

BIOL 230: Cell & Molecular Biology

Fall 2019

17-205

W, Aug. 14

Dr. Nathan Staples (Ph.D., UCSB)

1. **Part I:** Biochemistry & Cellular Biology.
❖ MT 1 = Mon., 9/23
2. **Part II:** Metabolism & Molecular Genetics.
❖ MT 2 = Mon., 10/21
3. **Part III:** Gene Regulation & Biotechnology.
❖ MT 3 = Mon., 11/18
4. **Part IV:** Cell Reproduction, Classical Genetics & Communication.

FINAL EXAM (1/3 cumulative): Wed., 12/11, 11:10am

“Fine Print”

INSTRUCTOR INFORMATION: Lecture: 11:10-12:35PM

- ❖ **Dr. Staples' Office hours** (██████████): MW 12:40PM-2:00PM; 10:10am-11am by Arrangement; TR 2-3PM; and *By Appointment!!* ☺
staplesn@smccd.edu, (650) 306-3251.
- **Course Website:** <http://accounts.smccd.edu/staplesn/biol230/>
 - 1) “Pre-Lecture” slides available online each evening before class.
 - 2) Study materials, course information, syllabus, lectures, etc.
 - 3) **Lab Quizzes ONLINE** every two weeks (posted by Mon., Due Wed.!)
- ❖ **IN-LAB REVIEW SESSIONS** before EACH Exam!! Be PREPARED!!!
- ❖ **Bring BLUE BOOKS (8.5x11”) to me by Monday!!** For in-class writing assignments.
- **** STUDENTS: BE PUNCTUAL, BE PRESENT!** You are expected to *keep-up with ALL the reading for each day's lecture*. Also, be sure to complete any *Applying Concepts and Discussion problems* before the next class. (11e/10e: **LaunchPad**) See also **SMCCD Canvas:** <https://smccd.instructure.com/>
- You will be tested primarily upon your **knowledge** gained in this class, and your level of **comprehension** of the major concepts (So, don't just memorize facts and details!!).
- **Diligence will be your key to success in this class!!**
- **I want you ALL to do well and have FUN learning about the fascinating microscopic world of molecular and cellular biology!!**

“Fine Print” cont’d

- **** EXAMS:** The Final Exam will be 33% cumulative!!
 - For every exam, bring **a pencil** (#2 or HB lead), **a blank “RED” scantron answer sheet** (100 questions per side, “a-e”), and a well-rested and ready mind!!
- **There will be NO MAKE-UP or RESCHEDULING of Exams (except in case of documented emergency), so check your schedule NOW and PLAN appropriately!!**
 - *If you have any problems, talk to Dr. Staples IMMEDIATELY!!!*
- You must satisfactorily **pass BOTH the Lecture and Lab (at least 60% in each)** to pass this course with a “C” or better!!!
- ❖ **PUNCTUAL ATTENDANCE: is MANDATORY For both LECTURE and LAB.** *You WILL FAIL the course if you do not attend at least 90% of class hours.*
- **Cheating in any form will NOT be tolerated, and disciplinary action will be severely enforced by College Administration!!**

- **LAB:** Lab Manual should be ready at the bookstore (Staples, 13th ed., 2018). Green cover.
 - Quizzes online every 2 weeks.
 - Read Introduction, write Pre-Lab, and prepare for Experiment #1 BEFORE Tuesday’s Lab!!

Study Tips (6)

1. **Read the Textbook** thoroughly, BEFORE CLASS.
 - If you do this, you WILL do well in this course.
 - If not, #2-6 won’t help much. **[Be IN CLASS ON TIME!!!]**
 - **Open your textbook TONIGHT!!**
 - **Answer Questions, Do Problems!! ... PRACTICE!**
2. Spend significant time understanding figures illustrating concepts or processes.
3. **Take good notes** and annotate notes from the textbook. **Record lectures!** *(Slides are NOT a substitute for active note-taking!!)*
4. Condense notes into summary sheet of main concepts (see **Study Guides!!**) with examples or diagrams, &
5. **Draw-out structures and processes** for yourself!
 - *Flow-charts, Diagrams, Outlines, TABLES to organize information.*
6. Form a **study group!!** Share ideas & understanding! Explain concepts and quiz each other!
 - **DRAW!! DRAW!! DRAW!! DRAW!! DRAW!!**

Why do you want to learn Biology?

