Unit 1

INTRODUCTION TO BIOLOGY & BASIC CHEMISTRY

Unit 1 Quiz: 9/2  Unit 1 Test: 9/7-8
A. Science is the use of evidence to construct **testable explanations** and **predictions** of natural phenomena, as well as the knowledge generated through this process.

B. Science only answers questions that are **testable** by a process called **scientific inquiry** - the planned and deliberate investigation of the natural world. It is both a creative process & a process rooted in **unbiased observation & experimentation**.
“The world is flat because NASA is lying and I said so...”
A. **Observation** - where it all begins - gathering information in an **orderly way**

B. **Inferring** - process of **combining** what you **know** with what you have **learned** to draw a **logical conclusion** - the conclusion themselves are called **inferences**
C. The term, “scientific method” is misleading because it actually refers to a process that is neither reserved for biologist and other scientists, nor a methodical set of steps to be followed in a specific order. Instead, it is an organized pattern of thinking to solve everyday problems.
The Scientific Method - “How dull!”, you might say

But it’s actually a tool we use everyday

To shop and compare and problem-solve, too

It’s just a pattern of thinking in much that we do!
The Scientific Methods (15-20)

A. ___________

B. Forming a ______________ - a testable hypothesis, explanation or ______________

“I’ve narrowed it to two hypotheses: it grew or we shrunk.”
Questions

Ask about objects, organisms, and events in the natural world.

Can be answered through investigations that involve experiments, observations, or surveys.

Are answered by collecting and analyzing evidence that is measurable.

Relate to scientific ideas rather than personal preference or moral values.

Do not relate to the supernatural or to non-measurable phenomena.
Is it a well-defined Question?

How does a paper airplane fly?

Not well-defined.
Does the shape of the wing affect how far a paper airplane will fly?

Well-defined!
Is rock music better than hip-hop music?

Not well-defined.
Does rock music make more money than hip-hop music?

Well-defined!
Hypothesis (The educated Guess)

● Most of the time a hypothesis is written like this: "If _____[I do this], then _____[this]_____ will happen."

● Other ways to write a hypothesis:
  - I predict that ______________ because ______________.
  - I hypothesize that __________________ because______________.

● Your hypothesis should be something that you can actually test.

● The word HYPOTHESES is plural for hypothesis.
C. Setting Up a Controlled Experiment

A controlled experiment usually consists of two groups:

a. Control (group) – Set-up used as a benchmark or standard for comparison.
b. **Experimental** Group – Group in which all conditions are kept the same except for a **single variable** - the factor changed by the experimenter. Only **1** factor should be changed in each experimental group. This change is designed to test the **hypothesis**.

i. **Manipulated (independent) variable** – factor that is **changed by the experimenter**

ii. **Responding (dependent) variable** – condition that is **measured or observed** as a result of the **change**

iii. **Constant**- factor that remains **fixed** while the independent & dependent variables **change**.
Practice Together

- Idea: manure is good for crops.

Is this specific and testable?

Better hypothesis:

- Manure produces taller crops than chemical fertilizer.
What are your...

- Independent variables?
- Dependent variables?
- Constants?
- Control groups?
- Experimental groups?
The independent variable is the one under your control. To find out its effect on the dependent variable is your goal.
c. Collecting Data - Data from an experiment should be presented in a **concise** and **organized** manner.

i. Quantitative data - numerical data such as **Measurements of time, temp., length, mass ext.**
   - **Precision** - how close a group of measurements are to one another
   - **Accuracy** - how close a group of measurements are to the real or accepted value.

ii. Qualitative data - **descriptions** of what our **senses** detect; interpreted differently
Accurate Precise
Not Accurate Precise
Accurate Not Precise
Not Accurate Not Precise
The Scientific Methods (15-20)

iii. Pie or Circle Graph – Used to show relationship of a part to a whole

iv. Bar Graph – Used when independent variable isn’t continuous; for example, absorbency of different brands of paper towels

v. Line Graph – Used when independent variable is continuous; for example, time. A line graph most clearly shows the relationship between the independent & dependent variables in an experiment. In a line graph, the manipulated (independent) variable is plotted on the X axis and the responding (dependent) variable is plotted on the Y axis.

Memory Helper: DRY MIX
Assume, at harvest...

- Average corn stalk height for unfertilized soil was 1.52 m
- Fertilized with chemicals, 1.67 m
- Fertilized with manure, 1.81 m

Draw a graph

- What kind of graph?
- How will you label the axes?
- Draw your scale on the axes
- Include units
What if you wanted to test the effect of the amount of fertilizer?

