Exploring Creation With Biology

Table of Contents

MODULE #1: Biology: The Study of Life

Introduction

In this course, you're going to take your first detailed look at the science of biology. Biology, the study of life itself, is a vast subject, with many subdisciplines that concentrate on specific aspects of biology. Microbiology, for example, concentrates on those biological processes and structures that are too small for us to see with our eyes. Biochemistry studies the chemical processes that make life possible, and population biology deals with the dynamics of many life forms interacting in a community. Since biology is such a vast field of inquiry, most biologists end up specializing in one of these subdisciplines. Nevertheless, before you can begin to specialize, you need a broad overview of the science itself. That's what this course is designed to give you.

What Is Life?

If biology is the study of life, we need to determine what life is. Now to some extent, we all have an idea of what life is. If we were to ask you whether or not a rock is alive, you would easily answer "No!" On the other hand, if we were to ask you whether or not a blade of grass is alive, you would quickly answer "Yes!" Most likely, you can intuitively distinguish between living things and nonliving things.

Even though this is the case, scientists must be a little more deliberate in determining what it means to be alive. Thus, scientists have developed several criteria for life. Not all scientists agree on all of these criteria, but in general, most biology courses will list at least some of the following criteria for life:

1. **All life forms contain deoxyribonucleic (dee ahk' see rye boh noo klay' ik) acid, which is called DNA.**

2. **All life forms have a method by which they extract energy from the surroundings and convert it into energy that sustains them.**

3. **All life forms can sense changes in their surroundings and respond to those changes.**

4. **All life forms reproduce.**

If something meets all of these criteria, we can scientifically say that it is alive. If it fails to meet even one of the criteria, we say that it is not alive. Now if you're not sure exactly what each of these criteria means, don't worry. We will discuss each of them in the next few sections of this module.

DNA and Life

Our first criterion states that all life contains DNA. Now we're sure you've at least heard about DNA. It is probably, however, still a big mystery to you at this point. Why is DNA so special when it comes to life? Basically, DNA provides the information necessary to take a bunch of lifeless chemicals and turn them into an ordered, living system. Suppose, for example, we were to analyze an organism and determine every chemical that made up the organism. Suppose further that we went into a laboratory and made all of those chemicals and threw them into a big pot. Would we have made something that is alive? Of course not. We would not even have made something that resembles the organism we studied. Why not?

In order to make life, we must take the chemicals that make it up and organize them in a way that will promote the other life functions mentioned in our list of criteria for life. In other words, just the chemicals themselves cannot extract and convert energy (criterion #2), sense and respond to changes (criterion #3), and reproduce (criterion #4). In order to perform those functions, the chemicals must be organized so that they work together in just the right way. Think about it this way: suppose you go to a store and buy a bicycle. The box says, "Some assembly required." When you get it home, you unpack the box and pile all of the parts on the floor. At that point, do you have a bicycle? Of course not. In order to make the bicycle, you have to assemble the pieces in just the right way, according to the instructions. When you get done with the assembly, all of the parts will be in just the right place, and they will work together with the other parts to make a functional bike.

In the same way, DNA is the set of instructions that takes the chemicals which make up life and arranges them in just the right way so as to produce a living system. Without this instruction set, the chemicals that make up a life form would be nothing more than a pile of goo. However, directed by the information in DNA, these molecules can work together in just the right way to make a living organism. Now of course, the exact way in which DNA does this is a little complicated. Nevertheless, in an upcoming module, we will spend some time studying DNA and how it works in detail.

Energy Conversion and Life

In order to live, organisms need energy. This is why our second criterion states that all life forms must be able to absorb energy from the surroundings and convert it into a form of energy that will sustain their life functions. The production and use of this energy is called **metabolism** (muh tab' uh liz uhm).

Metabolism – The sum total of all processes in an organism which convert energy and matter from outside sources and use that energy and matter to sustain the organism's life functions

Metabolism can be split into two categories: **anabolism** (uh nab' uh lizm) and **catabolism** (kuh tab' uh lizm).