❖ *You need a **PERSONAL** motivation to learn Cell & Molecular Biology!*

- *“I study Biology, because I want to understand more about the living world around me & that is a part of me.”*
- *“There is an immense **DIVERSITY** of life on earth, and an immense diversity of life-sustaining processes.....”*
- *“These fascinate me and I want to better understand them, so that I may better understand myself and the world I live in.”*

How to achieve our Goals?

❖ *In order to understand ourselves and understand life on earth, we need to understand the component molecules, subcellular structures, and cellular processes that make-up every living creature.*

- *There also is much **UNITY** in life!!!*

****MENTAL FRAMEWORK FOR LEARNING BIOLOGY: (perspective)**

1. **Evolutionary adaptation** – as we study biomolecules and cellular processes, think of how & why these processes could have evolved over time!!
2. ****Organisms must survive and reproduce successfully (natural selection):**
 - What functions do the biomolecules, biochemical reactions, and cellular structures and processes perform to help each organism propagate??
3. **What makes a particular molecule so well-suited for its particular biological function??**
 - a. Why is DNA a suitable chemical for storing genetic information?
 - b. Why is water such a suitable medium & component of biological systems?
4. **Before we begin studying the atoms and chemicals which make-up cells and living structures.....**

Ch. 1 Objectives: Students should be able to.....

1. Define what is **LIFE**? List and define 6 characteristics.
2. Describe the structures and functions of typical plant and animal **cell components (organelles)**, including characteristics unique to each cell type.
3. Outline the **Scientific Method**, defining each step, and explain the importance of control experiments and controlling variables.
4. Describe types of **questions that scientists ask**. What types of answers do they expect?
5. **Ch. 2:** List and define 5 types of molecular interactions important to cells.
6. Define and illustrate 5 properties of water that make it the best “solvent of life”.

❖ **These Objectives and Study Guide questions are your HOMEWORK between classes!!**

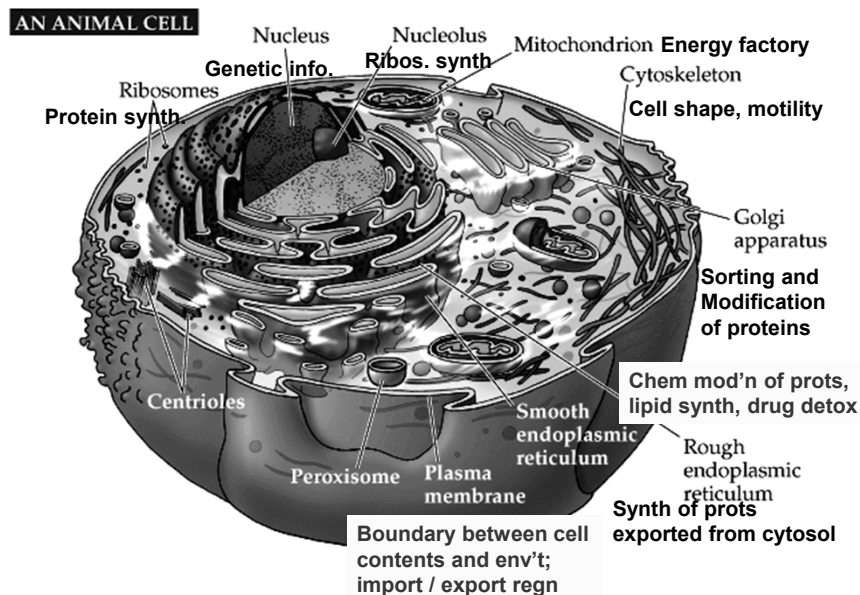
➤ **DUE every Thurs. at the end of lecture!! (DRAW, write, & chart!)**

Ch. 1: What is Life?

