BIOLOGY 101
CHAPTER 2: THE CHEMISTRY OF LIFE

Life on earth is a physical and chemical phenomenon.
Matter- the physical material of the universe that has mass and takes up space.
What are the types of matter? **THE ELEMENTS**

ORGANIZATION OF MATTER
ELEMENT- A fundamental substance, Cannot be broken apart by chemical means.
There are **92** naturally occurring elements
Bulk elements in living organisms are the six major elements. **CHONPS**
Trace elements are needed in lesser amounts.
Periodic table of elements - Reading the periodic table – Letter(s)-chemical symbol
Number above – atomic number, Number below – atomic mass

STRUCTURE OF ATOMS
ATOMIC THEORY - 1820 - John Dalton said that an **ATOM** is the smallest particle of an element

What is in the Atomic Nucleus?
Protons(+) - A positively charged particle What is the mass of this particle? **ONE**
Neutrons (0) - A neutral particle What is the mass of this particle? **ONE**

Atomic Number = Protons **EACH ELEMENT HAS ITS OWN UNIQUE NUMBER OF PROTONS**
What effect does the number of protons have on an element? **Protons make each element unique – different properties**

Atomic Mass= Protons + Neutrons What is mass? **Mass is measurable.**

Isotopes- Atoms with different number of neutrons
Radioisotopes- Emit radioactivity when the neutrons spontaneously decay.
Radioisotopes have a half-life **HALF OF THE ATOMS OF AN ISOTOPE DECAY**
Uses of radioactivity - **ENERGY, WEAPONS, POWER, ENVIRONMENTALRESEARCH, MEDICAL RESEARCH, MEDICAL TREATMENTS**

What is outside the atomic nucleus?
Electrons(-)- A negatively charged particle
(Why is the number of electrons equal to the number of protons?)
Atoms must have enough negative electrons to balance their positive protons.
Energy Levels- Set distances from the nucleus of an atom where electrons are distributed.

OCTET RULE- *Each energy level is satisfied with eight electrons except the first, which is satisfiedwith two.*
Ions- Atoms that either gains or loses one or more electrons.
When an atom loses electron(s) it becomes a **POSITIVE ION.** **$Na \rightarrow Na^+ + e^-$**
When an atom gains electron(s) it becomes a **NEGATIVE ION.** **$Cl + e^- \rightarrow Cl^-$**

CHEMICAL INTERACTIONS BETWEEN ATOMS INVOLVE ELECTRONS.
Inert - Nonreactive - has a satisfied outer energy level (Helium, Neon – far right row of periodic table)

Reactive - Outer energy level is not satisfied. (Hydrogen, Carbon)
Molecule- Two or more atoms joined (O_2, 0=0) Atoms bond to form molecules.
Compound - Two or more different atoms joined H_2O, CO_2, NH_3, CH_4
Mixture - two or more elements that are intermingled in proportions that vary (not joined)

MOLECULAR BONDS (Chemical Bonds - Electron links between atoms)
Chemical reactions – breaking old bonds and reforming new bonds
Ionic Bonding- Electrons are transferred from one atom to another and they are linked by positive and negative charges. We will use table salt **NaCl** as our main example.

Covalent Bonding- Shared pairs of electrons (2 pair = double covalent, 3 pair = triple covalent)
Nonpolar - Equal sharing of electrons Ex. O_2, CO_2, H_2, CH_4
Polar - Unequal sharing of electrons gives partial charges on the molecule Ex. H_2O, NH_3, DNA, &

Proteins

Hydrogen Bonding- Links between a charged part of a molecule and a hydrogen that is covalently bonded. Water molecules have hydrogen bonds between them.

PROPERTIES OF WATER

WATER'S COHESION

Cohesion- Attraction between two water molecules

Surface Tension- Cohesion is stronger at the surface of a body of water

Adhesion- Attraction of water molecules to hydrophilic substances

Meniscus - Attraction of water to glass that causes a curved surface at the edge

Capillarity- Combination of cohesion and adhesion that causes water to rise in a tube

POLARITY OF THE WATER MOLECULE - 105° angle of bonding

Hydrophobic- Substances repelled by water. Name some **_OIL, WAX, BUTTER, SHORTENING**

Hydrophilic- Substances attracted to water. Name some **__SUGAR, KOOLAID, TEA, COFFEE**

WATER'S SOLVENT PROPERTIES

Solvent- A substance capable of dissolving other molecules. (The greater amount)

Solutes- Any substance that has been dissolved. (The lesser amount)

What is the solvent in iced tea? **WATER** What are the solutes? **TEA,SUGAR,LEMON JUICE**

Solution – one or more solutes dissolved in a liquid solvent

WATER REGULATES TEMPERATURE

Water absorbs more heat than other liquids before its temperature rises.

What does this mean when you try to boil water? **MORE HEAT = MORE WATER LEAVING**

Evaporation is conversion of liquid to a vapor.

How do you benefit from this property of water? **__SWEATING COOLS OUR BODIES._**

Water Expands as It Freezes

Water expands when it freezes, forming a solid called **_ICE**.

How does ice protect organisms? **__Organisms survive below ice in warmer water.__**

How does ice destroy living cells? **__Ice can rupture delicate cells._____**

Why does ice float? **__Water molecules are further apart in ice so it is less dense._**

Water Participates in Life's Chemical Reactions

Water is used in reactions that break apart biomolecules.

