SAMPLE COPY

BIOLOGY
The Science of Life in its
Living Environment
Laboratory Workbook

The actual laboratory workbook is fully aligned with NYS Science Learning Standards within the Next Generation Science Standards Framework. The actual book contains 30 hands-on labs written by teachers for a budget conscious science department. Book size (8.5 x 11) Over 240 pages.
(ISBN 978-1-939246-17-2)

Labs include:

- Overview
- Science, Technology, and Engineering Practices: Phenomenon & Investigation
- Vocabulary
- Material Needed
- Crosscutting Concepts (CCC): Claim, Evidence & Reasoning

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ABOUT THIS LABORATORY HANDBOOK

Welcome to the wonderful world of the biological sciences. This book is about you and the world around you. Life is a unique, ephemeral, indescribable, and amazing process that we live day to day. You are taking the first step as a biological scientist.

This book is to serve as a guide through your discovery of life sciences in Biology. It is a book unlike any other lab manual you may have encountered in the past. This is a more open-ended book where you write your own interpretations of your findings. You will be more at liberty to predict, design, interpret, and conclude your findings than ever before. You will defend your findings with evidence-based reasoning. Your teacher is there to facilitate your journey of learning. Remember, learning is your responsibility. You must find the information, interpret the data, and report your findings. No one can do that for you.

Let's look at the layout of the investigations. Some investigations are designed for you, the student, to strictly learn from them. Some investigations are designed to create models to learn from. Others may tend to look more traditional. However, most of the investigations will focus on discovery learning.

The phenomenon, presented in the opening statement of each lab, will be analyzed, marked up, and summarized. From that written phenomenon, you can figure out how to understand the phenomenon by testing. The variables are teased out of the passage. The investigative statement is a place to present a model of your prediction. You will draw a model, using the variables, vocabulary words, and using the materials listed for your investigation. The prediction will be sketched out.

Does your outcome always have to be aligned to your prediction? In a word, no. Some of the best discoveries in science do not come from, "Eureka," but rather, "I didn't expect that." This is where Claim, Evidence, and Reasoning are so important. So, your experiment did not go as planned, but learning did take place. Alexander Fleming certainly did not set out to discover penicillin, yet here we are, due to an accident in his lab, one of the most potent antibiotics was discovered.

The author:

Rosemarie Sanders

Author of Earth Science Investigations

Science Teacher: Living Environment (Biology), Earth Science, Environmental Science, and Forensic Science

BIOLOGY
The Science of Life in Its Living Environment

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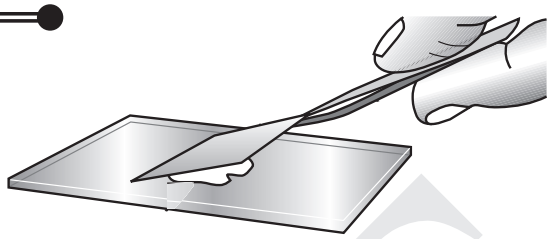
BIOLOGY
The Science of Life in Its Living Environment

Table of Contents

1 Laboratory Safety



By opening this lab manual, you are embarking on an exciting journey into the exploration of the story of life. Through the course of this school year, you will be investigating many aspects of living things and the environment in which they live.

In order to have a successful school year, we must familiarize ourselves with the laboratory environment and the processes in which students operate in this setting.

Materials and Descriptions:

1. **Beaker:** A wide mouthed piece of glassware* that has markers on the side. Used to measure volume.
2. **Erlenmeyer Flask:** A tapered flask, has a wide bottom but is a narrow-mouthed piece of glassware* that has markers on the side. Usage: Measure volume. Hazards: Glass breaking. Glass does not change appearance when heated.
3. **Graduated Cylinder:** A long, narrow piece of glassware* that has small markers on the side. Used to measure volume.
4. **Heat Lamp:** An electrical appliance used to heat materials. May have electrical issues if wires are frayed. BURN HAZARD.
5. **Metric Ruler:** A device which may be made of plastic, metal, or wood. Used to measure length.
6. **Slides:** Thin, small, flat piece of glass. Used to hold objects under a microscope. Handle with care to prevent breakage.
7. **Test Tube:** Long narrow piece glassware* that has no marks on the side. Usage: experiment, or test liquids. Hazards: Glass breaking. Glass does not change appearance when heated.
8. **Balance:** An instrument used to measure mass very precisely. Such devices typically have a reading error of ±0.05 grams. Its name refers to its three beams, where the middle beam is the largest, the far beam is medium size, and the front beam is the smallest. *Note:* Always transport with two hands when moving. Slide the weights away from the pan to prevent sudden movement and breakage.
9. **Thermometer:** Thermometers are made of glass and can break. Used to measure temperature.

