Biology I Workbook

CK-12 Foundation

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# Chapter 1

# Foundations of Life Science Worksheets

## 1.1 Chapter 1: Foundations of Life Science

- Lesson 1.1: Nature of Science
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## 1.2 Lesson 1.1: Nature of Science

### Lesson 1.1: True or False

**Name**____________________________________ **Class**_____________ **Date**_________

*Write true if the statement is true or false if the statement is false.*

__________1. Science involves objective, logical, and repeatable attempts to understand the principles and forces working in the natural universe.

__________2. Scientific methods are based on gathering observable, empirical and measurable evidence that is critically evaluated.

__________3. Scientific theories are supported by a great deal of data and evidence; they have yet to be proved false.

__________4. In natural experiments, it is difficult to control all variables.

__________5. The goal of science is to understand how everything works.

__________6. A superseded scientific theory is no longer considered the most complete description of reality by mainstream science.

_________7. Scientists accept all claims, regardless of scientific evidence.

_________8. A hypothesis is not really an educated guess, but is also based on what a scientist thinks could happen.

_________9. Scientific laws are principles which can be used to predict the behavior of the natural world.

_________10. An observation can only be made in a controlled, experimental environment.

_________11. Science can be used to answer all questions.

_________12. Answering scientific questions usually begins with an observation.

_________13. A law of nature is a scientific generalization based on a sufficiently large amouont of data or evidence.

_________14. Once an idea is accepted as scientific fact, that idea can never be changed.

_________15. The Cell Theory, the Theory of Evolution and the Germ Theory of Disease are important theories of biology.

## Lesson 1.1: Critical Reading

**Name**______________________________ **Class**___________ **Date**________

*Read this passage from the text and answer the questions that follow.*

**Experiments**

A scientific experiment must have the following features:

- a control, so variables that could affect the outcome are reduced
- the variable being tested reflects the phenomenon being studied
- the variable can be measured accurately, to avoid experimental error
- the experiment must be reproducible.

An **experiment** is a test that is used to eliminate one or more of the possible hypotheses until one hypothesis remains. The experiment is a cornerstone in the scientific approach to gaining deeper knowledge about the physical world. Scientists use the principles of their hypothesis to make predictions, and then test them to see if their predictions are confirmed or rejected.

Scientific experiments involve **controls**, or subjects that are not tested during the investigation. In this way, a scientist limits the factors, or variables that can cause the results of an investigation to differ. A **variable** is a factor that can change over the course of an experiment. **Independent variables** are factors whose values are controlled by the experimenter to determine its relationship to an observed phenomenon (the dependent variable). **Dependent variables** change in response to the independent variable. **Controlled variables** are also important to identify in experiments. They are the variables that are kept constant to prevent them from influencing the effect of the independent variable on the dependent variable.

For example, if you were to measure the effect that different amounts of fertilizer have on plant growth, the independent variable would be the amount of fertilizer used (the changing factor of the experiment). The dependent variables would be the growth in height and/or mass of the plant (the factors that are influenced in the experiment). The controlled variables include the type of plant, the type of fertilizer, the amount of sunlight the plant gets, the size of the pots you use. The controlled variables are controlled by you, otherwise they would influence the dependent variable.

In summary:

- The independent variable answers the question "What do I change?"
- The dependent variables answer the question "What do I observe?"
- The controlled variables answer the question "What do I keep the same?"

**Questions**

1. What is an experiment and how does an experiment relate to a hypothesis?

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2. What is the difference between a control and a variable in a scientific experiment?

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3. Discuss the differences between dependent variables and independent variables.

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4. What is a controlled variable? Provide an example.

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5. If you were to conduct an experiment measuring the effect that different amounts of fertilizer have on plant growth, what would be the independent variable(s), the dependent variable(s), and the controlled variable(s).

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## Lesson 1.1: Multiple Choice

**Name**______________________________ **Class**___________ **Date**________

*Circle the letter of the correct choice.*

1. A scientific experiment must have the following features:
   (a) a control, so variables that may affect the outcome are reduced.
   (b) the variable being tested reflects the question being asked.
   (c) the variable being tested can be measured accurately.
   (d) all of the above
2. In the general process of a scientific investigation, what comes directly after an observation?
   (a) experiment
   (b) prediction
   (c) hypothesis
   (d) theory
3. A hypothesis
   (a) is a suggested explanation for a phenomena based on evidence that can be tested by observation or experimentation.
   (b) is a guess.
   (c) is based on what a scientist thinks could happen.
   (d) is an explanation of a scientific concept.
4. A scientific theory
   (a) describes a guess or an opinion.
   (b) is supported by a great deal of data and evidence.
   (c) is the process of scientific investigation.
   (d) is just another name for a hypothesis.
5. Which of the following is not an accepted, verified scientific theory?

   (a) Atomic Theory
   (b) String Theory
   (c) Theory of Relativity
   (d) Theory of Evolution
6. Which of the following are not true of a scientific law?
   (a) Is a principle which can be used to predict the behavior of the natural world.
   (b) Is well-supported by observations and/or experimental evidence.
   (c) Is the same as a scientific theory.
   (d) Usually refers to rules for how nature will behave under certain conditions.
7. Arrows that are grouped tightly together but away from the bulls eye would be considered
   (a) accurate but not precise.
   (b) precise but not accurate.
   (c) neither accurate nor precise.
   (d) both accurate and precise.

## Lesson 1.1: Vocabulary

**Name**________________________________ **Class**____________ **Date**________

*Match the vocabulary word with the proper defination.*

**Term**

______ 1. deduction

______ 2. variable

______ 3. observation

______ 4. Occam's razor

______ 5. control

______ 6. phenomenon

______ 7. skepticism

______ 8. dependent variable

______ 9. induction

______ 10. hypothesis

**Definition**

a. the act of noting or detecting a phenomenon through the senses

b. is any occurrence that is observable

c. involves determining a single fact from a general statement

d. states that the explanation for a phenomenon should make as few assumptions as possible

e. claims must be exposed to scientific testing through critical thinking before being accepted

f. a factor that can change over the course of an experiment

g. changes in response to the independent variable

h. a suggested explanation based on evidence that can be tested by observation or experimentation

i. something that is not tested during the investigation

j. involves determining a general statement that is very likely to be true, from several facts

## 1.3 Lesson 1.2: Communicating Ideas

### Lesson 1.2: True or False

**Name**_______________________________ **Class**___________ **Date**________

*Write true if the statement is true or false if the statement is false.*

_________ 1. Peer-reviewed journal articles have the lowest level of trust.

_________ 2. One well known and well respected medical journal is JAMA.

_________ 3. Systematic bias is introduced from a flaw in measurements.

_________ 4. A science magazine is written for an expert audience.

_________ 5. Conducting science requires only human creativity.

_________ 6. One source of research funding is from the military.

_________ 7. Bioethics is a slow-growing academic area of inquiry.

_________ 8. One application of biotechnology is bioremediation.

_________ 9. The thale cress has been genetically modified to turn red, only in the presence of nitrogen dioxide.

_________ 10. “Snow World” is a virtual reality game.

### Lesson 1.2: Critical Reading

**Name**_______________________________ **Class**___________ **Date**________

*Read this passage from the lesson and answer the questions that follow.*

**Science in the Media**

A lot of popular science articles come from sources whose aim is to provide a certain amount of entertainment to the reader or viewer. Many popular science articles will examine how a phenomenon relates to people and to their environment. Nevertheless, there is a tendency in the popular media to dilute scientific debates into two sides, rather than cover the complexities and nuances of an issue.

Even well-intentioned scientists can sometimes unintentionally create truth-distorting media firestorms because of journalists' difficulty in remaining critical and balanced, the media's interest in controversy, and the general tendency of science reporting to focus on apparent "groundbreaking findings" rather than on the larger context of a research field. Sometimes scientists will seek to exploit the power of the media. When scientific results are released with great fanfare and limited peer review, the media often requires skepticism and further investigation by skilled journalists and the general public.

The dichloroacetic acid (DCA) story, discussed earlier in this lesson, is an example of what can go wrong when a scientific discovery grasps the public's attention.

An intense amount of public interest was raised by the study and the story received much media attention. As a result, the American Cancer Society and other medical organizations received a large volume of public interest and questions about the "miracle cure," DCA.

One of the first stories about the findings contained the headline:

"Cheap, 'safe' drug kills most cancers"

The article did explain that the studies were only carried out on cancer cells grown in the lab and in rats. However, the headline may have given some readers the impression that human testing of DCA was complete. People were wildly interested in this new "cure" to cancer. This prompted the American Cancer Society and other organizations to issue reports that reminded people that although the study results were promising, no formal clinical trials in humans with cancer had yet been carried out. They stressed the need for caution in interpreting the early results. Doctors warned of possible problems if people attempted to try DCA outside a controlled clinical trial. The media received some criticism for the sensation that arose due to their coverage of the discovery.

**Questions**

1. Rather than focusing on apparent "groundbreaking findings," what should science reporting focus on?

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2. What do scientific results need prior to release to the public, in order to be the most accurate?

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3. If scientific results are not accurate when they are released to the public, what should be the response of the media and the general public?

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4. In reporting about DCA, one of the first stories about the findings contained the headline: "Cheap, 'safe' drug kills most cancers." The headline may have given some readers what impression?

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5. In response to the article mentioned in question 4, what was the response of the American Cancer Society?

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## Lesson 1.2: Multiple Choice

**Name**______________________________ **Class**___________ **Date**________

*Circle the letter of the correct choice.*

1. In which of the following formats are scientific debates properly carried out and reviewed?
   (a) scientific articles published in scientific journals
   (b) government reports
   (c) presentations at academic conferences
   (d) all of the above
2. Which of the following is a well known and well respected science or medical journal?

(a) The Wall Street Journal
(b) The Lancet
(c) Time Magazine
(d) none of the above

3. The first section of a science article is called the

(a) materials and methods.
(b) introduction.
(c) abstract.
(d) discussion.

4. Under what conditions might scientific misconduct occur?

(a) to keep up one's reputation
(b) for commercial motivation
(c) for political motivation
(d) all of the above

5. Which of the following is written for a non-expert audience?

(a) New Scientist
(b) Scientific American
(c) International Polar Year website
(d) all of the above

6. When did Watson, Crick, and Franklin build a model of the double helix structure of DNA?

(a) 1930s
(b) 1940s
(c) 1950s
(d) 1960s

7. Which of the following is a source of funding for scientific research from a non-profit organization?

(a) American Cancer Society
(b) Center for Disease Control
(c) Food and Drug Administration
(d) none of the above

## Lesson 1.2: Vocabulary

**Name**______________________________ **Class**___________ **Date**________

*Match the vocabulary term with the correct definition.*

**Term**

______ 1. euthanasia

______ 2. conflict of interest

______ 3. reproducibility

______ 4. bioremediation

______ 5. peer review

______ 6. research scientist

______ 7. abstract

______ 8. scientific article

______ 9. ethics

______ 10. bioinformatics

**Definition**

a. ability to repeat experiments and get the same results

b. process of opening a scientist's research or ideas to examination by other scientists who are experts in the same field

c. brief, usually one-paragraph, summary of the work

d. choice by a terminally ill person to have medical assistance in dying

e. a written discussion of new research and findings, usually published in a scientific journal

f. person that does scientific investigations and makes discoveries

g. situation in which a researcher has professional or personal interests that are at odds with each other

h. an interdisciplinary field which helps solve biological problems using computers

i. discipline concerned with what is morally good and bad, right and wrong

j. use of microorganisms to clean up contaminated sites

## 1.4 Lesson 1.3: Tools and Techniques

### Lesson 1.3: True or False

**Name**______________________________ **Class**___________ **Date**________

*Write true if the statement is true or false if the statement is false.*

__________ 1. The SI system of measurement is based on multiples of 20.

__________ 2. The symbol for meter is m.

__________ 3. Kilo- is a multiple of a thousandth.

__________ 4. A physics lab might contain a particle accelerator.

__________ 5. Optical microscopes are the simplest and most widely used type of microscope.

__________ 6. TEM images show the outside of an object.

__________ 7. Scientific models are representations of reality.

__________ 8. Latex gloves are recommended for lab use.

__________ 9. Wear loose, floppy clothes in the lab.

__________ 10. Common safety equipment in a school lab includes an eye-wash fountain.

## Lesson 1.3: Critical Reading

**Name**________________________________ **Class**____________ **Date**________

*Read this passage from the lesson and answer the questions that follow.*

**Scientific Models**

Scientific models are representations of reality. To describe particular parts of a phenomenon, or the interactions among a set of phenomena, it is sometimes helpful to develop a model of the phenomenon. For instance, a scale model of a house or of a solar system is clearly not an actual house or an actual solar system; the parts of an actual house or an actual solar system represented by a scale model are, only in limited ways, representative of the actual objects.

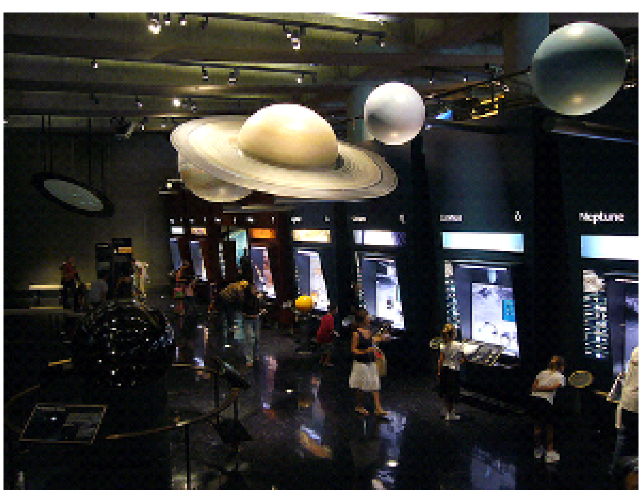

**Figure** A model of planets of the solar system. This model is clearly not a real solar system; it is a representation of the planets Jupiter, Saturn, Neptune, and Uranus. Scientists use representations of natural things to learn more about them. Also, the visitors to the Griffith Observatory in Los Angeles can get a better idea of the relative sizes of the planets (and Pluto!) by observing this model.

**Scientific modeling** is the process of making abstract models of natural phenomena. An **abstract model** is a theoretical construct that represents something. Models are developed to allow reasoning within a simplified framework that is similar to the phenomena being investigated. The simplified model may assume certain things that are known to be incomplete in some details. Such assumptions can be useful in that they simplify the model, while at the same time, allowing the development of acceptably accurate solutions. These models play an important role in developing scientific theories.

A **simulation** is a model that runs over time. A simulation brings a model to life and shows how a particular object or phenomenon will behave. It is useful for testing, analysis or training where real-world systems or concepts can be represented by a model. For the scientist, a model also provides a way for calculations to be expanded to explore what might happen in different situations. This method often takes the form of models that can be programmed into computers. The scientist controls the basic assumptions about the variables in the model, and the computer runs the simulation, eventually coming to a complicated answer.

Examples of models include:

- Computer models
- Weather forecast models
- Molecular models
- Climate models
- Ecosystem models
- Geologic models

One of the main aims of scientific modeling is to allow researchers to quantify their observations about the world. In this way, researchers hope to see new things that may have escaped the notice of other researchers. There are many techniques that model builders use which allow us to discover things about a phenomenon that may not be obvious to everyone.

### Evaluating Models

A person who builds a model must be able to recognize whether a model reflects reality. They must also be able to identify and work with differences between actual data and theory.

A model is evaluated mostly by how it reflects past observations of the phenomenon. Any model that is not consistent with reproducible observations must be modified or rejected. However, a fit to observed data alone is not enough for a model to be accepted as valid. Other factors important in evaluating a model include:

- Its ability to explain past observations
- Its ability to predict future observations
- Its ability to control events
- The cost of its use, especially when used with other models
- Ease of use and how it looks

**Questions**

1. What does a scientific model do?

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2. What is the advantage of assumptions in a model?

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3. What is a simulation?

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4. Name three examples of models.

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5. What is a model evaluated mostly by?

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## Lesson 1.3: Multiple Choice

**Name**______________________________ **Class**___________ **Date**________

*Circle the letter of the correct choice.*

1. The SI system of measurement is based on multiples of
    (a) 10s.
    (b) 20s.
    (c) 50s.
    (d) 100s.
2. The following are SI base units
    (a) meter.
    (b) kilogram.
    (c) kelvin.
    (d) all of the above
3. Equipment most likely found in a physics lab would include
    (a) Bunsen burners.
    (b) a particle accelerator.
    (c) microscopes.
    (d) none of the above
4. Typical magnification of a light microscope is up to
    (a) 500x.
    (b) 1000x.
    (c) 1500x.
    (d) 2000x.
5. An ocular lens with a magnification of 10x and an objective lens with a magnification of 50x together will magnify an object by
    (a) 60x.
    (b) 100x.
    (c) 250x.
    (d) 500x.
6. Biosphere 2 was built to
    (a) forecast wind speeds and directions.
    (b) attempt to recreate a self-sustaining biome.
    (c) predict water flow in the Everglades.
    (d) none of the above
7. What are the best kind of shoes to wear in the lab?
    (a) enclosed toe shoes
    (b) sandals
    (c) flip flops
    (d) none of the above

## Lesson 1.3: Vocabulary

**Name**________________________________ **Class**___________ **Date**________

*Match the vocabulary term with the correct definition.*

**Term**

______ 1. microscopes

______ 2. aseptic technique

______ 3. statistics

______ 4. stereo microscope

______ 5. lab techniques

______ 6. International System of Units (SI)

______ 7. simulation

______ 8. scientific modeling

______ 9. optical microscope

**Definition**

a. the procedures used in science to carry out an experiment

b. the measurements that scientists use; a form of the metric system

c. a mathematical science in which the collection, analysis, interpretation or explanation, and presentation of data is carried out

d. a microscope that uses visible light and lenses to magnify objects

e. a model that runs over time

f. a light microscope with two ocular lenses

g. instruments used to view objects that are too small to be seen by the naked eye

h. the process of making abstract models of natural phenomena

i. laboratory procedures that are carried out under sterile conditions

# 1.5 Lesson 1.4: Principles of Biology

## Lesson 1.4: True or False

**Name**________________________________ **Class**___________ **Date**________

*Write true if the statement is true or false if the statement is false.*

_________ 1. One of the traits of a living organism is it grows and changes.

_________ 2. The cell is the basic unit of life.

_________ 3. Evolutionary theory cannot explain how specialized features develop in different species.

_________ 4. In mutualism, both organisms in the relationship are harmed.

_________ 5. The biosphere includes all living things within all of their environments.

_________ 6. About 80 percent of freshwater fish from South America are not yet classified.

_________ 7. The Earth is about 2.0 billion years old.

_________ 8. Oswald Avery and his colleagues identified DNA as the genetic material.

_________ 9. Since 1953, genetics and molecular biology have become core aspects of evolutionary biology.

_________ 10. Humans evolved from chimpanzees.

## Lesson 1.4: Critical Reading

**Name**_______________________________ **Class**___________ **Date**________

*Read this passage from the lesson and answer the questions that follow.*

**Unifying Principles of Biology**

There are four unifying principles of biology that are important for types of biology studies. These are:

**The Cell Theory**

The cell is the basic unit of life. The Cell Theory states that all living things are made of one or more cells, or the secretions of those cells, such as the organisms shown in **Figure 3**. For example, shell and bone are built by cells from substances that they secrete into their surroundings. Cells come from cells that already exist, that is, they do not suddenly appear from nowhere. In organisms that are made of many cells (called multicellular organisms), every cell in the organism's body derives from the single cell that results from a fertilized egg. You will learn more about cells and the Cell Theory in the *Cell Structure and Function* chapter.

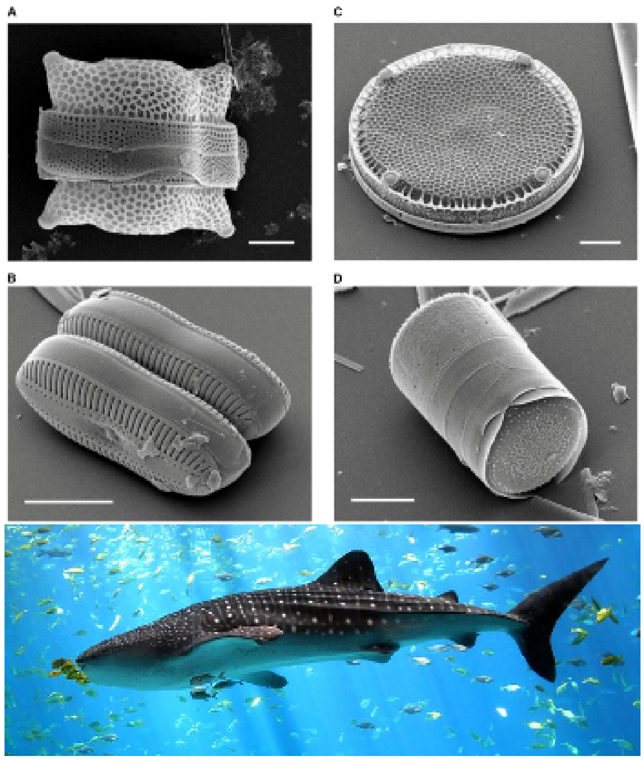


**Figure** Tiny diatoms and whale sharks are all made of cells. Diatoms are about 20 $\mu$ $m$ in diameter and are made up of one cell, whereas whale sharks can measure up to 12 *meters* in length, and are made up of billions of cells.

### Gene Theory

A living organism's traits are encoded in their DNA, the large molecule, or macromolecule, that holds the instructions needed to build cells and organisms. DNA makes up the genes of an organism. Traits are passed on from one generation to the next by way of these genes. Information for how the organism appears and how its cells work come from the organism's genes. Although the appearance and cell function of the organism may change due to the organism's environment, the environment does not change its genes. The only way that genes can change in response to a particular environment is through the process of evolution in populations of organisms. You will learn more about DNA and genes in the *Molecular Genetics* chapter.

### Homeostasis

Homeostasis is the ability of an organism to control its body functions in order to uphold a stable internal environment even when its external environment changes. All living organisms perform homeostasis. For example, cells maintain a stable internal acidity (pH); and warm-blooded animals maintain a constant body temperature. You will learn more about homeostasis in *The Human Body* chapter.

Homeostasis is a term that is also used when talking about the environment. For example, the atmospheric concentration of carbon dioxide on Earth has been regulated by the concentration of plant life on Earth because plants remove more carbon dioxide from the atmosphere during the daylight hours than they emit to the atmosphere at night.

**Evolution**

Evolution by natural selection, is the theory that maintains that a population's inherited traits change over time, and that all known organisms have a common origin. Evolutionary theory can explain how specialized features, such as the geckos sticky foot pads shown in Figure 4, develop in different species. You will learn more about evolution in the *Evolutionary Theory* and *Evolution in Populations* chapters.

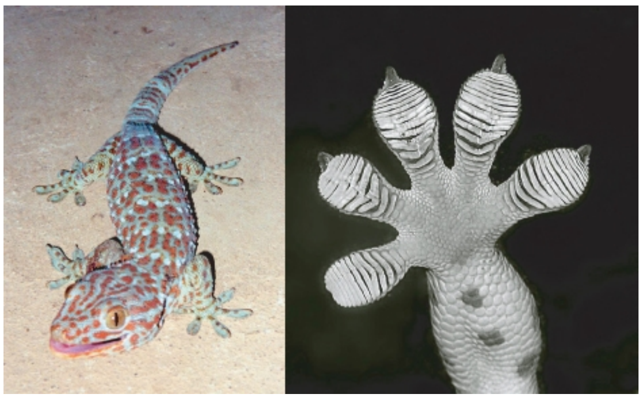

**Figure** A Tokay Gecko. The pads at the tip of the Tokay gecko's foot are covered in microscopic hairs, each split into hundreds of tips that measure about 200 *nanometers* in diameter. By using these tiny hairs that can cling to smooth surfaces, the geckos are able to support their entire body weight while climbing walls, definately a product of evolution.

**Questions**

1. What do diatoms and whale sharks have in common?

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2. What is the only way that genes can change in response to a particular environment?

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3. What is homeostasis?

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4. How do cells perform homeostasis?

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5. How are the pads of the Tokay gecko's foot adapted for climbing?

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## Lesson 1.4: Multiple Choice

**Name**_______________________________ **Class**____________ **Date**________

*Circle the letter of the correct choice.*

1. Immunology is the study of
   (a) how organisms interact with their environment.
   (b) life at the level of the cell.
   (c) an organism's resistance to disease.
   (d) none of the above
2. A living organism
   (a) responds to its environment.
   (b) grows and changes.
   (c) is composed of cells.
   (d) all of the above
3. Cells together form
   (a) atoms.
   (b) tissues.
   (c) molecules.
   (d) organelles.
4. How many numbers of cells are whale sharks made up of?
   (a) hundreds.
   (b) thousands.
   (c) millions.

(d) billions.

5. *E. coli* bacteria living inside your intestines is an example of what kind of relationship?
   (a) mutualistic.
   (b) parasitic.
   (c) predatory.
   (d) none of the above
6. A desert community consists of
   (a) rabbits.
   (b) ocotillo.
   (c) snakes.
   (d) all of the above
7. About how many billion years old is the Earth?
   (a) 1.5
   (b) 3.0
   (c) 4.5
   (d) 6.0

## Lesson 1.4: Vocabulary

**Name**________________________________ **Class**____________ **Date**________

*Match the vocabulary term with the correct definition.*

**Term**

______ 1. cell

______ 2. biochemistry

______ 3. botany

______ 4. organism

______ 5. adaptation

______ 6. biology

______ 7. community

______ 8. biological interactions

______ 9. cell biology

______ 10. evolutionary biology

**Definition**

a. the study of the chemicals that make up life

b. the study of life

c. an individual living creature

d. the study of life at the level of the cell

e. the interactions between different organisms in an environment

f. composed of the relationships between groups of different species

g. the smallest unit of structure and function of living organisms

h. refers to the process of becoming adjusted to an environment

i. the study of how populations and species change over time

j. the study of plants

# Chapter 2

# Chemical Basis of Life Worksheets

## 2.1 Chapter 2: Chemical Basis of Life

- Lesson 2.1: Matter
- Lesson 2.2: Organic Compounds
- Lesson 2.3: Chemical Reactions
- Lesson 2.4: Water

## 2.2 Lesson 2.1: Matter

### Lesson 2.1: True or False

**Name**________________________________ **Class**____________ **Date**________

*Write true if the statement is true or false if the statement is false.*

_________ 1. An atom is the smallest particle of a chemical compound.

_________ 2. There are only about 20 known elements.

_________ 3. Elements called metals are generally shiny.

_________ 4. Ionic bonds form between atoms with the same electronegativity.

_________ 5. Water is an example of an organic compound.

_________ 6. Most organic compounds are held together by covalent bonds.

_________ 7. Substances in a mixture can be separated only with a chemical reaction.

_________ 8. Energy is a property of matter.

_________ 9. Organisms change energy from one form to another.

_________ 10. Molecules of liquid water have less energy than molecules of ice.

_________ 11. Matter keeps changing state.

_________ 12. Water vapor is the same thing as air.

## Lesson 2.1: Critical Reading

**Name**_______________________________ **Class**___________ **Date**________

*Read this passage from the lesson and answer the questions that follow.*

**Matter and Energy**

Energy is a property of matter that is defined as the ability to do work. The concept of energy is useful for explaining and predicting most natural phenomena, and it is foundational for an understanding of biology. All living organisms need energy to grow and reproduce. However, energy can never be created or destroyed. It is always conserved. This is called the law of conservation of energy. Therefore, organisms cannot create the energy they need. Instead, they must obtain energy from the environment. Organisms also cannot destroy or use up the energy they obtain. They can only change it from one form to another.

**Forms of Energy**

Energy can take several different forms. Common forms of energy include light, chemical, and heat energy. Other common forms are kinetic and potential energy.

**How Organisms Change Energy**

In organisms, energy is always changing from one form to another. For example, plants obtain light energy from sunlight and change it to chemical energy in food molecules. Chemical energy is energy stored in bonds between atoms within food molecules. When other organisms eat and digest the food, they break the chemical bonds and release the chemical energy. Organisms do not use energy very efficiently. About 90 percent of the energy they obtain from food is converted to heat energy that is given off to the environment.

**Questions**

1. How is energy defined?

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2. Why do living organisms need energy?

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3. Why must organisms obtain energy from the environment?

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4. What is one way that organisms change energy?

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5. Explain what this statement means: *Organisms do not use energy very efficiently.*

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-

-

## Lesson 2.1: Multiple Choice

**Name**________________________________ **Class**____________ **Date**________

*Circle the letter of the correct choice.*

1. All elements and compounds are
   (a) rganic substances.
   (b) inorganic substances.
   (c) chemical substances.
   (d) all of the above.
2. Which element is a nonmetal?
   (a) iron
   (b) gold
   (c) copper
   (d) hydrogen
3. A chemical compound always has the same
   (a) composition.
   (b) volume.

(c) mass.
(d) state.

4. Chemical bonds form when atoms share
   (a) neutrons.
   (b) electrons.
   (c) protons.
   (d) molecules.
5. Types of chemical bonds include ionic bonds and
   (a) organic bonds.
   (b) covalent bonds.
   (c) atomic bonds.
   (d) potential bonds.
6. Common forms of energy include
   (a) light energy.
   (b) chemical energy.
   (c) heat energy.
   (d) all of the above.
7. Which object has kinetic energy?
   (a) A tire on a parked car.
   (b) A stone at the bottom of a pond.
   (c) A leaf falling from a tree.
   (d) A diver standing on a diving board.

## Lesson 2.1: Vocabulary

**Name**________________________________ **Class**____________ **Date**________

*Match the vocabulary term with the correct definition.*

**Term**

______ 1. element

______ 2. metal

______ 3. chemical compound

______ 4. water

______ 5. mixture

______ 6. energy

______ 7. kinetic energy

______ 8. potential energy

______ 9. solid

______ 10. liquid

**Definition**

a. substance that forms in a chemical reaction

b. chemical compound with twice as many hydrogen atoms as oxygen atoms

c. pure substance that cannot be broken down into different types of substances

d. ability to do work

e. stored energy

f. state of matter in which atoms change positions but do not move apart

g. type of element that is a good conductor of heat and electricity

h. state of matter in which atoms do not move

i. energy of movement

j. combination of two or more chemical substances in any proportions

## 2.3 Lesson 2.2: Organic Compounds

### Lesson 2.2: True or False

**Name**________________________________ **Class**____________ **Date**________

*Write true if the statement is true or false if the statement is false.*

_________ 1. Carbohydrates contain nitrogen, carbon, hydrogen, and oxygen.

_________ 2. Table sugar is an example of a monosaccharide.

_________ 3. Complex carbohydrates form the external skeleton of some animals.

_________ 4. Lipids include substances such as fats and oils.

_________ 5. Saturated fatty acids are found mainly in animals.

_________ 6. Unsaturated fatty acids form straight chains.

_________ 7. Lipids are the only organic molecules used for energy.

_________ 8. All amino acids have the same basic structure.

_________ 9. Long chains of amino acids are called polynucleotides.

_________ 10. Proteins make up the majority of muscle tissues.

_________ 11. Hemoglobin is a protein that carries oxygen in the blood.

_________ 12. Nucleic acids are found in all living cells and viruses.

_________ 13. Chains of nucleic acids are held together by bonds between sugars.

_________ 14. Groups of four bases each form "words" of the genetic code.

## Lesson 2.2: Critical Reading

**Name**_______________________________ **Class**___________ **Date**________

*Read this passage from the lesson and answer the questions that follow.*

**Lipids**

Lipids are organic compounds that contain mainly carbon, hydrogen, and oxygen. They include substances such as fats and oils. Lipid molecules consist of fatty acids, with or without additional molecules. Fatty acids are organic compounds that have the general formula CH3(CH2)nCOOH, where n usually ranges from 2 to 28 and is always an even number.

**Saturated and Unsaturated Fatty Acids**

Fatty acids can be saturated or unsaturated. The term saturated refers to the placement of hydrogen atoms around the carbon atoms. In a saturated fatty acid, all the carbon atoms (other than carbon in the -COOH group) are bonded to as many hydrogen atoms as possible. Saturated fatty acids do not contain any other groups except -COOH. This is why they form straight chains. Because of this structure, saturated fatty acids can be packed together very tightly. This allows organisms to store chemical energy very densely. The fatty tissues of animals contain mainly saturated fatty acids. In an unsaturated fatty acid, some carbon atoms are not bonded to as many hydrogen atoms as possible. This is because they are bonded to one or more additional groups. Wherever these other groups bind with carbon, they cause the chain to bend. This gives unsaturated fatty acids different properties than saturated fatty acids. For example, unsaturated fatty acids are liquids at room temperature whereas saturated fatty acids are solids. Unsaturated fatty acids are found mainly in plants, especially in fatty tissues such as nuts and seeds. Unsaturated fatty acids occur naturally in bent shapes. However, unsaturated fatty acids can be artificially manufactured to have straight chains like saturated fatty acids. Called trans fatty acids, these synthetic lipids were commonly added to foods, until it was found that they increased the risk for certain health problems. Many food manufacturers no longer use trans fatty acids for this reason.

**Types of Lipids**

Lipids may consist of fatty acids alone or in combination with other compounds. Several types of lipids consist of fatty acids combined with a molecule of alcohol:

- Triglycerides are the main form of stored energy in animals. This type of lipid is commonly called fat.
- Phospholipids are a major component of the membranes surrounding the cells of all organisms.
- Steroids have several functions. The steroid cholesterol is an important part of cell membranes and plays other vital roles in the body. Other steroids are male and female sex hormones.

**Questions**

1. What are fatty acids?

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-

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2. Compare and contrast saturated and unsaturated fatty acids.

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-

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3. Why should you avoid eating foods containing trans fatty acids?

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-

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4. What are triglycerides?

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-

-

5. Why do organisms need phospholipids?

-

-

-

## Lesson 2.2: Multiple Choice

**Name**______________________________ **Class**___________ **Date**________

*Circle the letter of the correct choice.*

1. Which carbohydrate is not a simple sugar?
   (a) fructose
   (b) sucrose
   (c) glucose
   (d) amylose
2. Complex carbohydrates that are used to store energy include
   (a) chitin.
   (b) cellulose.
   (c) glycogen.
   (d) all of the above
3. Which statement is true of all fatty acids?
   (a) They are liquids at room temperature.
   (b) They can be manufactured by the human body.
   (c) They consist of cholesterol and triglycerides.
   (d) They contain carbon, hydrogen, and oxygen.
4. Fatty acids to avoid in healthful diet include
   (a) omega-3 fatty acids.
   (b) omega-6 fatty acids.
   (c) saturated fatty acids.
   (d) all of the above
5. The part of an amino acid that determines its unique properties is its
   (a) sugar molecule.
   (b) phosphate group.
   (c) side chain.
   (d) peptide.
6. One role of proteins is to
   (a) help maintain the shape of cells.
   (b) form cell membranes.
   (c) contain the genetic code.
   (d) form cell walls.
7. Which statement is true of all nucleic acids?
   (a) They consist of two chains.
   (b) They are found only in the nucleus of cells.

(c) They have a double helix shape.
(d) They contain phosphorus.

## Lesson 2.2: Vocabulary

**Name**______________________________ **Class**___________ **Date**________

*Match the vocabulary term with the correct definition.*

**Term**

______ 1. functional group

______ 2. simple sugar

______ 3. complex carbohydrate

______ 4. lipid

______ 5. steroid

______ 6. amino acid

______ 7. peptide

______ 8. nucleic acid

______ 9. DNA

______ 10. RNA

**Definition**

a. another term for a polysaccharide

b. type of organic compound that consists of smaller units called nucleotides

c. small group of elements within an organic compound that determines the nature and function of the organic compound

d. double-stranded nucleic acid that contains the genetic instructions for proteins

e. another term for a monosaccharide or disaccharide

f. single-stranded nucleic acid that helps assemble amino acids and make proteins

g. short chain of amino acids

h. type of organic compound that consists of one or more fatty acids with or without additional molecules

i. small organic molecule that is a building block of proteins

j. type of lipid that helps form cell membranes

## 2.4 Lesson 2.3: Chemical Reactions

### Lesson 2.3: True or False

**Name**________________________________ **Class**____________ **Date**________

*Write true if the statement is true or false if the statement is false.*

_________ 1. The arrow in a chemical equation shows the direction in which the reaction occurs.

_________ 2. In a chemical reaction, the quantity of some of the elements usually changes.

_________ 3. A decomposition reaction occurs when sodium combines with hydrochloric acid to produce table salt.

_________ 4. The combustion of methane is an example of an exothermic reaction.

_________ 5. All catabolic reactions have heat as one of their products.

_________ 6. An example of an anabolic reaction is the breakdown of glucose molecules.

_________ 7. The energy released in a chemical reaction is called activation energy.

_________ 8. In all chemical reactions, reactants need energy to collide and react.

_________ 9. The speed of a chemical reaction depends only on the temperature of the reactants.

_________ 10. Most chemical reactions in organisms would be impossible without enzymes.

_________ 11. An enzyme speeds up a chemical reaction by adding heat to the reactants.

_________ 12. In animals, enzymes are needed only to help digest food.

### Lesson 2.3: Critical Reading

**Name**________________________________ **Class**____________ **Date**________

*Read this passage from the lesson and answer the questions that follow.*

**Enzymes and Biochemical Reactions**

Most chemical reactions within organisms would be impossible under the conditions in cells. For example, the body temperature of most organisms is too low for reactions to occur quickly enough to carry out life processes. Reactants may also be present in such low concentrations that it is unlikely they will meet and collide. Therefore, the rate of most biochemical reactions must be increased by a catalyst. A catalyst is a chemical that speeds up chemical reactions. In organisms, catalysts are called enzymes. Like other catalysts, enzymes are not reactants in the reactions they control. They help the reactants interact but are not used up in the reactions. Instead, they may be used over and over again. Unlike other catalysts, enzymes are usually highly specific for particular chemical reactions. They generally catalyze only one or a few types of reactions. Enzymes are extremely efficient in speeding up reactions. They can catalyze up to several million reactions per second. As a result, the difference in rates of biochemical reactions with and without enzymes may be enormous. A typical biochemical reaction might take hours or even days to occur under normal cellular conditions without an enzyme but less than a second with the enzyme.

### How Enzymes Work

How do enzymes speed up biochemical reactions so dramatically? Like all catalysts, enzymes work by lowering the activation energy of chemical reactions. Enzymes generally lower activation energy by reducing the energy needed for reactants to come together and react. For example:

- Enzymes bring reactants together so they don't have to expend energy moving about until they collide at random. Enzymes bind both reactant molecules (called substrate), tightly and specifically, at a site on the enzyme molecule called the active site.
- By binding reactants at the active site, enzymes also position reactants correctly, so they do not have to overcome intermolecular forces that would otherwise push them apart. This allows the molecules to interact with less energy.
- Enzymes may also allow reactions to occur by different pathways that have lower activation energy.

### Questions

1. Why are enzymes essential for life processes of organisms?

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2. Reactants are used up in chemical reactions but enzymes can be used over and over again. Why?

-

-

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3. How efficient are enzymes in speeding up chemical reactions? Give details to support your answer.

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4. How are enzymes like other catalysts? How are they different?

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-

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5. Describe one way that enzymes may lower the activation energy of reactions.

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## Lesson 2.3: Multiple Choice

**Name**_______________________________ **Class**___________ **Date**________

*Circle the letter of the correct choice.*

1. How many molecules of oxygen are reactants in this chemical reaction? $CH_4 + 2O_2 \rightarrow CO_2 + H_2O$
   (a) zero
   (b) one
   (c) two
   (d) four
2. What type of reaction is this: methane + oxygen → carbon dioxide + water?
   (a) endothermic reaction
   (b) combustion reaction
   (c) substitution reaction
   (d) anabolic reaction
3. Which reaction is an example of a synthesis reaction?
   (a) $N_2 + 3H_2 \rightarrow 2NH_3$
   (b) $2H_2O \rightarrow 2H_2 + O_2$
   (c) $2Na^+ + 2HCl \rightarrow 2NaCl + H_2$
   (d) $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$
4. What is the general formula for an endothermic reaction?
   (a) Reactants + Heat → Products
   (b) Reactants + Products → Heat
   (c) Reactants - Heat → Products

(d) Reactants $\rightarrow$Products + Heat

5. When amino acids combine to form a protein, the reaction is a(n)
    (a) exothermic reaction.
    (b) decomposition reaction.
    (c) anabolic reaction.
    (d) combustion reaction.
6. A catalyst is any chemical that
    (a) is present at the start of a chemical reaction.
    (b) is produced during a chemical reaction.
    (c) binds with an enzyme in a chemical reaction.
    (d) speeds up a chemical reaction.
7. A chemical reaction catalyzed by an enzyme requires
    (a) fewer reactants.
    (b) more products.
    (c) less activation energy.
    (d) more chemical bonds.

## Lesson 2.3: Vocabulary

**Name**________________________________ **Class**____________ **Date**________

*Match the vocabulary term with the correct definition.*

**Term**

______ 1. reactant

______ 2. product

______ 3. combustion reaction

______ 4. synthesis reaction

______ 5. substitution reaction

______ 6. exothermic reaction

______ 7. catabolic reaction

______ 8. anabolic reaction

______ 9. activation energy

______ 10. enzyme

**Definition**

a. reaction in which one element replaces another element in a compound

b. reaction in which reactants unite to form a more complex product

c. any chemical reaction that releases energy

d. energy needed for a chemical reaction to get started

e. substance that forms as a result of a chemical reaction

f. reaction in which a compound or element burns in oxygen

g. exothermic reaction that occurs in organisms

h. substance involved in a chemical reaction that is present at the beginning of the reaction

i. chemical that speeds up chemical reactions in organisms

j. endothermic reaction that occurs in organisms

## 2.5 Lesson 2.4: Water

### Lesson 2.4: True or False

**Name**______________________________ **Class**___________ **Date**________

*Write true if the statement is true or false if the statement is false.*

_________ 1. Most of Earth's water exists in the atmosphere as water vapor.

_________ 2. Hydrogen bonds form between hydrogen atoms of adjacent water molecules.

_________ 3. A solution has the same proportion of substances throughout.

_________ 4. Nonpolar substances are more soluble in water than are polar substances.

_________ 5. The concentration of hydronium ions in a solution indicates its solubility.

_________ 6. An example of a very strong acid is bleach.

_________ 7. Acids have a bitter taste and feel slimy to the touch.

_________ 8. Most enzymes require a specific range of pH in order to do their job.

_________ 9. Bicarbonate ions help the body maintain a healthful pH.

_________ 10. Humans are composed of about 95 percent water.

_________ 11. Water molecules are released during anabolic reactions.

_________ 12. An example of a hydration reaction is cellular respiration.

## Lesson 2.4: Critical Reading

**Name**________________________________ **Class**____________ **Date**________

*Read this passage from the lesson and answer the questions that follow.*

**Water and Life**

Humans are composed of about 70 percent water. This water is crucial for normal functioning of the body. Water's ability to dissolve most biologically significant compounds—from inorganic salts to large organic molecules—makes it a vital solvent inside organisms and cells. Water is an essential part of most metabolic processes within organisms. Metabolism is the sum total of all body reactions, including those that build up molecules (anabolic reactions) and those that break down molecules (catabolic reactions). In anabolic reactions, water is generally removed from small molecules in order to make larger molecules. In catabolic reactions, water is used to break bonds in larger molecules in order to make smaller molecules. Water is central to two related, fundamental metabolic reactions in organisms: photosynthesis and respiration. All organisms depend directly or indirectly on these two reactions.

- In photosynthesis, cells use the energy in sunlight to change water and carbon dioxide into glucose and oxygen. It is represented by the chemical equation:

$$6CO_2 + 6H_2O + \text{energy} \rightarrow C_6H_{12}O_6 + 6O_2$$

- In cellular respiration, cells break down glucose in the presence of oxygen and release energy, water, and carbon dioxide. It is represented by the chemical equation:

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + \text{energy}$$

Two other types of reactions that occur in organisms and involve water are dehydration and hydration reactions. A dehydration reaction occurs when molecules combine to form a single, larger molecule and also a molecule of water. It is a type of catabolic reaction. An example of a dehydration reaction is the formation of peptide bonds between amino acids in a polypeptide chain. When two amino acid bond together, a molecule of water is lost. A hydration reaction is the opposite of a dehydration reaction. A hydration reaction adds water to an organic molecule and breaks the large molecule into smaller molecules. It is a type of anabolic reaction. An example of a hydration reaction is the breaking of peptide bonds in polypeptides to form individual amino acids. Water is essential for all of these important chemical reactions in organisms. As a result, virtually all life processes depend on water. Clearly, without water, life as we know it could not exist.

**Questions**

1. Why is water a good solvent for organisms?

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2. Define metabolism.

-

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3. What is the difference between anabolic and catabolic reactions? Give an example of each.

-

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4. How is water involved in photosynthesis?

-

-

-

5. What is water's role in hydration reactions?

-

-

-

## Lesson 2.4: Multiple Choice

**Name**_______________________________ **Class**___________ **Date**________

*Circle the letter of the correct choice.*

1. The greatest percentage of Earth's freshwater is in
   (a) the atmosphere.
   (b) rivers and lakes.

(c) living organisms.
(d) glaciers and polar ice caps.

2. The polarity of water molecules causes them to form
   (a) new elements.
   (b) hydrogen bonds.
   (c) nuclei.
   (d) solutes.
3. In ocean water, water is the
   (a) ion.
   (b) base.
   (c) solute.
   (d) solvent.
4. Water cannot dissolve substances that are
   (a) very dense.
   (b) highly basic.
   (c) highly acidic.
   (d) strongly nonpolar.
5. A solution with a low hydronium ion concentration is
   (a) an acid.
   (b) a base.
   (c) a neutral solution.
   (d) pure water.
6. Compared with the pH of pure water, the pH of a base is
   (a) lower.
   (b) higher.
   (c) the same.
   (d) zero.
7. What type of reaction is represented by this equation? $NaOH + HCl \rightarrow NaCl + H_2O$
   (a) neutralization
   (b) hydration
   (c) catabolism
   (d) precipitation

## Lesson 2.4: Vocabulary

**Name**______________________________ **Class**___________ **Date**________

*Match the vocabulary term with the correct definition.*

**Term**

______ 1. acid

______ 2. base

______ 3. ion

______ 4. metabolism

______ 5. neutralization

______ 6. pH

______ 7. polarity

______ 8. solubility

______ 9. solute

______ 10. solvent

**Definition**

a. ability of a solute to dissolve in a particular solvent

b. sum total of all body reactions

c. measure of the acidity of a solution

d. solution with a higher hydronium ion concentration than pure water

e. substance in a solution that dissolves the other substance

f. solution with a pH higher than 7

g. reaction in which an acid and a base react to form a salt and water

h. substance in a solution that is dissolved by the other substance

i. difference in electrical charge between different parts of a molecule

j. electrically charged atom or molecule

# Chapter 3

# Cell Structure and Function Worksheets

## 3.1 Chapter 3: Cell Structure and Function

- Lesson 3.1: Introduction to Cells
- Lesson 3.2: Cell Structures
- Lesson 3.3: Cell Transport and Homeostasis

## 3.2 Lesson 3.1: Introduction to Cells

### Lesson 3.1: True or False

**Name**______________________________ **Class**___________ **Date**________

*Write true if the statement is true or false if the statement is false.*

_________ 1. Individual cells are so tiny that they must be viewed with an electron microscope.

_________ 2. Robert Hooke viewed cork cells using a light microscope that he himself made.

_________ 3. Anton van Leeuwenhoek used a light microscope to view plaque from his own teeth!

_________ 4. The magnification of a microscope is the same number as its resolution.

_________ 5. Individual organelles can be seen with an electron microscope.

_________ 6. One strand of the cell theory states that all cells have a nucleus.

_________ 7. Another strand of the cell theory states that all living organisms are comprised of one or more cells.

__________ 8. Today, the spontaneous generation of life hypothesis is generally accepted as true.

__________ 9. Most cells are small so that they have a large surface-area-to-volume ratio.

__________ 10. One micrometer ($\mu m$) is the same distance as $10^{-2}$ *meters*.

__________ 11. Most cells are between 1 and 100 $\mu m$ in diameter.

__________ 12. All cells that synthesize proteins have ribosomes.

__________ 13. Prokaryotic cells do not have a nucleus.

__________ 14. Prokaryotic cells do not have any genetic material.

__________ 15. Eukaryotic cells lack mitochondria.

## Lesson 3.1: Critical Reading

**Name**________________________________ **Class**____________ **Date**________

*Read this passage from the lesson and answer the questions that follow.*

**Cell Size**

If cells have such an important job, why are they so small? And why are there no organisms with huge cells? The answers to these questions lie in a cell's need for fast, easy food. The need to be able to pass nutrients and gases into and out of the cell sets a limit on how big cells can be. The larger a cell gets, the more difficult it is for nutrients and gases to move in and out of the cell.

As a cell grows, its volume increases more quickly than its surface area. If a cell were to get very large, the small surface area would not allow enough nutrients to enter the cell quickly enough for the cell's needs. **Figure 5** explains how this works. However, large cells have a way of dealing with some size challenges. Big cells, such as some white blood cells, often grow more nuclei so that they can supply enough proteins and RNA for the cell's needs. Large, metabolically active cells often have lots of folds in their cell surface membrane. These folds increase the surface area available for transport into or out of the cell. Such cell types are found lining your small intestine, where they absorb nutrients from your food through little folds called microvilli.

**Scale of Measurements**

$1\ centimeter\ (cm) = 10\ millimeters\ (mm) = 10^{-2}\ meters\ (m)$

$1\ mm = 1000\ micrometers\ (\mu m) = 10^{-3}\ m$

$1\ \mu m = 1000\ nanometers\ (nm) = 10^{-6}\ m$

$1\ nm = 10^{-3}\ \mu m$

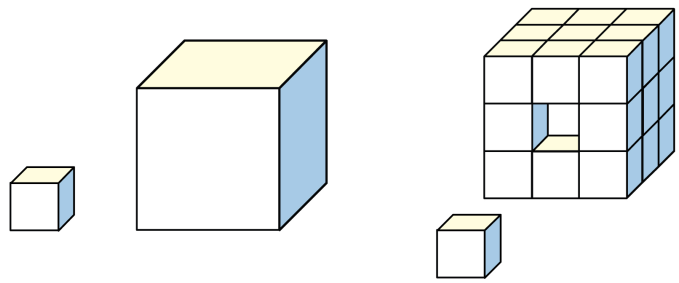

Figure 3.1: A small cell (left), has a larger surface-area to volume ratio than a bigger cell (center). The greater the surface-area to volume ratio of a cell, the easier it is for the cell to get rid of wastes and take in essential materials such as oxygen and nutrients. (1)

Imagine cells as little cube blocks. A small cube cell is one unit in length.

