

Week 3

BIO-1305 - Biology 1 – Campbell Textbook

Hello and welcome to the weekly resources for BIO-1305 - Biology 1 – Campbell Textbook!

This week is **Week 3 of class**, and typically in this week of the semester, your professors are covering the topics below. If you do not see the topics your particular section of class is learning this week, please take a look at other weekly resources listed on our website for additional topics throughout the semester.

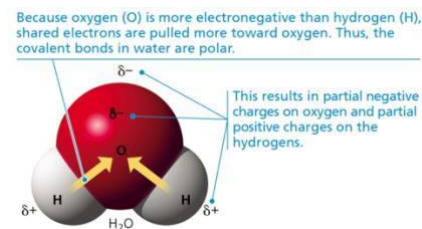
We also invite you to **look at the group tutoring chart on our website to see if this course has a group tutoring session offered this semester.**

If you have any questions about these study guides, group tutoring sessions, private 30 minute tutoring appointments, the Baylor Tutoring YouTube channel, or any tutoring services we offer, please visit our website www.baylor.edu/tutoring or call our drop in center during open business hours (M-Th 9am-8pm on class days at 254-710-4135).

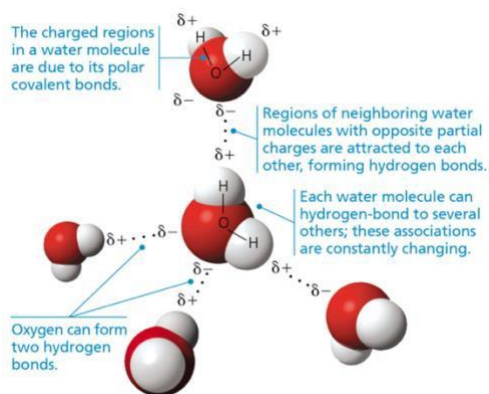
Keywords: Foundations, Water, Chemical Basics, Biological Molecules

Topic of the Week: Water & It's Properties

Water is one of the most amazing substances on earth! Though it looks like a simple molecule, because of its **chemical properties**, it is responsible for many of the most important parts of life. Let's start by looking at the *basic structure* of a water molecule with the picture on the right.



Because of its structure, water can form **hydrogen bonds**. This is an extremely important quality of water and is the basis of life!



To the left you will see a diagram of how *hydrogen bonds* form between water molecules. This hydrogen bonding allows water to have these four important properties:

- **Cohesion**
- **Ability to moderate temperature**
- **Expansion upon freezing**
- **Versatility as a solvent**

Let's break these down...

1. Cohesion

- Linking together of like molecules because of *hydrogen bonds*

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- This is what allows for *high surface tension & the transport of water* in plants. The ability of water to *stick together* and form a liquid is based on this quality.
- 2. Ability to moderate temperature**
 - Water can **absorb heat** from the air that is warm and **release heat** into air that is cool. Because of *hydrogen bonding*, water can **resist changes in temperature**.
 - As a result of this, water has a *very high specific heat*, which is defined as the amount of heat that must be absorbed or lost for 1 g of that substance to change its temp by 1 degree C.
 - Also as a result, water has a *high heat of vaporization*, which is defined as the quantity of heat a liquid must absorb for 1 g of it to be converted from the liquid to the gaseous state.
- 3. Expansion upon freezing**
 - Water is most dense at **4 degree C**. As the temperature approaches 0 degrees, water freezes and *hydrogen bonds become fixed*. Each water molecule has **4 hydrogen bonds**, and the liquid water now forms a solid crystal lattice. This is what allows water to float!
- 4. Versatility as a solvent**
 - Water is often called the **universal solvent** due to its polar nature. Some important terms to remember when moving forward with biology are *hydrophilic*, meaning “**affinity for water,**” and *hydrophobic*, meaning “**no affinity for water**”

Highlight #1: Evolution & The Foundations of Biology

Let's start the semester off by learning some **basics** about the study of biology. These concepts will be the foundation of what you study this semester, so it's always good to keep them in the back of your mind throughout the entire course!