* Glassware in the laboratory can break and cause injury. Be careful when handling. Glassware does not change appearance when heated. Always heat test tubes away from yourself and others. Wear safety goggles when heating liquids.

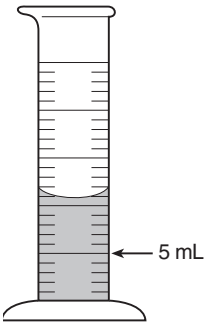
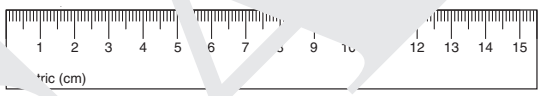
When working with liquids, wear an apron or other material to protect your clothing. Tie loose hair back. Remove dangling jewelry. Wear eye protection. In the unlikely event of chemical burns, use the eye wash or emergency shower. In the unlikely event of clothing catching on fire, do the following: stop, drop, and roll. Do NOT run as it will make the fire spread more rapidly.

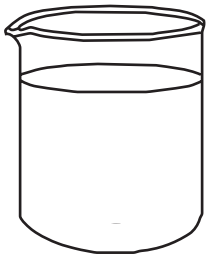
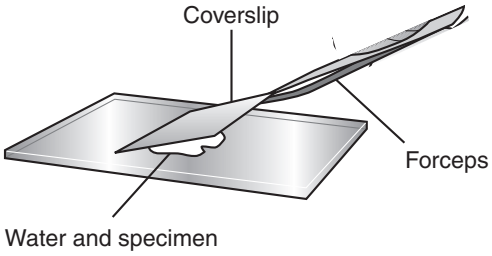
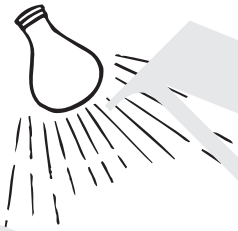
Material: In addition to charts/tables found in this lab, it will be helpful to have the following to complete this lab (but not necessary):

- Balance
- Beaker
- Graduated Cylinder
- Slide with coverslip
- Test Tube
- Thermometer
- Calculator
- Metric Ruler

Directions: In the activity below, list the name of the item. Write what it is used for, and give possible hazards that could occur if not handled properly.

ITEMS COMMONLY FOUND IN A LABORATORY

	Item	Name, Uses, and Possible Hazards
1.		
2.		
3.		

	Item	Name, Uses, and Possible Hazards
4.		
5.		
6.		
7.		

Directions: Find the following objects in your classroom. Describe the objects and have your teacher initial that they have been located.

1. Emergency Eye Wash Station: _____

   _____

2. Gas Cut Off Valve: _____

   _____

3. Fire Blanket: _____

   _____

4. Fire Alarm (visual/auditory): _____

   _____

5. Rescue Window: _____

   _____

6. Phone – Paging System: _____

   _____

7. Emergency Evacuation Procedures: _____

   _____

8. Exit Signs: _____

   _____

9. Grounded Outlets with Reset: _____

   _____

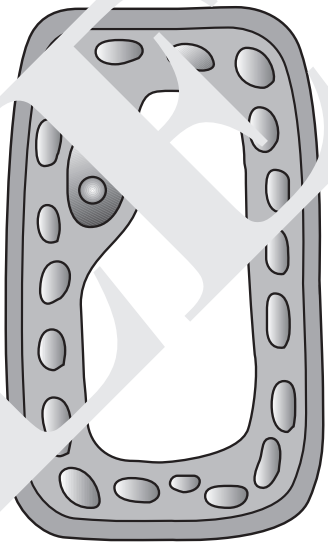
10. First Aid Procedures: _____

    _____

Directions: Draw the layout of your lab room. All 10 Items from page 4 should be drawn and labeled in your drawing.

