



Your competence will be assessed as you complete the objective assessment (BPC2) for this course of study. This course of study may take you up to 21 weeks to complete.

## Introduction

**This course of study is aligned to the BPC2 objective assessment. The same study materials are utilized in the BPT2 performance assessment. If you have previously completed the BPT2 assessment, then you should have already completed the required study activities found in this course of study. You may wish to review the assignments here, but you are not required to repeat these activities. If you have not yet completed the BPT2 assessment, then please proceed through this course of study in full.**

### Overview

Welcome to the exciting topic of biology, which involves the study of all living things! Biology covers a broad range of topics, from the chemical processes that occur inside a cell's organelles to the climates of various biomes. As a science teacher, you will want to convey to your students how exciting the careers related to biology are.

The six main topics in biology include cellular biology, heredity, evolution, diversity of life, interdependence of life, and ecology. The topics are chunked into manageable sections of activities to complete. Be sure to check your understanding for each section. This practice will help you build on your knowledge. Model the behaviors you would want your students to practice when learning new material.

### Outcomes and Evaluation

There are 6 competencies covered by this course of study; they are listed in the ["Competencies for Interdisciplinary Biological Science \(BPT2\)"](#) page.

You will complete the following assessments as you work through the course of study.

#### Pre-Assessment

You will complete the following pre-assessment:

- PBPC

#### Objective Assessment

You will complete the following objective assessment:

- BPC2

For specific information about this assessment, select this course under the "Course Details" section of your Degree Plan.

#### Teaching Dispositions Statement

Please review the [Statement of Teaching Dispositions](#).



## Preparing for Success

The information in this section is provided to help you become ready to complete this course of study. As you proceed, you will need to be organized in your studies in order to gain competency in the indicated areas and prepare yourself to pass the final assessments.

### Your Learning Resources

Enroll in or order the learning resources for this course as early as possible so as to give them time to arrive and give you enough time to become familiar with them.

#### Automatically Enrolled Learning Resources

You will be automatically enrolled at the activity level for the following learning resources. Simply click on the links provided in the activities to access the learning materials.

#### VitalSource E-Texts

The following textbook is available to you as an e-text within this course of study. You will be directly linked to the specific readings required within the activities that follow.

- Campbell, N., & Reece, J. (2011). *Biology* (9th ed.). San Francisco, CA: Benjamin Cummings. ISBN-13: 978-0-321-69707-3.

*Note: These e-texts are available to you as part of your program tuition and fees, but you may purchase hard copies at your own expense through a retailer of your choice. If you choose to do so, please use the ISBN listed to ensure that you receive the correct edition.*

#### Thinkwell's Biology Online

You will access Thinkwell materials at the activity level within this course of study. This web-based resource includes multimedia video lectures, review notes, interactive animations, and sample exercises.

#### Enroll in Learning Resources

You will need to enroll in or subscribe to additional learning resources as a part of this course of study.

You may already have enrolled in these resources for other courses. Please check the "Learning Resources" tab and verify that you have access to the following learning resources. If you do not currently have access, please enroll or renew your enrollment at this time.

*Note: For instructions on how to enroll in or subscribe to learning resources through the "Learning Resources" tab, please see the ["Acquiring Your Learning Resources"](#) page.*

#### LabPaq

The "BioScience (Biology)" LabPaq from Hands-On Labs is a physical shipment. This lab kit (LabPaq) is covered by your program lab fee and is required to complete the performance assessment. You may have already enrolled for this resource through a different course. This kit includes the lab manual on a DVD, science equipment, specimens, supplies, and chemicals



necessary to complete biology laboratory experiments at home. The experiments reinforce science content and teach laboratory techniques.

### **AMNH Seminars (Optional)**

Discuss with your mentor which, if any, of the appropriate American Museum of Natural History (AMNH) online seminars are right for you. There are three seminars related to this course of study:

- "Genetics, Genomics, Genethics"
- "Evolution"
- "Diversity of Fishes."

These online resources use multimedia and discussions to connect teachers and future teachers from around the world to cutting-edge research, classroom resources, and each other. Participating in the seminars develops your understanding of the material, as well as models a teaching technique and exposes you to an array of resources available to help with lesson planning. Each six-week seminar requires about eight hours per week of your time. This is an optional learning resource. These resources have definite start and stop times for each seminar, so review the [AMNH Calendar](#) to determine when the courses are offered and consult with your mentor to coordinate these seminars with your schedule.

Discuss the [AMNH-WGU FAQ](#) with your mentor to better understand how to successfully use the AMNH courses as a WGU learning resource.

### **Additional Preparation**

There are many different learning tools available to you within your course of study in addition to the learning resources already discussed. Take the time to familiarize yourself with them and determine how best to fit them into your learning process.

#### **Message Boards, Study Notes, FAQs**

Message boards, study notes, and FAQs are available in every course of study.

Use the ["Additional Learning Tools"](#) page to review these tools.

#### **Course Mentor Assistance**

Course mentors are available to help you. Their job is to aid understanding in areas where you need to improve, and to guide you to the learning resources that will help you. Request their help as needed when preparing for assessments.

If you fail assessment attempts, go through the provided feedback first, then ask specific questions. Mentors cannot guarantee you pass as they do not evaluate assessments; however, they can provide the assistance and advice necessary to help you succeed.

#### **Acquire a Calculator**

Refer to the [Science Calculator Guidelines](#) for details regarding acceptable calculators.



This assessment only requires a basic calculator. However, to learn the material and to be a successful high school chemistry teacher, you need to be familiar with using a graphing calculator. It is recommended that all candidates in secondary science education programs obtain a TI-83+, TI-84+, or TI-Nspire (non-CAS) graphing calculator.

### **Pre-Assessment**

Take the pre-assessment now to evaluate your competence in the subject matter.

