Keystone Biology Remediation

A2: The Chemical Basis for Life

Assessment Anchors:

- to describe unique properties of water and how these properties support life on Earth (e.g. freezing point, high specific heat, cohesion) (A.2.1.1)
- to explain how carbon is uniquely suited to form biological macromolecules (A.2.2.1)
- to describe how biological macromolecules form from monomers (A.2.2.2)
- to compare the structure and function of carbohydrates, lipids, proteins, and nucleic acids in organisms (A.2.2.3)
- to describe the role of an enzyme as a catalyst in regulating a specific biochemical reaction (A.2.3.1)
- to explain how factors such as pH, temperature, and concentration levels can affect enzyme function (A.2.3.2)

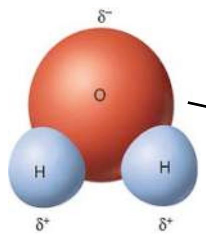
Unit Vocabulary:

activation energy
active site
adhesion
biological macromolecule
capillary action
carbohydrate
catalyst
cohesion
dehydration synthesis
DNA
enzyme
freezing point
hydrogen bond
hydrolysis
lipids
macromolecule
monomer
nucleic acid
organic molecule
pH
polarity
polymer
protein
specific heat
substrate
surface tension
temperature
universal solvent

Assessment Anchor: Describe unique properties of water and how these properties support life on Earth (e.g. freezing point, high specific heat, cohesion) (A.2.1.1)

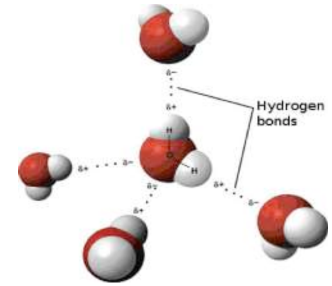
PROPERTIES OF WATER

Water is a **polar** molecule because it has regions of positive charge and a region of negative charge.



The polarity of the molecule and the hydrogen bonding between molecules are responsible for water's unique properties.

Hydrogen bonds form between the positive end of one molecule and the negative end of another molecule.



Water is the **universal solvent**.

importance

The chemical reactions that keep organisms alive take place in solution.

Surface tension

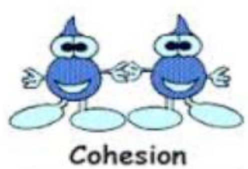
results in some insects being able to walk of the surface of water.

An example from lab is floating a paperclip on the surface of water.

Cohesion

results in water molecules being attracted to other water molecules.

creates → Surface tension



An example from lab is the dome created by putting water on a penny.

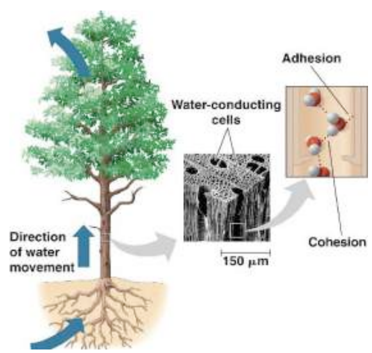
One way this is important to living things is:

Capillary Action

is responsible for (Cohesion)

is responsible for (Adhesion)

is the ability of a liquid to flow through narrow spaces (like narrow tubes), sometimes in opposition to the pull of gravity.



This allows water to travel to the tops of tall trees.

Adhesion

results in water molecules being attracted to molecules of other substances.

An example from lab is the meniscus created at the top of the liquid in a graduated cylinder.

One way this is important to living things is:

High specific heat

results in water resisting changes in temperature.

This is important to living things because it allows them to maintain a fairly constant body temperature.

Density

The **density** of ice is lower than that of liquid water, which means that water expands when it freezes.

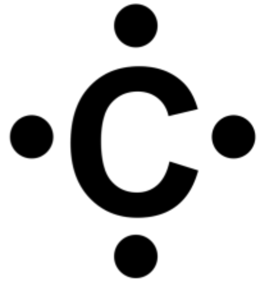
As a result, ice floats on the surface of water.