My Lab Room Layout

5-7 Cell Theory



The following chapters 5-7, are investigations into Cell Theory. In the following investigations, cells are viewed, their functions as a single unit of life are evaluated, and finally the life functions of a cell are compared to an organism. In order to fully appreciate Cell Theory, it is highly recommended that the three labs are completed in the order in which they are listed.

Cell Theory states:

- All organisms are composed of one or more cells and important life functions of an organism occur within cells.
- All cells come from other cells that existed in the past.
- All cells contain information necessary for instructions for regulating cell functions and for passing this information to the next generation of cells.

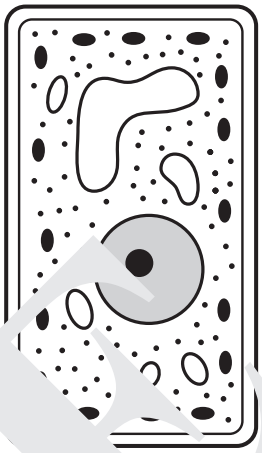
Viewing Plant and Animal Cells uses a microscope to better understand the form of the plant and animal cell. These cells are compared and contrasted for a greater understanding.

Cell City creates a model of a city or farm to illustrate the dynamic activity that occurs in cells. Each organelle, when compared to municipal or farming functions, demonstrates not only an interdependency of the organelles but the ability of the cell to perform these life functions.

Body Systems directly compares organelles to organ systems in the human body. Upon completion of this task, students will not only gain an appreciation for cellular functions but the intricacies of the organ system and the level of organization in the human body.

Each lab depends on the previous to develop. For this reason, it is strongly recommended that the following labs 5, 6, and 7 be completed in that order.

5 Viewing Plant & Animal Cells



The cell is the basic unit of life. It is the smallest unit of life, that is classified as a living thing, and is often called the building block of life. Some organisms, such as most bacteria, consist of a single cell. Other organisms, such as humans, are multicellular. You have about 100 trillion or 10^{14} cells; a typical cell size is 10 μm, a micrometer, which is one-millionth of a meter. One millionth of a meter is also expressed as 0.000001 m. The largest known cells are unfertilized ostrich egg cells which weigh 3.3 pounds.

There are two types of eukaryotic cells, which are animal cells and plant cells. Cells are often called the smallest unit of life. Cells contain small structures called organelles. These structures help the cell to carry out all life functions. One group is animal cells, which we as humans are made of. Only animal cells have centrioles to help with cell division. Only plant cells have a tough, rigid cell wall to give added stability and protection for the cell. They have chloroplasts that convert sunlight into energy and a single, large, proinent, liquid-filled vacuole, which stores nutrients.

Science, Technology, and Engineering Practices:

Phenomenon: _____

_____

Planning and Carrying Out Investigations

- plan investigation

- gather data

- produce evidence

- include measurements

- consider limitations on the precision

Sketch Your Model

Material: In addition to charts/tables found in this lab, you will also need the following to complete this lab:

- Microscope
- Microscope slide
- Paper towel
- Eyedropper
- Paper
- Prepared slides of animal cells
- Water
- Red onion

Animal Cell Procedure: Follow steps 1-5 for preparing an animal cell slide.

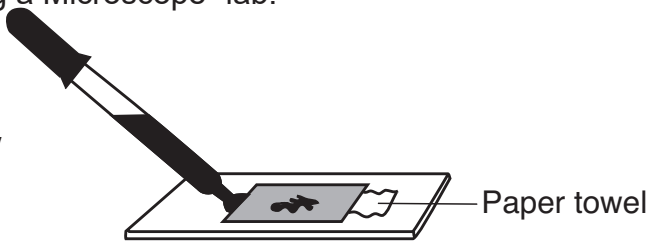
Prepare an animal cell slide

1. Carefully hold the slide on each side.
2. Place the slide on the microscope stage.
3. Make sure you have enough light to see. You might want to adjust the diaphragm.
4. First adjust the coarse focus to see the cells, then use the fine focus for detail.
5. On the following page, draw your findings using low, medium, and high magnifications in their appropriate box.

Plant Cell Procedure: Follow steps 6-10 for preparing a plant cell slide.

Prepare a plant cell slide

6. Gently remove the outer most layer of a red onion.
7. Place the cells on a flat slide.
8. Make a wet mount as you did in the "Using a Microscope" lab.
9. Now you need to add stain to the slide. To add stain, put a drop of the stain next to the coverslip on the slide and then draw it under the coverslip by placing a piece of paper towel against the other side of the coverslip. The paper towel will soak up the water, drawing the stain under the coverslip around the cell. Drawing the stain under the cell is called "wicking."



