Biology LEVEL 2

SECOND EDITION

Blair H. Lee, MS

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Biology 2 Preview

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Included in this sample are seven chapters, one from each unit:

Unit I Organisms: Chapter 1 – All Living Things

Unit II Cells: Chapter 2 – Types

Unit III Genetics: Chapter 10 – Inheritance

Unit IV Anatomy and Physiology: Chapter 13 – Plant Reproduction

Unit V Evolution: Chapter 21 – How

Unit VI Ecology: Chapter 25 – Predator and Prey

Unit VII Classification: Chapter 31 – Kingdom Anamalia

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Illustrations by Denise Klitsie

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Biology LEVEL 2

Table of Contents

Table of Contents

Introduction

This Year You Are a Biologist

What do you think the most important word in science is? (Stop right now and try to think of it!) Do you think it is really long, complicated, and hard to pronounce? I will give you a hint: It is three letters long. (Stop again and think of a three-letter answer.) The most important word in science is *why*. A good scientist asks that question and then spends time researching and experimenting to find the answer. This year while studying biology, I hope you ask a lot of questions that begin with "why" and spend time trying to figure out the answers.

Humans are naturally interested in learning about biology because biology explains about us. You probably know a lot about the science of biology already, just from going outside and looking around—observing what's going on in nature, watching your little sister or brother grow up, or thinking about why you like to eat some foods and dislike others. All of these questions and observations are biology. The science of biology is the study of life, and any science issues that have to do with life are biology.

You will start your study of biology outside, which is where I think every biology class should start, looking at all the living things around you. After that, you come inside and learn about the cell, the building block of all living things. Next, you will learn about how the cells of different living beings make the molecules that make them different. Then you will look at plants and humans and the different organs and organ systems that make up both plants and humans. After that you will study evolution. Evolution explains how all the different types of living organisms came to be. Then it is outside again to learn about ecology. This area of biology focuses on what is going on in nature, how living things relate, and how people impact nature. Last, you will focus on classification. The different systems of classification are tools scientists use to help them understand the characteristics that make one type of organism or one group of organisms different from another.

Biologists use math . . .

When people say they are not good at science, they almost always mean they are not good at the math used in science, called applied math. If you love math, this is the part where you might think, "Fantastic, that means I am going to love science too."

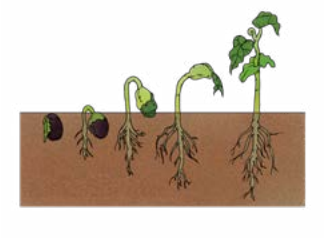
What about those of you who do not like math, or at least think you are not very good at it? In order to start applying math, you have to memorize a lot of facts, and that is just the fact of it. Why are you memorizing all those math facts anyway; where is the meaningful application of them? It takes a long time before it seems like all those math facts are applied in a meaningful way. You have been learning math for this reason: so that you can apply your math skills to use in much more interesting ways. Over the next several years, in middle school and high school science, you will become much better at applying math. You might even discover, once you start really using those math facts you have been learning in real-world applications, you actually like math and are good at it.

All sciences use the metric system, and this biology course is no exception. The metric system is used in science and by most of the rest of the world because it is a base 10 system. It is easier to multiply and divide by 10 and 100 than by 8, 12, and 16. You can use web-based tools that convert back and forth between the U.S. system and the metric system. Or, you can just stick with it, and before you know it you will be an expert at the metric system too. The best way to become good at something is by doing it, and the more you do it the better you become.

Biologists use microscopes . . .

Why? Because a microscope allows you to see things you can't see with just your eyes, microscopic things, and much of biology is microscopic. This biology course could be completed without a microscope, but my hope is you are going to be able to use one. If you are lucky enough to have a microscope, thank your parent or teacher, and take very special care of it. Your microscope is an expensive and delicate precision instrument. If it is properly cared for, it will last many years. You should decide early on if you are going to keep it in the case it comes with, or find a safe area of a room where it will sit, covered, when not in use.

Biologists are interested in learning about life . . .

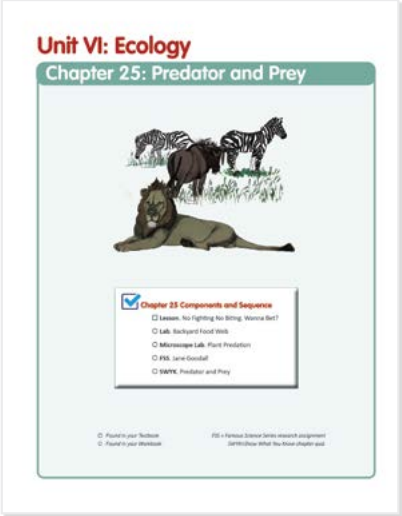


Whether it is observing a bee in flight, learning how flowers grow, or viewing cells for the first time, biologists find the study of life fascinating. This course is not about learning science sitting in a chair. You will spend some time sitting down studying theory, but then you will apply the science you just read about using your hands, eyes, and brain. You will be examining things with a microscope that have been right in front of you your whole life but never saw before.

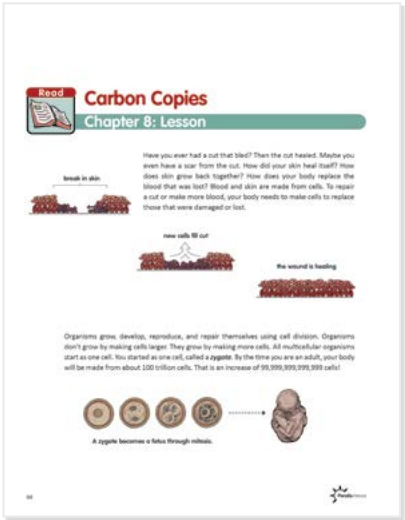
I hope this year you take the time when you are out walking, playing with your family and friends, or even just sitting on the porch to think about what is happening around you in nature or even inside of you.

Course Structure and Use

Your biology course is comprised of 32 chapters contained in seven units: Organisms, Cells, Genetics, Anatomy and Physiology, Evolution, Ecology, and Classification. The course consists of two student books: this textbook and a consumable Workbook. Your textbook presents science material in narrative-style Lessons that include many colorful illustrations, figures, and charts. After carefully reading a Lesson, you will apply what you've learned in activities and assignments found in your student Workbook. The Workbook contains labs, research assignments, assessments, and other activities for each chapter. When completed, your Workbook serves as a record of the biology course.

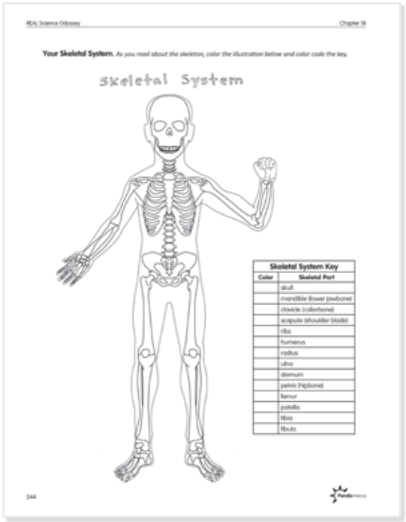


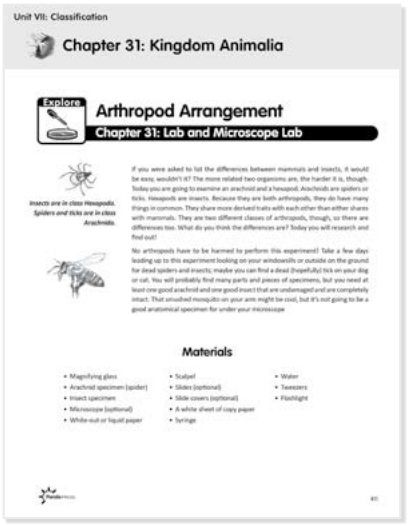
Begin each chapter in your textbook with the **Components and Sequence** schedule. Assignments from the textbook and Workbook are listed in the order they should be completed.



Each chapter in the textbook opens with a **Lesson** that provides foundational science material, ideas, concepts, and vocabulary.

Some Lessons include **color and labeling activities** found in the Workbook.




Unit VII: Classification

Chapter 31: Kingdom Animalia

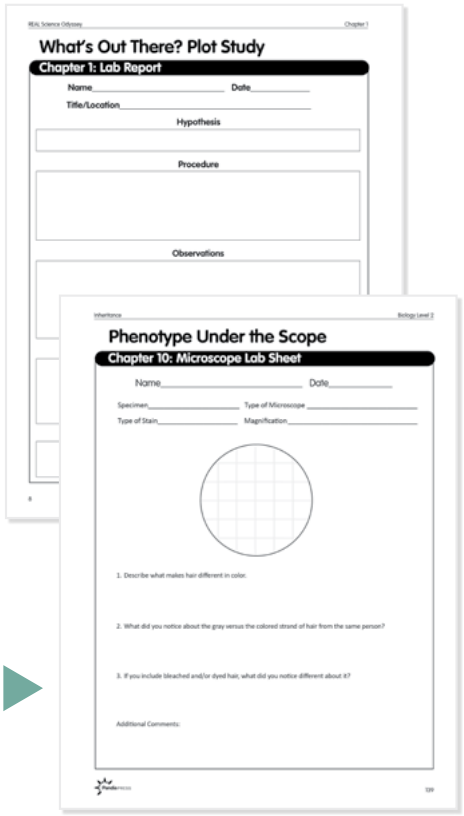
Explore

Arthropod Arrangement

Chapter 31: Lab and Microscope Lab

Materials

Lessons are followed by hands-on **lab activities** found in the Workbook. The labs reinforce and expand the concepts presented in the Lesson. Lab results are recorded directly on the included lab sheets.


What's Out There? Plot Study

Chapter 1: Lab Report

Name_____ Date_____

Title/Location_____

Hypothesis

Procedure

Observations

Phenotype Under the Scope

Chapter 10: Microscope Lab Sheet

Name_____ Date_____

Specimen_____ Type of Microscope_____

Type of Stain_____ Magnification_____

1. Describe what makes hair different in color.

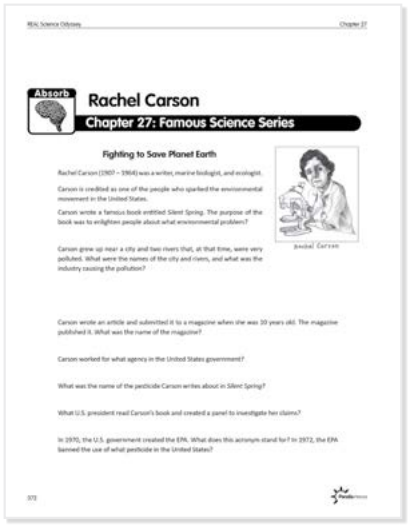
2. What did you notice about the gray versus the colored strand of hair from the same person?

3. If you include bleached and/or dyed hair, what did you notice different about it?

Additional Comments:

Formal **lab reports** are completed for some labs.

Most chapters include a microscope lab. Draw what you see under the microscope on **microscope view sheets**.


Absorb

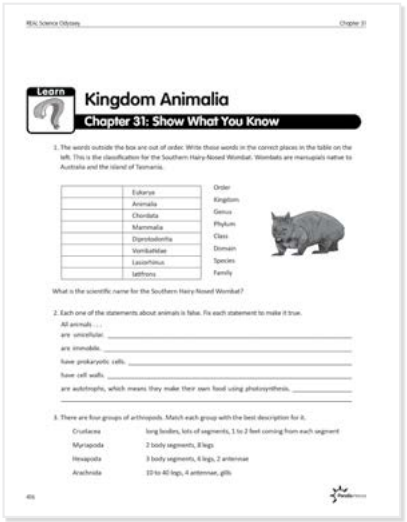
Rachel Carson

Chapter 27: Famous Science Series

Fighting to Save Planet Earth

Each chapter contains a **Famous Science Series** (FSS) research assignment. Explore the subject matter and learn about scientists, discoveries, pathogens, and even some famous pigs.

Each chapter ends with a **Show What You Know** (SWYK) quiz found in the Workbook.


Learn

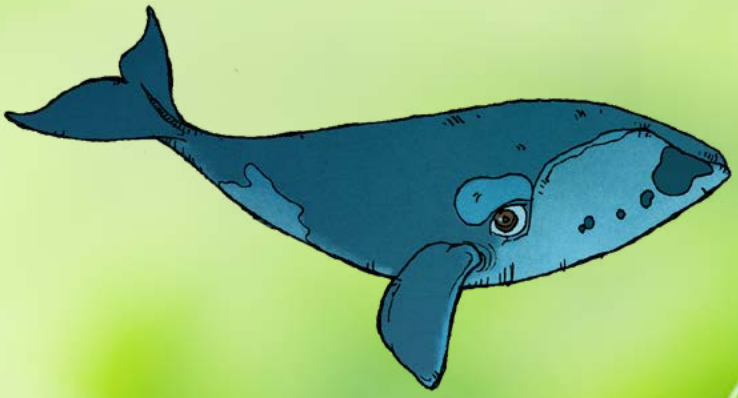
Kingdom Animalia

Chapter 31: Show What You Know

Unit 1

Biology LEVEL 2

Organisms



TBYB Sample

Unit I: Organisms

Chapter 1: All Living Things

Chapter 1 Components and Sequence

- ☐ **Poetry**. All Living Things
- ☐ **Lesson**. What Is Life?
- ○ **Lab**. What's Out There? Plot Study
- ○ **Microscope Lab 1**. Your Microscope: Parts
- ○ **Microscope Lab 2**. Your Microscope: Focus
- ○ **FSS**. Polio
- ○ **SWYK**. All Living Things

☐ *Found in your Textbook*
○ *Found in your Workbook*

FSS = Famous Science Series research assignment
SWYK=Show What You Know chapter quiz

All Living Things

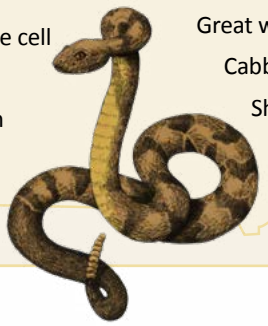
Chapter 1: Poetry

All Living Things . . .

All living things have at least one cell
Bacteria
All living things have at least one cell
All living things take in energy
Bacteria
Wisteria
All living things have at least one cell
All living things take in energy
All living things have respiration
Bacteria
Wisteria
Rattlesnake
All living things have at least one cell
All living things take in energy
All living things have respiration
All living things have circulation
Bacteria
Wisteria
Rattlesnake
Silver Hake
All living things have at least one cell
All living things take in energy
All living things have respiration
All living things have circulation
All living things get rid of waste
Bacteria
Wisteria
Rattlesnake
Silver hake
Great white shark

All living things have at least one cell
All living things take in energy
All living things have respiration
All living things have circulation
All living things get rid of waste
All living things grow
Bacteria
Wisteria
Rattlesnake
Silver hake
Great white shark
Cabbage bark
All living things have at least one cell
All living things take in energy
All living things have respiration
All living things have circulation
All living things get rid of waste
All living things grow
All living things move
Bacteria
Wisteria
Rattlesnake
Silver Hake
Great white shark
Cabbage bark
Shrew
All living things have at least one cell
All living things take in energy
All living things have respiration
All living things have circulation

All living things get rid of waste
All living things grow
All living things move
All living things reproduce
Bacteria
Wisteria
Rattlesnake
Silver Hake
Great white shark
Cabbage bark
Shrew
Gnu
All living things have at least one cell
All living things take in energy
All living things have respiration
All living things have circulation
All living things get rid of waste
All living things grow
All living things move
All living things reproduce
All living things respond to their environment
Bacteria
Wisteria
Rattlesnake
Silver Hake
Great white shark
Cabbage bark
Shrew
Gnu
You



What Is Life?

Chapter 1: Lesson

Living Being = Organism

Have you wondered why dogs don't speak? Have your parents ever measured you to see how much you've grown? Have you ever noticed the fall colors? Do you wonder if animals have preferences like people do? If you answered yes to any of these, then you have already been studying biology. People have been studying living beings, ***organisms***, ever since there have been people. The study of these living things is called ***biology***. The people who study life are called ***biologists***.