For directions on how to receive access to pre-assessments, see the ["Accessing Pre-Assessments"](#) page.

## **Biochemistry**

Biochemistry is the study of the molecules and chemical reactions that sustain life. It uses chemistry to explain the biological processes that happen at the molecular level. The basic principles of biochemistry are common for all living organisms. The further you go into your studies of biology, the more you will need to understand and rely on chemistry.

### **Unique Properties of Water**

Water molecules have the unusual characteristic of hydrogen bonding. Hydrogen bonding is the attraction of the partially positively charged hydrogen atoms of one water molecule with the partially negatively charged oxygen atoms of another water molecule. This unusual behavior creates properties of water that are essential for life.

### **Water and the Fitness of the Environment**

Read the following chapter in *Biology*:

- [chapter 3 \("Water and Life"\)](#)

This will provide you with a review of bonds related to water. In your notebook, draw water molecules showing two different types of bonds related to water. Explain how these bonds affect water's properties.

In your notebook, describe the characteristics of water and how these are helpful to living organisms. Write a brief explanation of why water is called the "miracle liquid." Provide examples of both hydrophilic and hydrophobic substances.

### **Properties of Water Lab**

Complete the following exercises in laboratory 6 ("The Properties of Water") of the General Biology LabPaq.

- exercise 1
- exercise 3
- exercise 4

After you complete the lab, send your lab report to the course mentor to receive feedback. These exercises are related to surface tension, density, and specific heat capacity



## Biochemical Functional Groups

Molecules, such as proteins, have functional groups that interact with the molecules' surroundings. This is an important feature as molecules interact with each other in the body. Enzymes bind to their substrate. Hormones bind to markers.

### Carbon and the Molecular Diversity of Life

Read the following in *Biology*:

- [chapter 4 \("Carbon and the Molecular Diversity of Life"\)](#)

In your notebook, write down the structure and properties of some important biochemical functional groups. As your guide, use figure 4.9 "Exploring Some Biologically Important Chemical Groups." You should be able to describe each of these chemical groups on your own.

## Macromolecules

In the previous section, you studied the properties of relatively simple molecules (such as water) and some basic organic functional groups. Properties of a molecule come from its physical structure.

In this section, you will expand your knowledge of macromolecules.

### Structure and Function of Macromolecules

During Life Science you studied macromolecules, but now you need to understand more details regarding these types of molecules.

#### Chemical Subunits

The bonding characteristics of carbon atoms result in many biological molecules. Each of the four main classes of biological molecules is built out of particular chemical subunits. Using the following in *Biology* as a resource, make a chart of biological molecules (carbohydrates, nucleic acids, proteins, and lipids) with two columns:

- [chapter 5 \("The Structure and Function of Large Biological Molecules"\)](#)

Put "Name of Molecule" as the heading for the first column and "Subunit" as the heading for the second column. Notice that the physical shape and structure of the molecule are related to its function.

#### Molecular Structure Review

Make a chart of biological molecules (e.g., simple and complex hydrocarbons) and macromolecules (e.g., polysaccharides, nucleic acids [DNA, RNA], proteins, starch, and lipids) with four columns.

Put "Name of Molecule" in the first column, "Structure" in the second column, and "Biological Function" in the third column. In the fourth column, write any interesting information that will help you remember the properties of the molecule. Notice that the physical shape of the molecule is related to its function.



## Specifics on Lipids and Carbohydrates

In the "Molecular Structure Review" activity you completed previously, you described the four main classes of macromolecules in general. Now you need to know more specifics.

Lipids include fatty acids, waxes, triglycerides, phospholipids, and steroids. Carbohydrates include monosaccharides, disaccharides, and polysaccharides.

In your notebook, describe the general structure and function of these specific molecules.

### Testing for the Presence of Macromolecules

Complete the following in the General Biology LabPaq:

- laboratory 1 ("Basic Chemistry for Investigating Living Systems")

Be sure to read through the entire lab, including the introduction. After completing this lab, send your lab report to the course mentor to receive feedback.

## Cellular Activities

Living organisms are made up of cells. Cells are made up of molecules. There are different types of cells that make up the various living organisms. In more complex organisms, cells work together and form tissues.

### Types of Cells

Work through the activities in this section to understand the various types of cells and the processes that occur in cells.

#### Eukaryotic Versus Prokaryotic Cells

Review your notes from [chapter 6 \("A Tour of the Cell"\)](#) of Biology regarding eukaryotic and prokaryotic cells.

Review the following Thinkwell Biology section:

- ["An Introduction to Cell Biology"](#)

Be sure to take the quiz after each step in the section to check your understanding. Check your notes for accuracy.

Complete the following in the General Biology LabPaq:

- exercise 1 in laboratory 2 ("Cell Structure and Function").

After completing this exercise in the lab, send your lab report to the course mentor to receive feedback.

#### Plant and Animal Cell Structure and Function



Complete the following in the General Biology LabPaq:

- exercise 2 in laboratory 2 ("Cell Structure and Function")

After completing this exercise in the lab, send your lab report to the course mentor to receive feedback.

Review [chapter 6 \("A Tour of the Cell"\)](#) of Biology.

Make a Venn diagram depicting the similarities and differences between plant and animal cells.

## **Cell Structure and Transport**

Work through the activities in this section to understand the various types of cells and the processes that occur in cells.

### **Membrane Structure and Function**

Read the following in *Biology*:

- [chapter 7 \("Membrane Structure and Function"\)](#)

For each component of the cell membrane, you should be able to describe its structure and function.

### **Passive Transport of Materials Through the Cell Membrane**

Review Section 7.3 "[Passive transport is diffusion of a substance across a membrane with no energy investment](#)". In your notebook, write down an explanation of passive transport, osmosis, and diffusion as it relates to cellular membranes.

Complete the following in the General Biology LabPaq:

- exercise 3 in laboratory 2 ("Cell Structure and Function")

After completing this exercise in the lab, send your lab report to the course mentor to receive feedback.