10. On the following page, draw your findings using low, medium, and high magnifications in their appropriate box.

What is the animal cell that you are viewing? _____

Name of tissue are you viewing? _____

Animal Cells	
Low Magnification	
Medium Magnification	
High Magnification	

Directions: In the boxes below, draw your findings in the appropriate space.

Plant Cells	
Low Magnification	
Medium Magnification	
High Magnification	

Clarifying Questions:

1. Explain cell theory in detail.

_____

_____

_____

_____

2. Which cell was easier to see? Explain.

_____

_____

3. What are the small parts in a cell called?

_____

4. Name *two* of these "parts" and describe their functions.

(1)_____

(2)_____

5. Describe what you saw in the animal cell.

_____

_____

6. Describe what you saw in the plant cell.

_____

_____

7. How are plant and animal cells similar?

_____

_____

8. How are plant and animal cells different?

_____

_____

9. Describe something that surprised you that you did not expect to see when you looked at the cells. Explain why this surprised you.

_____

_____

_____

_____

10. Assuming a classmate was absent today, on a separate sheet of paper, write an essay explaining what you learned in this lab about plant and animal cells.

Crosscutting Concepts (CCC):

Claim: _____

_____

Structure and Function

How is the object:
- shaped?
- structured?

What is the objects:
- properties?
- functions?

How do structures play a role in the function of the system?

sketch a model – what are the shapes – how does it work – variables - use labels

Conclusion:_____

_____

_____

8 Measuring Photosynthesis

Photosynthesis is the process in which plants make their own food using chemicals in the air and sunlight.

Plants use atmospheric carbon dioxide, CO_2, and water, H_2O, to make glucose, $C_6H_{12}O_6$. The process is simple yet amazing. It involves structures found only in plants: chloroplasts, grana, thylakoids and the electron transport chain. Inside the chloroplast are structures called grana. Each grana are made up of smaller structures called thylakoids. It is on the surface of the thylakoid that the light reaction of photosynthesis takes place. The dark reaction occurs in the stroma, which is the fluid inside the chloroplast.

Photosynthesis is the basis of nourishment as well as atmospheric oxygen for all living things. This process is a balance of atmospheric oxygen and carbon dioxide. Photosynthesis is an ancient process that ranges from two to three billion years ago. This investigation will study the measurable process of photosynthesis.

Vocabulary:
Chloroplasts: _____

_____

Grana: _____

_____

Thylakoids: _____

_____

Pre-lab: Balance the following equation. Recall that the numbers of atoms need to agree on both sides.

Photosynthesis: _____ **CO_2 +** _____ **H_2O → light → $C_6H_{12}O_6$ +** _____ **O_2**

Now that you have just figured out photosynthesis, let's reverse and figure out cellular respiration

Cellular Respiration: **$C_6H_{12}O_6$ +** _____ **O_2** _____ **CO_2 +** _____ **H_2O**

Material: In addition to charts found in this lab, you will also need the following to complete this lab:

- 500 ml Beaker
- Test tube
- Metric ruler
- 50 ml graduated cylinder
- China marker
- Elodea sprig
- Funnel
- Light source

Science, Technology, and Engineering Practices:

Phenomenon: _____

_____

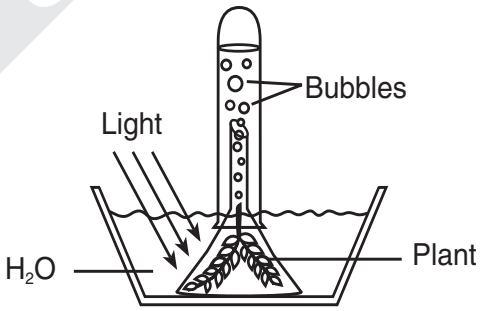
Using Mathematics and Computational Thinking

- *sketch representatives*
- *mathematical modeling*
- *computational thinking*
- *analyze*
- *design solutions*

Sketch Your Model

Procedure:

1. Fill the beaker with 400 ml of water.
2. Place a sprig of elodea at the bottom of the beaker.
3. Place the funnel inversely at the bottom of the beaker, as shown in the accompanying picture.
4. Fill the test tube with water. Place your thumb over the test tube and quickly place the test tube, upside down, at the end of the funnel.