- Independent?
- Dependent?
- Constants?
- Control?
- Experimental?
- Graph?
The Scientific Methods (15-20)

d. Analysis and Conclusion- After collecting data, a scientist must analyze the data and form conclusions based on the following questions:

i. Do the results support or refute the hypothesis?

ii. Is the experimental set-up valid?

iii. Was there a large enough sample size?

iv. Although no experimental set-up can be perfect, were the sources of error minimized?

v. Was there only variable tested?

vi. Is the experiment repeatable?
A **Scientific Theory** - explanation of natural or physical phenomenon supported by many observations & experiments over time. Tested by many, considered valid until new study developed or new technologies are developed & new evidence found. EX. Cell theory, atomic theory, theory of general relativity.
B. **Scientific Law** - describes relationships under certain conditions in nature. EX. Law of conservation of matter indicates that before & after a chemical change the same amount of matter exists; it does not explain why this occurs. Theories do not become laws and laws do not become theories!

C. **Scientific theory vs. Hypothesis** Hypothesis are not well established explanations; can become be incorporated into a theory after being tested many times & the explanation is durable
THEORY

consistent

observations ➔ hypothesis ➔ predictions

not consistent: modify hypothesis

tests
A. What is Biology?
Biology means the study of life.

Bio=life logy=study of

Biology is the science that seeks to understand the living world.
Characteristics of Life

A. Living things are **made of cells**.
   1. A cell is the **smallest working unit of life** of life.
   2. Living organisms are grouped by the number of cells:
      - **Unicellular** – single-celled organisms;
      - ex. Bacteria, amoebas
      * **Multicellular** – organisms made up of more than one cell; ex. Humans, frogs, fish, insects, plants
B. Living things Displays **Organization**

1. A cell is a collection of _organized structures_ that carries on life functions

2. All living structures are composed of _atoms_ and _molecules_.

3. In multicellular organisms

   Specialized cells are organized into groups that _work together_ called _tissues_.

   . Tissues are _organized_ into _organs_,

   iii. Organ systems work together to support an _organism_
Characteristics of Life

C. Living things **grow & develop**

1. **Growth** - all living things grow at least part of their lives, single-celled organism simple increase in size

2. **Development** - describes physical changes that take place during the lifetime of an organism
Characteristics of Life

D. Living things **reproduce**

1. Not essential for individual, but essential for the **species**

2. Species- group of organisms that can **breed** with one another and produce **fertile offspring**.

3. Two ways:
   
   i. **asexual**- new organism has a single parent; example- single-celled organism splits in half. **NO EXCHANGE OF GENETIC MATERIAL**
Characteristics of Life

D. Living things reproduce

ii. Sexual - two cells (egg & sperm) from different parents unite to form an embryo.

IS AN EXCHANGE OF GENETIC MATERIAL
Characteristics of Life

E. Living things **respond to stimuli**

1. External stimulus - includes things outside the organism. Ex. Temp. light
2. Internal stimulus - all things inside the organism. Ex. Hunger, thirst
Characteristics of Life

F. Living things require energy.

1. Two main ways to obtain energy:
   i. Photosynthesis - energy from sun. Ex. Plants, some bacteria & protist
   ii. Consumer - energy from the food they eat. Ex. Us, other animals, fungi
Characteristics of Life

Living things **require energy**.

2. One way to **use** energy:
   
i. All organisms use its energy for **Metabolism** - the combination of chemical reactions through which an organism **builds up or breaks down materials** as it carries out its life processes.
Characteristics of Life

G. Living things maintain **homeostasis**

1. process by which organisms maintain a relatively stable internal environment
Characteristics of Life

H. Adaptations **evolve** over time

1. Adaptations are **inherited changes** that occur over time that help the species **survive** & pass their **genes** to their **offspring**
Organisms are composed of **matter**, which is anything that takes up space and has mass. All matter is composed of **elements**, pure substances that consists entirely of one type of **atom**.
A. Elements

1. 92 naturally occurring elements
2. 25 essential to life
3. 4 making up 96% of living matter: carbon, hydrogen, oxygen, nitrogen
B. Atoms

1. **Nucleus**
   a. center of atom
   b. **protons** which have a **positive** charge
   c. **neutrons** which are **neutral**
B. Atoms

2. Electron cloud/orbital-
   a. space surrounding nucleus
   b. **Electrons** in constant **motion** in this space
   c. electrons have a **negative** charged; therefore attracted to the + charged nucleus
B. Atoms

3. Charge of Atoms
   a. Have equal # of protons & electron so they are neutral
   b. Atomic # = # of protons that element contains.

