Chapter 1 Study Guide

Just because I didn't go over some part of a chapter doesn't mean you shouldn't learn it. Hence this study guide to let you know what you are responsible for. This is the only chapter where I'll require you to learn anything significant that's not in the book.

1.1 Defining Life

Cell - the smallest unit of life, much more later. Viruses are not cells and so are not alive by this definition. All cells use **DNA** as their genetic material, a **plasma membrane** to separate the inside of the cell from the outside, and the major liquid portion of the cell called the **cytoplasm**. Much more later.

Organism - an individual living thing. They may be

unicellular - single celled liked bacteria or many protists

multicellular - multiple cells - like you

Organization - This semester we will only be looking at the bottom three levels of organization shown in **figure 1.2** - atom, molecule, and cell. The others are covered in BIOL 1120. You should still be able to recognize the levels from organism on up well enough for a multiple choice question. **Emergent properties** are those that arise from increasing complexity. Parts of a cell make a living cell, populations of organisms make a community. Again, this is not something I particularly emphasized.

Living things **acquire materials and energy**. **Energy** is the capacity to do work and almost all life depends ultimately on the sun (via photosynthesis) for that energy. We'll look at photosynthesis in detail later. **Metabolism** refers to the chemical reactions that occur in a cell.

Homeostasis is the ability of an organism to maintain a consistent internal environment. Cells control the level of various salts, water, and pH within their boundaries. Organism like you control temperature, blood glucose levels, etc.

Living things respond to their environment in lots of ways. Plants grow toward light, animals seek food or safety, etc.

Living things **reproduce**. You probably already knew that.

Living things are **adapted** to their environment. Duh. Evolution is the process by which this adaptation occurs.

1.2 **Evolution, the Unifying Concept of Biology**

We will spend considerable time looking at evolution. Evolution is sometimes called the theory of biology because of its explanatory power. A simple definition is that it means "**descent with modification**", that is, changes occur from one generation to the next. In this chapter, we are just using it to organize life. If life started with a single instance. than all life is related. Some life is more related than others, just as you are more related to some people than others. Organizing life is the science of **taxonomy**. I'm not going to require you to remember all the levels of classification (table 1.1) but you should know: The three **domains**: **Bacteria**, **Archaea**, **Eukarya**. We often divide cell types into two large categories: **Prokaryote** - literally "before kernel" meaning they do not have a

membrane bound nucleus (more later on this) and **Eukaryote** ("true kernel"). Both domain Bacteria and domain Archaea are prokaryotic and unicellular. They tend to be very small, looking like dots and dashes under the microscope. You won't spend a lot of time in General Biology studying these organism but know that they have existed far longer into the past, are much more diverse biochemically, and into far more habitats in the present than all the multicellular eukaryotes we see everyday. Because of their nearly invisible nature, you'll have to take Microbiology to really learn about them.
Domain Eukarya (eukaryotes) are those species that have cells with nuclei (the plural of nucleus). The nucleus contains the genetic material of the cell (DNA) - much more later. This domain contains the species that we are most familiar with. It is divided into four (at least) **kingdoms**. The "tree of life" is a branching diagram that depicts the relatedness of species and really divides eukaryotes into more than four kingdoms but we will learn the more traditional ones. Animals, Plants, and Fungi can be considered true kingdoms because all members are more closely related to other members of their kingdom than to any members of other kingdoms. Protists are basically eukaryotes that do not belong to the other three kingdoms. Taxonomists today generally organize members of this traditional kingdom into multiple other kingdoms but we won't worry with them. Just know that this is a catch-all and therefore diverse group. Many of it's members are unicellular like paramecium and amoeba.
The other two levels of classification you should know are **Genus** and **Species**. Species is the lowest level of the taxonomic classification. There are multiple definitions but the most commonly used one for sexual species is Ernst Mayr's: "groups of actually or potentially interbreeding natural populations, which are reproductively isolated from other such groups". In other words, they look similar and interbreed. The next level up is genus. This is a group of closely related species. There are currently 1.9 million named species. Among animals, insects make up the majority of named species. Some species can have the same species name but not within the same genus. This is why scientist use the binomial name, genus and species. We are *Homo sapiens* (genus and species). Know that evolution is common descent with modification (p8) but don't worry about natural selection at this time.

1.3 Biosphere Organization

Biosphere, ecosystems, biodiversity, sustainability, and the effects of human populations are arguably the most important aspects of biology for you to be familiar with. We won't be doing a lot with it this semester but have some basic familiarity with these terms. Notice in Figure 1.10 that plants capture some of the sun's energy and pass on portions of that energy to animals. All the sun's energy ends up eventually as heat. We'll see a bit more of this in chapter 6, which is also included in your first test.