Anabolism – The sum total of all processes in an organism which use energy and simple chemical building blocks to produce large chemicals and structures necessary for life

Catabolism – The sum total of all processes in an organism which break down chemicals to produce energy and simple chemical building blocks

Although these definitions might seem hard to understand, think about them this way: when you eat food, your body has to break it down into simple chemicals in order to use it. Once it is broken down, your body will either burn those simple chemicals to produce energy or use them to make larger chemicals. The entire process of breaking the chemicals down and then burning them to produce energy is part of your body's catabolism. Once your body has that energy, it will use some of it to take simple chemicals and build large, complex chemicals that are necessary for your body to work correctly. The process of making those complex chemicals from simple chemicals is part of your body's anabolism. As we progress throughout the course, we will discuss specific examples of anabolism and catabolism, and that will help you better understand the distinction between them. One way to remember these two definitions is to notice that "catabolism" has the same prefix as "catastrophe," so they both involve things being broken down.

Obviously, then, the energy that an organism gets from its surroundings is important. Where does it come from? Ultimately, almost all of the energy on this planet comes from the sun, which bathes the earth with its light. When you take chemistry, you'll learn a lot more about light. For right now, however, all you need to know is that light is a form of energy and that it is the main energy source for all living organisms on our planet. Green plants (and some other things you will learn about later) take this energy and, by a process called **photosynthesis** (foh' toh sin thuh' sis), convert that energy into food for themselves.

<u>Photosynthesis</u> – The process by which green plants and some other organisms use the energy of sunlight and simple chemicals to produce their own food

We'll be looking at photosynthesis in great detail in a later module. Thus, if the definition is a little confusing to you, don't worry about it. What you need to know at this point is that photosynthesis allows plants and certain other organisms to convert the energy of sunlight into food. Photosynthesis is a part of anabolism, because the organism takes simple chemicals and converts them into food, which is composed of larger chemicals.

If plants and other photosynthetic organisms absorb their energy from the sun, where do other life forms get their energy? Well, that depends. Some organisms eat plants. By eating plants, these organisms take in the energy that plants have stored up in their food reserves. Thus, these organisms are indirectly absorbing energy from the sun. They are taking the energy from plants in the form of food, but that food ultimately came from sunlight. Organisms that eat only plants are called **herbivores** (ur' bih vorz).

<u>Herbivores</u> – Organisms that eat only plants

So you see that even though herbivores don't get their energy directly from sunlight, without sunlight there would be no plants, and therefore there would be no herbivores.

If an organism does not eat plants, it eats organisms other than plants. These organisms are called **carnivores** (kar' nih vorz).

<u>Carnivores</u> – Organisms that eat only organisms other than plants

Even though carnivores eat other organisms, their energy ultimately comes from the sun. After all, the organisms that carnivores eat have either eaten plants or have eaten other organisms that have eaten plants. The plants, of course, get their energy from the sun. In the end, then, carnivores also indirectly get their energy from the sun.

Finally, there are organisms that eat both plants and other organisms. We call these **omnivores** (ahm nih' vors).

<u>Omnivores</u> – Organisms that eat both plants and other organisms

Ultimately, of course, these organisms also get their energy from the sun.

Think about what we just did in the past few paragraphs. We took a large number of the organisms that live on this earth and placed them into one of three groups: herbivores, carnivores, or omnivores. This kind of exercise is called **classification**. When we classify organisms, we are taking a great deal of data and trying to organize it into a fairly simple system. In other words, classification is a lot like filing papers. When you file papers, you place them in folders according to their similarities. In this case, we have taken many of the organisms on earth and put them into one of three folders based on what they eat. This is one of the most important contributions biologists have made in understanding God's creation. Biologists have taken an enormous amount of data and have arranged it into many different classification systems. These classification systems allow us to see the similarities and relationships that exist between organisms in creation. Figure 1.1 illustrates the classification system you have just learned.

FIGURE 1.1
Herbivores, Carnivores, and Omnivores

Giraffe Photo by Dawn Strunc
Tiger Photo © Comstock, Inc.
Woman eating Photo © Tan Kian Khoon

Giraffes eat only plants; they are herbivores.

Tigers eat only meat. This makes them carnivores.

Humans eat both plants and meats; we are omnivores.