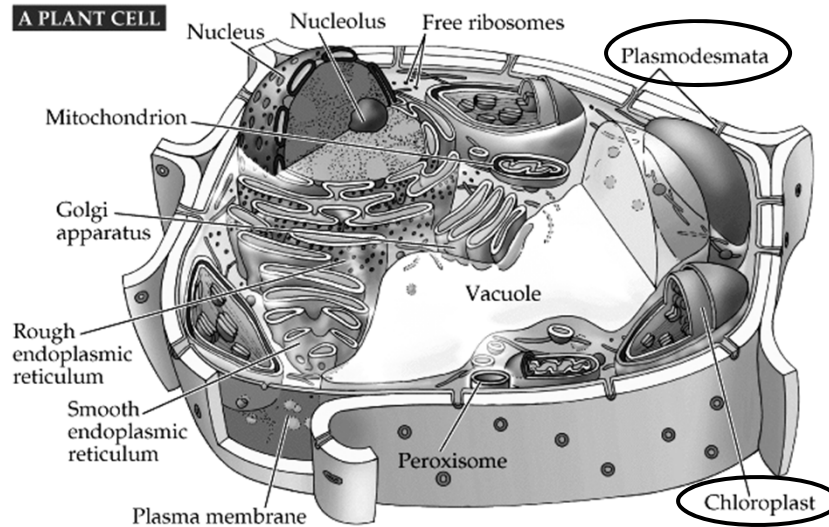
❖ **Life can be defined as an organized genetic unit capable of metabolism, reproduction, and evolution.**

1. Life is composed of **cells** – compartments of organized metabolism separated from the external environment by a membrane.
2. Life **transforms energy & materials**: An organism's **metabolism** is its total chemical activity and consists of thousands of individual chemical reactions. (Genes control)
3. Life **Reproduces** with variation (sexual mixing, mutations).
4. Life **Senses and responds** to the environment – **Adaptation**.
5. Life maintains **Homeostasis** – a relatively stable range of internal physical and chemical conditions .
6. Life carries information in **DNA** – the genetic material.
7. Life **has evolved**, and all life is **genetically related**.

The Eukaryotic/Animal Cell fig. 4.7 (2004)



The Eukaryotic/Plant Cell fig. 4.7 (2004)



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Eukaryotic Organelles

1. **Plasma Membrane**
 - Define cell boundaries/ cytoplasm
 - Regulates entry/exit
2. **Nucleus** – contains the chromosomal DNA (genetic material)
3. **Nucleolus** – dark strx within the nucleus – site of ribosome synthesis
4. **Ribosomes** – free in cytoplasm or associated with the Endoplasmic Reticulum – responsible for protein synthesis
5. **Mitochondria** – the powerhouses of the cell; convert stored chemical energy into a form useable by the cell
6. **Endoplasmic Reticulum** – continuous with the nuclear envelope
 - a) **Rough ER** – “studded” with ribosomes; synthesis of proteins which function outside of the cytosol (secreted, membrane, or organellar)
 - b) **Smooth ER** – chemical modification of proteins, lipid synthesis, detoxification of drugs
7. **Golgi Apparatus** – storage, modification, and packaging of proteins for delivery
8. **Cytoskeleton** – protein fibers (scaffold) which provide structural support, shape, & motility to cells

Understanding the Cell: How does life work?

❖ **LIFE = organized CHEMISTRY!**
(fundamentally)

– Bio-chemicals and their reactions.

1. **6 elements = 98%** of living mass.
– **C, H, N, O, P, S**
2. **Outer shell electrons** = chemistry of atoms
3. **Molecule** = two or more atoms linked by chemical bonds.
4. **Octet rule** = 8 electrons in outer shell is stable!

