Bio 1 General Biology – Exam 1 Outline

Scientific Thinking (Ch. 1)

I. Science – (Latin = ‘to know’) a way of knowing and a body of knowledge about the natural world

A. Okay, but what exactly is “science”? Go to: A Science Checklist and answer the following:
   1. List the top four key characteristics of science on the checklist.

Now read about each characteristic and answer the following:
2. Explain why science cannot study supernatural forces, explanations, or entities.

3. In science, can findings be proven? Why or why not?

B. Science is testable and hypothesis-driven

1. Hypothesis

2. The Scientific Method
Go to: Science at Multiple Levels and answer the following:
C. What is the difference between a “scientific theory” and the everyday use of the word “theory”?
What Is Life? Ch. 1

I. Biology

A. What is Life?
   1. What characteristics do living things possess?

2. Life’s Hierarchy of Organization – lower levels of organization are progressively integrated to make up higher levels

   Watch the Amoeba Sisters Biological Levels in Biology: The World Tour:

   a. Atoms – building blocks of matter, base of life’s structure
   b. Molecules – atoms come together
   c. Cells – smallest ‘living’ unit; have all living characteristics
   d. Tissues – collection of cells
   e. Organs and organ systems – collection of tissues
   f. Organism – assemblage of cells, tissues and organs
   g. Population – members of a single type of organism living together
   h. Community – all kinds of living things in a given area
   i. Ecosystem – a community together in its nonliving environment
Chemistry and Life (Ch. 2)

I. Chemistry and Life – all life has a chemical basis
   A. Element

      1. 92 naturally occurring elements on Earth
      2. 4 of these 92 elements constitute 96.3 % of your body weight. What are they?

   B. Atoms

      1. Structure of Atoms: subatomic particles
         a. Nucleus

            Atomic number

            Atomic mass

         a. Electrons

      2. Isotopes – atoms of a particular element that have the same # of protons and electrons but a different # of neutrons and therefore a different atomic mass.
         a. Atoms with too many or too few neutrons are considered unstable (unbalanced). Unstable atoms undergo radioactive decay which means their nuclei change or decay by spitting out radiation in the form of particles or electromagnetic waves. They do this until they become a more stable (balanced) atom.

         b. Radioactive isotopes have many uses in biological research and medicine. Living cells cannot tell the difference between radioactive and nonradioactive isotopes. Organisms take up and use compounds containing radioactive isotopes in the usual way. Once taken up, their location and concentration can be detected because of the radiation they give off. These isotopes can then be used as tags and tracers within the body.

<table>
<thead>
<tr>
<th>Table 2.1</th>
<th>Isotopes of Carbon</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon-12</td>
<td>Protons: 6, mass number 12</td>
</tr>
<tr>
<td>Neutrons: 6</td>
<td></td>
</tr>
<tr>
<td>Electrons: 6</td>
<td></td>
</tr>
<tr>
<td>Carbon-13</td>
<td>Protons: 6, mass number 13</td>
</tr>
<tr>
<td>Neutrons: 7</td>
<td></td>
</tr>
<tr>
<td>Electrons: 6</td>
<td></td>
</tr>
<tr>
<td>Carbon-14</td>
<td>Protons: 6, mass number 14</td>
</tr>
<tr>
<td>Neutrons: 8</td>
<td></td>
</tr>
<tr>
<td>Electrons: 6</td>
<td></td>
</tr>
</tbody>
</table>
c. Use this website to list specific ways in which radioactive isotopes are used today: 
http://chemistry.tutorvista.com/nuclear-chemistry/uses-of-isotopes.html

d. Carbon Dating: Go to: https://www.youtube.com/watch?v=phZeE7Att_s and https://www.youtube.com/watch?v=Kcuz1JiMk9k to learn how an isotope of carbon is used to determine the age of fossils and answer the following.

1. Every living thing is made up of carbon. How do plants obtain carbon? How do animals obtain carbon?

2. How is Carbon-14 formed and how is it different from Carbon-12?

3. What is unique and important about Carbon-14 and what will happen to it once an animal dies?


5. What is measured to determine the number of years that have passed since the animal died?

C. Electrons & Chemical Bonding

1. Electrons determine how an atom behaves when it encounters other atoms. Electrons orbit an atom at specific levels called electron shells.