Think of five questions you have about the life around you. My five questions are:

1.) What kind of dinosaurs used to live where I live now?

2.) Do trees have a maximum height they can grow, like people do?

3.) Why is my little toe so much smaller than the rest of my toes?

4.) Why do different kinds of birds sing different kinds of songs, but the same kinds of birds all sing the same songs?

5.) Do individual insects have different personalities from each other like people, dogs, cats, raccoons, and horses do?

What are your five questions? Write them down and discuss them with your teacher or parent.

Some of these questions will be answered this year, and some may not be answered in our lifetime. My question about insect personalities, for instance, is one that may never be answered. How would someone figure out the answer to that?

Characteristics of Life

There are many different kinds of organisms in the world. If you were asked to compare them, it would be easier to list their differences than their similarities. There are nine characteristics that all organisms have in common.

There are nine characteristics of all living things.

1. **All organisms are made of one or more cells.** Some organisms, like bacteria, are made of one cell. Others, like you, are made from many cells. You started out as one cell. Your cells keep making more and more cells as you grow. When you are an adult, you will be made of about 100 trillion cells.

2. **All organisms take in energy.** You probably think of energy as electricity and light. So how do you take in energy? Food is energy for organisms. But where does food energy come from? It comes from sunlight. The sun shines on plants. Plants change sunlight to food energy they can use. The rest of the organisms on Earth get their energy from plants. Even animals, like cats, that are ***carnivores*** (meat eaters) get their energy from other animals that got their energy from plants that got their energy from the sun.

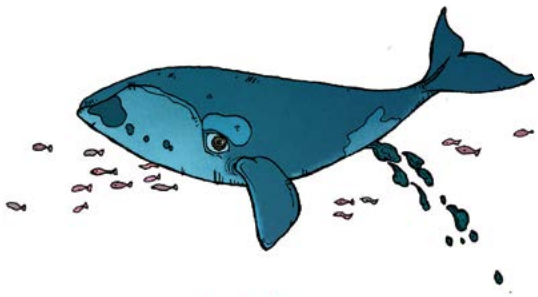
3. **All organisms have some type of respiration.** How do organisms get energy from eating food or absorbing sunlight? ***Respiration***, that's how. In people, blood takes food molecules and oxygen molecules to the cells. Inside your cells, the food molecules and oxygen react together to release energy.

Respiration


Circulation

4. **All organisms have some type of circulation.** Organisms use ***circulation*** to move food and waste throughout their cells and bodies. Your heart pumps your blood, and your blood circulates through your body. Your blood circulates food to your cells, so they can make energy. Your blood also removes waste products from your cells.

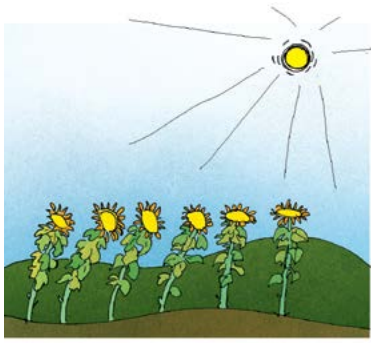
5. **All organisms get rid of waste.** The term ***waste*** refers to quite a few things for organisms. You get rid of waste by breathing out, sneezing, blowing your nose, coughing, burping, defecating, urinating, crying, blinking, and (when you are sick) vomiting.


waste


grow

6. **All organisms grow.** I wonder how tall you were when you were one year old. How much have you grown since then? Do you think that some bacteria grow faster than other bacteria the way some people grow faster than other people? What about insects?

7. **All organisms move.** You can see it when people move. What about plants, though? Have you ever noticed a plant growing next to a window? Most of the leaves of the plant will be facing toward the window. Plants need to get sunlight on their leaves to make energy. The leaves of the plant move toward the window to get more sunlight on them so they can make more energy. This type of movement in plants is called ***phototropism***.



8. **All organisms respond to their environment.** Two ways you respond to your environment are sweating and shivering. When you are hot your body sweats to help you cool down. When you are cold your body shivers to help you warm up. Many plants respond to hot and cold too. When the weather gets cold, they lose their leaves. The leaves grow back again when the weather gets warmer.

9. **All organisms reproduce.** Organisms reproduce by making copies of themselves.

Viruses! Living? Or not?

You usually know when something is living or not without really thinking about it. You do not need a list to tell you that a cow or a tree is an organism. Most of the time it is straightforward to determine if something is alive, but not always.

There is a question that has led to a debate among biologists: Are ***viruses*** organisms?

Let's look at what has led to this debate.

Viruses *do not*

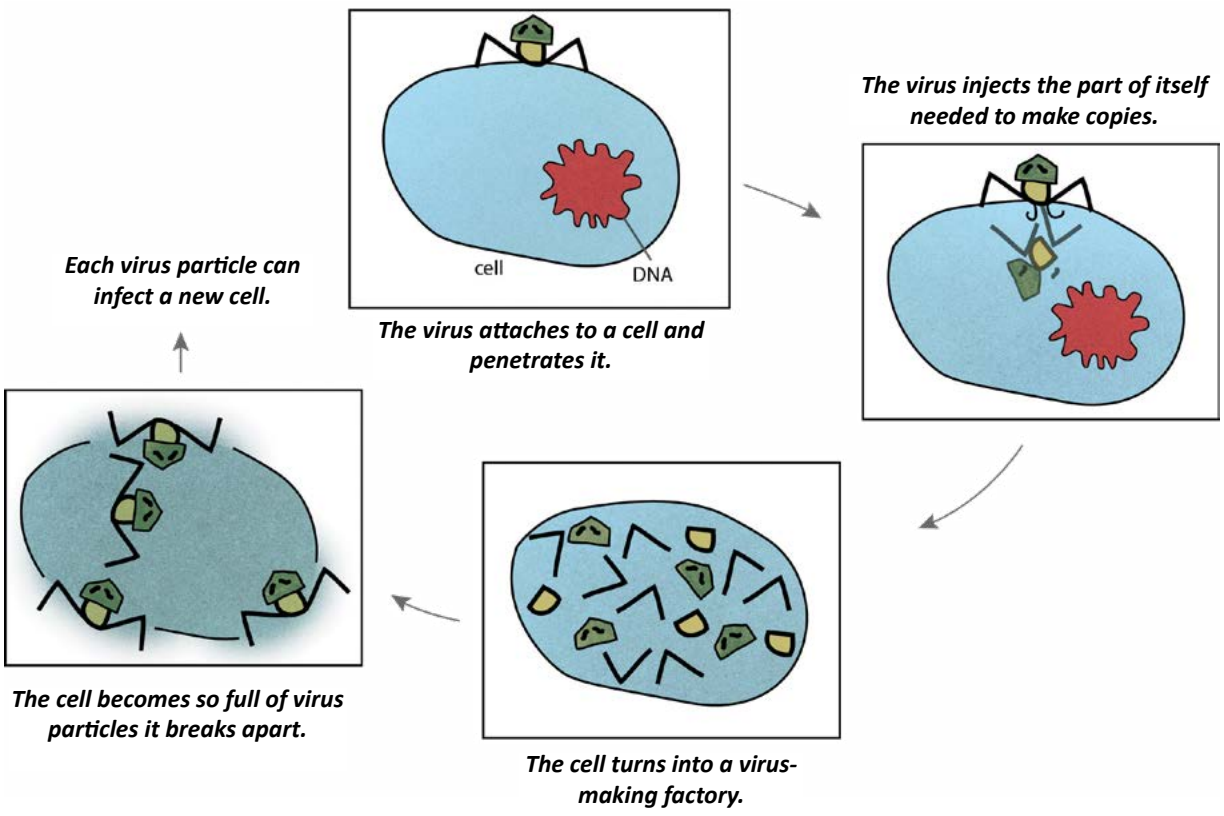
- ★ take in or use energy (virus-infected cells do, however)
- ★ get rid of waste
- ★ move
- ★ grow
- ★ have a type of circulation
- ★ have a type of respiration

and . . . viruses *are not*

- ★ made of cells

At this point you might be wondering what the debate is. It sounds like viruses are not living, doesn't it? What viruses do really well, though, is reproduce!

Virus Reproduction Cycle



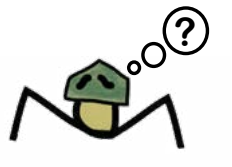
Viruses have a unique method of reproduction.

Viruses reproduce (make copies of themselves) differently than anything else. First, a virus attaches to the cell of an organism. Next, it penetrates the cell. After that, it injects the parts of itself needed to reproduce into the cell. This turns the cell into a virus-making factory. The cell becomes so full of newly made viruses that it breaks open and these new copies of the virus hunt for more cells to attack. If there are more cells around, the virus attacks the cells and makes more and more copies of itself.

If there are no cells around, viruses cannot reproduce. A dishful of virus particles with nothing else will sit there and never make copies of itself. Because a virus needs other, non-virus organisms to reproduce, some scientists think the ability to reproduce is not enough to reclassify viruses as organisms.

Scientists also disagree on whether viruses respond to their environment. Some scientists argue that, of course, viruses respond to their environment. They are able to respond to a cell in their environment and infect it. Other scientists say that viruses cannot move on their own so they cannot respond to their environment.

Viruses are considered right on the border of living and nonliving. Some scientists want to change the definition of an organism to include viruses. They think viruses should be classified as organisms. Other scientists say that viruses are not organisms.



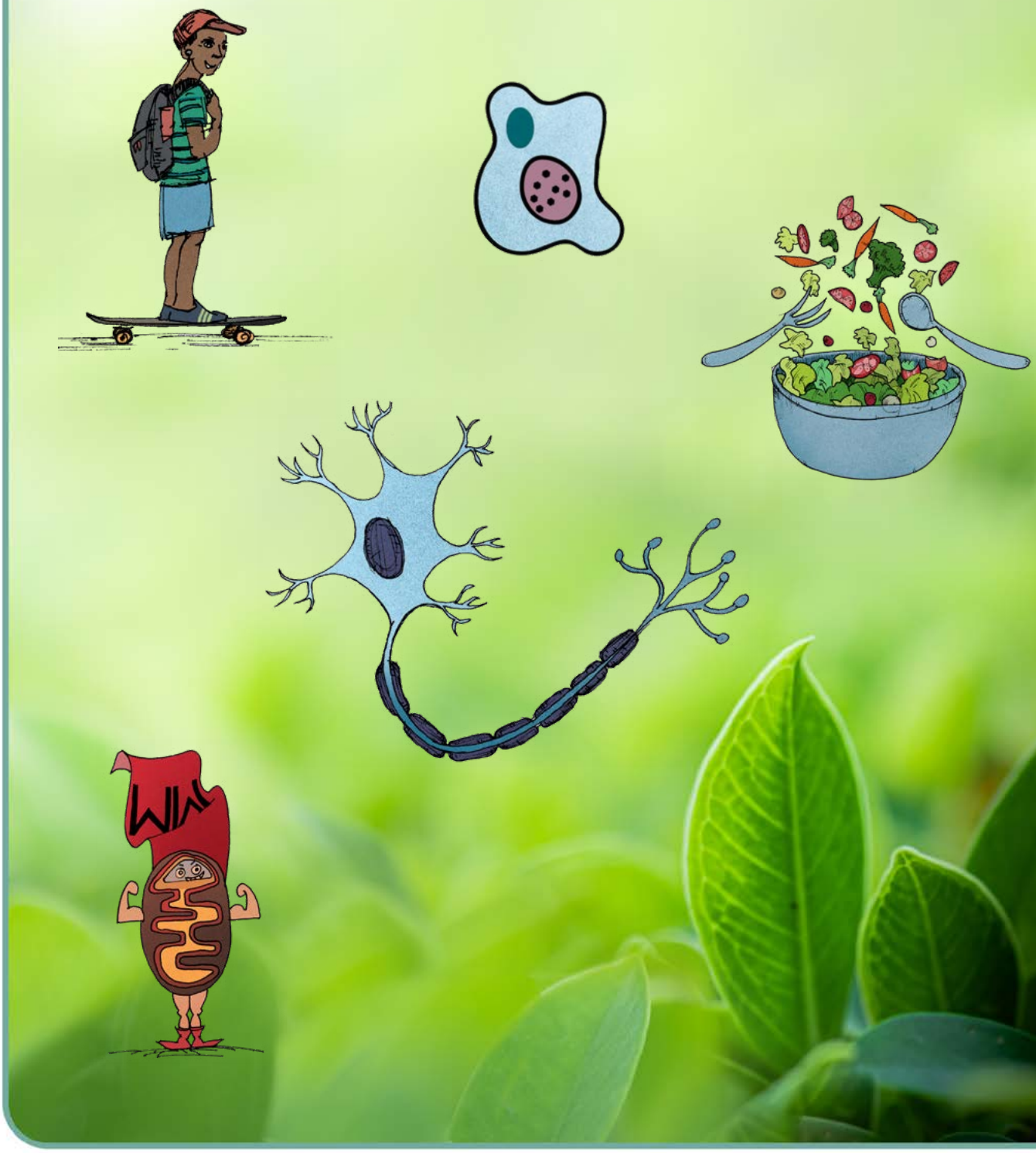
Weighing In on the Debate

Now that you know the facts, what do you think? Should the definition of organism be changed to include viruses, and why or why not?

Unit II

Biology LEVEL 2

Cells



TBYB Sample

Unit II: Cells

Chapter 2: Types

Chapter 2 Components and Sequence

- ☐ **Lesson**. You Are a Eukaryote
- ○ **Lab**. Death to the Prokaryotes!
- ○ **Microscope Lab**. Discovering Cells
- ○ **FSS**. Antony van Leeuwenhoek
- ○ **SWYK**. Types

☐ *Found in your Textbook*
○ *Found in your Workbook*

FSS = Famous Science Series research assignment
SWYK=Show What You Know chapter quiz

You Are a Eukaryote

Chapter 2: Lesson

All organisms are made from one or more cells. The ***cell*** is the basic unit of life. Most cells are so small that you need a microscope to see them. If you crack open a chicken egg, though, you have a cell big enough to see without a microscope. In fact, the ostrich egg is the largest cell on Earth.

Cell Theory

The cell theory states:

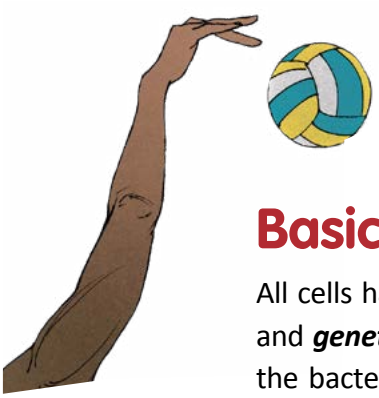
- ★ Every organism is made of one or more cells.
- ★ Cells come only from other living cells.
- ★ Cells are the basic unit of structure and function needed to support life.

★ **Every organism is made of one or more cells.** Bacteria are made of one cell. They are ***unicellular organisms*** (one-celled, living beings). Organisms such as toads, which are made of many cells, are ***multicellular organisms*** (many-celled, living beings).

★ **Cells come only from other living cells.** To make new cells, one living cell divides into two living cells. For multicellular organisms, like people, cell division can repair an injury such as a cut, replace cells that have died, or result in growth. Think about the size of your skin when you were a baby. Your skin had to grow a lot since then. Your skin cells have divided many times, making more skin cells so that your skin still fits.

★ **Cells are the basic unit of structure and function needed to support life.** Organisms are built from cells. All the functions needed for life are carried out in cells too. That means the one cell of a bacteria has to take in energy, get rid of waste, move, grow, reproduce, respond to its environment, have some type of circulation, and have some type of respiration.

Multicellular organisms have different types of cells. A person has muscle cells, nerve cells, liver cells, and bone cells, to name just a few. These different types of cells must work together to carry out the functions needed to support your life.



Muscle cells, bone cells, skin cells, and blood cells work together when you spike a ball.