In biology, there are hundreds and hundreds of different ways that we can classify organisms, depending on what kind of data we are trying to organize. For example, the classification system we just talked about groups organisms according to what they eat. Thus, organisms that eat similar things are grouped together. In this way, we learn something about how energy is distributed from the sun to all of the creatures on earth.

This is not the only way we can classify organisms to learn how energy is distributed from the sun to all of the creatures on earth. We could, alternatively, classify organisms according to these groups: **producers**, **consumers**, and **decomposers**.

<u>Producers</u> – Organisms that produce their own food

<u>Consumers</u> – Organisms that eat living producers and/or other consumers for food

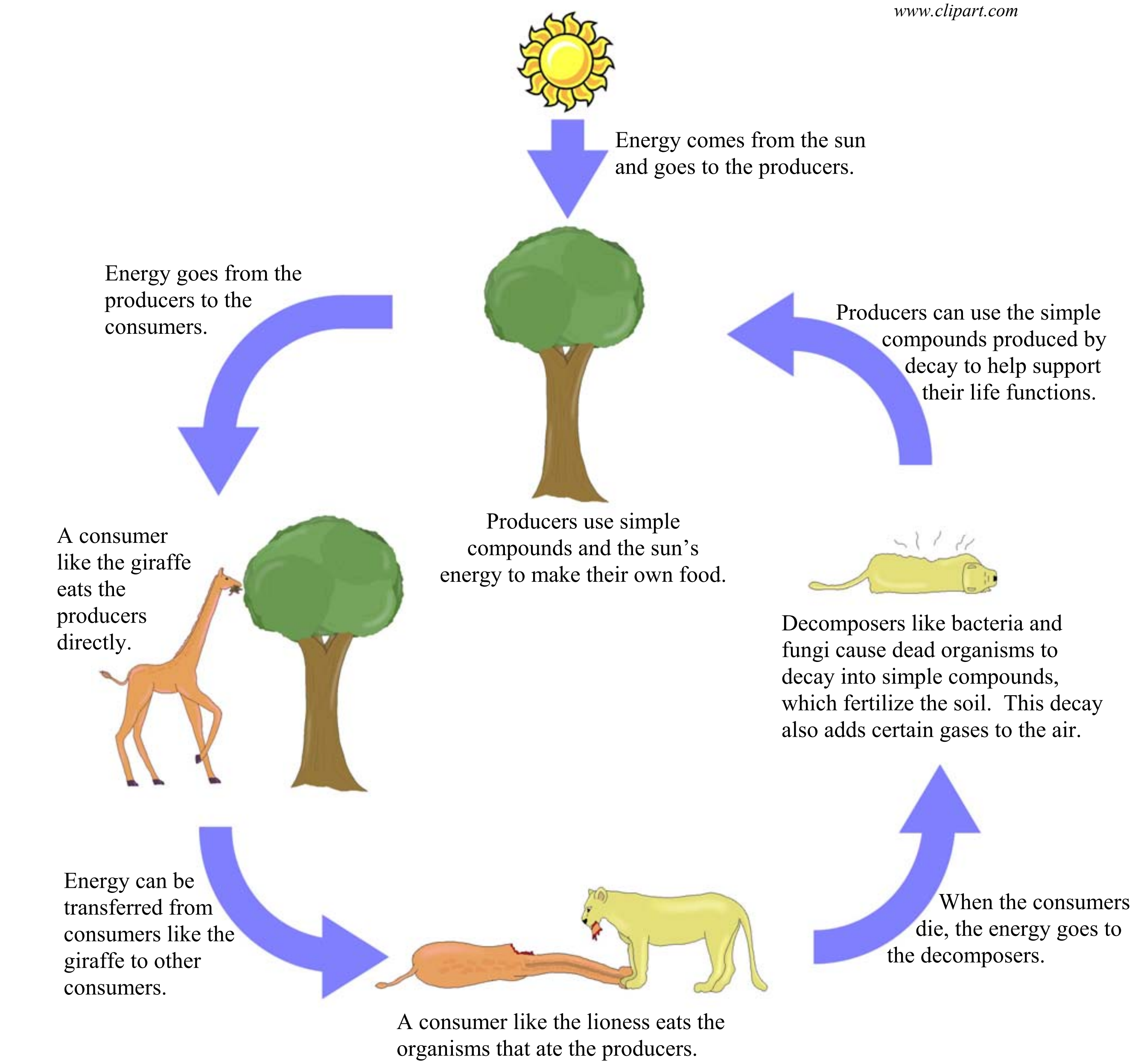
<u>Decomposers</u> – Organisms that break down the dead remains of other organisms