The layer of ice acts as an insulting barrier for the water below and helps aquatic organisms survive cold winters.

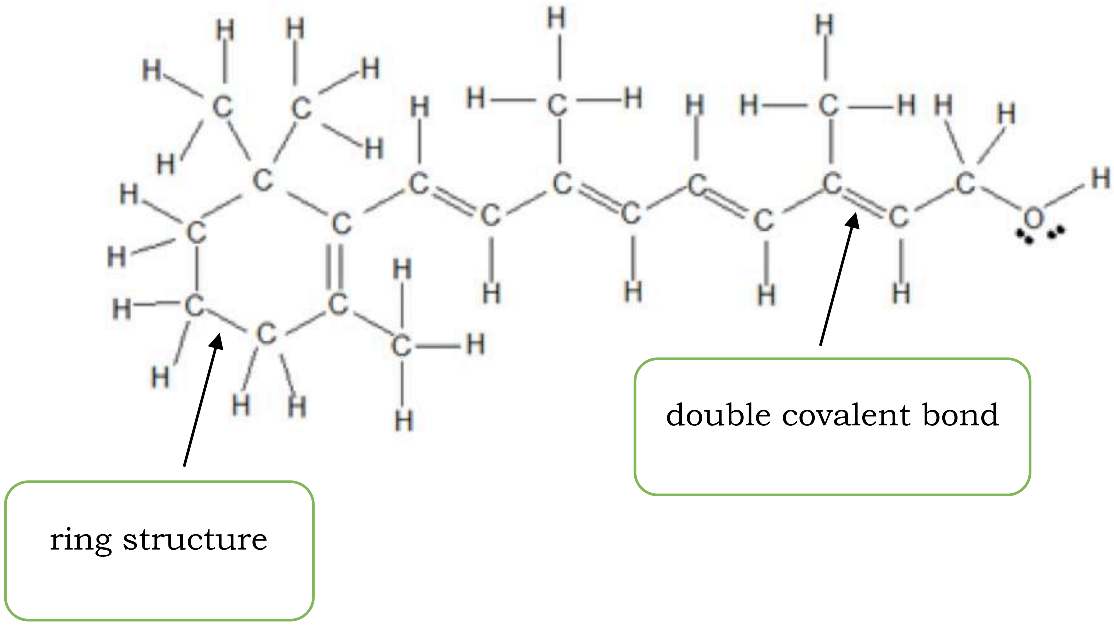
Assessment Anchor: Explain how carbon is uniquely suited to form biological macromolecules (A.2.2.1)

Carbon's structure makes it uniquely suited to the formation of macromolecules because:

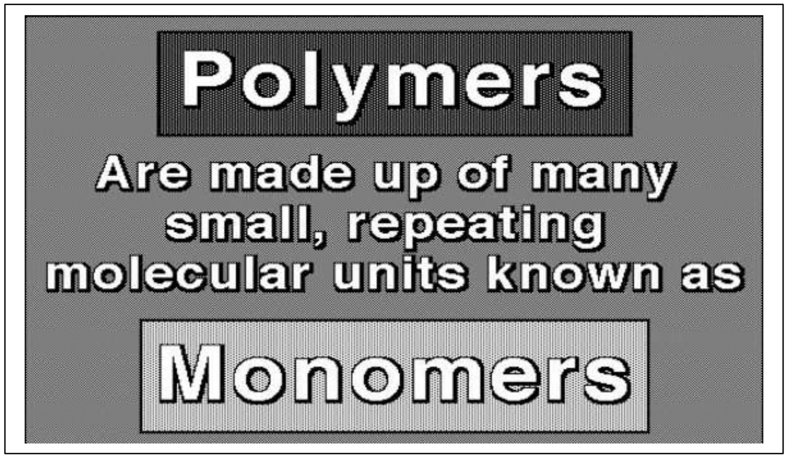
- Each carbon atom can make 4 covalent bonds
- Carbon atoms can form long chains
- Carbon atoms can form large, complex structures (branches, rings)
- Carbon atoms can make single, double, or triple covalent bonds with other atoms