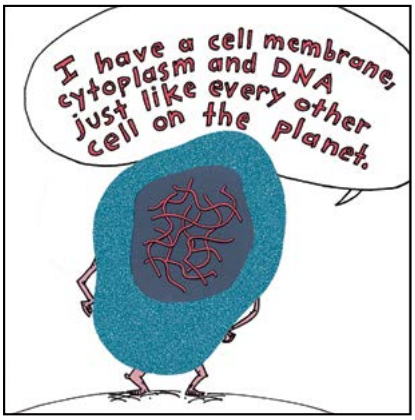
Basic Cell Structure

All cells have three things in common. They all have a ***cell membrane***, ***cytoplasm***, and ***genetic material***. Just think: Every cell that makes a tree, a mushroom, a dog, the bacteria that sours milk, and you, all share these three things. Cells can have various other things in them too, but they all have these three things.

Every cell of every organism has a cell membrane. The cell membrane encloses and protects the inside of the cell. Just like the walls of your house help control what goes into and out of your house, the cell membrane controls what goes into and out of the cell. It is through the cell membrane that cells take in energy and get rid of waste.

Every cell of every organism is filled with cytoplasm. Cytoplasm is a jelly-like material. The other things inside the cell float in the cytoplasm.

Every cell of every organism has genetic material in it. Genetic material, DNA, contains hereditary information, passed from one generation to the next. Deoxyribonucleic acid, DNA, is the material in cells that gives the cell the information it needs to do its job. For example, how does a cell in your eye "know" that it is supposed to be used to see and not to help you breathe, like a cell in your lung? The DNA in your eye cells is the same DNA that is in your lung cells. But the DNA in your eye cells tell your eye to see, and the DNA in your lung cells tell your lung to help you breathe, that's how. DNA also instructs cells when it is time to divide to make more copies of the cell.



All of your cells except one type have DNA for the entire life of that cell. Mature ***red blood cells***, like those that make your blood red, do not have DNA in them. Red blood cells do have genetic material when they are first made, but as they grow, the DNA is squeezed out to make room for hemoglobin. Hemoglobin is the molecule that carries oxygen through your body. The DNA in young red blood cells must "tell" the cell to squeeze it out to make room for hemoglobin.

Not All Cells Are the Same

Biologists like to divide and group organisms. They do this by looking at their similarities and differences. The first tool biologists use to divide organisms is on the cellular level. This makes sense, since every living organism is made of cells.

First, let's review the things all cells have in common:

1. All cells have a cell membrane.
2. All cells have cytoplasm.
3. All cells have DNA.
4. The cytoplasm and the DNA are inside the cell membrane.

Biologists divide and group organisms based on where the DNA is in the cytoplasm. DNA can be free-floating in the cytoplasm or it can be inside a structure called a ***nucleus***. The location of DNA in a cell defines a cell as either ***prokaryotic*** or ***eukaryotic***. Most unicellular organisms have prokaryotic cells. Multicellular organisms, like you, have eukaryotic cells.

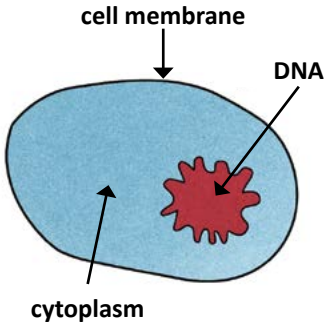
There are two main classes of cell type:

Prokaryotic = DNA free-floating in the cytoplasm
Eukaryotic = DNA inside a protective structure called a nucleus in the cytoplasm

Prokaryotic Cells

In prokaryotic cells, the DNA is in the cytoplasm. Organisms with prokaryotic cells are called ***prokaryotes***. ***Bacteria*** and ***Archaea*** are prokaryotes. Prokaryotic cells are simpler than eukaryotic cells. All organisms with prokaryotic cells are unicellular.

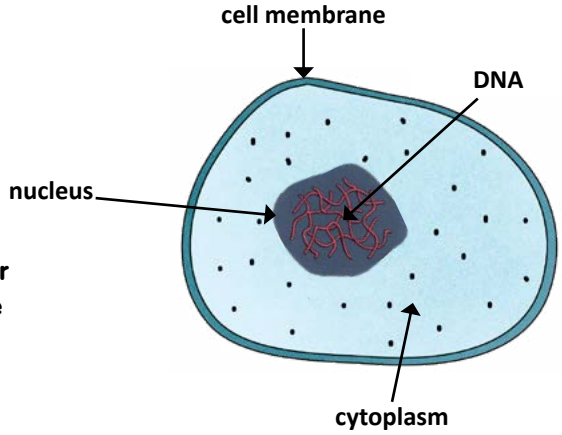
All prokaryotes are unicellular, and DNA is in the cytoplasm.



Prokaryotic organisms, like those that live at this deep-sea hydrothermal vent, do not have a membrane around their DNA.

You Are an Eukaryote

In eukaryotic cells, the DNA is enclosed inside a membrane. The membrane is called a ***nucleus***. Organisms with eukaryotic cells are eukaryotes. There are unicellular and multicellular eukaryotes. ***Amoebas*** are an example of a unicellular eukaryote. Amoebas are made of only one cell, but their DNA is in a nucleus.



Eukaryotes can be unicellular or multicellular, and DNA is in the nucleus.

All multicellular organisms are made only from eukaryotic cells.

Here is a good way to remember it: You are multicellular and you are made from "*you*-karyotic" cells. This is good, because you probably want your DNA protected by a nucleus. I know I do!

Eukaryotes can be unicellular,

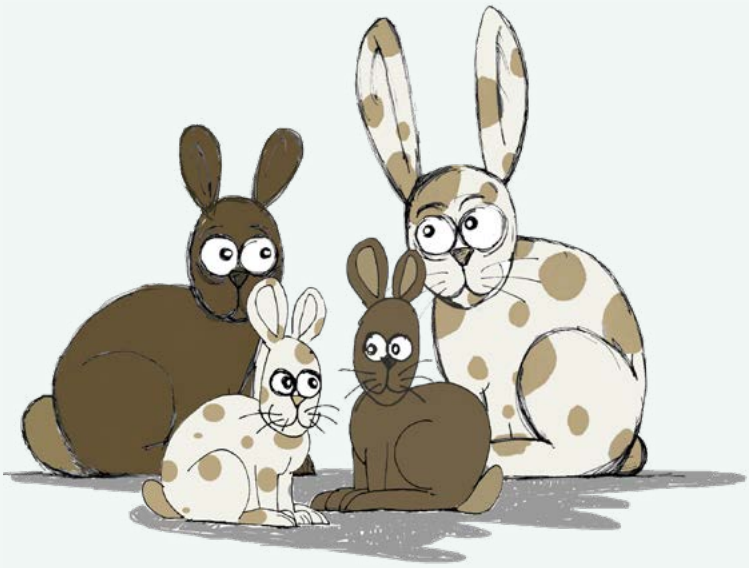
but

all multicellular organisms are eukaryotes.

That means YOU!

Unit III: Genetics

Chapter 10: Inheritance



Chapter 10 Components and Sequence

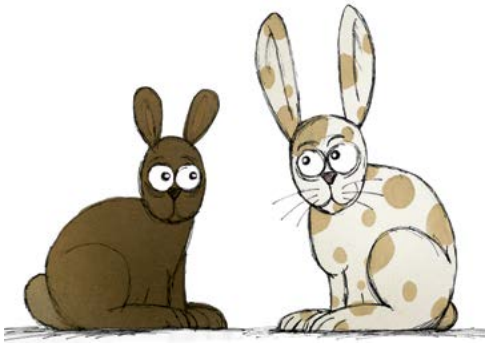
- ☐ **Lesson**. What Makes You You?
- ○ **Lesson Activity**. Color the Homologous Chromosomes
- ○ **Lab**. Family Traits
- ○ **Microscope Lab**. Phenotype Under the Scope
- ○ **FSS**. Gregor Mendel
- ○ **Activity.** Make Your Own Qwitekutesnute
- ○ **SWYK**. Inheritance
- ○ **Unit III Exam**. Genetics Chapters 7–10

☐ *Found in your Textbook*
○ *Found in your Workbook*

FSS = Famous Science Series research assignment
SWYK=Show What You Know chapter quiz

What Makes You You?

Chapter 10: Lesson



These two rabbits are going to be parents. What do you think the babies will look like? Will they have spots or be solid-colored? Will they have big ears like their father or small ears like their mother? It is hard to predict exactly how the babies will look. Most likely, they will look like a combination of their mother and father.

What about you? Do you share any traits with your biological parents? ***Traits*** are your inherited and acquired characteristics. Maybe you have your mother's curly hair or the same color eyes as your father. But that scar on your chin is all your own. Some of your traits are ***inherited***, such as hair and eye color. Other traits such as scars are ***acquired***.

Organisms inherit their genes from their parents. The entire set of genes in an organism is their ***genotype***. The genes in an organism code for proteins. These proteins are responsible for much of an organism's phenotype. Your ***phenotype*** is your appearance, the way you look.

In the last chapter, we saw how meiosis leads to variability in gametes. When the gametes fuse during fertilization, genes on chromosomes combine to form a unique individual. This is why children look similar to their parents and siblings, but different too.

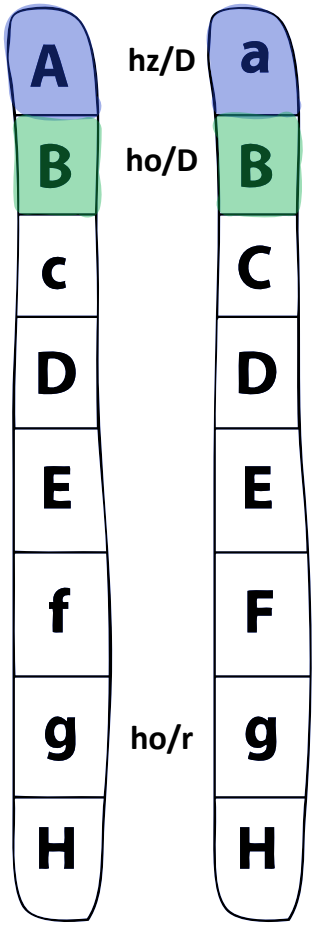
Alleles: Genes in Different Forms

Diploid organisms have two sets of paired chromosomes. The pairs are called homologous chromosomes. If you are a human female, your somatic cells have two sets with 23 pairs of homologous chromosomes; and if you are a human male, your somatic cells have two sets with 22 pairs of homologous chromosomes and a pair with an X and a Y chromosome that is not a homologous pair. These homologous chromosomes have genes that code for the same traits, such as eye color. The genes code for the same trait, but they come in different forms: blue eyes versus brown eyes, for example. The different forms genes come in are called ***alleles***.

The baby bunnies inherited different alleles from their parents. One baby inherited the alleles for small ears and brown fur. The other baby inherited alleles for small ears and spots.

If you think you are understanding genes and alleles, get out your colored pencils and follow the directions in the box below. *(You will find a copy of this exercise in your Workbook on page 131.)* If you aren't quite getting it yet, come back to this box after you complete the rest of the chapter.

Homologous Chromosomes

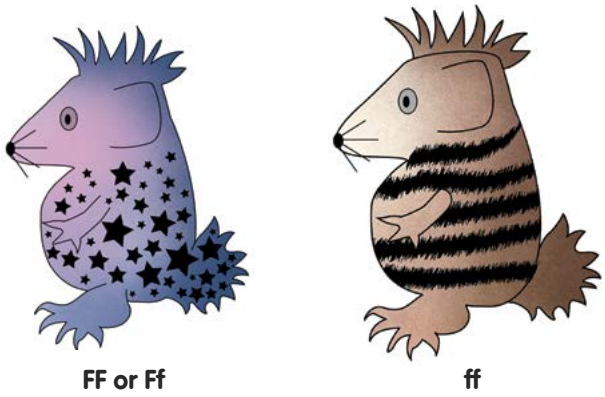


1. Each segment is a gene. The genes come in pairs, one on each homologous chromosome.
2. The set of all the genes in an organism is their genotype. An organism's genotype has all their alleles.
3. Phenotype is the appearance and chemical makeup of an organism. Brown eyes and sickle cell anemia are both examples of phenotype. An organism's phenotype is determined by its genotype.
4. Letters are used for alleles. The same letters are used for alleles of the same gene. Different letters are used for different genes. A and a are alleles of each other but B is not. Color the alleles the same color, different from the others. For example, A and a are the same color as each other but not the same color as B and B, which are the same color as each other.
5. When two alleles are written exactly the same, the organism is homozygous for that allele. The chromosome pair is homozygous for the BB alleles. Write "ho" between the homozygous alleles.
6. When the two alleles are written differently, the organism is heterozygous for that allele. This chromosome pair is heterozygous for the Aa alleles. Write "hz" between the heterozygous alleles.
7. Alleles can be dominant or recessive. Uppercase letters are used to show an allele is dominant. Lowercase letters are used to show an allele is recessive.
8. A dominant allele is one that is expressed in the phenotype even if there is only one copy of it present in the genotype. Write a "D" next to hz or ho if a dominant allele is in the pair.
9. A recessive allele is one that is expressed in the phenotype only if there are two copies of it present in the genotype. Write an "r" next to ho if there is a pair of recessive alleles in the pair.

An Example of How It Works

You are a scientist who travels to the Island of Mythical Creatures. While on the island, you discover a small animal that you name qwitekutesnute. You name them this because their nose reminds you of your mother's, who also has quite a cute snoot. Qwitekutesnutes have dark gray, light gray, or white fur that has one of two patterns on it: stars or stripes. You observe many qwitekutesnutes. You notice that stars are a much more common fur pattern than stripes. Just as in other animals, the fur color and fur patterns of qwitekutesnutes is determined by their genes.

One gene controls for fur pattern in qwitekutesnutes. Let's call that gene F, for fur. Qwitekutesnutes are diploid, so they have two copies, two alleles, of each gene.



FF or Ff **ff**

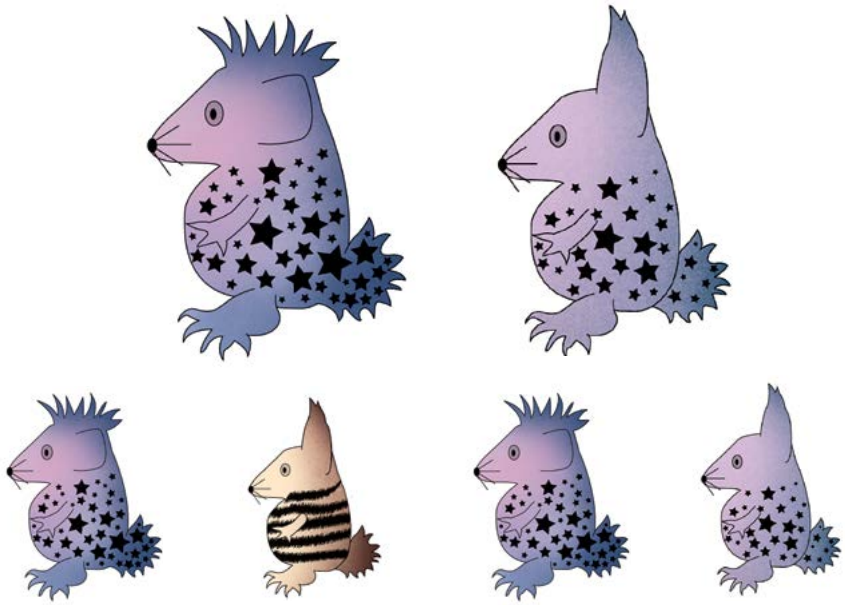
The possible genotypes for the fur pattern of qwitekutesnutes are FF, Ff, and ff. F is the dominant allele and f is the recessive allele. Qwitekutesnutes with the genotype FF or Ff have stars. They have different genotypes but they both have stars so they have the same phenotype. Qwitekutesnutes with the genotype ff have stripes.

Qwitekutesnutes with the genotype FF and ff are homozygous for these alleles. Qwitekutesnutes with the genotype Ff are heterozygous for these alleles. They have different alleles for fur pattern on their chromosome pairs.