Biology is defined as “**the study of life.**” This is a very broad idea, but we can approach the study of biology with five unifying themes that overarch the entire discipline of bio:

Unifying themes:

- 1. Organization**
 - Life is organized into a hierarchy as follows from most inclusive to most detailed: *The biosphere, ecosystems, communities, populations, organisms, organs, tissues, cells, organelles, molecules*
- 2. Information**
 - Expression and transmission of *genetic information* is the basis of life. We will see more on this later in the semester!
- 3. Energy and Matter**
- 4. Interactions between systems**
- 5. Evolution**
 - *Charles Darwin* proposed the idea of natural selection, a process where individuals that have certain traits have a better chance of survival and tend to reproduce at high rates to continue passing those traits down.

Highlight #2: The Chemical Context of Life

Biology may seem like a completely different class than chemistry, but you would be surprised

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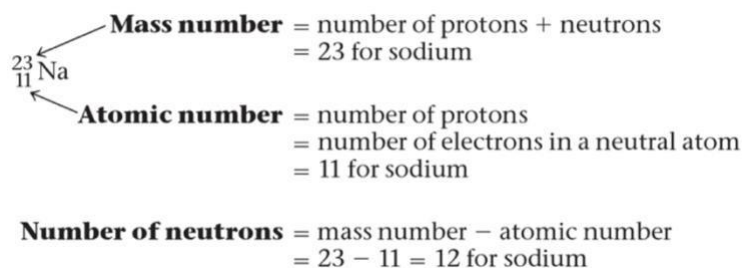
by how much chemistry is incorporated into what you will study in bio 1! Here are the **basic chemistry topics** you will want to be familiar with moving forward:

All *matter* is made of **elements**. Elements are substances that cannot be broken down into other substances. These are what you see on the periodic table! A **compound** is *two or more elements that are combined in a fixed ratio*.

When looking at elements, here are the main definitions to be familiar with:

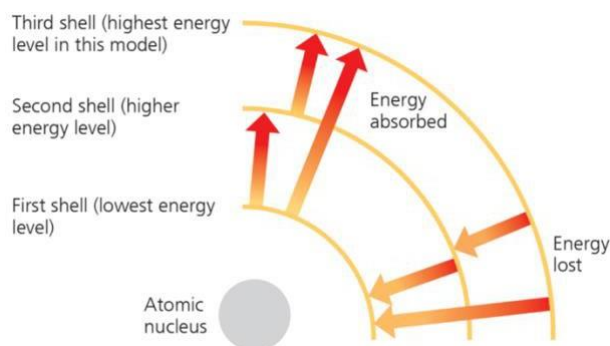
- **Atomic number: number of protons**
- **Mass number: total number of protons and neutrons**
- **Atomic mass: total mass of an atom**

These definitions are incorporated into a *specific notation* that describes an element:



Energy Levels of Electrons:

- **Electrons** of an atom have **potential energy** because of their distance from the positively charged nucleus. Electrons are arranged into **“shells”** that correspond to their potential energy. An electron can move between shells *as long as the energy it absorbs or releases is equal to the exact difference in energy between the shells*.