2. If an atom’s outer electron shell is unfilled, it is reactive and wants to be unreactive. 
2 electrons = fill first electron shell, 8 electrons fill all other shells

   a. How can atom become unreactive?

   b. Atom looks to other atoms for help & may form a bond with them in order to fill its outer electron shell = unreactive
3. What do hydrogen, carbon, nitrogen, and oxygen atoms have in common? And what does this allow these atoms to do, that is important to life?

4. Go to: http://cnx.org/contents/s8Hh0oOc@9.25:IBRqRY3C@8/The-Building-Blocks-of-Molecules to read about ionic and covalent bonds and view course website animations on chemical bonds and define the following bond types and give an example of a molecule or compound that is formed by each bond type.

   a. Ionic bond

   b. Covalent bond

D. Chemical reactions – changes in chemical composition of matter
   1. Molecular (Chemical) Formulas – short hand method for describing chemical composition
      a. Ex. O₂ (molecule of oxygen) How many atoms of oxygen?
         Ex. How would you write three molecules of O₂?
         Ex. C₅₅H₇₂Mg₄O₅ = chlorophyll

      b. Chemical Equations – short hand for describing chemical reactions
         Ex. C + 4H → CH₄  
         carbon hydrogen methane
         What are the reactants? What is the product?
         How many atoms of carbon react with how many atoms of hydrogen to form how many molecules of methane?

         Notice how the same number of carbon and hydrogen atoms are present in the reactants and in the products. The atoms are just grouped differently in the products.
Ex. \( 2H_2 + O_2 \rightarrow 2H_2O \)

What are the reactants? What are the products?

How many molecules of hydrogen gas react with how many molecules of oxygen gas to form how many molecules of water?

How many hydrogen atoms in the reactants and in the product? How many oxygen atoms in the reactants and in the product?

Again, the same number of hydrogen and oxygen atoms are present in the reactants and in the products.

Ex. Now answer the following questions on your own using this equation. This is the equation for photosynthesis (how plants make their food):

\[ 6CO_2 + 12H_2O \rightarrow C_6H_{12}O_6 + 6H_2O + 6O_2 \]

What are the reactants? What are the products?

How many molecules of carbon dioxide react with how many molecules of water to form how many molecules of glucose, water, and oxygen?

How many carbon atoms in the reactants and in the products? How many oxygen atoms in the reactants and in the products? How many hydrogen atoms in the reactants and in the products? Remember, the same number of atoms are present n the reactants and in the products.
II. Water is Important to Life

Watch the Amoeba Sisters Properties of Water:

A. Structure of Water

1. Water is a polar molecule. Why?

2. What does this allow water molecules to do?

B. Water’s Life Supporting Properties

1. Water is a good solvent.
   a. Solute
   b. Solvent
   c. Solution
   d. Why is water a good solvent?
   e. Why is this important to life?
   f. Hydrophilic - “water loving” molecules that are attracted to and will dissolve in water. Examples?
   g. Hydrophobic – “water fearing” molecules that are not attracted to and will not dissolve in water. Examples?
2. Water is cohesive and adhesive
   a. Cohesion
   b. Adhesion
   c. Why is water so cohesive and adhesive?
   d. Why is this important to life?

3. Solid water (ice) is less dense than liquid water
   a. Why does ice float?
      1. Does liquid or solid H$_2$O contain more H-bonds?
      2. Does liquid H$_2$O or solid H$_2$O contain molecules that are farther apart due to higher number of H-bonds?
   3. Does liquid H$_2$O or solid H$_2$O contain fewer molecules in a given space?
   4. So, is liquid or solid H$_2$O less dense and therefore floats?
   b. Why important to life?
   a. Water vs. alcohol:
      1. What requires more time and energy to change its temp.?
   
   b. Why does water moderate temp.?
   
   b. How do H-bonds allow water to absorb heat and not greatly change in temp.?
   
   c. Why important to life?