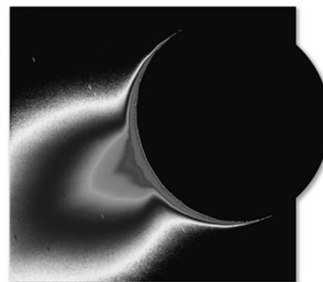
Ch. 2: Life and Chemistry: Small Molecules

1. **Atoms: The Constituents of Matter**
2. **Chemical Bonds: Linking Atoms Together**
3. **Chemical Reactions: Atoms Change Partners**
4. **Water: Structure and Properties**
5. **Acids, Bases, and the pH Scale**
6. **Properties of Molecules**

*Water spray and vapor from
Saturn's moon, Enceladus*

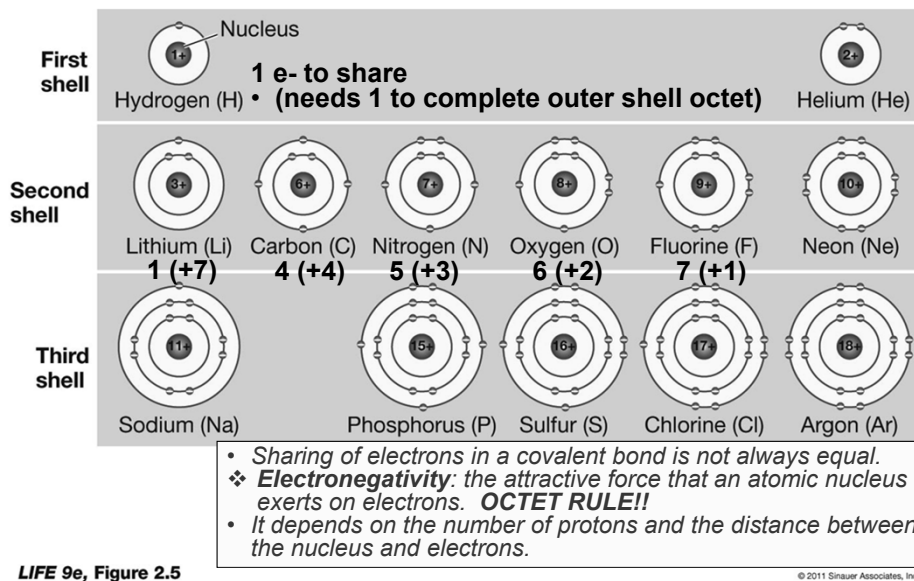


*Robotic rover, Opportunity
(not Curiosity), on Mars*



2.1) ATOMS: The basic units of matter

Electron shells determine the reactivity of atoms



2.2) CHEMICAL BONDS

TABLE 2.1			
Chemical Bonds and Interactions			
NAME	BASIS OF INTERACTION	STRUCTURE	BOND ENERGY* (KCAL/MOL)
1. Covalent bond	Sharing of electron pairs		50-110
2. Ionic bond	Attraction of opposite charges		3-7
3. Hydrogen bond	Sharing of H atom		3-7
4. Hydrophobic interaction	Interaction of nonpolar substances in the presence of polar substances (especially water)		1-2
5. van der Waals interaction	Interaction of electrons of nonpolar substances		1

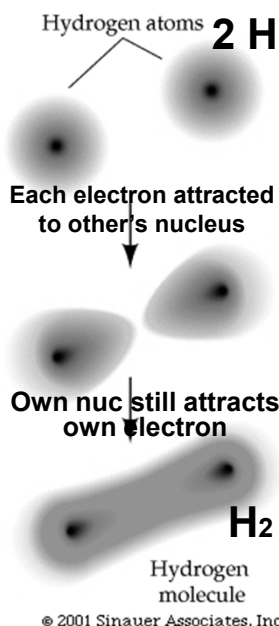
*Bond energy is the amount of energy needed to separate two bonded or interacting atoms under physiological conditions.

- Sharing of electrons in a covalent bond is not always equal.
- **Electronegativity:** the attractive force that an atomic nucleus exerts on electrons.
- It depends on the number of protons and the distance between the nucleus and electrons.

LIFE 9e, Table 2.1

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1. Covalent Bonds: Fig 2.7, Table 2.2


TABLE 2.2

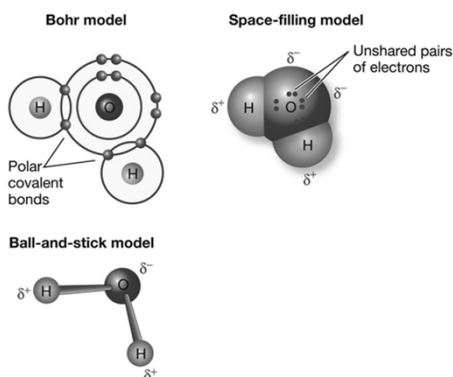
Covalent Bonding Capabilities of Some Biologically Important Elements