In this system, plants are producers because they make their own food from chemicals and the sun's light. Omnivores, herbivores, and carnivores are all consumers, because they eat producers and other consumers. Certain bacteria and fungi (the plural of "fungus"), organisms we'll learn about in detail later, take the remains of dead organisms and break them down into simple chemicals. Thus, these creatures are decomposers. Once the decomposers have done their job, the chemicals that remain are once again used by plants to start the process all over again. This classification scheme, illustrated in Figure 1.2, gives us a nice view of how energy comes to earth from the sun and is distributed to all creatures in God's creation.

FIGURE 1.2
Producers, Consumers, and Decomposers

All illustrations except the sun by Megan Whitaker

Sun illustration from www.clipart.com



Those who work with baraminology think that God created specific kinds of creatures and that He created them with the ability to adapt to their changing environment. As time went on, then, these created kinds did change within strict limits that we will discuss later on in the course. This led to a greater diversity of life on the planet than what existed right after creation. As a result, baraminologists think that all organisms we see on the planet today came from one of the many kinds of creatures that God created during the creation period discussed in the first chapter of Genesis. Baraminologists, then, try to define groupings called "baramins." Any organisms that exist within a baramin came from the same originally-created organism. For example, some baraminologists place domesticated dogs, wild dogs, and wolves into the same baramin because they believe that God created a basic kind of creature called a "dog," and the various forms of dogs and wolves that we see today are simply the result of that basic kind of creature adapting to a changing environment.

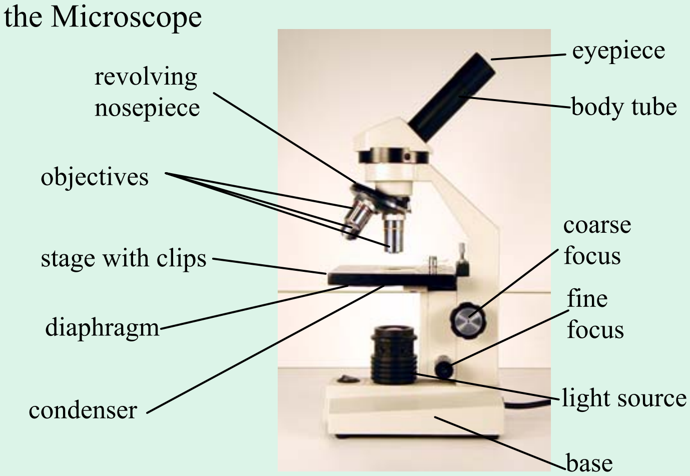
Although we think that there is a lot of evidence in favor of this new classification scheme, we still do not think that it should be used in this course. It is still relatively new and not fully developed. We doubt that it will be fully developed for many, many years to come. As a result, we think that the five-kingdom system still provides the best overall means by which to classify the organisms of God's creation, and we will limit ourselves to that system. Nevertheless, we will mention the other systems (the three-domain system and baraminology) from time to time, so it is important that you understand the basics of each.

The Microscope

We'll be revisiting classification in nearly every module, so don't worry. It won't go away. However, this brief introduction allows us to get started exploring creation. In the next two modules, we will be taking an in-depth look at kingdoms Monera and Protista. Since these kingdoms are composed of microorganisms, the labs we do in those two modules are heavily microscope-oriented. If you don't have a microscope, however, don't be concerned. We will have drawings or pictures of everything that you need to know, so a microscope isn't essential for taking this course. It does, however, help to make things clearer and more interesting. So for those who do have one, you need to perform Experiment 1.2. If you don't have a microscope, please read through the experiment so that you get a basic idea of what it covers.

EXPERIMENT 1.2
Introduction to the Microscope

Photo by Kathleen J. Wile



Supplies:

- Microscope
- Lens paper
- Slides
- Coverslips
- Cotton swabs
- Eyedropper
- Water
- Small pieces of bright thread
- Methylene blue stain

Object: To learn the various parts of the microscope and to learn to use the microscope properly

Procedure:

A. Place the microscope on your table with the arm of the microscope nearest you. With the aid of the illustration, locate all the parts of the microscope and become familiar with them.