At the end of your research trip, you are ready to get home. The qwitekutesnutes are cute but they are also pests. They are not afraid of people at all. They really like to get into your gear and make nests out of your clothes. They also have been getting into your food. It seems that qwitekutesnutes will eat anything and that they eat all the time. You pack your gear in your backpack and go to say good-bye to the rest of the team.

When you get home, you throw your backpack into a closet. A couple of days later you unpack. To your horror, you find two qwitekutesnutes. Once the shock wears off, you are disappointed that both of the qwitekutesnutes have stars. You thought the qwitekutesnutes with stripes were cuter than those with stars. Even worse, one of the qwitekutesnutes looks pregnant! You run to the pet store, buy a cage, wait a week, and lo and behold, you have four baby qwitekutesnutes—three with stars and one with stripes.

Stars are dominant over stripes in qwitekutesnutes.



Being a scientist, you begin to wonder about the genotype for fur color of the two adult qwitekutesnutes. How could two starred qwitekutesnutes have a striped baby? Because fur with stars is more common than fur with stripes you think that the allele that codes for stars must be ***dominant*** over the allele for stripes. This would mean the allele that codes for stripes is ***recessive*** to stars. You decide to use a Punnett square to get some answers.

Punnett Squares

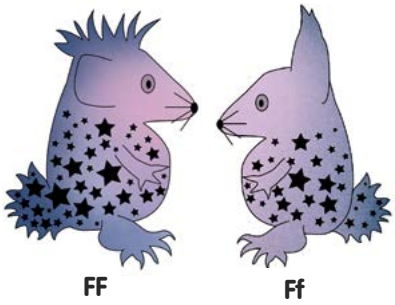
A ***Punnett square*** is a table used to show the possible genotypes for offspring based on the parents' genotypes. Each square represents a possible outcome. The information from the Punnett square can be put into a probability table. A ***probability*** is the likelihood of an outcome occurring. Punnett squares and probability tables are used to predict the likely outcome of having offspring with certain genotypes and phenotypes, based on the genotypes of the parents. They can only be used to predict. Let's look at how to use them.*

* Punnett squares can be fun once you get the hang of them. Refer to "How to Use Punnett Squares" in Appendix B of your Workbook on page 473 if you're not feeling the fun!

In the Punnett squares pictured on this page, the parents both have stars. The possible allele combinations for a qwitekutesnute with stars are FF or Ff. A Punnett square can be used to determine how two qwitekutesnutes with stars can have babies with stars and with stripes. A qwitekutesnute will only have stripes if its genotype is ff, homozygous recessive.

A Cross Between Qwitekutesnutes with Genotypes FF and Ff

The two alleles of the parents are separated, each along one side of the Punnett square. Each box has a possible allele combination for these two parents.

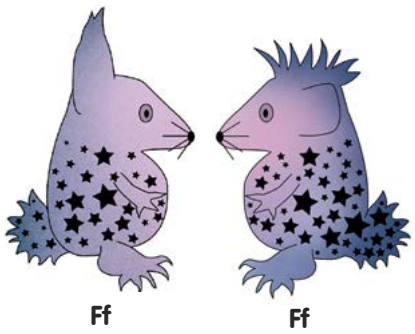


FF Ff

Parents' fur color allele	F	F
F	FF	FF
f	Ff	Ff

One of these parents is homozygous dominant for the fur color allele FF. One of the parents is heterozygous for the fur color allele Ff. These two parents could have babies with one of these two genotypes. Both of these genotypes result in the phenotype for fur with stars, not stripes.

A Cross Between Qwitekutesnutes with Genotypes Ff and Ff



Ff Ff

Parents' fur color allele	F	f
F	FF	Ff
f	Ff	ff

Both of these parents are heterozygous for the fur color allele Ff. These two parents could have babies with three different genotypes: FF, Ff, and ff. FF and Ff result in the phenotype stars. But, ff results in the phenotype stripes.

Based on the results of the two Punnett squares, you can tell that the qwitekutesnutes you brought home both must have been heterozygous dominant for the trait of fur pattern. They both must have had the genotype Ff to have a baby with the phenotype stripes (ff).

Now let's put the data from the cross Ff x Ff into a probability table.

Baby's Genotype	Genotype Probability	Genotype Fraction	Genotype Percentage	Baby's Phenotype	Phenotype Probability	Phenotype Fraction	Phenotype Percentage
FF	1 in 4	¼	25%	Stars	3 in 4	¾	75%
Ff	2 in 4	2/4 or ½	50%				
ff	1 in 4	¼	25%	Stripes	1 in 4	¼	25%

This probability table shows that the chance of your stowaway qwitekutesnutes having a striped baby is only 25 percent. There is a 75 percent probability that they will have a baby with stars.

Nature Versus Nurture

Your genes control many things about you. However, many things about you are not controlled by your genes. The environment you grow up in and the choices you make have a lot to do with who you are too. This is called nature versus nurture. Nature means the genes that nature gave you. Nurture means the care given to you by others, the care you take of yourself, and the choices you make. Most people believe these are as important to who you are as your genes.

Choices you make like working hard at your schoolwork, eating healthy, and not using drugs or cigarettes can be as important as the genes you get from your parents.

TBYB Sample

Unit IV: Anatomy and Physiology

Chapter 13: Plant Reproduction

Chapter 13 Components and Sequence

- ☐ **Lesson**. Making More Plants
- ○ **Dissection Lab**. Flower and Seed: Inside View
- ○ **FSS**. Sunflower
- ○ **SWYK**. Plant Reproduction

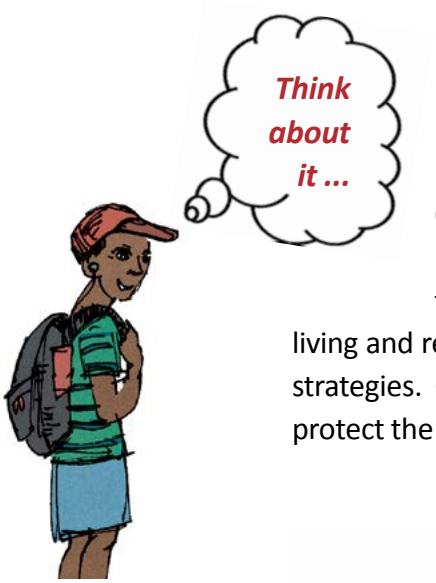
☐ *Found in your Textbook*
○ *Found in your Workbook*

FSS = Famous Science Series research assignment
SWYK=Show What You Know chapter quiz

Read

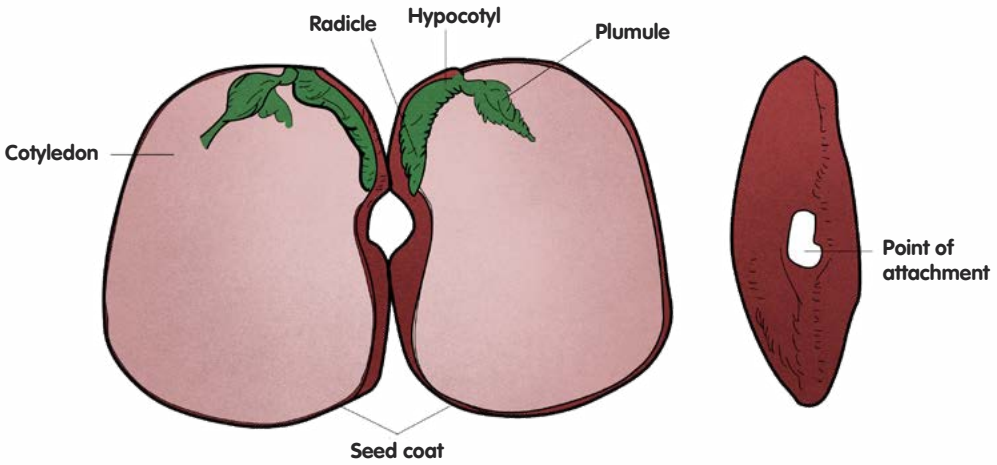
Making More Plants

Chapter 13: Lesson



What strategies would people need to develop to make the transition from land to water? Could it be done without building any structures that mimicked land-like conditions?

Organisms make more. If they don't, they go extinct. The first plants on Earth lived and reproduced in water. Plants in water rely on the water to carry the sperm to the egg. When plants made the transition from living and reproducing in water to living and reproducing on land, they needed new strategies. One of these strategies was ***seeds***. Seeds are survival capsules. They protect the embryo inside them until conditions are favorable for the plants to grow.



Dicot Seed Parts

The **cotyledons** develop into the first leaves of the embryo. It is their job to carry out photosynthesis for the developing embryo. The cotyledon leaves fall off as the plant grows.

The **radicle** grows and develops into the root system. It begins by growing the primary root. This root eventually branches to form the lateral roots.

The **hypocotyl** is the region between the radicle and the cotyledon.

The **plumule** grows to become the shoot system of the plant.

The **seed coat** is a protective covering surrounding the seed.

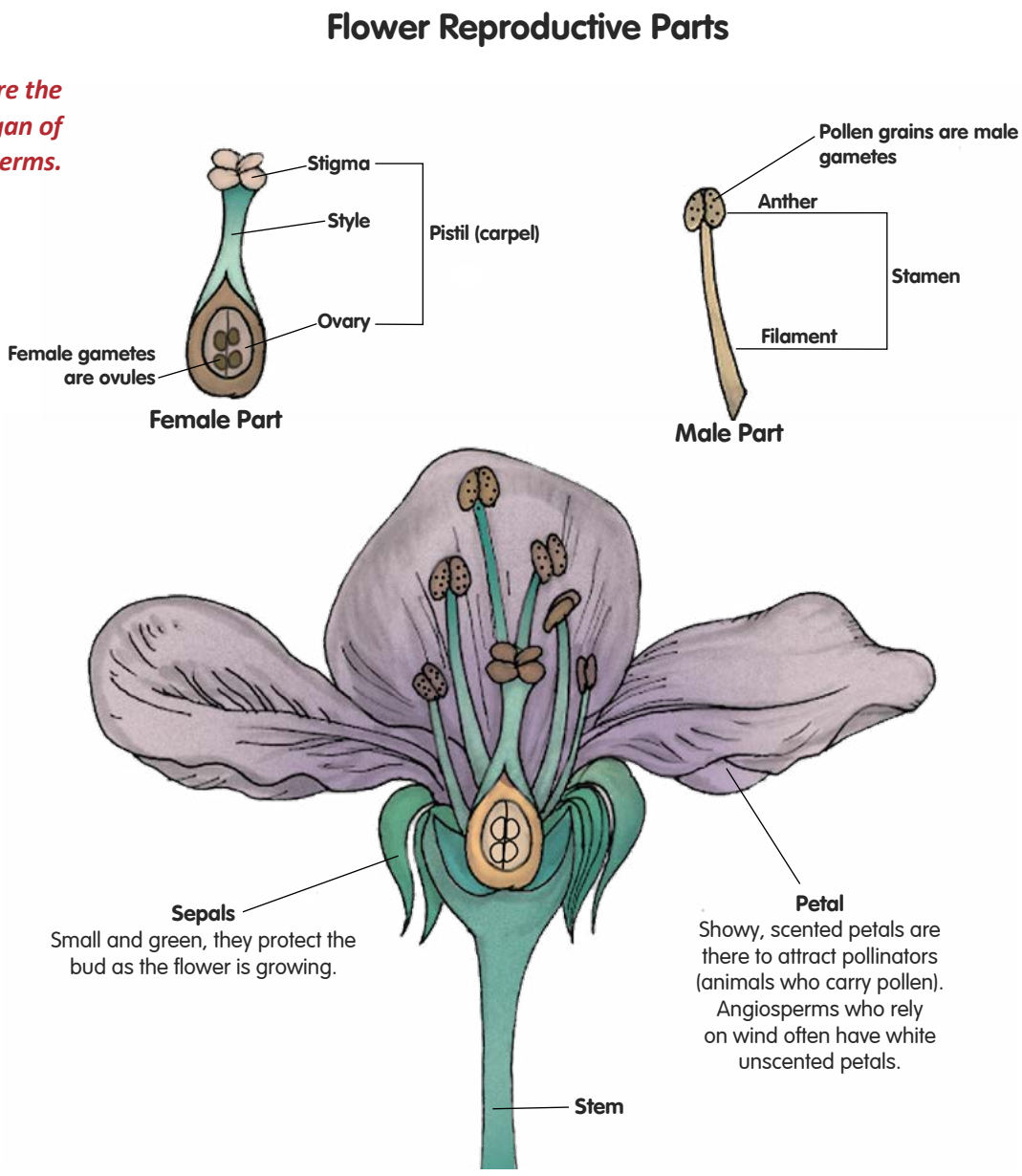
The **point of attachment** is the site where the two halves of dicot seeds are held together.

Angiosperms

Angiosperms are the largest group of plants. There are 250,000 to 400,000 species of angiosperms. The name *angiosperm* means "seed vessel." Angiosperms include the plants you think of as flowering plants; they also include grasses, shrubs, vegetable plants, and many tree species.

The reproductive organ of angiosperms is the ***flower***. Most angiosperms have the male and female reproductive structures in the same flower. The female reproductive structure is called the ***pistil***. The pistil is made from the ***stigma***, ***style***, and ***ovary***. The ovary is where the ***ovules***, the plant's eggs, are stored. The male reproductive structure is called the ***stamen***. Each stamen is made from one ***filament*** and one ***anther***. The anther is where pollen, the plant's sperm, is produced.

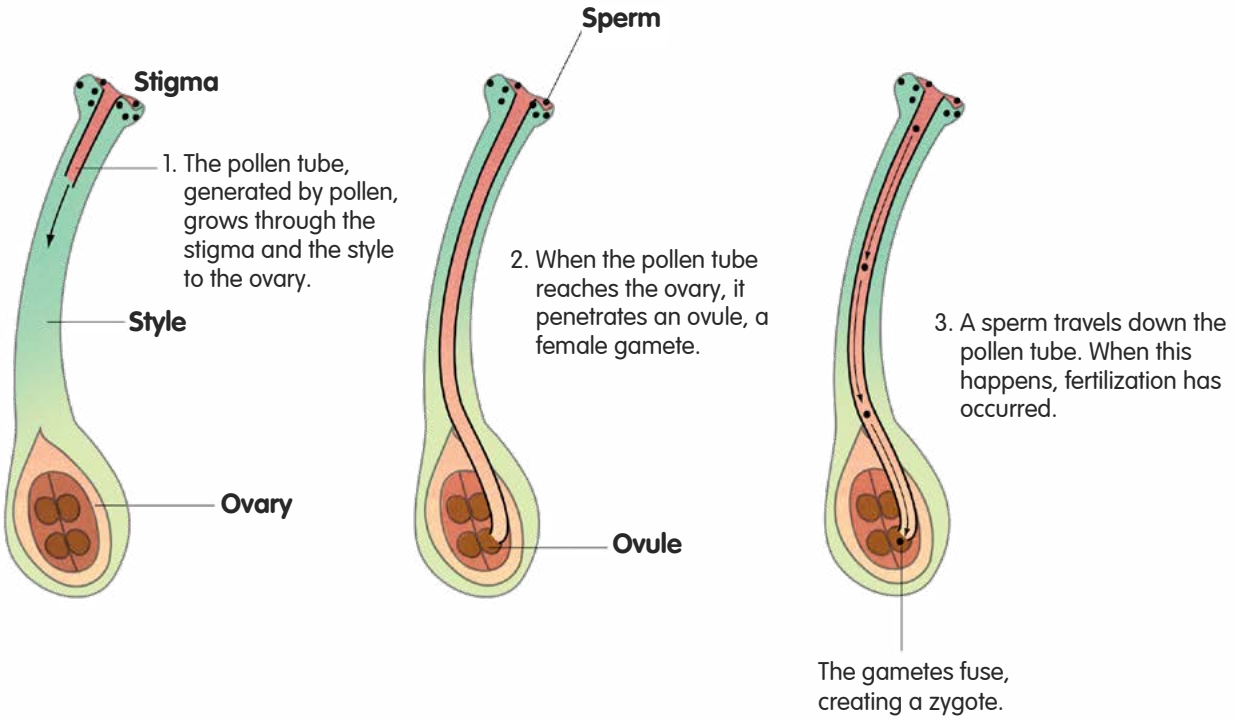
Flowers are the reproductive organ of angiosperms.