Ex. Atomic #
C = 6
C. Isotopes –

1. Atom with same # of protons but a different of neutrons

2. An example of an element that forms isotopes is carbon.
   - Carbon-12 → the most common & stable form of carbon; has 6 protons and 6 neutrons
   - Carbon-13 → 6 protons & 7 neutrons
   - Carbon-14 → 6 protons & 8 neutrons

3. Some are very unstable or reactive, (because of change nucleus unstable causing it to decay or break apart) which gives off radiation
   - Useful in research and medicine
D. Compounds

1. elements combined in **fixed ratios** of atoms form compounds
2. held together by **chemical bonds**
3. Cannot be broken down into simpler compounds or elements by physical means such as tearing or crushing
4. Can be broken down by chemical means
5. Chemical formula

a. shorthand to show elements in a compound

b. \( \text{H}_2\text{SO}_4 \) = 2 hydrogen atoms, 1 sulfur atom, 4 oxygen atoms for a total of 7 atoms

c. Ex. \( \text{C}_6\text{H}_{12}\text{O}_6 \) = ___ carbon atoms, ___ hydrogen atoms, ___ oxygen atoms, total of ___ atoms
D. Compounds

6. Chemical Equation-
   a. recipe for making a compound
   b. Reactants - what goes into the reaction
   c. Products - substance that is formed
   d. Ex. $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$;
      Reactant = $\text{H}_2 & \text{O}_2$,
      Product = $\text{H}_2\text{O}$
E. Chemical Bonds

1. Involves the **valence electron**, what would be the outermost electrons
2. Ionic Bonds
   a. One or more electrons are transferred from one atom to another
   b. Results in 2 oppositely charged particles called IONS
      ** an atom that gains electrons has a negative charge
      ** an atom that losses electrons has a positive charge
E. Chemical Bonds

2. Ionic Bonds
   c. Attraction between __oppositely____charged ions forms ionic bonds
   d. Ex. NaCl or table salt
   e. Ions in living things- sodium, potassium, calcium, carbonate ions- they help maintain __homeostasis__ as they travel ___ in & out ____ of ___ cells, help __transmit signals__ among ___ cells that allows you to see, taste, hear, feel, & smell
f. **Weaker** bonds than covalent

g. Most **crystalline** at room temp & high **melting points** than molecules
E. Chemical Bonds

3. Covalent Bonds
   a. electrons are being **shared**
   b. results in very **stable** compounds called **MOLECULES**
   C. Ex. **Water, Glucose, DNA**
   D. **Stronger** bonds than ionic
Atoms

Sharing of electrons → Molecule → Covalent bond

Transfer of electron → Positive ion and Negative ion → Ionic bond

Atoms
III. WATER (pp. 40 – 43)

Water is the most essential and abundant substance on Earth. Cells are made up of mostly water and most cells are surrounded by water. The importance of water is largely due to its unique characteristics, which all directly relate to one very important property of water . . . Water is polar.
A. Polarity

a. Unequal sharing of _______electrons_______ in molecules formed with covalent bonds

b. How this works: A closer look at a water molecule:

1. oxygen has 8 protons in nucleus & each hydrogen has ___ proton in their nucleus
A. Polarity

b. 10 shared electrons will be more attracted to the more positively charged oxygen nucleus; thus orbiting around the oxygen end of the molecule just about all the time

c. The oxygen end will have a slightly negative charge

d. The hydrogen ends will have a slightly positive charge

e. Not true charges because the electrons are not transferred; just shared unequally
2. Hydrogen “Bonds”

a. Not a **true** bond- does not form a **new** compound

b. Attraction between **two polar** molecules; like water
2. Hydrogen “Bonds”

c. **attraction** between slightly **positively** charged hydrogen end of one **polar** molecule and the slightly **negatively** charged end of another **polar** molecule.

d. EX. In water: forms between positively charged **H** end of one water molecule and the negatively charged **O** end of another water molecule.
3. Hydrophilic vs Hydrophobic

a. Polar molecules are attracted to other polar molecules,

Any molecule attracted to water is described as hydrophilic

b. Non-polar molecules are attracted to Non-polar molecules.

Molecules repelled by water are described as hydrophobic.
B. Properties

- **Polarity** gives water some unique properties important in maintaining **homeostasis**.
B. Properties of Water

Water is "sticky" – Water molecules tend to stick together, called **cohesion** and results in **surface tension**. Water molecules also tend to stick to other surfaces - known as **adhesion**. This explains the phenomenon known as **capillary** action.

b. Ex. Insects walking do a belly flop

http://www.reptilianagenda.com/img/pics/lizard.mov
B. Properties of Water

2. Water is the solvent of life – Slightly-charged ends of water molecules attract and separate atoms that make up other compounds, thus dissolving them. Anything dissolved in water is referred to as a solution. Many important compounds in cells are in solution.
B. Properties of Water

3. Water has a high heat of vaporization – Perspiring cools us because it requires ________ energy to change water from a liquid to a ______. When perspiration ______ evaporate, the heat required is drawn from our ______. Also, why our lakes do not totally evaporate in the hot summers of Texas.
B. Properties of Water

Water has a high specific heat – This allows large bodies of water to maintain a stable temperature.
B. Properties of Water

Liquid water expands as it freezes – Ice is less dense than water so it \textbf{floats} which \textbf{protects} organisms and \textbf{Insulates lakes, rivers, oceans}