The total surface area of this cell is calculated by the equation:

height × width × number of sides × number of boxes

$$1 \times 1 \times 6 \times 1 = 6$$

The volume of the cell is calculated:

height × width × length × number of boxes

$$1 \times 1 \times 1 \times 1 = 1$$

The surface-area to volume ratio is:

area ÷ volume

$$6 \div 1 = 6$$

A larger cell that is 3 *units* in length would have a total surface area of

$$3 \times 3 \times 6 \times 1 = 54$$

and a volume of:

$$3 \times 3 \times 3 \times 1 = 27$$

The surface-area to volume ratio of the large cell is:

$$54 \div 27 = 2$$

Now, replace the three unit cell with enough one unit cells to equal the volume of the single three unit cell. This can be done with 27 one unit cells. Find the total surface area of the 27 cells:

$$1 \times 1 \times 6 \times 27 = 162\ units$$

The total volume of the block of 27 cells is:

$$1 \times 1 \times 1 \times 27 = 27$$

The surface-area to volume ratio of the 27 cells is:

$$162 \div 27 = 6$$

**Questions**

1. Why are cells small?

-

-

-

2. What are microvilli? What is their function?

-

-

-

3. What is the surface area of a cube with a length of 2 $\mu m$?

-

-

-

4. What is the volume of a cube with a length of 2 $\mu m$?

-

-

-

5. What is the surface area-to-volume ratio of a 2 $\mu m$ cube?

-

-

-

## Lesson 3.1: Multiple Choice

**Name**______________________________ **Class**___________ **Date**________

*Circle the letter of the correct choice.*

1. Studying the cellular functions of bacteria
   (a) is a waste of time for scientists.
   (b) can give us insight into how many cells, including human cells, work.
   (c) is obsolete, because everything is known about all bacteria.
   (d) none of the above
2. The $17^{th}$ century Dutch scientist Antony van Leeuwenhoek viewed the following types of organisms with his light microscope:
   (a) living sperm cells
   (b) ciliates
   (c) rotifers
   (d) all of the above
3. A typical light microscope can magnify an object
   (a) up to two times its size (2x).
   (b) up to 10x maximum.
   (c) hundreds of times its original size.
   (d) millions of times its original size.
4. An advantage of using an electron microscope is

(a) it can be used to visualize subcellular structures that are too small to see with a light microscope.
(b) they are cheap.
(c) they can fit in the palm of your hand.
(d) all of the above

5. The cell theory was first postulated by scientists in

(a) 2002.
(b) 1992.
(c) Germany.
(d) New York City.

6. A cell has a volume of 27 $\mu m^3$. Its surface area is 54 $\mu m^2$. The surface area-to-volume ratio is

(a) $\frac{1}{2}$.
(b) 1.
(c) 2.
(d) 1458.

7. Prokaryotes and eukaryotes are similar in that

(a) both have DNA as the genetic material.
(b) both have chloroplasts.
(c) neither have a nucleus.
(d) neither have a semipermeable cell membrane.

## Lesson 3.1: Vocabulary

**Name**________________________________ **Class**____________ **Date**_________

*Match the vocabulary term with the correct definition.*

**Term**

______ 1. ribosomes

______ 2. nucleus

______ 3. organelle

______ 4. DNA

______ 5. Prokaryotic cells

______ 6. resolution

______ 7. Eukaryotic cells

______ 8. cell

______ 9. cytosol

______ 10. cytoplasm

**Definition**

a. The minimum distance that two points can be separated by and still be distinguished as two separate points.

b. Cells that contain a nucleus.

c. The membrane bound organelle that contains DNA; found in eukaryotic cells.

d. A watery fluid that contains dissolved particles and organelles.

e. Contains the genetic information needed for building structures such as proteins.

f. Structure that carries out specific functions inside the cell.

g. The general term for all of the material inside the cell, between the cell membrane and the nucleus.

h. Typical of simple, single-celled organisms, such as bacteria; lack a nucleus and other membrane bound organelles.

i. The organelles on which proteins are made (synthesized).

j. The smallest unit that can carry out the processes of life; the basic unit of all living things.

## 3.3 Lesson 3.2: Cell Structures

### Lesson 3.2: True or False

**Name**________________________________ **Class**____________ **Date**________

*Write true if the statement is true or false if the statement is false.*

_________ 1. The eukaryotic plasma membrane is made mostly of carbohydrates.

_________ 2. A phospholipid molecule has a hydrophilic part and a hydrophobic part.

_________ 3. All plasma membrane proteins extend across the entire width of the plasma membrane.

_________ 4. The cytoskeleton is made of protein.

_________ 5. The cytoskeleton can accurately be described as being fiber-like.

_________ 6. The centrioles contain short microtubules.

_________ 7. Flagella contain DNA.

_________ 8. Mitochondria contain DNA.

_________ 9. Proteins that function on the plasma membrane are synthesized by ribosomes that are attached to the rough endoplasmic reticulum during synthesis of that protein.

_________ 10. The lysosome is the organelle that stores calcium ions in eukaryotic cells.

_________ 11. Ribosomes are made up of only polypeptides and contain no other macromolecules.

_________ 12. Animal cells, but not plant cells, have the Golgi apparatus in the cytoplasm.

_________ 13. Chloroplasts contain DNA molecules.

_________ 14. All cells are either part of a colonial organism or a multicellular organism.

_________ 15. Even some bacteria can live in communities in which some bacteria specialize in one function, and other bacteria specialize in other functions.

## Lesson 3.2: Critical Reading

**Name**______________________________ **Class**___________ **Date**________

*Read this passage from the lesson and answer the questions that follow.*

**The nucleus**

The nucleus is a membrane-enclosed organelle found in most eukaryotic cells. The nucleus is the largest organelle in the cell and contains most of the cell's genetic information (mitochondria also contain DNA, called mitochondrial DNA, but it makes up just a small percentage of the cell's overall DNA content). The genetic information, which contains the information for the structure and function of the organism, is found encoded in DNA in the form of genes. A gene is a short segment of DNA that contains information to encode an RNA molecule or a protein strand. DNA in the nucleus is organized in long linear strands that are attached to different proteins. These proteins help the DNA to coil up for better storage in the nucleus. Think how a string gets tightly coiled up if you twist one end while holding the other end. These long strands of coiled-up DNA and proteins are called chromosomes. Each chromosome contains many genes. The function of the nucleus is to maintain the integrity of these genes and to control the activities of the cell by regulating gene expression. Gene expression is the process by which the information in a gene is "decoded" by various cell molecules to produce a functional gene product, such as a protein molecule or an RNA molecule.

The degree of DNA coiling determines whether the chromosome strands are short and thick or long and thin. Between cell divisions, the DNA in chromosomes is more loosely coiled and forms long thin strands called chromatin. Before the cell divides, the chromatin coil up more tightly and form chromosomes. Only chromosomes stain clearly enough to be seen under a microscope. The word chromosome comes from the Greek word chroma, (color) and soma, (body) due to its ability to be stained strongly by dyes.

**Questions**

1. Describe the structure of the nucleus.

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2. What is the function of the nucleus?

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3. Define a gene.

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4. What is a chromosome?

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5. Propose a reason why chromatin condenses before cell division.

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## Lesson 3.2: Multiple Choice

**Name**________________________________ **Class**____________ **Date**________

*Circle the letter of the correct choice.*

1. The head group of a typical membrane phospholipid is ________, whereas the two fatty acid tails are ________.
   (a) hydrophilic, hydrophobic
   (b) large, very small

(c) hydrophobic, hydrophilic
(d) hydrophilic, hydrophilic

2. Some membrane proteins are called integral membrane proteins. Some integral membrane proteins
   (a) transport molecules across the membrane.
   (b) are temporarily associated with the membrane.
   (c) easily fall off of the membrane.
   (d) are never associated with a membrane.
3. Vesicles and organelles are transported around the cell by
   (a) microfilaments.
   (b) microtubules.
   (c) intermediate filaments.
   (d) flagella.
4. A gene is
   (a) a protein that is wrapped around the DNA in the nucleus.
   (b) a phospholipid in the plasma membrane.
   (c) a random sequence of nucleotides that contains no information.
   (d) an information-rich segment of DNA that codes for some type of RNA molecule and/or a protein.
5. The number of mitochondria in a eukaryotic cell
   (a) can vary and depends upon the cell's energy needs.
   (b) is fixed and never varies.
   (c) is reduced in half every time a cell divides.
   (d) is the same as the number of nuclei in the cell.
6. Peroxisomes
   (a) form from vesicles delivered from the endoplasmic reticulum.
   (b) contain genetic material (DNA).
   (c) are organelles that break down toxic substances in the cell.
   (d) contain ribosomes and synthesize protein.
7. Consider a plant cell. If microtubules were inhibited from functioning with a microtubule-specific drug, then which of the following cell functions would be immediately and directly inhibitied?
   (a) the structure of the nuclear membrane
   (b) cell-to-matrix junctions
   (c) protein synthesis
   (d) normal cellulose deposition in the plant cell wall

## Lesson 3.2: Vocabulary

**Name**______________________________ **Class**___________ **Date**________

*Match the vocabulary term with the correct definition.*

**Term**

______ 1. chromoplasts

______ 2. nucleus

______ 3. Cell wall

______ 4. Golgi apparatus

______ 5. carotenoid

______ 6. lysosome

______ 7. Rough endoplasmic reticulum

______ 8. chloroplast

______ 9. Smooth endoplasmic reticulum

______ 10. nucleolus

**Definition**

a. A light-absorbing photosynthetic pigment.

b. The organelle that captures light energy from the sun and uses it with water and carbon dioxide to produce sugars for food.

c. Pigment-containing organelles that are found in flower petals and fruits.

d. An organelle, which in some cell types, can actually digest a bacterium.

e. The cell's "post office," which sorts its protein cargo into vesicles that are addressed to the appropriate final destination.

f. A cell structure that is composed of a large amount of cellulose.

g. The site of ribosomal subunit assembly.

h. Contains newly synthesized proteins, some of which are destined to go to the plasma membrane.

i. An organelle that is surrounded by a double phospholipid bilayer and whose outer membrane is contiguous with the rough endoplasmic reticulum.

j. An organelle that can detoxify some drugs.

## 3.4 Lesson 3.3: Cell Transport and Homeostasis

### Lesson 3.3: True or False

**Name**____________________________________ **Class**_____________ **Date**_________

*Write true if the statement is true or false if the statement is false.*

__________ 1. A selectively permeable membrane permits only some molecules across the membrane.

__________ 2. Selectively permeable cell membranes help maintain cell homeostasis.

__________ 3. Osmosis is one kind of active transport.

__________ 4. At equilibrium, the concentrations of a solute on both sides of a membrane will be equal.

__________ 5. At osmotic equilibrium, all water movement across the membrane stops.

__________ 6. Facilitated diffusion is a protein-mediated form of transport.

__________ 7. Some gated channel proteins open in response to specific chemical signals.

__________ 8. Ions such as $K^+$ and $Cl^-$ diffuse directly across the phospholipids of the membrane bilayer.

__________ 9. Active transport is transport of molecules down their concentration gradient.

__________ 10. Active transport requires ATP, either directly or indirectly.

__________ 11. The sodium-potassium pump transports sodium out of cells.

__________ 12. There is a voltage across the plasma membrane called the membrane potential.

__________ 13. Only liquids can be taken up into cells by endocytosis.

__________ 14. G-protein linked receptors are integral membrane proteins.

__________ 15. One advantage of a cell's having a signal transduction pathway is that the signal from a single ligand is amplified many times.

### Lesson 3.3: Critical Reading

**Name**____________________________________ **Class**_____________ **Date**_________

*Read this passage from the lesson and answer the questions that follow.*

**Signal Transduction**

A signal-transduction pathway is the signaling mechanism by which a cell changes a signal on its surface into a specific response inside the cell. It most often involves an ordered sequence of chemical reactions inside the cell, which are carried out by enzymes and other molecules. In many signal transduction processes, the number of proteins and other molecules participating in these events increases as the process progresses from the binding of the signal. A "signal cascade" begins. Think of a signal cascade as a chemical domino-effect inside the cell, in which one domino knocks over two dominos, which in turn knock over four dominos, and so on. The advantage of this type of signaling to the cell is that the message from one little signal molecule can be greatly amplified and have a dramatic effect. G protein-linked receptors are only found in higher eukaryotes, including yeast, plants, and animals. Your senses of sight and smell are dependent on G-protein linked receptors. The ligands that bind to these receptors include light-sensitive compounds, odors, hormones, and neurotransmitters. The ligands for G-protein linked receptors come in different sizes, from small molecules to large proteins. G protein-coupled receptors are involved in many diseases, but are also the target of around half of all modern medicinal drugs.

The sensing of the external and internal environments at the cellular level relies on signal transduction. Defects in signal transduction pathways can contribute or lead to many diseases, including cancer and heart disease. This highlights the importance of signal transductions to biology and medicine.

**Questions**

1. Cell signals have what purpose?

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2. In a cell, what is the advantage of having a signaling cascade?

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3. What organisms have G-protein linked receptors?

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4. What is a specific example of a ligand that binds to a G-protein linked receptor?

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5. How do G-protein linked receptors relate to human health and medicine?

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## Lesson 3.3: Multiple Choice

**Name**________________________________ **Class**____________ **Date**________

*Circle the letter of the correct choice.*

1. Both cations (positively charged ions) and anions (negatively charged ions)
   (a) diffuse rapidly through the phospholipid bilayer.
   (b) diffuse slowly across the glucose of the bilayer.
   (c) cannot pass directly through the lipid bilayer because the interior of the bilayer is hydrophobic.
   (d) cannot pass directly through the lipid bilayer because the interior of the bilayer is hydrophilic.
2. Several drops from a dropper full of a concentration glucose solution are dripped into a test tube of water. What will happen to the glucose molecules?
   (a) They will stay segregated in the area they were dripped into at the top of the test tube.
   (b) They will move by diffusion until their concentration is equal everywhere in the test tube and then there will be no net movement.
   (c) They will sink to the bottom of the test tube and stay there forever.
   (d) They will transform the chemical structure of the water molecules in the tube.
3. If a red blood cell shrinks when it is placed into an unknown solution, then that solution is ____________ relative to the red blood cell cytosol.
   (a) hypertonic
   (b) isotonic
   (c) hypotonic
   (d) monotonic
4. Most plant cells exist and thrive in _________ environments.
   (a) hypertonic
   (b) isotonic
   (c) hypotonic
   (d) monotonic

5. The group of proteins called ion channels includes those that are
   (a) made of 100% lipid.
   (b) always closed.
   (c) peripheral membrane proteins.
   (d) always open.
6. Receptor proteins can
   (a) be plasma membrane proteins.
   (b) be intracellular proteins.
   (c) bind to a ligand.
   (d) all of the above
7. The binding of a ligand to a G-protein linked receptor
   (a) activates the receptor by changing its shape.
   (b) occurs in the nucleus.
   (c) occurs in the cytosol.
   (d) is completely nonspecific.

## Lesson 3.3: Vocabulary

**Name**________________________________ **Class**____________ **Date**________

*Match the vocabulary term with the correct definition.*

**Term**

______ 1. Facilitated diffusion

______ 2. exocytosis

______ 3. ligand

______ 4. Contractile vacuole

______ 5. osmosis

______ 6. Transport protein

______ 7. Signal transduction pathway

______ 8. Second messenger

______ 9. endocytosis

______ 10. Channel protein

**Definition**

a. A type of vacuole that removes excess water from a cell.

b. The diffusion of solutes through transport proteins in the plasma membrane.

c. A protein that completely spans the membrane, and allows certain molecules or ions to cross the membrane.

d. A transport protein that acts like a pore in the membrane that lets water molecules or mall ions through quickly.

e. A small molecule that starts a change inside a cell in response to the binding of a specific signal to a receptor protein.

f. The process of capturing a substance or particle from outside the cell by engulfing it with the cell membrane.

g. A small molecule that binds to a larger molecule.

h. The signaling mechanism by which a cell changes a signal on it surface into a specific response inside the cell.

i. The process of vesicles fusing with the plasma membrane and releasing their contents to the outside of the cell.

j. The diffusion of water molecules across a selectively permeable membrane from an area of higher concentration to an area of lower concentration.

# Image Sources

(1) .

# Chapter 4

# Photosynthesis Worksheets

## 4.1 Chapter 4: Photosynthesis

- Lesson 4.1: Energy for Life: An Overview of Photosynthesis
- Lesson 4.2: Into the Chloroplast: How Photosynthesis Works

## 4.2 Lesson 4.1: Energy for Life: An Overview of Photosynthesis

### Lesson 4.1: True or False

**Name**________________________________ **Class**___________ **Date**________

*Write true if the statement is true or false if the statement is false.*

_________ 1. Some bacteria can photosynthesize.

_________ 2. All bacteria use light energy to fix carbon.

_________ 3. When chlorophyll molecules absorb light, electrons are energized.

_________ 4. A molecule of glucose has a total of 3 carbon atoms.

_________ 5. ATP contains a phosphate atoms.

_________ 6. Carbon dioxide is a waste product of photosynthesis.

_________ 7. Oxygen is a product of photosynthesis.

_________ 8. Methane is the source of carbon for photosynthesis.

_________ 9. All chemical reactions have two reactants and two products.

_________ 10. Most of the ATP produced by a plant cell is exported from the cell.

_________ 11. Plant cells can store energy in the form of carbon-containing compounds.

_________ 12. Breaking chemical bonds in food molecules can release some heat.

_________ 13. There are internal membranes inside a chloroplast.

_________ 14. Chlorophyll molecules are embedded in the thylakoid membranes of chloroplasts.

_________ 15. The reactions of the Calvin Cycle occur inside the chloroplast.

## Lesson 4.1: Critical Reading

**Name_______________________________ Class___________ Date________**

*Read this passage from the lesson and answer the questions that follow.*

**How Do Organisms Get Energy? Autotrophs vs. Heterotrophs**

Living organisms obtain chemical energy in one of two ways.

Autotrophs store chemical energy in carbohydrate food molecules they build themselves. Food is chemical energy stored in organic molecules. Food provides both the energy to do work and the carbon to build bodies. Because most autotrophs transform sunlight to make food, we call the process they use photosynthesis. Only three groups of organisms - plants, algae, and some bacteria - are capable of this life-giving energy transformation. Autotrophs make food for their own use, but they make enough to support other life as well. Almost all other organisms depend absolutely on these three groups for the food they produce. The producers, as autotrophs are also known, begin food chains which feed all life. Food chains will be discussed in the *Principles of Ecology* chapter.

Heterotrophs cannot make their own food, so they must eat or absorb it. For this reason, heterotrophs are also known as consumers. Consumers include all animals and fungi and many protists and bacteria. They may consume autotrophs, or other heterotrophs or organic molecules from other organisms. Heterotrophs show great diversity and may appear far more fascinating than producers. But heterotrophs are limited by our utter dependence on those autotrophs which originally made our food. If plants, algae, and autotrophic bacteria vanished from earth, animals, fungi, and other heterotrophs would soon disappear as well. All life requires a constant input of energy. Only autotrophs can transform that ultimate, solar source into the chemical energy in food which powers life.

**Questions**

1. What is an autotroph?

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2. Define a heterotroph.

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3. List one similarity between autotrophs and heterotrophs.

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4. Defend this statement: *Plants are autotrophs.*

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5. What would happen to life on earth if the sun's rays could no longer reach the earth's surface?

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## Lesson 4.1: Multiple Choice

**Name**______________________________ **Class**___________ **Date**________

*Circle the letter of the correct choice.*

1. A major difference between heterotrophs and autotrophs is that
   (a) heterotrophs live in the water and autotrophs live on land.
   (b) heterotrophs are multicellular and autotrophs are unicellular.
   (c) heterotrophs are different and all autotrophs are the same.
   (d) heterotrophs ingest food molecules and autotrophs can make food molecules.
2. A major similarity between heterotrophs and autotrophs is that

(a) both are always multicellular.
(b) both are always unicellular.
(c) all heterotrophs and autotrophs on the earth live on land.
(d) members of both groups can be found in the ocean and on land.

3. Chemosynthetic organisms are often found

(a) in hot water vents in the deep ocean.
(b) in intertidal regions (areas between low tide and high tide zones).
(c) in areas with abundant air and sunlight.
(d) all of the above

4. Food can be defined chemically as

(a) inorganic nitrogen-containing compounds that lack carbon.
(b) carbon-containing compounds that store energy in the chemical bonds between their constituent atoms.
(c) organic nitrogen-containing compounds that lack carbon.
(d) none of the above

5. When exposed to sunlight, chlorophyll appears __________ in color to the human eye.

(a) white
(b) black
(c) green
(d) orange

6. The chemical formula for glucose is

(a) $CO_2$.
(b) $C_6H_{12}O_6$.
(c) $CH_4$.
(d) $C_6H_5O_4$.

7. The role of enzymes in photosynthesis is

(a) that they are the light-absorbing pigments.
(b) that they accept the oxygen synthesized as a product of photosynthesis.
(c) to slow down chemical reactions.
(d) to speed up chemical reactions.

## Lesson 4.1: Vocabulary

**Name**________________________________ **Class**____________ **Date**________

*Match the vocabulary term with the correct definition.*

**Term**

______ 1. NADPH

______ 2. heat

______ 3. heterotrophs

______ 4. autotroph

______ 5. food chain

______ 6. glucose

______ 7. chlorophyll

______ 8. chloroplast

______ 9. inorganic molecules

______ 10. organic molecules

**Definition**

a. Molecules that have no carbon atoms (with a few exceptions such as carbon dioxide)

b. carbon-containing molecules that are synthesized by living organisms

c. An energy carrier molecule produced in the light reactions of photosynthesis and used to build sugar in the Calvin cycle

d. the primary pigment of photosynthesis

e. a six carbon organic molecule that is used as an energy source by many organisms

f. A pathway that traces energy flow from producers through consumers

g. an organisms that can make its own food

h. thermal energy

i. organisms that cannot make their own food; they must absorb in ingest food

j. the organelle in which photosynthesis occurs

## 4.3 Lesson 4.2: Into the Chloroplast: How Photosynthesis Works

### Lesson 4.2: True or False

**Name**________________________________ **Class**____________ **Date**________

*Write true if the statement is true or false if the statement is false.*

_________ 1. Both photosystems I and II (PS I and II) are located in the stromal fluid of the chloroplast.

_________ 2. Photosynthesis occurs only in plants.

_________ 3. There is no evidence supporting the endosymbiotic theory.

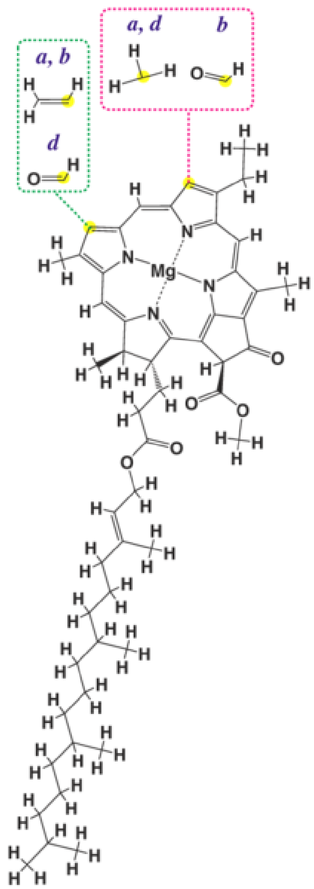
_________ 4. Chlorophyll absorbs blue and blue-violet light.

_________ 5. Chlorophyll absorbs green light.

_________ 6. The air we breathe contains mostly nitrogen.

_________ 7. A particular pigment will absorb light of some wavelengths, but not others.

_________ 8. The chlorophyll molecule (below) contains a hydrophobic region that allows it to be embedded in membranes inside the chloroplast.




_________ 9. The source of electrons for photosynthesis is water.

_________ 10. At some steps of the photosynthetic electron transport chain, energy released during the transfer of an electron from one electron carrier to another is used to pump a proton ($H^+$) across the thylakoid membrane.

_________ 11. When a chlorophyll molecule absorbs a photon of light, an electron of chlorophyll drops down to a lower energy level.

_________ 12. ATP synthesis happens during the light reactions of photosynthesis.

_________ 13. Carbon dioxide is a waste product of the Calvin Cycle.

_________ 14. Stomata can regulate gas exchange between the air and a leaf.

_________ 15. The Calvin Cycle fixes carbon dioxide into an organic compound.

## Lesson 4.2: Critical Reading

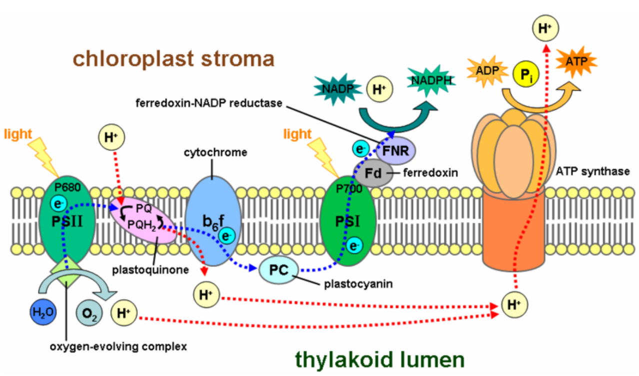
**Name**______________________________ **Class**___________ **Date**________

*Read this passage from the lesson and answer the questions that follow.*

**How Do Chloroplasts Convert Light Energy to Chemical Energy?**

Excited electrons that have absorbed light energy are unstable. However, the highly organized electron carrier molecules embedded in chloroplast membranes order the flow of these electrons, directing them through electron transport chains (ETCs). At each transfer, small amounts of energy released by the electrons are captured and put to work or stored. Some is also lost as heat with each transfer, but overall the light reactions are extremely efficient at capturing light energy and transforming it to chemical energy.

Two sequential transport chains harvest the energy of excited electrons, as shown in **Figure 9**.




1. First, they pass down an ETC that captures their energy and uses it to pump hydrogen ions by active transport into the thylakoids. These concentrated ions store potential energy by forming an electrochemical gradient – a higher concentration of both positive charge and hydrogen inside the thylakoid than outside. Picture this energy buildup of $H^+$ as a dam holding back a waterfall. Like water flowing through a hole in the dam, hydrogen ions "slide down" their concentration gradient through a membrane protein,

which acts as both ion channel and enzyme. As they flow, the ion channel/enzyme ATP synthase uses their energy to chemically bond a phosphate group to ADP, making ATP. The gradient formed by the $H^+$ ions is known as a chemiosmotic gradient.

2. Light re-energizes the electrons, and they travel down a second electron transport chain (ETC), eventually bonding hydrogen ions to $NADP^+$ to form a more stable energy storage molecule, NADPH. NADPH is sometimes called "hot hydrogen", and its energy and hydrogen atoms will be used to help build sugar in the second stage of photosynthesis.

NADPH and ATP molecules now store the energy from excited electrons – energy that was originally sunlight – in chemical bonds. Thus chloroplasts, with their orderly arrangement of pigments, enzymes, and electron transport chains, transform light energy into chemical energy. The first stage of photosynthesis – light-dependent reactions or simply "light reactions" – is complete.

**Questions**

1. What happens to the chlorophyll electron that has absorbed light?

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2. Why do $H^+$ need to be ferried across the thylakoid membrane? Why don't they simply diffuse across the phospholipid bilayer?

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3. Why do you think that electron transfer occurs between multiple electron carriers instead of between a single electron donor and a single electron acceptor?

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4. How does ATP synthase accomplish ATP synthesis?

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5. Consider the following hypothetical situation. A chemical called a proton ionophore

is added to photosynthetic plant cells. (Proton ionophores readily transport H+ across membranes and dissipate any concentration gradient.) What will happen to ATP synthesis after the ionophore is added?

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## Lesson 4.2: Multiple Choice

**Name**_______________________________ **Class**___________ **Date**________

*Circle the letter of the correct choice.*

1. When a healthy houseplant grows in a pot for several years,

(a) the dry mass of the soil stays about the same.

(b) the dry mass of the soil increases by 50%.

(c) the dry mass of the soil decreases by 50%.

(d) the minerals in the soil are converted to carbon atoms.

2. Why can't a mouse survive for long in a sealed container full of air?

(a) There is too much nitrogen in the air.

(b) The mouse uses up all of the carbon dioxide in the air.

(c) The mouse uses up all of the oxygen in the air.

(d) The mouse exhales so much oxygen that it is toxic.

3. When exposed to sunlight, carotenoids appear __________ in color to the human eye.

(a) white

(b) black

(c) green

(d) orange

4. Thylakoid membranes serve which of the following functions?

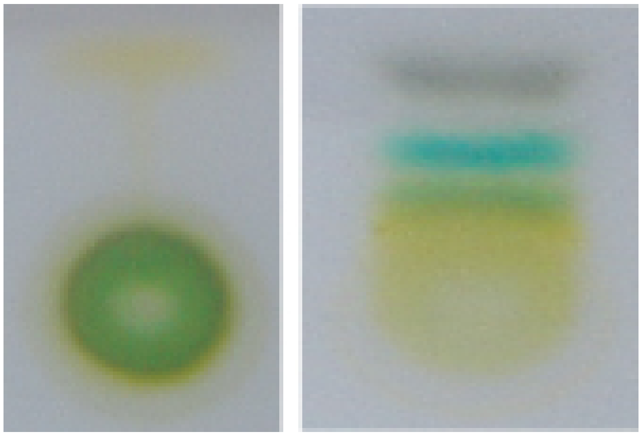
(a) Location of chlorophyll molecules.

(b) Location of electron carriers.

(c) Location of ATP synthase.

(d) all of the above

5. The photograph below shows



(a) Plant pigments before and after separation by paper chromatography.

(b) Chlorophyll before and after DNA analysis.

(c) The possible shapes of a chloroplast.

(d) none of the above

6. C4 plants evolved

(a) to maximize the efficiency of $CO_2$ fixation in hot, dry environments where the stomata must be closed at times during the day.

(b) to fix $CO_2$ only at night.

(c) another electron transport chain in the outer chloroplast membrane.

(d) before photosynthetic bacteria.

7. CAM plants

(a) fix $CO_2$ only in the day.

(b) fix $CO_2$ only at night.

(c) do not fix $CO_2$.

(d) evolved before photosynthetic bacteria.

## Lesson 4.2: Vocabulary

**Name**______________________________ **Class**___________ **Date**________

*Match the vocabulary term with the correct definition.*

**Term**

______ 1. thylakoids

______ 2. RuBisCo

______ 3. NADPH

______ 4. Calvin Cycle

______ 5. Endosymbiotic Theory

______ 6. photosystem

______ 7. photosynthesis

______ 8. stomata

______ 9. carbon fixation

______ 10. accessory pigments

**Definition**

a. "pores" in a leaf that can be opened and closed; when open, they permit diffusion of water vapor and gases

b. the process of integration of carbon dioxide into organic molecules

c. light-absorbing pigments that absorb light energy and transfer the absorbed energy to chlorophyll

d. an assembly of pigments and proteins that function in photosynthetic light absorption and use

e. the light-independent reactions of photosynthesis during which $CO_2$ is fixed into organic molecules

f. the set of chemical reactions by which light energy is transformed into chemical energy, which in turn is used to fix carbon from the air into organic compounds

g. internal chloroplast membranes; are flat and can be stacked upon one another; location of chlorophyll, accessory pigments and the electron carriers of the electron transport chain

h. the theory that explains why chloroplasts have structural similarities to prokaryotic cells; states that chloroplasts were once independent prokaryotic cells that were engulfed by a eukaryotic cell

i. an electron carrier that is an electron donor in the Calvin cycle

j. an abundant enzyme that combines one molecule of $CO_2$ with a 5-carbon sugar

# Chapter 5

# Cellular Respiration Worksheets

## 5.1 Chapter 5: Cellular Respiration

- Lesson 5.1: Powering the Cell: Cellular Respiration and Glycolysis
- Lesson 5.2: Into the Mitochondrion: Making ATP with Oxygen
- Lesson 5.3: Anaerobic Respiration: ATP, New Fuels, and Yogurt without Oxygen

## 5.2 Lesson 5.1 Powering the Cell: Cellular Respiration and Glycolysis

### Lesson 5.1: True or False

**Name**________________________________ **Class**____________ **Date**________

*Write true if the statement is true or false if the statement is false.*

_________ 1. All organisms on earth will die without a constant supply of oxygen.

_________ 2. Energy released during the breakdown of cells is used to synthesize ATP.

_________ 3. The energy released from the breakdown of a single molecule of glucose can be used to synthesize up to 38 molecules of ATP.

_________ 4. When wood is burned, carbon dioxide is a product of the burning reaction.

_________ 5. When glucose is broken down during cellular respiration, a product is light energy.

_________ 6. In eukaryotic cells, glycolysis occurs in the mitochondrion.

_________ 7. All ATP synthesis in a eukaryotic cell happens in the mitochondria.

_________ 8. Carbon dioxide is a product of both cellular respiration and photosynthesis.

_________ 9. An electron transport chain is involved in both cellular respiration and in photosynthesis.

_________ 10. The carbon-oxygen cycle connect consumers to producers.

_________ 11. Some anaerobic bacteria are used by humans to make yogurt.

_________ 12. There are no known anaerobic bacteria that can cause harm to humans.

_________ 13. Fats can be used as an energy source for glycolysis.

_________ 14. Glucose gets phosphorylated during glycolysis.

_________ 15. One of the final products of glycolysis is a five-carbon compound.

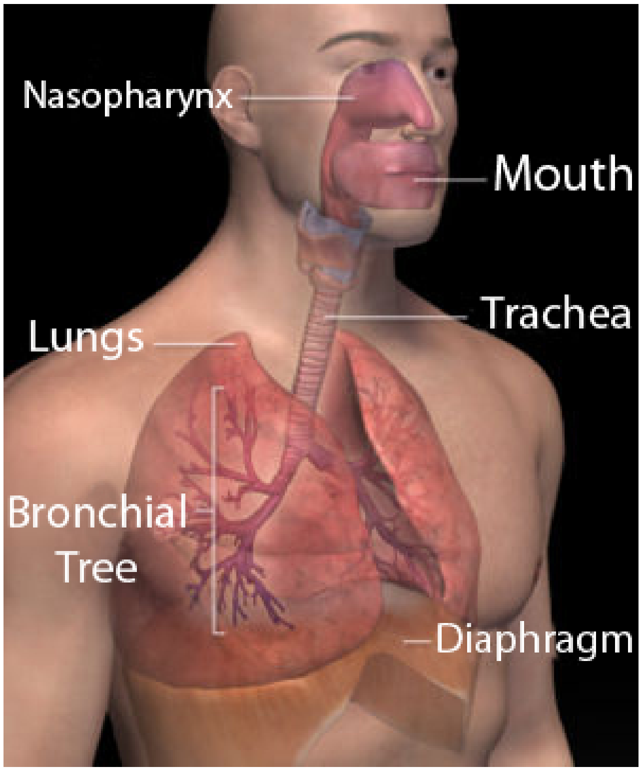
## Lesson 5.1: Critical Reading

**Name**______________________________ **Class**___________ **Date**________

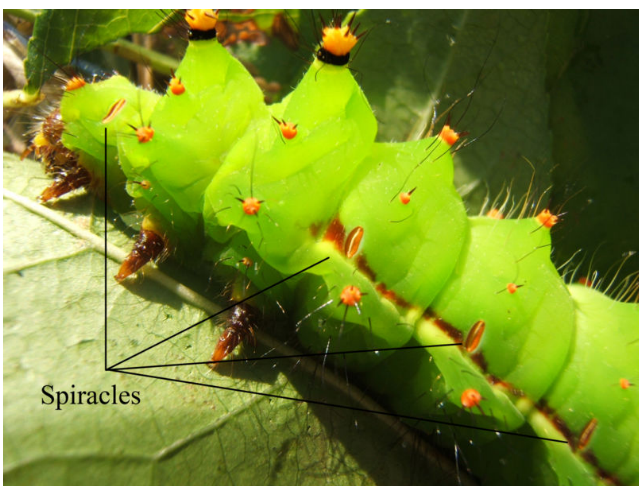
*Read this passage from the lesson and answer the questions that follow.*

**Introduction**

You know that humans deprived of oxygen for more than a few minutes will quickly become unconscious and die. Breathing, also known as respiration, is essential for human life, because the body cannot store oxygen for later use as it does food. The mammalian respiratory system, shown in **Figure 1** features a diaphragm, trachea, and a thin membrane whose surface area is equivalent to the size of a handball court - all for efficient oxygen intake. Other forms of life employ different types of respiratory organs: fish and aquatic amphibians and insects flaunt gills, spiders and scorpions develop "book lungs," and terrestrial insects use an elaborate network of tubes called tracheae, which open via spiracles, as shown in **Figure 2** and **3**. A constant supply of oxygen gas is clearly important to life. However, do you know why you need oxygen?




The human respiratory system is only part of the story of respiration. Diaphragm, lungs, and trachea take air deep into the body and provide oxygen gas to the bloodstream. The fate of that oxygen is the story of cellular respiration.




Spiracles in this Indian Luna Moth (*Actias selene*) caterpillar connect to a system of internal tubes (tracheae) which carry oxygen throughout the animal's body.

Gills in this alpine newt larva, *Triturus alpestris*, bring blood close to an extensive surface area so that the newt can absorb dissolved oxygen gas from its watery habitat.

**Questions**

1. Why do you need to breath continually, even when you sleep?

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2. Why do you think humans cannot store oxygen?

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3. Why is the surface area of a mammalian respiratory system so large?

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4. How do fish absorb oxygen?

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5. Explain why oxygen is essential to life?

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## Lesson 5.1: Multiple Choice

**Name**______________________________ **Class**___________ **Date**________

*Circle the letter of the correct choice.*

1. Cows need to breathe because
   (a) they need carbon dioxide from the air for cellular respiration.
   (b) they need oxygen from the air for cellular respiration.
   (c) they need to expel methane, a waste product of cellular respiration, from their lungs.
   (d) they need to expel nitrogen gas, a waste product of cellular respiration, from their lungs.
2. In mammals, oxygen gas diffuses from the air into the bloodstream via the
   (a) cells lining the nose.
   (b) kidney.
   (c) liver.
   (d) lungs.
3. In the chemical reaction that represents the burning of wood, the reactants are
   (a) wood and $O_2$.
   (b) $CO_2$, $H_2O$.
   (c) light energy and heat.
   (d) sparks (as from a match).
4. Organisms that are producers (such as plants)
   (a) produce only $O_2$.
   (b) produce only $CO_2$.
   (c) produce both $CO_2$ and $O_2$.
   (d) produce methane, octane, and $O_2$.
5. A typical eukaryotic liver cell may have as many as ____________ mitochondria.
   (a) one
   (b) 5
   (c) 15
   (d) 1500
6. The reaction $C_6H_{12}O_6 + 2\ NAD^+ + 2\ Pi + 2\ ADP \longrightarrow 2$ pyruvate $+ 2\ NADH + 2\ ATP$ is the overall reaction of
   (a) alcoholic fermentation.
   (b) wood burning.
   (c) glycolysis.
   (d) the Krebs cycle.

7. In the equation $O_2 + C_6H_{12}O_6 \longrightarrow 6CO_2 + 6H_2O$, what important reaction components are missing? (Hint: there are five.)

## Lesson 5.1: Vocabulary

**Name**_______________________________ **Class**___________ **Date**________

*Match the vocabulary term with the correct definition.*

**Term**

______ 1. cytosol

______ 2. Glycolysis

______ 3. glycogen

______ 4. NADH

______ 5. cellular respiration

______ 6. glucose

______ 7. ATP

______ 8. symbiont

______ 9. anaerobic

______ 10. aerobic

**Definition**

a. occurring only in the presence of oxygen

b. An organism that lives in a close, mutually beneficial relationship with an organism of a different species

c. a six-carbon sugar that is an energy source for cells

d. the universal energy currency of cells

e. occurring in the absence of oxgen

f. the aqueous part of the cell's cytoplasm; contains water, ions, small molecules, and organic macromolecules

g. An ATP-producing pathway in which glucose is broken down into two 3-carbon molecules; oxygen is not required

h. an electron carrier that delivers electrons to the electron transport chain of cellular respiration

i. a storage form of glucose that consists of covalently linked glucose molecules

j. The process that transfers chemical energy from glucose to ATP

## 5.3 Lesson 5.2: Into the Mitochondrion: Making ATP with Oxygen

### Lesson 5.2: True or False

**Name**________________________________ **Class**____________ **Date**________

*Write true if the statement is true or false if the statement is false.*

_________ 1. Oxygen has always been an abundant component of the earth's atmosphere.

_________ 2. Today, eighty percent of the volume of the earth's air is oxygen.

_________ 3. Aerobic respiration evolved before oxygenic photosynthesis.

_________ 4. In eukaryotic cells, if oxygen is present, then pyruvate is fermented to ethanol.

_________ 5. When oxygen first appeared in significant concentrations in the earth's air, some organisms were harmed.

_________ 6. The structure and function of mitochondria support the endosymbiotic theory.

_________ 7. Before pyruvate enters the Krebs Cycle, it is converted to a 2-carbon compound.

_________ 8. The Krebs cycle occurs in the cytosol.

_________ 9. $CO_2$ is produced during the Krebs Cycle.

_________ 10. On molecule of GTP is produced per turn of the Krebs Cycle.

_________ 11. 4 molecules of $NAD^+$ are produced per turn of the Krebs Cycle.

_________ 12. The invaginations (infoldings) of the inner mitochondrial membrane increase the surface area of the membrane.

_________ 13. ATP synthase is an integral membrane protein embedded in the inner mitochondrial membrane.

_________ 14. $FADH_2$ donates electrons to the electron transport chain in mitochondria.

_________ 15. The pH in the intermembrane space of the mitochondria is lower than the pH of the mitochondrial matrix.

# Lesson 5.2: Critical Reading

**Name**______________________________ **Class**___________ **Date**________

*Read this passage from the lesson and answer the questions that follow.*

**The Electron Transport Chain: ATP for Life in the Fast Lane**

At the end of the Krebs Cycle, energy from the chemical bonds of glucose is stored in diverse energy carrier molecules: four ATP, but also two FADH2 and ten NADH. The primary task of the last stage of cellular respiration, the electron transport chain (ETC), is to transfer energy from these carriers to ATP, the "batteries" which power work within the cell.

Pathways for making ATP in stage 3 of aerobic respiration closely resemble the electron transport chains used in photosynthesis. In both ETCs, energy carrier molecules are arranged in sequence within a membrane so that energy-carrying electrons cascade from one to another, losing a little energy in each step. In both photosynthesis and aerobic respiration, the energy lost is harnessed to pump hydrogen ions into a compartment, creating an electrochemical gradient across the enclosing membrane. And in both processes, the energy stored in the electrochemical gradient is used to build ATP.

For aerobic respiration, the electron transport chain or "respiratory chain" is embedded in the inner membrane of the mitochondria (**Figure 6**). $FADH_2$ and NADH (produced in glycolysis and the Krebs Cycle) donate high-energy electrons to energy carrier molecules within the membrane. As they pass from one carrier to another, the energy they lose is used to pump hydrogen ions into the intermembrane space, creating an electrochemical gradient. Hydrogen ions flow "down" the gradient – from outer to inner compartment – through an ion channel/enzyme, ATP synthase, which transfers their energy to ATP. Note the paradox that it requires energy to create and maintain a concentration gradient of hydrogen ions, which are then used by ATP synthase to create stored energy (ATP). In broad terms, it takes energy to make energy. Coupling the electron transport chain to ATP synthesis with a hydrogen ion gradient is chemiosmosis, first described by Nobel laureate Peter D. Mitchell.

**Questions**

1. Why are NADH and $FADH_2$ described as energy-carrying molecules?

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2. What is the purpose of the electron transport chain (ETC) in mitochondria?

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3. The electron transport chains of cellular respiration and photosynthesis share what characteristics?

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4. Where are $H^+$ pumped in mitochondria?

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5. Why do you think Peter Mitchell's discovery of chemiosmosis won a Nobel prize?

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## Lesson 5.2: Multiple Choice

**Name**_______________________________ **Class**____________ **Date**________

*Circle the letter of the correct choice.*

1. The "oxygen catastrophe" is
   (a) the harm caused by a decrease in oxygen in artic regions.
   (b) the harm caused by a decrease in oxygen during the ice age.
   (c) the period after oxygen first appeared in the earth's atmosphere at a significant concentration.
   (d) none of the above
2. The 2-carbon compound, acetyl CoA,
   (a) enters glycolysis at step 3.
   (b) enters the Krebs Cycle.
   (c) enter the ETC.
   (d) binds to NADH.
3. In cellular respiration, carbon dioxide is released
   (a) during the first half of glycolysis.
   (b) during the Krebs Cycle.
   (c) during the ETC.

(d) none of the above

4. One of the products of glycolysis is
   (a) GTP.
   (b) glycogen.
   (c) starch.
   (d) none of the above
5. The concentration gradient of $H^+$ across the inner mitochondrial membrane is a(n)
   (a) chemical gradient.
   (b) electrical gradient.
   (c) pH gradient.
   (d) A and B
   (e) A, B, and C
6. The net yield of ATP from the breakdown of a single molecule of glucose is
   (a) -2.
   (b) 0.
   (c) 2.
   (d) 38.
7. The function of oxygen in the ETC is
   (a) to accept electrons that have passed through the ETC of the mitochondria.
   (b) to combine with carbon dioxide and be excreted.
   (c) to donate electrons to the ETC.
   (d) all of the above

## Lesson 5.2: Vocabulary

**Name**________________________________ **Class**____________ **Date**________

*Match the vocabulary term with the correct definition.*

**Term**

______ 1. ATP synthase

______ 2. $FADH_2$

______ 3. matrix

______ 4. intermembrane space

______ 5. electrochemical gradient

______ 6. ATP

______ 7. cristae

______ 8. Krebs cycle

______ 9. glycolysis

______ 10. chemiosmosis

**Definition**

a. the mechanism by which energy stored in an $H^+$ gradient across a membrane is harnessed to synthesize ATP using the energy of hydrogen ions

b. space formed by infoldings of the inner mitochondrial membrane

c. the space between the outer and inner mitochondrial membranes

d. Ion channel and enzyme complex that chemically bonds a phosphate group to ADP, making ATP as H+ ions flow through the ion channel

e. stage 1 of aerobic cellular respiration

f. molecule which stores a usable amount of chemical energy; the universal energy currency of cells

g. A difference in both the net electrical charge and the concentration of a chemical across a membrane

h. stage 2 of aerobic cellular respiration

i. An electron carrier used to deliver energized electrons to the electron transport chain of aerobic respiration

j. The aqueous space inside the inner mitochondrial membrane

## 5.4 Lesson 5.3: Anaerobic Respiration: ATP, New Fuels, and Yogurt without Oxygen

### Lesson 5.3: True or False

**Name**________________________________ **Class**____________ **Date**________

*Write true if the statement is true or false if the statement is false.*

_________ 1. In Lactobacillus, if oxygen is absent, then pyruvate is fermented to lactic acid.

_________ 2. Facultative anaerobes die in the presence of oxygen.

_________ 3. Obligate aerobes thrive in the absence of oxygen.

_________ 4. A major purpose of fermentation is to regenerate NAD+ from NADH so that there is a continued supply of $NAD^+$ for glycolysis.

_________ 5. Beer-makers use yeast to produce the alcohol in beer.

_________ 6. Humans are obligate aerobes.

_________ 7. Red muscle is specialized for anaerobic sprinting.

_________ 8. White muscle is specialized for endurance activities.

_________ 9. In the absence of oxygen, muscle cells convert pyruvate to lactic acid.

_________ 10. Fermentation in bacteria occurs only in oxygen-rich environments.

_________ 11. One of the products of lactic acid fermentation is NADH.

_________ 12. The Lactobacillus in yogurt makes humans very ill.

_________ 13. Some gasoline in the USA contains ethanol made from corn.

_________ 14. The holes in yeasted breads are created by methane gas.

_________ 15. Ethanolic anaerobic respiration produces 2 ATP per molecule of glucose.

## Lesson 5.3: Critical Reading

**Name**_______________________________ **Class**___________ **Date**________

*Read this passage from the lesson and answer the questions that follow.*

**Are Drumsticks and Athletic Prowess Related?**

Yes! Muscle color reflects its specialization for aerobic or anaerobic metabolism. Although humans are obligate aerobes, our muscle cells have not given up on ancient pathways that allow them to keep producing ATP quickly when oxygen runs low. The difference is more pronounced in chickens and grouse (**Figure 3**), which stand around all day on their legs. For long periods of time, they carry out aerobic respiration in their "specialized-for-endurance" red muscles. If you have ever hunted grouse, you know that these birds "flush" with great speed over short distances. Such "sprinting" flight depends on anaerobic respiration in the white cells of breast and wing muscle. No human muscle is all red or all white, but chances are, if you excel at running short distances or at weight lifting, you have more white glycolytic fibers in your leg muscles. If you run marathons, you probably have more red oxidative fibers.

You probably were not aware that muscle cells "ferment." Lactic acid fermentation is the type of anaerobic respiration carried out by yogurt bacteria (Lactobacillus and others) and by your own muscle cells when you work them hard and fast. Converting pyruvate to 3-carbon lactic acid (**Figure 4**) regenerates $NAD^+$ so that glycolysis can continue to make ATP in low-oxygen conditions. For Lactobacillus bacteria, the acid resulting from fermentation kills bacterial competitors in buttermilk, yogurt, and some cottage cheese. The benefits extend to humans who enjoy these foods, as well. You may have noticed this type of fermentation in your own muscles, because muscle fatigue and pain are associated with lactic acid. Keep this in mind, however, as we discuss a second type of fermentation, which produces alcohol. Imagine what would happen as you ran a race if muscle cells conducted alcoholic rather than lactic acid fermentation!

**Questions**

1. How is muscle color related to muscle specialization?

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2. How does the color of red muscle reflect its function?

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3. Would an animal that was a great sprinter, but was a poor distance runner, have more red muscle or white muscle? Why?

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4. What are the products of lactic acid fermentation?

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5. What would happen if a person ran a race and her muscles carried out alcoholic fermentation instead of lactic acid fermentation?