1. The **eyepiece (called the ocular)** is what you look through. It usually contains a 10x lens.
2. The **body tube** starts at the eyepiece and runs to the part that holds the revolving nosepiece.
3. The **revolving nosepiece** is the disc that holds the lenses (which are called objectives).
4. The **coarse focus** is controlled by two large knobs on each side of the microscope. It allows for quick focus, but it does not make the image as sharp as it could be.
5. The **fine focus** knobs are used to produce sharp focus. They are usually smaller and lower than the coarse focus knobs, but in some scopes they are mounted on top of the coarse focus knobs.
6. The **arm** supports the body and stage and is attached to the base.
7. The **base** is the heavy structure at the bottom that supports the microscope and makes it steady.
8. The **stage with clips** is a platform just below the objectives and above the light source. The clips are used to hold the slide in place.
9. The **objectives** are found on the revolving nosepiece. They are metal tubes that contain lenses of varying powers, usually 4x, 10x, and 40x. Some microscopes have a 100x objective as well.
10. The **diaphragm** regulates the amount of light that passes through the specimen. It is located between the stage and the light source. It might be a disc that has several holes (a disc diaphragm), or it might be a single hole whose diameter can be varied (an iris diaphragm).
11. The **condenser** is also located between the light source and stage. It is a lens system that bends and concentrates the light coming through the specimen.
12. The **light source** is on the base and provides necessary light for the examination of specimens.

Magnification is an important feature of any microscope. In your laboratory notebook, write down the magnifications of the objectives on your microscope. You calculate the total magnification of the scope by taking the power of the ocular (usually 10x) and multiplying it by the power of each objective. Thus, if your ocular is 10x and your objectives are 4x, 10x, and 40x, your three magnifications are 40x, 100x, and 400x. Label your three magnifications as low, medium, and high.

B. Now that you are familiar with the parts of the microscope, you are ready to use it to view thread.

1. Rotate the low-power objective so that it is in line with the eyepiece. Listen for a click to make sure it is in place.
2. Turn your light on. If you have a mirror instead of a light, look through the eyepiece and adjust the mirror until you see bright light.
3. Using the coarse focus, raise the stage (or lower the body tube) until it can move no more. (*Never* force the knobs.)
4. Place a drop of water on a clean slide and add several short pieces of brightly-colored thread.
5. Add a coverslip (a thin piece of plastic or glass that will cover the water and press it against the slide). This works best if you hold the coverslip close to the drops of water and then drop it gently. If air bubbles form, tap the coverslip gently with the lead of your pencil.
6. Put the slide on the stage and clip it down, making sure the coverslip is over the hole in the stage.
7. Looking in the eyepiece, gently move the stage down (or body tube up) with the coarse focus. If you do not see anything after a couple of revolutions, move your slide a little to make sure the threads are in the center of the hole in the stage. This indicates that the threads are in the field of view.

8. Once you have the image in focus using the coarse focus, "fine tune" it with the fine focus.
9. Place the threads in the very center of the field of view by moving the slide as you look at it through the microscope. Make sure that the threads are at the center of the field, or you will lose them when you change to a higher magnification.
10. Turn the nosepiece so that the medium-power objective is in place. Until you are very familiar with any microscope, do not turn the nosepiece without checking to make sure it will not hit the slide. Always move the nosepiece slowly, making sure that it does not touch the slide in any way. A lens can easily be damaged if it hits or breaks a slide.
11. Once the medium-power objective is in place, you should use only the fine focus to make the image sharp. Once again, move the slide so that the thread is at the center of the field.
12. Again, watching to make sure you don't hit the slide, turn the nosepiece so that the high magnification objective is in place. You should use only the fine focus to refocus.
13. (Optional) If you like, repeat steps 1-12 using a strand of your own hair rather than thread.