### **Active Transport of Materials Through the Cell Membrane**

Review Section 7.4 "[Active transport uses energy to move solutes against their gradients](#)". In your notebook, write down an explanation of active transport as it relates to cellular membranes.

Complete the following in the General Biology LabPaq:

- exercise 4 in laboratory 2 ("Cell Structure and Function")

Review the structure of the cell membrane and the terms hydrophilic and hydrophobic. After completing this exercise in the lab, send your lab report to the course mentor to receive feedback.





## Organelles

Complete the following Thinkwell Biology sections:

- ["The Cytoskeleton"](#)
- ["Membrane-Bound Organelles"](#)

Be sure to take the quiz after each step in these sections to check your understanding. Write notes in your lab notebook describing the functions of the important organelles (e.g., cell wall, endoplasmic reticulum, nucleus, Golgi complex, lysosome, vacuoles, mitochondria, plastids, chloroplasts, cytoplasm, flagella, centriole, and ribosomes). The various organelles work together to meet the needs of the cell. Plant cells are the only cells with chloroplasts. Bacteria cells are prokaryotic and do not have the membrane-bound organelles. All cells have ribosomes and can therefore make proteins.

## Biochemical Reactions

Numerous chemical reactions occur inside cells. All of these reactions require energy in the form of ATP and are regulated by enzymes.

In this section, you will better understand the role of ATP and the role of enzymes in regulating cellular reactions.

### How ATP Powers Cellular Work

ATP is the source of energy for activities in your body. The exothermic reaction of ATP to ADP + P is paired with an endothermic reaction.

#### ATP Powers Cellular Work

Read the following in *Biology*:

- [section 8.3 "ATP powers cellular work by coupling exergonic reactions to endergonic reactions"](#)

In your notebook, describe how ATP powers cellular work. Energy is stored within the bonds of molecules. In this case, the bond holding the last phosphate group is broken to release energy. Enzymes play a role in pairing the exothermic reaction of breaking down ATP with an endothermic reaction needing energy.

### Enzyme Regulation

Enzymes and inhibitors can affect the speed of biochemical reactions. You need to better understand how these reaction processes occur.

#### Enzyme Function

Complete the following Thinkwell Biology section:

- ["Enzymes"](#)

Be sure to take the quiz after each step in this section to check your understanding. Write notes





in your lab notebook as needed. In your notebook, make a series of drawings that show the basic action of enzymes as you work through this information.

### **Role of Enzymes**

Read the following sections in *Biology*:

- section 8.4 ["Enzymes speed up metabolic reactions by lowering energy barriers"](#)
- [section 8.5 "Regulation of enzyme activity helps control metabolism"](#)

Your goal is to understand how enzymes, coenzymes, and inhibitors are used to regulate metabolic pathways. In organisms, the exergonic reaction of ATP to ADP + P is paired with an endergonic reaction.

### **Drawing to Check Your Understanding**

In your notebook, draw your own illustration of endergonic and exergonic reactions. Draw a simple diagram of a lock-and-key model of an enzyme.

### **Enzyme-Facilitated Reactions**

Enzymes function best under certain conditions. In this lab, you will investigate how enzyme activity is affected by temperature, substrate concentration, and pH level.

Complete the following lab in the General Biology LabPac:

- laboratory 3 ("Enzymes")

Be sure to read through the entire lab, including the introduction. After completing this lab, send your lab report to the course mentor to receive feedback

### **Redox**

Oxidation refers to the loss of electrons, while reduction refers to the increase of electrons. Your goal here is to understand how redox is related to the reactions of respiration and photosynthesis.

### **Oxidation and Reduction**

Read the following in *Biology* to better understand the principle of redox as it applies to respiration:

- [section 9.1 "Catabolic pathways yield energy by oxidizing organic fuels"](#)

Reduction is related to the increase of electrons. Oxidation is related to the loss of electrons. During cellular respiration, NAD<sup>+</sup> functions as an oxidizing agent, and glucose is oxidized.

Read the following in *Biology* to better understand the principle of redox as it applies to photosynthesis:

- section 10.1 ["Photosynthesis converts light energy to the chemical energy of food"](#)



In this reaction, NADP<sup>+</sup> functions as an electron acceptor as carbon-dioxide is reduced. Be sure that you can apply oxidation and reduction to the biological processes of photosynthesis and respiration and that you can give net chemical reactions.

## Making ATP

In this section, you will better understand how cells convert the energy stored within the bonds of organic molecules to energy stored within the ATP molecule. Prokaryotes do not have mitochondria and are therefore limited in their capacity to make ATP, which is one factor which limits their size. Eukaryotes, on the other hand, are bigger cells than prokaryotes and have mitochondria that can mass produce ATP. Because of the ability to make larger quantities of ATP, eukaryotes are much more diverse than prokaryotes.

## Anaerobic and Aerobic Metabolism

Work through the activities in this section to understand the breakdown of glucose and to gain an understanding of the term metabolism.

### Introduction to Respiration

Complete the following Thinkwell Biology section:

- ["An Introduction to Respiration"](#)

Be sure to take the quiz after each step in this section to check your understanding. Write notes in your lab notebook as needed.

### Cellular Respiration

Read of the following in *Biology*:

- [chapter 9 \("Cellular Respiration: Harvesting Chemical Energy"\)](#)

Your goal is to understand the main steps to harvesting usable energy from glucose and where these steps occur in the cell.

In your notebook, describe the reactants and products of glycolysis, the citric acid cycle, and oxidative phosphorylation.

Answer the following:

- Which of these processes require oxygen?
- Where do these reactions occur in the cell?