Water is released in reactions that build biomolecules.

ORGANISMS BALANCE ACIDS & BASES

Neutral– has a balance of H^+ and OH^-

Acids - Molecules capable of releasing H^+ in a solution (pH = <7) pH indicator used in lab – **Phenol red**

Bases - (Alkaline) - Molecules capable of releasing hydroxide ions or accepting H^+ in solution(pH = >7)

pH Scale (logarithmic) - Used to measure the concentration of free H^+.

Buffer Systems Regulate pH in Organisms

BUFFERS and the pH of Body Fluids - Buffers help to keep the intracellular and extracellular fluids at the proper pH. $H_2O + CO_2 <=> H_2CO_3 <=> HCO_3^- + H^+$

CHEMICAL INTERACTIONS IN CELLS

Keeping proteins in solution. (How? **__CHARGED AREAS ON PROTEINS CLING TO WATER**)

Using ions to conduct nerve impulses. (How? **__IONS STAY IN SOLUTION IN WATER___**)

Using ions to contract muscle cells. (How? **___DISSOLVED IONS MOVE INTO MUSCLE CELLS___**)

The Effect of Water on Life (How?)

Moderates temperature changes **WATER HEATS AND COOLS SLOWLY PROTECTING ORGANISMS_**

Cushions delicate cells and tissues**__WATER ALLOWS MANY CELLS TO RETURN TO SHAPE___**

Solvent for and participant in cellular chemical reactions. **__WATER IS LIFE'S PRIMARY SOLVENT.**

___WATER PARTICIPATES IN CHEMICAL REACTIONS IN LIVING CELLS._
Serves as habitat for many organisms **_MANY ORGANISMS LIVE IN WATER._**

ORGANIC MOLECULES GENERATE LIFE FORM AND FUNCTION

ORGANIC COMPOUNDS – The molecules of life contain carbon and at least one hydrogen. The broad name for them is **organic**. All other substances are **_INORGANIC_**. Ex. CO_2, H_2O, NaCl
Most organic compounds contain carbon in chains or rings.

BIOMOLECULES (NIT)
More specifically, the compounds that are part of or come from living organisms are **biomolecules**.

BONDING SITES: (NIT)
Carbon atoms have four electrons in their outer energy level so they have **__4__** bonding sites.
Single bonds in carbon compounds can rotate.
Double bonds in carbon compounds hold are rigid.

CARBON BONDING AND FUNCTIONAL GROUPS (NIT)
Carbon chains or rings form a backbone to which other atoms can be attached.
Functional groups are small clusters of atoms that impart specific chemical properties to the molecules to which they are attached.
MONOMERS - small subunits of biomolecules
_POLYMERS__ - three up to millions of subunits monomer + monomer + monomer = polymer

CHEMICAL REACTIONS THAT BUILD AND BREAKDOWN ORGANIC MOLECULES
DEHYDRATION SYNTHESIS- covalently bonding two smaller molecules (monomers) makes dimmers or polymers and releases water molecule s
HYDROLYSIS(Digestion) - splitting larger molecules (polymers) into smaller ones (monomers)uses water (Hydrolyze, Hydrolytic)

BIOMOLECULES- are organic compounds. There are four main types of biological molecules. They are polymers of monomers linked by covalent bonds.

Four families of biomolecules		Monomers of the four families of biomolecules
CARBOHYDRATES-		**MONOSACCHARIDES**
LIPIDS	-	**FATTY ACIDS**
PROTEINS-		**AMINO ACIDS**
NUCLEIC ACIDS-		**NUCLEOTIDES**

A. CARBOHYDRATES INCLUDE SIMPLE SUGARS AND POLYSACCHARIDES
-most abundant biomolecules in nature - structural components and energy reserves.
They contain carbon, hydrogen and oxygen in a ratio of 1:2:1 (CH_2O).
Monosaccharides- ($C_6H_{12}O_6$)**_GLUCOSE_,** Fructose, Galactose
Disaccharides- Glucose + Fructose =**SUCROSE** Other dissacharides - Lactose, Maltose
Polysaccharides: complex carbohydrates Common polysaccharides are composed of glucose.
_CELLULOSE- plant molecules used in cell walls, abundant in paper and wood
_CHITIN _- molecule used in arthropod shells and the cell walls of fungi
_STARCH___- plant method of storing glucose
_GLYCOGEN- animal method of storing glucose

B. LIPIDS ARE HYDROPHOBIC AND ENERGY RICH
Lipids - Can serve as long term energy storage molecules or as building blocks of cells.
The common link between the different types of lipids is that they are all insoluble in water -**_HYDROPHOBIC**.
Fatty acids are part of all the lipid molecules except the sterols.
_SATURATED fatty acids have all single bonds in their carbon chains.
_UNSATURATED fatty acids have one or more double bonds in their chains and so are not "saturated" with hydrogen atoms.
The four types of lipids are **Triglyceride**s (fats and oils), **Waxes, Phospholipids** and **Sterols**

TRIGLYCERIDESinclude fats and oils.
Each molecule contains a **glycerol** molecule bonded to three **fatty acids**.