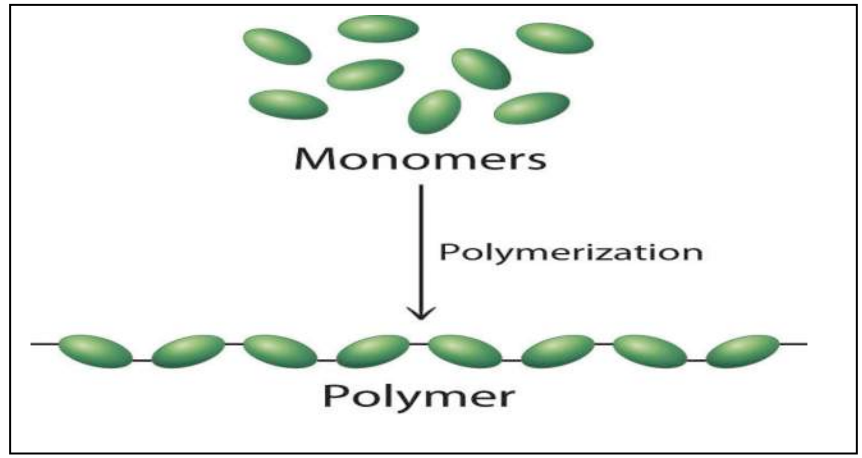


Example:

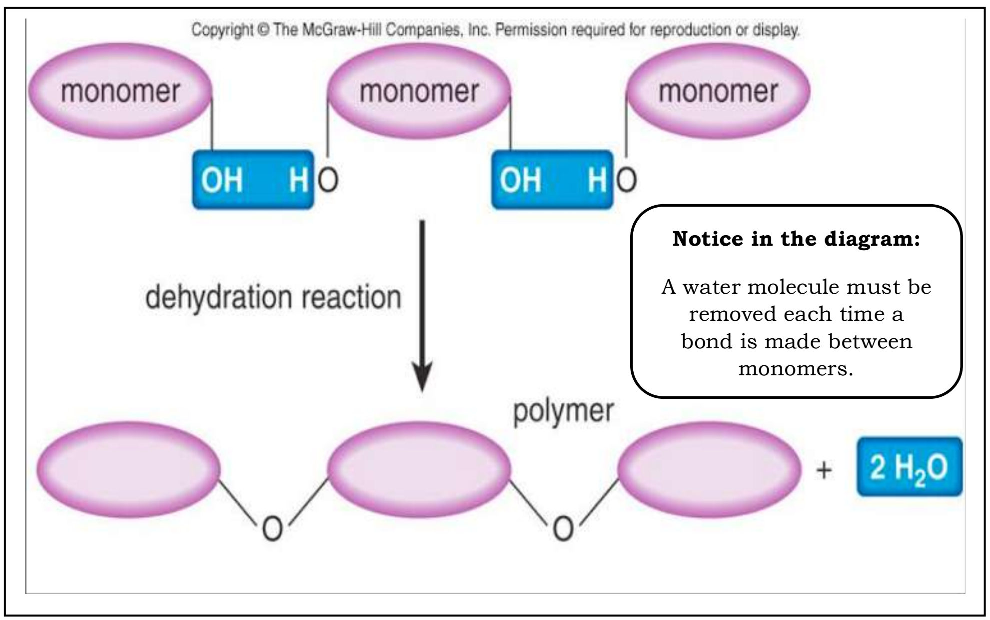


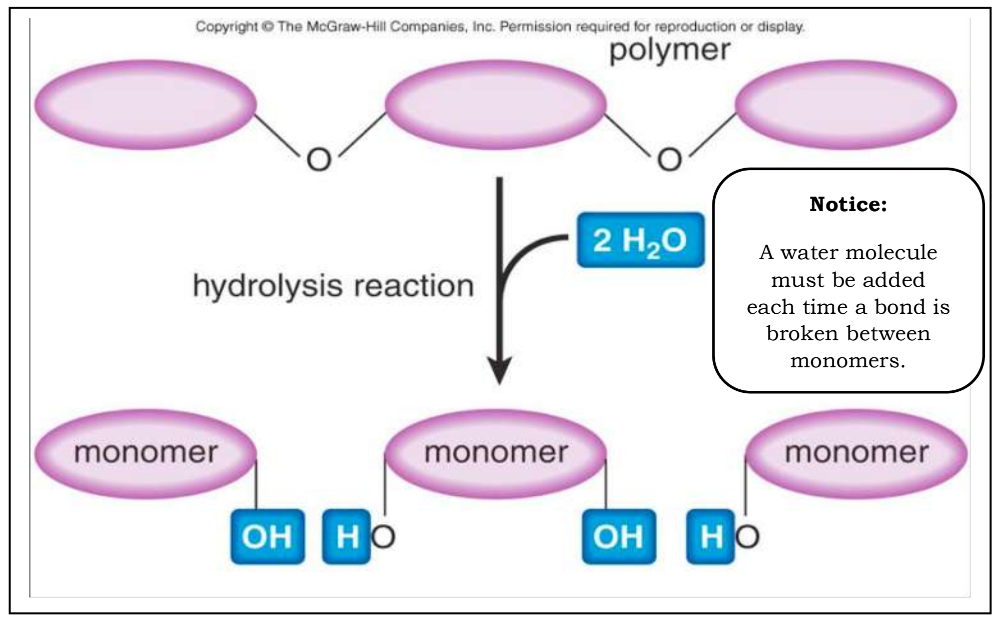
Assessment Anchor: Describe how biological macromolecules form from monomers (A.2.2.2)





The formation and breakdown of all four groups of organic molecules occurs by the same processes:





dehydration = removal of water	synthesis = to build

hydro = water	lysis = to break apart

Assessment Anchor: compare the structure and function of carbohydrates, lipids, proteins, and nucleic acids in organisms (A.2.2.3)

ORGANIC MACROMOLECULES → large molecules that contain carbon

ORGANIC MACROMOLECULES → monomers

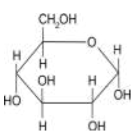
monomers → polymers: formed by the process of **dehydration synthesis**

polymers → monomers: broken down by the process of **hydrolysis**

CARBOHYDRATES

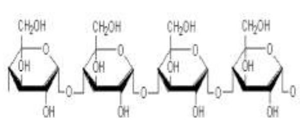
some of which are produced by plants during photosynthesis

whose monomers are **monosaccharides**



sugars → used for quick energy (like the glucose in your bloodstream)

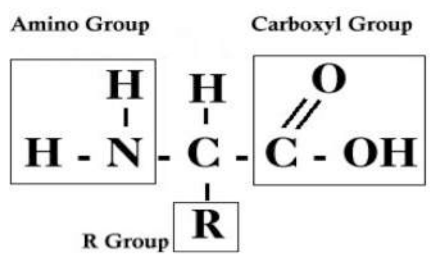
starch → used for storage in plants



PROTEINS

whose monomers are **amino acids**

The general structure is:

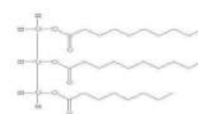


many uses in living things including enzymes, hormones, and antibodies

LIPIDS

Members of this group are insoluble in water and include:

1. phospholipids
2. steroids
3. fats



whose building blocks are

1 glycerol and 3 fatty acids

Uses of fats include: insulation, cushioning, and efficient energy storage.