5. Use a china marker to measure the water line in the test tube as soon as the test tube is placed on the end of the funnel.
6. Place in an area of bright light for several days.

Procedure: This portion is to be done after several days.

1. Using your metric ruler, find the water level on the test tube. Mark it with a china marker.
2. Remove test tube.
3. Measure the distance between the original mark and the new mark. _____cm
4. Fill the test tube up to the original water mark with water.
5. Transfer the water from the test tube to the graduated cylinder. Record your findings. _____ml
6. Empty when done.
7. Fill the test tube up to the new water mark with water.
8. Transfer the water from the test tube to the graduated cylinder. Record your findings.____ ml
9. Empty when done.

Clarifying Questions:

1. Where does the atmospheric carbon dioxide (CO_2) come from?

_____

_____

2. What was the volume of the new watermark in both cubic centimeters and milliliters?

_____

3. How much oxygen was produced in both cubic centimeters and milliliters?

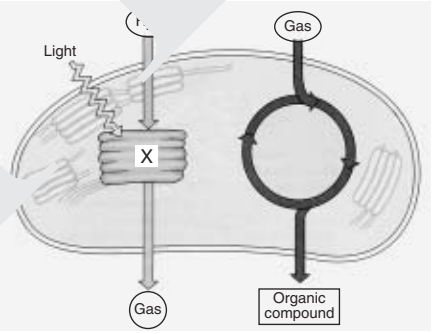
_____

4. Describe the ratio of oxygen to glucose molecules produced though photosynthesis.

_____

_____

Directions: Use the diagram of the plant cell to answer questions 5 – 9



5. What does structure **X** represent?

_____

_____

6. Describe the organic compound produced as a result of photosynthesis.

_____

_____

7. Identify the gases in the diagram and explain the functions of the gases.

_____

_____

8. Other groups may have had different results than you have. Brainstorm on some of the variables that may have led to this difference.

_____

_____

9. The Earth's atmosphere maintains a ratio of oxygen at about 20% and carbon dioxide at about 1%. Infer what cycles are in place to maintain that balance.

_____

_____

10. Many people are concerned about the loss of the Amazon rainforest or other forests around the world. Knowing what you've learned about photosynthesis and the relationship of plants to animals, how will this affect our air?

Describe the following:
- How does the oxygen cycle get affected?
- How does the carbon cycle get affected?
- How would this affect life globally?
- What steps could your community do to ensure healthy air?

_____

_____

_____

_____

_____

Crosscutting Concepts (CCC):

Claim: _____

_____

Energy and Matter

Track energy and matter
- flows into
- flows out of
- within systems

Note changes in the
- system

How does it flow in systems?

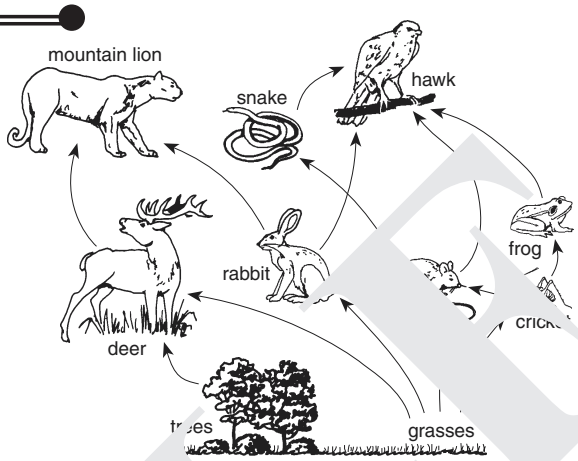
sketch a model – what are the shapes – how does it work – variables - use labels

Conclusion: _____

_____

_____

22 Food Web



Organisms interact with one another. Some organisms produce food. Some organisms consume other organisms as food. Each step is referred to as a trophic level. Organisms that have a photosynthetic ability are called autotrophs. Autotroph is a word derived from Greek meaning self-nourishing. These organisms include plants, algae, and cyanobacteria. Organisms that consume autotrophs are called heterotrophs. This too, comes from Greek, meaning “different nourishing”.