If we wanted to look at the threads at high magnification, why didn't we just start with the high-power objective? Had we tried to bring the threads into focus under high magnification without first looking at them under low and then medium magnification, we almost certainly would have never found the threads. When you look at the slide at high magnification, you are looking at a very, very tiny portion of the slide, and it is unlikely that what you are looking for will be there. As a result, you should always start your microscope investigation with the lowest magnification and then work your way up, centering the specimen in the field of view each time before you increase magnification.

C. Now it is time to get your first look at cells! (The course website discussed in the "Student Notes" section of this book has some magnified images of cheek cells. They may be of some help to you.)

1. Collect some cheek cells by rubbing a cotton swab back and forth on the walls of your cheek inside your mouth. Use only one side of the swab.
2. Remove the swab carefully without getting a lot of saliva on it.
3. Rub the wet side of the swab on the slide. You should see a smear where you rubbed the slide.
4. If you were to look at the cells under the microscope right now, it would be hard to find them, because they are almost transparent. To help make them easier to see, you will add a dye to them. This dye is called a **stain**, and it will help contrast the cells against the light, making them much easier to see. Place a drop of methylene blue stain on the area where you placed the cells. (This stain will not come out of most fabric, so use it with care.)
5. Add the coverslip carefully.
6. Place the slide on the microscope and begin the procedure outlined in section B, looking at the cells under low, then medium, and then high magnifications. At low magnification, the cells will look like dots. Once you find some dots, center them and increase the magnification. At high magnification, you should see a dark blob (the nucleus) and a ring outlining the cell (the plasma membrane). Note the irregular shape of the cells. Draw what you see at each magnification.
7. Rinse the slides that you used in water and wipe them dry with a paper towel. Wipe the lenses of the scope with lens paper, and put everything away. Clean up any mess you made.

Believe it or not, we are at the end of the first module. Now you need to take a look at the study guide. On a separate sheet of paper, write out all of the definitions listed in the study guide, and answer all of the questions. After you have completed the study guide, check your work with the solutions. When you are confident that you understand the material covered in the study guide, you are ready to take the test.

ANSWERS TO THE "ON YOUR OWN" PROBLEMS

1.1 a. Carnivores - Tigers eat only meat; thus, they are carnivores.
b. Herbivores - Cows eat grass. This makes them herbivores.
c. Omnivores - Humans eat plants and meat. This makes us omnivores.
d. Herbivores - Sheep graze on grasses. This makes them herbivores.

1.2 a. Producers – Rose bushes have green stems and leaves to produce food via photosynthesis.
b. Decomposers - Almost all fungi are decomposers.
c. Consumers - Lions depend on other organisms for food.
d. Consumers - Humans depend on other organisms for food.

1.3 These organisms reproduce asexually. If they reproduced sexually, the offsprings' traits would be a blend of both parents' traits. Since these offspring are identical to the organism that produced them, this must be asexual reproduction.

1.4 Science cannot prove anything. The best science can say is that all known data support a given statement. However, since all data come from experiments which might be flawed, there is no way that science can prove anything. If the experiments that produced the data which support a particular statement are flawed, the statement might be quite wrong.

1.5 It is a hypothesis. The explanation will have to be tested with a significant amount of data before it can even be considered a theory.

1.6 In a hierarchical classification scheme like ours, the further you go down the classification groups, the more similar the organisms within the groups become. This is because each group is made by splitting the previous group into smaller groups. Thus, since kingdoms are split into several phyla, we expect the organisms within the phyla to be more similar than those in the entire kingdom. Since family is several steps down from kingdom, the organisms in the same family should be much more similar.

1.7 Since going down the hierarchical scheme tells us that the organisms are getting more similar, going up the hierarchical should enhance the differences. Since class is one step higher than order, the organisms from different classes should have more differences.