III. Acids and Bases are Important to Life

Go to: http://cnx.org/contents/s8Hh0oOc@9.25:t90BfSb7@4/Water and read “Buffers, pH, Acids, and Bases” answer the following:

A. Define what an acid is, how it effects pH, and give an example of an acid.

B. Define what a base is, how it effects pH, and give an example of a base.

C. State the range of numbers that represents acids, neutral solutions, and bases on the pH scale.

D. Why does pH Matter?
   1. What will happen to your cells and proteins if your body pH is out of range?

   2. So how come we can consume acidic substances like orange juice or basic substances and not die?

   3. In 2000, scientists discovered that the breath of people who are having an asthma attack is 100 times more acidic than usual. An asthma attack occurs when the body mistakenly believes it is being invaded by harmful microbes. The body reacts by lowering its pH at the site of attack with the hope that the microbes will die. However, the excess acidity in the lungs closes down a person’s airway which makes it difficult to breath.
The Organic Molecules of Life (Ch. 2)

I. Organic Molecules - molecules that contain carbon (C) as central element
   A. All life is based on carbon
      1. Why is carbon important to life?
         The ability of organic molecules to be so variable allows for the production of many different molecule types that complex living organisms are made up of!
      2. Shape of organic molecules is very important because your body recognizes different molecules by recognizing different shapes
         Watch these 5 episodes “Global Warming: It's All About Carbon” https://www.youtube.com/watch?v=ypbb9Zi5Tao&list=PLE7B4FAD08F1EBCE2 and understand why carbon, which is central to life, is also at the root of our global climate change problem.

II. The Large Organic Molecules Found in All Cells – Carbohydrates, Lipids, Proteins, & Nucleic Acids
   Watch the Amoeba Sisters Biomolecules

   A. How are these large molecules made and broken down? Think of building blocks.
      1. These large molecules are made up of smaller molecules called monomers. Therefore, these large molecules are also called polymers because they are made up of many monomers linked together.
      2. Polymers can also be broken apart into their individual monomers

   B. Carbohydrates – “sugars” made up of carbon, hydrogen and oxygen
      Three Types of Carbohydrates:

   Table 3.2
<table>
<thead>
<tr>
<th>Monomers, Polymers</th>
<th>The polymer is…</th>
</tr>
</thead>
<tbody>
<tr>
<td>A monosaccharide (for example, glucose, fructose)</td>
<td>A polysaccharide (for example, starch, glycogen, cellulose)</td>
</tr>
<tr>
<td>An amino acid (for example arginine, leucine)</td>
<td>A polypeptide or protein (A- and B-chains of insulin are polypeptides and insulin is a protein)</td>
</tr>
<tr>
<td>A nucleotide (sugar, phosphate, base in combination)</td>
<td>A nucleic acid (for example, DNA, RNA)</td>
</tr>
</tbody>
</table>
1. Monosaccharides “one sugar” (Simple Sugars) = monomer unit
   a. Function:
   b. Examples of monosaccharides:
      - Glucose (blood sugar)
      - Fructose (in fruits)
2. Disaccharides “two sugars”
   a. Function:
   b. Examples of disaccharides:
      - Lactose - galactose bonded to glucose; sugar in dairy products
      - Maltose – glucose bonded to glucose; sugar from barley
      - Sucrose (table sugar) - glucose bonded to fructose; sugar in sugarcane and sugar beets
3. Polysaccharides “many sugars” (Complex Carbohydrates)

What monosaccharide is the building block of these polysaccharides?

a. Examples and functions of polysaccharides: Go to:  
   http://cnx.org/contents/s8Hh0oOc@9.25:QhGQhr4x@7/Biological-Molecules and read “Carbohydrates” and state 1) whether plants or animals initially use the following polysaccharides and 2) what each polysaccharide is used for (function) by the plant or animal. Also state which polysaccharide is the most abundant on Earth.
1. Starch
   1. Glycogen
   2. Cellulose
   3. Chitin
C. Proteins – most elaborate of life’s molecules; involved in many functions

1. General Characteristics:
   a. Monomer unit =

      - 20 different amino acids

   b. Chain of amino acids (polymer) is called:

      - Different arrangements of the 20 amino acids can make many different proteins (like a 20 letter alphabet)

   c. When polypeptide folds up into specific shape, it is called:

2. Importance of amino acid sequence
   Ex. sickle cell disease
3. Importance of protein structure (shape) = shape enables the protein to carry out specific function = shape determines function

4. Proteins need to maintain their shape in order to function properly.
   How can a protein lose its shape (denature)?

5. One type of protein is an enzyme
   Watch the Amoeba Sisters Enzymes: The Proteins that Remind Us of Pac-Man
   a. Function:

D. Lipids – fats, oils, phospholipids, and steroids (also made up of carbon, hydrogen and oxygen)
General Characteristics:
- mostly long hydrocarbons (H & C)
- do not have the typical monomer/polymer structure
- Hydrophilic or Hydrophobic?

Three Types of Lipids:
1. Fats & Oils (Triglycerides) – consist of 3 fatty acid tails linked to a glycerol head
   a. Functions:

b. Two Types of Fats:
   1. Saturated Fats

2. Unsaturated Fats

What are hydrogenated (trans fats) or partially hydrogenated oils?
2. Phospholipids – consist of 2 hydrophobic fatty acid tails linked to a hydrophilic phosphate group head
   a. Functions:

3. Steroids – very different from fats in structure and function; carbon skeleton bent into 4 fused rings
   Examples of Steroids:
   a. Cholesterol
      Function:

   Where does cholesterol come from?
   b. Sex hormones (ex. testosterone, estrogen, progesterone)
      Functions:

   Anabolic steroids:

High Density Lipoproteins (HDLs) vs. Low Density Lipoproteins (LDLs): Go to
http://www.heart.org/HEARTORG/Conditions/Cholesterol/AboutCholesterol/Good-vs-Bad-Cholesterol_UCM_305561_Article.jsp#.V9hyOekrLIU and answer the following:
1. What do lipoproteins do for you?

2. Lipoproteins are a combination of what two large organic molecules?

3. What are the two types of lipoproteins?

4. Which type is called the “bad cholesterol” and which is the “good cholesterol”?
5. Why is the “bad cholesterol” considered unhealthy and why is the “good cholesterol” healthier to have in one’s body?

Which type of fat is better for our health and why? Go to http://www.heart.org/HEARTORG/HealthyLiving/HealthyEating/Nutrition/Fats-and-Oils_UCM_304495_Article.jsp#.V-GkPPkrLIU and answer the following:

1. List the following dietary fats starting with the most healthful to most harmful: 1) Saturated Fats, 2) Monounsaturated & Polyunsaturated Fats, and 3) Trans fats.

2. State how each of the dietary fats that you listed in question #1 affect LDL and HDL levels and what type of foods each can be found in.

Read the online article “Rebuilding the Food Pyramid” and answer the following questions:
1. According to the article, describe why the rate of coronary heart disease is so much lower in the Greek island of Crete even though the people there tend to have a high fat diet.
2. Describe how the old food pyramid is different from the new food pyramid regarding the amount of meat (saturated fats) and plant oil (unsaturated fats) one should eat.

3. According to the article, state the best way to avoid obesity.

E. **Nucleic Acids**

1. **General Characteristics:**
   a. **Monomer unit =**

   Nucleotides are composed of:
   1) Sugar
   2) Phosphate
   3) Base

2. **Types of Nucleic Acids:**
   a. **DNA (deoxyribonucleic acid)**

   DNA Structure: like a twisted ladder
   - Sugar and phosphates are sides of the ladder and the bases are the rungs of the ladder
   - Bases = **Adenine, Guanine, Cytosine, Thymine**
   - 2 nucleotide strands (double stranded) are then twisted around each other to form a double helix

Functions:
- Contains many genes (specific series of hundreds or thousands of nucleotides)
- These genes are the directions for building proteins
- DNA is the genetic material passed along to offspring
In humans, 3 billion nucleotides make up a DNA molecule and every one of our cells that has a nucleus contains one of these 3 billion nucleotide long molecules.

b. RNA (ribonucleic acid)

RNA Structure:

Function:
### Organic Molecules Overview

#### Table 3.2

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</table>

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#### Table 3.5

**Summary Table of Biological Molecules**

<table>
<thead>
<tr>
<th>Type of Molecule</th>
<th>Subgroups</th>
<th>Examples and Roles</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Carbohydrates</strong></td>
<td>Monosaccharides</td>
<td>Glucose: energy source</td>
</tr>
<tr>
<td></td>
<td>Disaccharides</td>
<td>Sucrose: energy source</td>
</tr>
<tr>
<td></td>
<td>Polysaccharides</td>
<td>Glycogen: storage form of glucose</td>
</tr>
<tr>
<td></td>
<td>Triglycerides: 3 fatty acids and glycerol</td>
<td>Fats, oils (butter, corn oil): food, energy, storage, insulation</td>
</tr>
<tr>
<td></td>
<td>Fatty acids: components of triglycerides</td>
<td>Stearic acid: food, energy sources</td>
</tr>
<tr>
<td></td>
<td>Steroids: four-ring structure</td>
<td>Cholesterol: fat digestion, hormone precursor, cell membrane component</td>
</tr>
<tr>
<td></td>
<td>Phospholipids: polar head, nonpolar tails</td>
<td>Cell membrane structure</td>
</tr>
<tr>
<td><strong>Lipids</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Proteins</strong></td>
<td>Enzymes: chemically active</td>
<td>Sucrase: breaks down sugar</td>
</tr>
<tr>
<td></td>
<td>Structural</td>
<td>Keratin: hair</td>
</tr>
<tr>
<td></td>
<td>Lipoproteins: protein-lipid molecule</td>
<td>HDLs, LDLs: transport of lipids</td>
</tr>
<tr>
<td></td>
<td>Glycoproteins: protein-sugar molecule</td>
<td>Cell surface receptors</td>
</tr>
<tr>
<td><strong>Nucleic acids</strong></td>
<td>Deoxyribonucleic acid (DNA)</td>
<td>DNA contains information for the production of proteins</td>
</tr>
<tr>
<td></td>
<td>Ribonucleic acid (RNA)</td>
<td>One variety of RNA carries DNA’s information to the sites of protein production, the ribosomes; another variety of RNA helps make up ribosomes.</td>
</tr>
</tbody>
</table>
The Cell (Ch. 3)

Watch the Amoeba Sisters Introduction to Cells: The Grand Cell Tour

I. Two Main Types of Cells: Prokaryotic (Prokaryotes) & Eukaryotic (Eukaryotes)

- Prokaryotic (pro=before, karyon=nucleus) Cells
- Eukaryotic (eu=true, karyon=nucleus) Cells

Is an elephant made up of larger cells than ant or is it just made up of more cells?

Why are cells so small? Watch https://www.youtube.com/watch?v=CNkP4rycLbI and https://www.youtube.com/watch?v=nwEybrVJ-M and answer the following:

1. Which sized cube did the vinegar diffuse into the most? Which size did vinegar diffuse into the least?

2. When calculating surface area to volume ratios of cubes, which cube (the smallest or largest) has the smallest surface area? the largest surface area?

Which cube has the smallest volume? the largest volume?

When you compare the surface area to its volume (surface area to volume ratio), which cube has the greatest amount of surface area compared to its volume? the lowest amount of surface area compared to its volume?

3. Using what you just learned about the amount of surface area compared to its volume (surface area to volume ratio) an object has, briefly explain why cells are so small and limited to how large they can be. Use your own words to explain this!
II. Eukaryotic Cells

A. Main Parts of a Eukaryotic Cell: Go to
http://cnx.org/contents/s8Hh0oOc@9.25:EaHMyDB_@6/Comparing-Prokaryotic-and-Euka and
http://cnx.org/contents/s8Hh0oOc@9.25:EygPBNl9@9/Eukaryotic-Cells and define following cell parts, and
label them on this cell diagram.

1. Nucleus

2. Organelles

3. Cytosol and Cytoplasm

4. Cytoskeleton

5. Plasma Membrane

B. Two Types of Eukaryotic Cells: Animal Cells and Plant Cells

1. Animal Cells

   Organelles involved in making proteins:
   a. Nucleus –

   What step in protein production occurs here?

   b. Ribosomes –

   What step in protein production occurs here?
c. Rough Endoplasmic Reticulum (rough ER) –
   Why is it called “rough”?