Start with producers, which are plants and other photosynthetic organisms. These organisms produce glucose from energy they obtain from the sun. They are called producers because they produce their own food. Organisms that eat producers are called consumers. You may have learned about this as the food chain. It is more complicated than that. Producers receive energy from the sun. Consumers eat the producers. Consumers that eat producers only are called primary consumers. Consumers that eat primary consumers are called secondary consumers. Secondary consumers are eaten by tertiary consumers. At each trophic level, only about 10% of the organism’s energy is passed to the next level. Decomposers consume remains of organisms. Decomposers include bacteria and fungi.

An important aspect of the food web is to understand that although, there is a flow of energy, and a loss at each trophic level, there is also a mechanism for the recycling of matter in the system. The carbon cycle is evident in that atmospheric carbon is used by plants to create glucose. As the carbon moves though the food web, it is returned to the atmosphere though exhalation as a result of cellular respiration. The carbon that becomes part of the body of the producer or consumer, it is then recycled after the decomposers consume the dead organism. Nitrogen cycle is complex. Most of our atmosphere is nitrogen. The nitrogen is diatomic, meaning that is a molecule of simply two nitrogens, therefore not reactive, or more importantly, plants cannot take nitrogen out of the air. Nitrogen, consumed by consumers, is returned cycle though ammonia as a waste product. Bacteria in the soil develop this compound into usable nitrogen for plants. These bacteria are called nitrogen-fixing bacteria.

Material: In addition to the charts found in this lab, you will also need the following to complete this lab:

- Colored pencils (green, yellow, orange, red, and brown)

Science, Technology, and Engineering Practices:

Phenomenon: _____

_____

Developing and Using Models

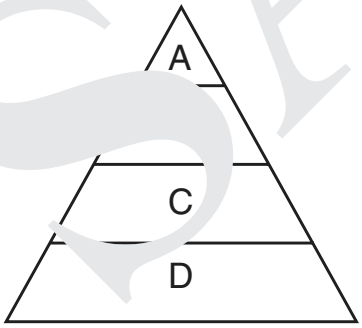
- *identify variables*
- *develop models to predict outcomes*
- *illustrate relationships*

Sketch Your Model

Procedure 1:

1. Label the different levels of the pyramid with the following in the correct position.
   - Producers
   - Primary Consumers
   - Secondary Consumers
   - Tertiary Consumers