Valence Electrons and Chemical Bonds

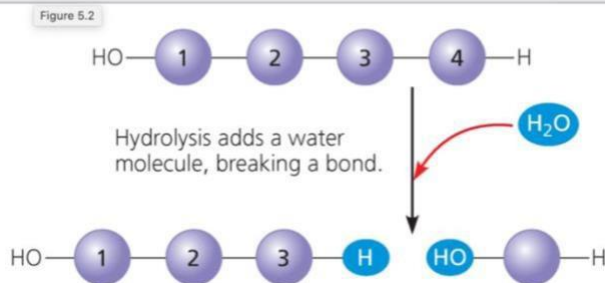
- **Valence electrons** are the *outermost electrons* found in the outside (valence) shell of an atom. These electrons give elements their chemical character and are **involved in bonding**. If an atom has a complete valence shell, it is unreactive. Such elements are called *noble gases*!
- There are some basic types of chemical bonds to be familiar with:
 - o **Covalent bond**: sharing of a pair of valence electrons by two atoms. This is how molecules are created!
 - o **Polar covalent bond**: a covalent bond between atoms that differ in electronegativity. *Electronegativity* is the attraction of an atom for the electrons in a bond. The more electronegative an atom, the more it wants the electrons. In polar covalent bonds, shared electrons are pulled closer to the more electronegative atom making that atom slightly negative and the other one slightly positive.
 - o **Nonpolar covalent bonds**: in these bonds, electrons are *shared equally* between two atoms of similar electronegativity

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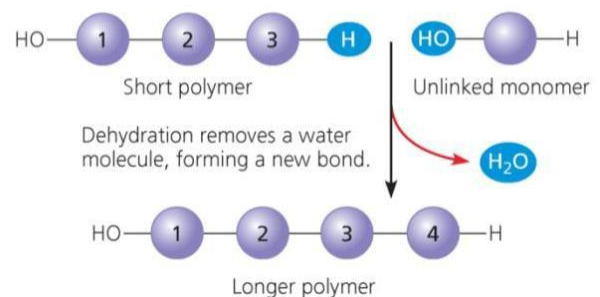
Highlight #3: Large Biological Molecules

Before we jump into the main biological molecules that make up living things, here are some important things to remember about how macromolecules are generally structured: Macromolecules are large molecules called **polymers**. Polymers are made of smaller “building blocks” called **monomers**. Monomers are connected to form polymers by a **dehydration reaction** (when two monomers join together, and a water molecule is lost as a result). The opposite process, where a polymer is broken down into monomers, is called **hydrolysis**. The key to this process is in the word: “hydro” = water and “lysis” = to break.

(b) Hydrolysis: breaking down a polymer

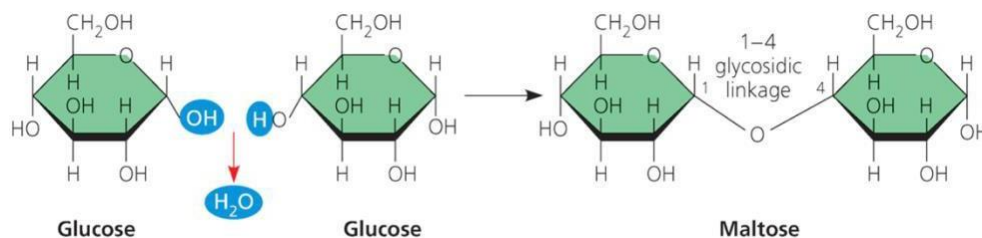


(a) Dehydration reaction: synthesizing a polymer



Now we can talk about the four classes of large biological molecules that make up all living things: **Carbohydrates, lipids, proteins, nucleic acids**

Carbohydrates: When you think of carbohydrates, think **FUEL** and **BUILDING MATERIAL**. Carbohydrate macromolecules are called **polysaccharides**. The monomers that make up polysaccharides are called **monosaccharides**, which are simple sugars. Glucose is an example of a monosaccharide. **Glycosidic linkages** are the types of bonds that join these sugar monomers into long polymers. ***remember that a glycosidic linkage is a result of a dehydration reaction!