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## Lesson 5.3: Multiple Choice

**Name**______________________________ **Class**___________ **Date**________

*Circle the letter of the correct choice.*

1. Human skeletal muscle cells are
   (a) obligate anaerobes.
   (b) obligate aerobes.
   (c) facultative alcoholic fermenters.
   (d) facultative anaerobes.
2. Trained marathoners will have
   (a) more red muscle cells and fewer white muscle cells.
   (b) more white muscle cells and fewer red muscle cells.
   (c) more alchoholic fermentation and less lactic acid fermentation.
   (d) more lactic acid fermentation when running slowly.
3. The purpose of lactic acid fermentation in Lactobacillus is
   (a) to regenerate NADH so glycolysis can continue and ATP can be made.
   (b) to regenerate $NAD^+$ so glycolysis can continue and ATP can be made.
   (c) to create acetyl CoA.
   (d) to use acetyl CoA.
4. Human uses of alcoholic fermentation include
   (a) bread baking.
   (b) wine making.
   (c) biofuel production.
   (d) all of the above
5. For each glucose molecule consumed, a cell performing aerobic respiration can synthesize as many as ________ ATP.
   (a) 2
   (b) 4
   (c) 38
   (d) 76
6. The Krebs Cycle
   (a) is present in aerobic bacteria.
   (b) is used in ethanolic fermentation.
   (c) is used in alcoholic fermentation.
   (d) all of the above
7. Myoglobin binds to
   (a) fructose.
   (b) oxygen.
   (c) pyruvate.
   (d) the ETC.

## Lesson 5.3: Vocabulary

**Name**______________________________ **Class**___________ **Date**________

*Match the vocabulary term with the correct definition.*

**Term**

______ 1. obligate aerobe

______ 2. glycolysis

______ 3. Red muscle

______ 4. lactic acid fermentation

______ 5. alcoholic fermentation

______ 6. obligate anaerobe

______ 7. aerobic

______ 8. White muscle

______ 9. Anaerobic

______ 10. facultative anaerobe

**Definition**

a. an organism which uses anaerobic respiration, and dies in the presence of oxygen

b. the process for making ATP in the absence of oxygen by converting glucose to lactic acid

c. the net synthesis of 2 ATP from the breakdown of one molecule of glucose into 2 pyruvate molecules

d. with oxygen, or living or occurring only in the presence of oxygen

e. the process for making ATP in the absence of oxygen, by converting glucose to ethanol and carbon dioxide

f. an organism which requires oxygen for cellular respiration

g. an organism which can respire aerobically when oxygen is present, but is also capable of fermentation when oxygen levels are low

h. muscle with a rich blood supply; specialized for aerobic respiration

i. muscle specialized for anaerobic respiration, specifically for lactic acid fermentation

j. without oxygen; living or occurring in the absence of oxygen

# Chapter 6

# Cell Division and Reproduction Worksheets

## 6.1 Chapter 6: Cell Division and Reproduction

- Lesson 6.1: Chromosomes and the Cell Cycle
- Lesson 6.2: Meiosis

## 6.2 Lesson 6.1: Chromosomes and the Cell Cycle

### Lesson 6.1: True or False

**Name**________________________________ **Class**____________ **Date**________

*Write true if the statement is true or false if the statement is false.*

_________ 1. Before most cell divisions, most cells do not increase in size.

_________ 2. During cell division, one of the daughter cells gets all of the larger chromosomes, and the other daughter cell gets all of the smaller chromosomes.

_________ 3. The number of chromosomes in a cell is duplicated before the beginning of mitosis.

_________ 4. Many species of bacteria have a single circular chromosome that consists of double stranded DNA.

_________ 5. Under ideal conditions, some bacteria can reproduce every 20 seconds.

_________ 6. Each human chromosomes contains a maximum of one gene.

_________ 7. The information needed to make a particular cellular protein is contained within a gene.

_________ 8. A chromosome is composed of DNA, RNA, protein, phospholipids, carbohydrates, and cell walls.

_________ 9. A human gamete contains 46 chromosomes.

_________ 10. Two sister chromatids are attached to each other until the beginning of anaphase.

_________ 11. Most cells spend the majority of their lives in interphase.

_________ 12. DNA is duplicated during S phase of the cell cycle.

_________ 13. During mitosis, the duplicated chromosomes move to opposite poles with the aid of microtubules.

_________ 14. Cells have cell cycle checkpoints that regulate progression from one phase of the cell cycle to the next.

_________ 15. Compared to normal cells, cancer cells have exceptionally slow cell division rates.

## Lesson 6.1: Critical Reading

**Name**_______________________________ **Class**___________ **Date**________

*Read this passage from the lesson and answer the questions that follow.*

**Control of the Cell Cycle**

How does the cell know when to divide? How does the cell know when to replicate the DNA? The answers to these questions have to do with the control of the cell cycle. But how is the cell cycle controlled?

The cell cycle is controlled by a number of protein-controlled feedback processes. Two types of proteins involved in the control of the cell cycle are kinases and cyclins. Cyclins activate kinases. Cyclins are a group of proteins that is rapidly produced at key stages in the cell cycle. Kinases activate other target molecules. It is this precise regulation of proteins that triggers advancement through the cell cycle.

The cell cycle has key checkpoints. When the cell receives key signals or information (feedback regulation), the cell can begin the next phase of the cell cycle. The cell can also receive signals that delay passage to the next phase of the cell cycle. These signals allow the cell to complete the previous phase before moving forward. Three key checkpoints are the cell growth (G1) checkpoint, the DNA synthesis (G2) checkpoint, and the mitosis checkpoint.

The cell growth (G1) checkpoint allows the cell to proceed into the S phase of the cell cycle and continue on to divide. The cell spends most of the cycle in the G1 phase. G1 is where the cell carries out its main functions. If the cell has performed its functions and has grown to significant size to be divided in half, key proteins will stimulate DNA replication to begin. If the cells are not to divide, such as some muscle and nerve cells, the cell will stop at this checkpoint and move into a resting phase. Some cells may stay in this resting period permanently, never dividing.

The DNA synthesis (G2) checkpoint determines if the cell is ready for mitosis. DNA repair enzymes check the replicated DNA at this point. If the checkpoint is passed, the many molecular mechanisms and processes needed for mitosis will begin.

The mitosis checkpoint determines the end of one cycle and the beginning of the next. This checkpoint signals the end of mitosis, allowing the cell to prepare for the beginning of G1 of the next cell cycle.

**Questions**

1. Does the cell have any control over its progression through the cell cycle? If so, how is it regulated?

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2. What happens at a cell cycle checkpoint?

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3. What are the five main phases of the cell cycle? What are the main events in each?

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4. List and briefly describe the three main cell cycle checkpoints.

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5. What do you think happens when a cell loses control of the cell cycle?

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## Lesson 6.1: Multiple Choice

**Name**_______________________________ **Class**____________ **Date**________

*Circle the letter of the correct choice.*

1. The process in prokaryotes by which a cell divides to form two identical cells by cytokinesis is called
   (a) binary fission.
   (b) cyclin.
   (c) multi-fission.
   (d) S phase.
2. During which phase of the cell cycle does the cytoplasm split such that two daughter cells are formed?
   (a) G1 phase
   (b) G2 phase
   (c) S phase
   (d) C phase
3. Human liver cells and kidney cells each contain
   (a) different genes from one another, because some of the proteins made differ between the two cell types.
   (b) the same genes, because in a single multicellular organism, all somatic cells (non-germ cells) contain the same genes.
   (c) a set of proteins, all of which are produced in both cell types.
   (d) a single, circular chromosome.
4. Human chromosomes
   (a) are present in cells as a set of 23 chromosomes total.
   (b) come in pairs, both pairs inherited from the mother.
   (c) come in pairs, one of which is inherited from the mother, and the other, from the father.
   (d) come in pairs, both pairs inherited from father.
5. Chromosomes that are the same size and shape and that contain the same genes
   (a) are duplicated during G2 phase.
   (b) are homologous chromosomes.
   (c) are present in prokaryotes, but not eukaryotes.
   (d) all of the above

6. Unfertilized human eggs contain what complement of sex chromosomes?
   (a) one Y chromosome
   (b) one X chromosome
   (c) two X chromosomes
   (d) one X and one Y chromosome
7. Some cancers are triggered by
   (a) ultraviolet radiation.
   (b) tobacco smoking.
   (c) asbestos.
   (d) all of the above

## Lesson 6.1: Vocabulary

**Name**________________________________ **Class**____________ **Date**________

*Match the vocabulary term with the correct definition.*

**Term**

______ 1. spindle

______ 2. zygote

______ 3. oncogene

______ 4. gene

______ 5. haploid

______ 6. mitosis

______ 7. cell plate

______ 8. S phase

______ 9. sister chromatid

______ 10. autosomes

**Definition**

a. The cell cycle phase during which the DNA is replicated, and correspondingly, the chromosomes are duplicated.

b. Microtubule-based fibers used to move chromosomes and separate the sister chromatids during mitosis.

c. The phase of the cell cycle during which the duplication of the nucleus occurs.

d. Forms during cytokinesis in plant cells; a new plasma membrane grows along each side of the cell plate, with a new cell wall forming on the outside of each new membrane.

e. Identical copies of a DNA molecule that are attached at their centromeres.

f. Chromosomes that are not directly involved in determining the sex of an individual.

g. The first cell of a new individual.

h. A segment of DNA that contains the information necessary to encode an RNA molecule or a protein.

i. A cell that contains one set of chromosomes, such as a human sperm cell or egg.

j. A gene, which when it is mutated and/or when it produces too much protein product, can cause cancer and speed up the cell cycle.

## 6.3 Lesson 6.2: Meiosis

### Lesson 6.2: True or False

**Name**________________________________ **Class**____________ **Date**________

*Write true if the statement is true or false if the statement is false.*

_________ 1. In some species, an organism can have just one parent.

_________ 2. Asexual reproduction produces an individual that is genetically different from the parent.

_________ 3. All bacteria are either distinctly male or female.

_________ 4. Fragmentation is actually a kind of asexual reproduction.

_________ 5. Human gametes are haploid.

_________ 6. Meiosis is required to form human gametes.

_________ 7. Both prophase I and metaphase II are stages of meiosis.

_________ 8. At the beginning of meiosis in humans, during prophase I, there are 92 chromatids in the cell.

_________ 9. At the end of oogenesis in human females, 4 haploid mature ova are produced from a single primary oocyte.

_________ 10. At the end of spermatogenesis, 4 spermatids are produced from a single primary spermatocyte.

_________ 11. In meiosis, the sister chromatids separate from each other at anaphase I.

_________ 12. Crossing-over during meiosis produces unique combinations of alleles (alternative forms of the same gene) in the recombinant chromosomes.

_________ 13. Sexual reproduction results in less genetically diverse offspring when compared to asexual reproduction.

_________ 14. Organisms with a haploid life cycle never undergo mitosis.

_________ 15. Organisms with a diploid life cycle produce diploid gametes.

## Lesson 6.2: Critical Reading

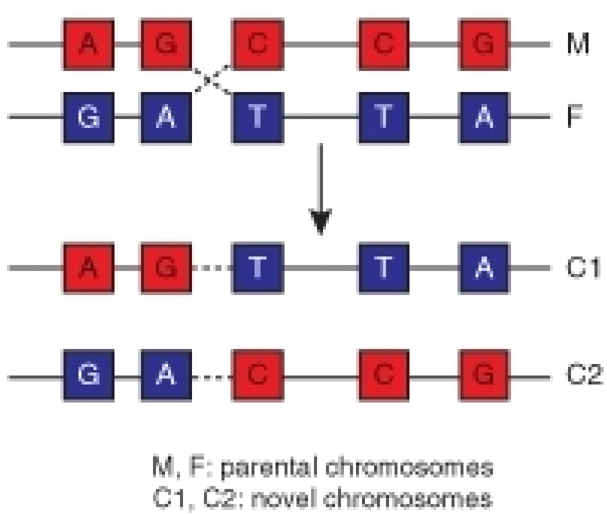
**Name**_______________________________ **Class**___________ **Date**________

*Read this passage from the lesson and answer the questions that follow.*

**Meiosis and Genetic Variation**

Sexual reproduction results in infinite possibilities of genetic variation. This occurs through a number of mechanisms, including crossing-over, the independent assortment of chromosomes during anaphase I, and random fertilization.

Crossing-over occurs during prophase I. Crossing-over is the exchange of genetic material between non-sister chromatids of homologous chromosomes. Recall during prophase I, homologous chromosomes line up in pairs, gene-for-gene down their entire length, forming a configuration with four chromatids, known as a tetrad. At this point, the chromatids are very close to each other and some material from two chromatids switch chromosomes, that is, the material breaks off and reattaches at the same position on the homologous chromosome (Figure below). This exchange of genetic material can happen many times within the same pair of homologous chromosomes, creating unique combinations of genes. This process is also known as recombination.



As mentioned above, in humans there are over 8 million configurations in which the chromosomes can line up during metaphase I. It is the specific processes of meiosis, resulting in four unique haploid cells, that results in these many combinations. Figure below compares mitosis and meiosis. This independent assortment, in which the chromosome inherited from either the father or mother can sort into any gamete, produces the potential for tremendous genetic variation. Together with random fertilization, more possibilities for genetic variation exist between any two people than individuals alive today. Sexual reproduction is the random fertilization of a gamete from the female using a gamete from the male. In humans, over 8 million (223) chromosome combinations exist in the production of gametes in both the male and female. A sperm cell, with over 8 million chromosome combinations, fertilizes an egg cell, which also has over 8 million chromosome combinations. That is over 64 trillion unique combinations, not counting the unique combinations produced by crossing-over. In other words, each human couple could produce a child with over 64 trillion unique chromosome combinations.

**Questions**

1. The genetic variation of offspring produced by sexual reproduction is almost limitless. List and describe the mechanisms responsible for this variation.

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2. What is crossing over? When does it occur?

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3. How do the products of crossing-over (the recombinant chromatids) differ from the parental chromosomes?

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4. What is a tetrad? During what phase of the cell cycle are tetrads found?

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5. In humans, there are over 8 million possible ways that chromosomes can line up during

metaphase I of meiosis. The common dog (*Canis lupus familiaris*) has 78 chromosomes (Lindblad-Toh K et al. 2005. Genome sequence, comparative analysis and haplotype structure of the domestic dog., *Nature,* 438:803-819). Is the number of possible ways that chromosomes can line up during metaphase I greater or less in dogs compared to humans? Why?

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## Lesson 6.2: Multiple Choice

**Name**______________________________ **Class**___________ **Date**________

*Circle the letter of the correct choice.*

1. Cytokinesis occurs ______ from the start to finish of meiosis.
   (a) once
   (b) twice
   (c) four times
   (d) not at all
2. In meiosis, the sister chromatids separate from one another during
   (a) metaphase I.
   (b) metaphase II.
   (c) anaphase I.
   (d) anaphase II.
3. In preparation for meiosis, the DNA replicates ______.
   (a) once
   (b) twice
   (c) four times
   (d) not at all
4. Gametogenesis in males produces _____ gametes, and in females ______ gametes.
   (a) two, two
   (b) four, four
   (c) one, four
   (d) four, one
5. In a newly formed zygote, most of the organelles and cytoplasm originated from the
   (a) somatic cells of the father.
   (b) somatic cells of the mother.
   (c) egg.

(d) sperm.

6. A life cycle in which the zygote is the only diploid cell is called a

   (a) diploid life cycle.
   (b) haploid life cycle.
   (c) alternation of generations life cycle.
   (d) monotypic life cycle.

7. Organisms that have an alternation of generations life cycle

   (a) have all females in one generation, and all males in the next.
   (b) have all males in one generation, and all females in the next.
   (c) alternate between mitosis and cytokinesis.
   (d) alternate between diploid and haploid phases.

## Lesson 6.2: Vocabulary

**Name**________________________________ **Class**____________ **Date**________

*Match the vocabulary term with the correct definition.*

**Term**

______ 1. Tetrad

______ 2. Gametes

______ 3. Spore

______ 4. budding

______ 5. gametophyte

______ 6. fertilization

______ 7. meiosis

______ 8. Fission

______ 9. polar body

______ 10. haploid **Definition**

a. A type of cell division in diploid organisms that results in the production of four haploid cells.

b. Results from the alignment of a pair of duplicated homologous chromosomes during prophase I.

c. A cell that is produced during oogenesis and does not develop into a viable gamete, but degrades.

d. A cell containing one set of chromosomes.

e. An organism's reproductive cells.

f. A form of asexual reproduction in which new cells are formed by cleavage of the parental cell in half.

g. A haploid reproductive cell that can develop into an adult without fusing with another haploid cell.

h. A type of asexual reproduction in which daughter cell buds off from a parent cell.

i. The fusion of two gametes to form a zygote.

j. An organism that produces gametes by mitosis.

# Chapter 7

# Mendelian Genetics Worksheets

## 7.1 Chapter 7: Mendelian Genetics

- Lesson 7.1: Mendel's Investigations
- Lesson 7.2: Mendelian Inheritance

## 7.2 Lesson 7.1: Mendel's Investigations

### Lesson 7.1: True or False

**Name**________________________________ **Class**____________ **Date**________

*Write true if the statement is true or false if the statement is false.*

_________ 1. The "father of modern genetics" is Gregor Mendel.

_________ 2. The passing of characteristics from parent to offspring is called heredity.

_________ 3. A dihybrid cross tracks the inheritance of one characteristic from parent to offspring.

_________ 4. Fertilization in which pollen from one flower pollinates a flower on a different plant is called self-pollination.

_________ 5. Offspring of the P generation are referred to as F2 offspring.

_________ 6. In Mendel's experiments, a true-breeding purple plant and a true-breeding white plant always produced purple offspring.

_________ 7. A variation of a gene is called an allele.

_________ 8. The allele that is expressed is called the recessive allele.

_________ 9. Genes that are likely to be inherited together because they are located close together on the same chromosome are called linked genes.

_________ 10. Albinism is a recessively inherited disorder in which the body does no produce enough of the pigment melanin.

_________ 11. In genetics problems, capital letters refer to recessive alleles, while lowercase letters refer to dominant alleles.

_________ 12. An organism that has an identical pair of alleles for a trait is called heterozygous.

_________ 13. The genotype of an organsim determines its phenotype.

_________ 14. The Law of Independent Assortment states that a pair of alleles is separated, or segregated, during the formation of gametes.

_________ 15. Genetics is the branch of biology that focuses on heredity in organisms.

## Lesson 7.1: Critical Reading

**Name**______________________________ **Class**___________ **Date**________

*Read this passage from the lesson and answer the questions that follow.*

**Dominant and Recessive Alleles**

Mendel used letters to represent dominant and recessive factors. Likewise, geneticists now use letters to represent alleles. Capital letters refer to dominant alleles, and lowercase letters refer to recessive alleles. For example, the dominant allele for the trait of green pod color is indicated by G. The recessive trait of yellow pod color is indicated by g. A true-breeding plant for green pod color would have identical alleles GG in all is somatic cells. Likewise, a true-breeding plant for yellow pod color would have identical alleles gg in all of its somatic cells. During gamet formation, each gamete receives one copy of an allele. When fertilization occurs between these plants, the offspring receives two copies of the allele, one from each parent. In this case, all of the offspring would have two different alleles, Gg, one from each of its parents.

An organism that has an identical pair of alleles for a trait is called homozygous. The true-breeding parents GG and gg are homozygous for the pod color gene. Organisms that have two different alleles for a gene are called heterozygous. The offspring of the cross between the GG and gg plants are all heterozygous for the pod color gene. Due to dominance and recesiveness of alleles, an organism's traits do not always reveal its genetics. Therefore, geneticists distinguish between an organism's genetic makeup, called its genotype, and its physical traits, called its phenotype. For example, the GG parent and the Gg offspring have the same phenotype (green pods) but different genotypes.

**Questions**

1. Capital letters and lowercase letters are used to identify what particular alleles?

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2. What defines a true-breeding plant?

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3. Contrast the terms homozygous and heterozygous.

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4. Why does an organism's genotype determine it's phenotype?

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5. What would be the phenotype for pod color of a pea plant with the genotype GG? Gg? gg? Why?

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## Lesson 7.1: Multiple Choice

**Name**_______________________________ **Class**___________ **Date**________

*Circle the letter of the correct choice.*

1. Who is known as the "father of modern genetics"?
   (a) Charles Darwin
   (b) Gregor Mendel

(c) Robert Hooke
(d) Carolus Linnaeus

2. The process of transferring pollen from the male part of the flower to the female part of another flower is called
   (a) artificial fertilization.
   (b) artificial selection.
   (c) artificial mating.
   (d) artificial mechanism.
3. According to the blending inheritance hypothesis that was popular in the 19th century, what would happen if a tall plant was mixed with a short plant?
   (a) All the offspring would be tall.
   (b) All the offspring would be short.
   (c) All the offspring would be medium height.
   (d) The offspring would be 50% tall and 50% short.
4. Due to the Law of Segregation, how many alleles are inherited from each parent?
   (a) 1
   (b) 2
   (c) 4
   (d) 5
5. An organism that has an identical pair of alleles for a trait is called
   (a) homozygous.
   (b) heterozygous.
   (c) monozygous.
   (d) dizygous.
6. The allele that is expressed when two separate alleles are inherited is referred to as
   (a) recessive.
   (b) dominant.
   (c) homozygous.
   (d) heterozygous.
7. Linked genes are genes that are located close together on a chromosome and
   (a) are unlikely to be inherited together.
   (b) are likely to be inherited together.
   (c) are never inherited together.
   (d) are always inheited together.

## Lesson 7.1: Vocabulary

**Name**______________________________ **Class**___________ **Date**________

*Match the vocabulary term with the correct definition.*

**Term**

______ 1. allele

______ 2. genotype

______ 3. phenotype

______ 4. hybridization

______ 5. linked genes

______ 6. heterozygous

______ 7. homozygous

______ 8. heredity

______ 9. dominant allele

______ 10. recessive allele

**Definition**

a. A cross between two individuals that have different traits.

b. Organisms that have two different alleles for a gene.

c. Different versions of a gene.

d. Genes that are close together on a chromosome and are packaged into the gametes together.

e. The passing of characteristics from parent to offspring.

f. The allele that is expressed only in the absence of a dominant allele.

g. An organism's genetic makeup.

h. An organism that has an identical pair of alleles for a trait.

i. The allele that is expressed when two separate alleles are inherited.

j. An organism's physical traits.

## 7.3 Lesson 7.2: Mendelian Inheritance

### Lesson 7.2: True or False

**Name**______________________________ **Class**___________ **Date**________

*Write true if the statement is true or false if the statement is false.*

_________ 1. Probability is the likelihood that a certain event will occur.

_________ 2. Results predicted by probablity are most accurate when few trials are performed.

_________ 3. A heterozygote (Bb) has a 50% chance of donating the recessive allele (b) into its gametes.

_________ 4. A test cross is a chart which shows the inheritance of a trait over several generations.

_________ 5. A dihybrid cross tracks the inheritance of two characteristics a the same time.

_________ 6. The genotypic ratio of offspring resulting from a dihybrid cross of two heterozygous individuals is 9:3:3:1.

_________ 7. Pedigrees are useful in tracking the inheritance patterns of genetic disorders.

_________ 8. A human male's sex chromosomes are XX.

_________ 9. Traits that are located on a sex chromosome are called sex-linked traits.

_________ 10. Most sex-linked disorders are dominant and found on the Y chromosome.

_________ 11. It is possible for males to be heterozygous for a sex-linked disorder.

_________ 12. A female who possesses one copy of a sex-linked disorder, but does not express that disorder is reffered to as a carrier of that disorder.

_________ 13. If a trait is recessive, a person with the trait may have one, both, or neither parent with the trait.

_________ 14. Environmental factors never influence an organism's phenotype.

_________ 15. Human height can be influenced by environmental factors in addition to genes.

## Lesson 7.2: Critical Reading

**Name**_______________________________ **Class**___________ **Date**________

*Read this passage from the lesson and answer the questions that follow.*

### Complex Forms of Heredity

When three or more alleles determine a trait, the trait is said to have **multiple alleles**. The human ABO blood group is controlled by a single gene with three alleles: i, $I^A$, $I^B$, and the recessive i allele. The gene encodes an enzyme that affects carbohydrates that are found on the surface of the red blood cell. A and B refer to two carbohydrates found on the surface of red blood cells. There is not an O carbohydrate. Type O red blood cells do not have either type A or B carbohydrates on their surface.

The alleles $I^A$ and $I^B$ are dominant over i. A person who is homozygous recessive ii has type O blood. Homozygous dominant $I^A I^A$ or heterozygous dominant $I^A i$ have type A blood, and homozygous dominant $I^B I^B$ or heterozygous dominant $I^B i$ have type B blood. $I^A I^B$ people have type AB blood, because the A and B alleles are codominant. Type A and type B parents can have a type AB child. Type A and a type B parent can also have a child with Type O blood, if they are both heterozygous ($I^B i$, $I^A i$).

**Questions**

1. How does increasing the number of alleles for a particular trait affect the amount of phenotypic variation possible?

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2. What are the three alleles found in the gene that codes for human blood type?

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3. What are the relationships found between the three alleles? Which ones are dominant? Which ones are recessive?

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4. Use the information found in the passage to complete the following table:

Table 7.1:

| **Genotype** | **Phenotype** |
|---|---|
| $I^A I^A$ | ? |
| ? | Type A |
| ? | Type B |
| $I^B i$ | ? |
| $I^A I^B$ | ? |
| ? | Type O |

5. Would it be possible for a man with type A blood and a woman with type B blood to produce a child with type O blood? Explain.

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## Lesson 7.2: Multiple Choice

**Name**______________________________ **Class**___________ **Date**________

*Circle the letter of the correct choice.*

1. If you toss a coin 10 times and get 7 heads and 3 tails, what is the probability that the next toss will result in a heads?
   (a) 50%
   (b) 30%
   (c) 70%
   (d) 100%
2. What are the possible parental genotypes of an individual who is homozygous recessive?
   (a) homozygous dominant
   (b) homozygous recessive
   (c) heterozygous
   (d) both b and c
3. In pea plants, the dominant allele (P) codes for purple flowers and the recessive allele (p) codes for white flowers. What is the probability that a cross between a homozygous dominant (PP) plant and a heterozygous plant (Pp) will result in offspring that have purple flowers?
   (a) 100%
   (b) 75%
   (c) 25%
   (d) 0%
4. What is the probability that a cross between a homozygous dominant (PP) plant and a homozygous recessive (pp) plant will result in offspring that have white flowers?
   (a) 100%
   (b) 0%
   (c) 75%
   (d) 25%
5. A pedigree can be used to determine whether

(a) a trait is sex-linked or autosomal.
(b) a trait is caused by a dominant or recessive allele.
(c) a person is heterozygous or homozygous for a particular trait.
(d) All of the above.

6. In certain plants called snapdragons, the heterozygous phenotype is a blend of the two homozygous phenotypes. Homozygous dominant plants are red, heterozygous plants are pink, and homozygous recessive plants are white. What type of inheritance pattern is this?

   (a) complete dominance
   (b) codominance
   (c) incomplete dominance
   (d) none of the above

7. The A and B alleles in human blood type follow what type of inheritance pattern?

   (a) complete dominance
   (b) codominance
   (c) incomplete dominance
   (d) none of the above

## Lesson 7.2: Vocabulary

**Name**________________________________ **Class**____________ **Date**________

*Match the vocabulary term with the correct definition.*

**Term**

______ 1. autosome

______ 2. pedigree

______ 3. polygenic traits

______ 4. carrier

______ 5. sex-linked trait

______ 6. sex chromosome

______ 7. testcross

______ 8. codominance

______ 9. Punnett square

______ 10. incomplete dominance

**Definition**

a. Traits that are affected by more than one gene.

b. A chromosome that determines the sex of an organism.

c. A cross used to determine an unknown genotype.

d. A person who is heterozygous for a recessive allele of a trait.

e. Any chromosome other than a sex chromosome.

f. Occurs when the phenotype of the offspring is somewhere in between the phenotypes of both parents.

g. A diagram that helps predict the probable inheritance of alleles in different crosses.

h. A chart which shows the inheritance of a trait over several generations.

i. Occurs when both traits appear in a heterozygous individual.

j. A trait whose allele is found on a sex chromosome.

# Chapter 8

# Mendelian Genetics Worksheets

## 8.1 Chapter 8: Molecular Genetics

- Lesson 8.1: DNA and RNA
- Lesson 8.2: Protein Synthesis
- Lesson 8.3: Mutation
- Lesson 8.4: Regulation of Gene Expression

## 8.2 Lesson 8.1: DNA and RNA

### Lesson 8.1: True or False

**Name**________________________________ **Class**____________ **Date**________

*Write true if the statement is true or false if the statement is false.*

__________ 1. Proteins give organisms their traits.

__________ 2. The function of proteins is determined by their structure.

__________ 3. Avery proved conclusively that DNA is the genetic material.

__________ 4. The backbone of DNA consists of base pairs.

__________ 5. DNA base sequences are often used to solve crimes.

__________ 6. DNA replication begins when polymerase breaks hydrogen bonds in DNA.

__________ 7. In DNA, the complement of ATC is TAG.

__________ 8. In RNA, guanine always bonds with uracil.

_________ 9. RNA is found only in the cytoplasm of the cell.

_________ 10. RNA molecules are smaller than DNA molecules.

_________ 11. Messenger RNA carries instructions to the ribosome.

_________ 12. Ribosomal RNA brings amino acids to the ribosome.

## Lesson 8.1: Critical Reading

**Name**_______________________________ **Class**___________ **Date**________

*Read this passage from the lesson and answer the questions that follow.*

**The Double Helix**

In the early 1950s, Rosalind Franklin started working on understanding the structure of DNA fibers. Franklin, together with Maurice Wilkins, used her expertise in x-ray diffraction photographic techniques to analyze the structure of DNA. In February 1953, Francis Crick and James D. Watson of the Cavendish Laboratory in Cambridge University had started to build a model of DNA. Watson and Crick indirectly obtained Franklin's DNA X-ray diffraction data demonstrating crucial information into the DNA structure. Francis Crick and James Watson then published their double helical model of DNA in *Nature* on April 25th, 1953.

DNA has the shape of a **double helix**, just like a spiral staircase. There are two sides, called the **sugar-phosphate backbone**, because they are made from alternating phosphate groups and deoxyribose sugars. The "steps" of the double helix are made from the base pairs formed between the nitrogenous bases. The DNA double helix is held together by hydrogen bonds between the bases attached to the two strands.

The double helical nature of DNA, together with the findings of Chargaff, demonstrated the base-pairing nature of the bases. Adenine always pairs with thymine, and guanine always pairs with cytosine. Because of this complementary nature of DNA, the bases on one strand determine the bases on the other strand. These complementary base pairs explain why the amounts of guanine and cytosine are present in equal amounts, as are the amounts of adenine and thymine. Adenine and guanine are known as **purines**. These bases consist of two ring structures. Purines make up one of the two groups of nitrogenous bases. Thymine and cytosine are **pyrimidines**, which have just one ring structure. By having a purine always combine with a pyrimidine in the DNA double helix, the distance between the two sugar-phosphate backbones is constant, maintaining the uniform shape of the DNA molecule.

So it is this four letter code, made of just A, C, G, and T, that determines what the organism will become and what it will look like. How can these four bases carry so much information? This information results from the order of these four bases in the chromosomes. This sequence carries the unique genetic information for each species and each individual. Humans have about 3,000,000,000 bits of this information in each cell. A gorilla may also have close to that amount of information, but a slightly different sequence. For example, the sequence AGGTTTACCA will have different information than CAAGGGATTA. The closer the evolutionary relationship is between two species, the more similar their DNA sequences will be. For example, the DNA sequences between two species of reptiles will be more similar than between a reptile and an elm tree.

**Questions**

1. The discovery of the structure of DNA was due to the work of many different scientists during the first half of the 1900s. Which two scientists first published the double-helical model of DNA? When did they publish it?

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2. Explain why DNA is like a spiral staircase.

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3. What holds together the complementary strands of a DNA molecule?

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4. List the complementary base pairs of DNA.

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5. How can the four bases of DNA carry all the genetic information of an organism?

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## Lesson 8.1: Multiple Choice

**Name**______________________________ **Class**___________ **Date**________

*Circle the letter of the correct choice.*

1. The structure of proteins is determined by the order and type of their
   (a) nitrogen bases.
   (b) pyrimidines.
   (c) amino acids.
   (d) nucleotides.
2. The central dogma of molecular biology is best represented by
   (a) DNA + RNA = Protein.
   (b) DNA $\rightarrow$ RNA + Protein.
   (c) DNA $\rightarrow$ RNA $\rightarrow$ Protein.
   (d) Protein $\rightarrow$ RNA $\rightarrow$ DNA.
3. What makes up the “steps” of the DNA spiral staircase?
   (a) sugars
   (b) phosphates
   (c) sugars and phosphates
   (d) nitrogenous base pairs
4. Pyrimidines include
   (a) uracil.
   (b) thymine.
   (c) cytosine.
   (d) all of the above.
5. During DNA replication, the two new strands of DNA are built
   (a) in opposite directions.
   (b) in the cell cytoplasm.
   (c) from amino acids.
   (d) at a ribosome.
6. When a protein is made in a cell, the instructions for the protein are first copied from DNA to
   (a) rRNA.
   (b) tRNA.
   (c) mRNA.
   (d) none of the above.
7. Most RNA codons code for a(n)
   (a) protein.
   (b) ribosome.
   (c) nucleotide.
   (d) amino acid.

## Lesson 8.1: Vocabulary

**Name**______________________________ **Class**___________ **Date**________

*Match the vocabulary term with the correct definition.*

**Term**

_____ 1. anticodon

_____ 2. codon

_____ 3. DNA

_____ 4. gene

_____ 5. nucleotide

_____ 6. purine

_____ 7. pyrimidine

_____ 8. ribosome

_____ 9. RNA

_____ 10. transformation

**Definition**

a. monomer of all nucleic acids

b. double-stranded nucleic acid

c. thymine or cytosine

d. site of protein synthesis

e. three-base code word in tRNA

f. single-stranded nucleic acid

g. segment of DNA that codes for a protein

h. genetic change due to assimilation of external DNA

i. adenine or guanine

j. three-base code word in mRNA

## 8.3 Lesson 8.2: Protein Synthesis

### Lesson 8.2: True or False

**Name**________________________________ **Class**____________ **Date**________

*Write true if the statement is true or false if the statement is false.*

_________ 1. Transcription is “RNA → DNA.”

_________ 2. Transcription begins with the formation of a ribosome.

_________ 3. Nucleotides are added to the 3  end of mRNA.

_________ 4. The 5  end of mRNA helps it find DNA.

_________ 5. Splicing is the process of amino acids joining to form a protein.

_________ 6. There are 64 different amino acids in proteins.

_________ 7. Francis Crick helped demonstrate the presence of codons.

_________ 8. All codons code for amino acids.

_________ 9. The reading frame in translation consists of four bases.

_________ 10. The same genetic code is found in all organisms.

_________ 11. Ribosomes are composed of 30 different subunits.

_________ 12. Proteins may be modified after protein synthesis.

### Lesson 8.2: Critical Reading

**Name**________________________________ **Class**____________ **Date**________

*Read this passage from the lesson and answer the questions that follow.*

**Transcription**

Transcription is “DNA → RNA.” In other words, transcription is the transfer of the genetic “instructions” from DNA to RNA. During transcription, a complementary copy of RNA is made. Whereas in DNA replication both strands of the DNA double helix are used as templates, in transcription only one strand is needed. RNA polymerase enzymatically “reads” a template strand of DNA, known as the coding strand, to synthesize the complementary RNA strand. Transcription is divided into 3 stages, appropriately named initiation, elongation and termination.

**Initiation**

**Transcription** begins with the binding of RNA polymerase to the promoter of a gene. An eukaryotic promoter usually includes specific sequences that are recognized by transcription factors, which are proteins that aid in the binding of RNA polymerase to the correct place on the DNA. The transcription initiation complex formed by the promoter, transcription factors, and RNA polymerase signals the start, or **initiation**, of transcription. The DNA unwinds and produces a small open complex, which allows **RNA polymerase** to "read" the DNA template and begin the synthesis of RNA.

**Elongation**

Transcription **elongation** involves the further addition of RNA nucleotides and the change of the open complex to a transcriptional complex. As the RNA transcript is assembled, DNA in front of RNA polymerase unwinds and transcription continues. As transcription progresses, RNA nucleotides are added to the 3' end of the growing RNA transcript. The transcriptional complex has a short DNA-RNA hybrid, an 8 base-pair stretch in which the newly made RNA is temporarily hydrogen bonded to the DNA template strand. Unlike DNA replication, mRNA transcription can involve multiple RNA polymerases, allowing numerous mRNAs to be produced from a single copy of the gene. This step also involves a proofreading mechanism that can replace an incorrectly added RNA nucleotide.

**Termination**

The termination of transcription in prokaryotes and eukaryotes is very different. Though both involve the detachment of the RNA from the DNA template, how this occurs is surprisingly distinct. Bacteria use two different strategies for transcription termination, Rho-dependent and Rho-independent termination. In **Rho-dependent termination**, a protein factor called "Rho" destabilizes the RNA-DNA hybrid, releasing the newly synthesized mRNA from the elongation complex. In Rho-independent termination, RNA transcription stops when the newly synthesized RNA molecule forms a hairpin loop followed by a run of uracils. This structure is the signal for the detachment of the RNA from the DNA. The DNA is now ready for translation.

The **termination** of transcription in eukaryotes is less well understood. The RNA polymerase transcribes a polyadenylation signal. Polyadenylation is the addition of a string of A's to the mRNA's 3' end and will be discussed in the next section. However, soon after the transcription of this signal, proteins cut the RNA transcript free from the polymerase and the polymerase eventually falls off the DNA. This process produces a pre-mRNA, an mRNA that is not quite ready to be translated.

**Questions**

1. Define transcription.

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2. List the three stages of transcription.

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3. Describe how transcription begins.

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4. What occurs during transcription elongation?

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5. Contrast transcription termination in prokaryotes and eukaryotes.

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## Lesson 8.2: Multiple Choice

**Name**______________________________ **Class**___________ **Date**________

*Circle the letter of the correct choice.*

1. What is one role in protein synthesis that is played by RNA polymerase?
   (a) It carries information out of the nucleus.
   (b) It begins the transcription process.
   (c) It forms a subunit of the ribosome.
   (d) It acts as a stop codon in RNA.
2. What happens during transcription?
   (a) A new polypeptide is created.
   (b) RNA is scanned by a ribosome.
   (c) A new copy of DNA is produced.
   (d) A complementary copy of RNA is made.
3. In eukaryotes, termination of transcription involves
   (a) Rho formation.

(b) polyadenylation.
(c) DNA promotion.
(d) RNA translation.

4. A codon is a(n)
   (a) nucleotide.
   (b) amino acid.
   (c) nitrogen base.
   (d) three-base sequence.
5. Which code word signals "start" in the genetic code?
   (a) UAG
   (b) AUG
   (c) UGA
   (d) UAA
6. How many amino acids can one codon code for?
   (a) 20
   (b) 4
   (c) 3
   (d) 1
7. During which phase(s) of translation is the ribosome assembled?
   (a) initiation
   (b) elongation
   (c) termination
   (d) all of the above

## Lesson 8.2: Vocabulary

**Name**________________________________ **Class**____________ **Date**________

*Match the vocabulary term with the correct definition.*

**Term**

______ 1. transcription

______ 2. translation

______ 3. exon

______ 4. intron

______ 5. initiation

______ 6. elongation

______ 7. termination

______ 8. editing

______ 9. splicing

______ 10. ribosome

**Definition**

a. process of changing the nucleotide sequence of mRNA

b. region of a gene that codes for a protein

c. site where polypeptides are assembled

d. process that uses DNA to make mRNA

e. region of DNA that has no known function

f. process by which introns are removed from pre-mRNA

g. process of adding more amino acids to a polypeptide

h. end of transcription or translation

i. start of transcription or translation

j. process that uses mRNA to make a protein

## 8.4 Lesson 8.3: Mutation

### Lesson 8.3: True or False

**Name**________________________________ **Class**___________ **Date**________

*Write true if the statement is true or false if the statement is false.*

_________ 1. It is possible for mutations to occur spontaneously.

_________ 2. Only somatic mutations can be passed on to offspring.

_________ 3. An inversion is a type of chromosomal alteration.

_________ 4. A mutation that changes C to G is a transition mutation.

_________ 5. A nonsense mutation codes for a premature stop codon.

_________ 6. A silent mutation codes for a different amino acid.

_________ 7. Some mutations have no significant effect.

_________ 8. Nearly all cancers are caused of mutations in DNA.

_________ 9. All cancers need an environmental trigger to develop.

_________ 10. Proto-oncogenes are abnormal cancer-causing genes.

_________ 11. A cell needs multiple mutations to transform to a cancerous cell.

_________ 12. Mutations in tumor suppressor genes are generally dominant alleles.

## Lesson 8.3: Critical Reading

**Name**_______________________________ **Class**___________ **Date**________

*Read this passage from the lesson and answer the questions that follow.*

**Types of Mutations**

In multicellular organisms, mutations can be subdivided into germline mutations, which can be passed on to descendants, and somatic mutations, which cannot be transmitted to the next generation. Germline mutations change the DNA sequence within a sperm or egg cell, and therefore can be inherited. This inherited mutation results in a class of diseases known as a genetic disease. The mutation may lead to a nonfunctional protein, and the embryo may not develop properly or survive. Somatic mutations may affect the proper functioning of the cell with the mutation. During DNA replication, the mutation will be copied. The two daughter cells formed after cell division will both carry the mutation. This may lead to the development of many cells that do not function optimally, resulting a less than optimal phenotype. Various types of mutations can all have severe effects on the individual. These include point mutations, framehift mutations and chromosomal alterations.

**Chromosomal Alterations**

**Chromosomal alterations** are large changes in the chromosome structure. They occur when a section of a chromosome breaks and rejoins incorrectly, or does not rejoin at all. Sometimes the segment may join backwards or reattach to another chromosome altogether. These mutations are very serious and usually lethal to the zygote or embryo. If the embryo does survive, the resulting organism is usually sterile and thus, unable to pass along the mutation.

The five types of chromosomal alterations are deletions, duplications, insertions, inversions, and translocations.

1. **Deletions**: removal of a large chromosomal region, leading to loss of the genes within that region.
2. **Duplications** (or **amplifications**): lead to multiple copies of a chromosomal region, increasing the number of the genes located within that region. Some genes may be duplicated in their entirety.
3. **Insertions**: the addition of material from one chromosome to a nonhomologous chromosome.

4. **Inversions**: reversing the orientation of a chromosomal segment.
5. **Translocations**: interchange of genetic material between nonhomologous chromosomes.

### Point Mutations

As the name implies, **point mutations** occur at a single site within the DNA. Lets go back to our earlier example from lesson 8.2:

THE BIG FAT CAT ATE THE RED RAT.

A change at any one position could result in a sequence that does not make sense. Such as:

THE BIG FAT SAT ATE THE RED RAT.

As shown above, point mutations exchange one nucleotide for another and are known as base substitution mutations. These mutations are often caused either by chemicals or by a mistake during DNA replication. A transition exchanges a purine for a purine (A $\leftrightarrow$ G) or a pyrimidine for a pyrimidine, (C $\leftrightarrow$ T), and is the most common point mutation. Less common is a transversion, which exchanges a purine for a pyrimidine or a pyrimidine for a purine ($\frac{C}{T} \leftrightarrow \frac{A}{G}$). Point mutations that occur within the protein coding region of a gene are classified by the effect on the resulting protein:

1. **Silent mutations**: which code for the same amino acid.
2. **Missense mutations**: which code for a different amino acid.
3. **Nonsense mutations**: which code for a premature stop codon.

These mutations may result in a protein with the same function, with altered function, or with no function.

### Questions

1. What are germline mutations?

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2. What are somatic mutations?

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3. Define chromosomal alterations, and explain why chromosomal alternations are often lethal.

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4. Define point mutations, and give an example.

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5. Compare and contrast transitions and transversion.

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## Lesson 8.3: Multiple Choice

**Name**________________________________ **Class**____________ **Date**________

*Circle the letter of the correct choice.*

1. Common mutagens include
   (a) X-rays.
   (b) chemicals.
   (c) ultraviolet light.
   (d) all of the above.
2. The exchange of genetic material between two nonhomologous chromosomes is known as
   (a) deletion.
   (b) inversion.
   (c) duplication.
   (d) translocation.
3. A point mutation in which one purine is exchanged for another purine is called a(n)
   (a) amplification.
   (b) transversion.
   (c) transition.
   (d) inversion.
4. Removing nucleotides or adding nucleotides results in a

(a) point mutation.
(b) proto-oncogene.
(c) base substitution.
(d) reading frame shift.

5. The role of DNA ligase is to
   (a) digest DNA.
   (b) divide DNA.
   (c) repair DNA.
   (d) make DNA.
6. The normal function of tumor suppressor genes is to
   (a) mutate.
   (b) cause cancer.
   (c) help tumors grow.
   (d) stop the cell cycle.
7. Mutation of a proto-oncogene produces a(n)
   (a) tumor suppressor gene.
   (b) loss-of-function gene.
   (c) backup gene.
   (d) oncogene.

## Lesson 8.3: Vocabulary

**Name**________________________________ **Class**____________ **Date**________

*Match the vocabulary term with the correct definition.*

**Term**

______ 1. deletion

______ 2. duplication

______ 3. germline mutation

______ 4. insertion

______ 5. inversion

______ 6. missense mutation

______ 7. nonsense mutation

______ 8. point mutation

______ 9. silent mutation

______ 10. somatic mutation

**Definition**

a. mutation that adds multiple copies of a chromosomal region

b. mutation that reverses the order of nucleotides of a chromosomal region

c. point mutation that codes for a different amino acid

d. mutation that removes a chromosomal region

e. mutation in which one nucleotide is substituted for another

f. mutation in the DNA of a body cell

g. mutation in the DNA of a gamete

h. point mutation that codes for the same amino acid

i. point mutation that codes for a premature stop codon

j. mutation that adds part of a chromosome to a nonhomologous chromosome

## 8.5 Lesson 8.4: Regulation of Gene Expression

### Lesson 8.4: True or False

**Name**________________________________ **Class**____________ **Date**________

*Write true if the statement is true or false if the statement is false.*

_________ 1. Any aspect of a gene's expression may be regulated.

_________ 2. Transcription factors are DNA regions that control gene expression.

_________ 3. Repressor proteins bind to DNA at the promoter region.

_________ 4. Basal factors regulate gene expression by preventing transcription.

_________ 5. Gene regulation is more complex in eukaryotes than prokaryotes.

_________ 6. Operators are generally located immediately downstream from the promoter.

_________ 7. The lac operon is found only in eukaryotic organisms such as humans.

_________ 8. RNA polymerase binds to the lac promoter when lactose is available.

_________ 9. Enhancers are regulatory proteins that prevent RNA translation.

_________ 10. Homeobox genes contain a highly conserved DNA sequence.

_________ 11. Hox genes determine whether cells produce lactose.

_________ 12. At least two separate mutations are necessary for cancer to develop.

## Lesson 8.4: Critical Reading

**Name**______________________________ **Class**___________ **Date**________

*Read this passage from the lesson and answer the questions that follow.*

**The Lac Operon**

The **lac operon** (**Figure** 8.1) is an operon required for the transport and metabolism of lactose in *E. coli*. The lac operon is regulated by the availability of lactose. The lac operon consists of a promoter, an operator, three adjacent structural genes which code for enzymes and a terminator. The three genes are: lacZ, lacY, and lacA. All three genes are controlled by the same regulatory elements.

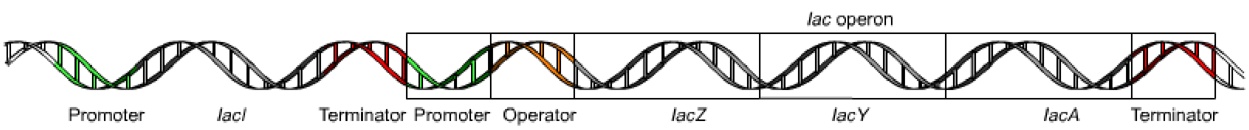


Figure 8.1: The lac operon. The lac operon contains genes for three enzymes, lac, lacY, and lac A, as well as the promoter, operator, and terminatory regulatory regions. (1)

In bacteria, the lac repressor protein blocks the synthesis of enzymes that digest lactose when there is no lactose present. When lactose is present, it binds to the repressor, causing it to detach from the DNA strand.

Specific control of the lac operon depends on the availability of lactose. The enzymes needed to metabolize lactose are not produced when lactose is not present. When lactose is available, and therefore needs to be metabolized, the operon is turned on, RNA polymerase binds to the promoter, and the three genes are transcribed into a single mRNA molecule. However, if lactose is not present (and therefore does not need to be metabolized), the operon is turned off by the lac repressor protein.

The lacI gene, which encodes the lac repressor, lies near the lac operon and is always expressed (constitutive). Therefore, the lac repressor protein is always present in the bacteria. In the absence of lactose, the lac repressor protein will bind to the operator, just past the promoter in the lac operon. The repressor blocks the binding of RNA polymerase to the promoter, keeping the operon turned off.

When lactose is available, a lactose metabolite called allolactose binds to the repressor. This interaction causes a conformational change in the repressor shape and the repressor falls off the operator, allowing RNA polymerase to bind to the promoter and initiate transcription.

**Questions**

1. List the basic components of an operon.

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2. What is the lac operon?

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3. What regulates the lac operon?

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4. What happens to the lac operon when lactose is present?

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5. What happens to the lac operon when lactose is not present?

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## Lesson 8.4: Multiple Choice

**Name**______________________________ **Class**___________ **Date**________

*Circle the letter of the correct choice.*

1. You have cells with different functions because you have cells with different
   (a) DNA.
   (b) genes.
   (c) proteins.
   (d) chromosomes.

2. Specificity factors help regulate genes by altering the specificity of RNA polymerase for a(n)
   (a) promoter.
   (b) activator.
   (c) enhancer.
   (d) operator.
3. An initiation complex is composed of trans-acting factors and
   (a) regulatory proteins.
   (b) RNA polymerase.
   (c) DNA sequences.
   (d) mRNA codons.
4. In bacteria, gene regulation is generally influenced by the presence or absence of certain
   (a) nutrients.
   (b) enhancers.
   (c) zinc fingers.
   (d) homeoboxes.
5. A cis-regulatory element found in the promoter of most eukaryotic genes is the
   (a) lac operon.
   (b) TATA box.
   (c) ras element.
   (d) lac repressor.
6. Genes important to eukaryotic development are regulated by
   (a) homeobox genes.
   (b) hox genes.
   (c) gap genes.
   (d) all of the above.
7. One way that genes may help prevent cancer in cells with DNA damage is by
   (a) causing cell death.
   (b) speeding up cell division.
   (c) stimulating the cell cycle.
   (d) promoting cell proliferation.