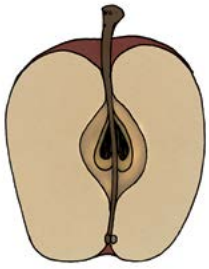


Fertilization

Fertilization begins when pollen, sperm, from the anther is transferred to the stigma. The pollen produces a tube that grows through the stigma to the ovary. When the ***pollen tube*** reaches the ovary, it penetrates an ovule. Next, sperm travels down the pollen tube. The ovule and sperm fuse, creating a zygote.

The zygote develops into an ***embryo*** inside a seed. Seeds are survival capsules. They are covered by a protective seed coat with the embryo and food supply inside. Seeds are enclosed by fruit.

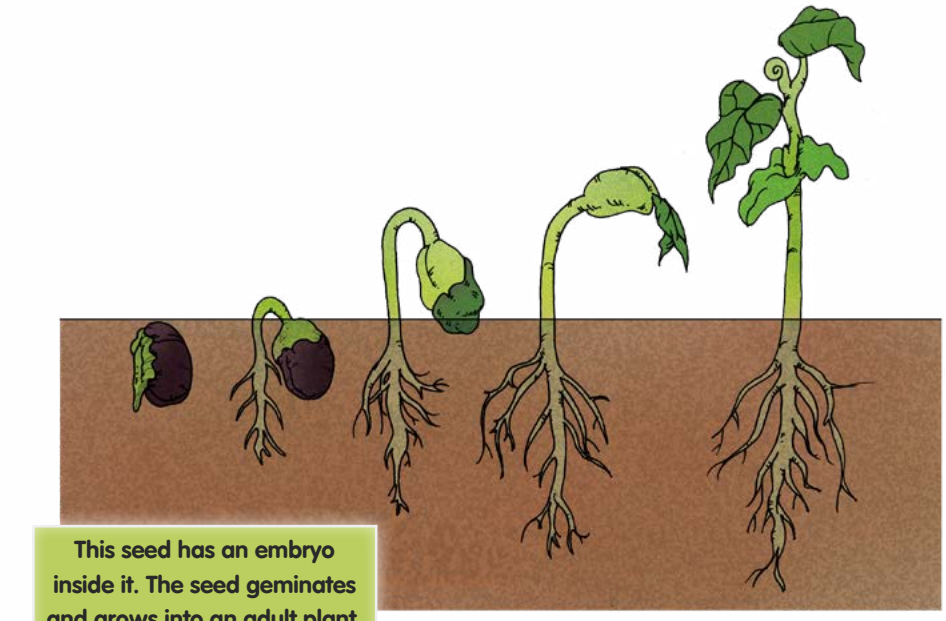




Fruits take many forms depending on the dispersal strategy of the plant. Because plants are rooted, they need help dispersing their offspring. They do this when their offspring are embryos, before they have started to grow roots of their own. Fleshy fruits, like berries, depend on animals to disperse them. If you have ever seen brown bear scat, you will know there are a lot of seeds in it. Other fruits, like those on the head of a dandelion, rely on the wind for dispersal. Even burrs, like those that get in your pet's fur, are fruit. What a prickly way they have of getting around!

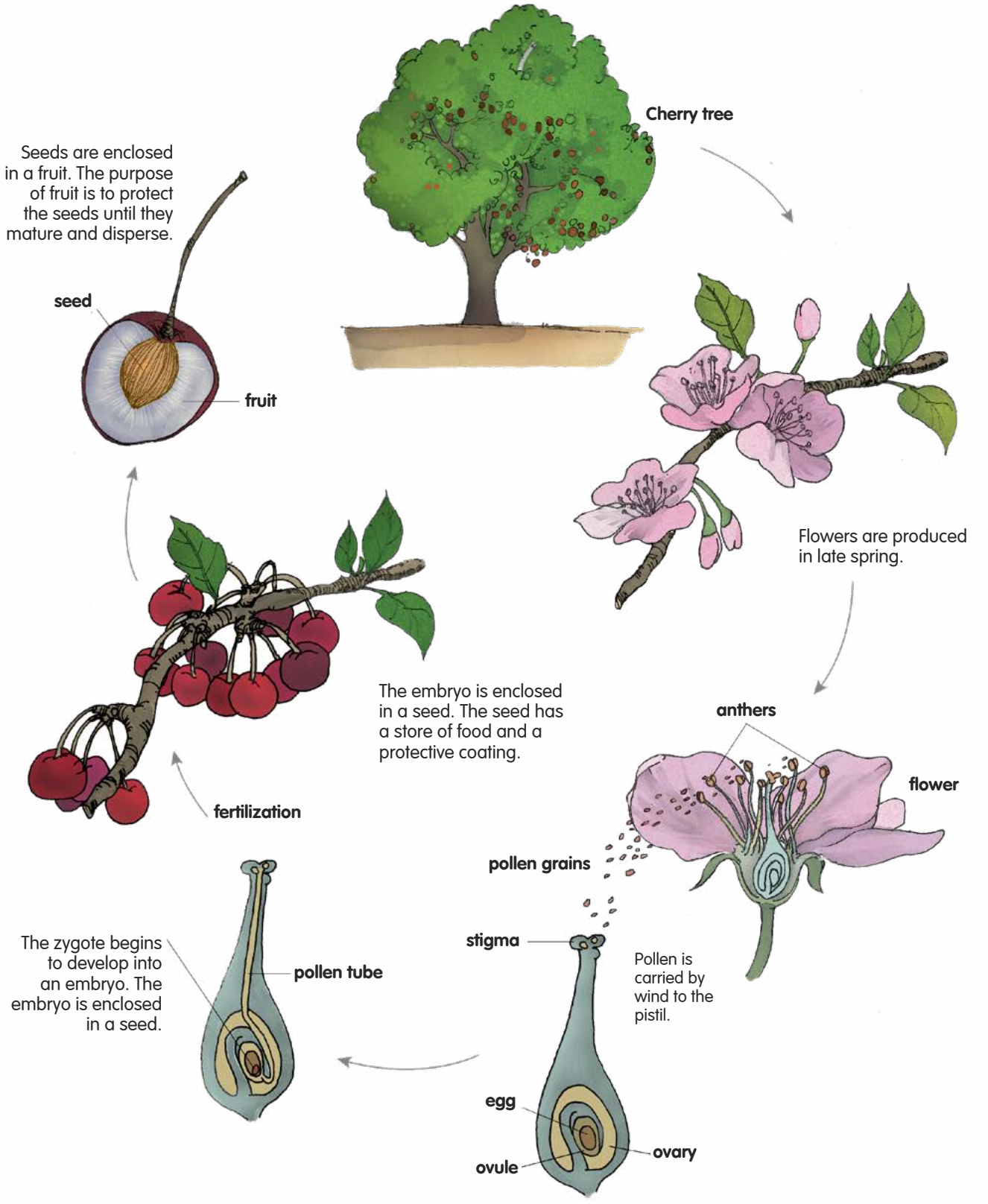
The bears eat the berries, the seeds of the berries go through the bear's digestive tract and come out in their scat. Bear fecal droppings are a good growing medium for the berries.

The embryo will grow when conditions are favorable. The most common trigger for the growth of embryos into plants is water seeping into the seed through the seed coat. When the embryo breaks out of the seed coat and begins to grow, it is called ***germination***.



This seed has an embryo inside it. The seed geminates and grows into an adult plant.

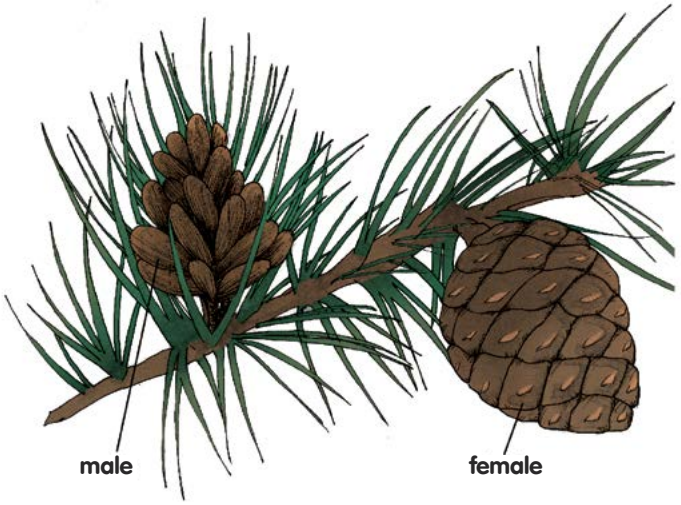
Life Cycle of an Angiosperm (a Cherry Tree)



Gymnosperms

Gymnosperms are another type of plant. Pine, spruce, redwood, hemlock, cedar, and fir trees are all gymnosperms; so are many types of shrubs, and a few types of vines. There are about 600 species of gymnosperms. The name *gymnosperm* means "naked seed." They are seed-producing plants that do not produce fruit or have flowers.

Cones are the most common reproductive organs of gymnosperms. They are the site of meiosis and gamete production in gymnosperms. There are both male and female cones on the same tree.



Cones are the most common reproductive organs of gymnosperms.

Gymnosperms reproduce sexually using wind dispersal for pollen. When it is time to reproduce, the male cone releases large amounts of pollen into the air. It is carried on the wind. If it lands on a female cone, the pollen grows a pollen tube to the egg of the female. The sperm cell travels down to the egg. Fertilization occurs and a zygote is formed. The zygote develops into a seed. The seed is "naked" because it is exposed to the elements. When the seeds have developed, the female cone releases them and they are carried away by the wind. If the seed lands in a good location, it may develop and grow into a new plant.

Plants Without Seeds

Some plants use ***spores*** instead of seeds for reproduction. Spores are small and can be carried by air a distance from their parents. Mosses and their relatives use spores to reproduce. The parent plant grows a stalk full of spores. The spores are released from the pod and carried away from the parent by the wind. If the spores land in a favorable spot, they will grow into a new plant.

Ferns and their relatives also use spores. Ferns have their spores on the undersides of their leaves. When the spores ripen, they fall off the leaf. If they land in a good spot, they will grow into a new fern.

Some plants reproduce without flowers or seeds.

Underside of a fern

Unit V: Evolution

Chapter 21: How

Chapter 21 Components and Sequence

- ☐ **Poetry**. Recipe for Making Something Different
- ☐ **Lesson**. How Evolution Happens
- ○ **Lab**. Natural Selection
- ○ **Microscope Lab**. Function and Form
- ○ **FSS**. Evolution Act 1: First Theories
- ○ **SWYK**. Evolution: How

☐ *Found in your Textbook*
○ *Found in your Workbook*

FSS = Famous Science Series research assignment
SWYK=Show What You Know chapter quiz

Recipe for Making Something Different

Chapter 21: Poetry

Recipe for Making Something Different

"I have a recipe,"
Said the walrus to the shrew,
"For making something different,
For making something new.

"I want my genes to mutate,
So my children aren't like me."
The shrew asked what they'd look like.
The walrus said, "We'll see.

"Maybe they will walk on land
Or fly above the earth.
Maybe they will be bright pink
And have a slender girth.

"Shrew, my dear, the recipe is
Isolation
Variation
Lots of time for
Speciation
To something very different
From me.

"First, a few of us must move away
So we have reproductive isolation.
Then many, many years from now
After lots of new mutations,
I might be the ancestor of something
Quite unique.
I know not what—that's the fun
It adds to the mystique.

"There has to be selection
For the good traits and the bad.
My offspring with the good traits,
They will do quite well.
And those that have bad traits . . .
It's just too sad
To tell.

"Yes, Shrew my dear, the recipe is
Isolation
Variation
Lots of time for
Speciation
To something very different
From me."

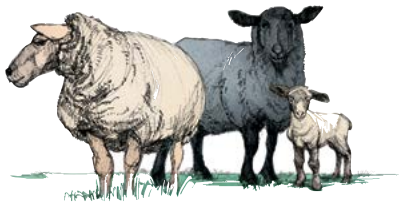
Read

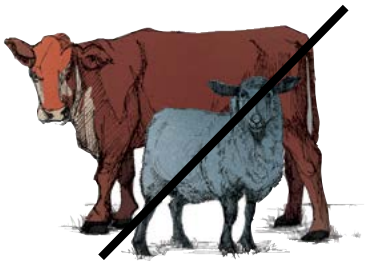
How Evolution Happens

Chapter 21: Lesson

A ***species*** is a group of organisms that can reproduce with each other but not with other groups of organisms.

Cows and sheep are two different species of organisms. Cows can breed and have offspring with other cows. Sheep can breed and have offspring with other sheep. However, because they are different species of organisms, cows and sheep cannot breed and have offspring.





Scientists have documented over 1.75 million different species as having lived on Earth. They estimate there are tens of millions more yet to be discovered and documented. That is a lot! The biological process that explains how over 1.75 million different types of life came to be is central to all of biology. Evolution is that process. How does evolution work? How did a microscopic organism billions of years ago evolve into all the different species on Earth today?

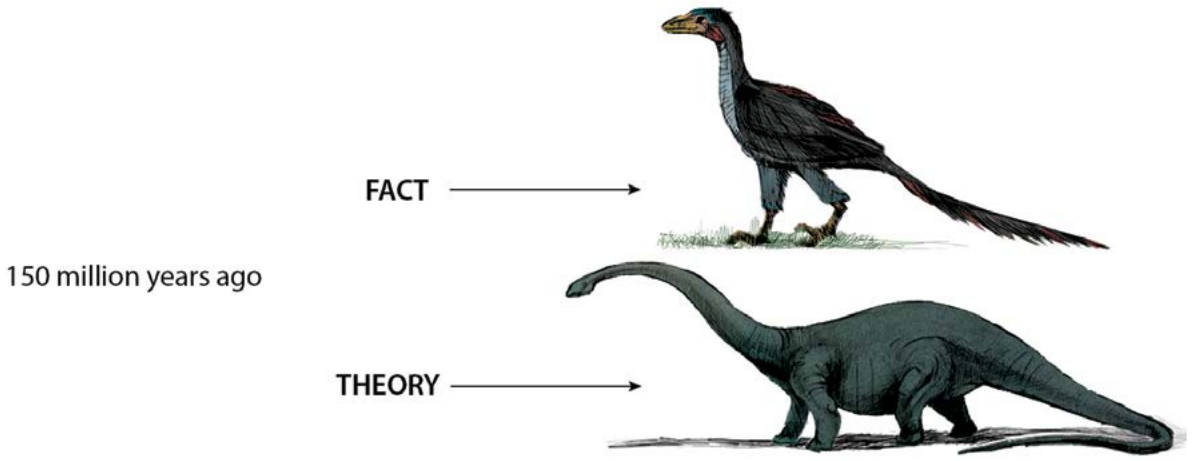
Scientific Theory

A ***scientific theory*** is a widely accepted explanation of something observed in science. Theories are based on experimentation, observation, and reasoning—the scientific method. Before something can be called a scientific theory, it must be tested many times by different researchers, who get results that are consistent with that theory.

Scientific Fact and Scientific Theory

It is a FACT that evolution occurs.
It is a FACT that the process of evolution is how all species that have ever lived came to be.
There are THEORIES about how the process of evolution works.

For example,
It is a FACT that birds evolved about 150 million years ago.
It is a THEORY that birds have descended from dinosaurs.



The Process of Evolution

Overproduction

In nature, more organisms are born than the environment can support. This is called ***overproduction***. The number of organisms in a population is controlled by environmental pressures such as predation, disease, weather, and food availability.

An Example of Overproduction in Mice

There are two mice and plenty of food.

The mice had many babies.

There are now more mice and less food.
If the mice do not find another food source, some of them will not survive.

Overproduction does not cause evolution. However, because there is ***genetic variation*** in the mouse population, when food becomes scarce, some mice will have a higher rate of survival than others will. It is part luck and part genetics.