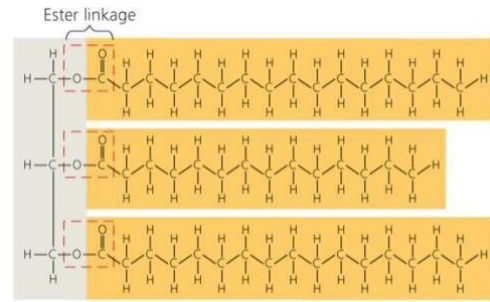
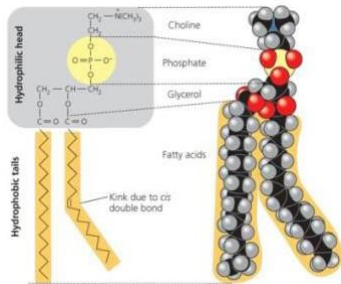


Lipids: These macromolecules are primarily **hydrophobic**, meaning they do NOT like water! This drives a lot of their functions! Lipids are known for their large **hydrocarbon regions**. Fun fact about lipids: they don't technically have a true monomer! Let's look at some of the

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important lipids in biology...

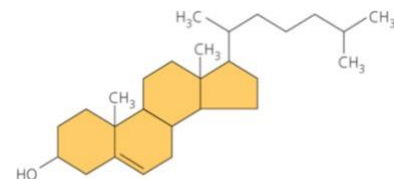
Fats: glycerol backbone with three fatty acid tails, which are long chains of carbon and hydrogen. These hydrocarbon tails make lipids hydrophobic and can be either **saturated** (no double bonds) or **unsaturated** (has double bonds) To the right is an important example of a fat molecule.



Phospholipids: these are VERY important because cells could not even exist without them! These resemble fats but just have **two fatty acid tails**. There is also a phosphate group connected to the glycerol, creating a **polar head** and making the molecule have both

hydrophobic and hydrophilic regions. To the left is the structure of a phospholipid.

Steroids: known for their **four fused rings**. One example is **cholesterol** (on the right) which has many important functions in animal cells.

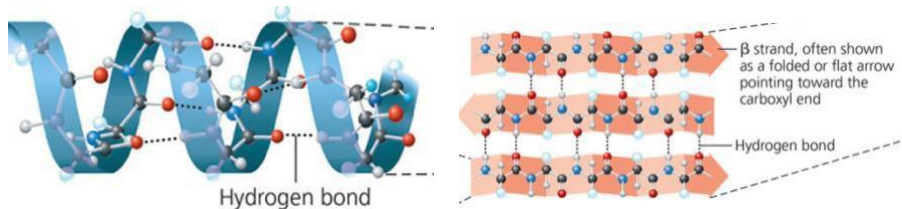


Proteins :These macromolecules carry out almost **ALL FUNCTIONS** in cells! Proteins come in many shapes and sizes, and their structures are important to all activities that occur in the cell! **Amino acids** are the monomers that create **polypeptides**, the polymers. The monomers are joined by **peptide bonds** (which is also a result of dehydration!)

There are different levels to how proteins are structured. The specific way that a protein folds and assembles is key to how it acts!!! You will likely hear this in all bio classes you take: **FORM EQUALS FUNCTION**. Let's talk about the four levels of protein structure...

Primary structure — sequence of amino acids that forms a polypeptide

Secondary structure – interactions between parts of the amino acid sequence to form either an α helix (left pic) or β pleated sheet (right pic)