## Lesson 8.4: Vocabulary

**Name**______________________________ **Class**___________ **Date**________

*Match the vocabulary term with the correct definition.*

**Term**

______ 1. activator

______ 2. gap gene

______ 3. hox gene

______ 4. operator

______ 5. operon

______ 6. promoter

______ 7. repressor

______ 8. RNA polymerase

______ 9. TATA box

______ 10. transcription factor

**Definition**

a. gene that functions in patterning the body during development by providing the placement of certain body parts

b. in most eukaryotic genes, part of the promoter where RNA polymerase binds

c. protein that enhances the interaction between RNA polymerase and a particular promoter

d. segment of DNA that allows a gene to be transcribed by helping RNA polymerase find the start of the gene

e. enzyme that transcribes DNA to make RNA

f. gene that controls the shape of a developing zygote early in its development

g. region of prokaryotic DNA with a promoter, operator, and one or more genes

h. protein involved in regulating gene expression

i. region of prokaryotic DNA where a repressor binds

j. protein that binds to non-coding sequences on DNA and impedes RNA polymerase

# Image Sources

(1) http://en.wikipedia.org/wiki/Image:Lac_operon1.png. Public Domain.

# Chapter 9

# Mendelian Genetics Worksheets

## 9.1 Chapter 9: Human Genetics

- Lesson 9.1: Human Genes and Chromosomes
- Lesson 9.2: Human Inheritance

## 9.2 Lesson 9.1: Human Genes and Chromosomes

### Lesson 9.1: True or False

**Name**________________________________ **Class**____________ **Date**________

*Write true if the statement is true or false if the statement is false.*

__________ 1. A genetic disease is caused by a mutation in a gene or chromosome.

__________ 2. The human genome consists only of genes that code for proteins.

__________ 3. All organisms have the same number of chromosomes.

__________ 4. A normal human gamete has 23 pairs of chromosomes.

__________ 5. Chromosomes are composed of both nucleic acids and proteins.

__________ 6. Gene expression is controlled by regulatory sequences on chromosomes.

__________ 7. Linkage refers to whether a gene is dominant or recessive.

__________ 8. Loci on the same chromosome always assort independently during meiosis.

__________ 9. The DNA base sequence CACACACA is a dinucleotide repeat sequence.

_________ 10. Females are heterozygous for the X chromosome.

_________ 11. All sex-linked genes control traits that determine an individual's sex.

_________ 12. The process of X-inactivation results in the formation of male gametes.

## Lesson 9.1: Critical Reading

**Name**______________________________ **Class**___________ **Date**________

*Read this passage from the lesson and answer the questions that follow.*

**The Human Genome**

What makes each one of us unique? You could argue that the environment plays a role, and it does to some extent. But most would agree that your parents have something to do with your uniqueness. In fact, it is our genes that make each one of us unique—or at least genetically unique. We all have the genes that make us human: the genes for skin and bones, eyes and ears, fingers and toes, and so on. However, we all have different skin colors, different bone sizes, different eye colors, and different ear shapes. In fact, even though we have the same genes, the products of these genes work a little differently in most of us. And that is what makes us unique. The human **genome** consists of all the DNA of *Homo sapiens*. Humans have about 3 billion bases of information, divided into roughly 20,000 genes, which are spread among non-coding sequences. Our genes are distributed on 24 distinct chromosomes. The human genome includes all of the hereditary information encoded in the DNA, not just genes but non-coding sequences as well. It consists of protein-coding exons, noncoding introns, and regulatory sequences. It also contains genes that code for RNA molecules, as well as "junk" DNA, which are regions of DNA for which no function has yet been identified. Our knowledge of the human genome has been advanced greatly by the Human Genome Project. This project is a huge collaborative effort that has sequenced all human genes and produced a reference sequence of the entire human genome.

**Chromosomes and Genes**

The human genome consists of 24 distinct chromosomes: 22 autosomes plus the sex chromosomes, X and Y. A **chromosome** is a threadlike molecule of genes, other DNA, and proteins. Chromosomes are located in the nucleus of cells. Different organisms have different numbers of chromosomes. Human somatic cells have 23 chromosome pairs for a total of 46 chromosomes: two copies of the 22 autosomes (one from each parent), plus an X chromosome from the mother and either an X or a Y chromosome from the father. There are an estimated 20,000 human protein-coding genes, but humans are known to have many more than 20,000 proteins. Most human genes have multiple exons separated by much larger introns. Regulatory sequences controlling gene expression are associated with exons. The introns are usually excised (removed) during post-transcriptional modification of the mRNA. Human cells make significant use of alternative splicing to produce a number of different proteins from a single gene. So even though the human genome is surprisingly similar in size to the genomes of simpler organisms, the human proteome is thought to be much larger. A **proteome** is the complete set of proteins expressed by a genome.

**Questions**

1. How do our genes makes us unique?

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2. What is the human genome. Describe in detail.

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3. How has the Human Genome Project contributed to knowledge of the human genome?

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4. Compare and contrast exons, introns, and regulatory sequences of chromosomes.

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5. How is the human proteome related to the human genome?

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## Lesson 9.1: Multiple Choice

**Name**______________________________ **Class**___________ **Date**________

*Circle the letter of the correct choice.*

1. What is the function of exons?
   (a) They regulate genes.

(b) They replicate genes.
(c) They code for proteins.
(d) Their function is not yet known.

2. How many pairs of autosomes are found in a normal human somatic cell?
   (a) 22
   (b) 23
   (c) 24
   (d) 46
3. Which sentence is true about introns in human genes?
   (a) They code for RNA molecules.
   (b) They are generally much smaller than exons.
   (c) They are usually removed from mRNA after transcription.
   (d) They splice together different proteins from a single gene.
4. Which two alleles are most likely to appear in the same human gamete?
   (a) an allele on the X chromosome and an allele on the Y chromosome
   (b) an allele for a gene on one chromosomes of a pair and the allele for the same gene on the other chromosome of the pair
   (c) an allele on the X chromosome and an allele on chromosome 23
   (d) two alleles on the same X chromosome
5. Which of the following is an example of an SNP?
   (a) GGATAA to CCTATT
   (b) GGATAA to GGATAG
   (c) GGATAA to GGCTCC
   (d) GGATAA to AATAGG
6. Repetitive DNA sequences
   (a) are highly variable from person to person.
   (b) are identical in all human beings.
   (c) always code for the most important proteins.
   (d) cannot be used for DNA testing.
7. A Barr body is a(n)
   (a) type of repeat polymorphism.
   (b) inactivated X chromosome.
   (c) X-linked or Y-linked gene.
   (d) gene that causes a genetic disorder.

## Lesson 9.1: Vocabulary

**Name**________________________________ **Class**____________ **Date**________

*Match the vocabulary term with the correct definition.*

**Term**

______ 1. autosome

______ 2. chromosome

______ 3. genome

______ 4. karyotype

______ 5. linkage

______ 6. sex chromosome

______ 7. repetitive sequence

______ 8. SNP

______ 9. SRY

______ 10. X-inactivation

**Definition**

a. X or Y chromosome in humans

b. all the hereditary information encoded in DNA

c. DNA sequence that repeats a number of times

d. any chromosome that is not a sex chromosome

e. variation in an individual nucleotide base

f. sex-determining region of the Y chromosome

g. relationship between genes located close together on the same chromosome

h. random inactivation of one X chromosome in each cell of a female

i. photograph of the chromosomal complement of an individual

j. threadlike molecule that contains DNA wound around proteins

## 9.3 Lesson 9.2: Human Inheritance

### Lesson 9.2: True or False

**Name**______________________________ **Class**___________ **Date**________

*Write true if the statement is true or false if the statement is false.*

_________ 1. All sex-linked traits are controlled by genes on the X chromosome.

_________ 2. Only dominant traits are passed from parents to their children.

_________ 3. A healthy heterozygote for a defective recessive allele is called a carrier.

_________ 4. You need only one dominant allele for a dominant trait to be expressed.

_________ 5. A man passes all of his X-linked genes to all of his daughters.

_________ 6. Only one mutation for Tay-Sachs disease has ever been identified.

_________ 7. People with achondroplasia have severely shortened bones.

_________ 8. Carriers of X-linked recessive disorders are always male.

_________ 9. A person with the ABO genotype AB has type A blood.

_________ 10. The allele that causes sickle-cell disease is pleiotropic.

_________ 11. The most common trisomy in humans is trisomy X.

_________ 12. Gene therapy techniques include selective reverse mutation.

## Lesson 9.2: Critical Reading

**Name**______________________________ **Class**___________ **Date**________

*Read this passage from the lesson and answer the questions that follow.*

**Complex Traits**

So far we have discussed traits inherited in a simple Mendelian pattern. Either the trait is dominate or recessive. The trait is affected by only one gene. But this is not the case for many genes; rarely is inheritance that simple. More complex patterns of inheritance are common. Mendel's pea plants showed complete dominance of one allele over the other. The offspring always looked like one of the parents—there was never any phenotype "in between" the two parents. The heterozygous individuals were indistinguishable from the homozygous dominant individuals. Is it possible for both alleles to be dominant, or neither to be completely dominant? The answer to both of these questions is yes.

**Codominance**

**Codominance** occurs when two alleles are both expressed in the heterozygous individual; that is, both alleles affect the phenotype in separate and distinguishable ways. The A and B alleles of the ABO blood group system are a classic example. The A and B alleles are codominant with each other. When a person has both an A allele and a B allele, the person has type AB blood. When two people with type AB blood have children, the children can be type A, type AB, or type B. There is a 1A:2AB:1B expected phenotype ratio instead of the 3:1 phenotype ratio expected when one allele is dominant and the other is recessive.

### Incomplete Dominance

**Incomplete dominance** is seen in heterozygous individuals with an intermediate phenotype. For example, if Mendel had ever observed a medium stem length plant when a tall and short plant were crossed, that would have suggested incomplete dominance. In incomplete dominant situations, the phenotype expression is dependent on the dosage of the genes. Two copies of the gene result in full expression, while only one copy produces partial expression and an intermediate phenotype.

### Questions

1. What does codominance refer to?

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2. Describe an example of codominance in humans.

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3. For a gene with two codominant alleles, how many possible phenotypes are there? Explain your answer.

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4. What is incomplete dominance?

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5. When an allele has incomplete dominance, how does the heterozygous phenotype compare to the dominant and recessive homozygous phenotypes?

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## Lesson 9.2: Multiple Choice

**Name**______________________________ **Class**___________ **Date**________

*Circle the letter of the correct choice.*

1. Two normal parents could have a child with an inherited disease if the disease is
   (a) fatal.
   (b) recessive.
   (c) uncommon.
   (d) dominant.
2. Which of the following is an autosomal dominant genetic disorder?
   (a) Huntington's disease
   (b) cystic fibrosis
   (c) Tay-Sachs disease
   (d) hemophilia A
3. A man with a certain genetic trait has several sons and daughters, but none of them has the trait. However, some of the daughters' sons have the trait. This trait is most likely to be a(n)
   (a) autosomal dominant trait.
   (b) Y-linked recessive trait.
   (c) X-linked dominant trait.
   (d) X-linked recessive trait.
4. Duchenne muscular dystrophy is a genetic disease controlled by a gene on
   (a) the X chromosome.
   (b) the Y chromosome.
   (c) an autosome.
   (d) chromosome 21.
5. A human gene that produces a collagen protein is known to affect not only the skeletal system but also the eyes and ears. This is an example of
   (a) epistasis.
   (b) hypostasis.
   (c) pleiotropy.
   (d) codominance.
6. Which genetic disorder is a sex chromosome trisomy?
   (a) trisomy 21
   (b) Klinefelter's syndrome
   (c) Down syndrome
   (d) Turner syndrome

7. What is the most common method of gene therapy?
    (a) replacing a mutant allele with a normal allele
    (b) creating a vaccine against a viral vector
    (c) using ultrasonography to correct abnormalities
    (d) injecting patients with normal placental tissue

## Lesson 9.2: Vocabulary

**Name**_______________________________ **Class**___________ **Date**________

*Match the vocabulary term with the correct definition.*

**Term**

______ 1. pedigree

______ 2. mutation

______ 3. achondroplasia

______ 4. multiple allele trait

______ 5. pleiotropy

______ 6. epistasis

______ 7. polygenic trait

______ 8. nondisjunction

______ 9. trisomy

______ 10. amniocentesis

**Definition**

a. procedure to test fetal DNA for genetic abnormalities

b. change in the nucleotide sequence of DNA or RNA

c. situation in which a gene at one locus alters the phenotypic expression of a gene at another locus

d. autosomal dominant disorder characterized by dwarfism

e. trait for which there are more than two possible alleles

f. chart that represents genetic inheritance in a family

g. situation in which a gene has multiple phenotypic effects

h. trait that is controlled by more than one gene and usually influenced by the environment

i. situation in which an extra chromosome is present in a person's cells

j. failure of replicated chromosomes to separately properly during meiosis

# Chapter 10

# Biotechnology Worksheets

## 10.1 Chapter 10: Biotechnology

- Lesson 10.1: DNA Technology
- Lesson 10.2: Biotechnology

## 10.2 Lesson 10.1: DNA Technology

### Lesson 10.1: True or False

**Name**_______________________________ **Class**___________ **Date**________

*Write true if the statement is true or false if the statement is false.*'

_________ 1. The DNA sequence of one human being is on average 99.9% identical to another random human being.

_________ 2. As of 2009, all living human beings have had their entire genome sequenced.

_________ 3. The nucleotide bases present in a DNA sequence are A, U, G, C.

_________ 4. Techniques that enabled scientists to clone genes were developed in the 1970s.

_________ 5. A restriction enzyme is useful because it is a generic enzyme that recognizes and cuts many different DNA sequences.

_________ 6. Ligation of 2 DNA fragments is an enzyme-catalyzed reaction.

_________ 7. Plasmids are circular, double-stranded DNA molecules.

_________ 8. The gels used in gel electrophoresis are made of gelatin-like materials such as agarose or polyacrylamide.

_________ 9. PCR stands for polyacrylamide gel electrophoresis.

_________ 10. Using recombinant DNA techniques, scientists can join DNA fragments from different species.

_________ 11. The process of DNA transfection is always 100% successful.

_________ 12. A standard recombinant DNA procedure is to use antibiotics to kill off cells that have been successfully transfected with a recombinant plasmid.

_________ 13. To determine if a DNA fragment has been successfully inserted into a plasmid, a scientist can sequence DNA of the plasmid.

_________ 14. The standard procedure of gel electrophoresis separates DNA that is positively charged from DNA that is negatively charged.

_________ 15. A chemical called ethidium bromide is often used to detect DNA that has been subjected to gel electrophoresis.

## Lesson 10.1: Critical Reading

**Name**________________________________ **Class**____________ **Date**________

*Read this passage from the lesson and answer the questions that follow.*

**The Polymerase Chain Reaction**

The Polymerase Chain Reaction (PCR) is used to amplify specific regions of a DNA strand millions of times. A region may be a number of loci, a single gene, a part of a gene, or a non-coding sequence. This technique produces a useful quantity of DNA for analysis, be it medical, forensic or some other form of analysis. Amplification of DNA from as little as a single cell is possible. Whole genome amplification is also possible.

PCR utilizes a heat stable DNA polymerase, Taq polymerase, named after the thermophilic bacterium *Thermus aquaticus*, from which it was originally isolated. *T. aquaticus* is a bacterium that lives in hot springs and hydrothermal vents, and Taq polymerase is able to withstand the high temperatures required to denature DNA during PCR (discussed below). Taq polymerase's optimum temperature for activity is between $75°C$ and $80°C$. Recently other DNA polymerases have also been used for PCR.

A basic PCR involves a series of repeating cycles involving three main steps (see Figure below):

1. denaturation of the double stranded DNA
2. annealing of specific oligonucleotide primers
3. extension of the primers to amplify the region of DNA of interest

These steps will be discussed in additional detail below.

The oligonucleotide primers are single stranded pieces of DNA that correspond to the 5' and 3' ends of the DNA region to be amplified. These primers will anneal to the corresponding segment of denatured DNA. Taq Polymerase, in the presence of free deoxynucleotide triphosphates (dNTPs), will extend the primers to create double stranded DNA. After many cycles of denaturation, annealing and extension, the region between the two primers will be amplified.

The PCR is commonly carried out in a thermal cycler, a machine that automatically allows heating and cooling of the reactions to control the temperature required at each reaction step (see below). The PCR usually consists of a series of about 30 to 35 cycles. Most commonly, PCR is carried out in three repeating steps, with some modifications for the first and last step.

PCR is usually performed in small tubes or wells in a tray, each often beginning with the complete genome of the species being studied. As only a specific sequence from that genome is of interest, the sequence specific primers are targeted to that sequence. PCR is done with all the building blocks necessary to create DNA: template DNA, primers, dNTPs, and a polymerase.

The three basic steps of PCR are:

- Denaturation step: This step is the first regular cycling event and consists of heating the reaction to $94-98°C$ for 30 to 60 seconds. It disrupts the hydrogen bonds between complementary bases of the DNA strands, yielding single strands of DNA.
- Annealing step: The reaction temperature is lowered to $50-65°C$ for 30 to 60 seconds, allowing annealing of the primers to the single-stranded DNA template. Stable hydrogen bonds form between the DNA strand (the template) and the primers when the primer sequence very closely matches the complementary template sequence. Primers are usually 17 - 22 nucleotides long and are carefully designed to bind to only one site in the genome. The polymerase binds to the primer-template hybrid and begins DNA synthesis.
- Extension step: A temperature of around $72°C$ is used for this step, which is close to the optimum temperature of Taq polymerase. At this step the Taq polymerase extends the primer by adding dNTPs, using one DNA strand as a template to create the other (new) DNA strand. The extension time depends on the length of the DNA fragment to be amplified. As a standard, at its optimum temperature, the DNA polymerase will polymerize a thousand bases in one minute.

### Questions

1. Why is the Polymerase Chain Reaction (PCR) technique useful for scientists?

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2. What enzyme is necessary to perform PCR? What are some special characteristics of this enzyme?

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3. Name and briefly describe the three stages of a PCR cycle.

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4. Draw a diagram depicting your answer to question 3.

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5. Theoretically, PCR cycles could continue indefinitely. In practice, PCR will cease when what is used up?

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## Lesson 10.1: Multiple Choice

**Name**______________________________ **Class**___________ **Date**________

*Circle the letter of the correct choice.*

1. Which of the pairs of sequences below contain a single nucleotide polymorphism (SNP)?
   (a) AAGGCTAA and AAGGCTAA
   (b) AAGGCTAA and AAGGCTGG
   (c) AAGGCTAA ATGGCTAA
   (d) GGGGGGGG and TTTTTTTT
2. A restriction enzyme such as *EcoRI*

(a) recognizes a short, specific sequence of nucleotides and cuts both strands of the double-strnded DNA molecule.
(b) recognizes a short, specific sequence of nucleotides and cuts only one strand of the double-stranded DNA molecule.
(c) recognizes any six-base-pair DNA sequence and cuts both DNA strands.
(d) cleaves RNA strands, not DNA strands.

3. The order of steps during the FIRST cycle of a Polymerase Chain Reaction is

(a) extend the oligonucleotide primers, denature the DNA, denature the DNA again.
(b) primers anneal, denature the DNA, anneal more primers.
(c) Taq polymerase extends the primers, the primers anneal, DNA is denatured.
(d) denature the double-stranded DNA, oligonucleotide primers anneal to the template DNA, primers are extended with the help of Taq polymerase.

4. Scientists can typically distinguish cells that have been successfully transfected with a plasmid from those that have not by

(a) viewing them under a basic light microscope—the larger cells are transfected, and the smaller cells are not.
(b) screening them for resistance to a specific antibiotic.
(c) growing them at high temperature—the cells that die are transfected and the cells that live are not.
(d) oberving replication of the chromosome. Cells that have been transfected can replicate their chromosome; cells that have not been transfected cannot replicate their chromosome.

5. Standard gel electrophoresis of DNA separates DNA fragments based upon

(a) charge differences.
(b) sequence differences at one nucleotide.
(c) size differences.
(d) none of the above

6. The enzyme DNA ligase

(a) joins together two double-standed DNA pieces by making a phosphodiester bonds between them.
(b) adds base pairs to a double-stranded DNA molecule.
(c) deletes multiple base pairs from a single-stranded DNA molecule.
(d) functions only at temperatures below $20°C$.

7. The enzyme Taq polymerase

(a) was originally purified from a bacterium that lives in hot springs.
(b) can work at high temperatures (such as $95°C$).
(c) extends a DNA primer by adding dNTPs complementary to the template DNA.
(d) all of the above

# Lesson 10.1: Vocabulary

**Name**________________________________ **Class**____________ **Date**________

*Match the vocabulary term with the correct definition.*

**Term**

______ 1. Taq polymerase

______ 2. biotechnology

______ 3. Genbank

______ 4. Restriction enzyme

______ 5. Gene cloning

______ 6. Gel electrophoresis

______ 7. Polymerase chain reaction (PCR)

______ 8. plasmid

______ 9. Recombinant DNA

______ 10. The Human Genome Project

**Definition**

a. An enzyme, often isolated from bacteria, that catalyzes the cutting of both strands of a double-stranded DNA molecule at a specific sequence.

b. An analytical technique in which DNA molecules are separated by size during their migration through a charged electrical field.

c. The project in which the DNA of all of the human chromosomes was sequenced.

d. The field in which biological knowledge is used in concert with technology to solve practical problems.

e. A small, circular, double-stranded DNA molecule often found in bacteria.

f. A thermostable enzyme that catalyzes primer extension in a PCR reaction.

g. The National Center for Biotechnology Information, part of the United States Government, which maintain genomic sequences (and other sequences) in a database.

h. Two or more DNA strands that combine DNA sequences which would not normally occur together; the DNA ligated together can even be from different organisms.

i. The process of isolating a DNA sequence of interest for the purpose of making multiple copies of it.

j. A cyclic process in which three main chemical reactions are repeated to create millons of copies of a target DNA sequence from starting material that might contain only a single copy of the target sequence.

## 10.3 Lesson 10.2: Biotechnology

### Lesson 10.2: True or False

**Name**________________________________ **Class**____________ **Date**________

*Write true if the statement is true or false if the statement is false.*

_________ 1. Because the human genome is sequenced, we now know all of the phenotypes associated with mutations in all human genes.

_________ 2. Two different individuals can metabolize the same drug at a different rate.

_________ 3. Fetuses can be screened for some genetic diseases while in utero (in the mother's uterus).

_________ 4. Scientists and physicians can use the polymerase chain reaction (PCR) to test for genetic mutations in newborn babies.

_________ 5. The most commonly grown transgenic crops are extremely sensitive to minute amounts of herbicides.

_________ 6. Transgenic corn making Bt toxin is resistant to damage by certain insects.

_________ 7. Certain vaccines can be made in bananas.

_________ 8. In animal cloning, a nucleus from a skin cell is added to a nucleus from a enucleated muscle cell.

_________ 9. PCR is now the most commonly used technique in DNA fingerprinting.

_________ 10. It is extremely likely that two first cousins will have the same genetic fingerprint.

_________ 11. The biotechnology term STR stands for Standard telomore Restriction.

_________ 12. The probability that a person has the genotype ABC at three independent loci equals the probability of A plus the probability of B plus the probability of C.

_________ 13. In Southern blotting, DNA fragments produced by restriction enzyme digestion are separated by gel electrophoresis.

_________ 14. Hybridization of two single DNA strands will occur under the appropriate conditions if the two strands have complementary nucleotide sequences.

_________ 15. Because genetic engineering is technology-based, there are no ethical issues surrounding its use.

## Lesson 10.2: Critical Reading

**Name**________________________________ **Class**____________ **Date**_________

*Read this passage from the lesson and answer the questions that follow.*

**Applications of DNA Technology: Medicine**

As discussed in the first lesson of this chapter, the Human Genome Project has opened up many applications to take advantage of what we know about our genome in order to help us. Many of these applications are medically related. Others will be legally related. And yet still other uses of DNA technology include those in agriculture and the food sciences.

Understanding and curing genetic diseases is the ultimate goal of human geneticists. As discussed in the *Human Genetics* chapter, gene therapy is the insertion of a new gene into an individual's cells and tissues to treat a disease, replacing a mutant disease-causing allele with a normal, non-mutant allele. Of course, the findings of the Human Genome Project are significant in determining the disease-causing alleles.

In the 1920s, there was no known way to produce insulin, which was needed by people to remove excess sugar from the bloodstream. People with diabetes either lack insulin, produce low levels of insulin, or are resistant to insulin, and thus they may need external insulin to control blood glucose levels. This problem was solved, at least temporarily, when it was found that insulin from a pig's pancreas could be used in humans. This method was the primary solution for diabetes until recently. The problem with insulin production was raised again: there were not enough pigs to provide the quantities of insulin needed. Scientists needed to devise another way. This led to one of the biggest breakthroughs in recombinant DNA technology: the cloning of the human insulin gene.

By methods discussed in the first lesson in this chapter, the specific gene sequence that codes for human insulin was introduced into *E. coli*. In a 24 hour period, billions of *E. coli* containing the human insulin gene resulted, producing human insulin to be administered to patients.

Though the production of human insulin by recombinant DNA procedures is an extremely significant event, many other aspects of DNA technology are beginning to become reality. In medicine, modern biotechnology provides significant applications in such areas as pharmacogenomics, genetic testing (and prenatal diagnosis), and gene therapy. These applications use our knowledge of biology to improve our health and our lives. Many of these medical applications are based on the Human Genome Project.

**Questions**

1. What is gene therapy?

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2. What is insulin and what is its general function?

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3. What is diabetes?

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4. When a person does not make any insulin, what is a main treatment?

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5. How is insulin for diabetics produced?

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## Lesson 10.2: Multiple Choice

**Name**_______________________________ **Class**___________ **Date**________

*Cirle the letter of the correct choice.*

1. The field of study that focuses on how an individual's genome (the particular alleles inherited) affects his or her response to a drug or drugs is called
   (a) genetics.
   (b) pharmacology.
   (c) genomics.
   (d) pharmacogenomics.
2. Genetic testing is an effective method to use for all of the following except

(a) confirm a diagnosis.
(b) predict disease risk.
(c) perform genetic screening of newborns.
(d) treat a disease.

3. Transgenic crops, such as rice, are created using
   (a) traditional breeding methods.
   (b) recombinant DNA techniques.
   (c) special minerals in the soil.
   (d) mouse cells as an incubator.
4. Corn resistant to being eaten by the corn borer caterpillar contains
   (a) a cold-resistant gene from fish.
   (b) caterpillar genes in the corn genome.
   (c) a gene coding for a toxin which specifically kills the caterpillar.
   (d) higher protein levels than other corn.
5. Most transgenic crops grown in 2001 contained inserted genes for
   (a) herbicide-resistance.
   (b) drought-tolerance.
   (c) improved flavor.
   (d) improved nutrition.
6. The first mammal to be cloned from an adult somatic cell was a
   (a) human.
   (b) dog.
   (c) sheep.
   (d) rat.
7. The DNA of one individual can be distinguished as different from another individual by the technique of
   (a) DNA ligation.
   (b) DNA fingerprinting.
   (c) chromosome counting.
   (d) chromatid counting.

## Lesson 10.2: Vocabulary

**Name**________________________________ **Class**____________ **Date**________

*Match the vocabulary term with the correct definition.*

**Term**

______ 1. Transgenic crops

______ 2. CODIS

______ 3. DNA fingerprinting

______ 4. Transgenic animals

______ 5. STR profiling

______ 6. Southern blot

______ 7. pharmacogenomics

______ 8. microsatellites

______ 9. Genetic testing

______ 10. Preimplantation genetic diagnosis (PGD)

**Definition**

a. Genetically engineered animals that contain a gene from another species.

b. Analysis of 13 short tandem repeat loci to create a forensic DNA profile.

c. Adjacent repeating units of 2 - 10 bases in length, for example (GATC)n , where GATC is a tetranucleotide repeat and n refers to the number of repeats.

d. The result of cloning genes into crop plants to give the crops a beneficial trait.

e. Molecular genetic analysis performed on embryos prior to implantation in a uterus.

f. The Combined DNA index system, which stores DNA profiles.

g. The study of how the genetic inheritance of an individual affects his or her body's response to and processing of drugs.

h. The direct examination of DNA sequences for mutated sequence.

i. Molecular biology techniques are used to create a distinct pattern of an individual's DNA.

j. Named after its inventor Edwin Southern, is a method used to check for the presence of a specific DNA sequence in a DNA sample.

# Chapter 11

# History of Life Worksheets

## 11.1 Chapter 11: History of Life

- Lesson 11.1: Studying the History of Life
- Lesson 11.2: Early Life
- Lesson 11.3: Multicellular Life

## 11.2 Lesson 11.1: Studying the History of Life

### Lesson 11.1: True or False

**Name**________________________________ **Class**____________ **Date**________

*Write true if the statement is true or false if the statement is false.*

_________ 1. Fossilization most often preserves soft body parts.

_________ 2. Paleontologists are scientists who study fossils.

_________ 3. Index fossils can help identify rock layers of the same age in different places.

_________ 4. Relative dating relies on the position of fossils within a rock column.

_________ 5. Carbon-14 dating can be used to date fossils that are up to 6 million years old.

_________ 6. Radioactive decay is a random process that occurs at a fixed rate.

_________ 7. Molecular clocks support a universal common ancestor for all life.

_________ 8. Eras of the geologic time scale are divided into eons.

_________ 9. Only one mass extinction has ever occurred in the history of life on Earth.

_________ 10. The fossil record does not support the idea of a common ancestor of all life on Earth.

_________ 11. The rate of evolution is always the same.

_________ 12. Geographic changes can affect patterns of evolution.

## Lesson 11.1: Critical Reading

**Name**______________________________ **Class**___________ **Date**________

*Read this passage from the lesson and answer the questions that follow.*

**A Geologic Time Scale Measures the Evolution of Life**

Observation of rock layers, dating techniques, and correlation of similar strata from around the world led to the development of a geologic time scale. How does the scale divide the 4.6 billion years of Earth's history? What themes emerge from its stories of the past? One theme is the almost unimaginable amounts of time in Earth's history. The deep time of Earth's history is far beyond our experience, and our knowledge is far more detailed for recent periods than for the distant past. A scale divided into evenly spaced periods of time would not show this recent detail, so the divisions of the geologic time scale are not evenly spaced. Instead, they mark major changes in Earth's climate, geography, atmosphere, and life. In the geologic time scale, the largest units of time are eons. Eons include smaller units called eras, which in turn include periods, epochs, and stages. Faunal stages identify specific fossil groups. Terms such as upper (or late) and lower (or early) may be used to divide units into more or less recent subdivisions. The total history of Earth comprises four eons. From most to least recent they are the Phanerozoic, Proterozoic, Archean, and Hadean. Their names refer to a second major theme of Earth's history: the evolution of life. Phanerozoic means "visible life." The Phanerozoic Eon spans the most recent 545 million years of Earth's history. It is divided into three eras well known for their chronicle of life in the fossil record:

- The Cenozoic ("recent life") Era is the present era. It is the era we humans live in.
- The Mesozoic ("middle life") Era precedes the Cenozoic Era. It is the middle era of the Phanerozoic Eon.
- The Paleozoic ("old life") Era is oldest era of the Phanerozoic Eon. It begins with the Cambrian Period, when the first great explosion of life occurred. For the first time in the Cambrian, living things were composed of hard parts that turned to fossils and left a record of their lives. (The name "Cambrian" refers to where these fossils were first studied.)

Proterozoic means "before complex life." The Proterozoic Eon precedes the Phanerozoic Eon. It extends back to 2.5 billion years ago. The Archean ("ancient") Eon precedes the Proterozoic Eon. The Hadean ("unseen") Eon reaches back to the formation of Earth. These three oldest eons are combined in the Precambrian Supereon, which includes all of Earth's history up to the Cambrian explosion of life.

**Questions**

1. How long is the history of Earth?

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2. What is the basis for divisions of the geologic time scale?

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3. What is the most recent eon of the geologic time scale, and what eras does it include?

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4. Briefly describe the first three eons of Earth's history.

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5. Why is the Cambrian Period such an important division of the geologic time scale?

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## Lesson 11.1: Multiple Choice

**Name**_______________________________ **Class**___________ **Date**________

*Circle the letter of the correct choice.*

1. If rock layers are undisturbed, the lowest layers are
   (a) oldest.

(b) newest.
(c) youngest.
(d) most recent.

2. The method of dating fossils that provides an approximate age in years is called
   (a) relative dating.
   (b) absolute dating.
   (c) geologic dating.
   (d) rock-layer dating.
3. The time it takes half of a given amount of a radioactive element to decay is its
   (a) isotope.
   (b) half-life.
   (c) light-year.
   (d) molecular clock.
4. Isotopes used to measure the ages of rocks and fossils include
   (a) carbon-14.
   (b) uranium-238.
   (c) potassium-40.
   (d) all of the above.
5. Which choice lists the divisions of the geologic time scale from largest to smallest?
   (a) era-eon-epoch-period
   (b) period-eon-epoch-era
   (c) epoch-era-eon-period
   (d) eon-era-period-epoch
6. Eukaryotic cells first appeared in the fossil record about
   (a) 4.2 billion years ago.
   (b) 3.5 billion years ago.
   (c) 1.8 billion years ago.
   (d) 0.5 billion years ago.
7. Massive geographic changes that occurred during Earth's history are explained by the theory of
   (a) plate tectonics.
   (b) adaptive radiation.
   (c) quantum evolution.
   (d) episodic speciation.

## Lesson 11.1: Vocabulary

**Name**________________________________ **Class**___________ **Date**________

*Match the vocabulary term with the correct definition.*

**Term**

_____ 1. adaptive radiation

_____ 2. coevolution

_____ 3. coextinction

_____ 4. convergent evolution

_____ 5. divergent evolution

_____ 6. gradualism

_____ 7. macroevolution

_____ 8. microevolution

_____ 9. punctuated equilibrium

_____ 10. quantum evolution

**Definition**

a. increased risk of extinction in interdependent species when one of the species goes extinct

b. type of evolution in which closely related species become less similar

c. evolution in taxa higher than the species level

d. idea that evolution occurs infrequently but rapidly

e. evolution within a population or species

f. type of evolution in which distantly related species become more similar

g. idea that higher taxa originated in response to drastic environmental changes

h. rapid evolution from a single species to several species to fill a diversity of niches

i. idea that evolution occurs via slow, steady change

j. type of evolution in which two species influence each other's evolution

## 11.3 Lesson 11.2: Early Life

### Lesson 11.2: True or False

**Name**_____________________ **Class**__________ **Date**________

*Write true if the statement is true or false if the statement is false.*

_________ 1. There is fossil evidence for life during the Hadean Eon.

_________ 2. Most scientists agree that organic molecules arose before cells.

_________ 3. The metabolism-first model is the idea that biochemical pathways evolved before replicator molecules.

_________ 4. Archaebacteria are thought to have evolved from Eukaryota.

_________ 5. Comets and meteors are known to contain organic molecules.

_________ 6. A single LUCA is thought to have given rise to all cellular life on Earth.

_________ 7. The oldest known fossils represent photosynthetic organisms.

_________ 8. The earliest prokaryotes lacked cell membranes.

_________ 9. Massive deposits of iron ore formed when Earth first became a planet.

_________ 10. Ozone in the atmosphere protects Earth from harmful radiation.

_________ 11. Endosymbiotic theory is no longer accepted by most scientists.

_________ 12. Mitochondria have the same DNA sequences as the DNA in the nucleus.

## Lesson 11.2: Critical Reading

**Name**_______________________________ **Class**___________ **Date**________

*Read this passage from the lesson and answer the questions that follow.*

Formation of Earth: We are Made of Stardust!

Earth began as the solar system began—often described as a giant rotating cloud of dust, rocks, and gas. "Dust, rocks, and gas" may not sound inspiring, but this cloud contained the 92 elements, or kinds of atoms, that combine to form everything—both living and non-living—of the wonderful world we inhabit. The Big Bang (9 billion years earlier!) produced atoms of hydrogen and helium. Elements as heavy as lithium followed the Big Bang within minutes. Stars such as red giants fused hydrogen and helium nuclei to form elements from carbon (the foundation of life!) to calcium (now in our bones and teeth). Supernova explosions formed and ejected heavier elements such as iron (found in red blood cells). We are not just "dust." We—and our world—are stardust!

How did this rotating cloud of stardust become our solar system? One theory suggests that a nearby supernova sent a shock wave through a cloud of stardust, increasing its spin to form a protoplanetary disk. Most of the mass concentrated in the middle of the disk, which began to heat up. Eventually, heat in this central core began nuclear fusion of hydrogen to helium, and the core ignited. The sun was born.

Matter outside the sun's gravity separated into rings of debris. Collisions of objects within the rings formed larger objects. These were protoplanets that would eventually became the planets of the solar system. One protoplanet, about 150 million kilometers from the sun, would become Earth. Solar wind cleared much of the remaining non-planetary material from the disk.

Early Earth was very different from the Earth we know today. The planet was bombarded by debris and heated by radioactive decay and the pressure of contraction. As a result, Earth was molten at first. Heavy elements sank to the center, and lighter ones traveled to the surface. Heat and solar wind meant that early Earth had no atmosphere or oceans. Eventually, contraction and cooling allowed formation of a crust and retention of an atmosphere. However, continued bombardment melted portions of the crust for a long time.

About 4.5 billion years ago, Earth collided with another protoplanet, named Theia. This "Big Whack" gave Earth its moon and tilted Earth on its current axis. The tilt led to the seasons, which now influence so much of life's diversity. The Big Whack may also have initiated plate tectonic activity by speeding up Earth's rotation. The day/night cycle during the Hadean Eon may have been as short as 10 hours. Since then, the moon's tidal drag may have resulted in Earth's slower rotation.

As Earth continued to cool amidst heavy bombardment, steam escaped from the crust and active volcanoes released other gases to form a primitive atmosphere. The early atmosphere was reddish in color and would have been toxic to modern multicellular organisms. It contained ammonia, methane, water vapor, carbon dioxide, and nitrogen, but no more than a trace of oxygen. In the absence of oxygen, no ozone layer protected Earth from the sun's ultraviolet rays. Between 4.2 and 3.8 billion years ago, clouds produced rain, which formed the oceans. The early oceans were olive green.

**Questions**

1. Explain how stardust became our solar system.

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2. In detail, describe early Earth.

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3. What happened when Earth collided with the protoplanet Theia?

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4. Describe Earth's early atmosphere.

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5. How did early Earth's oceans form? What did they look like?

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## Lesson 11.2: Multiple Choice

**Name**________________________________ **Class**____________ **Date**________

*Circle the letter of the correct choice.*

1. The solar system formed from a
   (a) protocell.
   (b) protoplasm.
   (c) protoplanet.
   (d) protoplanetary disk.
2. Miller and Urey tested the hypothesis that conditions on primitive Earth would have allowed the
   (a) formation of living cells from organic molecules.
   (b) synthesis of organic molecules from inorganic precursors.
   (c) evolution of eukaryotic organisms from prokaryotic organisms.
   (d) development of DNA and RNA from primitive protein molecules.
3. The idea that a replicator molecule evolved before the evolution of biochemical pathways is known as the
   (a) metabolic-pathway model.
   (b) endosymbiotic model.
   (c) genes-first model.
   (d) replicator model.
4. The exogenesis hypothesis is supported by the discovery of
   (a) Archaebacteria in hydrothermal vents.
   (b) circular DNA in mitochondria.

(c) living cells in black smokers.
(d) organic molecules in space.

5. The earliest life on Earth most likely evolved during the
   (a) Proterozoic Eon.
   (b) Primitive Eon.
   (c) Primeval Eon.
   (d) Hadean Eon.
6. Not long after prokaryotic cells evolved, they split into two major groups, called the Eubacteria and the
   (a) Protista.
   (b) Eukaryota.
   (c) Mitochondria.
   (d) Archaebacteria.
7. Before the evolution of photosynthesis, organisms were
   (a) aerobic.
   (b) symbiotic.
   (c) anaerobic.
   (d) eukaryotic.

## Lesson 11.2: Vocabulary

**Name**________________________________ **Class**____________ **Date**________

*Match the vocabulary term with the correct definition.*

**Term**

______ 1. protocell

______ 2. prokaryote

______ 3. heterotroph

______ 4. chemoautotroph

______ 5. glycolysis

______ 6. photosynthesis

______ 7. anaerobe

______ 8. eukaryote

______ 9. endosymbiont

______ 10. stromatolite

**Definition**

a. organism that feeds on other organisms

b. pathway for transferring energy from organic molecules to ATP

c. organism that requires an environment without oxygen

d. mat of photosynthetic microorganisms

e. organism that lives inside the cells of another organism

f. simple, membrane-enclosed early metabolic unit

g. use of sunlight to make carbohydrates from carbon dioxide and water

h. single-celled organism that lacks a nucleus

i. organism whose DNA is enclosed within a nuclear membrane

j. organism that extracts energy from inorganic molecules

## 11.4 Lesson 11.3: Multicellular Life

### Lesson 11.3: True or False

**Name**________________________________ **Class**____________ **Date**________

*Write true if the statement is true or false if the statement is false.*

_________ 1. The first animals evolved before the first true plants.

_________ 2. The evolution of sexual reproduction may have increased the rate of evolution.

_________ 3. Arthropods called trilobites first appeared in the Permian Period.

_________ 4. There has been only one supercontinent in Earth's history.

_________ 5. Evolution of lobe-like fins allowed vertebrates to eventually move from the ocean to the land.

_________ 6. Levels of oxygen in the air were lower during the Carboniferous Period than they are now.

_________ 7. Pangaea formed during the Permian Period of the Paleozoic Era.

_________ 8. There was a resurgence of evolution at the beginning of the Mesozoic Era.

_________ 9. The Paleogene Period was the golden age of large dinosaurs.

_________ 10. The K-T extinction occurred at the end of the Cretaceous Period.

_________ 11. Homo erectus was probably the first hominid to leave Africa.

_________ 12. There has been a decrease in carbon dioxide since the Industrial Revolution.

## Lesson 11.3: Critical Reading

**Name**______________________________ **Class**___________ **Date**________

*Read this passage from the lesson and answer the questions that follow.*

**Introduction**

The history of life reaches the last billion years of Earth's 4.6 billion-year history with no hint of the wondrous diversity of life as humans know it. Not until nearly 80% of Earth's history had passed did multicellular life evolve. The fossil record tells the story: millions of species of fish, amphibians, reptiles, birds, mammals, mosses, ferns, conifers, flowering plants, and fungi eventually populated the seas and covered Earth, as continents crashed together and broke apart, glaciers advanced and retreated, and meteors struck, causing massive extinctions. Biologists estimate that 99% of the species that have ever lived on Earth are now extinct. Nonetheless, up to 80 million species populate our world today. Life has had a colorful and exciting last billion years, spawning diversity almost beyond our comprehension. And yet, the giant steps of evolution remain back in the Precambrian. Its catalog of evolutionary innovations is long and impressive:

- Energized elements from stardust formed simple organic molecules.
- Building blocks chained together to form catalysts and self-replicating macromolecules.
- Biochemical pathways evolved.
- Protective yet permeable membranes enclosed the catalysts, replicators, and their metabolic retinue.
- Early prokaryotic cells "learned" to make ATP by splitting glucose.
- Other cells began to harvest the energy of sunlight through photosynthesis.
- Photosynthetic cyanobacteria produced vast amounts of "waste" oxygen, dramatically altering Earth's atmosphere.
- The oceans rusted and iron ore was deposited.
- An ozone layer formed, shielding life from UV radiation.
- The "oxygen catastrophe" killed many anaerobic prokaryotes.
- Still other prokaryotes "learned" to use the new oxygen to release the energy remaining in carbohydrate products of glycolysis.
- Endosymbiosis created eukaryotes, firmly establishing the three major evolutionary lineages, which today still comprise the living world.

The timing and exact nature of most of these innovations is speculative; indeed, the first few may have been extraterrestrial and even deeper in time. They comprise perhaps the most important landmarks in the evolution of life, but the fossil record is sketchy due to prokaryote size, rock layer metamorphosis, and burial by more recent rocks.

**Questions**

1. At what point in Earth's history did multicellular life evolve?

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2. State the number of species and the percent of Earth's total species that exist today.

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3. List significant events that occurred in the early evolution of life on Earth up through the evolution of early prokaryotes.

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4. How did the evolution of photosynthesis by cyanobacteria affect early Earth and its life forms?

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5. Why is the fossil record sketchy for the early evolution of life on Earth?

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## Lesson 11.3: Multiple Choice

**Name**______________________________ **Class**___________ **Date**________

*Circle the letter of the correct choice.*

1. The evolution of sexual reproduction occurred about
    (a) 4 billion years ago.
    (b) 3 billion years ago.
    (c) 2 billion years ago.
    (d) 1 billion years ago.
2. Nearly all modern animal phyla first appeared during the
    (a) Neogene Period.
    (b) Cambrian Period.
    (c) Cretaceous Period.
    (d) Quaternary Period.
3. Which statement is true about the first fish?
    (a) They had scaly skin and claws.
    (b) They lacked jaws and had armor.
    (c) They spent part of the time on land.
    (d) They evolved during the Jurassic Period.
4. The evolution of eggs with shells allowed vertebrates to
    (a) outcompete fish.
    (b) reproduce on land.
    (c) survive in the water.
    (d) live on the ocean floor.
5. The massive Permian extinction allowed an adaptive radiation of
    (a) amphibians.
    (b) dinosaurs.
    (c) hominids.
    (d) humans.
6. During the Paleocene, mammals took over ecological niches formerly occupied by
    (a) birds.
    (b) fishes.
    (c) insects.
    (d) dinosaurs.
7. What is the main cause of the "sixth extinction"?
    (a) human actions
    (b) impact events
    (c) glaciations
    (d) megafauna

## Lesson 11.3: Vocabulary

**Name**_______________________________ **Class**___________ **Date**________

*Match the vocabulary term with the correct definition.*

**Term**

______ 1. Paleozoic Era

______ 2. trilobite

______ 3. liverwort

______ 4. Permian Period

______ 5. Mesozoic Era

______ 6. Pangaea

______ 7. Jurassic Period

______ 8. Cenozoic Era

______ 9. Paleocene Epoch

______ 10. Holocene Epoch

**Definition**

a. first true plant to live on land

b. supercontinent that eventually broke up into all the continents we know today

c. most recent era of the geologic time scale

d. geologic era that starts with the Cambrian Period

e. first epoch of the Cenozoic Era

f. era known as the "age of dinosaurs"

g. current epoch of the geologic time scale

h. arthropod that was common during the Cambrian Period

i. last period of the Paleozoic Era

j. period of the Mesozoic Era when large dinosaurs were widespread

# Chapter 12

# Evolutionary Theory Worksheets

## 12.1 Evolutionary Theory

- Lesson 12.1: Darwin and The Theory of Evolution
- Lesson 12.2: Evidence for Evolution
- Lesson 12.3: Evolution Continues Today - Can We Control It?

## 12.2 Lesson 12.1: Darwin and The Theory of Evolution

### Lesson 12.1: True or False

**Name**________________________________ **Class**___________ **Date**________

*Write true if the statement is true or false if the statement is false.*

_________ 1. Darwin is the only scientist responsible for our understanding of how evolution works.

_________ 2. Traits that an individual acquires during their lifetime can be passed on to their offspring.

_________ 3. Darwin studied to become a doctor and then a clergyman before becoming a "gentleman scientist."

_________ 4. Natural selection selects favorable characteristics that best suit the future environment.

_________ 5. Natural selection that is guided by humans is called artificial selection.

_________ 6. Variation must be heritable for natural selection to operate.

_________ 7. Prior to Darwin and the development of evolutionary theory, most people believed the earth to be very old.

_________ 8. *All life is related through a common ancestor* is one of Darwin's two major evolutionary ideas.

_________ 9. An adaptation is a characteristic that helps an organism survive in its environment.

_________ 10. Cloning is a good way to guarantee the survival of a species.

_________ 11. John Baptiste Lamarck provided nothing useful to our understanding of evolution.

_________ 12. Darwin's idea that individuals in a population compete for resources came from reading a book by Thomas Malthus.

_________ 13. Darwin regretted using the term natural selection to describe his theory and wished he had called it "natural preservation" instead.

_________ 14. Mutations occur when an organism needs change in order to survive.

_________ 15. Species produce more offspring than can survive in the environment.

## Lesson 12.1: Critical Reading

**Name**_______________________________ **Class**___________ **Date**________

*Read this passage from the lesson and answer the questions that follow.*

**Darwin's Theory of Evolution**

Darwin delighted in the great diversity of life, but also saw unity within that diversity. He saw striking patterns in the similarities and differences. Seeking an explanation for those patterns, he developed the concept of natural selection. Natural selection explains how today's organisms could be related – through "descent with modification" from common ancestors. Natural selection explains the story told by the fossil record – the long history of life on Earth. Natural selection is a scientific answer (if only partial) to the old questions: Who are we? How did we come to be?

In the light of natural selection, it is easy to see that variation – differences among individuals within a pop-ulation – increases the chance that at least some individuals will survive if the environment changes. Here is a strong argument against cloning humans: if we were all genetically identical – if variation (or genetic variation) did not exist – a virus which previously could kill just some of us would either kill all of us, or none of us. Throughout the long history of life, variation has provided insurance that inevitable changes in the environment will not mean the extinction of a species. Similarly, the diversity of species ensures that envi-ronmental change will not mean the extinction of life. Life has evolved (or, the Earth's changing environment has selected) variation and diversity because they ensure survival.

**Questions**

1. "Darwin delighted in the great diversity of life, but also saw unity within that diversity." Using any two organisms of your choosing, identify how they are unified and how they are diverse. What similarities do they have in common? Differences? How can these similarities and differences be explained by the theory of evolution?

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2. In your own words, explain the meaning of the phrase, "descent with modification."

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3. Why is variation so important to the continuation of life on earth?

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4. Explain in your own words why a virus could cause the extinction of a population if that population's members were all identical to each other?

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5. Why can natural selection only be a "partial" answer to the questions: Who are we? How did we come to be? What questions can science not answer about life?