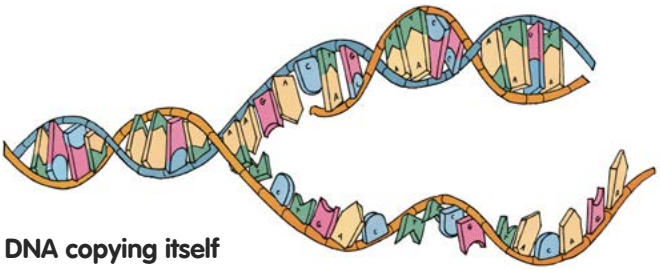
Variation

Individuals are not genetically identical. There is ***genetic variation*** between the members of a population. This is because there are different alleles for genes. Genetic variation, or allelic differences, creates different traits. These different traits are passed on in a huge number of combinations. The two main sources of variation are ***mutation*** and ***genetic recombination***.

Differences in coloration in a population are caused by genetic variations. There is genetic variation, differences, in the alleles that code for fur color in these Great Danes.

Evolution occurs when variations become either more or less common in a population.

During meiosis, mistakes are sometimes made when DNA replicates. These mistakes are called mutations.



DNA copying itself

- ★ Mutations can be passed on to an organism's offspring.
- ★ Mutations lead to genetic variation within a population.
- ★ Genetic variation leads to different traits.
- ★ Traits can affect the survival of an organism. Traits are harmful, neutral, or beneficial.
- ★ The effect of an accumulation of mutations in a population leads to an accumulation of variable traits in that population.
- ★ This can result in the formation of a new species.

Genetic variation is also caused by ***genetic recombination***. During meiosis, homologous chromosomes pair up. Genetic recombination occurs when homologous chromosomes ***crossover*** one another. The pieces of chromosomes can break off and reattach to the other chromosome. This creates unique genetic combinations. For example, a copy of a chromosome from your father may now have a genetic sequence from your mother on it.

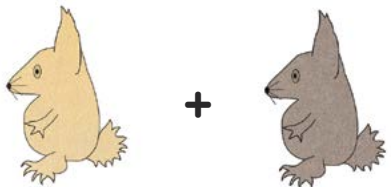
Evolution occurs when variations become either more or less common in a population. ***Natural selection*** and ***genetic drift*** are the two main processes that cause this to happen.

Genetic recombination occurs when homologous chromosomes crossover.

Natural Selection

Because of overproduction, more organisms are born in nature than can survive. The organisms in a population have a range of traits. It is a tough world out there. Some traits help organisms survive and some don't. This leads to the natural selection of organisms based on their traits. ***Natural selection*** is the process where organisms have a better or a worse chance of survival because of their traits. The genetic mechanism that led to the trait was random. The effect of the trait on individuals in a population is not random.

A Qwitekutesnutes Example: Mutations in DNA can be passed on when the two Qwitekutesnutes (QKS) reproduce. These mutations lead to variability.



Mutations can be: Potential Offspring: Selection:

Harmful

No Tail!
This QKS cannot climb trees to avoid predators. It is eaten and does not have offspring. It does not pass on its genes.

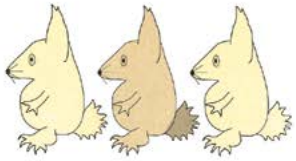
Selection Against

The trait "no tail" is selected against. It is harmful to the organism.

Neutral

Different-Colored Tail
This has no effect on survival.

No Change



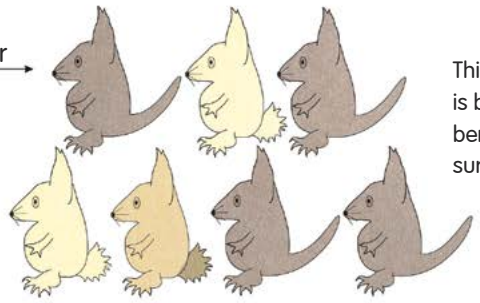
This trait is neutral. It has no effect on the survival of the organism.

Long Tail
This improves the climbing ability of this QKS. It allows better balance.

Beneficial

Selection For

This QKS lives longer because it is harder for predators to catch it. It has many offspring. Some of them might have long tails too. This trait becomes more common in the QKS population.



This trait long "tail" is beneficial. It has a beneficial effect on the survival of the organism.

With natural selection, traits can have a beneficial, harmful, or neutral effect on an organism:

- ★ Beneficial traits are caused by mutations that bring a benefit to an organism.
- ★ Beneficial traits improve the likelihood that an organism will survive and have offspring.
- ★ Harmful traits are caused by mutations that bring harm to an organism.
- ★ Harmful traits make it less likely that an organism will survive and have offspring.
- ★ Neutral traits are caused by mutations that do not affect the survival of an organism.
- ★ Neutral traits do not affect the likelihood that an organism will survive to have offspring. However, a neutral mutation might affect the health of organisms in the population later, when conditions change.

A Case of Evolution Through Natural Selection: Peppered Moths of England

The Industrial Revolution in England occurred between the late 1700s to the end of the 1800s. Before the Industrial Revolution, many of the trees in England were covered in lichen that grew on the trees. The lichen was light-colored, which made the trees light-colored. Peppered moths are a species of moth found throughout England. Up until the Industrial Revolution, most peppered moths were light-colored with dark, peppery-looking speckles. Rarely, there would be a peppered moth that was dark all over. Birds eat peppered moths, and the dark peppered moths showed up better on the light, lichen-covered tree trunks. They were more likely to be eaten than their light-colored relatives were. There was natural selection *for light* color and *against dark* color.

Before the Industrial Revolution
There are six moths.
Can you find them?

During the Industrial Revolution
There are five moths.
Can you find them?

During the Industrial Revolution, there was a lot of air pollution from coal-burning factories. The coal smoke killed the lichen and coated the tree trunks. Tree trunks went from light-colored to dark-colored. Which color of peppered moth blended in best against the tree then? If you guessed the dark-colored peppered moths, you are right. Which color of peppered moth were birds more likely to eat? If you guessed the light-colored peppered moths, you are right again. Within one hundred years, the dark-colored peppered moth was no longer rare. It was now the more common type. There was natural selection *for dark* color and *against light* color.

Now, most of England is no longer polluted with coal smoke. Lichen has grown back on trees in unpolluted areas. Which peppered moth do you think is the most common in these unpolluted areas? That's right. The light-colored peppered moths are now the most common color of peppered moth in unpolluted areas.

Inherited variations that improve the survival of organisms with that trait are called ***adaptations***. Light-colored peppered moths are better adapted when trees are light-colored. Dark-colored peppered moths are better adapted when trees are dark-colored. The color of peppered moths is an adaptation.

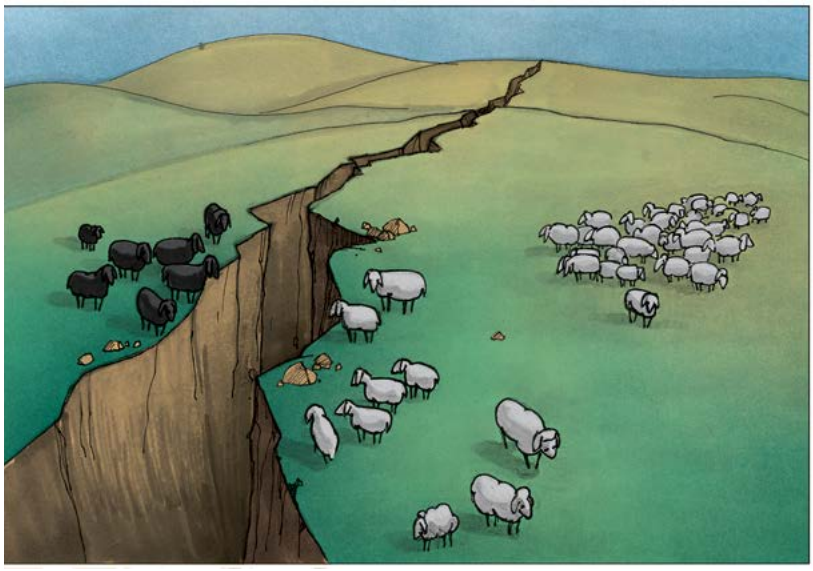
Genetic Drift

Genetic drift can lead to evolution. ***Genetic drift*** is the *random* change in the frequency of alleles in a population due to chance events. For example, some organisms leave more offspring than others do for each generation. When this occurs, the frequency of their alleles increases in the population. If this continues over many generations, these alleles can become fixed while less common forms of alleles are lost to the population. When an allele becomes fixed, it means that there are no other forms of this allele present in this population. Genetic drift is not selected for or against; it is random.

Genetic drift is especially important in small populations. Small populations have fewer numbers overall, so an increase or a decrease in the frequency of an allele makes a bigger difference.

Speciation

A Story of Genetic Drift with Sheep



Once upon a time, there was one population of sheep living in the area. A massive earthquake struck, creating a fault line that was too deep for the sheep to cross. What was once one small population of sheep is now two small populations of sheep. This random event has affected the frequency of the alleles for fur color.

By pure chance, there are seven black sheep forever separated from the white sheep. Black is a recessive trait for the sheep. All these sheep must be homozygous recessive for the black allele (bb). There is a greater frequency of the allele for black fur in this new population than there was in the old population. The allele for black fur color has become fixed in this population of sheep. Unless a mutation occurs, these black sheep will only have black babies. There has been genetic drift toward the allele for black fur in this new population.

On the other side of the fault, there are only white sheep. There is a greater frequency of the allele for white fur in this new population than there was in the old population. There has been genetic drift toward the allele for white fur and away from the allele for black fur. This may not last, though. Some of the white sheep might be heterozygous (Bb) for the fur color allele. The future colors of this group of sheep will depend on the alleles these sheep pass on to their offspring, and the alleles those offspring pass onto their offspring, and the alleles those offspring pass onto their offspring, and . . . . It's like a never-ending story.

New species evolve from existing species. When a new species evolves from another, it is called ***speciation***. All living species have evolved from a common ancestor. Each speciation event, over 1.75 million of them, has taken many genetic changes and time; 3.5 billion years is a *lot* of time.

In order for speciation to occur, a population must have ***reproductive isolation***, such as occurred in the two sheep populations. Gene flow, the mixing of genes, must be stopped between populations for one population to evolve into a new species. This allows mutant alleles and recombinations to become fixed and evolution into a new species to occur. Reproductive isolation can occur if two populations of the same species are geographically separated, if they feed on different foods, or reproduce at different times of the year.

Putting It All Together

You have learned that the evolution of a species can be caused by a succession of many different events including overproduction, variation, natural selection, genetic drift, and speciation. Let's look at how each of these can affect one group—flies.

Overproduction

More organisms are born than the environment can support. Population numbers are controlled by predation, disease, climate, and the amount of food.

These two flies can have hundreds of offspring, who can also have hundreds of offspring.

Variation

There is genetic variation within each population of organisms. Genetic variation is caused by mutations and genetic recombinations.

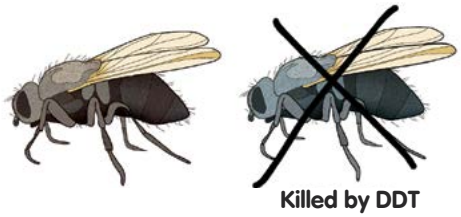
They may look alike, but they have a big difference. One of the flies has an allele that makes it resistant to the effects of DDT. The other does not.

DDT is a pesticide used to kill insects.

Natural Selection

Because there are more organisms than the environment can support, there are selective pressures on the members of a populations. Predators, disease, weather, and the amount of food affect the survival of organisms. The variation of traits results in some members in each population of organisms having better adaptations for their environment. These are the members most likely to have more offspring and pass more of their genes on to future generations.

When DDT was used to kill the flies, this lucky fly and a few others were not killed. There was natural selection FOR the trait DDT-resistant. In a few generations, with the continued use of DDT, the entire fly population will be resistant to DDT. The allele for this trait will have become fixed in this population. There was genetic drift toward DDT resistance.



Killed by DDT

Genetic Drift

There is random drift in the frequency of alleles in populations. In small populations, this can be an important mechanism for speciation.

Genetic drift has occurred in fruit fly populations on the Pacific Islands. The number of fruit flies that originally colonized any one of these islands was small. There were some rare alleles within each small group. These alleles became common as each population increased in number in isolation.

Speciation

If there is an accumulation of many mutations and recombinations in a population, a new species can evolve. This takes time.

After many generations, on each island, with isolation, variation, and lots of time, there is speciation.

TBYB Sample

Unit VI: Ecology

Chapter 25: Predator and Prey

Chapter 25 Components and Sequence

- ☐ **Lesson**. No Fighting No Biting. Wanna Bet?
- ○ **Lab**. Backyard Food Web
- ○ **Microscope Lab**. Plant Predation
- ○ **FSS**. Jane Goodall
- ○ **SWYK**. Predator and Prey

☐ *Found in your Textbook*
○ *Found in your Workbook*

FSS = Famous Science Series research assignment
SWYK=Show What You Know chapter quiz

No Fighting No Biting. Wanna Bet?

Chapter 25: Lesson

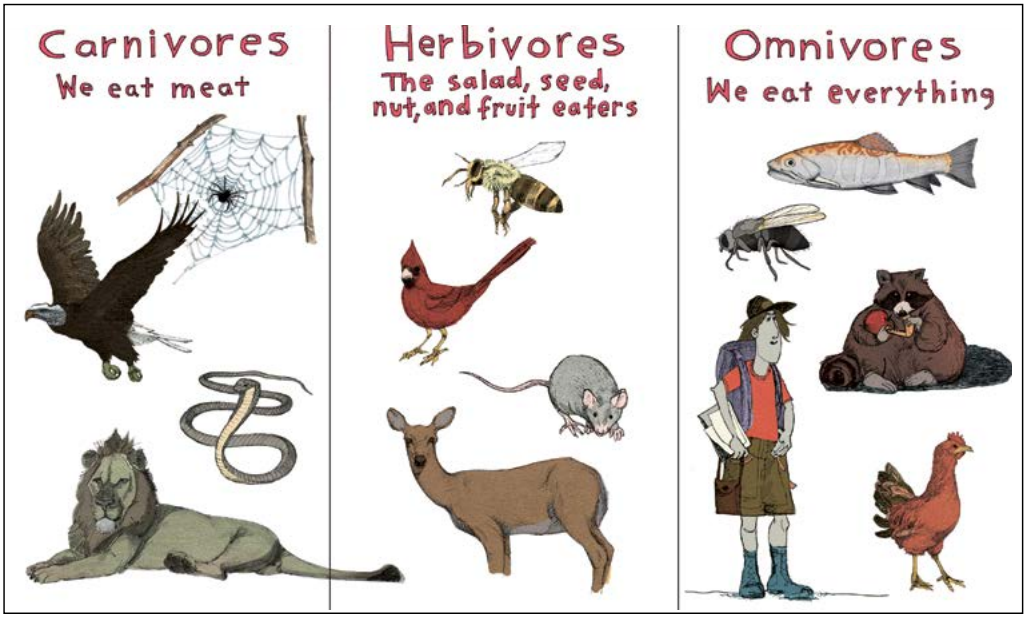
Organisms are affected by the abiotic and ***biotic*** components of their environment. All organisms that live in an area form a community. ***Community ecology*** examines how interactions within and between populations in a community shape the community.

Who Eats Whom

Cells need food. Organisms have to get it for them. It is their job. Some organisms make their own food and some eat other organisms to get food. One way or another, though, they all have to have food. The members of communities are divided into three groups: producers, consumers, and decomposers, based on how they get their food.