NUCLEIC ACIDS

whose monomers are **nucleotides**

Examples are

DNA → stores genetic information

RNA → functions in protein synthesis

Assessment Anchor: Describe the role of an enzyme as a catalyst in regulating a specific biochemical reaction (A.2.3.1)

ALL ABOUT ENZYMES ……

Enzymes

often have names that end in -ase

are biological **catalysts**

which means that they speed up chemical reactions in living cells

are **proteins**

which are composed of chains of amino acids

joined by peptide bonds

The chain is folded in such a way as to create the

Extreme heat or pH can disrupt the bonds that keep the protein folded into shape. When this happens, the enzyme is said to be **denatured**. This destroys the shape of the

are not used up or changed during a reaction

so

are needed in very small amounts

work by lowering the **activation energy** needed for a chemical reaction to occur

can only bond to a certain **substrate**

explained by

lock and key model

with

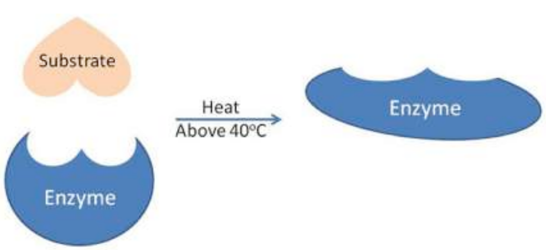
the enzyme being the lock

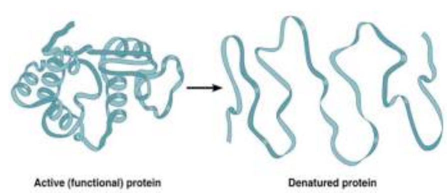
the substrate being the key

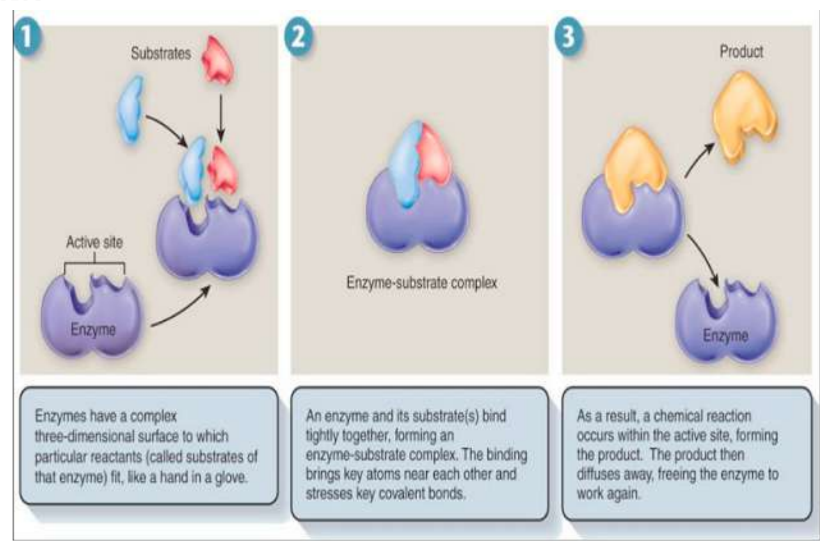
which has

binds to

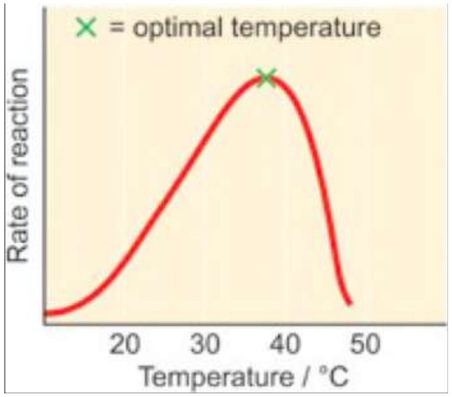
active site

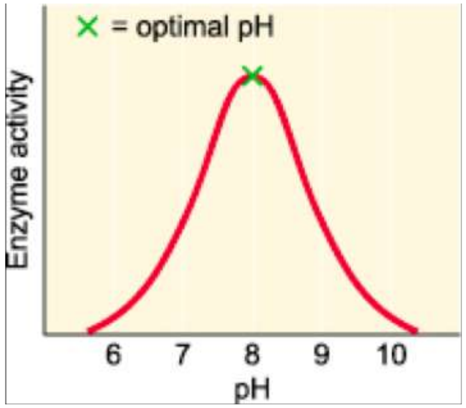


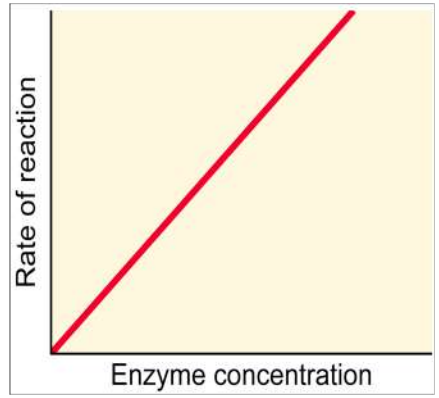


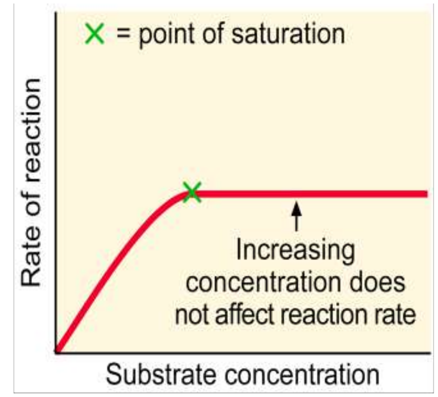


Assessment Anchor: Explain how factors such as pH, temperature, and concentration levels can affect enzyme function (A.2.3.2)









Every enzyme has an **optimum temperature**. The optimum temperature is the temperature at which the enzyme works the fastest. The actual optimum temperature varies from enzyme to enzyme, but is generally related to the body temperature of the organism in which it works. Below the optimum temperature, the enzyme works slower because molecular movement is slower. Therefore, the chance of a collision between enzymes and substrates