### Fermentation

Review the following in *Biology*:

- [chapter 9 \("Cellular Respiration: Harvesting Chemical Energy"\)](#)

Your goal is to describe fermentation, which is an anaerobic process of producing ATP. During



anaerobic glycolysis, sugar is broken down into pyruvate molecules within the cytoplasm. Yeast cells can anaerobically convert pyruvate into ethanol and carbon dioxide to produce more ATP. When your muscle cells need ATP when no oxygen is present, they can convert pyruvate into lactic acid to make more ATP.

Explain to a peer the flow of energy through anaerobic respiration.

### **Respiration in Plants**

Complete the following in the General Biology LabPaq:

- exercise 3 in laboratory 4 (“Photosynthesis and Respiration”)

After completing this lab, send your lab report to the course mentor to receive feedback.

## **Primary Producers**

As part of the food chain, primary producers store energy in the form of organic molecules. Photosynthesis and chemosynthesis are processes that only primary producers can perform. An ecosystem is dependent on its primary producers to provide the initial source of energy for other organisms. From here, the entire food web can be formed and biodiversity increased.

### **Photoautotrophs**

During photosynthesis, light energy is stored within organic molecules using carbon dioxide as the carbon source.

#### **Introduction to Photosynthesis**

Complete the following Thinkwell Biology sections:

- ["Discovering Photosynthesis"](#)
- ["Adaptations for Photosynthesis"](#)

Be sure to take the quiz after each step to check your understanding. Write notes in your lab notebook as needed.

#### **Photosynthesis**

Read the following in *Biology*:

- [chapter 10 \("Photosynthesis"\)](#)

In your notebook, write down an overview of the stages of photosynthesis:

- electron transport reactions
- ATP synthesis
- the Calvin cycle

This chapter also describes the unique abilities of C3 and C4 plants. Take notes on these



sections. Appreciate that plant cells are involved in the process of cellular respiration as well as in photosynthesis.

In your notebook, draw a large plant cell with mitochondria and chloroplasts. Illustrate the stages of cellular respiration and photosynthesis as they would occur in this plant cell.

### **Chlorophyll Pigments**

Complete the following in the General Biology LabPaq:

- exercise 1 in laboratory 4 ("Photosynthesis and Respiration")

After completing this exercise in the lab, send your lab report to the course mentor to receive feedback.

### **Drawing to Check Your Understanding**

In your notebook, draw and label a diagram of chloroplasts in leaves. Next to your drawing, describe the structure of chloroplasts. You can then check your understanding by trying to recreate this diagram without looking at any resources.

### **Conversion of Light Energy to Food by Plants**

Complete the following in the General Biology LabPaq:

- exercise 2 in laboratory 4 ("Photosynthesis and Respiration")

After completing this exercise in the lab, send your lab report to the course mentor to receive feedback.

### **Chemoautotrophs**

During chemosynthesis, inorganic substances are oxidized and energy is stored within organic molecules using carbon dioxide as the carbon source.

### **Chemosynthesis**

Primary producers process energy from inorganic sources and create organic substances used by other organisms. For example, plants use photosynthesis to convert inorganic water and carbon dioxide into sugars with the help of sunlight's energy. Another example of a primary producer is found at hydrothermal vents on the ocean floor.

Read the following in Biology to learn more about how these chemoautotrophs perform chemosynthesis and prokaryotes that live in the harsh conditions found at hydrothermal vents:

- section 27.3 ["Diverse nutritional and metabolic adaptations have evolved in prokaryotes"](#)

Page 1162 in Biology has a picture of hydrothermal vents.

### **Cell Division**

In this section you will investigate mitosis and meiosis in more detail.



## **Meiosis Versus Mitosis**

In this topic, you will learn about the similarities and differences between meiosis and mitosis.

### **Introduction to the Cell Cycle**

Complete the following Thinkwell Biology section:

- ["An Introduction to the Cell Cycle and Mitosis"](#)

Be sure to take the quiz after each step in the section to check your understanding. Write notes in your lab notebook as needed.

### **Cell Cycle**

Read the following in *Biology*:

- [chapter 12 \("The Cell Cycle"\)](#)

In your notebook, describe the main phases of the cell cycle, including a description of the main phases of mitosis. Draw a labeled picture for each phase of mitosis.

### **Mitosis Lab**

Complete the following in the General Biology LabPaq:

- exercise 1 in laboratory 5 ("Mitosis and Meiosis")

After completing this exercise in the lab, send your lab report to the course mentor to receive feedback.

### **Introduction to Meiosis**

Complete the following Thinkwell Biology section:

- ["Meiosis"](#)

Be sure to take the quiz after each step in this section to check your understanding. Be sure you understand the genetic significance of haploid and diploid cells.

### **Meiosis and Sexual Life Cycles**

Complete the following Thinkwell Biology section:

- ["Understanding Meiosis"](#)

Be sure to take the quiz after each step in this section to check your understanding.

Read the following in *Biology*:

- [chapter 13 \("Meiosis and Sexual Life Cycles"\)](#)



In your notebook, explain how genetic diversity of offspring is possible.

## **Meiosis Lab**

Complete the following in the General Biology LabPaq:

- exercises 2 and 3 in laboratory 5 ("Mitosis and Meiosis")

After completing these exercises in the lab, send your lab report to the course mentor to receive feedback.

## **Genes**

In this section, you will study various inheritance patterns that enable scientists to predict the outcomes of crosses and analyze how traits are passed on.

## **Inheritance Patterns**

With the current knowledge of genetics, it is possible to analyze the inheritance of characteristics.

### **Mendelian Inheritance**

Complete the following Thinkwell Biology sections:

- ["Laws and Probability"](#)
- ["The Laws of Mendelian Inheritance"](#)
- ["Segregation and Independent Assortment"](#)

Be sure to take the quiz after each step in these sections to check your understanding.

Read the following sections in *Biology*:

- [section 14.1 "Mendel used the scientific approach to identify two laws of inheritance"](#)
- [section 14.2 "The laws of probability govern Mendelian inheritance"](#)

In your notebook, describe how Mendel derived his laws of inheritance.