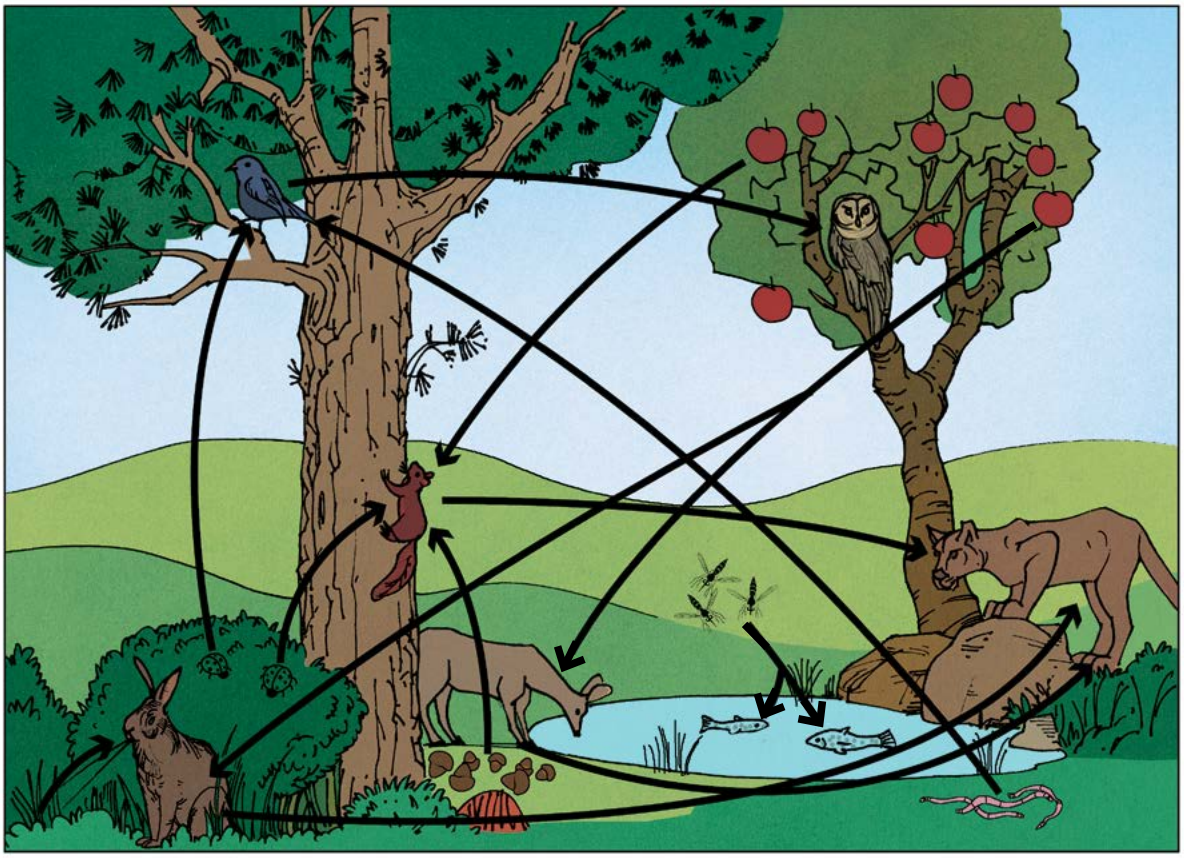
Producers are autotrophs. Producers are plants and those bacteria that photosynthesize. They *produce* their own food.

Consumers are heterotrophs. Consumers *consume* other organisms to get food. There are four types of consumers. You might be familiar with ***carnivores***, ***herbivores***, and ***omnivores***.

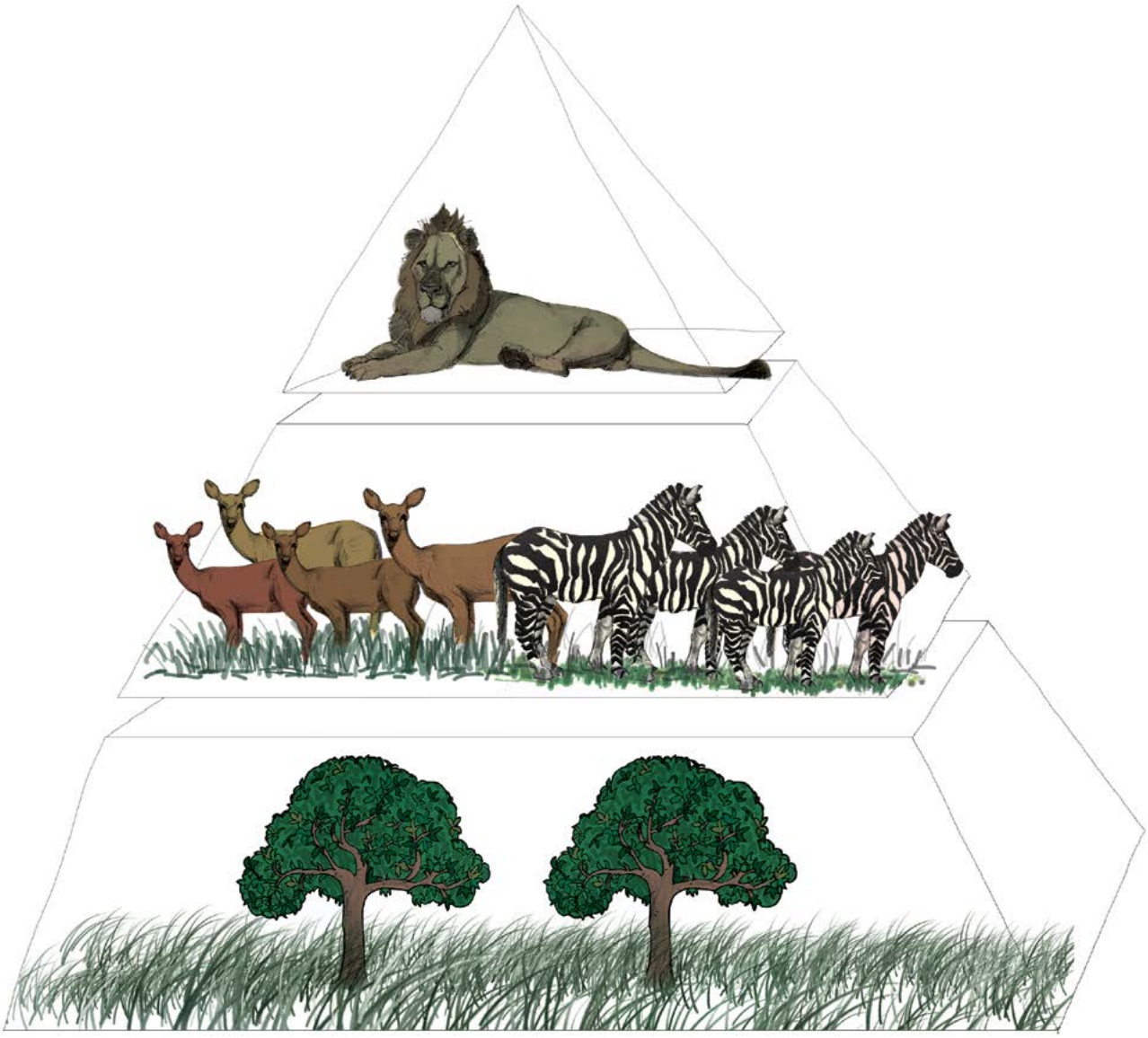


Decomposers are the fourth type of consumers. They are the nutrient recyclers in the community. They feed on dead plants and animals, feces, and plant debris like dead leaves. Decomposers secrete chemicals that break down large molecules into smaller molecules that they can absorb and use for food. This benefits all the organisms in the ecosystem because it releases nutrients and minerals back into the soil. These nutrients and minerals are then taken out of the soil by plants, to be used when they build new cells. Fungi, bacteria, and worms are the main types of decomposers.

Scientists use a diagram called a ***food web*** to show how the organisms included in the web get their food. Arrows are drawn *from* the food source *to* the consumer. The arrows stand for "eaten by." Could you add anymore arrows to the illustration?



Look out your window. Do you see more producers or consumers? In savannas in Africa, are there more deer or more lions? As you have noticed, there are more producers and more deer. Plants make food to use for their own needs. When herbivores eat plants, only a small percentage of the food energy made by plants is available to the herbivore. In turn, the herbivores use this food energy for their own needs. There is only a small percentage of food energy available to carnivores when they eat herbivores. Below is an energy pyramid. At each level of the pyramid, there is less energy available to be passed up to the next level.



At each level up, the amount of available energy decreases. A decrease in available energy results in a decreased population size for organisms in the higher levels.

Let's Mess with Each Other

Can you imagine what it would be like to share your living space with many different types of organisms? This might sound like fun to you, but would you really want to live with a hungry mountain lion or poisonous snakes? Think about how your family and you sometimes get on each other's nerves. At least none of them wants to eat you!

The most important interspecific interactions are predation, competition, and symbiosis.

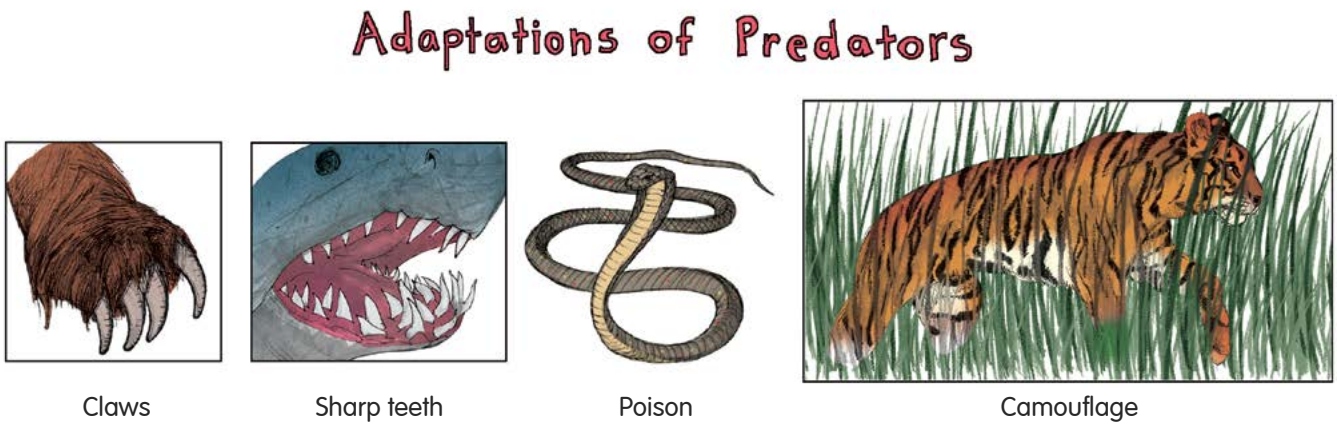
The organisms in a community interact with each other. The interactions between them are called ***biotic interactions***. ***Interspecific interactions*** are between *different* species of organisms. The three most important interspecific interactions are ***predation***, ***competition***, and ***symbiosis***.

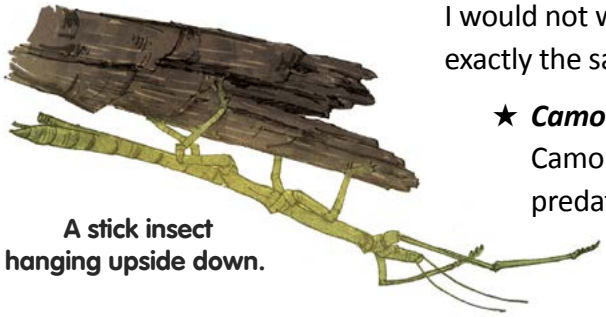
The Predator/Prey Relationship

Have you ever watched a nature show where lions catch and kill an animal? Or one where killer whales catch a grey whale? One word sums it up—GRUESOME! It does not seem very gruesome when deer eat grass, though. But grass is a type of living organism, and the deer are eating it. All of these are examples of predators and their prey, including deer and grass.

As gruesome as ***predation*** might seem, predators have an important role in the community where they live. It is a tough world out there. Predators in nature do not get to go to the store to buy their favorite food to eat. They eat what they can catch, and if a population of prey animals becomes large, there are more of them to catch and more of them to eat. This keeps one population from becoming too numerous and using too many resources. *Predation helps increase the diversity of organisms in the community.* The more diverse a community, the more stable it is.

Predators have adaptations to help them catch their dinner. And their dinner, their prey, have adaptations to help them escape. Predator/prey relationships are a driving force in evolution. Natural selection works continuously to make predators with better weapons, and prey with better defenses.

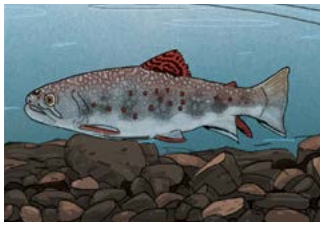




A stick insect hanging upside down.

I would not want to be someone's dinner, would you? Prey animals feel exactly the same way. They have adaptations to help them survive.

★ ***Camouflage*** helps animals blend into their surroundings. Camouflage helps organisms, like stick insects, go unnoticed by predators.



Animals in the aqueous environments are camouflaged to take advantage of light variations. Have you ever looked at a fish, like a trout or a shark? It is darker on its topside and lighter on its underside. When you look down through water, it is dark and when you look up through water, it is light.

Another type of camouflage is ***disruptive coloration***. This is where there is a pattern on the skin or fur that does not coincide with the pattern of the body. It makes the animal difficult to see, in the case of a tiger, or difficult to distinguish the individual from the herd, in the case of the zebra.

★ It is dark in the bottom of the deep blue sea. ***Bioluminescence*** is an adaptation where organisms create their own light. Aqueous organisms use bioluminescence to find food, find mates, and temporarily blind predators so they can escape.

★ Bright warning colors, called ***aposematic coloration***, are used by some animals, like the poisonous dart frog, to warn predators that they are poisonous.

★ Some species of animals use ***mimicry*** to keep from being eaten. They have evolved to look like poisonous or bad-tasting species.

The viceroy butterfly (right) is a mimic to the terrible-tasting monarch (left).

A chemical causes a rash after coming in contact with the leaves of a poison oak plant.

Plants have also evolved defenses against predation.

- ★ Plants make chemicals that taste bad or that have a toxic effect.
- ★ Stickers and thorns, like those on holly and rose plants, are a defense against predation.
- ★ Some plants, like the coconut, protect their seeds with a hard shell.

Competition

Do you have chores you have to do, things that are your job in your family? Maybe you feed the dogs or take out the trash. Your place and jobs in your family define your niche.

In a community, a ***niche*** is the "job" a population has in the community. Niches are important in a community because they decrease competition. In a community, there is a limited amount of space and a limited amount of resources. ***Competition*** occurs when two or more organisms need the same resource and the resource is limited; they have the same or similar niches. Competition is strongest between organisms with the same or similar niches. The most intense competition in a community comes from organisms of the same species because they occupy the same niche. This is called ***intraspecific competition***.

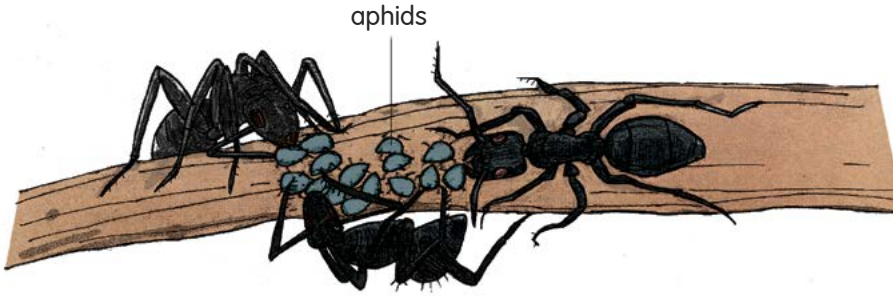
Intraspecific means between organisms of the SAME species. Territorial behavior and displays of dominance are two examples of intraspecific competition.

Interspecific competition, between different species, is minimized by resource portioning. ***Resource partitioning*** occurs when populations living in the same ecosystem have similar needs, but they use resources in slightly different ways. This lessens the overlap of their niches.

The lion is a predator. Its niche is much different from that of a wildebeest or zebra. The zebra and wildebeest have similar niches, which increases the risk of **interspecific competition** between them. They deal with this through **resource partitioning**. Wildebeests and zebras eat different parts of the same plants.

Symbiosis

Symbiosis is an interspecific relationship (between two different species) that involves frequent close contact. There are three types of symbiosis: ***mutualism***, ***parasitism***, and ***commensalism***. Each of these is explained below through an example found in nature.