1.8 Protista - This kingdom has the single-celled eukaryotes.

1.9 Plantae - Almost all autotrophs belong in this kingdom.

1.10 Fungi – Most decomposers are in this kingdom.

ANSWERS TO EXPERIMENT 1.1

Number	Specimen	Specimen Classification	Numbers from the Key
1.	Butterfly	K. Animalia C. Insecta P. Arthropoda O. Lepidoptera	1, 3, 5, 6, 7, 9, 14, 16, 17, 19
2.	Chipmunk	K. Animalia C. Mammalia P. Chordata O. Rodentia	1, 3, 5, 6, 22, 23, 26, 28, 29, 31, 33, 34
3.	Grapevine	K. Plantae C. Dicotyledonae P. Anthophyta O.	1, 3, 4
4.	Swan	K. Animalia C. Aves P. Chordata O.	1, 3, 5, 6, 22, 23, 26, 28
5.	Spider	K. Animalia C. Arachnida P. Arthropoda O.	1, 3, 5, 6, 7, 9, 14, 15
6.	Tiger	K. Animalia C. Mammalia P. Chordata O. Carnivora	1, 3, 5, 6, 22, 23, 26, 28, 29, 31, 32
7.	Corn	K. Plantae C. Monocotyledonae P. Anthophyta O.	1, 3, 4
8.	Fish	K. Animalia C. Osteichthyes P. Chordata O.	1, 3, 5, 6, 22, 23, 24, 25
9.	Paramecium	K. Protista C. P. O.	1, 2
10.	Mushroom	K. Fungi C. P. O.	1, 3, 5
11.	Frog	K. Animalia C. Amphibia P. Chordata O. Anura	1, 3, 5, 6, 22, 23, 26, 27
12.	Bacterium	K. Monera C. P. O.	1, 2
13.	Bison	K. Animalia C. Mammalia P. Chordata O. Artiodactyla	1, 3, 5, 6, 22, 23, 26, 28, 29, 30
14.	Grasshopper	K. Animalia C. Insecta P. Arthropoda O. Orthoptera	1, 3, 5, 6, 7, 9, 14, 16, 17, 19, 20
15.	Baboon	K. Animalia C. Mammalia P. Chordata O. Primates	1, 3, 5, 6, 22, 23, 26, 28, 29, 31, 33, 35

STUDY GUIDE FOR MODULE #1

1. On a separate sheet of paper, write down the definitions for the following terms. You will be expected to have them memorized for the test!

a. Metabolism
b. Anabolism
c. Catabolism
d. Photosynthesis
e. Herbivores
f. Carnivores
g. Omnivores
h. Producers
i. Consumers
j. Decomposers
k. Autotrophs
l. Heterotrophs
m. Receptors
n. Asexual reproduction
o. Sexual reproduction
p. Inheritance
q. Mutation
r. Hypothesis
s. Theory
t. Scientific law
u. Microorganisms
v. Abiogenesis
w. Prokaryotic cell
x. Eukaryotic cell
y. Species
z. Taxonomy
aa. Binomial nomenclature

2. What are the four criteria for life?

3. An organism is classified as a carnivore. Is it a heterotroph or an autotroph? Is it a producer, consumer, or decomposer?

4. An organism has receptors on tentacles that come out of its head. If those tentacles were cut off in an accident, what life function would be most hampered?

5. A parent and two offspring are studied. Although there are many similarities between the parent and the offspring, there are also some differences. Do these organisms reproduce sexually or asexually?

6. What is wrong with the following statement?

"Science has proven that energy must always be conserved."

7. Briefly explain the scientific method.

8. Why does the story of spontaneous generation illustrate the limitations of science?

9. Where does the wise person place his or her faith: science or the Bible?

10. Why is the theory of abiogenesis just another example of the idea of spontaneous generation?

11. Name the classification groups in our hierarchical classification scheme in order.

12. An organism is a multicellular consumer made of eukaryotic cells. To what kingdom does it belong?

13. If we were using the three-domain system of classification, in which domain would the organism in question #12 belong?

14. An organism is a single-celled consumer made of prokaryotic cells. To what kingdom does it belong?

15. If we were using the three-domain system of classification, could you determine the domain of the organism in question #14? If so, give the domain. If not, give the possible domains in which it could be placed.

16. Use the biological key in the appendix to classify the organisms pictured below:

a. 

Owl
Photo © Comstock, Inc.

b. 

Fly
Photo © Jason Ng

Note: Since the study guide specifically tells you that you can use the biological key to classify the creatures shown above, you know that if such a question is asked on the test, you will be able to use the biological key on the test as well. This is how you can use the study guide to determine what you must memorize and what you will be able to reference during the test. Had we asked you to classify these creatures without telling you to use the biological key, you would have known that you would be required to memorize the biological key for the test.