ELEMENT	USUAL NUMBER OF COVALENT BONDS
Hydrogen (H)	1
Oxygen (O)	2
Sulfur (S)	2
Nitrogen (N)	3
Carbon (C)	4
Phosphorus (P)	5

LIFE 8e, Table 2.2
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- = Sharing of pairs of electrons between atoms. (*nonpolar, polar*)

Polar Covalent Bonds & Electronegativity



- Polar covalent bond =
 - unequal sharing of electrons
 - Related to Octet Rule.

TABLE 2.3

Some Electronegativities

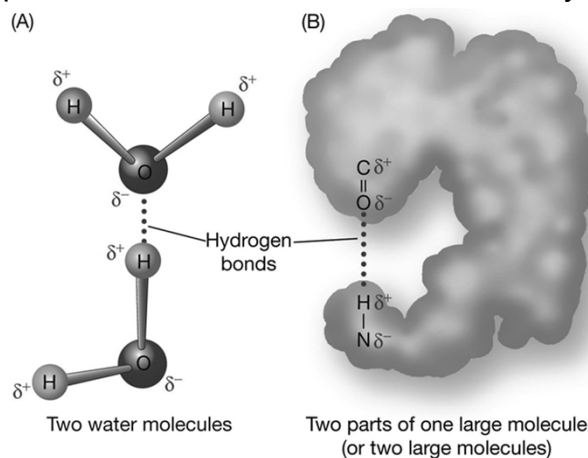
ELEMENT	ELECTRONEGATIVITY
Oxygen (O)	3.5
Chlorine (Cl)	3.1
Nitrogen (N)	3.0
Carbon (C)	2.5
Phosphorus (P)	2.1
Hydrogen (H)	2.1
Sodium (Na)	0.9
Potassium (K)	0.8

- More Electronegative atoms draw electrons more strongly towards themselves during covalent bonding

- Gain a partial negative charge
- Other bonded atom gains a partial positive charge
- A "weak ionic bond" is formed

2. Hydrogen Bonds

- = weak electrostatic attraction between partial charges on polar molecules
- 2 electronegative atoms partially share an H atom
 - -- important in Water, DNA, Proteins, carbohydrates,.....



LIFE 9e, Figure 2.11

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3. Ionic Bonds = attraction of opposite charges

- Octet achieved on each atom!
= stable!
(one now +,
other now -)

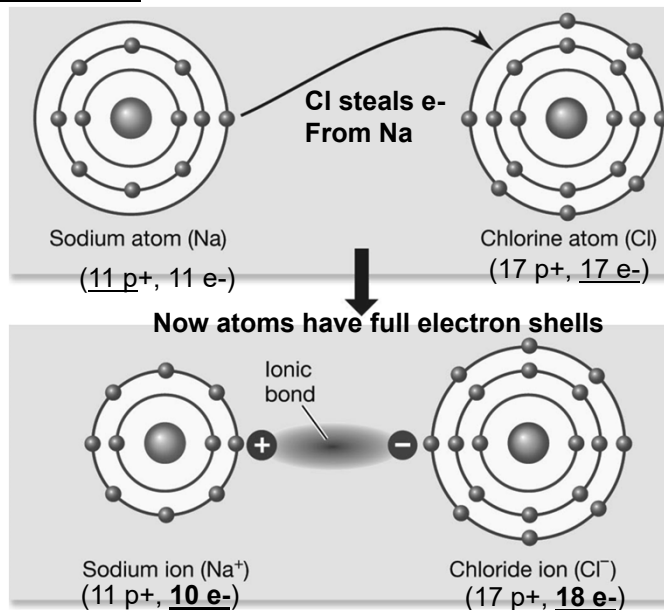


Figure 2.10

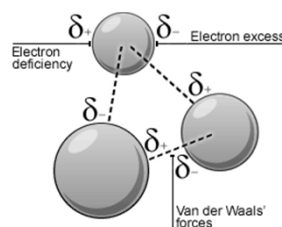
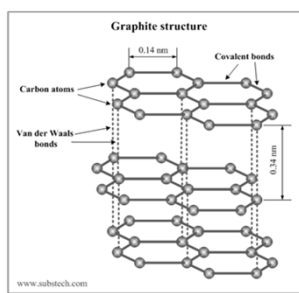
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4. Van der Waals Forces