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## Lesson 12.1: Multiple Choice

**Name**________________________________ **Class**____________ **Date**________

*Circle the letter of the correct choice.*

1. A scientist who studies fossils to explore the history of life is called a
   (a) geologist.
   (b) botanist.
   (c) archeologist.
   (d) paleontologist.
2. Charles Darwin lived during the
   (a) $20^{th}$ century.
   (b) $19^{th}$ century.
   (c) $18^{th}$ century.
   (d) $17^{th}$ century.
3. What type of fossil remains did Darwin discover in Argentina that turned out to be one of the largest land mammals that have ever lived?
   (a) Galapagos tortoise
   (b) Ground sloth
   (c) Giraffe
   (d) Elephant
4. What is the process by which a certain trait becomes more common within a population?
   (a) Inheritance of Acquired Characteristics
   (b) Natural selection
   (c) Struggle for existance
   (d) Overproducing of offspring
5. Who developed a theory of evolution similar to Darwin's?
   (a) Alfred Russel Wallace
   (b) Charles Lyell
   (c) John Baptiste Lamarck
   (d) Thomas Malthus
6. An explanation which ties together or unifies a large group of observations is called a
   (a) hypothesis.
   (b) law.
   (c) theory.
   (d) trait.
7. A population of worms comes in two varieties: black worms and pink worms. A predator moves into the area that likes to eat only pink worms. What will happen to the worm population over time?
   (a) The population will eventually consist of more black worms than pink worms.

(b) The population will eventually consist of more pink worms than black worms.
(c) The predator will eat all the worms causing the worm population to go extinct.
(d) The population will not change.

## Lesson 12.1: Vocabulary

**Name**_____________________________ **Class**__________ **Date**_______

*Match the vocabulary term with the correct definition.*

**Term**

_____ 1. Natural Selection

_____ 2. Charles Darwin

_____ 3. John Steven Henslow

_____ 4. John Baptiste Lamarck

_____ 5. Theory

_____ 6. Law

_____ 7. Charles Lyell

_____ 8. Artificial Selection

_____ 9. Thomas Malthus

_____ 10. Alfred Russell Wallace

**Definition**

a. The process by which a certain trait becomes more common within a population, including heritable variation, overproduction of offspring, and differential survival and reproduction.

b. Concluded that the earth was very old and that many small changes over long periods of time led to present-day landscapes.

c. A statement which reliably describes a certain set of observations in nature; usually testable.

d. An explanation which ties together or unifies a large group of observations.

e. Described competition among humans as a result of overpopulation and too little food which lead to the realization that all animals must compete to survive.

f. Origin of Species author

g. Darwin's mentor

h. Animal or plant breeding where humans determine which individuals will reproduce.

i. Developed independently the same theory of evolution as Darwin

j. Although incorrect, his concept of inheritance of acquired characteristics provided more interest to the idea that life had evolved

## 12.3 Lesson 12.2: Evidence for Evolution

### Lesson 12.2: True or False

**Name**________________________________ **Class**____________ **Date**________

*Write true if the statement is true or false if the statement is false.*

_________ 1. Goosebumps are a type of vestigial structure found in humans.

_________ 2. Analogous structures are structures which evolved from the same structure within a common ancestor.

_________ 3. Plate tectonics explains the distant locations of closely related species as the result of continental drifting.

_________ 4. The fossil record for horses shows gradual changes which correspond to changes in the environment.

_________ 5. Evolution is like a progressing ladder, where species become more and more perfect as time goes on.

_________ 6. Species that are related to each other by a recent common ancestor are located near each other on a cladogram.

_________ 7. The number of differences in DNA bases between any two species measures the time elapsed since two organisms shared a common ancestor.

_________ 8. Human DNA sequences are 50-55% the same as those of chimpanzees.

_________ 9. Comparative embryology reveals homologies which form during adulthood.

_________ 10. The wing of a bat and the wing of a bird are considered to be analogous structures.

_________ 11. The fossil record for horse evolution has large gaps where huge amounts of information are missing.

_________ 12. Fossils are easily formed and maintained over time.

_________ 13. A fossil can be dated by looking at the relative position of the fossil in the rock layer in which it was found.

_________ 14. The study of fossils to explore the history of life is called paleontology.

_________ 15. A theory is a proposed, testable answer to a question or explanation of an observation.

## Lesson 12.2: Critical Reading

**Name**_______________________________ **Class**___________ **Date**________

*Read this passage from the lesson and answer the questions that follow.*

**Molecular Biology**

Did you know that your genes are 50% the same as those of a banana? Unknown in Darwin's time, the "comparative anatomy" of the molecules which make up life has added an even more convincing set of homologies to the evidence for evolution. All living organisms have genes made of DNA. The order of nucleotides –As, Ts, Cs, and Gs - in each gene codes for a protein, which does the work or builds the structures of life. Proteins govern the traits chosen (or not) in natural selection. For all organisms, a single Genetic Code translates the sequence of nucleotides in a gene into a corresponding chain of 20 amino acids. By itself, the universality of DNA genes and their code for proteins is strong evidence for common ancestry. Yet there is more.

If we compare the sequence of nucleotides in the DNA of one organism to the sequence in another, we see remarkable similarities. For example, human DNA sequences are 98-99% the same as those of chimpanzees, and 50% the same as a banana's! These similarities reflect similar metabolism. All organisms have genes for DNA replication, protein synthesis, and processes such as cellular respiration. Although metabolic processes do not leave fossils, similar DNA sequences among existing organisms provides excellent evidence for common ancestry.

**Questions**

1. What things are made up of DNA?

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2. What four substances make up DNA and what do these substances do?

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3. What do you think is meant by the phrase, "the universality of DNA genes and their code for proteins is strong evidence for common ancestry"?

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4. What does the amount of similarity in two species' DNA indicate?

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5. What type of genes make up the 50% that you share with bananas?

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## Lesson 12.2: Multiple Choice

**Name**_______________________________ **Class**___________ **Date**________

*Circle the letter of the correct choice.*

1. Structures that evolved independently in two different species are referred to as
   (a) homologous.
   (b) vestigial.
   (c) analogous.
   (d) comparative.
2. The study of the development of vertebrate animals before birth or hatching is called
   (a) anatomy.
   (b) embryology.
   (c) homology.
   (d) biogeography.
3. What two structures appear in the early development of all vertebrate embryos?
   (a) fur and nails
   (b) feathers and lungs
   (c) fingers and toes
   (d) gill slits and a tail
4. Which of the following types of evidence for evolution did Darwin not know about?
   (a) Molecular data

(b) Biogeography
(c) Comparative anatomy
(d) Fossils

5. A cladogram is a tree-like diagram used to show
   (a) the position of fossils found in different rock layers.
   (b) analogous structures found in different organisms.
   (c) how life may evolve in the future.
   (d) evolutionary relationships among organisms.
6. The process where a single ancestor rapidly evolves into a large number of different species is known as
   (a) homology.
   (b) adaptive radiation.
   (c) island biogeography.
   (d) adaptation.
7. The study of the distribution of plants and animals and the processes that influence their distribution is called
   (a) biogeography.
   (b) comparative anatomy.
   (c) comparative embryology.
   (d) molecular data.

## Lesson 12.2: Vocabulary

**Name**______________________________ **Class**___________ **Date**________

*Match the vocabulary term with the correct definition.*

**Term**

_____ 1. cladogram

_____ 2. homologous structures

_____ 3. embryology

_____ 4. biogeography

_____ 5. vestigial structures

_____ 6. analogous structures

_____ 7. fossils

_____ 8. comparative anatomy

_____ 9. relative dating

______ 10. paleontology

**Definition**

a. The study of patterns of distribution of species on continents and islands.

b. Similar structures with identical functions shared by distantly related species that are a result from natural selection in similar environments, but that evolved independently.

c. The study of the similarities and differences in organisms' structures.

d. Structures which evolved from the same structure within a common ancestor; may or may not serve the same function.

e. The study of fossils to explore the history of life.

f. A tree-like diagram showing evolutionary relationships according to a given set of data, such as molecular data.

g. Structures which are reduced and perhaps even nonfunctional in one species but homologous to functional structures in a closely related species.

h. A technique for aging fossils based on comparing their positions within rock layers; fossils in lower layers are usually older than fossils in upper layers.

i. A branch of comparative anatomy which studies the development of vertebrate animals before birth or hatching.

j. The mineralized remains of an animal, plant, or other organism.

## 12.4 Lesson 12.3: Evolution Continues Today - Can We Control It?

### Lesson 12.3: True or False

**Name**________________________________ **Class**____________ **Date**________

*Write true if the statement is true or false if the statement is false.*

_________ 1. Darwin used his observations of artificial selection, as he called it, to derive and promote his theory of evolution by natural selection.

_________ 2. Transgenic animals are produced by interbreeding two different species.

_________ 3. The first mammal to be cloned was a type of dog named Dolly.

_________ 4. Cloning eliminates variation in a population.

_________ 5. Most pest population evolve resistance to pesticides after a few short generations of exposure.

_________ 6. XDR-Tuberculosis has not evolved resistance to antibiotics.

_________ 7. Antibiotics should be taken to treat the common cold.

_________ 8. You should always finish your bottle of antibiotics even after you begin to feel better.

_________ 9. Sharing antibiotics is a good idea.

_________ 10. A worldwide epidemic is called a pandemic.

_________ 11. Peppered moth populations adapted to changes in their environment by migrating to a new location.

_________ 12. Changes in beak size and body size in Darwin's Finches were determined by changes in weather.

_________ 13. Avian flu is a type of influenza in which the main host is a type of bird.

_________ 14. The biggest concern regarding the spread of viruses among the human population is that the virus will mutate and become more easily transmissible from human to human.

_________ 15. Transgenic animals have provided no benefits to humans.

## Lesson 12.3: Critical Reading

**Name**______________________________ **Class**___________ **Date**________

*Read this passage from the lesson and answer the questions that follow.*

**Evolution of Resistance**

The evolution of resistance is a growing problem for many disease-causing bacteria and also for parasites, viruses, fungi, and cancer cells. The "miracle" of drug treatment which appeared to protect humans from disease may be short-lived. How does resistance happen? How can we prevent it?

First, recognize that resistance describes the bacterium (or other microorganism) – not the human. Bacteria multiply much more rapidly than humans, and therefore can evolve much more rapidly. Consider a population of bacteria infecting an individual with tuberculosis. Like all populations, individuals within that population show variation. Mutations add more variation. By chance, mutation may change the chemistry of one or a few bacteria so that they are not affected by a particular antibiotic. If the infected human begins to take antibiotics, they change the environment for the bacteria, killing most of them. However, the few bacteria which by chance have genes for resistance will survive this change in environment - and reproduce offspring which also carry the genes. More and more of the bacterial population will be resistant to antibiotics, because the antibiotics select for resistance. The bacteria are merely evolving in response to changes in their habitats! If the resistant bacteria are transmitted to another human "habitat", their population continues to expand, and if the new "habitat" takes different drugs, natural selection may result in multi-drug resistance.

**Questions**

1. Compare the rate of reproduction in humans to the rate of reproduction in bacteria.

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2. How does the difference in rates of reproduction between humans and bacteria relate to the amount of time it takes each organism to evolve?

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3. Are all individual bacterium in a population of bacteria the same?

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4. What role does chance play in the development of antibiotic resistance?

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5. Explain in your own words how a population of bacteria evolves resistance to an antibiotic over time.

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## Lesson 12.3:Multiple Choice

**Name**________________________________ **Class**____________ **Date**________

*Circle the letter of the correct choice.*

1. The mating of two different species to produce offspring is called
   (a) cloning.
   (b) hybridization.
   (c) artificial selection.
   (d) coevolution.
2. Which of the following outcome of genetic engineering provides NO direct benefits to humans?
   (a) invention of new medicines
   (b) transgenic animals
   (c) genetic pollution
   (d) improved agriculture
3. The development of resistance to antibiotics is a classic example of
   (a) genetic engineering.
   (b) natural selection.
   (c) cloning.
   (d) transgenic animals.
4. Why does cloning contradict the principles of natural selection?
   (a) It produces no variation.
   (b) It is too slow.
   (c) It is too fast.
   (d) It is another mechanism by which evolution can occur.
5. Epidemics that become wide-spread and impact large numbers of people world-wide are referred to as
   (a) pandemics.
   (b) genetic pollution.
   (c) global epidemics.
   (d) superbugs.
6. What is the virus which causes AIDS that is quickly becoming resistant to anti-viral medications?
   (a) Tuberculosis
   (b) Swine flu
   (c) Avian flu
   (d) HIV
7. The name of a virus that is transmissible from birds to humans is called
   (a) Tuberculosis.
   (b) Swine flu.

(c) Avian flu.
(d) HIV.

## Lesson 12.3: Vocabulary

**Name**________________________________ **Class**____________ **Date**________

*Match the vocabulary term with the correct definition.*

**Term**

______ 1. cloning

______ 2. genetic engineering

______ 3. transgenic animal

______ 4. coevolution

______ 5. mutation

______ 6. geologic time

______ 7. genetic pollution

______ 8. genetically modified organism

______ 9. natural selection

______ 10. artificial selection

**Definition**

a. An animal which possesses genes of another species.

b. A change in the nucleotide sequence of DNA or RNA.

c. The process of creating an identical copy of an organism

d. The process by which a certain trait becomes more common within a population, including heritable variation, overproduction of offspring, and differential survival and reproduction.

e. An organism whose genes have been altered by genetic engineering.

f. The manipulation of an organism's genes, usually involving the insertion of a gene or genes from one organism into another.

g. Time on the scale of the history of Earth, which spans 4.6 billion years.

h. Animal or plant breeding that involves humans choosing which individuals will reproduce according to desirable traits.

i. The natural hybridization or mixing of genes of a wild population with a domestic or feral population.

j. A pattern in which species influence each other's evolution and therefore evolve in tandem.

# Chapter 13

# Evolutionary Theory Worksheets

## 13.1 Lesson 13.1: Genetics of Populations

### Lesson 13.1: True or False

**Name**________________________________ **Class**____________ **Date**________

*Write true if the statement is true and false if the statement is false.*

_________ 1. Darwin didn't know how traits are passed from parent to offspring.

_________ 2. Albinism is caused by having two copies of a recessive gene.

_________ 3. An individual who has identical copies of the same gene is referred to as heterozygous for that gene.

_________ 4. Mutations in body cells do not affect the DNA in eggs and sperm.

_________ 5. Sexual reproduction can create new alleles for a population.

_________ 6. Individuals do not evolve.

_________ 7. Genes code for proteins.

_________ 8. Mutations never improve an organism's fitness.

_________ 9. It is possible to determine an organism's genotype by its phenotype.

_________ 10. The ability of an organism with a certain genotype to survive and reproduce is known as fitness.

## Lesson 13.1: Critical Reading

**Name**______________________ **Class**__________ **Date**________

*Read this passage from the lesson and answer the questions that follow.*

**Populations and Gene Pools**

Individuals do not evolve. Natural selection may affect an individual's chance to survive and reproduce, but it cannot change the individual's genes. However, a **population** – a group of organisms of a single species in a certain area – evolves when natural selection imposes differential survival on individuals within it. **Population genetics** studies populations at the level of genes and alleles in order to discover how evolution works.

If we consider all the alleles of all the genes of all the individuals within a population, we have defined the **gene pool** for that population. Gene pools contain all the genetic variation – that raw material for natural selection – within a population. The gene pool for a rabbit population, for example, includes alleles which determine coat color, ear size, whisker length, tail shape, and more. If a population geneticist wants to focus on the variation in an individual gene, s/he may look at the gene pool of all the alleles for that gene alone.

**Questions**

1. Why can't an individual evolve?

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2. Name some populations of organisms that live in your neighborhood.

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3. What does population genetics study?

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4. What are some alleles present in the gene pool of a rabbit population?

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5. What are some alleles present in the gene pool of a human population?

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## Lesson 13.1: Multiple Choice

**Name**________________________________ **Class**____________ **Date**________

*Circle the letter of the correct choice.*

1. Segments of DNA located on a particular place on a chromosome are called
   (a) proteins
   (b) alleles
   (c) genes
   (d) nitrogenous bases
2. How many copies of an individual gene do humans receive?
   (a) 1
   (b) 2
   (c) 4
   (d) It varies from person to person.
3. The mutation that causes sickle cell anemia is what type of mutation?
   (a) single-base substitution
   (b) neutral
   (c) chromosomal
   (d) non-heritable
4. Mutations can be
   (a) neutral
   (b) harmful
   (c) helpful
   (d) all of the above
5. If you saw a rabbit with brown fur color, what would you be able to determine about the rabbit?
   (a) Its phenotype for fur color.
   (b) Its genotype for fur color.
   (c) The number of offspring it will be able to produce.

(d) The age of the rabbit.

6. The amount of a particular allele in a population is referred to as allele
   (a) abundance
   (b) frequency
   (c) popularity
   (d) potential
7. What is it called when a particular gene is transcribed and translated?
   (a) replication
   (b) coding
   (c) expression
   (d) sequencing

## Lesson 13.1: Vocabulary

**Name**______________________________ **Class**___________ **Date**________

*Match the vocabulary term with the correct definition.*

**Term**

______ 1. gene

______ 2. allele

______ 3. genotype

______ 4. phenotype

______ 5. heterozygous

______ 6. homozygous

______ 7. population

______ 8. gene pool

______ 9. allele frequency

______ 10. mutation

**Definition**

a. Describes a genotype or individual having two copies of the same allele for a gene.

b. Within a population, the sum of all the alleles of all the genes of all the individuals.

c. A group of organisms of a single species living within a certain area.

d. The physical appearance of an organism determined by a particular genotype (and sometimes also by the environment).

e. The genetic makeup of an organism; specifically, the two alleles present.

f. A change in the nucleotide sequence of DNA or RNA.

g. A segment of DNA which codes for a protein or RNA molecule; a unit of inheritance.

h. An alternative form or different version of a gene.

i. The fraction (usually expressed as a decimal) of a population's gene pool made up of a particular allele.

j. Describes a genotype or individual having two different alleles for a gene.

## 13.2 Lesson 13.2: Genetic Change in Populations

### Lesson 13.2: True or False

**Name**________________________________ **Class**____________ **Date**________

*Write true if the statement is true and false if the statement is false.*

_________ 1. A population that is evolving is said to be in Hardy-Weinberg equilibrium.

_________ 2. Large populations are more vulnerable to genetic drift than small populations.

_________ 3. Genetic drift is a random process.

_________ 4. Macroevolution can be measured as a generation-to-generation change in allele frequencies.

_________ 5. Mutations must occur in all body cells in order for them to be passed on from parent to offspring.

_________ 6. Skin color is a polygenic trait in humans.

_________ 7. Natural selection acts on phenotypes, rather than genotypes.

_________ 8. Neutral mutations hold potential for future selection if the environment changes.

_________ 9. Stabilizing selection shifts the frequency curve away from the average by favoring individuals with an extreme form of the variation.

_________ 10. Kin selection involves the sacrifice by an individual of his/her reproductive potential in order to help a close relative reproduce successfully.

### Lesson 13.2: Critical Reading

**Name**________________________________ **Class**____________ **Date**________

*Read this passage from the lesson and answer the questions that follow.*

**Natural Selection**

Another way to look at natural selection is in terms of fitness - the ability of an organism with a certain genotype to reproduce. Fitness can be measured as the proportion of that organism's genes in all of the next generation's genes. When differences in individual genotypes affect fitness; the genotypes with higher fitness become more common. This change in genotype frequencies is natural selection.

An intriguing corollary of genotype selection is kin selection. Behaviors which sacrifice reproductive success or even survival can actually increase fitness if they promote the survival and reproduction of close relatives who share a significant proportion of the same genes. Examples include subordinate male turkeys, who help their dominant brothers display to potential mates and honeybee workers, who spend their lives collecting pollen and raising young to ensure that their mother, the queen, reproduces successfully.

**Questions**

1. What is fitness?

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2. Organism A lives a long life and produces no offspring. Organism B lives a short life, but produces offspring. Which organism has the higher fitness?

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3. How is fitness measured?

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4. What do subordinate male turkeys do in order to increase their fitness?

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5. Why does an organism benefit from helping its kin survive and reproduce?

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## Lesson 13.2: Multiple Choice

**Name**________________________________ **Class**____________ **Date**________

*Circle the letter of the correct choice.*

1. Large changes in a species (speciation) over geologic time would be considered
   (a) microevolution
   (b) macroevolution
   (c) Hardy-Weinberg model
   (d) genetic equilibrium
2. In the Hardy-Weinberg equation, what part of the equation refers to heterozygotes?
   (a) $p^2$
   (b) $2pq$
   (c) $q^2$
   (d) $p^2 + 2pq + q^2$
3. Which of the following conditions of the Hardy-Weinberg model were not met in the cystic fibrosis example given in the text?
   (a) no migration
   (b) random mating
   (c) no natural selection
   (d) all of the above
4. In order for a mutation to be passed from parent to offspring it must appear in
   (a) gametes
   (b) any of the parents' cells
   (c) all of the body cells
   (d) none of the above
5. All of the following are examples of events that could cause genetic drift EXCEPT:
   (a) earthquake
   (b) flood
   (c) fire
   (d) migration
6. What type of natural selection results in a shift of allele frequencies toward one extreme?

(a) stabilizing selection
(b) disruptive selection
(c) directional selection
(d) extreme selection

7. Why did early humans living in Africa have dark skin?

(a) It protected them from the harmful effects of UV radiation.
(b) It was caused by the type of food that was in their diet.
(c) It was the result of genetic drift.
(d) It was the result of gene flow.

## Lesson 13.2: Vocabulary

**Name**______________________________ **Class**___________ **Date**________

*Match the vocabulary term with the correct definition.*

**Term**

______ 1. Hardy-Weinberg model

______ 2. gene flow

______ 3. genetic drift

______ 4. fitness

______ 5. bottleneck effect

______ 6. founder effect

______ 7. adaptive radiation

______ 8. kin selection

______ 9. stabilizing selection

______ 10. disruptive selection

**Definition**

a. Behaviors which sacrifice reproductive success or even survival to promote the survival and reproduction of close relatives who share a significant proportion of the same genes.

b. Describes a population at genetic equilibrium, meeting five conditions: no mutation, no migration, very large population size, random mating, and no natural selection.

c. The loss of diversity resulting from a drastic reduction in population size and subsequent genetic drift.

d. The ability of an organism with a certain genotype to survive and reproduce, often measured as the proportion of that organism's genes in all of the next generation's genes.

e. The net movement of genes into or out of a population through immigration or emigration.

f. Random changes in allele frequencies in small populations.

g. Selection which favors the two extremes of a phenotypic distribution – the ends of a bell curve, or the homozygous phenotypes, as opposed to the average, or heterozygous phenotype.

h. Relatively rapid evolution of several species from a single founder population to several to fill a diversity of available ecological niches.

i. Selection which favors the average or heterozygous phenotype, resulting in no change or in a narrowing of the distribution of phenotypes.

j. The loss of genetic diversity resulting from colonization of a new area by a small group of individuals which have broken off from a larger population.

## 13.3 Lesson 13.3: The Origin of Species

### Lesson 13.3: True or False

**Name**________________________________ **Class**____________ **Date**________

*Write true if the statement is true and false if the statement is false.*

_________ 1. The Morphological Species Concept groups organisms based on their structural and biochemical similarities.

_________ 2. Any two individuals that can mate and produce offspring are always considered to be the same species.

_________ 3. The Biological Species Concept does not adequately define asexually reproducing organisms.

_________ 4. All humans are members of the same species.

_________ 5. Geographic isolation is required for reproductive isolation to occur.

_________ 6. Long periods of environmental stability may slow the rate of speciation.

_________ 7. Gradualism describes the rate of evolution as relatively stable with brief periods of rapid speciation.

_________ 8. While tetraploid plants may self-pollinate or interbreed with other tetraploids, they cannot successfully reproduce with their parents

_________ 9. Rivers, mountains, and glaciers are examples of geographic barriers that result in Sympatric speciation.

_________ 10. Differences in mating seasons is an example of reproductive isolation that may lead to Sympatric speciation.

## Lesson 13.3: Critical Reading

**Name**______________________________ **Class**___________ **Date**________

*Read this passage from the lesson and answer the questions that follow.*

**The Tempo of Speciation**

Speciation and extinction characterize all life on earth; the fossil record clearly documents both. Two startling facts emerge from careful study of the fossil record: First, the average successful species lives for "just" a few million years. Second, over 99.9% of all species that have ever lived have become extinct. The last aspects of speciation that we will consider are the tempo and pattern of species formation.

Over time, geographic changes isolate populations. Small populations experience genetic drift. Mutations alter individual genotypes and gene pools. New habitats form, and small groups colonize them. It is clear that evolution continues to change life. However, there is considerable debate about the rate at which speciation occurs over geologic time. Most biologists agree that single mutations seldom if ever cause new species in single evolutionary "leaps." Mutations in regulatory genes, which have major effects during development, may be an exception, but in general, mutations are more likely to be harmful, and selected against. Except for the special case of polyploidy, discussed above, speciation cannot occur within a single generation. So, what do we know about the rate and pattern of speciation?

Some evolutionary biologists consider the rate of evolution to be slow and constant, with small changes accumulating to form big changes – the idea of gradualism. Others (Niles Eldridge and Stephen Jay Gould), in response to the apparently "sudden" appearance of new forms in the fossil record, suggest that species diverge in bursts of relatively rapid change, and then remain stable for relatively long periods – a model known as punctuated equilibrium. Gould maintains that speciation and evolution occur rapidly in small, peripheral populations, whereas large, central populations remain stabilized for long periods of time. It is the large, central, stable populations which are represented in our fossil record, he argues – not the small, peripheral, evolving ones.

**Questions**

1. What two startling facts does the fossil record document?

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2. Why do you think 99.9% of all species that have ever lived have gone extinct?

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3. While there is no debate that evolution occurs, what do scientists debate about with regards to evolution?

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4. In what type of genes should a mutation occur in that might quickly lead to speciation?

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5. Describe the two hypotheses given that explain the tempo of speciation.

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## Lesson 13.3: Multiple Choice

**Name**________________________________ **Class**____________ **Date**________

*Circle the letter of the correct choice.*

1. According to the Biological Species Concept, a horse and a donkey are not members of the same species because a horse and a donkey are
   (a) unable to mate.
   (b) unable to produce offspring.
   (c) unable to produce offspring that are fertile.
   (d) not found in the same habitat.
2. In the Allopatric speciation experiment with fruit flies, flies that were fed on maltose preferred to mate with what type of fly?
   (a) Only maltose-fed flies
   (b) Only starch-fed flies
   (c) Both maltose-fed flies and starch-fed flies
   (d) Neither maltose-fed flies ore starch-fed flies

3. The duplication of chromosome sets, often resulting in instant speciation is called
   (a) diploidy
   (b) polyploidy
   (c) haploidy
   (d) tetraploidy
4. Sympatric speciation occurs
   (a) with no geographic barriers.
   (b) with geographic barriers.
   (c) only in certain types of organisms.
   (d) none of the above
5. Reproductive isolation
   (a) increases gene flow
   (b) decreases gene flow
   (c) stabilizes gene flow
   (d) has no effect on gene flow
6. What percentage of species that have ever lived are now extinct?
   (a) 20.9%
   (b) 60.9%
   (c) 75.9%
   (d) 99.9%
7. The idea that the rate of evolution is slow and constant, with small changes accumulating to form big changes, is called
   (a) punctuated equilibrium
   (b) Biological species concept
   (c) ecological niche
   (d) gradualism

## Lesson 13.3: Vocabulary

**Name**______________________________ **Class**___________ **Date**________

*Match the vocabulary term with the correct definition.*

**Term**

______ 1. Biological species concept

______ 2. reproductive isolation

______ 3. gradualism

______ 4. ecological niche

______ 5. sympatric speciation

______ 6. Morphological species concept

______ 7. punctuated equilibrium

______ 8. Genealogical (evolutionary) species concept

______ 9. allopatric speciation

______ 10. speciation

**Definition**

a. The idea that species diverge in bursts of relatively rapid change and then remain stable for relatively long periods.

b. The process which results in new, separate and genetically distinct groups of organisms (species).

c. A group of organisms similar enough that they could interbreed and produce fertile offspring under natural conditions.

d. The set of environmental conditions and resources used or required by a species; the role a species plays in its ecosystem.

e. The idea that the tempo of evolution is slow and constant, with small changes accumulating to form big changes.

f. A group of organisms which share a recent, unique common ancestor – common ancestry without divergence.

g. The evolution of new species from closely related populations located in the same area.

h. The separation of closely related populations by barriers to producing viable offspring.

i. A group of organisms which share extensive structural and biochemical similarities.

j. The evolution of a new species from a closely related population isolated by geographic barriers.

# Chapter 14

# Evolution in Populations Worksheets



## 14.1 Lesson 14.1: Form and Function

### Lesson 14.1: True or False

**Name**____________________________ **Class**____________ **Date**________

*Write true if the statement is true and false if the statement is false.*

__________ 1. Scientists have identified millions of different species of organisms.

__________ 2. Classification helps scientists understand the diversity of organisms.

__________ 3. Aristotle considered birds to be the most complex organisms.

__________ 4. Linnaeus tried to classify the entire known natural world.

__________ 5. All organisms capable of moving on their own belong to the same class.

__________ 6. Linnaeus thought of each species as an unchanging "ideal type."

__________ 7. More than one species may have the same genus and species names.

__________ 8. In binomial nomenclature, the species name is always capitalized.

__________ 9. Linnaeus' method for naming species is no longer used.

__________ 10. Linnaean taxonomy has not been revised since it was first introduced.

_________ 11. Modern classification systems are based on evolutionary relationships.

_________ 12. Vertebrates are a subphylum in the phylum called chordates.

## Lesson 14.1: Critical Reading

**Name**_______________________________ **Class**___________ **Date**________

*Read this passage from the lesson and answer the questions that follow.*

**Binomial Nomenclature**

The single greatest contribution that Linnaeus made to science is his method of naming species. This method, called **binomial nomenclature**, gives each species a unique, two-word name (also called a scientific or Latin name). Just like we have a first and last name, organisms have a distinguishable two word name as well. The two words in the name are the genus name and the species name. For example, the human species is uniquely identified by its genus and species names as *Homo sapiens*. No other species has this name.

Both words in a scientific name are Latin words or words that have been given Latin endings. The genus name is always written first and starts with an upper-case letter. The species name is always written second and starts with a lower-case letter. Both names are written in italics.

As another example, consider the group of organisms called *Panthera*. This is a genus in the cat family. It consists of all large cats that are able to roar. Within the genus *Panthera*, there are four different species that differ from one another in several ways. One obvious way they differ is in the markings on their fur. *Panthera leo* (lion species) has solid-colored fur, *Panthera tigris* (tiger species) has striped fur, and the other two *Panthera* species have fur with different types of spots. As this example shows, the genus name *Panthera* narrows a given cat's classification to big cats that roar. Adding the species name limits it to a single species of cat within this genus.

Why is Linnaeus' method of naming organisms so important? Before Linnaeus introduced his method, naming practices were not standardized. Some names were used to refer to more than one species. Conversely, the same species often had more than one name. In addition, a name could be very long, consisting of a string of descriptive words. For example, at one time, common wild roses were named *Rosa sylvestris alba cum rubore folio glabro*. Names such as this were obviously cumbersome to use and hard to remember.

For all these reasons, there was seldom a simple, fixed name by which a species could always be identified. This led to a great deal of confusion and misunderstanding, especially as more and more species were discovered. Linnaeus changed all that by giving each species a unique and unchanging two-word name. Linnaeus's method of naming organisms was soon widely accepted and is still used today.

*Questions*

1. What is Linnaeus' single greatest contribution to science?

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2. What two words make up the name of a species in Linnaeus' naming system?

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3. What is the scientific name for the human species? For the tiger species?

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4. Describe naming practices that were used before Linnaeus introduced his method.

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5. What are the advantages of binomial nomenclature over earlier naming practices?

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## Lesson 14.1: Multiple Choice

**Name**______________________________ **Class**___________ **Date**________

*Circle the letter of the correct choice.*

1. Which grouping of organisms is a kingdom?
   (a) plants
   (b) cats
   (c) mammals
   (d) vertebrates
2. Whales, bats, and humans all belong to the same

(a) species.
(b) genus.
(c) family.
(d) class.

3. Among animals, the most diverse group of organisms is the
   (a) rodents.
   (b) insects.
   (c) amphibians.
   (d) reptiles.
4. The scientist known as the "father of taxonomy" was
   (a) Linnaeus.
   (b) Aristotle.
   (c) Darwin.
   (d) Taxonomus.
5. A species is a division of a(n)
   (a) genus.
   (b) phylum.
   (c) order.
   (d) species.
6. Which taxon is missing from the sequence below? kingdom - phylum - _____?___ - order - family
   (a) superfamily
   (b) domain
   (c) genus
   (d) class
7. Lions have the scientific name *Panthera leo*. What genus do lions belong to?
   (a) leo
   (b) Panthera
   (c) Catus
   (d) Carnivora

## Lesson 14.1: Vocabulary

**Name**________________________________ **Class**____________ **Date**________

*Match the vocabulary term with the correct definition.*

*Term*

______ 1. taxonomy

______ 2. taxa

______ 3. kingdom

______ 4. species

______ 5. phylum

______ 6. class

______ 7. order

______ 8. family

______ 9. genus

______ 10. binomial nomenclature

*Definition*

a. taxon that is a division of a kingdom

b. taxon that is a division of an order

c. major grouping of organisms such as plants or animals

d. method of organizing living things into groups

e. taxon that is a division of a phylum

f. group of organisms that are similar enough to mate and produce offspring together

g. taxon that is a division of a class

h. Linnaeus' method of naming species using a unique two-word name

i. taxon that is a division of a family

j. categories of organisms in a taxonomy

## 14.2 Lesson 14.2: Phylogenetic Classification

### Lesson 14.2: True or False

**Name**________________________________ **Class**__________ **Date**________

*Write true if the statement is true and false if the statement is false.*

_________ 1. The tips of the branches of a phylogenetic tree represent common ancestors.

_________ 2. Species that shared a more recent common ancestor are more closely related.

_________ 3. A clade always includes at least five species of related organisms.

_________ 4. An example of a derived trait in humans is the presence of eyes.

_________ 5. Derived traits are always entirely new traits, unlike any traits in ancestors.

_________ 6. The phylogenetic classification of birds groups them with mammals rather than reptiles.

_________ 7. There is no limit on the number of levels in a cladogram.

_________ 8. A phylogenetic classification can include any organisms without regard to ancestry.

_________ 9. Phylogenetic classifications always agree with Linnaean taxonomic classifications.

_________ 10. Phenetic analysis distinguishes between ancestral traits and derived traits.

_________ 11. Similar nucleic acid base sequences are assumed to indicate descent from a common ancestor.

_________ 12. Horizontal gene transfer is a drawback in using nucleic acid base sequences for phylogenetic analysis.

## Lesson 14.2: Critical Reading

**Name**______________________________ **Class**___________ **Date**________

*Read this passage from the lesson and answer the questions that follow.*

**Cladistics**

The most popular method of making phylogenetic trees is called cladistics. It depicts hypotheses about how organisms are related, based on traits of ancestor and descendent species. Cladistics was developed in the 1950s by a scientist named Willi Hennig. Over the next several decades, it became very popular. It is still widely used today.

**Clades and Cladograms**

The term cladistics comes from the word clade. A clade is a group of organisms that includes an ancestor species and all of its descendants. A diagram showing evolutionary relationships within one or more clades is called a cladogram. Clade is a relative concept. How you define a clade depends on which species you are interested in. For example, all insects can be considered a clade because they have a common ancestor. Within the insect clade, butterflies, moths, and flies can also be considered a clade for the same reason.

**Generating Cladograms**

The starting point in constructing a cladogram is a set of data on traits of a group of related species. The traits could be physical traits, genetic traits, or both. The next step is deciding which traits were inherited from the common ancestor and which traits evolved only in a descendant species after splitting off from the common ancestor. Traits inherited from a common ancestor are called ancestral traits. Traits that evolved since two groups shared a common ancestor are called derived traits. In cladistics, the sharing of derived traits is the most important evidence for evolutionary relationships. Organisms with the same derived traits are grouped in the same clade. More than one possible cladogram usually can be created from the same set of data. In fact, the number of possible cladograms increases exponentially with the number of species included in the analysis. Only one cladogram is possible with two species. More than 100 cladograms are possible with five species. With nine species, more than two million cladograms are possible!

**Choosing the Best Cladogram**

How do scientists know which of many possible cladograms is the "right" one? There is no right or wrong cladogram. However, some cladograms fit the facts better than others. Statistical methods can be used to determine which cladogram best fits a particular data set. An important deciding factor is parsimony. Parsimony means choosing the simplest explanation from among all possible explanations. In cladistics, parsimony usually means choosing the cladogram with the fewest branching points. A cladogram shows just one of many possible phylogenies for a group of organisms. It can provide insights about how evolution occurred. However, a cladogram should not be considered a model of actual evolutionary events. It does not necessarily show what really happened. It just shows what could have happened.

*Questions*

1. What is cladistics?

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2. Why is clade a relative concept?

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3. What is the difference between ancestral traits and derived traits?

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4. What does parsimony usually mean in cladistics?

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5. How is a cladogram like a hypothesis?

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## Lesson 14.2: Multiple Choice

**Name________________________________ Class____________ Date________**

*Circle the letter of the correct choice.*

1. What was Charles Darwin trying to show with his "Tree of Life"?

(a) how life had originated

(b) how evolution had occurred

(c) what factors had led to natural selection

(d) why some species had gone extinct

2. Which two species in the cladogram below shared the most recent common ancestor?

Species A Species B Species C Species D

(a) species A and B

(b) species B and C

(c) species C and D

(d) species A and D

3. How many clades are represented by the cladogram in question 2?

(a) one

(b) two

(c) three

(d) four

4. An example of a derived trait in birds is

(a) eyes.

(b) lungs.

(c) feathers.

(d) legs.

5. A drawback of phylogenetic classification is that it

(a) has fixed numbers and types of taxa.

(b) is based only on physical traits of form and function.

(c) does not include a method for naming species.

(d) does not represent evolutionary relationships.

6. What is one problem in using DNA data for phylogenetic analysis?

(a) DNA data are rarely available for extinct species.

(b) DNA can pass only from parents to offspring.

(c) DNA is not found in microorganisms.

(d) DNA is found only in fossils.

## Lesson 14.2: Vocabulary

**Name________________________________ Class____________ Date________**

*Match the vocabulary term with the correct definition.*

*Term*

______ 1. phylogeny

______ 2. phylogenetic tree

______ 3. common ancestor

______ 4. cladistics

______ 5. clade

______ 6. cladogram

______ 7. ancestral traits

______ 8. derived traits

______ 9. parsimony

______ 10. phylogenetic classification

*Definition*

a. last ancestral species that two descendant species shared

b. diagram showing evolutionary relationships within one or more clades

c. evolutionary history of a group of genetically related organisms

d. traits inherited from a common ancestor

e. method of making evolutionary trees based on traits of ancestor and descendant species

f. diagram representing a phylogeny

g. choosing the simplest explanation from among all possible explanations

h. classification of organisms on the basis of evolutionary relationships

i. traits that evolved since two groups shared a common ancestor

j. group of organisms that includes an ancestor species and all of its descendants

## 14.3 Lesson 14.3: Modern Classification Systems

### Lesson 14.3: True or False

**Name**_______________________________ **Class**___________ **Date**________

*Write true if the statement is true and false if the statement is false.*

_________ 1. The Linnaean system of classification was first revised in the late 1900s.

_________ 2. By 1977, a total of six new kingdoms had been added to the Linnaean system.

_________ 3. The protist kingdom originally included both bacteria and protozoa.

_________ 4. Bacteria were placed in their own kingdom when it was discovered that they do not make their own food.

_________ 5. The original Monera kingdom was later renamed the Eukarya domain.

_________ 6. The five-kingdom classification system included the Fungi kingdom.

_________ 7. The last kingdom to be added to Linnaeus' original classification was the Eukarya.

_________ 8. The Eubacteria kingdom was later re-classified as the Archaea domain.

_________ 9. There are more organisms in the Eukarya domain than in both other domains combined.

_________ 10. Archaea were found to differ from the other organisms in the composition of their cell membranes.

_________ 11. Animals and archaea are currently classified in the same domain.

_________ 12. The three-domain system of classification is unlikely to be revised in the future.

## Lesson 14.3: Critical Reading

**Name**_______________________________ **Class**___________ **Date**________

*Read this passage from the lesson and answer the questions that follow.*

**Domains**

The six-kingdom system didn't show that all four eukaryote kingdoms are more closely related to each other than to the two bacteria kingdoms. It also didn't show that the two bacteria kingdoms are as different from each other as they are from the eukaryote kingdoms. To show these similarities and differences, a new taxon, called the domain, was introduced. It was defined as a taxon higher than the kingdom.

**The Three-Domain System**

In 1990, a new classification system was introduced that contained three domains: Bacteria, Archaea, and Eukarya. The Bacteria domain was formerly the Eubacteria kingdom, and the Archaea domain was formerly the Archaebacteria kingdom. The Eukarya domain includes all four eukaryote kingdoms: plants, animals, protists, and fungi. The three-domain system emphasizes the similarities among eukaryotes and the differences among eukaryotes, bacteria, and archaea. By using domains, these relationships could be shown without replacing the popular six-kingdom system. Archaea were first found in extreme environments. For example, they were found in the hot water geysers in Yellowstone National park. Archaea have since been found in all of Earth's habitats. They are now known to be present everywhere in high numbers. They may contribute as much as 20 percent to Earth's total biomass. The three-domain system was quickly adopted by many other biologists. There were some critics, however, who argued that the system put too much emphasis on the uniqueness of Archaea. Later studies confirmed how different Archaea are from other organisms. For example, organisms belonging to Archaea were found to differ from both Eukarya and Bacteria in the composition of their cell membranes and the system they use for DNA replication. These differences convinced most critics that the three-domain system was justified. After its introduction in 1990, the three-domain system became increasingly popular. Within a decade of its introduction, it had largely replaced earlier classifications.

**How Are the Three Domains Related?**

Comparisons of ribosomal RNA base sequences showed that organisms belonging to Eukarya are more similar to Archaea than they are to Bacteria. This suggested the hypothesis that Archaea and Eukarya shared a more recent common ancestor with each other than with Bacteria. However, the results of a study published in 2007 seem to conflict with this hypothesis. Comparing DNA base sequences, the 2007 study suggested that the domain Archaea may be older than either Bacteria or Eukarya. That would make Archaea the most ancient group of organisms on Earth. Which, if either, hypothesis is correct is not yet known. Scientists need to learn more about Archaea and their relationships with other organisms to resolve these questions.

*Questions*

1. Where does the domain fit into Linnaean taxonomy?

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2. Why was there a need for the domain?

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3. List the domains of the three-domain system.

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4. What kingdoms are included in each of the three domains?

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5. State two current hypotheses about how the three domains are related.

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## Lesson 14.3: Multiple Choice

**Name________________________________ Class____________ Date________**

*Circle the letter of the correct choice.*

1. Protozoa were originally classified as animals because

(a) they consist of just one cell.
(b) they do not have a nucleus.
(c) they lack a cell membrane.
(d) they can move on their own.

2. When the protist kingdom was first introduced in 1866, it consisted of all known
   (a) fungi.
   (b) microorganisms.
   (c) plants.
   (d) animals.
3. In a bacterial cell, the cell's organelles may
   (a) be found in the nucleus.
   (b) lack surrounding membranes.
   (c) have nuclear membranes.
   (d) contain DNA.
4. All of the following are eukaryotes except
   (a) frogs.
   (b) halobacteria.
   (c) molds.
   (d) mushrooms.
5. Bacteria that were once classified in the Eubacteria kingdom are now placed in the
   (a) Monera kingdom.
   (b) Bacteria domain.
   (c) Archaea domain.
   (d) Eukarya domain.
6. The human species is placed in the domain called
   (a) Chordata.
   (b) Mammalia.
   (c) Eukarya.
   (d) Animalia.
7. At present, the most widely used classification system is the
   (a) five-kingdom system.
   (b) three-kingdom system.
   (c) three-domain system.
   (d) one-domain system.

## Lesson 14.3: Vocabulary

**Name**______________________________ **Class**___________ **Date**________

*Match the vocabulary term with the correct definition.*

*Term*

______ 1. protozoa

______ 2. Protista

______ 3. prokaryote

______ 4. eukaryote

______ 5. Monera

______ 6. fungi

______ 7. domain

______ 8. Bacteria

______ 9. Archaea

______ 10. Eukarya

*Definition*

a. kingdom of single-celled eukaryote organisms such as protozoa

b. organism whose cells have nuclei

c. original name of the kingdom that included all bacteria

d. kingdom of eukaryote organisms such as mushrooms and molds

e. domain that was formerly the Archaebacteria kingdom

f. single-celled organisms that can move on their own

g. domain that includes all four eukaryote kingdoms

h. domain that was formerly the Eubacteria kingdom

i. organism whose cells lack nuclei

j. taxon higher than the kingdom

# Chapter 15

# Classification Worksheets

## 15.1 Lesson 15.1 Worksheets

### Lesson 15.1: True or False

**Name**_______________________________ **Class**___________ **Date**________

*Write true if the statement is true and false if the statement is false.*

_________ 1. Ecology is usually considered to be a branch of biology.

_________ 2. The environment of an organism includes only nonliving physical factors.

_________ 3. The biosphere extends from sea level to about 11,000 meters above sea level.

_________ 4. An important ecological issue is the rapid growth of the human population.

_________ 5. A community is the biotic component of an ecosystem.

_________ 6. An ecosystem is always closed in terms of energy.

_________ 7. An ecosystem depends on continuous inputs of matter from outside the system.

_________ 8. Organisms that depend on different food sources have different niches.

_________ 9. Mammals that live in very cold habitats must have insulation to help them stay warm.

_________ 10. Different species cannot occupy the same niche in the same geographic area for very long.

_________ 11. Field studies refer to the collection of data in a field, meadow, or other open area.

_________ 12. Ecologists use inferential statistics to describe the data they collect.

## Lesson 15.2: Critical Reading

**Name**_______________________________ **Class**___________ **Date**________

*Read this passage from the lesson and answer the questions that follow.*

**Ecosystem**

An ecosystem is a natural unit consisting of all the living organisms in an area functioning together with all the nonliving physical factors of the environment. The concept of an ecosystem can apply to units of different sizes. For example, a large body of fresh water could be considered an ecosystem, and so could a small piece of dead wood. Both contain a community of species that interact with one another and with the abiotic components of their environment.

Like most natural systems, ecosystems are not closed, at least not in terms of energy. Ecosystems depend on continuous inputs of energy from outside the system. Most ecosystems obtain energy from sunlight. Some obtain energy from chemical compounds. In contrast to energy, matter is recycled in ecosystems. Elements such as carbon and nitrogen, which are needed by living organisms, are used over and over again.

**Niche**

One of the most important ideas associated with ecosystems is the niche concept. A niche refers to the role of a species in its ecosystem. It includes all the ways species' members interact with the abiotic and biotic components of the ecosystem. Two important aspects of a species' niche include the food it eats and how it obtains the food.

**Habitat**

Another aspect of a species' niche is its habitat. A species' habitat is the physical environment to which it has become adapted and in which it can survive. A habitat is generally described in terms of abiotic factors, such as the average amount of sunlight received each day, the range of annual temperatures, and average yearly rainfall. These and other factors in a habitat determine many of the traits of the organisms that can survive there.

Consider a habitat with very low temperatures. Mammals that live in the habitat must have insulation to help them stay warm. Otherwise, their body temperature will drop to a level that is too low for survival. Species that live in these habitats have evolved fur, blubber, and other traits that provide insulation in order for them to survive in the cold.

Human destruction of habitats is the major factor causing other species to decrease and become endangered or go extinct. Small habitats can support only small populations of organisms. Small populations are more susceptible to being wiped out by catastrophic events from which a large population could bounce back.

**Questions**

1. What is an ecosystem? Give an example.

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2. How do ecosystems obtain energy?

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3. What happens to matter in ecosystems?

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4. Define niche. What are two aspects of a niche?

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5. What factors make up a species' habitat?

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## Lesson 15.1: Multiple Choice

**Name**______________________________ **Class**____________ **Date**________

*Circle the letter of the correct choice.*

1. Abiotic components of the environment include
   (a) air temperature.
   (b) other species.
   (c) producers.

(d) all of the above.

2. The chief food producers in the ocean are
   (a) plants.
   (b) zooplankton.
   (c) phytoplankton.
   (d) fish.
3. Coyotes and rabbits that live in the same area
   (a) are in direct competition with each other.
   (b) have a predator-prey relationship.
   (c) belong to the same population.
   (d) have the same niche.
4. Aspects of a species' habitat include
   (a) the average rainfall it receives.
   (b) the amount of sunlight it gets.
   (c) the range of temperatures it experiences.
   (d) all of above.
5. The niche of a plant includes all of the following except its
   (a) role as a producer.
   (b) need for sunlight.
   (c) use of soil nutrients.
   (d) genetic makeup.
6. According to the competitive exclusion principle, if two species occupied the same niche in the same area, they would
   (a) outcompete species in other niches.
   (b) move to a different habitat.
   (c) be in competition with each other.
   (d) both go extinct.
7. An example of a descriptive statistic is a(n)
   (a) hypothesis.
   (b) summary.
   (c) inference.
   (d) mean.