1.4 The Process of Science

The **Scientific Method** is a good formula for investigating many phenomena.
1. First make an **observation** about some biological phenomenon This leads you to some **question** concerning the observed phenomenon.

2. Form a **hypothesis**. This is an educated guess that explains the observation. This should lead you a testable **prediction**.
3. Design and conduct an **experiment** that will either support or negate the prediction. Experiments are designed to test one **variable** (factor) at a time. Changing multiple factors generally leads to inconclusive results. A **control** is included where the factor being tested is not included.
4. **Data** are the results of an experiment. The variable you varied is called the **independent** or **experimental variable**. The results that you measure are the **dependent variable** because they depend on the changes you made with the independent variable. If you are measuring the effect of temperature on plant growth then temperature in the independent variable (you control it) and plant growth is the dependent variable (you measure it). The data should be objective (as opposed to subjective), often quantitative (they're numbers) so statistical analysis can be performed.
5. A **conclusion** is reached on whether the data support or reject the hypothesis. Published papers may rely on previous reached conclusions in other papers and will in turn generate new questions.
Science is not always pursued in such a clean cut manner. Not all questions have easily testable hypotheses. Scientists don't always sit down with their five-step plan and work out their next publication. Science is about being **curious**, **open minded**, and **skeptical**. It's about figuring out ways to find things out and not stopping till you've found everything you can. Science doesn't know everything. If it did, scientists would be out of work. Michael Sherman, who writes the Skeptics Corner for Scientific American, has a nice Youtube video about scientific thinking at http://www.youtube.com/watch?v=eUB4j0n2UDU. Feel free to be skeptical of his opinions, that's what thinking is about.

The science focus on page 13 is a nice piece about the values and limitations of statistical studies. The two studies on pages 14 through 16 are nice examples of the scientific process.
Your book talks about **scientific theories** being the "ultimate goal of science". This is because theories are explanations and explanations are far more interesting than collections of facts. A scientific theory can take into account many observations and laws. It explains them and provides testable predictions. Theories that have lots of support may be considered factual in that they are very unlikely to change in a dramatic way. **Scientific laws** tend to be concise statements (often involving math) that express a fundamental property of nature.

The scientific method would be useless if we kept it to ourselves. We need to present our findings to the scrutiny of the scientific community. This is not discussed in the book but involves presenting your study in seminars and meetings and ultimately getting it published. **Publication** generally works like this:

1. This data is written up in a paper and submitted to an appropriate journal (there are hundreds of scientific journals, some much better than others). The format required is similar to what you will be doing for your 40 point paper in lab.
2. An editor will read the paper and either reject it outright or send it to several reviewers. Reviewers are simply other scientists in the field and are anonymous to the paper's author.
3. Reviewers will provide written reviews and recommend the paper to be rejected, accepted, or accepted with revision. This is called the **peer-review process** and is used by almost all journals.
5. After publication, the scientific community-at-large will eventually decide on how valid the paper is. Publication is just the start of critiquing a paper.

Scientists go through all this rigmarole so that we might more objectively determine what is likely to be true. People often decide what is true based on **dogma** (Aristotle says illness is caused by imbalance of the four humors) and **anecdotal evidence** (my personal experience is…). Psychology tells us that we are all prone to a number of biased ways of thinking. Here are a couple of them.
Cognitive dissonance – one the main theories in social psychology. It relates to the difficulty in holding two contrary beliefs. If I bought a car, It can be hard to think these three things as true:

1. I paid a lot of money for this car.
2. I'm a smart person.
3. It's a terrible car.

Because of this, I'm more likely to look for good things about the car than bad things. This leads to the more scientifically important:
Confirmation bias – the tendency to over value information that supports a belief (or hypothesis) and under value negative information. I gave the example of blood-letting, practiced for two thousand years by smart people.. Science applied to medicine is called **Evidence Based Medicine**. The best medical studies are done when neither the doctor nor patient knows who is getting the real medicine. Clinical trials done this way are called **double blind placebo controlled** studies. Another example of confirmation bias is that people are much more likely to look favorably on something done by a group that they associate with, like a political party or their school, than outside groups.
Scientists are people too, so science has developed methods for discovering new information and interpreting that information in a **less** biased fashion. Wikipedia has nice articles on dissonance and confirmation bias. There is a bias that creeps into the scientific literature called **publication bias**. This is the tendency of studies by researchers to not be submitted for publication if they do not fit with their financial or ideological goals. This need not be considered deliberately deceitful.
I also mentioned **logical fallacies**. A logical fallacy is simply a statement (which may be true) does not support the conclusion you think it does. There are lots of these (google it if interested) and you don't need to learn them.
What should you know about all this extra stuff that's not in your book? You should at least understand confirmation bias and be able to discuss why the scientific method is

preferable to these other forms of reasoning as far as figuring out what likely represents reality (at least that's my bias).