### **Punnett Squares**

[Section 14.3](#) in *Biology* describes how to use Punnett squares to make predictions.

Complete the genetics problems at the end of [chapter 14 \("Mendel and the Gene Idea"\)](#) in *Biology* to practice making predictions.

### **Dominance Types**

When first working with Punnett squares, you should usually start with the traits that show complete dominance, causing the heterozygotes to display the dominant trait.

Review the following in *Biology* to understand the effects of codominance, incomplete dominance, and multiple alleles:



- [section 14.3 "Inheritance patterns are often more complex than predicted by simple Mendelian genetics"](#)

[Section 14.3](#) also describes the circumstance of multiple genes affecting a trait.

Read the following in *Biology* to better understand the effects of sex-linked genes:

- section 15.2 ["Sex-linked genes exhibit unique patterns of inheritance"](#)

Complete the genetics problems at the end of [chapter 15 \("The Chromosomal Basis of Inheritance"\)](#) in *Biology* to practice making predictions.

### **Pedigree Analysis**

Section 14.4 ["Many human traits follow Mendelian patterns of inheritance"](#) in *Biology* describes how to analyze pedigrees. There is a genetics problem on page 285 to help you practice this analysis.

Complete the following Thinkwell Biology section:

- ["Sex Linkage and Pedigree Charts"](#)

### **Human Karyotype**

A karyotype illustrates that sexually-reproducing organisms have two complete sets of chromosomes. One set was given by the father, and one set was given by the mother.

Page 250 of *Biology* has a picture of a normal human karyotype. Notice that the chromosomes are numbered, number one being the biggest chromosome.

Genetic testing can examine a person's karyotype. [Section 15.4 "Alterations of chromosome number or structure cause some genetic disorders"](#) in *Biology* describes chromosomal alterations that can be detected by examining a karyotype.

### **Learned Characteristics**

Traits found in DNA are considered inherited traits and can be passed on to the next generation genetically. Learned characteristics are determined after birth through environmental experiences. These two, inherited traits and learned characteristics, are often discussed as "nature versus nurture."

[Section 51.2 "Learning establishes specific links between experience and behavior"](#) in *Biology* describes learned characteristics. In your notebook, compare and contrast inherited traits with learned characteristics.

## **DNA and RNA**

DNA holds the code for making the various proteins needed for cellular function. This coding is passed on to the next generation. Scientists have discovered that different organisms have the





same genetic coding, which uses the A,C,G,T bases. If a human gene is inserted into a bacteria's DNA, the bacteria can read the code and make the corresponding protein.

In this section, you will first investigate the rules associated with the genetic code, and then the technological advances possible based on this understanding.

## **Structure and Role of DNA and RNA**

DNA is an example of a macromolecule. The "NA" stands for nucleic acid. Hydrogen bonds keep the two halves of DNA "zipped" together.

### **Replication of DNA**

Complete the following Thinkwell Biology sections:

- ["Introduction to DNA Replication"](#)
- ["Events of DNA Replication"](#)

Be sure to take the quiz after each step to check your understanding. Write notes in your lab notebook as needed.

View the animation of DNA replication within Thinkwell by clicking on "Animations" from the left-hand column and then choosing "DNA Replication."

[Section 16.2 "Many proteins work together in DNA replication and repair"](#) of *Biology* also reviews this information. In your notebook, draw a storyboard showing the steps in DNA replication.

### **RNA Versus DNA**

In your notebook, draw a Venn diagram comparing RNA and DNA.

### **Base Pairing Rules**

During transcription and translation, base pairing rules are significant. In your notebook, draw pictures to show the base pairing rules in effect during transcription as the mRNA is formed. Also, draw pictures to show the base pairing rules in effect during translation, as the tRNA pairs with mRNA to make the protein.

## **Process of Protein Synthesis**

Protein synthesis occurs during translation at the ribosome.

### **Protein Synthesis**

Complete the following Thinkwell Biology sections:

- ["Translation"](#)
- ["Protein Synthesis Review"](#)

Be sure to take the quiz after each step in these sections to check your understanding.

Read the following in *Biology*:



- [chapter 17 \("From Gene to Protein"\)](#)

In your notebook, describe the process of protein synthesis, starting with RNA.

### **Codons**

Describe the genetic code with reference to the structure, number, and function of various codons.

### **Mutagens**

Some environmental factors can cause mutations. Some mutations can have no effect on the organism, while others create more recognizable changes.

Review mutagens in [section 17.5 "Mutations of one or a few nucleotides can affect protein structure and function"](#) of *Biology*. In your notebook, describe some causes of mutations.

### **How Viruses Can Effect DNA**

Work through the activities in this section to understand how viruses depend on cells for the energy and raw materials they need to reproduce.

### **Bacteria Cells Versus Viruses**

Complete the following Thinkwell Biology section:

- ["Viruses and Prions"](#)

Be sure to take the quiz after each step in this section to check your understanding. Write down the differences between bacteria cells (prokaryotes) and viruses.

### **How Viruses Reproduce**

Read the following in *Biology*:

- [chapter 19 \("Viruses"\)](#)

Describe how viruses use their host. Compare and contrast the lytic and lysogenic cycles of viral reproduction.

### **Biotechnology**

DNA can be manipulated to make useful products. Biotechnology has benefitted agriculture, health, and the environment.

### **Recombinant DNA Techniques**

The term recombinant DNA refers to the recombining of DNA segments in a new way. Restriction enzymes cut DNA at certain points, creating "sticky" ends. DNA ligase connects DNA segments.