## Lesson 15.1: Vocabulary

**Name**____________________________ **Class**__________ **Date**_______

*Match the vocabulary term with the correct definition.*

**Term**

______ 1. ecology

______ 2. organism

______ 3. abiotic components

______ 4. biotic components

______ 5. biosphere

______ 6. population

______ 7. community

______ 8. ecosystem

______ 9. niche

______ 10. habitat

**Definition**

a. living organisms in the environment

b. physical environment to which an organism has become adapted

c. populations of different species that live in the same area and interact with one another

d. scientific study of the interactions of living things with each other and their environments

e. role of a species in its ecosystem

f. areas of Earth where all organisms live

g. life form consisting of one or more cells

h. natural unit consisting of all the living organisms in an area together with all the nonliving physical factors of the environment

i. nonliving physical aspects of the environment

j. organisms of the same species that live in the same area and interact with one another

## 15.2 Lesson 15.2 Worksheets

### Lesson 15.2: True or False

**Name**________________________________ **Class**____________ **Date**________

*Write true if the statement is true and false if the statement is false.*

_________ 1. All organisms use organic compounds for energy.

_________ 2. Plants are the most important heterotrophs in terrestrial ecosystems.

_________ 3. Zooplankton are the chief aquatic producers.

_________ 4. Archaea make food using energy in sunlight.

_________ 5. A few plants trap and digest animals.

_________ 6. Energy flows from producers and consumers to decomposers.

_________ 7. Saprotrophs complete the breakdown of any remaining organic matter.

_________ 8. Bacteria are the only organisms that can decompose dead wood.

_________ 9. A fish that eats zooplankton is a primary consumer.

_________ 10. Hawks have more energy than plants in a terrestrial ecosystem.

_________ 11. Multiple intersecting food webs make up a food chain.

_________ 12. Cows eat grass, so they are secondary consumers.

## Lesson 15.2: Critical Reading

**Name**______________________________ **Class**___________ **Date**________

*Read this passage from the lesson and answer the questions that follow.*

**Producers**

Producers are organisms that produce organic compounds from energy and simple inorganic molecules. Producers are also called autotrophs, which literally means "self nutrition." This is because producers synthesize food for themselves. They take energy and materials from the abiotic environment and use them to make organic molecules. Autotrophs are a vital part of all ecosystems. The organic molecules they produce are needed by all the organisms in the ecosystem. There are two basic types of autotrophs: photoautotrophs and chemoautotrophs. They differ in the type of energy they use to synthesize food.

**Photoautotrophs**

Photoautotrophs are organisms that use energy from sunlight to make glucose from carbon dioxide and water by photosynthesis. Glucose, a carbohydrate, is an organic compound that can be used by autotrophs and other organisms for energy. Photoautotrophs include plants, algae, and certain bacteria. Plants are the most important photoautotrophs in land-based, or terrestrial, ecosystems. There is great variation in the plant kingdom. Plants include organisms as different as trees, grasses, mosses, and ferns. Nonetheless, all plants are eukaryotes that contain chloroplasts, the cellular "machinery" needed for photosynthesis.

Algae are photoautotrophs found in most ecosystems, but they generally are more important in water-based, or aquatic, ecosystems. Like plants, algae are eukaryotes that contain chloroplasts for photosynthesis. Algae include single-celled eukaryotes, such as diatoms, as well as multicellular eukaryotes, such as seaweed.

Photoautotrophic bacteria, called cyanobacteria, are also important producers in aquatic ecosystems. Cyanobacteria were formerly called blue-green algae, but they are now classified as bacteria. Other photosynthetic bacteria, including purple photosynthetic bacteria, are producers in terrestrial as well as aquatic ecosystems.

Both cyanobacteria and algae make up phytoplankton. Phytoplankton refers to all the tiny photoautotrophs found on or near the surface of a body of water. Phytoplankton usually is the primary producer in aquatic ecosystems.

**Chemoautotrophs**

In some places where life is found on Earth, there is not enough light to provide energy for photosynthesis. In these places, producers called chemoautotrophs make organic molecules from carbon dioxide and water by chemosynthesis. Instead of energy from sunlight, chemosynthesis depends on energy from the oxidation of inorganic compounds, such as hydrogen sulfide (H2S). Oxidation is an energy-releasing chemical reaction in which a molecule, atom, or ion loses electrons. Chemoautotrophs include bacteria called nitrifying bacteria. Nitrifying bacteria live underground in soil. They oxidize nitrogen-containing compounds and change them to a form that plants can use. Chemoautotrophs also include archaea. Archaea are a domain of microorganisms that resemble bacteria. Most archaea live in extreme environments, such as around hydrothermal vents in the deep ocean floor. They use the toxic chemicals released from the vents to produce organic compounds. The organic compounds can then used by other organisms, such as tube worms.

**Questions**

1. What are producers? Name two types of producers.

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2. How do photoautotrophs produce food?

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3. What are the components of phytoplankton, and what is the role of phytoplankton in aquatic ecosystems?

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4. How do chemoautotrophs produce food?

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5. What are examples of chemoautotrophs?

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## Lesson 15.2: Multiple Choice

**Name**______________________________ **Class**___________ **Date**________

*Circle the letter of the correct choice.*

1. What is the main contribution of autotrophs to ecosystems?
   (a) organic molecules such as glucose.
   (b) elements such as nitrogen.
   (c) carbon dioxide.
   (d) water.
2. All of the following are true of algae except
   (a) all algae are eukaryotes.
   (b) some algae are single-celled.
   (c) most algae are aquatic.
   (d) some algae are bacteria.
3. What do carnivores eat?
   (a) herbivores
   (b) other consumers
   (c) other carnivores
   (d) all of the above
4. Fungi are the main decomposers of dead
   (a) animals.
   (b) plants.
   (c) bacteria.

(d) protozoa.

5. A food web is best described as a diagram of
   (a) feeding relationships in an ecosystem.
   (b) energy flow among producers.
   (c) Calories available to primary consumers.
   (d) nutrients present in certain foods.

6. The broadest level of an energy pyramid consists of
   (a) producers.
   (b) decomposers.
   (c) scavengers.
   (d) saprotrophs.

7. Which trophic level of an ecosystem has the least biomass?
   (a) tertiary consumers
   (b) secondary consumers
   (c) primary consumers
   (d) producers

## Lesson 15.2: Vocabulary

**Name**_______________________________ **Class**___________ **Date**________

*Match the vocabulary term with the correct definition.*

**Term**

______ 1. producers

______ 2. photoautotrophs

______ 3. phytoplankton

______ 4. consumers

______ 5. herbivores

______ 6. zooplankton

______ 7. scavengers

______ 8. carnivores

______ 9. omnivores

______ 10. decomposers

**Definition**

a. organisms that eat a diet consisting mainly of herbivores or of other organisms that eat herbivores

b. all organisms that depend on other organisms for food

c. organisms that eat both plants and animals as primary food sources

d. small organisms that consume producers on or near the surface of a body of water

e. organisms that consume dead plants and animals and other organic waste

f. all organisms that produce organic compounds from energy and simple inorganic molecules

g. tiny photoautotrophs found on or near the surface of a body of water

h. carnivores that mainly eat the carcasses of dead animals

i. organisms that consume only producers such as plants or algae

j. organisms that use energy from sunlight to make food by photosynthesis

## 15.3 Lesson 15.3 Worksheets

### Lesson 15.3: True or False

**Name**_______________________________ **Class**___________ **Date**________

*Write true if the statement is true and false if the statement is false.*

_________ 1. All chemical elements that are needed by living things are recycled in ecosystems.

_________ 2. The deep ocean is a reservoir for water in the water cycle.

_________ 3. Earth's gravity is the driving force behind the water cycle.

_________ 4. Rain that flows over the ground is called groundwater.

_________ 5. The water cycle ends when precipitation falls and returns to the ocean.

_________ 6. Carbon is stored in the ocean as carbon dioxide.

_________ 7. All organisms release carbon dioxide as a byproduct of cellular respiration.

_________ 8. When volcanoes erupt, they return carbon from the mantle to the atmosphere.

_________ 9. Of living things, only producers need nitrogen.

_________ 10. Plants absorb nitrogen gas through their root hairs.

_________ 11. Some nitrogen-fixing bacteria live in the root nodules of legumes.

_________ 12. The anammox reaction of the nitrogen cycle occurs in water.

## Lesson 15.3: Critical Reading

**Name**_______________________________ **Class**___________ **Date**________

*Read this passage from the lesson and answer the questions that follow.*

**Nitrogen Cycle**

The atmosphere is the largest reservoir of nitrogen on Earth. It consists of 78 percent nitrogen gas. The nitrogen cycle moves nitrogen through abiotic and biotic components of ecosystems.

**Absorption of Nitrogen**

Plants and other producers use nitrogen to synthesize nitrogen-containing organic compounds, including chlorophyll, proteins, and nucleic acids. Consumers also make use of the nitrogen in these compounds. Plants absorb nitrogen from the soil through their root hairs. However, they cannot absorb nitrogen gas directly. They can absorb nitrogen only in the form of nitrogen-containing ions, such as nitrate ions.

**Nitrogen Fixation**

The process of converting nitrogen gas to nitrate ions that plants can absorb is called nitrogen fixation. It is carried out mainly by nitrogen-fixing bacteria. Some nitrogen-fixing bacteria live in soil. Others live in the root nodules of legumes such as peas and beans. In aquatic ecosystems, some cyanobacteria are nitrogen fixing.

**Ammonification and Nitrification**

After being used by organisms, nitrogen is released back into the environment. When decomposers break down organic remains and wastes, they release nitrogen in the form of ammonium ions. This is called ammonification. Certain soil bacteria, called nitrifying bacteria, convert ammonium ions to nitrites. Other nitrifying bacteria convert the nitrites to nitrates, which plants can absorb. The process of converting ammonium ions to nitrites or nitrates is called nitrification.

**Denitrification and the Anammox Reaction**

Still other bacteria, called denitrifying bacteria, convert some of the nitrates in soil back into nitrogen gas in a process called denitrification. It is the opposite of nitrogen fixation. Denitrification returns nitrogen gas back to the atmosphere, where it can continue the nitrogen cycle. In the ocean, an anammox reaction returns nitrogen to the atmosphere. The reaction involves certain bacteria, and it converts ammonium and nitrite ions to nitrogen gas.

**Questions**

1. What is the only form of nitrogen that plants can absorb?

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2. What do nitrogen-fixing bacteria do, and where do they live?

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3. What role do decomposers play in the nitrogen cycle?

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4. Describe what happens during nitrification.

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5. What is the anammox reaction, and when does it occur in the nitrogen cycle?

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## Lesson 15.3: Multiple Choice

**Name**_______________________________ **Class**____________ **Date**________

*Circle the letter of the correct choice.*

1. Water that infiltrates the ground is called
   (a) runoff.
   (b) groundwater.
   (c) reservoir water.
   (d) discharge water.
2. Water vapor condenses as it rises high in the atmosphere because it
   (a) cools down.

(b) gains energy.
(c) is under more pressure.
(d) is pulled by gravity.

3. Methane gas released by landfills is

   (a) burned in car engines.
   (b) used to heat homes.
   (c) released into the air.
   (d) added to fertilizers.

4. Calcium carbonate that settles out of ocean water forms

   (a) bicarbonate ions.
   (b) carbon dioxide.
   (c) natural gas.
   (d) limestone.

5. Nitrogen-fixing organisms in aquatic ecosystems are

   (a) plants.
   (b) large fish.
   (c) zooplankton.
   (d) cyanobacteria.

6. Ammonium ions are converted to nitrites or nitrates by

   (a) nitrifying bacteria.
   (b) denitrifying bacteria.
   (c) nitrogen-fixing bacteria.
   (d) all of the above.

7. The anammox reaction changes ammonium ions to a form that can enter the

   (a) atmosphere.
   (b) mantle.
   (c) biosphere.
   (d) ocean.

## Lesson 15.3: Vocabulary

**Name**_______________________________ **Class**___________ **Date**________

*Match the vocabulary term with the correct definition.*

**Term**

______ 1. sublimation

______ 2. transpiration

______ 3. infiltration

______ 4. cellular respiration

______ 5. subduction

______ 6. nitrogen fixation

______ 7. ammonification

______ 8. nitrification

______ 9. denitrification

______ 10. anammox reaction

**Definition**

a. process by which plants lose water through their leaves

b. process in which the ocean floor is pulled down into the mantle

c. process of converting ammonium ions to nitrites or nitrates

d. transformation of snow and ice directly into water vapor

e. release of ammonium ions by decomposers as they break down organic remains and wastes

f. chemical reaction in which ammonium and nitrite ions combine to form water and nitrogen gas

g. general process of converting nitrates into nitrogen gas

h. process of rainwater soaking into the ground

i. process of converting nitrogen to nitrate ions that plants can absorb

j. process by which cells oxidize glucose and produce energy

# Chapter 16

# Principles of Ecology Worksheets

## 16.1 Biomes, Ecosystems and Communities Worksheets

## 16.2 Lesson 16.1: Biomes

### Lesson 16.1: True or False

**Name**_________________________ **Class**__________ **Date**________

*Write true if the statement is true and false if the statement is false.*

________ 1. Climate is the most important abiotic factors affecting terrestrial biomes.

________ 2. Climate is determined only by distance from the equator.

________ 3. The northern temperate zone goes from the equator to the arctic circle.

________ 4. The moisture of a biome is determined solely by precipitation.

________ 5. When air masses cool, they can hold more water vapor.

________ 6. Coastal areas may have warmer winters and cooler summers than inland areas.

________ 7. Between the equator and 20° north latitude, the climate is very dry.

________ 8. Warm, sunny areas have less evaporation than cool, cloudy areas.

________ 9. Dry climates are found only where the weather is hot and sunny.

________ 10. Air masses that have passed over a wide expanse of land carry little moisture.

________ 11. Climate has no influence on the quality of soil in an area.

________ 12. Adaptations to dryness include thick, barrel-like stems in plants.

## Lesson 16.1: Critical Reading

**Name**______________________________ **Class**___________ **Date**________

*Read this passage from the lesson and answer the questions that follow.*

### Climate and Plant Growth

Plants are the major producers in terrestrial biomes. Almost all other terrestrial organisms depend on plants either directly or indirectly for food. Plants need air, warmth, sunlight, water, and nutrients to grow. Climate is the major factor affecting the number and diversity of plants that can grow in a terrestrial biome. Climate determines the average temperature and precipitation, the length of the growing season, and the quality of the soil, including levels of soil nutrients.

### Growing Season

The growing season is the period of time each year when it is warm enough for plants to grow. The timing and length of the growing season determine what types of plants can grow in an area. For example, near the poles the growing season is very short. The temperature may rise above freezing for only a couple of months each year. Because of the cold temperatures and short growing season, trees and other slow-growing plants are unable to survive. The growing season gets longer from the poles to the equator. Near the equator, plants can grow year-round if they have enough moisture. A huge diversity of plants can grow in hot, wet climates. The timing of precipitation also affects the growing season. In some areas, most of the precipitation falls during a single wet season (such as in California), rather than throughout the year (such as in New England). In these areas, the growing season lasts only as long as there is enough moisture for plants to grow.

### Soil

Plants need soil that contains adequate nutrients and organic matter. Nutrients and organic matter are added to soil when plant litter and dead organisms decompose. In cold climates, decomposition occurs very slowly. As a result, soil in cold climates is thin and poor in nutrients. Soil is also thin and poor in hot, wet climates because the heat and humidity cause such rapid decomposition that little organic matter accumulates in the soil. The frequent rains also leach nutrients from the soil. Soil in temperate climates is typically thicker and richer in nutrients. It contains more organic matter and is the best soil for growing most plants.

### Questions

1. Why do most terrestrial organisms depend on plants?

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2. List what plants need to grow.

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3. What factors determine the growing season in a given location?

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4. What do plants need in soil? What type of soil is best for most plants?

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5. Why are soils thin and poor in hot, wet climates?

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## Lesson 16.1: Multiple Choice

**Name**______________________________ **Class**___________ **Date**________

*Circle the letter of the correct choice.*

1. Major subdivisions of the biosphere are called
   (a) niches.
   (b) habitats.
   (c) climate zones.
   (d) biomes.
2. Climates are classified as tropical, temperate, or arctic based on their
   (a) air pressure.
   (b) temperature.
   (c) precipitation.
   (d) wind speed.
3. Coastal areas tend to be mild because

(a) coastal winds blow severe weather out to sea.
(b) the temperature of the ocean changes little from season to season.
(c) coastal areas are always at low latitudes.
(d) dense forests protect coastal areas from extreme weather.

4. The major producers in terrestrial biomes are
   (a) plants.
   (b) bacteria.
   (c) algae.
   (d) herbivores.
5. Plants need nutrients that are naturally added to soils in the process of
   (a) leaching.
   (b) root growth.
   (c) adaptation.
   (d) decomposition.
6. Biodiversity is usually greater in biomes that are
   (a) wetter.
   (b) warmer.
   (c) closer to the equator.
   (d) all of the above.

## Lesson 16.1: Vocabulary

**Name**________________________________ **Class**____________ **Date**________

*Match the vocabulary term with the correct definition.*

**Term**

______ 1. biome

______ 2. climate

______ 3. weather

______ 4. latitude

______ 5. altitude

______ 6. tropical zone

______ 7. temperate zone

______ 8. rain shadow

______ 9. growing season

______ 10. biodiversity

**Definition**

a. conditions of temperature and precipitation on any given day

b. zone from the tropical zone to the arctic or antarctic circle.

c. land on the leeward side of a mountain range that receives little precipitation

d. group of similar ecosystems that cover a broad area

e. the number of different species of organisms in a biome or ecosystem

f. zone from the Tropic of Capricorn to the Tropic of Cancer

g. average weather in an area over a long period of time

h. distance north or south of the equator

i. period of time each year when it is warm enough for plants to grow

j. distance above sea level

## 16.3 Lesson 16.2: Terrestrial Biomes

### Lesson 16.2: True or False

**Name**________________________________ **Class**____________ **Date**________

*Write true if the statement is true and false if the statement is false.*

_________ 1. The distribution of terrestrial biomes reflects patterns of temperature and moisture.

_________ 2. All tundra biomes have high biodiversity.

_________ 3. Arctic tundra is found in the Rocky Mountains in the United States.

_________ 4. Only Alpine tundra has permafrost.

_________ 5. When permafrost melts, it releases greenhouse gases.

_________ 6. The primary vegetation in boreal forests is lichen.

_________ 7. There are boreal forests in Canada and the United States.

_________ 8. Temperate rainforests consist mainly of evergreen tress such as hemlocks and firs.

_________ 9. Chaparral is a type of tropical biome.

_________ 10. The largest deserts are found at about 60° north or south latitude.

_________ 11. Death Valley is an example of rain shadow desert.

_________ 12. Little sunlight reaches the floor of a tropical dry forest.

## Lesson 16.2: Critical Reading

**Name**______________________________ **Class**___________ **Date**________

*Read this passage from the lesson and answer the questions that follow.*

**Arctic and Subarctic Biomes**

Artic and subarctic biomes are found near the north and south poles or at high altitudes in other climate zones. The biomes include tundra and boreal forests. Both have cold, dry climates and poor soil. They can support only limited plant growth and have low biodiversity. The remainder of this passage describes tundra biomes.

**Tundra**

**Tundra** is an arctic biome where it is too cold for trees to grow. Outside of the polar ice caps, tundra has the coldest temperatures on Earth. There are two types of tundra: arctic tundra, which is also found in Antarctica, and alpine tundra, which is found only at high altitudes.

- **Arctic tundra** occurs north of the arctic circle and south of the antarctic circle. It covers much of Alaska and vast areas of northern Canada and Russia. It is also found along the northern coast of Antarctica.
- **Alpine tundra** occurs in mountains around the world at any latitude, but only above the tree line. The **tree line** is the edge of the zone at which trees are able to survive. Alpine tundra is found in the Rocky Mountains in the United States and in several other mountain ranges around the world.

Both types of tundra receive very low precipitation, but little of it evaporates because of the cold. Arctic tundra has **permafrost**, which is frozen soil year-round. The top layer of soil thaws in the summer, but deeper layers do not. As a result, water cannot soak into the ground. This leaves the soil soggy and creates many bogs, lakes, and streams. Alpine tundra does not have permafrost, except at very high altitudes. Therefore, alpine tundra soil tends to be dry rather than soggy.

Global warming poses a serious threat to arctic tundra biomes because it is causing the permafrost to melt. When permafrost melts, it not only changes the tundra. It also releases large amounts of methane and carbon dioxide into the atmosphere. Both are greenhouse gases, which contribute to greater global warming.

The most common types of vegetation in tundra are mosses and lichens. They can grow in very little soil and become dormant during the winter. Tundra is too cold for amphibians or reptiles, which cannot regulate their own body heat. Insects such as mosquitoes can survive the winter as pupae and are very numerous in summer. In addition, many species of birds and large herds of caribou migrate to arctic tundra each summer. However, few birds and mammals live there year-round. Those that remain have adapted to the extreme cold. Polar bears are an example. They have thick fur to insulate them from the cold. In alpine tundra, animals must adapt to rugged terrain as well as to cold. Alpine animals include mountain goats, which not only have wool to keep them warm but are also sure-footed and agile.

**Questions**

1. Where are arctic and subarctic biomes located?

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2. Describe arctic tundra.

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3. Where is alpine tundra found? How does it differ from arctic tundra?

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4. How is global warming threatening arctic tundra biomes?

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5. What species are commonly found in tundra biomes?

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## Lesson 16.2: Multiple Choice

**Name**_____________________________ **Class**__________ **Date**_______

*Circle the letter of the correct choice.*

1. A humid biome between 30° south and 30° north latitude is called a
   (a) tropical rainforest.
   (b) tropical dry forest.
   (c) boreal rainforest.
   (d) chaparral forest.
2. Alpine tundra biomes are found only
   (a) north of the arctic circle.
   (b) close to the South Pole.
   (c) at 90° north or south latitude.
   (d) above certain altitudes.
3. What type of climate would you expect in a boreal forest?
   (a) continental climate
   (b) temperate climate
   (c) tropical climate
   (d) subtropical climate
4. Cone-bearing, needle-leaved evergreen trees such as spruces are called
   (a) deciduous trees.
   (b) conifers.
   (c) epiphytes.
   (d) shrubs.
5. Which biome, found in central and southern California, has a Mediterranean climate?
   (a) rainforest
   (b) conifer forest
   (c) boreal forest
   (d) chaparral
6. Deserts are characterized by
   (a) humid air masses.
   (b) extreme daily temperature variations.
   (c) rich soil with a high organic content
   (d) more than 25 centimeters of precipitation per year.
7. Which sentence is true about tropical grassland biomes?
   (a) They receive very high rainfall.
   (b) They are found mainly in Europe.

(c) They have cool temperatures.
(d) They have large herds of herbivores.

## Lesson 16.2: Vocabulary

**Name**________________________________ **Class**__________ **Date**________

*Match the vocabulary term with the correct definition.*

**Term**

______ 1. tundra

______ 2. temperate deciduous forest

______ 3. temperate rainforest

______ 4. temperate grassland

______ 5. tropical grassland

______ 6. desert

______ 7. boreal forest

______ 8. tropical dry forest

______ 9. tropical rainforest

______ 10. chaparral

**Definition**

a. tropical biome that receives heavy rainfall and consists mainly of tall, broadleaf evergreen trees

b. temperate biome that receives relatively low precipitation and consists mainly of grasses

c. tropical biome that receives relatively low rainfall, has a dry season, and consists mainly of widely spaced, drought-adapted trees

d. arctic biome where is it too cold for trees to grow

e. temperate biome with a Mediterranean climate that consists mainly of densely-growing evergreen shrubs such as scrub oak

f. temperate biome that receives moderate rainfall and consists mainly of deciduous trees such as maples

g. tropical biome that receives relatively low rainfall, has a dry season, and consists mainly of grasses

h. temperate or tropical biome that receives no more than 25 centimeters of precipitation per year

i. temperate biome that receives heavy rainfall and consists mainly of evergreen trees such as hemlocks

j. subarctic biome covered with conifers

## 16.4 Lesson 16.3: Aquatic Biomes

### Lesson 16.3: True or False

**Name**________________________________ **Class**____________ **Date**________

*Write true if the statement is true and false if the statement is false.*

_________ 1. Most aquatic organisms have to deal with extremes of temperature.

_________ 2. Aquatic biomes have more total biomass than terrestrial biomes.

_________ 3. There is generally plenty of oxygen to support organisms in the photic zone.

_________ 4. Oceanic biomes occur in ocean water over the continental shelf.

_________ 5. Nekton are aquatic organisms that can make their own food.

_________ 6. Sponges and clams are examples of benthic organisms.

_________ 7. Water at the bottom of the ocean is always cold.

_________ 8. The intertidal zone has very low biodiversity.

_________ 9. Corals are colored rocks found at the bottom of tropical ocean water.

_________ 10. The depth of the photic zone in a lake depends on clarity of water.

_________ 11. Plants are important producers in ocean water biomes.

_________ 12. Both riparian zones and wetlands help prevent erosion.

### Lesson 16.3: Critical Reading

**Name**________________________________ **Class**____________ **Date**________

*Read this passage from the lesson and answer the questions that follow.*

**Marine Biomes**

**Marine biomes** are aquatic biomes found in the salt water of the ocean. Major marine biomes include neritic, oceanic, and benthic biomes. Neritic and oceanic biomes are described in the rest of this passage.

### Neritic Biomes

**Neritic biomes** occur in ocean water over the continental shelf. They extend from the low-tide water line to the edge of the continental shelf. The water here is shallow, so there is enough sunlight for photosynthesis. The water is also rich in nutrients, which are washed into the water from the nearby land. Because of these favorable conditions, large populations of phytoplankton live in neritic biomes. They produce enough food to support many other organisms, including both zooplankton and nekton. As a result, neritic biomes have relatively great biomass and biodiversity. They are occupied by many species of invertebrates and fish. In fact, most of the world's major saltwater fishing areas are in neritic biomes.

### Oceanic Biomes

**Oceanic biomes** occur in the open ocean beyond the continental shelf. There are lower concentrations of dissolved nutrients away from shore, so the oceanic zone has a lower density of organisms than the neritic zone. The oceanic zone is divided into additional zones based on water depth.

- The **epipelagic zone** is the top 200 meters of water, or the depth to which enough sunlight can penetrate for photosynthesis. Most open ocean organisms are concentrated in this zone, including both plankton and nekton.
- The **mesopelagic zone** is between 200 and 1,000 meters below sea level. Some sunlight penetrates to this depth but not enough for photosynthesis. Organisms in this zone consume food drifting down from the epipelagic zone, or they prey upon other organisms in their own zone. Some organisms are detrivores, which consume dead organisms and organic debris as they drift down through the water.
- The **bathypelagic zone** is between 1,000 and 4,000 meters below sea level. No sunlight penetrates below 1,000 meters, so this zone is completely dark. Most organisms in this zone either consume dead organisms drifting down from above or prey upon other animals in their own zone. There are fewer organisms and less biomass here than in higher zones. Some animals are bioluminescent, which means they can give off light. This is an adaptation to the total darkness.
- The **abyssopelagic zone** is between 4,000 and 6,000 meters below sea level and is completely dark. It has low biomass and low species diversity.
- The **hadopelagic zone** is found in the water of deep ocean trenches below 6,000 meters. It is totally dark and has very low biomass and very low species diversity.

### Questions

1. Describe a neritic biome.

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2. Why do oceanic biomes generally have a lower density of organisms than neritic biomes?

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3. Why are most open ocean organisms found in the epipelagic zone?

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4. Name three oceanic biomes that are located in the aphotic zone.

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5. What types of organisms are found in aphotic ocean biomes?

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## Lesson 16.3: Multiple Choice

**Name**________________________________ **Class**____________ **Date**________

*Circle the letter of the correct choice.*

1. Deep ocean water may contain more nutrients than surface water due to
   (a) decomposition of marine organisms.
   (b) photosynthesis by photic organisms.
   (c) runoff from nearby land.
   (d) turnover of deep ocean water.
2. Plankton consists of
   (a) algae.
   (b) bacteria.
   (c) animals.
   (d) all of the above.
3. In ocean zones deeper than 200 meters, most organisms are

(a) consumers.
(b) producers.
(c) phytoplankton.
(d) zooplankton.

4. How do organisms in the hadal zone of the ocean make food?
   (a) photosynthesis
   (b) chemosynthesis
   (c) decomposition
   (d) predation
5. Based on the availability of sunlight, lakes are divided into the littoral zone, limnetic zone, profundal zone, and
   (a) intertidal zone.
   (b) benthic zone.
   (c) pelagic zone.
   (d) epipelagic zone.
6. Compared with lakes that have low nutrient levels, lakes that have high nutrient levels have
   (a) higher productivity.
   (b) clearer water.
   (c) lower biodiversity.
   (d) more dissolved oxygen.
7. Any area that is saturated or covered by water for a least one season of the year is classified as a
   (a) wetland.
   (b) riparian zone.
   (c) littoral zone.
   (d) coral reef.

## Lesson 16.3: Vocabulary

**Name**________________________________ **Class**____________ **Date**________

*Match the vocabulary term with the correct definition.*

**Term**

______ 1. abyssal zone

______ 2. aphotic zone

______ 3. bathyal zone

______ 4. benthic zone

______ 5. hadal zone

______ 6. intertidal zone

______ 7. littoral zone

______ 8. mesopelagic zone

______ 9. neritic zone

______ 10. riparian zone

**Definition**

a. part of the ocean floor that makes up the continental slope

b. narrow strip along the coastline of the ocean that is exposed to air at low tide

c. part of the ocean floor that is under the deep ocean

d. part of the pelagic zone over the continental shelf

e. bottom surface of the ocean or a lake

f. water between 200 and 1,000 meters below sea level in the oceanic zone

g. interface between running freshwater and land

h. deep water where too little sunlight penetrates for photosynthesis to occur

i. part of the ocean floor that is in deep ocean trenches

j. shallow water near the shore of a lake or the ocean

## 16.5 Lesson 16.4: Community Interactions

### Lesson 16.4: True or False

**Name**________________________________ **Class**____________ **Date**________

*Write true if the statement is true and false if the statement is false.*

_________ 1. Species interact in the same basic ways in all biomes.

_________ 2. Types of community interactions include symbiosis.

_________ 3. Predation always involves one animal consuming another animal.

_________ 4. If the population of a prey species increases, the population of its predator is likely to decrease.

_________ 5. Some prey species have adaptations that make them more visible to predators.

_________ 6. Interspecific competition always leads to the extinction of one of the species.

_________ 7. Predation is an example of a symbiotic relationship.

_________ 8. A mosquito and the animal from which it takes blood have a mutualistic relationship.

_________ 9. Many plants and fungi are parasitic during some stages of their life cycle.

_________ 10. The species that is harmed in a parasitic relationship is called the host.

_________ 11. Most ecosystems are stable and unchanging.

_________ 12. Primary succession usually occurs faster than secondary succession.

## Lesson 16.4: Critical Reading

**Name**________________________________ **Class**____________ **Date**________

*Read this passage from the lesson and answer the questions that follow.*

**Symbiotic Relationships**

**Symbiosis** is a close association between two species in which at least one species benefits. For the other species, the outcome of the association may be positive, negative, or neutral. There are three basic types of symbiotic relationships: mutualism, commensalism, and parasitism. The rest of this passage describes mutualism and commensalism.

**Mutualism**

**Mutualism** is a symbiotic relationship in which both species benefit. Lichen is a good example. A lichen is not a single organism but a fungus and an alga. The fungus absorbs water from air and minerals from rock or soil. The alga uses the water and minerals to make food for itself and the fungus. Another example involves goby fish and shrimp. The nearly blind shrimp and the fish spend most of their time together. The shrimp maintains a burrow in the sand in which both the goby and the shrimp live. When a predator comes near, the fish touches the shrimp with its tail as a warning. Then, both fish and shrimp retreat to the burrow until the predator is gone. Each gains from this mutualistic relationship: the shrimp gets a warning of approaching danger, and the fish gets a safe home and a place to lay its eggs. Co-evolution often occurs in species involved in mutualistic relationships. Many examples are provided by flowering plants and the species that pollinate them. Plants have evolved flowers with traits that promote pollination by particular species. Pollinator species, in turn, have evolved traits that help them obtain pollen or nectar from certain species of flowers. For example, some plants with tube-shaped flowers co-evolved with hummingbirds. The birds evolved long, narrow beaks that allowed them to sip nectar from the tubular blooms.

**Commensalism**

**Commensalism** is a symbiotic relationship in which one species benefits while the other species is not affected. In commensalism, one animal typically uses another for a purpose other than food. For example, mites attach themselves to larger flying insects to get a "free ride," and hermit crabs use the shells of dead snails for shelter. Co-evolution explains some commensal relationships. An example is the human species and some of the species of bacteria that live inside humans. Through natural selection, many species of bacteria have evolved the ability to live inside the human body without harming it.

**Questions**

1. Define symbiosis, and name types of symbiotic relationships.

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2. Explain why lichen is an example of mutualism.

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3. Describe an example of co-evolution in a mutualistic relationship.

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4. How is commensalism different from mutualism?

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5. Describe an example of commensalism involving humans.

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## Lesson 16.4: Multiple Choice

**Name**______________________________ **Class**___________ **Date**________

*Circle the letter of the correct choice.*

1. The focus of species interactions is the
   (a) biome.
   (b) climate zone.
   (c) community.
   (d) individual.
2. Camouflage is an adaptation to predation that occurs in
   (a) prey species only.
   (b) predator species only.
   (c) both prey and predator species.
   (d) animal species only.
3. Which sentence is true about all symbiotic relationships?
   (a) Both species always benefit.
   (b) At least one species always benefits.
   (c) One species is always harmed.
   (d) Neither species is ever harmed.
4. A hermit crab uses the shell of a dead snail for shelter. This is an example of a
   (a) mutualistic relationship.
   (b) commensal relationship.
   (c) predator-pray relationship.
   (d) parasite-host relationship.
5. Whole communities change through time in the process of ecological
   (a) symbiosis.
   (b) succession.
   (c) competition.
   (d) evolution.
6. Secondary succession occurs where
   (a) the soil is already in place.
   (b) organisms have never lived.
   (c) there is nothing but bare rock.
   (d) lava has hardened into rock.
7. The final stage of ecological succession is called a(n)
   (a) successional community.
   (b) secondary community.
   (c) pioneer community.
   (d) climax community.

## Lesson 16.4: Vocabulary

**Name**________________________________ **Class**____________ **Date**________

*Match the vocabulary term with the correct definition.*

**Term**

______ 1. commensalism

______ 2. competition

______ 3. intraspecific competition

______ 4. interspecific competition

______ 5. mutualism

______ 6. parasitism

______ 7. predation

______ 8. primary succession

______ 9. secondary succession

______ 10. symbiosis

**Definition**

a. relationship between organisms that strive for the same limited resources

b. ecological succession that occurs in an area that has never been colonized

c. symbiotic relationship in which one species benefits and one species is harmed

d. symbiotic relationship in which one species benefits and one species is not affected

e. competition between members of the same species

f. any close association between two species in which at least one species benefits

g. ecological succession that occurs in a formerly inhabited area that was disturbed

h. symbiotic relationship in which both species benefit

i. relationship in which members of one species consume members of another species

j. competition between members of different species

# Chapter 17

# Biomes, Ecosystems, and Communities Worksheets

## 17.1 Chapter 17: Populations

- Lesson 17.1: Characteristics of Populations
- Lesson 17.2: Population Dynamics
- Lesson 17.3: Human Population Growth: Doomsday, Cornucopia, or Somewhere in Between?

## 17.2 Lesson 17.1: Characteristics of Populations

### Lesson 17.1: True or False

**Name**_________________________________ **Class**____________ **Date**________

*Write true if the statement is true or false if the statement is false.*

_________ 1. Humans first started worrying about overpopulation in the 1960s.

_________ 2. A Malthusian crisis refers to a population outgrowing its food supply.

_________ 3. Everyone agrees that human overpopulation is a serious problem.

_________ 4. Garrett Hardin argued that people can solve all their population problems.

_________ 5. Members of the same population may belong to different species.

_________ 6. Population Viability Analysis predicts the probability of extinction.

_________ 7. Almost all populations have a uniform pattern of dispersion.

_________ 8. A clumped dispersion pattern is typical of a highly competitive species.

_________ 9. Populations whose individuals do not interact often have random dispersion.

_________ 10. A later age of reproduction results in a slower growing population.

_________ 11. A growing population usually has many more adults than young people.

_________ 12. With an early loss pattern of survivorship, most individuals live to old age.

## Lesson 17.1: Critical Reading

**Name**_______________________________ **Class**___________ **Date**________

*Read this passage from the lesson and answer the questions that follow.*

**Introduction**

What exactly is the "population problem"? How can it be solved? To most people, the population problem is too many people, or a human population that is growing too fast. Humans have shown concern for overpopulation for thousands of years. Here are just a few examples:

- The ancient Greeks built outposts for their expanding population. They also delayed the age of marriage for men to 30 years to slow down population growth.
- In 1798, the economist Thomas Malthus predicted that the human population would outgrow its food supply by the middle of the $19^{th}$ century. That time arrived without this crisis occurring, but Charles Darwin nevertheless embraced Malthus' ideas and made them a foundation of his own theory of evolution by natural selection.
- In a 1968 essay in the journal Science, titled "The Tragedy of the Commons," the ecologist Garrett Hardin argued that humans should "relinquish their freedom to breed... [because] the population problem has no technical solution... [but] requires a fundamental extension in morality."
- In 1979, the government of China instituted a "birth planning" policy. It charged fines to families with more than one child.

Not everyone has been concerned about overpopulation. In fact, others have taken the opposite view, that bigger is better when it comes to the human population. For example, Julian Simon, a business professor, argued that population is "the ultimate resource." He also believed that people and markets would find solutions for any problems caused by overpopulation. A group known as cornucopians continues to promote a similar view. They believe that a big population is good thing, not a problem.

Would you support a law forbidding you to marry until a certain age? Do you know how such a law would affect population growth? Would you limit the size of all families to one child? Or do you believe families should welcome as many children as possible? Should these decisions be regulated by law, or by individual choice? These and similar questions about population show that the "population problem" reaches beyond biology to economics, law, morality, and religion. Nonetheless, understanding the biology of populations can shed light on the human population problem.

**Questions**

1. What does the "population problem" usually refer to?

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2. Describe two ways the ancient Greeks tried to control their population.

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3. What prediction did Thomas Malthus make about the human population?

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4. What view of population did Garrett Hardin put forth in his article "The Tragedy of the Commons"?

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5. Why is the "population problem" not just a biological issue? Give examples to illustrate your answer.

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## Lesson 17.1: Multiple Choice

**Name**_______________________________ **Class**____________ **Date**_________

*Circle the letter of the correct choice.*

1. Charles Darwin was influenced by the population ideas of
   (a) Paul Ehrlich.
   (b) Julian Simon.
   (c) Garrett Hardin.
   (d) Thomas Malthus.
2. A gene pool reflects the interaction between the environment and a(n)
   (a) species.
   (b) ecosystem.
   (c) population.
   (d) community.
3. If the number of organisms in a species falls bellow its MVP, then the species is likely to
   (a) go extinct.
   (b) be healthy.
   (c) grow rapidly.
   (d) become overpopulated.
4. The pattern of population dispersion in which organisms are evenly spaced is referred to as
   (a) random.
   (b) uniform.
   (c) clumped.
   (d) clustered.
5. If a population has roughly equal proportions at each age, then the population's size is likely to be
   (a) stable.
   (b) doubling.
   (c) increasing.
   (d) decreasing.
6. When the death rate of a population is high, life expectancy is generally
   (a) long.
   (b) short.
   (c) rising.
   (d) none of the above.
7. A species in which most individuals live to old age typically has a(n)
   (a) high birth rate.
   (b) high death rate.

(c) early loss pattern.
(d) high level of parental care.

## Lesson 17.1: Vocabulary

**Name**_____________________________ **Class**__________ **Date**_______

*Match the vocabulary term with the correct definition.*

**Term**

_____ 1. age at maturity

_____ 2. age-sex structure

_____ 3. birth rate

_____ 4. death rate

_____ 5. dispersion

_____ 6. life expectancy

_____ 7. minimum viable population

_____ 8. overpopulation

_____ 9. population density

_____ 10. survivorship curve

**Definition**

a. number of deaths in a population per unit time

b. average survival time of individuals in a population

c. condition in which population size exceeds carrying capacity

d. smallest number of individuals needed for a species to avoid extinction

e. proportions of males and females across all age levels of a population

f. graph of the number of individuals still living at each age

g. number of organisms per unit area or volume

h. age at which individuals become able to reproduce

i. pattern of spacing of individuals within a population

j. number of births in a population per unit time

## 17.3 Lesson 17.2: Population Dynamics

### Lesson 17.2: True or False

**Name**________________________________ **Class**___________ **Date**________

*Write true if the statement is true or false if the statement is false.*

_________ 1. Few populations are capable of geometric growth.

_________ 2. Exponential growth is slow at first and then speeds up.

_________ 3. Dispersal helps to reduce intraspecific competition.

_________ 4. Ducks use a precocial strategy to ensure reproductive success.

_________ 5. Populations change only through births and deaths.

_________ 6. Introductions involve non-native species moving into an area.

_________ 7. Exponential growth occurs at the beginning of an S-shaped growth model.

_________ 8. Limiting factors increase population growth rates.

_________ 9. Light may be a density-dependent limiting factor.

_________ 10. DDT was a density-dependent factor for peregrine falcons.

_________ 11. J-curves depict the pattern of logistic population growth.

_________ 12. K-selected species are regulated by density-independent factors.

### Lesson 17.2: Critical Reading

**Name**________________________________ **Class**___________ **Date**________

*Read this passage from the lesson and answer the questions that follow.*

**Births and Deaths: Balancing Costs of Reproduction and Survival**

The growth rate of a population is the change in population size per member of the population per unit of time. The symbol r denotes growth rate. The growth rate clearly depends on the birth rate, represented by b, which is the number of births per individual in the population over a given unit of time. The growth rate also depends on the death rate, represented by d, which is the number of deaths per individual over a given unit of time. Growth rate can be calculated with this formula:

$r = b - d$

If the birth rate is greater than the death rate, r is positive and the population grows. If the death rate is greater than the birth rate, r is negative and the population declines. If the birth rate and death rate are the same, the growth rate is zero, and the size of the population stays the same.

Mere survival does not spell success in the game of life. Natural selection requires that survivors also reproduce. Individuals in a species must make trade-offs between their own survival and their ability to successfully reproduce. However, species vary in the strategies they use to achieve reproductive success. There are two extreme strategies: precocial and altricial.

The precocial strategy is to have as many offspring as possible but to provide little parental care. The offspring are relatively mature at birth or hatching. Geese, ducks, and chickens use this strategy. Often living and nesting on the ground, precocial species are subject to high predation rates, so few offspring survive long enough to reproduce. Those who do reproduce lay many eggs at once, and the eggs are large. When the chicks hatch, they are already developed enough to find food and escape from predators.

The altricial strategy is to have few offspring but to provide a lot of parental care. The offspring are relatively immature at birth. Robins and hummingbirds use this strategy. These birds hatch helpless and naked, completely unprepared for independent life. Survival of the offspring matters a great deal, because there are so few of them, so parents build elaborate nests safely hidden in trees and invest a great deal of energy finding food for the young until they have developed enough to fly and find food on their own.

**Questions**

1. How is population growth rate calculated from birth and death rates?

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2. Explain the relationship between birth and death rates and population growth.

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3. What is the precocial strategy? Name a species that uses this strategy.

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4. Describe the altricial strategy. What is one species that uses this strategy?

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5. What are examples of parenting behaviors in altricial bird species?

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## Lesson 17.2: Multiple Choice

**Name**______________________________ **Class**___________ **Date**________

*Circle the letter of the correct choice.*

1. Change in a population's size over a unit of time, such as a year, is the population's
   (a) birth rate.
   (b) growth rate.
   (c) migration rate.
   (d) carrying capacity.
2. Birds with a precocial reproductive strategy have
   (a) large numbers of eggs.
   (b) eggs that are small in size.
   (c) high levels of parental care.
   (d) low rates of predation on chicks.
3. Which of these choices is an example of dispersal?
   (a) A seed blows away from the parent plant.
   (b) A flock of robins flies south for the winter.
   (c) An arctic owl wanders south to find prey.
   (d) An insect species gradually extends its range.
4. When animals such as gray whales migrate, it can affect
   (a) the population growth rate.
   (b) the death rate.
   (c) the birth rate.
   (d) all of the above.
5. The size of a population when it reaches its plateau in the logistic model is called the
   (a) limiting factor.

(b) population density.
(c) carrying capacity.
(d) K-selection.

6. Examples of density-dependent limiting factors include
   (a) wastes.
   (b) pesticides.
   (c) herbicides.
   (d) habitat destruction.

7. Which statement is typically true of r-selected species?
   (a) They are regulated by density-dependent factors.
   (b) They have long average life expectancy.
   (c) They have unstable environments.
   (d) They are large organisms.

## Lesson 17.2: Vocabulary

**Name**________________________________ **Class**____________ **Date**________

*Match the vocabulary term with the correct definition.*

**Term**

______ 1. altricial

______ 2. colonization

______ 3. dispersal

______ 4. emigration

______ 5. immigration

______ 6. irruption

______ 7. migration

______ 8. nomadism

______ 9. precocial

______ 10. range expansion

**Definition**

a. movement of offspring away from parents

b. movement of individuals into a population's range from other areas

c. regular, wide-ranging wandering to compensate for fluctuating food supplies

d. direct, often seasonal movement of a species or population

e. relating to the situation in which the young are relatively mature and mobile from the moment of birth or hatching

f. movement of a population into a newly created or newly found area

g. gradual extension of a population beyond its original boundaries

h. irregular population movements, often caused by food source failures

i. relating to the situation in which the young cannot move around on their own soon after birth or hatching

j. movement of individuals out of a population's range

## 17.4 Lesson 17.3: Human Population Growth: Doomsday, Cornucopia, or Somewhere in Between?

### Lesson 17.3: True or False

**Name**_______________________________ **Class**___________ **Date**________

*Write true if the statement is true and false if the statement is false.*

_________ 1. All populations have the capacity to grow infinitely large.

_________ 2. Different human populations have different growth rates today.

_________ 3. Humans first invented agriculture about 1000 years ago.

_________ 4. The development of agriculture lowered the carrying capacity for humans.

_________ 5. By 1804, the world's human population reached one million.

_________ 6. No country today remains in stage 1 of the demographic transition.

_________ 7. Replacement fertility is lower if there are more males than females.

_________ 8. The U.S. population has reached stage 5 of the demographic transition.

_________ 9. The growth of the total human population has started to slow down.

_________ 10. Modern agriculture depends heavily on the use of fossil fuels.

_________ 11. All scientists agree that humans have surpassed their carrying capacity.

_________ 12. The U.S. population has the world's smallest ecological footprint.

## Lesson 17.3: Critical Reading

**Name**______________________________ **Class**___________ **Date**________

*Read this passage from the lesson and answer the questions that follow.*

**Demographic Transition**

Major changes in human population growth began during the $18^{th}$ century in Europe. First, agricultural improvements led to a major increase in food supplies. As a result, death rates due to starvation declined. Improvements in sanitation and personal hygiene lowered death rates even more. In the $19^{th}$ century, the industrial revolution led to the development of new energy sources, such as coal and electricity. The new sources of energy further increased the efficiency of agriculture and food production. They also promoted the development of new forms of transportation, which improved the distribution of food. All of these changes led to a continued decline in death rates.

As death rates fell, more children survived to reproduce. As a result, birth rates remained high. The gap between birth and death rates widened. This caused population growth rates to increase. Although these changes did not happen uniformly throughout the world, they were soon reflected in world population levels. It took 200,000 years for the human population to grow to 1 billion, but only 123 years to grow to 2 billion!

Demographic transition theory holds that all or most human populations pass through the same four stages of growth as the populations of Europe since the $18^{th}$ century.

- Stage 1 is characterized by slow, uneven growth maintained by high rates of birth and death. Most human populations were at this stage up until the $18^{th}$ century.
- Stage 2 is characterized by a lower death rate but not a lower birth rate, so the rate of population growth is high.
- Stage 3 is characterized by a decline in the birth rate, bringing it closer to the already low death rate. The birth rate falls because of a variety of technological and social changes. As a result, the population growth rate slows.
- Stage 4 is characterized by birth rates that decline even more until they equal death rates. The population growth rate falls to zero.

Overall, the world's human population is currently at about stage 2 of the demographic transition. However, many countries have populations that are in stage 3 or 4 of the demographic transition.

**Questions**

1. What are some reasons that death rates declined in Europe during the $18^{th}$ and $19^{th}$ centuries?

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2. Why did the human population grow from 1 to 2 billion in just 123 years when it took 200,000 years for it to grow to 1 billion?

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3. What is demographic transition theory?

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4. Briefly describe the four stages of the demographic transition.

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5. Rate the human population today in terms of its progression through the demographic transition.

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## Lesson 17.3: Multiple Choice

**Name**______________________________ **Class**___________ **Date**________

*Circle the letter of the correct choice.*

1. Stable environments favor adaptations for
   (a) low carrying capacity.
   (b) efficient resource use.
   (c) r-selected growth.
   (d) high birth rates.
2. In 18th century Europe, death rates fell because of

(a) farming improvements.
(b) safer water supplies.
(c) personal hygiene.
(d) all of the above.

3. Soon after the start of the demographic transition in Europe, the rate of population growth

    (a) increased.
    (b) decreased.
    (c) fell to zero.
    (d) stayed the same.

4. According to demographic transition theory, in which stage do birth rates decline?

    (a) stage 1
    (b) stage 2
    (c) stage 3
    (d) stage 4

5. Reasons for the decline in birth rates during Europe's demographic transition included

    (a) compulsory education.
    (b) high child mortality.
    (c) early marriage.
    (d) all of the above.

6. A population in the second stage of the demographic transition has a population pyramid with

    (a) a wide base.
    (b) straight sides.
    (c) a narrow base.
    (d) a bulge in the middle.

7. If a population has a negative growth rate, its population pyramid is

    (a) top heavy.
    (b) broad based.
    (c) bottom heavy.
    (d) none of the above.