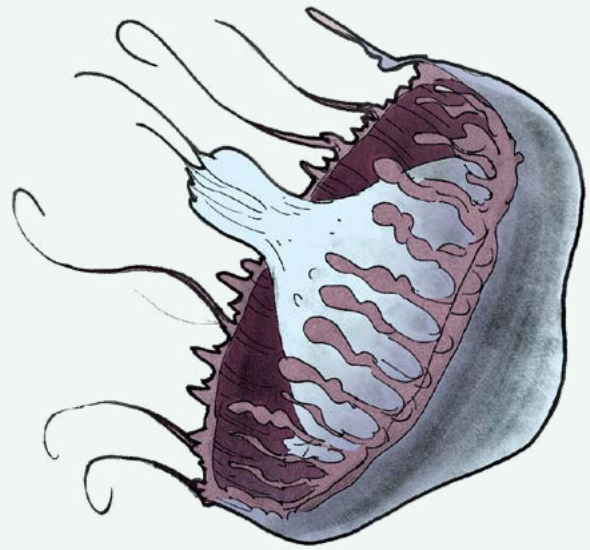
Mutualism is a symbiotic relationship that benefits BOTH species. The relationship between aphids and ants is an example of mutualism. Aphids are slow-moving defenseless predators of plants. Alone they are an easy target for ladybugs and spiders. Aphids excrete a sticky substance called honeydew that ants harvest and eat. Ants that eat honeydew protect the aphids from predation. They will attack and bite animals who try to eat aphids. The aphids get protection and the ants get dinner.

Parasitism is a symbiotic relationship that benefits one species and harms the other. Ticks are parasites that feed on the blood of other organisms. This benefits the ticks and harms the other organism.

Commensalism is a symbiotic relationship that benefits one species and leaves the other species unaffected. The relationship between moss and trees is an example of commensalism. The moss benefits from growing on the tree because it is raised above the forest floor, away from herbivores and into more sunlight. The tree is not affected by the moss.

Unit VII: Classification

Chapter 31: Kingdom Animalia



Chapter 31 Components and Sequence

- ☐ **Lesson**. Lords of Their Domain
- ○ **Lab and Microscope Lab**. Arthropod Arrangement
- ○ **FSS**. John James Audubon
- ○ **SWYK**. Kingdom Animalia

☐ *Found in your Textbook*
○ *Found in your Workbook*

FSS = Famous Science Series research assignment
SWYK=Show What You Know chapter quiz

Read

Lords of Their Domain

Chapter 31: Lesson

Kingdom Animalia

If plants are the kings of domain Eukarya, the organisms in kingdom Animalia are the lords of domain Eukarya. Most of the known and classified species of domain Eukarya are in kingdom Animalia, about 1,324,000. There are 36 animal phyla, but 96 percent of all animal species are in nine of them. With so many different species, there are bound to be many differences, but all of them have some shared traits.

Animals have several shared traits. All animals . . .

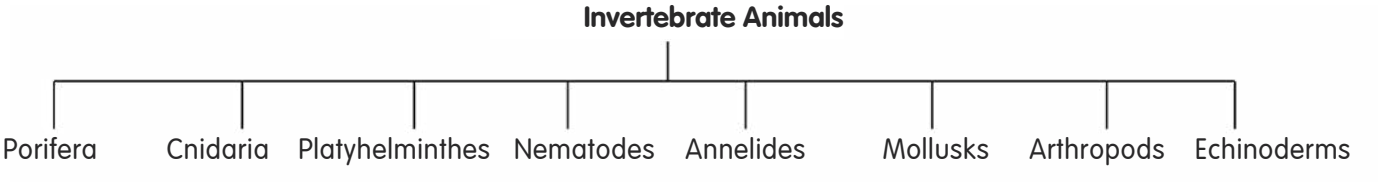
- ★ are multicellular
- ★ are mobile
- ★ have eukaryotic cells
- ★ do not have cell walls
- ★ are heterotrophs, which eat other organisms to get food

Nine Major Animal Phyla

Eukarya	**Domain**
Animalia	**Kingdom**
Porifera  Cnidaria  Platyhelminthes  Nematoda  Annelides  Mollusks  Arthropoda  Echinoderm  Chordata 	**Phyla**

Invertebrates

Most animals are ***invertebrates***. Invertebrates are animals without a backbone. Put your hands around your back and feel your backbone. Can you think of other animals that have a backbone? If you said a dog or a cat, you are right. What about a fish? Fish do have backbones. What about a spider or a fly? A clam or a snail? None of them have backbones; they are all invertebrates.



Phylum Porifera

Everybody knows what sponges are—right? Well, these are probably not the kind of sponges you use to wipe your kitchen counter. The sponges of phylum Porifera are animals!

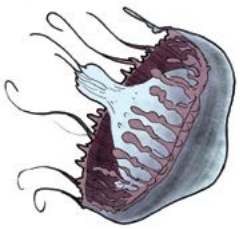
Shared traits of sponges:

- ★ All sponges are aquatic animals.
- ★ All sponges do not have tissues or organs.
- ★ All sponges do have specialized cells and a hollow body.
- ★ Food and water move into the sponge's body through openings called pores. These pores are how phylum Porifera got its name.
- ★ Waste moves out of the sponge's body through a hole in its top.
- ★ Most sponges have a hard spine that gives them support and shape.

Phylum Cnidaria

Have you ever stuck your finger in a sea anemone, been stung by a jellyfish, or seen a piece of coral jewelry? Sea anemones, jellyfish, and coral are all in the same phylum. They are all cnidarians.

Shared traits of cnidarians:



- ★ Cnidarians are aquatic.
- ★ Cnidarians have a radial body plan. This means their body has a central point that the rest of their body is arranged around. This gives them a circular shape.
- ★ Cnidarians have a sac-like body with one opening: their mouth.
- ★ Cnidarians have tentacles with stinging cells surrounding their mouth. They use their stinging cells to paralyze their prey. Then they push the paralyzed prey into their mouth and eat them.

Worm Phyla

There are three phyla of worms: Platyhelminthes, Nematoda, and Annelida.

Phylum Platyhelminthes are flatworms:

★ All flatworms have a flat body with a mouth at one end.

★ Most flatworms are parasites. Tapeworms that can infest your pet are flatworms.

Phylum Nematoda are roundworms:

★ All roundworms have long, threadlike bodies.

★ Most roundworms are parasites.

Phylum Annelida are segmented worms:

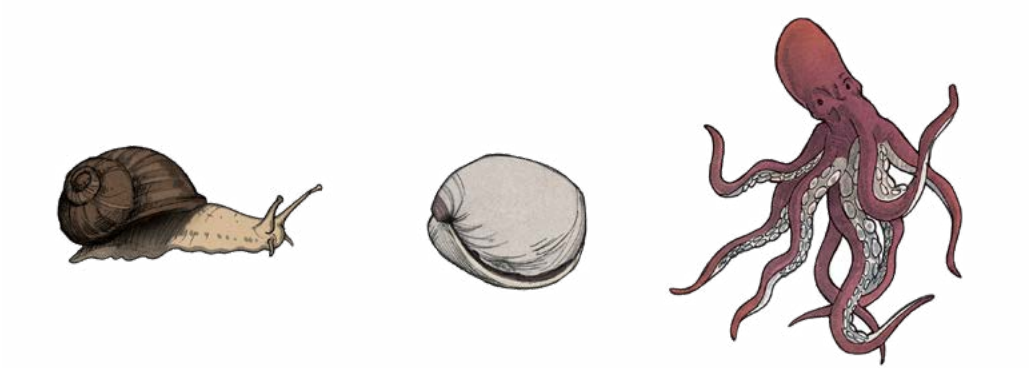
★ Earthworms and leeches are two types of segmented worms.

★ All segmented worms have tube-shaped bodies made from segments.

★ A segmented worm has both male and female parts on it.

Phylum Mollusca

Snails, slugs, squids, octopuses, and shellfish like clams and scallops are all ***mollusks***.



Shared traits of mollusks:

★ Most mollusks live in water; exceptions are snails and slugs.

★ Most mollusks have a shell; exceptions are squids, octopuses, and some species of slugs.

★ All mollusks have a muscular foot that they use so they can move and burrow.

★ All mollusks have soft bodies with a layer of folded skin that protects their internal organs.

Phylum Arthropoda

The largest group of invertebrates is arthropods. The four main classes of arthropods are Crustacea, Myriapoda, Hexapoda, and Arachnida.

Shared traits of arthropods:

- ★ All arthropods have jointed legs and bodies divided into segments.
- ★ All arthropods have an ***exoskeleton***. When they outgrow their exoskeleton, they molt, cast the old exoskeleton off, and grow a new one.
- ★ Most arthropods have antennae; exceptions are arachnids.

Class Crustacea are crustaceans:

- ★ Most crustaceans live in water, such as lobsters, crabs, and shrimp.
- ★ Crustaceans have between 10 and 40 legs!
- ★ Crustaceans always have two pairs of antennae.
- ★ Crustaceans breathe through gills.

Class Myriapoda are centipedes and millipedes:

- ★ Centipedes and millipedes form the class Myriapoda.
- ★ Centipedes and millipedes have long bodies made from lots of segments.
- ★ Centipedes have one pair of legs coming from each segment.
- ★ Millipedes have two pairs of legs coming from each segment.

Class Hexapoda are insects:

Class Hexapoda is the insect group. There are hundreds of thousands of insects on Earth. Insects live in every biome, including the aquatic biome. They might "bug" you when they are around, but insects are important to ecosystems. There are insect species that are decomposers. There are insect species that pollinate plants. In fact, many angiosperm species would go extinct without their insect pollinators.

- ★ All insects have three body divisions: a head, thorax, and abdomen.
- ★ All insects have six legs.
- ★ All insects have one pair of antennae.
- ★ Most insects have one or two pairs of wings.

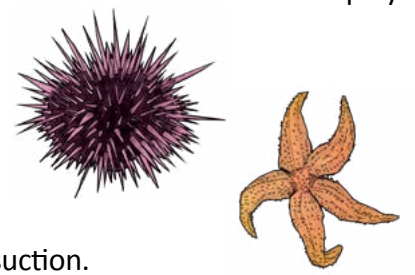
Class Arachnida are arachnids:

Class Arachnida is full of animals you do not want to bump into at night. The arachnids are spiders, scorpions, mites, and ticks.

- ★ Arachnids have two body divisions: a cephalothorax and abdomen.
- ★ Arachnids have eight legs.
- ★ Arachnids do not have antennae.
- ★ Arachnids do not have wings.

Phylum Echinodermata

Starfish, sea urchins, and sand dollars are all echinoderms. The name ***echinoderm*** means "spiny skin."

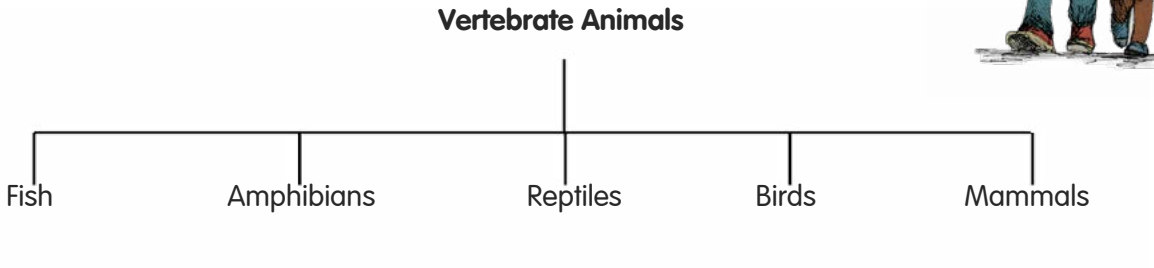


Shared traits of echinoderms:

- ★ Echinoderms live in the marine biome.
- ★ Echinoderms have tough, spiny skin.
- ★ Echinoderms have a radial body plan arranged in five parts.
- ★ Echinoderms move on tube feet by creating and releasing suction.

Vertebrate Animals

Vertebrate animals are in phylum Chordata. Animals with backbones, like you, are vertebrates. Vertebrates have an ***endoskeleton***. An endoskeleton is an internal skeleton that grows with an animal. The endoskeleton can be made of bone, as yours is, or cartilage like that found in sharks. All vertebrates have a head and sophisticated body system.



Phylum Chordata

There are seven classes of chordates, three of them are for fish.

Three classes of fish:

1. Agnatha–jawless fish that do not have scales, such as lamprey
2. Chondrichthyes–fish with cartilage in place of bone, such as sharks
3. Osteichthyes–bony fish, such as tuna and salmon

The other four classes:

4. Amphibia
5. Reptilia
6. Aves–class for birds
7. Mammalia

Fish

Shared traits of fish:

- ★ All fish live in water.
- ★ All fish have a bullet, streamlined shape.
- ★ All fish have fins for swimming.
- ★ All fish breathe through gills. As fish swim, water comes in through their gills. Gills remove oxygen from the water, exchanging it with carbon dioxide.
- ★ Most fish are ***ectotherms***. Ectotherms are sometimes called cold-blooded. Ectotherms regulate their body temperature by exchanging heat with their environment.
- ★ Most fish lay eggs.

Amphibians

Frogs, toads, and salamanders are all amphibians.

Shared traits of amphibians:

- ★ Amphibians lay eggs in water.
- ★ Amphibians go through ***metamorphosis***. Metamorphosis means "change." Amphibians hatch from eggs laid in water. When they hatch they look like fish. They have a tail, fins, and gills. They change as they grow to adult forms that live on land. Adult amphibians have lungs, and four feet instead of fins. Adult frogs and toads lose their tail as well.
- ★ Amphibians have smooth, moist skin they exchange oxygen across.
- ★ Amphibians are also ectotherms.

Reptiles

Crocodiles, alligators, turtles, snakes, and lizards are all reptiles. Dinosaurs were lizards too.

Shared traits of reptiles:

- ★ Reptiles have dry, scaly skin. This cuts down on water loss and enables them to live in dry environments, like the desert biome.
- ★ Reptiles breathe through lungs.
- ★ Reptiles lay eggs that have a leathery shell. The egg contains a food source, and the embryo develops in the egg.
- ★ When reptiles hatch from their egg, they look like miniature adults.
- ★ Reptiles are also ectotherms.

Birds

Shared traits of birds:

- ★ All birds have feathers and wings.
- ★ All birds have two legs covered in scaly skin.
- ★ All birds have a beak with no teeth.
- ★ All birds breathe through lungs.
- ★ All birds lay eggs in hard shells. The egg contains a food source, and the embryo develops in the egg.
- ★ All birds are ***endotherms***. Endotherms are sometimes called warm-blooded. Endotherms regulate their body temperature internally. Their body temperature does not change with the weather as an ectotherm does.
- ★ Most birds can fly.

Mammals

There are three types of mammals: placental mammals, marsupial mammals, and monotremes.

In both ***placental mammals*** and ***marsupial mammals***, a placenta develops in the mother when she is pregnant. Embryos attach to the placenta, and nutrients and waste are transferred across the placenta between mother and embryo. Marsupials give birth to their babies at an earlier stage in development than placental mammals. The babies attach to their marsupial mothers and continue developing on the outside of the mother's body, usually in a pouch. For placental mammals, babies are born at a later and less vulnerable stage of development. You are a placental mammal.

Monotremes are mammals that lay eggs. Monotremes do have internal fertilization, but instead of forming a placenta, an egg forms around each embryo and the mother lays the eggs. The egg contains a food source, and the embryos develop in the eggs outside of the mother. There are only three species of monotremes alive today: the duck-billed platypus, the long-beaked echidna, and the short-beaked echidna. Monotremes are native to Australia, Tasmania, and New Guinea.

A wildebeest is a placental mammal.

A kangaroo is a marsupial mammal.

A duck-billed platypus is a monotreme.

Shared traits of mammals:

- ★ Mammals have hair or fur.
- ★ Mammals breathe through lungs.
- ★ Mammals have ***mammary glands***. Mammals feed milk to their young from their mammary glands.
- ★ Mammals are also endotherms.

TBYB Sample