To gain a better understanding of these techniques, read the following in *Biology*:

- [section 20.1 "DNA Cloning yields multiple copies of a gene or other DNA segment"](#)



## DNA Cloning Using Bacteria

Often, mass quantities of a gene are wanted. Bacteria have a plasmid, which is a circular form of DNA. Fortunately, the same genetic coding used in human cells is also used in other organisms. When a human gene is placed within a bacterial plasmid, the bacteria will reproduce as normal, including the new section of DNA.

To better understand this process, examine the following in *Biology*:

- [figure 20.4](#)

## Gene Therapy

Read the following in *Biology* to better understand the biotechnology techniques used in gene therapy:

- [section 20.4 "The practical applications of DNA technology affect our lives in many ways"](#)

## PCR

Another way of multiplying DNA is with the technique called polymerase chain reaction (PCR).

To better understand this process, examine the following in *Biology*:

- [figure 20.8](#)

## The Evolution of Populations

Variety within a population is beneficial to the survival of the population. Environments change, and if there is variety in a population, then it is more likely that some will be suited to survive in the new environment.

## Mechanisms of Evolution

Complete the activities in this section to understand how life has changed over time.

### Adaptations

Read the following in *Biology*:

- [chapter 22 \("Descent with Modification: A Darwinian View of Life"\)](#)

As the beginning of chapter 22 in *Biology* describes, evolutionary adaptation is an accumulation of inherited characteristics that enhance organisms' ability to survive and reproduce in specific environments.

In this section, focus on the specific illustrations of how organisms are adapted to their environment, both on land and in water.

As you read, take notes on how organisms have adapted to their environments, including



aquatic environments.

### **Evidence**

Complete the following Thinkwell Biology section:

- ["Evidence for Evolution"](#)

Be sure to take the quiz after each step to check your understanding.

In your notebook, describe the evidence showing that life has changed over time. For example, the homologous structures of different mammals.

### **Genetic Material**

[Section 17.1 "Genes specify proteins via transcription and translation"](#) in *Biology* discusses the genetic code. At the end of this section, there is a discussion on the evolution of the genetic code. Plants and animals contain the same genetic code, which is evidence for a common ancestor.

### **Importance of the Hardy-Weinberg Law**

A gene pool consists of all the alleles in a population. Individuals possess two alleles for a trait. Given certain conditions, the Hardy-Weinberg law states that the frequencies of alleles in a population will remain constant.

### **Variation**

Complete the following Thinkwell Biology section:

- ["Variations in Populations"](#)

Be sure to take the quiz after each step in this section to check your understanding. In your notebook, write down the role of natural selection on species variation.

Then read the following in *Biology* to better understand this concept:

- [section 23.1 "Genetic variation makes evolution possible"](#)

### **Hardy-Weinberg Theory**

Complete the following Thinkwell Biology section

- ["The Hardy-Weinberg Theory"](#)

Be sure to take the quiz after each step in this section to check your understanding.

Then read the following in *Biology* to better understand this concept:

- [Section 23.2 "The Hardy-Weinberg equation can be used to test whether a population is evolving"](#)



The importance of the Hardy-Weinberg equation is discussed at the end of this section. For example, the percentage of carriers in a population can be determined using the Hardy-Weinberg equation. In your notebook, describe the Hardy-Weinberg theory and its importance.

### **Adaptive Genetic Change**

Complete the following lab in the General Biology LabPaq:

- laboratory 13 ("The Hardy-Weinberg Principle")

After completing this lab, send your lab report to the course mentor to receive feedback.

## **Evolution**

In this section, you will focus on specific cases that cause populations to change over time.

### **Genetic Drift**

Read the following in *Biology* to learn more about genetic drift:

- [section 23.3 "Natural selection, genetic drift, and gene flow can alter allele frequencies in a population"](#)

Sudden changes in the environment can drastically change populations. In your notebook, explain how this happens.

### **Different Magnitudes of Evolution**

Read the following in *Biology*:

- [chapter 24 \("The Origin of Species"\)](#)

In your notebook, compare and contrast microevolution, macroevolution, and speciation.

### **Value of Sexual Reproduction**

Reflecting on your reading of [section 23.1 "Genetic variation makes evolution possible"](#), write down how sexual reproduction can increase variation within a species.

## **Phylogeny**

As populations change, a new species might emerge. There has been much evidence collected over time regarding all the different species that have existed on earth. Scientists then try to create a time line of events regarding life on earth; DNA analysis has provided more information regarding the relationship between species.

In this section you will investigate the different methods used to organize the vast amount of information that now exists regarding the history of life on earth.

## **Classification**

There are many organisms living on Earth. Scientists have studied these organisms' characteristics in order to classify living organisms into groups.



## Classification

Complete the following Thinkwell Biology sections:

- ["Classifying Life"](#)
- ["Classifying Earth's Organisms"](#)

These are part of the "Biology of Organisms" chapter. Be sure to take the quiz after each step in these sections to check your understanding. Write notes in your lab notebook as needed.

In your notebook, describe the basis for the three-domain system.

### Linnaean Taxonomic System

Read the following in *Biology*:

- [section 26.1 "Phylogenies show evolutionary relationships"](#)

Carolus Linnaeus based his classification on the resemblances of organisms. Now that DNA can be compared between organisms, the limitations of this system can be figured out. Organisms may have similar features and yet have had very different evolutionary paths. Binomial nomenclature is used for naming organisms.

As you can see from [figure 26.3](#) in *Biology*, domain is the largest group, to which kingdoms belong. In your notebook, explain how phylogeny is used in classification.

### Homologous and Analogous

Read the following in *Biology*:

- [section 26.2 "Phylogenies are inferred from morphological and molecular data"](#)

In your notebook, distinguish between homologous and analogous structures. As a reminder, homologous structures were described in more detail in [chapter 22](#).

### Phylogenetic System

Read the following in *Biology* to understand how to classify organisms using the phylogenetic system:

- [section 26.3 "Shared characters are used to construct phylogenetic trees"](#)

While working in this section, be sure you can interpret cladograms.