## Lesson 17.3: Vocabulary

**Name**______________________________ **Class**___________ **Date**________

*Match the vocabulary term with the correct definition.*

**Term**

______ 1. carrying capacity

______ 2. cornucopian

______ 3. demographic transition theory

______ 4. density-dependent factor

______ 5. density-independent factor

______ 6. ecological footprint

______ 7. exponential model

______ 8. logistic model

______ 9. neo-Malthusian

______ 10. replacement fertility

**Definition**

a. model in which the population growth rate increases as population size increases

b. person who believes humans will find solutions to any overpopulation problems

c. factor that has the potential to control population because its effects are proportional to population density

d. number of births per female required to maintain current population levels

e. people who believe that human population growth cannot continue without dire consequences

f. maximum population size an environment can support without habitat degradation

g. model in which the population growth rate slows as the population reaches the carrying capacity

h. amount of land area needed to sustain a particular lifestyle

i. factor that may affect population size or density but cannot control it

j. theory that human populations pass through predictable stages of growth

# Chapter 18

# Ecology and Human Actions Worksheets

## 18.1 Chapter 18: Ecology and Human Actions

- Lesson 18.1: The Biodiversity Crisis
- Lesson 18.2: Natural Resources
- Lesson 18.3: Natural Resources II: The Atmosphere
- Lesson 18.4: Climate Change

## 18.2 Lesson 18.1: The Biodiversity Crisis

### Lesson 18.1: True or False

**Name**________________________________ **Class**___________ **Date**________

*Write true if the statement is true or false if the statement is false.*

_________ 1. Scientists estimate that fewer than 1 million species currently live on Earth.

_________ 2. There are fewer species alive today than there were millions of years ago.

_________ 3. There is a general increase in biodiversity from the equator to the poles.

_________ 4. Over 99 percent of all species that have ever lived on Earth are extinct.

_________ 5. The first species ever to go extinct because of human actions was the dodo.

_________ 6. Monocultures provide the greatest genetic variety for hybridization.

_________ 7. The largest cause of deforestation today is road construction.

_________ 8. Alien species often lack natural enemies in their new habitats.

_________ 9. Eating high on the food chain allows a given area to support more people.

_________ 10. Growing crops organically is better for the environment.

_________ 11. Incandescent light bulbs are more energy efficient than fluorescent bulbs.

_________ 12. You should properly dispose of old computers because they contain toxins.

## Lesson 18.1: Critical Reading

**Name**_____________________________ **Class**__________ **Date**________

*Read this passage from the lesson and answer the questions that follow.*

**Biodiversity Patterns in Time**

How has Earth's biodiversity changed over time? The fossil record is our window into the past. Coupled with gene studies, fossils show a distinct pattern of increasing biodiversity through time.

Evidence suggests that life did not appear on Earth until perhaps 4 billion years ago. For several billion years, unicellular organisms were the only form of life. During that time, biodiversity clearly increased. Eubacteria and Archaebacteria emerged from a common ancestor some 3 billion years ago. Eukaryotes emerged by endosymbiosis about 2 billion years ago.

The emergence of multicellular life about 1 billion years ago certainly increased biodiversity, although we have little way of knowing whether it might also have negatively affected the diversity of microorganisms. Fossils remain relatively rare until the Cambrian explosion 542 million years ago. Since then, a much more detailed fossil record shows a pattern of increasing biodiversity marked by major extinctions.

The fossil record suggests a dramatic increase in biodiversity over the last 200 million years. Most scientists think this increase in biodiversity was real and due to an expanding numbers of niches. However, some scientists think that it is a product of sampling bias. More recent fossils and rock layers are better preserved, they argue, so it only appears that there is greater biodiversity in recent periods than in the more distant past.

Most scientists also accept that there were at least five major mass extinctions. Some think that there may be regular cycles of extinction. Causes for these extinctions are not completely understood. Hypotheses include global climate change, major volcanic eruptions, continental drift, dramatic oceanic change, extraterrestrial impacts, and supernova events.

Increasingly accepted is a current sixth, or Holocene, extinction event. In a 1998 survey, more than 70% of biologists considered the present era to be a sixth mass extinction event. It may also be the extinction event in which extinctions are occurring faster than at any time in the past.

**Questions**

1. What general trend in biodiversity do fossils show for the entire history of life on Earth? What trend do they show over just the last 200 million years?

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2. How might the emergence of multicellular life have affected the diversity of microorganisms on Earth?

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3. Some scientists think that sampling bias may account for the increase in biodiversity in recent periods of Earth's history. Explain why.

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4. What hypotheses have been suggested for why the first five mass extinctions occurred?

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5. What is the sixth extinction event? What rate of extinction is associated with this event?

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## Lesson 18.1: Multiple Choice

**Name**______________________________ **Class**___________ **Date**________

*Circle the letter of the correct choice.*

1. The statement "diversity begets diversity" is true because more species lead to more
   (a) ecosystems.
   (b) kingdoms.

(c) biomes.
(d) niches.

2. Estimates of biodiversity for early in Earth's history may be too low because the earliest organisms were
   (a) less likely to be preserved as fossils.
   (b) more likely to live on land.
   (c) less likely to evolve.
   (d) all of the above.
3. Organisms that help decompose wastes include
   (a) fungi.
   (b) protists.
   (c) scavengers.
   (d) all of the above.
4. The major reason for habitat loss is
   (a) using land for agriculture.
   (b) hunting wild animals.
   (c) building new homes.
   (d) spreading diseases.
5. What is one reason that the burning of tropical rain forests contributes to global warming?
   (a) It uses up carbon dioxide.
   (b) It reduces photosynthesis.
   (c) It increases UV radiation.
   (d) It destroys the ozone layer.
6. Why should you avoid using plastic bags?
   (a) They cannot be re-used.
   (b) They cannot be recycled.
   (c) They are made from fossil fuels.
   (d) They do not hold as much as paper bags.
7. When you buy a car, your number one priority in terms of helping the environment should be to buy a(n)
   (a) used car.
   (b) small car.
   (c) American car.
   (d) fuel efficient car.

## Lesson 18.1: Vocabulary

**Name**______________________________ **Class**___________ **Date**________

*Match the vocabulary term with the correct definition.*

**Term**

______ 1. biodiversity hotspot

______ 2. biodiversity

______ 3. endemic species

______ 4. epiphyte

______ 5. extirpation

______ 6. genetic diversity

______ 7. genetic pollution

______ 8. keystone species

______ 9. exotic species

______ 10. species diversity

**Definition**

a. plant that grows on top of another plant

b. elimination of a species from a particular region of its range

c. number of different species in an ecosystem or on Earth

d. mixing of genes of a wild population with a domestic or feral population

e. unique species found only in a certain area and nowhere else

f. region that has lost at least 70 percent of its original habitat but contains at least 1500 endemic species of vascular plants

g. species with an importance to ecosystem diversity and stability that outweighs its numbers or mass

h. variation among individuals and populations within a species

i. variation in life at all levels of organization, from genes to ecosystems

j. non-native species that is introduced to a completely new ecosystem

## 18.3 Lesson 18.2: Natural Resources

### Lesson 18.2: True or Flase

**Name**______________________________ **Class**___________ **Date**________

*Write true if the statement is true or false if the statement is false.*

_________ 1. The formation of soils may require millions of years.

_________ 2. The only way people use soils is for agriculture.

_________ 3. The acidification of soil generally increases its productivity.

_________ 4. Contour plowing is one way to prevent soil erosion.

_________ 5. Paving over land can degrade streams and rivers.

_________ 6. A wetland is any area that is permanently covered with water.

_________ 7. Most wetlands have very high biodiversity.

_________ 8. Most of Earth's water is in the form of water vapor in the atmosphere.

_________ 9. Adding nutrients to aquatic ecosystems is a good way to increase their biodiversity.

_________ 10. It takes less water to produce 1 kg of wheat than 1 kg of beef.

_________ 11. One way to reduce water use is to landscape with native plants.

_________ 12. Gray water is water that comes from deep under Earth's surface.

### Lesson 18.2: Critical Reading

**Name**______________________________ **Class**___________ **Date**________

*Read this passage from the lesson and answer the questions that follow.*

**Renewable and Nonrenewable Resources**

A resource replenished by natural processes at a rate roughly equal to the rate at which humans consume it is a renewable resource. Sunlight and wind, for example, are in no danger of being used in excess of their long-term availability. Hydropower is renewed by the Earth's hydrologic cycle. Water has also been considered renewable, but overpumping of groundwater is depleting aquifers, and pollution threatens the use of many water resources, showing that the consequences of resource use are not always simple depletion. Soils are often considered renewable, but erosion and depletion of minerals proves otherwise.

Living things (forests and fish, for example) are considered renewable because they can reproduce to replace individuals lost to human consumption. This is true only up to a point, however. Overexploitation can lead to extinction, and overharvesting can remove nutrients so that soil fertility does not allow forest renewal. Energy resources derived from living things—such as ethanol, plant oils, and methane—are considered renewable, although their costs to the environment are not always adequately considered. Renewable materials include sustainably harvested wood, cork, and bamboo, as well as sustainably harvested crops. Metals and other minerals are sometimes considered renewable because they are not destroyed when they are used and can be recycled.

A nonrenewable resource is not regenerated or restored on a time scale comparable to its consumption. Nonrenewable resources exist in fixed amounts (at least relative to our time frame) and can be used up. The classic examples are fossil fuels such as petroleum, coal, and natural gas. Fossil fuels have formed from remains of plants (for coal) and plankton (for oil) over periods of 50 to 350 million years. Many tons of plankton are required to produce just 1 liter of gasoline! We have been consuming fossil fuels for less than 200 years, yet even the most optimistic estimates suggest that remaining reserves can supply our needs for just a few decades or centuries at most.

Nuclear power is considered a nonrenewable resource because uranium fuel supplies are finite. Some estimates suggest that known supplies could last 70 years at current rates of use, although unknown reserves are probably much larger, and new technologies could make some reserves more useful.

**Questions**

1. What is a renewable resource? Give three examples.

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2. Define the term nonrenewable resource. What are three nonrenewable resources?

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3. Living things are considered renewable because they can reproduce. Why is this true only up to a point?

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4. Metals and other minerals are finite; more of them cannot be produced. Why are they

sometimes considered renewable?

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5. Some people consider nuclear power to be a renewable resource because it is an alternative to fossils fuels. Explain why nuclear power is actually nonrenewable.

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## Lesson 18.2: Multiple Choice

**Name**________________________________ **Class**____________ **Date**________

*Circle the letter of the correct choice.*

1. “Something supplied by nature that supports life” is the definition of a
   (a) natural resource.
   (b) renewable resource.
   (c) nonrenewable resource.
   (d) renewable energy source.
2. Use of a resource in a way that conserves it for future generations is called
   (a) virtual use.
   (b) secondary use.
   (c) sustainable use.
   (d) anthropogenic use.
3. Practices that contribute to soil erosion include
   (a) overgrazing.
   (b) strip farming.
   (c) no-till farming.
   (d) all of the above.
4. One result of deforestation is a decrease in
   (a) soil erosion.
   (b) photosynthesis.
   (c) carbon dioxide.
   (d) global warming.

5. Draining wetlands is most likely to cause an increase in
   (a) flooding.
   (b) water storage.
   (c) sedimentation.
   (d) denitrification.
6. An algal bloom indicates that a body of water
   (a) is a dead zone.
   (b) has excessive nutrients.
   (c) is being used sustainably.
   (d) is a healthy aquatic ecosystem.
7. What causes eutrophication?
   (a) runoff from agricultural lands
   (b) overexploitation of fish
   (c) use of virtual water
   (d) none of the above

## Lesson 18.2: Vocabulary

**Name**______________________________ **Class**___________ **Date**________

*Match the vocabulary term with the correct definition.*

**Term**

______ 1. anthropogenic source

______ 2. dead zone

______ 3. desertification

______ 4. eutrophication

______ 5. biological magnification

______ 6. nonpoint source pollution

______ 7. point source pollution

______ 8. primary pollutant

______ 9. secondary pollutant

______ 10. salination

**Definition**

a. degradation of formerly productive dry land

b. process in which synthetic chemicals concentrate as they move up a food chain

c. source of pollution related to human activities

d. single-site source of pollutants, such as from a sewer overflow

e. substance formed when pollutants interact with sunlight, air, or each other

f. increase in nutrient levels in a body of water

g. substance released directly into air by a process such as the burning of fossil fuel

h. addition of salts to soils, often by irrigation

i. runoff of pollutants from land, such as agricultural or developed land

j. region of a lake or the ocean where life can no longer survive due to eutrophication

## 18.4 Lesson 18.3: Natural Resources II: The Atmosphere

### Lesson 18.3: True or Flase

**Name**______________________________ **Class**___________ **Date**________

*Write true if the statement is true or false if the statement is false.*

_________ 1. Acid rain is an example of a secondary pollutant.

_________ 2. Pesticides are major sources of mercury pollution.

_________ 3. Smog causes respiratory problems and eye irritation.

_________ 4. Global dimming has worsened steadily since 1990.

_________ 5. Aerosol pollution may lower ocean temperatures.

_________ 6. Acid rain is no longer a problem once it falls to Earth.

_________ 7. Coal burning is the primary source of sulfur oxides.

_________ 8. Areas with colder climates are less affected by acid rain.

_________ 9. Air pollution adds harmful ozone to the stratosphere.

_________ 10. The ozone layer is thicker near the equator than at the poles.

_________ 11. Ozone depleting pollutants include carbon monoxide and asbestos.

_________ 12. The hole in the ozone layer is the major cause of global warming.

## Lesson 18.3: Critical Reading

**Name**______________________________ **Class**___________ **Date**________

*Read this passage from the lesson and answer the questions that follow.*

**Upsetting the Equilibrium of the Atmosphere: Air Pollution**

Despite the atmosphere's apparent vastness, human activities have significantly altered its equilibrium in ways that threaten its services for life. Chemical substances, particulate matter, and even biological materials cause air pollution if they modify the natural characteristics of the atmosphere. Primary pollutants are directly added to the atmosphere by processes such as fires and burning of fossil fuels. Examples of primary pollutants include sulfur oxides and nitrogen oxides, both of which contribute to acid rain. Secondary pollutants form when primary pollutants interact with sunlight, air, or each other. Examples of secondary pollutants include chlorine and bromine, both of which threaten the ozone layer.

What causes air pollution? The majority of air pollutants can be traced to the burning of fossil fuels or other materials. We burn fossil fuels in power plants to generate electricity; in factories to power machinery; in stoves and furnaces for heat; and in airplanes, ships, trains, and motor vehicles for transportation. Pollutants are also released when waste is burned in waste facilities. In addition, we burn wood for heat and burn vegetation for agriculture and land management. Besides burning, there are many other anthropogenic (human-caused) sources of air pollution. For example, methane and ammonia are produced by agricultural practices, and both contribute to global warming.

What are the effects of air pollution? In 2002, the World Health Organization estimated that 2.4 million people die each year as a consequence of air pollution—more than are killed in automobile accidents. Respiratory and cardiovascular problems are the most common health effects of air pollution. Accidents that release airborne poisons (such as the accident at the Chernobyl nuclear plant) have also killed many people—and undoubtedly other animals. In addition, air pollution affects entire ecosystems worldwide by causing acid rain, ozone depletion, and global warming.

Particulates and aerosols (airborne solid particles or liquid droplets) are unique types of pollutants. They pollute only air, not soils or water. Among other problems, these two types of pollutants cause global dimming. This is a reduction in the amount of solar radiation reaching Earth's surface. It occurs because particulates and aerosols absorb solar energy and reflect sunlight back into space. As a result, there is less sunlight for photosynthesis, less food at all trophic levels, and less energy to drive the water cycle. Other effects of global dimming include cooler oceans and less rainfall, which may lead to droughts, less plant growth, and famines.

**Questions**

1. What is air pollution?

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2. Compare and contrast primary and secondary pollutants.

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3. List several causes of air pollution.

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4. What are some of the effects of air pollution?

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5. Some types of air pollution cause global dimming. How can this affect ecosystems?

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## Lesson 18.3: Multiple Choice

**Name**_______________________________ **Class**___________ **Date**________

*Circle the letter of the correct choice.*

1. Secondary pollutants form when primary pollutants interact with
   (a) air.
   (b) sunlight.
   (c) each other.
   (d) all of the above.
2. The majority of air pollutants can be traced to the
   (a) burning of fossil fuels.

(b) eruption of volcanoes.
(c) use of fertilizers.
(d) erosion of soil.

3. Light pollution may have harmful effects on
   (a) human health.
   (b) animal behavior.
   (c) animal navigation.
   (d) all of the above.
4. Natural precipitation is slightly acidic because a weak acid forms when water in the atmosphere combines with
   (a) ozone.
   (b) aerosols.
   (c) particulates.
   (d) carbon dioxide.
5. Catalytic converters in cars help address the problem of
   (a) acid rain.
   (b) light pollution.
   (c) noise pollution.
   (d) sustainable use.
6. Effects of ozone depletion include an increase in
   (a) skin cancers.
   (b) plant growth.
   (c) plankton.
   (d) asthma.
7. Ways to reduce air pollution include using
   (a) more electricity.
   (b) less hydropower.
   (c) more solar energy.
   (d) less geothermal energy.

## Lesson 18.3: Vocabulary

**Name**_______________________________ **Class**___________ **Date**________

*Match the vocabulary term with the correct definition.*

**Term**

_____ 1. acid rain

_____ 2. aerosol

______ 3. air pollution

______ 4. global dimming

______ 5. global warming

______ 6. greenhouse effect

______ 7. light pollution

______ 8. ozone depletion

______ 9. ozone hole

______ 10. ozone layer

**Definition**

a. alteration of Earth's atmosphere by chemical, particulate, or biological materials

b. trapping by the atmosphere of heat energy radiated from Earth's surface

c. recent increases in Earth's average near-surface and ocean temperatures

d. reduction in the stratospheric concentration of ozone molecules

e. any form of precipitation that has an unusually low pH

f. concentration of ozone molecules in the stratosphere

g. airborne solid particles or liquid droplets

h. seasonal reduction in the ozone layer over Antarctica

i. reduction in the amount of radiation reaching Earth's surface

j. production of light by humans in amounts that are annoying, wasteful, or harmful

## 18.5 Lesson 18.4: Climate Change

### Lesson 18.4: True or False

**Name**________________________________ **Class**____________ **Date**________

*Write true if the statement is true or false if the statement is false.*

_________ 1. The greenhouse effect is a natural feature of Earth's atmosphere.

_________ 2. Earth's temperature increased by almost half a degree Celsius between 1995 and 2004.

_________ 3. The warmest year ever recorded on Earth was the year 1940.

_________ 4. Earth was very cold during the Jurassic Period because of sun spot activity.

_________ 5. One source of temperature information for the past comes from tree rings.

_________ 6. The so-called "little ice age" occurred during the Middle Ages.

_________ 7. The difference between an entirely glaciated Earth and an ice-free Earth is just $10°C$.

_________ 8. Most scientists agree that human actions are the main cause of global warming.

_________ 9. Earth's average temperature first began to increase steadily in 1990.

_________ 10. The concentration of carbon dioxide in the atmosphere has declined since the year 2000.

_________ 11. More greenhouse gases are emitted in the U.S. by agriculture than by industry.

_________ 12. The melting of permafrost is one cause of a runaway greenhouse effect.

## Lesson 18.4: Critical Reading

**Name**________________________________ **Class**____________ **Date**________

*Read this passage from the lesson and answer the questions that follow.*

**What is the Greenhouse Effect?**

The greenhouse effect is a natural feature of Earth's atmosphere and an ecosystem service. Without the greenhouse effect, Earth's surface temperature would average $-18°C$ ($0°F$)—a temperature far too cold to support life as we know it. With the greenhouse effect, Earth's surface temperature averages $15°C$ ($59°F$). This is the average temperature to which today's diversity of life has adapted.

How does this ecosystem service work? Of the solar radiation that reaches Earth's surface, as much as 30 percent is reflected back into space. About 70 percent is absorbed as heat, warming the land, waters, and atmosphere. If there were no atmosphere, most of the heat would radiate back out into space as infrared radiation. Earth's atmosphere, however, contains molecules of water, carbon dioxide, methane, and ozone, and these molecules absorb some of the infrared radiation. Some of this absorbed radiation further warms the atmosphere, and some is radiated back down to Earth's surface or out into space. A balance between the heat that is absorbed and the heat that is radiated out into space results in an equilibrium that maintains a constant average temperature for Earth and its life.

If we compare Earth's atmosphere to the atmospheres of Mars and Venus, we can better understand the precision and value of Earth's thermal equilibrium. Mars' atmosphere is very thin, exerting less than 1 percent of the surface pressure of our own atmosphere. As you might expect, the thin atmosphere of Mars cannot hold heat from the sun. As a result, the average surface temperature on Mars is $-55°C$ ($-67°F$), even though the atmosphere of Mars is 95 percent carbon dioxide and also contains a great deal of dust. Mars' daily variations in temperature are extreme because the atmosphere cannot hold heat.

In contrast, Venus' atmosphere is much thicker than Earth's, and it exerts 92 times the surface pressure of Earth's atmosphere. Moreover, 96 percent of Venus' atmosphere is carbon dioxide, so a strong greenhouse effect heats Venus' surface to as high as $500°C$ ($932°F$). This is hotter than any other planet in our solar system. The thick atmosphere also prevents heat from escaping at night, so daily temperature variations are minimal on Venus.

Considering the extremes of the greenhouse effect on Mars and Venus, we can better appreciate the precise balance that allows our own atmosphere to provide temperatures hospitable to liquid water and life.

**Questions**

1. Contrast the average temperature on Earth's surface with and without the greenhouse effect.

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2. Explain how the atmosphere warms Earth's surface.

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3. Why would Earth's temperature be much different if the planet had no atmosphere?

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4. Mars' atmosphere is 95 percent carbon dioxide, which is a greenhouse gas, yet Mars' surface has extreme variations in temperature. Explain why.

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5. Why is Venus hotter than any other planet in our solar system?

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# Lesson 18.4: Multiple Choice

**Name**_______________________________ **Class**___________ **Date**________

*Circle the letter of the correct choice.*

1. What percentage of the solar radiation that reaches Earth's surface is reflected back into space?
   (a) 1 percent
   (b) 30 percent
   (c) 70 percent
   (d) 100 percent
2. Greenhouse gases absorb energy in the form of
   (a) visible light.
   (b) UV light.
   (c) X rays.
   (d) heat.
3. During the past 100 years, surface air temperatures on Earth have risen by
   (a) $0.74°C$.
   (b) $3.74°C$.
   (c) $5.74°C$.
   (d) $7.74°C$.
4. One reason that deforestation increases greenhouse gases is because it leads to
   (a) less soil erosion.
   (b) more respiration.
   (c) more weathering.
   (d) less photosynthesis.
5. A major greenhouse gas released by cattle production is
   (a) iron oxide.
   (b) nitrous oxide.
   (c) sulfur dioxide.
   (d) carbon monoxide.
6. Global warming is causing permafrost to melt. How may this lead to even greater global warming?
   (a) It causes droughts.
   (b) It raises sea levels.
   (c) It increases erosion.

(d) It releases methane.

7. Which human action, by itself, both increases the amount of carbon entering the atmosphere and decreases the amount of carbon removed from the atmosphere?

   (a) burning trash
   (b) burning fossil fuels
   (c) composting yard waste
   (d) slash-and-burn agriculture

## Lesson 18.4: Vocabulary

**Name**______________________________ **Class**___________ **Date**________

*Match the vocabulary term with the correct definition.*

**Term**

______ 1. carbon sink

______ 2. carbon offsetting

______ 3. carbon sequestration

______ 4. carbon-neutral

______ 5. emissions cap

______ 6. emissions trading

______ 7. greenhouse effect

______ 8. greenhouse gas

______ 9. planetary engineering

______ 10. runaway greenhouse effect

**Definition**

a. process that removes carbon dioxide from the atmosphere

b. buying or exchanging a means of reducing carbon dioxide for rights to release carbon dioxide

c. positive feedback loop in which increasing temperature triggers the release of more greenhouse gases

d. atmospheric substance that transmits solar radiation and absorbs infrared radiation

e. reservoir that increases absorption of carbon dioxide

f. radical, often global changes in technology, culture, or biosphere management

g. upper limit on carbon dioxide or other pollutant release

h. trapping by the atmosphere of heat energy from Earth's surface

i. reducing greenhouse gas emissions by trade-offs from one location to another

j. relating to anything that balances carbon dioxide release against something that sequesters carbon

# Chapter 19

# The Human Body Worksheets

## 19.1 The Human Body



## 19.2 Lesson 1: Organization of the Human Body

### Organization of the Human Body: Reading Comprehension

**Name**______________________________ **Class**___________ **Date**________

Read this passage from the text and answer the questions that follow.

**Cells**

**Stem Cells**

An unspecialized cell that can divide many times and give rise to different, specialized cells is called a **stem cell**, as shown in **Figure 1**. Zygotes and embryonic cells are both types of stem cells. The stem cells found in embryos can divide indefinitely, can specialize into any cell type and are called **embryonic stem cells**. Embryonic stem cells are totipotent. Undifferentiated cells that are found within the body and that divide to replace dying cells and damaged tissues are called adult stem cells. **Adult stem cells** can divide indefinitely, and generate all the cell types of the organ from which they originate. They can potentially re-grow the entire organ from just a few cells. A third type of stem cell is found in blood from the umbilical cord of a new-born baby, and the placenta. These "cord blood stem cells" are considered to be adult stem cells because they cannot generate all body cell types, just different types of blood cells. Therefore, adult stem cells and cord blood stem cells are

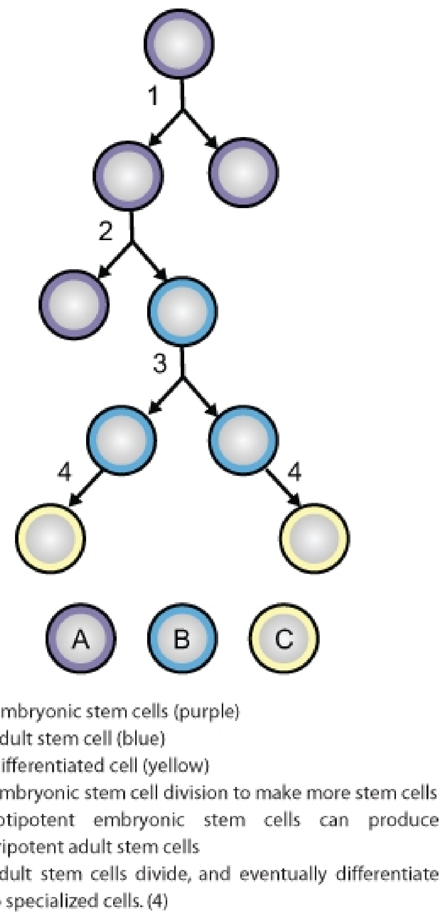


Figure 19.1: Division and differentiation of stem cells into specialized cells. (2)

pluripotent.

### Stem Cells in Medicine

Stem cells are of great interest to researchers because of their ability to divide indefinitely, and to differentiate into many cell types. Stem cells have many existing or potential therapeutic applications. Such therapies include treatments for cancer, blood disorders, brain or spinal cord injuries, and blindness.

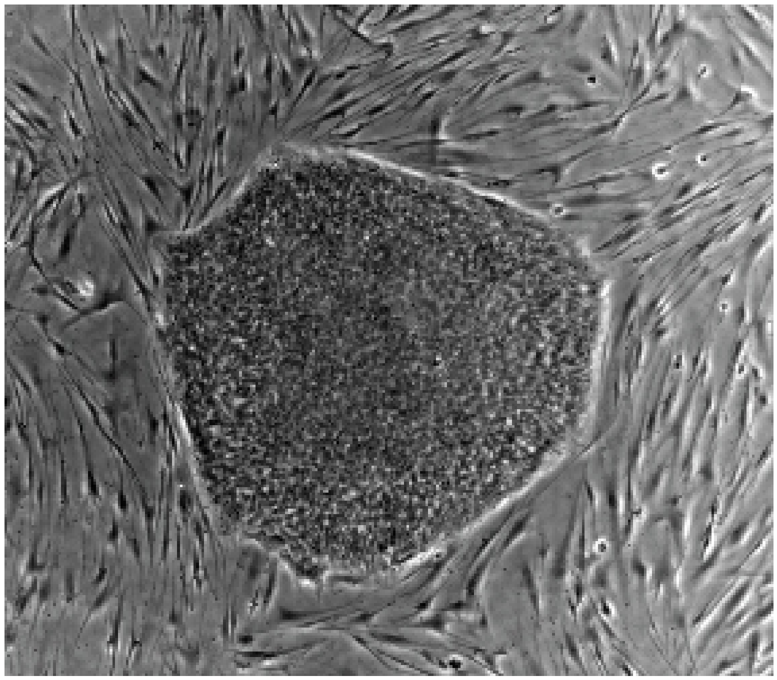

Figure 19.2: Human embryonic stem cell colony, which was grown in a laboratory on a feeder layer of mouse cells. Embryonic stem cells are totipotent. (1)

Embryonic stem cells, as shown in **Figure 2**, are taken from eggs that were fertilized in the laboratory and donated to research. They may have the greatest potential because they are totipotent, and thus have the most potential medical applications. However, embryonic stem cells harvested from a donated embryo differ from a potential patient's tissue type. Therefore, just as in organ transplantation, there is a risk of a patient's body rejecting transplanted embryonic stem cells. Some individuals and groups have objections to the harvesting of embryonic stem cells, because harvesting the stem cells involves the destruction of the embryo. Some researchers are looking into methods to extract embryonic stem cells without destroying the actual embryo. Other researchers have claimed success in harvesting embryonic stem cells from the embryonic fluid that surrounds a growing fetus.

Adult stem cells, including cord blood stem cells, have already been used to treat diseases of the blood such as sickle-cell anemia and certain types of cancer. Unlike embryonic stem cells, the use of adult stem cells in research and therapy is not controversial because the production of adult stem cells does not require the destruction of an embryo. Adult stem cells can be isolated from a tissue sample, such as bone marrow, from a person. Scientists have recently discovered more sources of adult stem cells in the body. Adult stem cells have been found in body fat, the inside lining of the nose, and in the brain. Some researchers are investigating ways to revert adult stem cells back to a totipotent stage.

*Questions*

1. What is the definition of a stem cell?

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2. What can adult stem cells replace?

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3. What is the main difference between embryonic and adult stem cells?

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4. Name two ways in which researchers could harvest embryonic stem cells without destroying the actual embryo.

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5. Name one source of adult stem cells in the human body.

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## Organization of the Human Body: Multiple Choice

**Name**_______________________________ **Class**___________ **Date**________

*Circle the letter of the correct choice.*

1. A cell that is able to differentiate into all cell types is called
   (a) pluripotent
   (b) differentiated
   (c) totipotent
   (d) none of the above
2. Adult stem cells
   (a) can divide indefinitely
   (b) can generate all the cell types of the organ from which they originate
   (c) can potentially re-grow the entire organ from just a few cells
   (d) all of the above
3. A third type of stem cell is found in
   (a) the placenta
   (b) the liver
   (c) the pancreas
   (d) the heart
4. Muscle tissue is made up of
   (a) neurons
   (b) fat cells
   (c) cells that contain contractile filaments
   (d) none of the above
5. One of the structures involved in the respiratory system is the
   (a) lymph node
   (b) pharynx
   (c) pancreas
   (d) adenoids

## Organization of the Human Body: True-False

**Name**________________________________ **Class**____________ **Date**________

*Write true if the statement is true and false if the statement is false.*

_________ 1. In most multicellular organisms, not all cells are like.

_________ 2. Each specialized cell has a specific function in the body.

_________ 3. Every cell in the body originated from a single fertilized egg.

_________ 4. A cell that is able to differentiate into all cell types within a body is called pluripotent.

_________ 5. Human adult stem cells cannot be isolated from a tissue sample, such as bone marrow.

_________ 6. Though the sponge is a large organized, multicellular structure, its cells are not organized into true tissues.

_________ 7. Epithelial tissue is made up of layers of tightly packed cells.

_________ 8. Your skin is the smallest organ in your body.

_________ 9. One of the functions of the integumentary organ system is for movement.

_________ 10. Leukocytes are among the structures involved in the immune system.

## Organization of the Human Body: Vocabulary

**Name**______________________________ **Class**___________ **Date**________

*Match the vocabulary term with the correct definition Terms.*

______ 1. differentiation

______ 2. organ system

______ 3. tissue

______ 4. muscle tissue

______ 5. pluripotent

______ 6. organ

______ 7. connective tissue

______ 8. epithelial tissue

______ 9. stem cell

______ 10. cells

**Definitions**

a. the most basic units of life in your body

b. a group of connected cells that have a similar function within an organism

c. layers of tightly packed cells that line the surfaces of the body for protection, secretion, and absorption

d. a cell able to differentiate into many cell types, but not all

e. process by which an unspecialized cell divides many times to produce specialized cells that work together and make up the body

f. an unspecialized cell that can divide many times and give rise to different, specialized cells

g. cells that contain contractile elements that move past each other and change the size of the cell

h. a group of organs that act together to carry out complex interrelated functions

i. made up of many different types of cells that are all involved in structure and support of the body

j. structure made of two or more tissues that work together for a common purpose

## 19.3 Lesson 1: Homeostasis and Regulation

## Homeostasis and Regulation: Reading Comprehension

**Name**_______________________________ **Class**___________ **Date**________

*Read this passage from the text and answer the questions that follow.*

**Disruption of Homeostasis**

Many homeostatic mechanisms keep the internal environment within certain limits (or set points). When the cells in your body do not work correctly, homeostatic balance is disrupted. Homeostatic imbalance may lead to a state of disease. Disease and cellular malfunction can be caused in two basic ways: by deficiency (cells not getting all they need) or toxicity (cells being poisoned by things they do not need). When homeostasis is interrupted, your body can correct or worsen the problem, based on certain influences. In addition to inherited (genetic) influences, there are external influences that are based on lifestyle choices and environmental exposure. These factors together influence the body's ability to maintain homeostatic balance. The endocrine system of a person with diabetes has difficulty maintaining the correct blood glucose level. A diabetic needs to check their blood glucose levels many times during the day, as shown in **Figure 3**, and monitor daily sugar intake.

**Internal Influences: Heredity**

**Genetics**: Genes are sometimes turned off or on due to external factors which we have some control over. Other times, little can be done to prevent the development of certain genetic diseases and disorders. In such cases, medicines can help a person's body regain homeostasis. An example is the metabolic disorder Type 1 diabetes, which is a disorder where the pancreas is no longer producing adequate amounts of insulin to respond to changes in a person's blood glucose level. Insulin replacement therapy, in conjunction with carbohydrate counting and careful monitoring of blood glucose concentration, is a way to bring the body's handling of glucose back into balance. Cancer can be genetically inherited or be due to a mutation caused by exposure to toxin such as radiation or harmful drugs. A person may also inherit a predisposition to develop a disease such as heart disease. Such diseases can be delayed

Figure 19.3: A person with diabetes has to monitor their blood glucose carefully. This glucose meter analyses only a small drop of blood. (4)

or prevented if the person eats nutritious food, has regular physical activity, and does not smoke.

**External Influences: Lifestyle**

**Nutrition**: If your diet lacks certain vitamins or minerals your cells will function poorly, and you may be at risk to develop a disease. For example, a menstruating woman with inadequate dietary intake of iron will become anemic. Hemoglobin, the molecule that enables red blood cells to transport oxygen, requires iron. Therefore, the blood of an anemic woman will have reduced oxygen-carrying capacity. In mild cases symptoms may be vague (e.g. fatigue), but if the anemia is severe the body will try to compensate by increasing cardiac output, leading to weakness, irregular heartbeats and in serious cases, heart failure.

**Physical Activity**: Physical activity is essential for proper functioning of our cells and bodies. Adequate rest and regular physical activity are examples of activities that influence homeostasis. Lack of sleep is related to a number of health problems such as irregular heartbeat, fatigue, anxiety, and headaches. Being overweight and obesity, two conditions that are related to poor nutrition and lack of physical activity greatly affect many organ systems and their homeostatic mechanisms. Being overweight or obese increases a person's risk of developing heart disease, Type 2 diabetes, and certain forms of cancer. Staying fit by regularly taking part in aerobic activities such as walking, shown in **Figure 4**, has been shown to help prevent many of these diseases.

*Questions*


Figure 19.4: Adding physical activity to your routine can be as simple as walking for a total of 60 minutes a day, five times a week. (3)

1. When homeostasis is interrupted, what are two ways your body can respond?

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2. Why does a person with diabetes have to monitor his or her blood glucose carefully?

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3. Explain how in a person with Type 1 diabetes, insulin replacement therapy helps bring the body's handling of glucose back into balance.

-

-

-

4. How can such diseases as cancer or heart disease be delayed or prevented?

-

-

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5. Give an example of how a poor lifestyle choice can lead to a health problem.

-

-

-

## Homeostasis and Regulation: Multiple Choice

**Name________________________________ Class____________ Date________**

*Circle the letter of the correct choice.*

1. When body temperature rises, the temperature change triggers a command from the
   (a) brain
   (b) muscles
   (c) glands
   (d) none of the above
2. The urinary system is directly involved in maintaining
   (a) muscle strength
   (b) the species
   (c) proper blood volume
   (d) growth
3. Disruption of homeostasis can be caused by
   (a) heredity
   (b) lifestyle
   (c) environmental exposure
   (d) all of the above
4. A woman whose ovaries are removed early in life is at higher risk of developing
   (a) diabetes
   (b) osteoporosis
   (c) cancer
   (d) depression
5. A person with diabetes has to monitor what carefully?
   (a) muscle strength
   (b) how much he or she eats
   (c) blood glucose
   (d) the amount of water he or she drinks

## Homeostasis and Regulation: True-False

**Name**______________________________ **Class**___________ **Date**________

*Write true if the statement is true and false if the statement is false.*

_________ 1. The release of hormones into the blood is caused by a response.

_________ 2. Control of blood glucose level is an example of positive feedback.

_________ 3. One of the homeostatic processes of chemical regulation is the release of insulin and glucagon into the blood

_________ 4. Cell toxicity is one cause of disease and cellular malfunction

_________ 5. Insulin replacement therapy is not used to bring the body's handling of glucose back into balance

_________ 6. The blood of an anemic woman will have increased oxygen-carrying capacity.

_________ 7. Genes are sometimes turned off or on due to external factors which we have some control over.

_________ 8. Physical activity is essential for proper functioning of our cells and bodies.

_________ 9. Medications cannot help balance the amount of mood-altering chemicals within the brain.

_________ 10. When a person takes too much of a drug that affects the central nervous system, basic life functions are disrupted.

## Homeostasis and Regulation: Vocabulary

**Name**______________________________ **Class**___________ **Date**________

*Match the vocabulary term with the correct definition Term.*

______ 1. negative feedback

______ 2. homeostasis

______ 3. positive feedback **Definition**

a. occurs when the response to a stimulus increases the original stimulus

b. occurs when the response to a stimulus reduces the original stimulus

c. stability, balance, or equilibrium within the cell or a body

## Image Sources

(1) http://en.wikipedia.org/wiki/Image:Human_embryonic_stem_cell_colony_phase.jpg. Public Domain.

(2) http://en.wikipedia.org/wiki/Image:Stem_cell_division_and_differentiation.svg. Public Domain.

(3) *Jame* . CC-SA-BY 2.0.

(4) http://commons.wikimedia.org/wiki/Image:Glucose_test.jpg. GFDL 1.2.

# Chapter 20

# The Human Body Worksheets

## 20.1 Lesson 1: Nervous System

### Lesson 1: Worksheet 1

**True/False**

**Name**________________________________ **Class**____________ **Date**________

*Write true if the statement is true and false if the statement is false.*

_________ 1. The axon is a long, membrane-bound extension of the cell body.

_________ 2. The sodium-potassium pump removes Na+ ions from the cell by active transport.

_________ 3. Chemical synapses use ions as messengers.

_________ 4. The cerebellum is involved in coordination and control of body movement.

_________ 5. If the cerebellum is damaged there will be paralysis.

_________ 6. A reflex is an automatic action caused by a defined stimulus and carried out through a reflex arc.

_________ 7. The parasympathetic division gets the body ready for "fight or flight."

_________ 8. The fovea contains the largest concentration of rod cells in the eye.

_________ 9. Hair cells send electrical signals to the cerebellum.

_________ 10. A psychoactive drug alters cognitive function in the central nervous system.

# Lesson 1: Worksheet 2

**ritical Reading**

**Name_______________________________ Class___________ Date________**

Read this passage from the lesson and answer the questions that follow.

**Somatic and Autonomic Nervous Systems**

The motor division of the peripheral nervous system is divided into the somatic nervous system and the autonomic nervous system: The somatic nervous system is the part of the PNS that is associated with the conscious (voluntary) control of the body through the movement of skeletal muscles and the perception of external stimuli through senses such as touch, hearing, and sight. The system includes all the neurons connected with muscles, skin and sense organs. The somatic nervous system is made up of sensory nerves that receive sensory information from the external environment, and motor nerves responsible for muscle contraction. Together with interneurons, the sensory and motor neurons are found in a reflex arc. A reflex is an automatic (involuntary) action caused by a defined stimulus and carried out through a reflex arc. For example, a person stepping on a sharp object would start the reflex action through the creation of a stimulus, (pain) within specialized pain receptors located in the skin tissue of the foot. The resulting stimulus would be passed along sensory neurons to the spinal cord. This stimulus is usually processed by an interneuron to create an immediate response to pain by initiating a motor response in the muscles of the leg which pull the foot away from the object. This reflexive action would occur as the pain sensation is arriving in the brain. A reflex arc is shown in **Figure 19**.

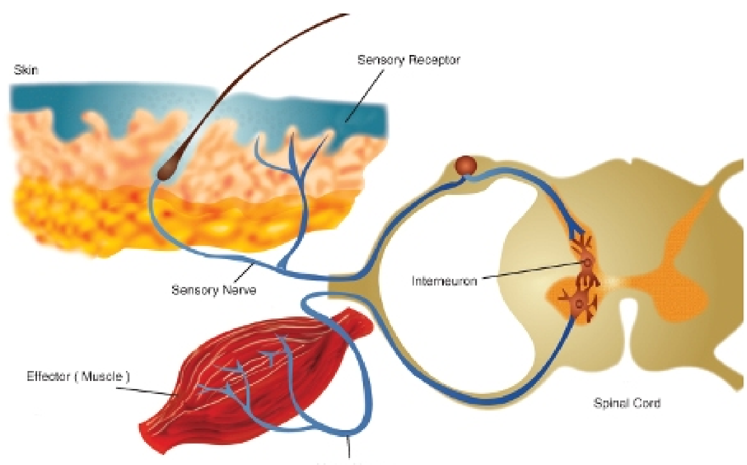


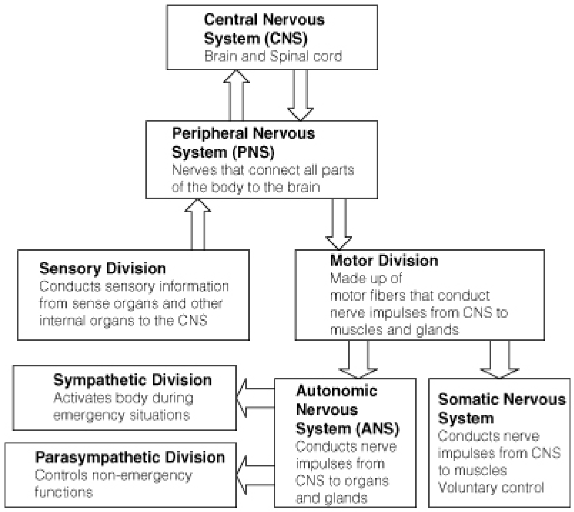

Figure 20.1: The components of a reflex. A sensory receptor that detects a stimulus and sends nerve signals to the spinal cord. These signals activate motor neurons that lead back to the effector (muscle). (3)

The autonomic nervous system (ANS) is the part of the peripheral nervous system that maintains homeostasis in the body. Your body carries out most of these maintenance activities without your conscious control, which is why the autonomic nervous system is also called the involuntary nervous system. The ANS has far reaching effects, such as the control of heart rate, digestion, respiration rate, salivation, and perspiration. Some autonomic nervous system functions work in line with the conscious mind, such as breathing.

The ANS is also made up of the sensory and motor neurons that send messages to and from the internal organs. These neurons form reflex arcs that pass through the medulla oblongata. This explains why even a person's cerebrum may experience trauma, yet their cardiovascular, digestive and respiratory functions will continue even if higher level functions such as awareness and consciousness, are lost. Such a low level of brain functioning is referred to as a vegetative state.

The ANS has two subdivisions: the sympathetic division and parasympathetic division. The sympathetic division generally stimulates body systems during emergency situations. It gets the body ready for "fight or flight", which would probably be required by the situation shown in **Figure 20**, while the parasympathetic division controls non-emergency functions such as digestion. The relationship between the divisions of the nervous system is illustrated in **Figure 21**.

Figure 20.2: A situation in which your sympathetic nervous system (and hopefully your somatic nervous system), would be firing at full speed.[1] (1)




## Questions

1. The motor division of the peripheral nervous system is divided into what two nervous systems?

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2. List two ways in which the somatic nervous system is associated with the voluntary control of the body.

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3. If a person steps on a sharp object, what reflexive action occurs as the pain sensation is arriving in the brain?

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4. Give an example of a bodily function that is controlled by both the somatic and autonomic nervous systems.

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5. Look at Figure 20. Explain how both the sympathetic and somatic nervous systems would be working here.

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## Lesson 1: Worksheet 3

**Multiple Choice**

**Name**________________________________ **Class**____________ **Date**________

*Circle the letter of the correct choice.*

1. In myelinated neurons, ion flows occur only at the
   (a) myelin sheaths
   (b) Nodes of Ranvier
   (c) synapses
   (d) Schwann cells
2. One of the three functional groups of nerves is the
   (a) sensory neurons
   (b) interneurons
   (c) motor neurons
   (d) all of the above
3. The most common excitatory transmitter in the body is
   (a) glutamate
   (b) GABA
   (c) glycine
   (d) acetylcholine
4. The receptors for epinephrine are called
   (a) histamine receptors
   (b) adrenoceptors
   (c) glutamate receptors
   (d) 5-HT receptors
5. One of the autonomic functions is

(a) heartbeat
(b) breathing
(c) temperature regulation
(d) all of the above

6. The central region of the spinal cord is known as

(a) white matter
(b) grey matter
(c) the brainstem
(d) none of the above

7. Photoreceptors are found in the

(a) iris
(b) cornea
(c) retina
(d) lens

## Lesson 1: Worksheet 4

**Vocabulary**

**Name**________________________________ **Class**____________ **Date**________

*Match the vocabulary term with the correct definition.*

**Term**

______ 1. dendrites

______ 2. axon

______ 3. action potential

______ 4. neuromuscular junction

______ 5. glial cell

______ 6. midbrain

______ 7. nociceptor

______ 8. synapse

______ 9. cerebellum

______ 10. psychoactive drug

**Definition**

a. a substance that affects the central nervous system by altering cognitive function

b. cell that provides a support system for the neurons

c. a long, membrane-bound extension of the cell body that passes the nerve impulse onto the next cell

d. extend from the cell body and receive a nerve impulse from another cell

e. the part of the brain involved in coordination and control of body movement

f. part of the brain involved with unconscious functions such as breathing, heartbeat, and temperature regulation

g. an electrical charge that travels along the membrane of a neuron

h. a type of pain receptor which responds to potentially damaging stimuli

i. a specialized junction at which neurons communicate with each other

j. a synapse between a neuron and a muscle cell

## 20.2 Lesson 2: Endocrine System

## Lesson 2: Worksheet 1

**True/False**

**Name**________________________________ **Class**____________ **Date**________

*Write true if the statement is true and false if the statement is false.*

_________ 1. The nervous and endocrine systems work closely together to help us respond to our environment.

_________ 2. Hormones are chemical messenger molecules that are made by cells in one part of the body and cause changes in cells in another part of the body.

_________ 3. Exocrine glands secrete hormones.

_________ 4. Steroid hormones diffuse through cell membranes.

_________ 5. The pituitary gland secretes hormones that stimulate exocrine glands.

_________ 6. Insulin and glucagon are both involved in controlling blood glucose levels.

_________ 7. Cortisol decreases blood pressure and blood sugar levels.

_________ 8. The gonads only produce endocrine actions, not exocrine ones.

_________ 9. Epinephrine is a "fight or flight" hormone.

_________ 10. Positive feedback mechanisms are not as common as negative feedback mechanisms.

## Lesson 2: Worksheet 2

**Critical Reading**

**Name**________________________________ **Class**____________ **Date**_________

Read this passage from the lesson and answer the questions that follow.

**Negative Feedback**

Negative feedback is a reaction in which the system responds in such a way as to reverse the direction of change. Since this tends to keep things constant, it allows for a process to return from a state of imbalance back to a homeostatic equilibrium.

A common, non-biological example of negative feedback happens in a home heating system. When you are home, you set your thermostat to $21°C$ (about $70°F$), which is the **set point**. The thermometer in the thermostat monitors the room temperature and will sense when the temperature drops below the $21°C$ set point (the stimulus). The thermometer will then send a message to the thermostat (control center), which in turn sends a message to the furnace to switch on and heat up the room. When the room temperature returns to the set temperature, the thermostat shuts the furnace off. In this home-heating example, the increase in air temperature is the negative feedback that results in the furnace being shut off. In this way a set room temperature of $21°C$ (within a degree or two) is maintained.

An example of negative feedback in the body is the control of blood-glucose concentrations by insulin. A higher amount of glucose in the blood (the stimulus), signals the beta cells of the pancreas to release insulin into the blood. Hormone concentration alone cannot trigger a negative feedback mechanism, negative feedback is instead triggered by an overproduction of the effect of the hormone, such as the lowering of blood glucose concentration (the effect), which causes a decrease in the secretion of insulin by the pancreas.

**Negative Feedback: Regulation of Thyroid Hormones**

The thyroid hormones thyroxine (T4) and triiodothyronine (T3) regulate the rate of metabolism. The production of T4> and T3 is regulated by thyroid-stimulating hormone (TSH), which is released by the anterior pituitary. The thyroid and the TSH-producing cells of the anterior pituitary form a negative feedback loop, as shown in **Figure 14**.

Thyroid-stimulating hormone production is decreased when the T4 levels are high, and when TSH levels are high, T4 production is decreased. The production and secretion of TSH is in turn controlled by thyrotropin-releasing hormone (TRH), which is produced by the hypothalamus. The rate of TRH secretion is increased in situations such as cold temperature because increasing the metabolic rate would generate more heat. Increased levels of T4 and T3 in the blood cause a reduction in TRH secretion. Among other things, TSH secretion is reduced by high levels of thyroid hormones, as well as the antagonistic hormone somatostatin.

These feedback loops keep the concentration of thyroid hormones within a narrow range of concentrations.

