

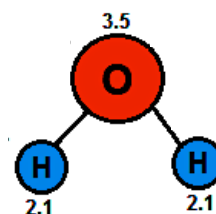
**STUDY GUIDE - Ch. 3.1 – Polar covalent bonds in water molecules results in hydrogen bonding** (*between one water molecule and another or between one water molecule and other charged substances*)

NAME: \_\_\_\_\_

- **PHYSICALLY PRINT OUT** this PDF and **HANDWRITE** (with a black or blue pen) your answers directly on this PDF. Typed or digitally-written work is **not** be accepted. Do **not** answer questions on separate paper.
- **Importantly, study guides are NOT GROUP PROJECTS!!!** You, and you alone, are to answer the questions as you **read** your assigned textbook. You are **not** to share answers with other students. You are **not** to copy any answers from any other source, including the internet.
- **Get in the habit of writing LEGIBLY, neatly, and in a medium-sized font.** AP essay readers and I will skip grading anything that cannot be easily read so start perfect your handwriting, and don't write so large you can't add all the relevant details and key elaborations in the space provided.
- **SCAN** physical documents in color and with good resolution. Then, upload your final work as **PDFs** to Archie. Avoid uploading dark, shaded, washed out, side ways, or upside down scans of homework. Keep completed physical study guides organized in your biology binder to use as future study and review tools.
- **READ FOR UNDERSTANDING** and not merely to complete an assignment. **First**, read a section quickly to get an overview of the topic covered. Then, read it a **second** time slowly, paraphrasing each paragraph **out loud** and analyzing every figure. Finally, read it a **third** time as you answer the study guide questions if assigned and to start building your memory. Try to write answers out in your own words when possible and to purposefully and accurately use all new terminology introduced.

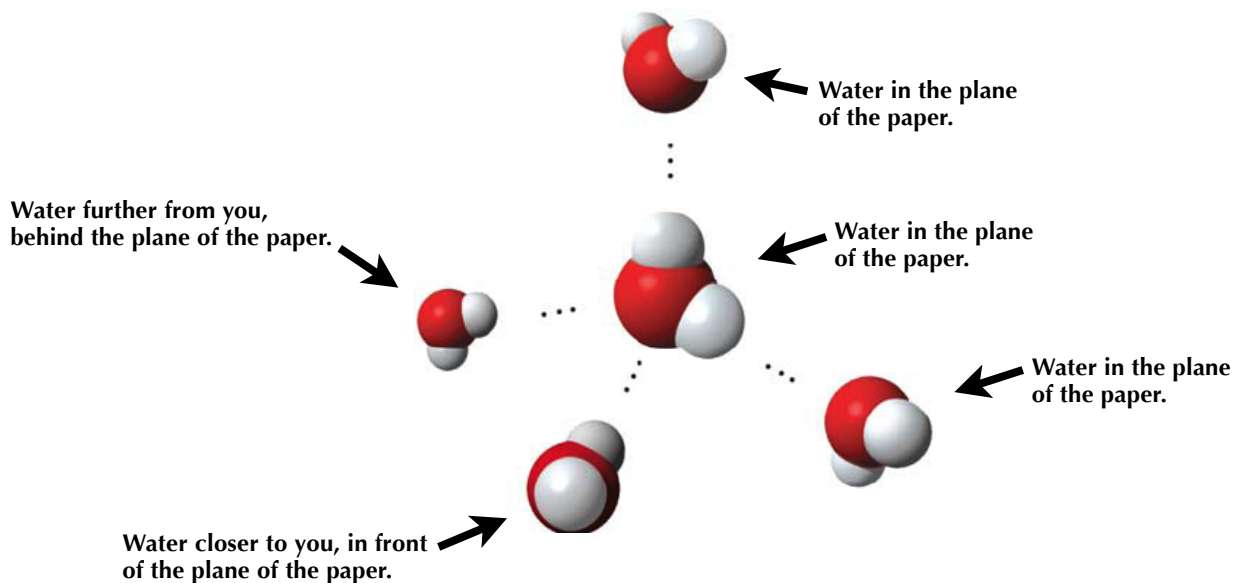
1. What is the **shape** of a water molecule?
2. What **types of atoms (elements)** make up one individual water molecule?
3. a. What **types of bonds** make up one individual water molecule?  
  
b. Are the **bonds within the water molecule polar or non-polar**. **Why?** (Use the knowledge gained in our Ch.2 lecture to fully answer this question, discussing electronegativity of the atoms and the forces - and resulting net dipole moments - that exist between the atoms in each bond too)

**Electronegativity Values**



- c. For life, water is essential. Life began in water and evolved there **for 3 billion years** before spreading onto land. Modern life, even terrestrial life, still remains tied to water. Most cells are surrounded by water and are made up of 70-95% water. **Water displays many emergent properties as a result of its structure and molecular interaction.** Based on water's shape and the type of bonds it contains, is a water molecule, on the whole, **a polar or a nonpolar molecule?** **Why?** (Use the knowledge gained in our Ch.2 lecture to fully answer this question, discussing the forces - dipole moments - that exist within the molecule)

4. Draw a large water molecule in the space below. Add all the **partial charges** ( $\delta^+$  and  $\delta^-$ ) that exist on a water molecule given its polarity (*P.S. there should be **four** areas labeled in total*). Also label the **covalent bonds** between the O and H atoms *within* the water molecule.
5. a. What kind of intermolecular **bonding is responsible for the emergent properties of water**?
- b. Between which atoms in water molecules do **these intermolecular attractions form**? *Be very clear in your answer.*
6. a. Study Figure 3.2 carefully. What **caused the partially charged regions to exist on each one water molecule** again?
- b. How many **covalent bonds exist within a water molecule**?
- c. How many total **hydrogen bonds can form between a water molecule and neighboring water molecules**???!?
- d. Label all **partial charges** and all **hydrogen bonds** in the image below. *Notice the location of the hydrogen bonds and the orientation of all molecules involved as attractions occur between two peripheral water molecules and the central water's oxygen atom. Notice too the orientation of two peripheral water molecules and the central water's hydrogen atoms.*



7. In liquid water, **how strong are these hydrogen bonds between water molecules** compared to the covalent bonds within the water molecule?
8. Describe the **state of hydrogen bonding between water molecules in liquid water**?
9. Why is it unlikely that two neighboring water molecules would be found arranged like the picture below?



*(Check your answers by going to the Ch.3.1 **Concept Check Question #3** in Appendix A of your textbook)*

10. *Think:* What would be the effect on the properties of water if oxygen and hydrogen had equal electronegativities instead? **Explain** step-by-step, and fully, all the changes that would occur **BOTH WITHIN AND BETWEEN** water molecules and **why**.

**Within each water molecule =**

**Between water molecules =**

*(Check your answers by going to the Ch.3.1 **Concept Check Question #4** in Appendix A of your textbook)*