- Brief, weak attraction between molecules in close proximity
- Very weak opposite charge interactions between **“sparse” (more pos.)** and **“dense” (more neg.)** regions of each molecule's electron cloud
- Strengthened by the sum of many interactions over surface of a large nonpolar molecule

5. Hydrophobic Interactions

- **Exclusion of nonpolar** substances from interactions with polar or ionic molecules
 - Eg: oil in water – clumps together/separates
- **Enhanced by Van der Waals Forces**



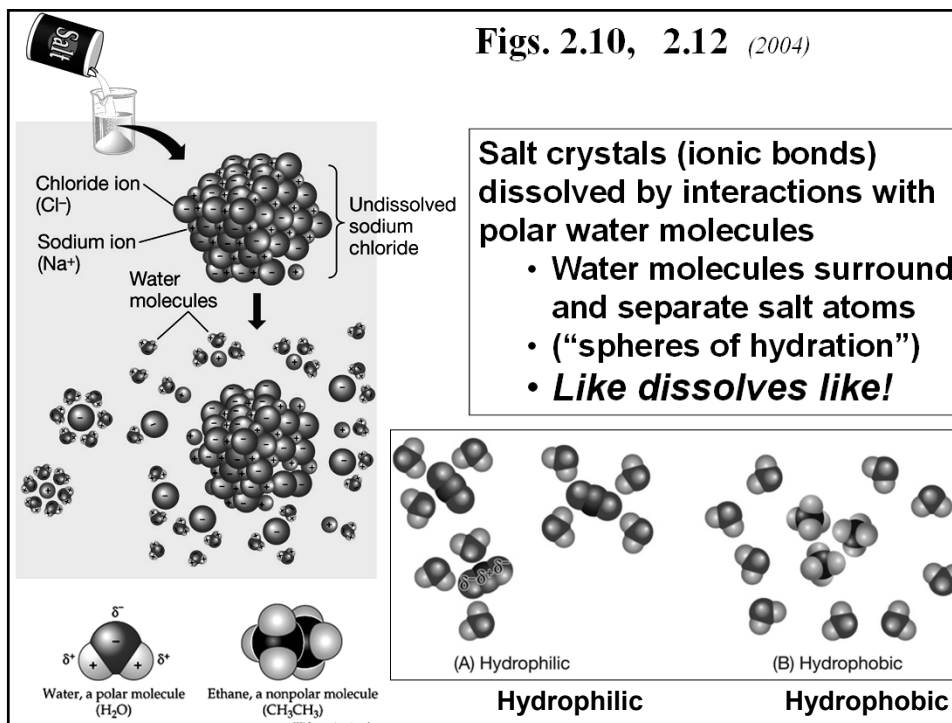
Chemical Bonds Table 2.1

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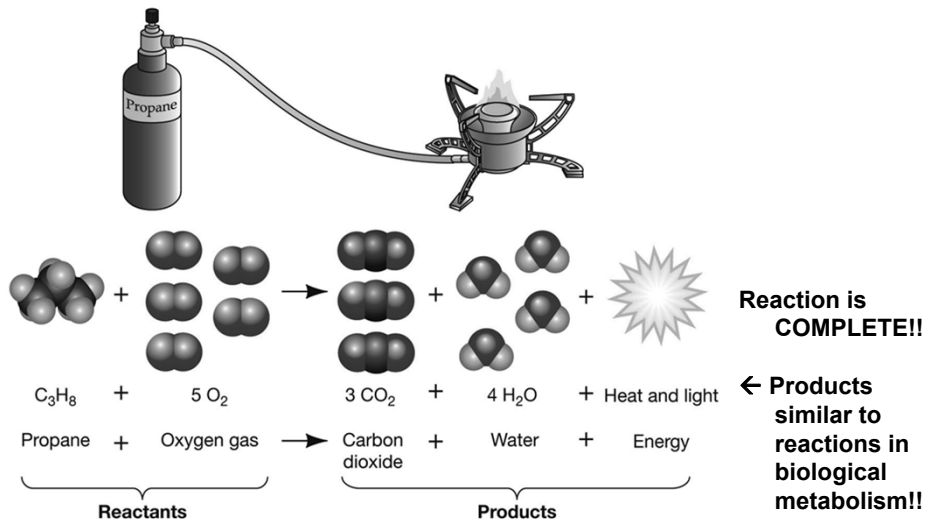
^aBond energy is the amount of energy needed to separate two bonded or interacting atoms under physiological conditions.