After working through this course, you will be able to describe the organization of living organisms from ecosystems to the inside of cells.

### Eukaryotic Organisms

Complete the following Thinkwell Biology sections



- ["Protists"](#)
- ["Fungi"](#)
- ["Plants"](#)

In your lab notebook, describe the characteristics of protists, which are one-celled eukaryotic organisms.

Also describe the characteristics of these multicellular groups of organisms: plants, fungi, and animals. Plants and animals are covered in more detail in later sections in this course of study.

## **Geologic Time**

Fossils have been found around the world, providing evidence of organisms that no longer inhabit Earth. Footprints are considered a type of fossil..

Due to plate tectonics, the strata that fossils are in can shift. Scientists studying fossils also have to understand some geology to properly interpret the significance of the fossil.

### **The Geologic Time Scale**

Complete the activities in this section to better understand when the different forms of life first appeared on Earth.

#### **Origin of Life**

Complete the following Thinkwell Biology section:

- ["The Origin of Life"](#)

Be sure to take the quiz after each step in this section to check your understanding.

Read the following section in *Biology*:

- [section 25.1 "Conditions on early Earth made the origin of life possible"](#)

Write notes in your lab notebook related to how life might have begun in the water during the early stages of Earth's atmosphere.

#### **Major Divisions**

[Table 25.1 within section 25.3](#) in *Biology* depicts the approximate dates of the major divisions of the modern geologic time scale. Precambrian refers to the time period before the start of the Cambrian time period, which would be any time before 542 million years ago. In your notebook, state the time periods for the following divisions:

- Precambrian
- Paleozoic era and periods
- Cenozoic era, periods, and epochs

Place important events within a geologic time frame (e.g., first land plants, first vertebrates, first





gymnosperms, extinction of the dinosaurs).

### **Extinction**

[Section 25.4 "The rise and fall of groups of organisms reflect differences in speciation and extinction rates"](#) in *Biology* outlines evidence for mass extinctions that have occurred.

Complete the following Thinkwell Biology subsection within the section "Fossils and Evolution":

- ["Mass Extinctions: An Asteroid Can Ruin Your Day"](#)

Extinction provides an open niche for new species to fill. Consequently, biodiversity has the opportunity to increase after a niche is opened for new species. In your notebook, write down causes for extinction.

### **Major Fauna and Flora**

In your notebook, describe the Paleozoic, Mesozoic, and Cenozoic fauna and flora (especially dominant species), and identify samples from important taxa. For example, dinosaurs are an important fauna of the Mesozoic Era.

### **The Fossil Record**

Complete the activities in this section to better understand how to interpret various fossils.

#### **Types of Fossils**

Complete the following Thinkwell Biology subsections within the section "Fossils and Evolution":

- ["Fossil Formation, Dating, and Indexing"](#)
- ["The Fossil Record"](#)

[Figure 25.4](#) in *Biology* illustrates different fossils.

Complete the following lab in the General Biology LabPaq:

- laboratory 10 ("The Fossilization Process")

After completing this lab, send your lab report to the course mentor to receive feedback.

In your notebook, describe:

- different ways preservation can take place, as described within the lab
- the use of indexing to age fossils

### **Prokaryotes to Eukaryotes**

Read the following in *Biology* to learn more about the oldest known fossils:

- [section 25.3 "Key events in life's history include the origins of single-celled and multicelled organisms and the colonization of land"](#)



In your notebook, describe the following:

- stromatolites
- the endosymbiont theory
- the complexity of organisms and the biodiversity during the cambrian explosion
- significance of the Ediacaran fauna

### **Examining Fossil Evidence**

Complete the following lab in the General Biology LabPaq:

- laboratory 12 ("Life through Time")

After completing this lab, send your lab report to the course mentor to receive feedback.

### **The Geologic Record**

Biologists should be able to interpret geologic maps. For example, the physical features of the Earth can help explain why organisms might be isolated.

### **Geologic Cross Sections**

Complete the following lab in the General Biology LabPaq

- laboratory 7 ("The Large Scale: Stratigraphy and Relative Age Dating")

After completing this lab, send your lab report to the course mentor to receive feedback. Your goal is to interpret various diagrams which depict the changing rock layers. To properly interpret the significance of a fossil, an understanding of rock layering and geological faulting is needed. In your notebook, explain the importance of unconformities and faulting to understanding the fossil record.

### **Interpreting Maps**

Complete the following in the General Biology LabPaq:

- laboratory 8 ("Geologic Maps")

[Figure 25.13 "Earth's major tectonic plates"](#) on page 520 in *Biology* shows the movement of Earth's plates.

Your goal is to interpret geologic maps and geologic cross-sections.

After completing this lab, send your lab report to the course mentor to receive feedback.

### **Applying Knowledge of Maps**

Complete the following lab in the General Biology LabPaq:

- laboratory 9 ("Coal, Oil, and Gas")



After completing this lab, send your lab report to the course mentor to receive feedback.



## Major Steps in the Evolution of Primates and Hominids

Complete the activities in this section to better understand the major steps in the evolution of primates and hominids.

### Human Evolution

Complete the following Thinkwell Biology section:

- ["Human Evolution"](#)

Be sure to take the quiz after each step in this section to check your understanding.

Read the following in *Biology*:

- [section 34.8 "Humans are mammals that have a large brain and bipedal locomotion"](#)

In your notebook, describe major steps in the evolution of primates and hominids.

### Common Decent

Complete the following lab in the General Biology LabPaq:

- laboratory 11 ("Evolution")

After completing this lab, send your lab report to the course mentor to receive feedback.

## Animals and Plants

Animals and plants have a variety of structures to meet their needs. Animals and plants are complex organisms. Both plants and animals have specialized cells that are organized into tissues. Both plants and animals have specialized structures to help the organisms survive.