Trophic Pyramid



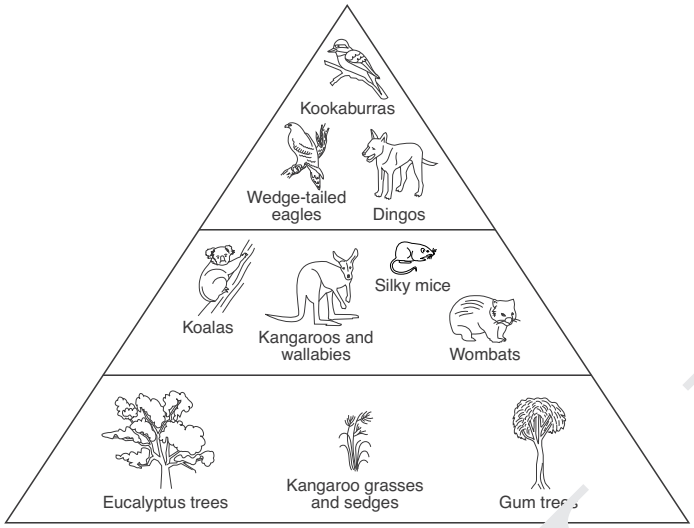
A _____

B _____

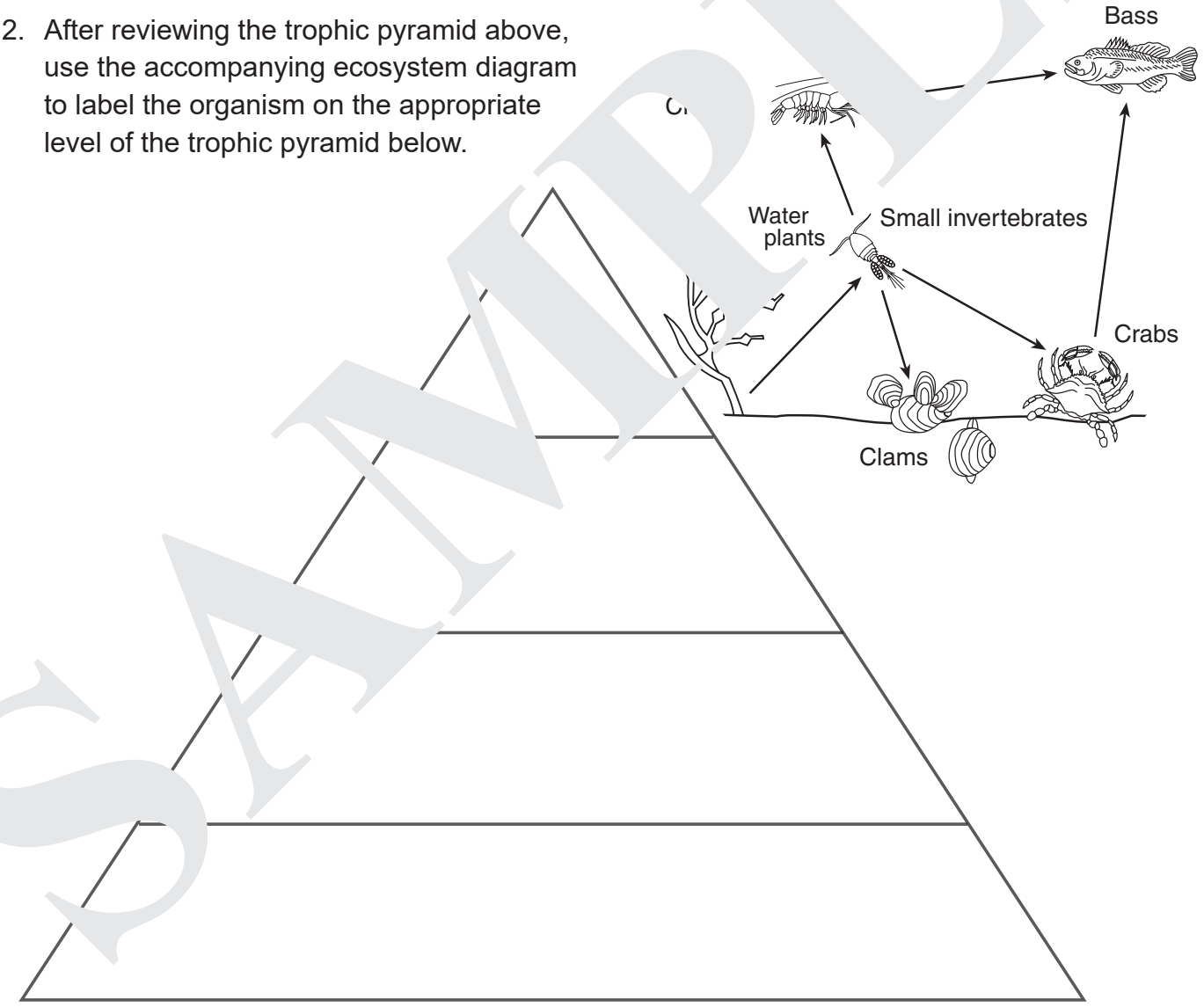
C _____

D _____

The illustration below is a trophic pyramid of species of organisms that form an ecosystem in Australia.