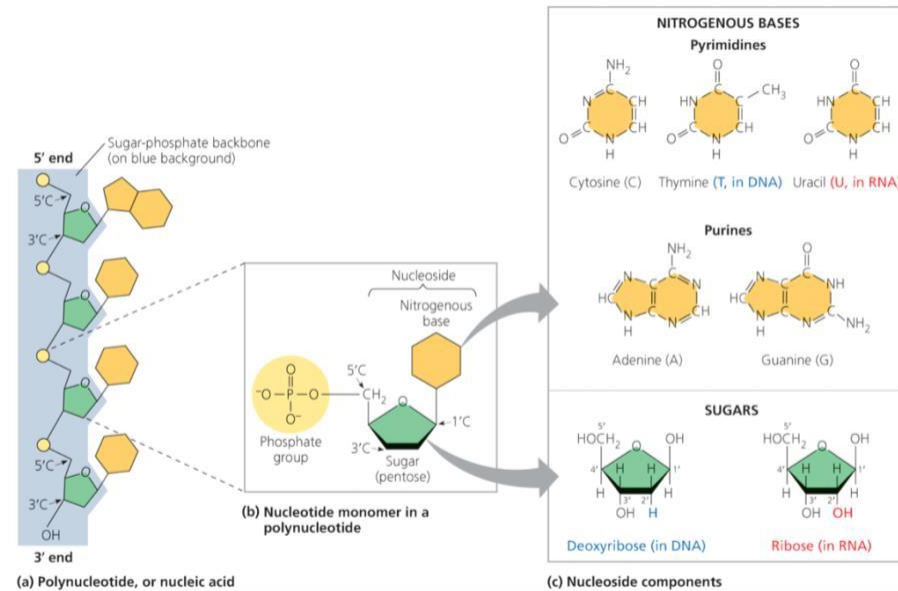


Tertiary structure – three-dimensional structure formed by interactions between side chains

Quaternary structure – two or more polypeptides interact with each other

Nucleic Acids: When you think about nucleic acids, think about DNA and RNA! These polymers are made up of monomers called nucleotides. The polymers are called polynucleotides. A nucleotide is made of a **pentose (5 carbon) sugar**, **nitrogenous base**, and a **phosphate group**.

Without the phosphate group, it is called a nucleoside. The picture on the next page breaks everything up nicely!

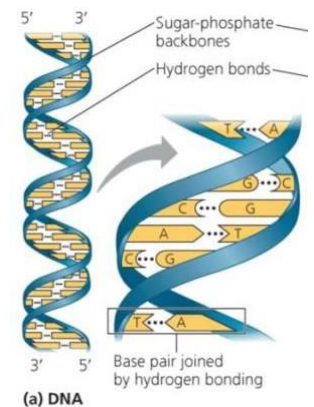


Something important to note about DNA is that the two strands run antiparallel and are complementary. This means that one of the strands runs $5' \rightarrow 3'$ while the other strand runs $3' \rightarrow 5'$. The nitrogenous bases are complementary, meaning the A matches with the T while the C matches with the G

A Tour of the Cell

Cells are the basic units of life. There are two types: **prokaryotic** and **eukaryotic**.

There are great picture/diagrams in your Campbell biology book about the different organelles and their functions, but the videos on the tutoring YouTube channel will sum up most of what you need to know: [Biology Videos](#)



CHECK YOUR LEARNING

1. What are the four important properties of water that are responsible for the basis of life?
2. What is the term used for electrons involved in chemical bonds?
3. What are the four large biological molecules and their corresponding monomers?

THINGS YOU MAY STRUGGLE WITH

1. It is important to remember that mass number and atomic number are different! They sound similar so it is easy to confuse them but remember that MASS number includes both protons AND neutrons while ATOMIC number only includes protons!
2. Hydrolysis and dehydration are OPPOSITES. Remember that hydrolysis involves the addition of a water molecule while dehydration involves the loss of a water molecule.

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3. Don't get too caught up on the 5' and 3' ends of DNA for now. We will dive deeper into that later when we talk about genetics in biology. For now, just know the basic structure of DNA and RNA and that the strands are antiparallel.

Thanks for checking out these weekly resources!

Don't forget to check out our website for group tutoring times, video tutorials and lots of other resources: www.baylor.edu/tutoring! Answers to "Check your Learning" questions are below!

Answers:

1. Cohesion, ability to moderate temperature, expansion upon freezing, versatility as a solvent.
2. Valence electrons
3. Carbohydrates (monomer: monosaccharide), lipids (monomer: no true monomer!), proteins (monomer: amino acids), nucleic acids (monomer: nucleotides)

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