LIFE 9e, Table 2.1

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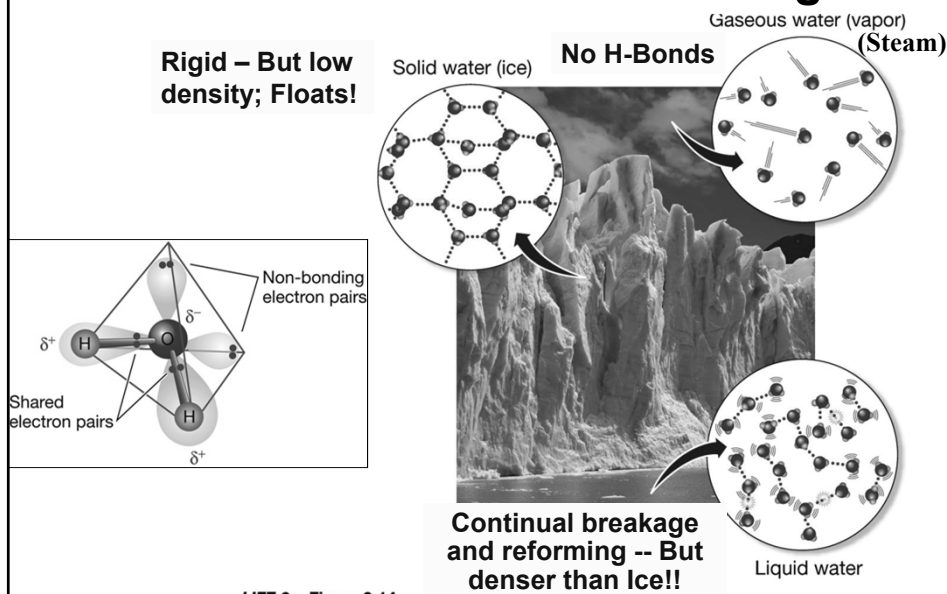


2.3) Chemical Reactions: changing of bonding partners and energy



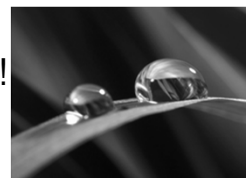
~ Glucose sugar + O₂ → CO₂ and H₂O and Energy

2.4) WATER: H-Bonds hold water molecules together



Water: Strx and Properties

- Tetrahedral** shape – 4 e- orbitals repel each other
 - Structure → Properties → **BIOLOGICAL FUNCTION!!**
- H-bonding** – highly cohesive and adhesive
 - great **solvent (polarity!!)**
- Solid / **Ice** = less dense than liquid → **floats!**
 - Aquatic env't = insulating, protective
- Lot of heat energy to melt ice or freeze liq.**
 - Great moderator of temperature changes
 - **High heat capacity/ specific heat** – lots of heat to raise the temp of water, break H-bonds
 - = good Temperature buffer!
 - In cells, aquatic envt, atmosphere



2.5) Acids and Bases

- Pure water ionizes to acidic or basic components (OH⁻ or H₃O⁺)
 - but remains neutral in pH (7) when pure, since this ionization is reciprocal.
- ACIDS** = donate proton (H⁺, actually H₃O⁺), accept -OH
 - HCl → H⁺ + Cl⁻
- BASES** = accept proton, release hydroxide
 - NaOH → Na⁺ + OH⁻
- pH (potential of Hydrogen) = - log [H⁺];**
 - Concentration in molar units (**Molar= moles/L**)