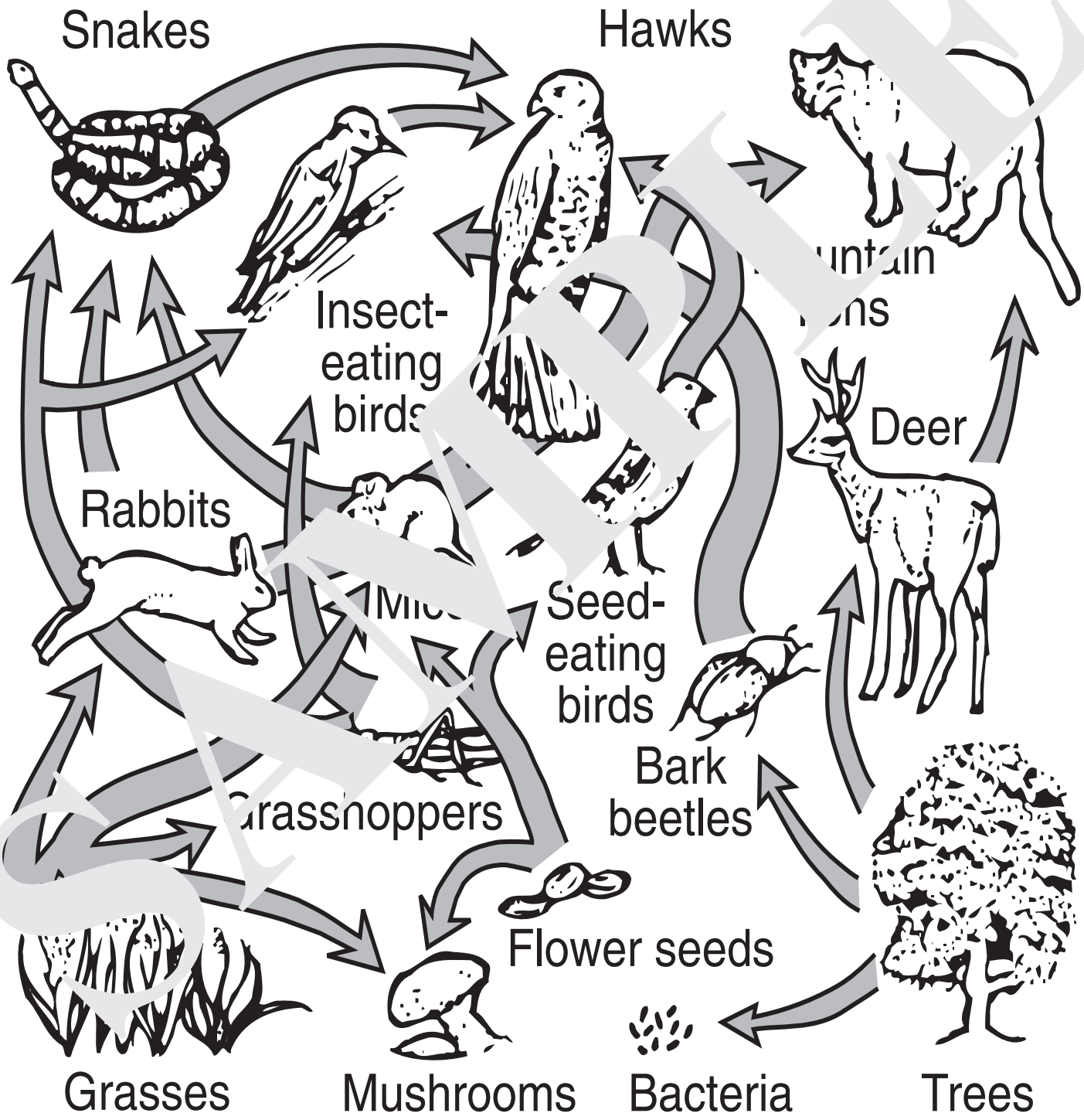
2. After reviewing the trophic pyramid above, use the accompanying ecosystem diagram to label the organism on the appropriate level of the trophic pyramid below.



Procedure 2:

Look at the following food web. Recall that the energy leaves the organism so we will color in the energy according to trophic level.

1. Producer – Green
2. Primary Consumer – Yellow
3. Secondary Consumer – Orange
4. Tertiary Consumer – Red
5. Decomposers – Brown



Clarifying Questions:

1. What is the role of producers in an ecosystem?

_____

_____

2. What is the role of decomposers in an ecosystem?

_____

_____

3. Grass is a producer. What does the term producer refer to?

_____

_____

4. Why are both rabbits and coyotes considered consumers?

_____

_____

5. What percentage of an organism's energy does the consumer that eats it consume?

_____

_____

6. Why must there be more producers than consumers in a sustainable ecosystem?

_____

_____

7. Why are trophic interactions usually depicted as a pyramid?

_____

_____

8. Which trophic level receives the least nutrient energy from the sun?

_____

_____

9. What organisms are at the top of trophic pyramid?

_____

_____

_____

10. If insecticides were to be sprayed in the trees, how would that affect the food web?

_____

_____

_____

_____

Crosscutting Concepts (CCC):

Claim: _____

_____

Energy and Matter

Track energy and matter
- flows into
- flows out of
- within systems

Note changes in the
- system

How does it flow in systems?

sketch a model – what are the shapes – how does it work – variables - use labels

Conclusion: _____

_____

_____