is less. Beyond the optimum temperature, the enzyme activity decreases, eventually reaching zero because the enzyme is **denatured**. When an enzyme is denatured, the shape of the enzyme changes which changes the shape of the **active site**. The shape of the active site is very specific to a particular substrate so if the shape changes, the enzyme can no longer bind to the substrate.

Every enzyme also has an **optimum pH**. The optimum pH is the pH at which the enzyme activity is the greatest. The optimum pH varies from enzyme to enzyme, but is related to the environment in which the enzyme works. For example, the pH of the mouth is ~7. Salivary amylase, which works in the mouth, has an optimum pH of 7. The pH of the stomach is ~2. Pepsin, which works in the stomach, has an optimum pH of 2. Enzymes work fastest within a very narrow pH range. If the pH of the environment becomes more acidic or more basic, the enzyme activity decreases, because the shape of the enzyme changes which affects the enzymes ability to bind to the substrate. When the enzyme is so damaged that it is no longer functional, it is said to be **denatured**.

Increasing enzyme concentration will increase the rate of the reaction because additional enzyme will mean that the chance of a collision between an enzyme molecule and a substrate molecule increases. (This assumes that you have unlimited substrate. If you don't, then the graph will not increase indefinitely. If the substrate is all used up, then the rate of reaction will be zero.)

Increasing the substrate concentration increases the rate of enzyme activity, to a point. If you increase the substrate concentration, the chance of a collision between an enzyme molecule and a substrate molecule increases. However, beyond a certain concentration, additional substrate will not increase the rate of enzyme activity because the enzymes are already working at their maximum speed.