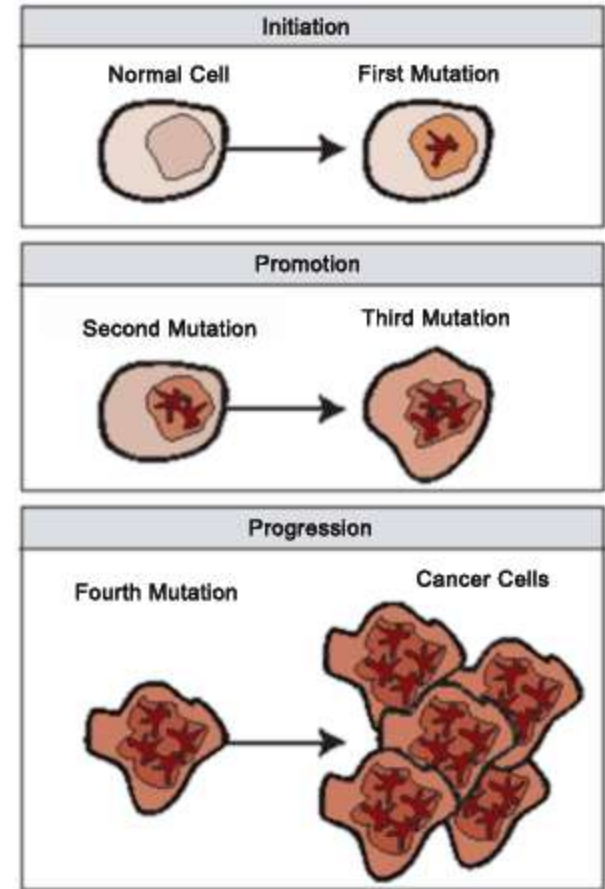
n

n


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Part C: Compare the effects of a disorder caused by chromosomes failing to separate during meiosis, such as Patau syndrome, to the effects of chromosomes failing to separate during mitosis.

- *Due to the improper number of chromosomes, the organism has an improper amount of genetic material in the form of DNA of the sperm or egg. This mutation will be found in every cell of the organism's body.*
- *If chromosomes fail to separate during mitosis, it does not affect the sex cells but a body cell. This mutant body cell then can be reproduced and produce more of the abnormal cells. The cell either dies or is replicated quickly. This could possibly lead to cancer if the cells are not destroyed by the immune system.*

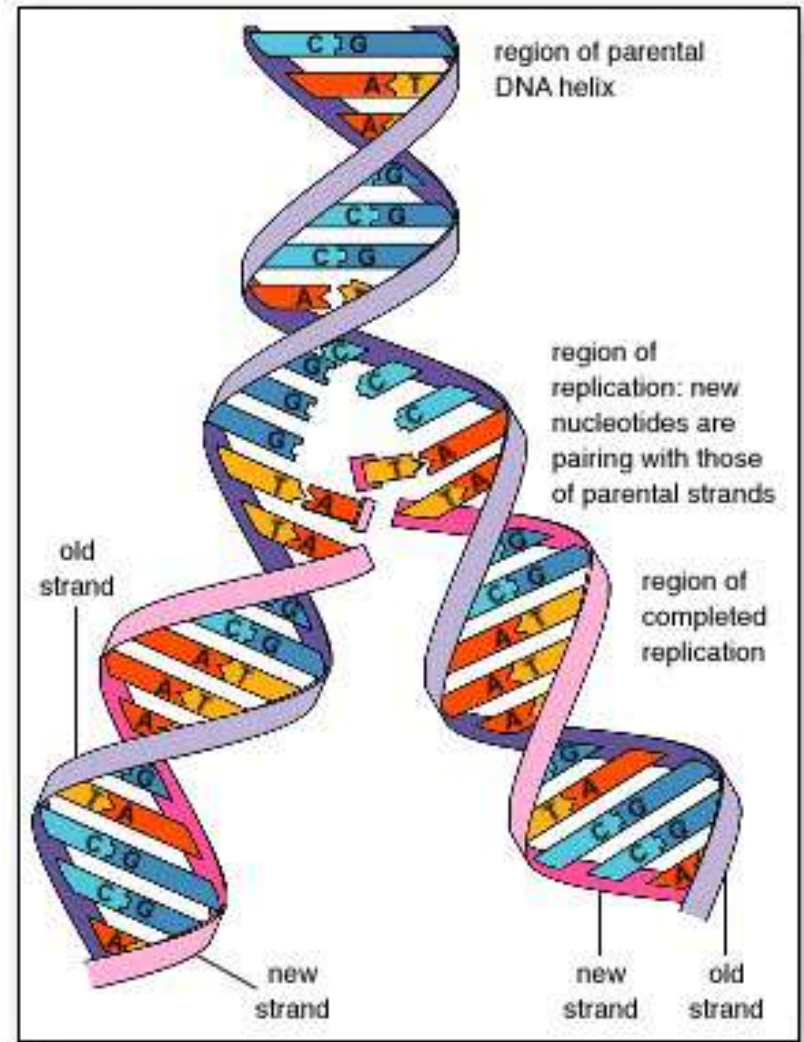


24.) Which process helps to preserve the genetic information stored in DNA during DNA replication?


- A.) The replacement of nitrogen base thymine with uracil.
- B.) Enzymes quickly linking nitrogen bases with hydrogen bonds.
- C.) The synthesis of unique sugar and phosphate molecules for each nucleotide.
-  D.) Nucleotides lining up along the template strand according to base pairing rules.

DNA Replication

- *This is key for DNA replication. DNA (a double stranded molecule) splits into two halves, and each half serves as a “template” or pattern to build the new half.*
- *The result is two identical strands of DNA*
 - *Adenine always pairs with Thymine (straight line letters AT go together) and Guanine always pairs with Cytosine (curvy letters GC go together)*



25.) In a flowering plant species, red flower color is dominant over white flower color. What is the genotype of any red-flowering plant resulting from this species?

- A. Red and white alleles present on one chromosome.
- B. Red and white alleles present on two chromosomes.
- C. A red allele present on both homologous chromosomes
-  D. A red allele present on at least one of two homologous chromosomes.

Genetics

- *Dominant traits are represented by capital letters, while recessive (non-dominant traits) are represented by lower case letters.*
 - *Each parent has two copies of the gene, so they will get two letters. The different letters represent the different alleles (flower pedal color) of a trait.*
 - *Since white is the recessive trait, in order to have white petals, the flower has to be **ff** or **pure for the white trait**.*
 - *Since red color is dominant, the red parent could be **Ff** or **FF** since it shows red petals. It is either pure for the red trait or a hybrid for red.*
- When the dominant trait shows, only one allele (form of the gene) must be present to show the trait.