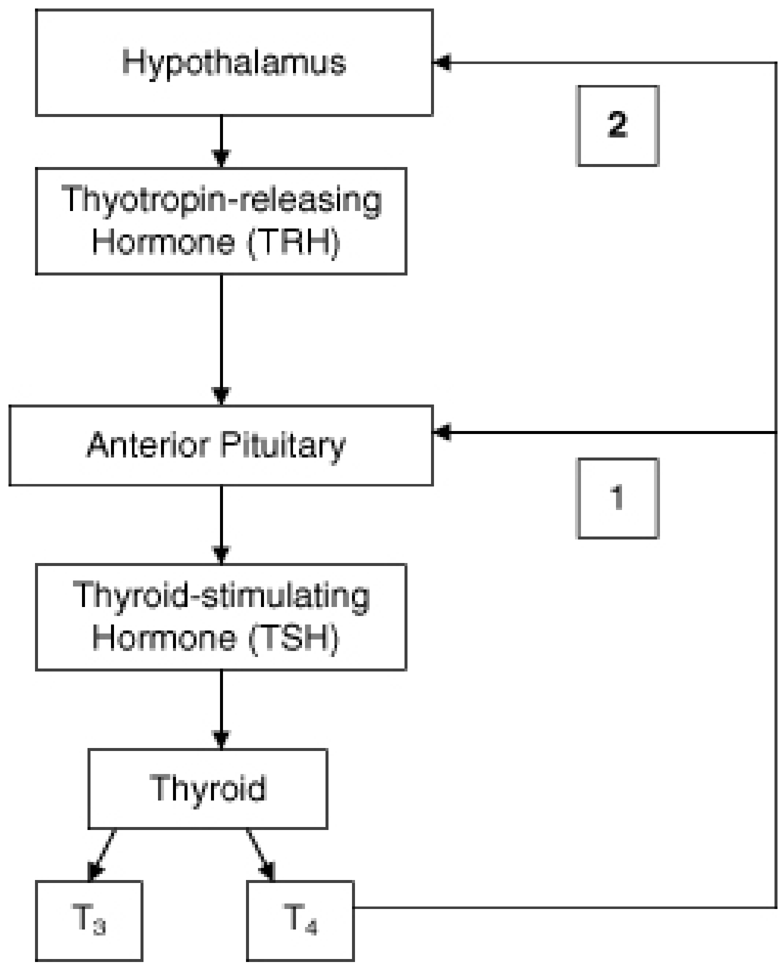


Figure 20.3: Two negative feedback loops exist in the control of thyroid hormone secretion. (1) shows the loop between the TSH-producing cells of the anterior pituitary and the thyroid. Increased levels of T4 and T3 in the blood cause a reduction in TSH secretion. (2) shows that increased levels of T4 and T3 in the blood cause a reduction in TRH secretion. (2)

**Questions**

1. What is negative feedback?

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-

2. In the home-heating example, what is the negative feedback?

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-

-

3. What hormone effect triggers the negative feedback in the blood-glucose example?

-

-

-

**Look at the figure above to answer questions 4 and 5:**

4. In negative feedback loop 1, what effect does the increased levels of T3 and T4 in the blood have?

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-

-

5. What is the effect of the two negative feedback loops on the concentration of thyroid hormones?

-

-

-

## Lesson 2: Worksheet 3

**Multiple Choice**

**Name**________________________________ **Class**____________ **Date**________

*Circle the letter of the correct choice.*

1. The endocrine system releases hormones into the
   (a) nervous system
   (b) muscles
   (c) blood
   (d) none of the above
2. Amino acid-based hormones usually bind to receptors that are found on the
   (a) cell nucleus
   (b) cell membrane

(c) mitochondria
(d) none of the above

3. Glucagon is released by the
   (a) thymus
   (b) pituitary gland
   (c) ovary
   (d) pancreas
4. The posterior pituitary releases which of the following?
   (a) oxytocin
   (b) LH
   (c) FSH
   (d) growth hormone
5. Melatonin is involved in
   (a) digestion
   (b) water loss
   (c) sleep cycles
   (d) none of the above
6. An example of a positive feedback mechanism is
   (a) control of blood glucose concentrations
   (b) control of milk production
   (c) control of thyroid hormone secretion
   (d) none of the above
7. Which of the following regulates metabolism?
   (a) pancreas
   (b) pituitary gland
   (c) adrenal glands
   (d) kidneys

## Lesson 2: Worksheet 4

### Vocabulary

**Name**_________________________________ **Class**____________ **Date**________

*Match the vocabulary term with the correct definition.*

**Term**

______ 1. cortisol

______ 2. glucagon

______ 3. target cell

______ 4. islets of Langerhans

______ 5. hypersecretion

______ 6. hyposecretion

______ 7. prostaglandins

______ 8. gonads

______ 9. exocrine glands

______ 10. endocrine glands

**Definition**

a. an important hormone involved in carbohydrate metabolism

b. the production of too much of a hormone

c. a steroid hormone produced by the adrenal glands

d. the gamete producing organs

e. areas of the pancreas with groupings of endocrine cells

f. hormone-like substance made from essential fatty acids, produced by most cells in the body

g. the cell on which a hormone has an effect

h. the production of no hormone or too little of a hormone

i. a system of organs that releases chemical message molecules into the blood

j. organs that secrete their products into ducts

# Image Sources

(1) .

(2) .

(3) .

# Chapter 21

# Nervous and Endocrine Worksheets

## 21.1 Lesson 1: Nervous System

### Lesson 1: Worksheet 1

**True/False**

**Name**________________________________________________ **Class**____________ **Date** ______________

Write true if the statement is true and false if the statement is false.

_________ 1. The axon is a long, membrane-bound extension of the cell body.

_________ 2. The sodium-potassium pump removes Na+ ions from the cell by active transport.

_________ 3. Chemical synapses use ions as messengers.

_________ 4. The cerebellum is involved in coordination and control of body movement.

_________ 5. If the cerebellum is damaged there will be paralysis.

_________ 6. A reflex is an automatic action caused by a defined stimulus and carried out through a reflex arc.

_________ 7. The parasympathetic division gets the body ready for "fight or flight."

_________ 8. The fovea contains the largest concentration of rod cells in the eye.

_________ 9. Hair cells send electrical signals to the cerebellum.

_________ 10. A psychoactive drug alters cognitive function in the central nervous system.

# Lesson 1: Worksheet 2

**ritical Reading**

**Name**________________________________________ **Class**__________ **Date** ____________

Read this passage from the lesson and answer the questions that follow.

**Somatic and Autonomic Nervous Systems** The motor division of the peripheral nervous system is divided into the somatic nervous system and the autonomic nervous system: The somatic nervous system is the part of the PNS that is associated with the conscious (voluntary) control of the body through the movement of skeletal muscles and the perception of external stimuli through senses such as touch, hearing, and sight. The system includes all the neurons connected with muscles, skin and sense organs. The somatic nervous system is made up of sensory nerves that receive sensory information from the external environment, and motor nerves responsible for muscle contraction. Together with interneurons, the sensory and motor neurons are found in a reflex arc. A reflex is an automatic (involuntary) action caused by a defined stimulus and carried out through a reflex arc. For example, a person stepping on a sharp object would start the reflex action through the creation of a stimulus, (pain) within specialized pain receptors located in the skin tissue of the foot. The resulting stimulus would be passed along sensory neurons to the spinal cord. This stimulus is usually processed by an interneuron to create an immediate response to pain by initiating a motor response in the muscles of the leg which pull the foot away from the object. This reflexive action would occur as the pain sensation is arriving in the brain. A reflex arc is shown in **Figure 19**.

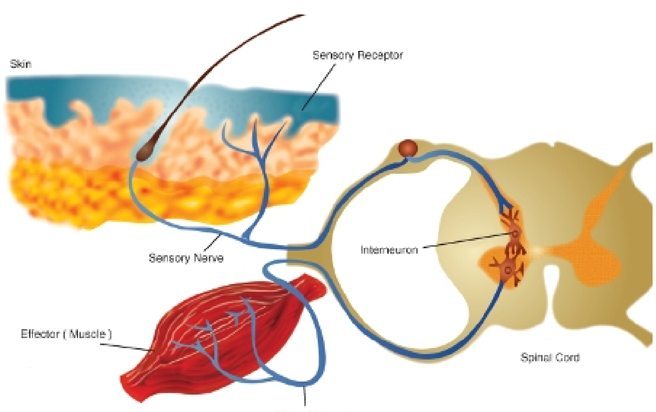


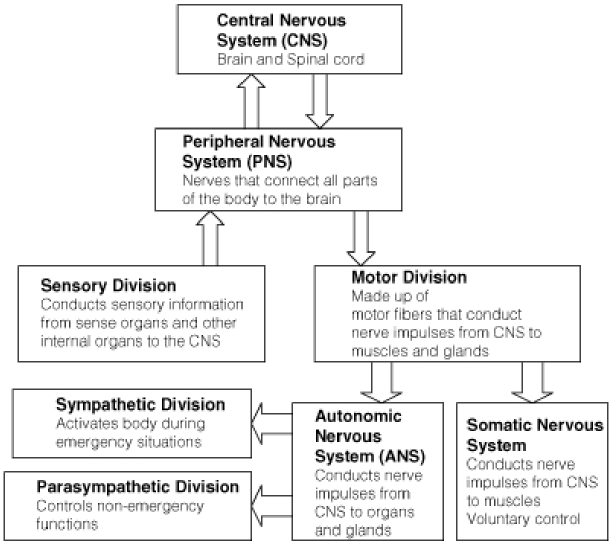

Figure The components of a reflex. A sensory receptor that detects a stimulus and sends nerve signals to the spinal cord. These signals activate motor neurons that lead back to the effector (muscle).

The autonomic nervous system (ANS) is the part of the peripheral nervous system that maintains homeostasis in the body. Your body carries out most of these maintenance activities without your conscious control, which is why the autonomic nervous system is also called the involuntary nervous system. The ANS has far reaching effects, such as the control of heart rate, digestion, respiration rate, salivation, and perspiration. Some autonomic nervous system functions work in line with the conscious mind, such as breathing.

The ANS is also made up of the sensory and motor neurons that send messages to and from the internal organs. These neurons form reflex arcs that pass through the medulla oblongata. This explains why even a person's cerebrum may experience trauma, yet their cardiovascular, digestive and respiratory functions will continue even if higher level functions such as awareness and consciousness, are lost. Such a low level of brain functioning is referred to as a vegetative state.

The ANS has two subdivisions: the sympathetic division and parasympathetic division. The sympathetic division generally stimulates body systems during emergency situations. It gets the body ready for "fight or flight", which would probably be required by the situation shown in **Figure 20**, while the parasympathetic division controls non-emergency functions such as digestion. The relationship between the divisions of the nervous system is illustrated in **Figure 21**.

Figure Watch out! A situation in which your sympathetic nervous system (and hopefully your somatic nervous system), would be firing at full speed.[1] Questions [C head]




### Questions

1. The motor division of the peripheral nervous system is divided into what two nervous systems?

2. List two ways in which the somatic nervous system is associated with the voluntary control of the body.

3. If a person steps on a sharp object, what reflexive action occurs as the pain sensation is arriving in the brain?

4. Give an example of a bodily function that is controlled by both the somatic and autonomic nervous systems.

5. Look at Figure 20. Explain how both the sympathetic and somatic nervous systems would be working here.

## Lesson 1: Worksheet 3

### Multiple Choice

**Name**________________________________________ **Class**___________ **Date** _____________

Circle the letter of the correct choice.

1. In myelinated neurons, ion flows occur only at the

A. myelin sheaths
B. Nodes of Ranvier

C. synapses
D. Schwann cells

2. One of the three functional groups of nerves is the

A. sensory neurons
B. interneurons
C. motor neurons
D. all of the above

3. The most common excitatory transmitter in the body is

A. glutamate
B. GABA
C. glycine
D. acetylcholine

4. The receptors for epinephrine are called

A. histamine receptors
B. adrenoceptors
C. glutamate receptors
D. 5-HT receptors

5. One of the autonomic functions is

A. heartbeat
B. breathing
C. temperature regulation
D. all of the above

6. The central region of the spinal cord is known as

A. white matter
B. grey matter
C. the brainstem
D. none of the above

7. Photoreceptors are found in the

A. iris
B. cornea
C. retina
D. lens

# Lesson 1: Worksheet 4

**Vocabulary**

**Name**____________________________________________ **Class**___________ **Date** _____________

Match the vocabulary term with the correct definition.

**Term**

______ 1. dendrites

______ 2. axon

______ 3. action potential

______ 4. neuromuscular junction

______ 5. glial cell

______ 6. midbrain

______ 7. nociceptor

______ 8. synapse

______ 9. cerebellum

______ 10. psychoactive drug

**Definition**

a. a substance that affects the central nervous system by altering cognitive function

b. cell that provides a support system for the neurons

c. a long, membrane-bound extension of the cell body that passes the nerve impulse onto the next cell

d. extend from the cell body and receive a nerve impulse from another cell

e. the part of the brain involved in coordination and control of body movement

f. part of the brain involved with unconscious functions such as breathing, heartbeat, and temperature regulation

g. an electrical charge that travels along the membrane of a neuron

h. a type of pain receptor which responds to potentially damaging stimuli

i. a specialized junction at which neurons communicate with each other

j. a synapse between a neuron and a muscle cell

## 21.2 Lesson 2: Endocrine System

## Lesson 2: Worksheet 1

**True/False**

**Name**____________________________________________ **Class**___________ **Date** _____________

Write true if the statement is true and false if the statement is false.

_________ 1. The nervous and endocrine systems work closely together to help us respond to our environment.

_________ 2. Hormones are chemical messenger molecules that are made by cells in one part of the body and cause changes in cells in another part of the body.

_________ 3. Exocrine glands secrete hormones.

_________ 4. Steroid hormones diffuse through cell membranes.

_________ 5. The pituitary gland secretes hormones that stimulate exocrine glands.

_________ 6. Insulin and glucagon are both involved in controlling blood glucose levels.

_________ 7. Cortisol decreases blood pressure and blood sugar levels.

_________ 8. The gonads only produce endocrine actions, not exocrine ones.

_________ 9. Epinephrine is a "fight or flight" hormone.

_________ 10. Positive feedback mechanisms are not as common as negative feedback mechanisms.

## Lesson 2: Worksheet 2

**Critical Reading**

**Name**____________________________________________ **Class**___________ **Date** _____________

Read this passage from the lesson and answer the questions that follow.

**Negative Feedback**

Negative feedback is a reaction in which the system responds in such a way as to reverse the direction of change. Since this tends to keep things constant, it allows for a process to return from a state of imbalance back to a homeostatic equilibrium.

A common, non-biological example of negative feedback happens in a home heating system. When you are home, you set your thermostat to 21 $^\circ$C (about 70 $^\circ$F), which is the **set point**. The thermometer in the thermostat monitors the room temperature and will sense when the temperature drops below the 21 °C set point (the stimulus). The thermometer will then send a message to the thermostat (control center), which in turn sends a message to the furnace to switch on and heat up the room. When the room temperature returns to the set temperature, the thermostat shuts the furnace off. In this home-heating example, the increase in air temperature is the negative feedback that results in the furnace being shut off. In this way a set room temperature of 21 °C (within a degree or two) is maintained.

An example of negative feedback in the body is the control of blood-glucose concentrations by insulin. A higher amount of glucose in the blood (the stimulus), signals the beta cells of the pancreas to release insulin into the blood. Hormone concentration alone cannot trigger a negative feedback mechanism, negative feedback is instead triggered by an overproduction of the effect of the hormone, such as the lowering of blood glucose concentration (the effect), which causes a decrease in the secretion of insulin by the pancreas.

**Negative Feedback: Regulation of Thyroid Hormones**

The thyroid hormones thyroxine (T4) and triiodothyronine (T3) regulate the rate of metabolism. The production of T4> and T3 is regulated by thyroid-stimulating hormone (TSH), which is released by the anterior pituitary. The thyroid and the TSH-producing cells of the anterior pituitary form a negative feedback loop, as shown in **Figure 14**.

Thyroid-stimulating hormone production is decreased when the T4 levels are high, and when TSH levels are high, T4 production is decreased. The production and secretion of TSH is in turn controlled by thyrotropin-releasing hormone (TRH), which is produced by the hypothalamus. The rate of TRH secretion is increased in situations such as cold temperature because increasing the metabolic rate would generate more heat. Increased levels of T4 and T3 in the blood cause a reduction in TRH secretion. Among other things, TSH secretion is reduced by high levels of thyroid hormones, as well as the antagonistic hormone somatostatin. These feedback loops keep the concentration of thyroid hormones within a narrow range of concentrations.

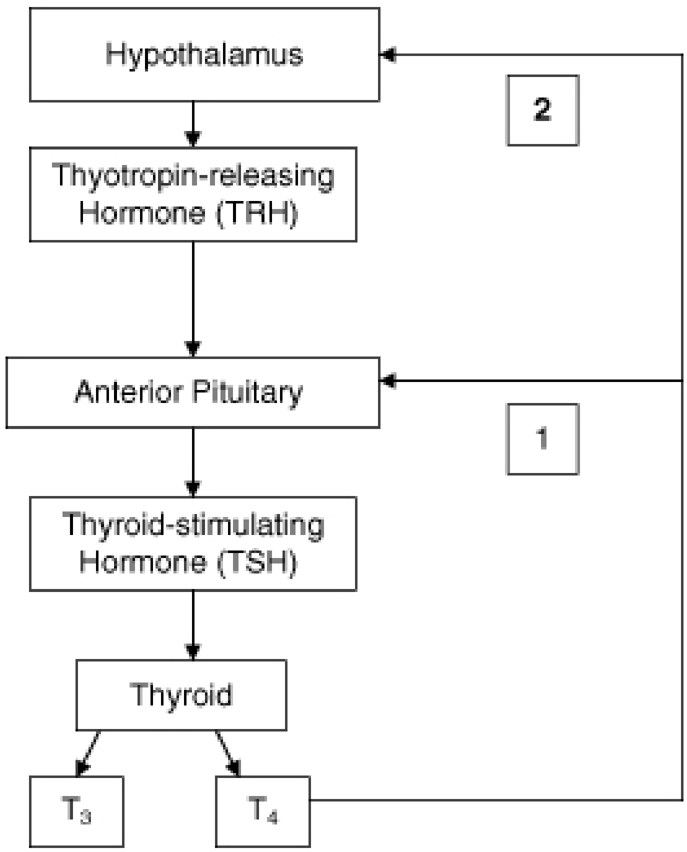



Figure Two negative feedback loops exist in the control of thyroid hormone secretion. (1) shows the loop between the TSH-producing cells of the anterior pituitary and the thyroid. Increased levels of T4 and T3 in the blood cause a reduction in TSH secretion. (2) shows that increased levels of T4 and T3 in the blood cause a reduction in TRH secretion.

**Questions**

1. What is negative feedback?

2. In the home-heating example, what is the negative feedback?

3. What hormone effect triggers the negative feedback in the blood-glucose example?

**Look at the figure above to answer questions 4 and 5:**

4. In negative feedback loop 1, what effect does the increased levels of T3 and T4 in the blood have?

5. What is the effect of the two negative feedback loops on the concentration of thyroid hormones?

# Lesson 2: Worksheet 3

**Multiple Choice**

**Name**__________________________________________ **Class**___________ **Date** ____________

Circle the letter of the correct choice.

1. The endocrine system releases hormones into the

A. nervous system
B. muscles
C. blood
D. none of the above

2. Amino acid-based hormones usually bind to receptors that are found on the

A. cell nucleus
B. cell membrane
C. mitochondria
D. none of the above

3. Glucagon is released by the

A. thymus
B. pituitary gland
C. ovary
D. pancreas

4. The posterior pituitary releases which of the following?

A. oxytocin
B. LH
C. FSH
D. growth hormone

5. Melatonin is involved in

A. digestion
B. water loss
C. sleep cycles

D. none of the above

6. An example of a positive feedback mechanism is

A. control of blood glucose concentrations
B. control of milk production
C. control of thyroid hormone secretion
D. none of the above

7. Which of the following regulates metabolism?

A. pancreas
B. pituitary gland
C. adrenal glands
D. kidneys

## Lesson 2: Worksheet 4

**Vocabulary**

**Name**________________________________________ **Class**___________ **Date** ____________

Match the vocabulary term with the correct definition.

**Term**

______ 1. cortisol

______ 2. glucagon

______ 3. target cell

______ 4. islets of Langerhans

______ 5. hypersecretion

______ 6. hyposecretion

______ 7. prostaglandins

______ 8. gonads

______ 9. exocrine glands

______ 10. endocrine glands

**Definition**

a. an important hormone involved in carbohydrate metabolism

b. the production of too much of a hormone

c. a steroid hormone produced by the adrenal glands

d. the gamete producing organs

e. areas of the pancreas with groupings of endocrine cells

f. hormone-like substance made from essential fatty acids, produced by most cells in the body

g. the cell on which a hormone has an effect

h. the production of no hormone or too little of a hormone

i. a system of organs that releases chemical message molecules into the blood

j. organs that secrete their products into ducts

# Chapter 22

# Circulatory and Respiratory Systems Worksheets

**Lesson 1 Worksheet 1**

**Name**________________________________ **Class**____________ **Date**________

**True/False**

*Write true if the statement is true and false if the statement is false.*'

_________ 1. In adults, the normal mass of the heart is 100-200 grams.

_________ 2. The right side of the heart collects oxygenated blood from the body.

_________ 3. Valves in the heart maintain the flow of blood.

_________ 4. Cardiac muscle is self-exciting.

_________ 5. The heartbeat is made up of three parts.

_________ 6. Arteries carry blood away from the heart.

_________ 7. The aorta is the largest artery in the body.

_________ 8. Capillaries are the smallest of the body's blood vessels.

_________ 9. The lymphatic system is often called the primary circulatory system.

_________ 10. Atherosclerosis normally begins in adulthood.

**Lesson 1 Worksheet 2**

**Name**________________________________ **Class**____________ **Date**________

**Reading**

Read this passage from the lesson and answer the questions that follow.

**Homeostatic Imbalances of the Cardiovascular System**

Cardiovascular disease (CVD) refers to any disease that affects the cardiovascular system, but it is usually used to refer to diseases related to atherosclerosis, which is a chronic inflammatory response in the walls of arteries that causes a swelling and buildup of materials called plaque. Plaque is made of cell debris, cholesterol, fatty acids, calcium, and fibrous connective tissue that build up around an area of inflammation. As a plaque grows it stiffens and narrows the artery, which reduces the flow of blood through the artery, shown in Figure 20.

# Chapter 23

# Circulatory and Respiratory Systems Worksheets

Lesson 1 Worksheet 1 [A head]

Name_________________________________________ Class__________ Date ___________ [B head]

True/False [B head]

Write true if the statement is true and false if the statement is false.

_________ 1. In adults, the normal mass of the heart is 100-200 grams. _________ 2. The right side of the heart collects oxygenated blood from the body. _________ 3. Valves in the heart maintain the flow of blood. _________ 4. Cardiac muscle is self-exciting. _________ 5. The heartbeat is made up of three parts. _________ 6. Arteries carry blood away from the heart. _________ 7. The aorta is the largest artery in the body. _________ 8. Capillaries are the smallest of the body's blood vessels. _________ 9. The lymphatic system is often called the primary circulatory system. _________ 10. Atherosclerosis normally begins in adulthood.

Lesson 1 Worksheet 2 [A head]

Name_________________________________________ Class__________ Date ___________ [B head]

Reading [B head]

Read this passage from the lesson and answer the questions that follow. Homeostatic Imbalances of the Cardiovascular System [C head] Cardiovascular disease (CVD) refers to any disease that affects the cardiovascular system, but it is usually used to refer to diseases related to atherosclerosis, which is a chronic inflammatory response in the walls of arteries that causes a swelling and buildup of materials called plaque. Plaque is made of cell debris, cholesterol, fatty acids, calcium, and fibrous connective tissue that build up around an area of inflammation. As a plaque grows it stiffens and narrows the artery, which reduces the flow of blood through the artery, shown in Figure 20.

# Chapter 24

# Immune System and Disease Worksheets

## 24.1 Chapter 40: Immune System and Disease

- Lesson 40.1: Nonspecific Defenses
- Lesson 40.2: Immune Response
- Lesson 40.3: Immune System Diseases
- Lesson 40.4: Environmental Problems and Human Health

## 24.2 Lesson 40.1: Nonspecific Defenses

### Lesson 40.1: True or False

**Name**_______________________________ **Class**___________ **Date**________

*Write true if the statement is true or false if the statement is false.*

_________ 1. Pathogens are physically forced out of the respiratory tract when a person coughs.

_________ 2. In a healthy human, the skin's surface contains no bacteria.

_________ 3. Pathogen is a technical term for germ.

_________ 4. All immune system responses are specific; there are no nonspecific defenses.

_________ 5. The common cold is caused by a bacterium.

_________ 6. Strep throat is caused by a virus.

_________ 7. Athlete's foot is caused by a fungus.

__________ 8. Tuberculosis is caused by a bacterium.

__________ 9. Cold sores are caused by a fungus.

__________ 10. Some mushrooms contain chemicals harmful to humans.

__________ 11. Mucus made by the respiratory system is one kind of immune system defense.

__________ 12. Cilia move pathogens into the bloodstream.

__________ 13. The main function of red blood cells is to make antibodies.

__________ 14. Histamines reduce inflammation.

__________ 15. Some types of white blood cells secrete histamines.

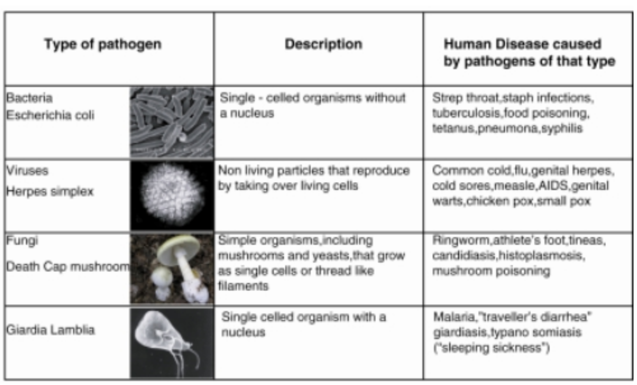
## Lesson 40.1: Critical Reading

**Name________________________________ Class____________ Date________**

*Read this passage from the lesson and answer the following questions.*

### First Line of Defense

The immune system has three lines of defense. The first line of defense includes a variety of barriers against pathogens that keep most pathogens out of the body. Pathogens are disease-causing agents, such as bacteria and viruses. Defenses in the first line are the same regardless of the type of pathogen. This is why they are called nonspecific defenses. Several types of pathogens that are common causes of human disease can be seen in the Figure below.



| Type of pathogen | Description | Human Disease caused by pathogens of that type |
|---|---|---|
| Bacteria Escherichia coli | Single - celled organisms without a nucleus | Strep throat,staph infections, tuberculosis,food poisoning, tetanus,pneumona,syphilis |
| Viruses Herpes simplex | Non living particles that reproduce by taking over living cells | Common cold,flu,genital herpes, cold sores,measle,AIDS,genital warts,chicken pox,small pox |
| Fungi Death Cap mushroom | Simple organisms,including mushrooms and yeasts,that grow as single cells or thread like filaments | Ringworm,athlete's foot,tineas, candidiasis,histoplasmosis, mushroom poisoning |
| Giardia Lamblia | Single celled organism with a nucleus | Malaria,"traveller's diarrhea" giardiasis,typano somiasis ("sleeping sickness") |

### Mechanical Barriers

Mechanical barriers physically block pathogens from entering the body. The skin is the most important mechanical barrier. In fact, it is the single most important defense of the body against pathogens. It forms a physical barrier between the body and the outside world. The outer layer of the skin is a tough, nearly water-proof coating that is very difficult for pathogens to penetrate.

At body openings, such as the mouth and nose, the body has a different mechanical barrier. Instead of skin, mucous membranes line these and other organs that are exposed to the outside environment. They include the organs of the respiratory, gastrointestinal, and urinary tracts. Mucous membranes secrete mucus, a slimy substance that coats the membranes and traps pathogens. Mucous membranes also have cilia, which are tiny projections that have wavelike motions. The movements of cilia sweep mucus and trapped pathogens toward body openings to be removed from the body.

Pathogens are removed from the respiratory tract when you sneeze or cough. In addition, tears wash pathogens from the eyes, and urine flushes pathogens out of the urinary tract. Chemical Barriers

Chemical barriers are proteins that destroy pathogens at the body's surface. The skin and mucous membranes secrete proteins that kill many of the pathogens with which they come into contact. For example, enzymes called lysozymes—which are found in sweat, mucus, tears, and saliva—kill pathogens by breaking open their cell walls. Urine and vaginal secretions are too acidic for many pathogens, and semen contains zinc, which most pathogens cannot tolerate. Hydrochloric acid secreted by mucous membranes lining the stomach kills pathogens that enter the stomach in food or water.

**Biological Barriers**

Biological barriers involve living organisms that compete with pathogens. Human skin is covered by millions of bacteria. Millions more colonize the gastrointestinal, urinary, and genital tracts. Most of these bacteria are helpful or at least not harmful. They are important in defense because they help prevent harmful bacteria from becoming established in or on the body. They do this by competing with harmful bacterial for food and space. Helpful bacteria may also change pH or other factors and make conditions less suitable for harmful bacteria.

**Questions**

1. Name and briefly describe the immune system's first line of defense.

-

-

-

2. How can the skin be considered part of the immune system?

-

-

-

3. What are mucous membranes? Where are they found?

-

-

-

4. Are all bacteria that live in the human body harmful? Why or why not?

-

-

-

5. What is the purpose of the cilia of the cells that line the respiratory lining?

-

-

-

## Lesson 40.1: Multiple Choice

**Name________________________________ Class____________ Date_________**

*Circle the letter of the correct choice.*

1. A component of the immune system's first line of defense is

(a) cytokines.

(b) antibodies.

(c) the skin.

(d) the spine.

2. Lysozymes

(a) are enzymes that break down histamines.

(b) are enzymes that break down bacterial cell walls.

(c) are antibodies that bind to red blood cells.

(d) produce acid from protein.

3. Mucus is produced by

(a) only damaged respiratory passages.

(b) by healthy tissues, including the respiratory tract and intestinal tract.

(c) by the respiratory tract, but not by the intestinal tract.

(d) none of the above

4. The diagram below shows the process of

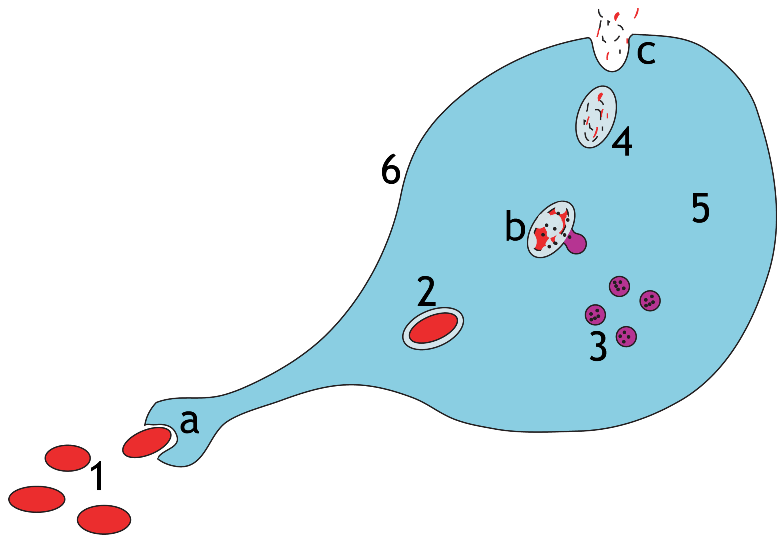



Figure 24.1: (1)

(a) skin cell production.

(b) cilia action.

(c) pinocytosis.

(d) phagocytosis.

5. When bacteria enter the body through a cut in the skin

(a) the second line of defense of the immune system is activated.

(b) the first line of defense of the immune system has succeeded.

(c) the third line of defense of the immune system is activated within seconds.

(d) the immune system shuts down.

6. A chemical that is produced as a part of the inflammatory response is

(a) histamine.

(b) monoamine.

(c) cilia.

(d) flagella.

7. A type of human immune system cell that ingests pathogens by phagocytosis is

(a) bacteria.

(b) muscle cell.

(c) macrophage.

(d) neuron.

## Lesson 40.1: Vocabulary

**Name________________________________ Class____________ Date________**

*Match the vocabulary term with the correct definition.*

**Term**

______ 1. pathogens

______ 2. lysozymes

______ 3. cytokines

______ 4. chemical barriers

______ 5. white blood cells

______ 6. nonspecific defenses

______ 7. inflammatory response

______ 8. histamines

______ 9. biological barriers

______ 10. phagocytosis

**Definition**

a. Defenses that are the same regardless of the type of pathogen; found in the first and second line of defense.

b. Living organisms that compete with pathogens; help prevent harmful bacteria from becoming established in or on the body.

c. Disease-causing agents, such as bacteria and viruses.

d. Enzymes that kill pathogens by breaking open their cell walls; found in sweat, mucus, tears, and saliva.

e. leukocytes

f. Chemicals that destroy pathogens at the body's surface.

g. Proteins that act as chemical signals used to communicate between cells.

h. A complex biological reaction to tissue damage; one of the first responses of the immune system to infection or injury; triggered by chemicals called cytokines and histamines.

i. The process of engulfing and breaking down pathogens and other unwanted substances.

j. chemicals that cause inflammation

## 24.3 Lesson 40.2: Immune Response

### Lesson 40.2: True or False

**Name**________________________________ **Class**___________ **Date**________

*Writee true if the statement is true or false if the statement is false.*

_________ 1. The third line of defense is nonspecific.

_________ 2. The lymphatic system is not part of the immune system.

_________ 3. The lymphatic system transports fatty acids out of the bloodstream.

_________ 4. The lymphatic system produces white blood cells.

_________ 5. Another name for white blood cell is leukocyte.

_________ 6. The red bone marrow is part of the lymphatic system.

_________ 7. T cells mature in the thymus.

_________ 8. The spleen makes new red blood cells.

_________ 9. Humans cannot survive without tonsils.

_________ 10. Lymph is pumped through the lymphatic vessels by the lymphatic pumping organ.

_________ 11. B cells mature in the thymus.

_________ 12. A major function of the humoral immune system is to destroy proteins that are nonself.

_________ 13. Both T cells and B cells have receptors that bind specifically to a particular antigen.

_________ 14. Helper T cell cytokines stimulate the development of B cells into mature antibody-producing cells.

_________ 15. The base of a Y-shaped antibody is the part of the protein that binds specifically to an antigen.

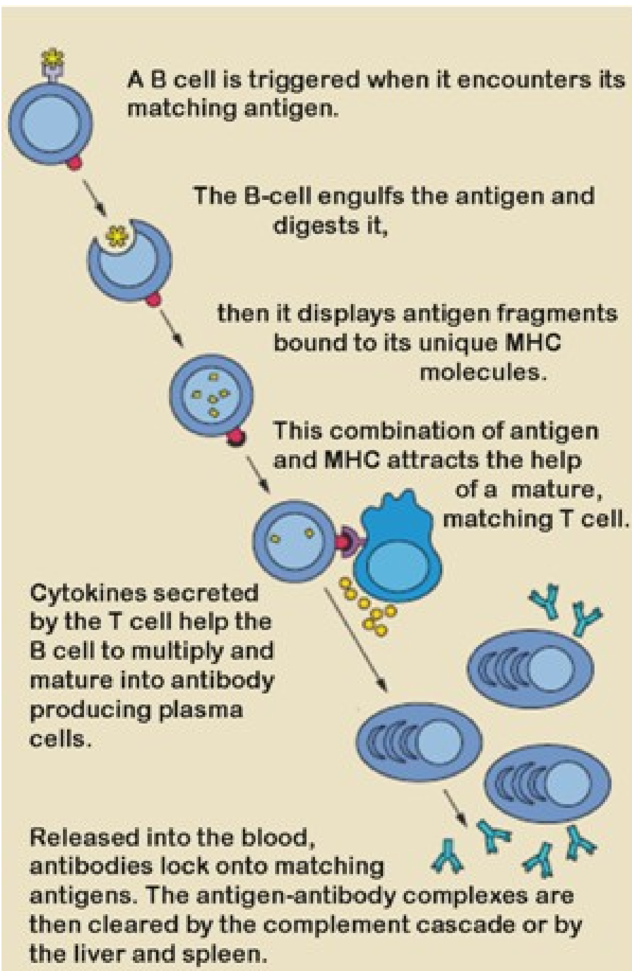
# Lesson 40.2: Critical Reading

**Name**______________________________ **Class**___________ **Date**________

*Read this passage from the lesson and answer the questions that follow.*

### B Cell Activation

Naïve B cells are activated by an antigen in the sequence of events shown in Figure below. A B cell encounters its matching antigen and engulfs it. The B cell then displays fragments of the antigen on its surface. This attracts a helper T cell (which you will read about below). The helper T cell binds to the B cell at the antigen site and releases cytokines. As you read in Lesson 1, cytokines are chemical signals used to communicate between cells. Cytokines from the helper T cell stimulate the B cell to develop into plasma cells or memory cells.




### Questions

1. What is the first step in the activation of a naïve B cell?

-

-

-

2. What is the second step in the activation process?

-

-

-

3. Define antigen display as illustrated in the above figure.

-

-

-

4. Describe the basis of the T cell binding to the B cell in the above figure.

-

-

-

5. What stimulates the maturation of B cells? What do mature B cells produce?

-

-

-

## Lesson 40.2: Multiple Choice

**Name**________________________________ **Class**____________ **Date**________

*Circle the letter of the correct choice.*

1. Transport of fatty acids occurs from the ____________ into the ____________.
   (a) small intestine, lymphatic system
   (b) blood, small intestine
   (c) skeletal muscle cells, small intestine
   (d) urinary tract, antigen
2. From the choices below, one possible cause of localized fluid accumulation in the tissues is

(a) too rapid transport of fatty acids from the intestine into the lymph.
(b) too rapid transport of fatty acids from the blood to the intestine.
(c) drinking more than 8 glasses of water in one day.
(d) damage to the lymph vessels such that they do not take up excess body fluids from the tissues.

3. Located behind the breast bone, this gland functions to mature T cells of the immune system
   (a) spleen.
   (b) thymus.
   (c) heart.
   (d) gall bladder.
4. Lymph drains into the bloodstream from the
   (a) intestine.
   (b) lymphatic ducts in the chest.
   (c) tonsils.
   (d) spleen.
5. Cells that display parts of a pathogen's proteins on their surface are called
   (a) red blood cells.
   (b) regulatory T cells.
   (c) antigen-presenting cells.
   (d) helper T cells.
6. Helper T cells
   (a) destroy pathogens.
   (b) make antibodies.
   (c) kill cancerous cells.
   (d) none of the above
7. Cells infected with a virus are
   (a) stimulated to divide by helper T cells.
   (b) making antibodies.
   (c) destroyed by cytotoxic T cells.
   (d) none of the above

## Lesson 40.2: Vocabulary

**Name**________________________________ **Class**____________ **Date**________

*Labeling a Diagram* In the diagram of the human lymphatic system, label the structures to which arrows point.

http://commons.wikimedia.org/wiki/File:Illu_lymphatic_system.jpg#filehistory

## 24.4 Lesson 40.3: Immune System Diseases

### Lesson 40.3: True or False

**Name**_______________________________ **Class**___________ **Date**________

*Write true if the statement is true or false if the statement is false.*

_________ 1. Inflammation of the skin can result from a bee sting.

_________ 2. An allergen is any antigen that causes an allergic reaction in a sensitive person.

_________ 3. A person is either allergic to many antigens, or to none.

_________ 4. All allergies are severe.

_________ 5. Histamines stimulate inflammation.

_________ 6. One symptom of an allergy can be itchy eyes.

_________ 7. Anaphylaxis is the most severe response to an allergen, and is potentially fatal.

_________ 8. An antidote to anaphylaxis is immediate injection of epinephrine.

_________ 9. HIV is an example of an autoimmune disease.

_________ 10. Multiple sclerosis is an example of an autoimmune disease.

_________ 11. Joint inflammation is a typical symptom of both Type I diabetes and multiple sclerosis.

_________ 12. Congenital immunodeficiency is usually caused by a mutation.

_________ 13. The absence of a thymus (thymic aplasia) results from a genetic defect.

_________ 14. People who have received an organ transplant often are treated with drugs that suppress their immune system.

_________ 15. People who have AIDS are susceptible to certain types of pathogens that don't often infect healthy people.

### Lesson 40.3: Critical Reading

**Name**_______________________________ **Class**___________ **Date**________

*Read this passage and answer the questions that follow.*

**Contact with Poison Ivy: A Classic Example of a Delayed Hypersensitivity Response**

Have you every heard the saying "Leaves of three, let them be?" That admonition refers to

Figure 24.2: (2)

poison ivy. Poison Ivy grows in the 48 contiguous states of the United States. Depending upon the particular variety and its environment, poison ivy can be a fuzzy, climbing vine, a short, trailside plant, or shrub-like. Leaves are arranged in groups of three. The exact shape and color of the leaves can vary (they can be green, green with a reddish tinge, shiny, or not). The variation in appearance is probably one reason why so many people brush against poison ivy without knowing. They then suffer from an intensely itchy red rash that results from contact with poison ivy's leaves or stems. Such a rash is a classic example of a delayed hypersensitivity response. This response is also a form of allergic contact dermatitis.

You may be wondering, what is it in poison ivy that causes the rash? Is poison ivy contagious? The answer to the first question is: urushiol, an oil that the plant makes, causes the angry red rash. People get the rash when they touch or brush up against part of the plant, and some of the urushiol gets transferred to their skin. Urushiol can also be transferred to garden tools, clothes, and pet fur. It can be inactivated with lots of soap and water. However, if you touch poison ivy you must wash it off immediately, since the hypersensitivity response begins in as little as a few minutes after exposure.

Now let's answer to the second question: is poison ivy contagious? If you touch someone who still has urushiol on their skin or clothes, or a pet who has urushiol on its fur, then yes, you can contract the poison ivy rash this way. However, if you touch a poison ivy rash on someone else, you will not get a rash.

*References:*

http://www.cdc.gov/niosh/topics/plants/

http://www.ipm.uconn.edu/IPM/homegrnd/htms/poisivy2.htm

Poison Ivy from http://www.cdc.gov/niosh/topics/plants/

**Questions**

1. Where is poison ivy found in the United States?

-

-

-

2. What does poison ivy look like?

-

-

-

3. What kind of immune response does poison ivy contact elicit (provoke) in sensitive individuals?

-

-

-

4. What is urushiol? What are some of its characteristics?

-

-

-

5. What are some strategies to prevent poison ivy?

-

-

-

## Lesson 40.3: Multipple Choice

**Name**______________________________ **Class**___________ **Date**________

*Circle the letter of the correct choice.*

1. Allergic symptoms of sneezing and itchy, watery eyes can often be treated effectively with

(a) aspirin.

(b) antibiotics.

(c) antihistamines.

(d) histamines.

2. In one type of immunotherapy used to treat allergic symptoms,

(a) the antigen is removed from the person's environment.

(b) all T cells are inactivated.

(c) a person is injected repeatedly over time with an allergen to which they are sensitive, with the goal of reducing the person's sensitivity to that allergen.

(d) the allergen is removed from a person's system.

3. Pollen from the ragweed plant (shown below)

(a) acts as an antihistamine.

(b) causes HIV.

(c) causes allergic rhinitis in sensitive individuals.

(d) most often causes joint pain.

4. Painful joints, caused by inflammation of the joints resulting from an immune system attack against the joint tissues typifies _____________.

(a) AIDS.

(b) delayed hypersensitivity response.

(c) type I diabetes.

(d) rheumatoid arthritis.

5. The autoimmune disease that results from the body attacking tissues such as the heart or lungs is called

(a) rheumatoid arthritis.

(b) type I diabetes.

(c) multiple sclerosis.

(d) systemic lupus erythematosus.

6. Treatment for type I diabetes includes

(a) elevation of the heart.

(b) a diet high in sugar.

(c) insulin, delivered as injections or through a pump.

(d) avoidance of exercise.

7. HIV results from

(a) destruction of helper T cells because of infection by the human immunodeficiency virus.

(b) an overactive immune system that persists for years.

(c) a bacterium found in contaminated water.

(d) all of the above

## Lesson 40.3: Vocabulary

**Name**______________________________ **Class**___________ **Date**________

*Match the vocabulary term with the correct definition.*

**Term**

______ 1. opportunistic diseases

______ 2. epinephrine

______ 3. HIV

______ 4. immunodeficiency

______ 5. allergic rhinitis

______ 6. acquired immunodeficiency

______ 7. AIDS

______ 8. antihistamines

______ 9. autoimmunity

______ 10. anaphylaxis

**Definition**

a. Acquired immune deficiency syndrome; a late stage in the progression of an HIV infection.

b. Diseases that occur when the immune system fails to recognize the body's own molecules as self and attacks the body's cells as though they were foreign invaders.

c. An allergic response in which there is a sudden, massive release of histamines throughout the body.

d. Drugs that reduce or eliminate the effects of histamines.

e. The "fight-or-flight" hormone that your adrenal glands normally produce when you are in danger.

f. A common immediate hypersensitivity reaction; affects mainly mucous membranes lining the nose; often called hay fever.

g. Infections and tumors rare in people with a healthy immune system but common in immunodeficient people.

h. Occurs when one or more components of the immune system are not working normally.

i. Immunodeficiency that occurs when immune function declines in a person who was born with a normal immune system.

j. The human immunodeficiency virus, the virus that causes AIDS.

## 24.5 Lesson 40.4: Environmental Problems and Human Health

### Lesson 40.4: True or False

**Name**________________________________ **Class**____________ **Date**________

*Write true if the statement is true or false if the statement is false.*

__________ 1. Chemicals in the environment are one cause of some cancers.

__________ 2. There is no link between air pollution and asthma.

__________ 3. Mutations in some genes can contribute to the development of cancer.

__________ 4. Since it is present in sunlight, ultraviolet radiation is not considered a carcinogen.

__________ 5. All viruses cause the same cancer.

__________ 6. Non-cancerous cells have lost the ability to regulate their cell cycles.

__________ 7. Damaged DNA can be repaired by the gene products of tumor-suppressor genes.

__________ 8. Oncogenes are mutated genes that have lost their normal, regulated function.

__________ 9. All tumors are cancerous.

__________ 10. Tumor removal by surgery is one strategy used to treat some cancers.

__________ 11. The Air Quality Index can vary between different geographical locations.

__________ 12. Ozone is a gas that can be hazardous to human health.

__________ 13. Some people are allergic to mold.

__________ 14. All agents of bioterrorism are spread through the air.

__________ 15. As of 2009, there have not yet been any acts of bioterrorism in the US.

### Lesson 40.4: Critical Reading

**Name**________________________________ **Class**____________ **Date**________

*Read this passage from the lesson and answer the questions that follow.*

**Cancer Treatment and Prevention**

Most cancers can be treated and some can be cured. The general goal of treatment is to remove the tumor without damaging the rest of the body. Cancer may be treated with a combination of surgery, chemotherapy, and/or radiation. In the past, chemotherapy drugs caused serious side effects. Many of today's chemotherapy drugs target specific molecules in tumors. This reduces damage to normal body cells and causes fewer side effects.

The outcome of cancer treatment depends on factors such as the type of cancer and its stage. The stage of cancer refers to the extent to which the cancer has developed. Generally, early diagnosis and treatment lead to the best chances of survival. That's why it's important for people to be aware of the following warning signs of cancer:

- A change in bowel or bladder habits
- A sore that does not heal
- Unusual bleeding or discharge from any place
- A lump in the breast or other parts of the body
- Chronic indigestion or difficulty in swallowing
- Obvious changes in a wart or mole
- Persistent coughing or hoarseness

Having warning signs of cancer does not mean that you have cancer, but you should see a doctor to be sure. Getting recommended tests for particular cancers, such as colonoscopies for colon cancer, can also help detect cancers early, when chances of a cure are greatest.

Many cancers can be prevented, or at least their risk can be reduced. You can help reduce your risk of cancer by avoiding specific carcinogens and maintaining a healthy lifestyle. Carcinogens you can avoid or limit your exposure to include tobacco smoke, sexually transmitted viruses, improperly cooked foods, and UV radiation. Other lifestyle choices you can make to reduce your risk of cancer include being physically active, eating a low-fat diet, and maintaining a normal weight.

**Questions**

1. What are three standard types of cancer treatment?

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2. What is meant by a stage of cancer?

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3. How does early diagnosis aid survival?

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4. Name 3 symptoms that may indicate cancer.

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5. How can you reduce your risk of developing cancer?

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## Lesson 40.4: Multiple Choice

**Name**_______________________________ **Class**___________ **Date**________

*Circle the letter of the correct choice.*

1. Which of the following is a potential carcinogen?
   (a) radon
   (b) hepatitis B virus
   (c) ultraviolet radiation
   (d) asbestos
   (e) all of the above
2. Carcinogens cause cancer by
   (a) inducing mutations that cause unregulated cell division of cells.
   (b) repairing mutations in DNA.
   (c) suppressing the division of cells that have damaged DNA.
   (d) none of the above
3. A tumor of connective tissues is classified as a
   (a) carcinoma.
   (b) sarcoma.
   (c) neuroma.
   (d) lymphoma.
4. The most common type of infant cancer is

(a) colorectal cancer.
(b) lung cancer.
(c) leukemia.
(d) bladder cancer.

5. ____________ air pollution is a human health problem

   (a) No
   (b) Outdoor
   (c) Indoor
   (d) Indoor and outdoor

6. One of the most dangerous bioterrorism agents is

   (a) cholera.
   (b) brucellosis.
   (c) ricin.
   (d) smallpox.

7. ____________ is a pathogen that has been used in a documented incident of bioterrorism in the US.

   (a) Smallpox
   (b) Cholera
   (c) Anthrax
   (d) Brucellosis

## Lesson 40.4: Vocabulary

**Name**________________________________ **Class**____________ **Date**________

*Match the vocabulary term with the correct definition.*

**Term**

______ 1. tumor-suppressor genes

______ 2. proto-oncogenes

______ 3. lymphoma

______ 4. tumor

______ 5. oncogene

______ 6. ozone

______ 7. carbon monoxide

______ 8. Sarcoma

______ 9. bioterrorism

______ 10. carcinoma

**Definition**

a. A gas that forms close to the ground when high concentrations of air pollutants are heated by sunlight.

b. A tumor of connective tissues, such as bone.

c. An abnormal mass of tissue.

d. A tumor of epithelial tissues, such as lung tissue.

e. A gas produced by cars, furnaces, and other devices that burn fuel; replaces oxygen in the blood and quickly leads to death.

f. Genes that normally repair damaged DNA or prevent cells with badly damaged DNA from dividing.

g. Terrorism by intentional release or spread of pathogens.

h. A tumor of lymphatic cells, such as T cells.

i. Genes that normally help regulate cell division.

j. A gene that, when mutated or expressed at high levels, helps turn a normal cell into a cancer cell.

# Image Sources

(1) Obli at en.wikipedia.
http://commons.wikimedia.org/wiki/File:Phagocytosis.png. CC-BY-SA.

(2) http://www.cdc.gov/niosh/topics/plants/.