   What step in protein production occurs here?

   Why does rough ER have such a highly folded shape?

d. Transport Vesicles –

   What step in protein production occurs here?

e. Golgi Complex “Distribution Center” -

   What step in protein production occurs here?

Path of Protein Production in Cells: On the following diagram, state each step of protein production that occurs within each organelle listed.

1. Nucleus:

2. Ribosomes

3. Rough Endoplasmic Reticulum

4. Transport Vesicles

5. Golgi Complex
Organelles not involved in making proteins:

Go to: http://cnx.org/contents/s8Hh0oOc@9.25:EygPBNl9@9/Eukaryotic-Cells and state the functions of these three organelles:

f. Smooth Endoplasmic Reticulum -

Why is it called “smooth”?

g. Lysosomes “Breakdown Body”–

h. Mitochondria –

Why is it highly folded on the inside? (Hint: same reason the rough ER is highly folded)

Go to http://cnx.org/contents/s8Hh0oOc@9.25:EygPBNl9@9/Eukaryotic-Cells and answer the following:

i. What is the cytoskeleton of a cell and what is its function?

j. What are cilia and flagella and what are they used for

View course website animations on cilia
REVIEW:
Label the following parts on this animal cell and state the function of each part: nucleus, ribosomes, rough endoplasmic reticulum, transport vesicles, Golgi complex, smooth endoplasmic reticulum, lysosomes, mitochondria, and cytoskeleton. Also view course website animation on animal cells.

2. Plant Cells – have the same organelles that animal cells do with the following additions:
   Label these parts onto this plant cell:

   a. Cell

   Wall

   b. Chloroplasts
c. Large Central Vacuole

Turgor pressure: force of the plasma membrane pushing against the cell wall

View course website animation on plant cells.

Watch the Amoeba Sisters Cell Membranes and Cell Transport: Molecules like to Move it, Move it

C. The Plasma Membrane – outer lining of cell; separates the living cell from its nonliving surroundings

Functions:

1. Plasma Membrane Components: – mostly phospholipids and proteins
a. Phospholipid Bilayer – two layers of phospholipids
   - Phosphate group head = hydrophilic or hydrophobic?
   - Fatty acid tails = hydrophilic or hydrophobic?

b. Cholesterol

c. Proteins – embedded within membrane

d. Carbohydrates – sugar chains
Cell Transport: How Materials Move In & Out of Cell Through the Plasma Membrane (Ch. 3)

I. Plasma membrane is semi-permeable

Small molecules move through using no energy. Large or charged molecules move through by using energy. **Watch the Amoeba Sisters** [Cell Membranes and Cell Transport: Molecules like to Move it, Move it](https://www.amoebasisters.com/)

A. Passive Transport -

Types of Passive Transport:
1. Diffusion –

**Watch course website animations on diffusion**

**Watch the Amoeba Sisters** [Osmosis: A Solute and Solvent Love Story](https://www.amoebasisters.com/)

2. Osmosis –

Effect of Osmosis on Cells: causes cells to shrink or swell
a. Hypertonic solution – solution has higher concentration of solutes than other solution

Plant cells undergo plasmolysis (plasma membrane shrinks away from cell wall)

b. Isotonic solution – two solutions have equal concentration of solutes

c. Hypotonic solution – solution has lower concentration of solutes than the other solution

View course website animations on osmosis

3. Facilitated Diffusion –

View course website animations on Facilitated Diffusion

B. Active Transport –
If you want to learn more about different types of specialized plant and animal cells, watch the Amoeba Sisters [Specialized Cells: Significance and Examples](#)

**The Endosymbiotic Theory (Ch. 3)**

How did the complex eukaryotic cell come about?

*Watch the Amoeba Sisters [Endosymbiotic Theory](#) and answer the following:*

1. What does the endosymbiotic theory explain?

2. What does prokaryote symbiosis mean?

3. Describe how some larger prokaryotes may have taken in smaller prokaryotes and state what kinds of organelles these smaller prokaryotes may have evolved into overtime.

4. State the four lines of evidence that support this theory.