### Plant and Animal Tissues

Complete the activities in this section to better understand tissues.

#### Plant Tissues

[Section 35.1 "Plants have a hierarchical organization consisting of organs, tissues, and cells"](#) in *Biology* describes three plant tissues: dermal, vascular, and ground. In your notebook, describe the different types of plant tissues.

Complete the following in the General Biology LabPaq:

- exercise 2 in laboratory 6 ("The Properties of Water")

This lab demonstrates the capillary action of vascular tissue. After completing this exercise in the lab, send your lab report to the course mentor to receive feedback.

#### Animal Tissues

[Section 40.1 "Animal form and function are correlated at all levels of organization"](#) in *Biology*



describes animal tissues. In your notebook, describe the different types of animal tissues.

## **Major Systems in Plants and Animals**

In this section, you will investigate the structures that organisms have to perform various functions.

### **Diverse Structures of Plants**

Read and review the following in *Biology*:

- [chapter 29 \("Plant Diversity I: How Plants Colonized Land"\)](#)
- [chapter 30 \("Plant Diversity II: The Evolution of Seed Plants"\)](#)
- [chapter 35 \("Plant Structure, Growth, and Development"\)](#)

In your notebook, describe the structures, components, and functions of the major systems in plants.

These chapters also illustrate the life cycles of some plants. Describe these life cycles in your notebook.

### **Invertebrate Structures**

Some invertebrate animals have exoskeletons for support (such as lobsters) while others use the properties of water to support their bodies (such as squid).

Read the following in *Biology*:

- [chapter 33 \("An Introduction to Invertebrates"\)](#)

In your notebook, describe the structures, components, and functions of the major systems in invertebrates. This chapter also illustrates the life cycles of some invertebrates. Describe some of these varied life cycles in your notebook.

### **Vertebrate Structures**

Vertebrate animals have skeletons for support. Read the following in *Biology*:

- [chapter 40 \("Basic Principles of Animal Form and Function"\)](#)

In your notebook, describe the structures, components, and functions of the major systems in vertebrate animals.

## **Stages of Embryonic Development**

Animals start off as one cell, called a zygote. Cells divide and undergo specialization during development.

### **Key Stages**

Read the following in *Biology* to learn the stages of embryonic development:

- [section 47.1 "Fertilization and cleavage initiate embryonic development"](#)



In your notebook, name and describe the principal stages in embryonic development (fertilization, cleavage, gastrulation, and organogenesis).

## **Populations Within a Community**

When populations are interacting with each other, it is called a community. When focusing on the living organisms within an ecosystem, you can see that there are several communities within an ecosystem.

### **Population Dynamics**

Population sizes often show some fluctuation.

#### **Variations in Population Size**

Read the following in *Biology*:

- [chapter 53 "Population Ecology"](#)

Define population dynamics in terms of changes in size, density, dispersion, and age distribution in response to environmental change.

In your notebook, define exponential population growth. Discuss the history of global human population size and projections for the future. What societal issues are related to human population growth? Describe the importance of the predator-prey relationship in the functioning of an ecosystem.

### **A Community's Interactions and Their Importance**

Work through the activities in this section to understand community ecology.

#### **Interdependence Within a Community**

Complete the following Thinkwell Biology section:

- ["Community Ecology: Interspecific Interactions"](#)

Be sure to take the quiz after each step in these sections to check your understanding. Write notes in your lab notebook as needed.

Read the following in *Biology*:

- [Section 54.1 "Community interactions are classified by whether they help, harm, or have no effect on the species involved"](#)

In your notebook, explain types of interspecific competition, symbiosis, parasitism, commensalism, and mutualism, and how organisms may serve certain functions (ecological niches).

In your notebook, describe the defenses or survival adaptations (e.g., protective coloration and production of toxic chemicals) some organisms use against parasites and against predation.

#### **Coevolution**



Review page 806 in *Biology* to better understand coevolution.

Define coevolution and include an example in your notebook.

### **Succession**

After a forest fire, the recolonization of species in the forest is somewhat predictable. This predictability is possible because of an understanding of ecological succession. Review the following in *Biology*:

- [section 54.3 "Disturbance influences species diversity and composition"](#)

In your notebook, define and describe the stages of ecological succession.

## **Ecological Issues**

The biotic and abiotic components of the environment constantly interact. The oxygen in the atmosphere is considered abiotic, but after it is breathed in, the oxygen is considered biotic as the atoms are reconfigured inside of organisms. There is interdependence between all components of the environment.

### **Nutrient Cycles**

Nutrients are continually circulating between the biosphere, lithosphere, atmosphere, and hydrosphere.

### **Limitations of an Ecosystem**

A rain forest has many more organisms than a desert. Primary productivity plays a role in this difference.

Read the following in *Biology*:

- [chapter 55 "Ecosystems and Restoration Ecology"](#)

In your notebook, define net primary production and primary productivity. Explain how it limits the number of organisms in an ecosystem.

### **Biogeochemical Cycles**

Complete the following Thinkwell Biology section:

- ["Chemical Cycling in the Ecosystem"](#)

Be sure to take the quiz after each step in this section to check your understanding.

Explain how phosphorous, sulfur, carbon, nitrogen and trace elements, such as iron, are cycled between living and nonliving parts of an ecosystem, as well as globally.

From your reading of [chapter 55 "Ecosystems and Restoration Ecology"](#) in *Biology*, make note of the main reservoirs for each nutrient.





The hydrosphere on Earth allows life to exist. Water molecules are continually circulating; explain how water is recycled globally and in the ecosystem.

### **Nutrients for Plants**

The cycling of nutrients in an ecosystem is important. Ultimately, plants use sunlight's energy to convert inorganic nutrients into organic molecules.

Using section 37.2 "[Plants require essential elements to complete their life cycle](#)" in *Biology* as a guide, differentiate between macronutrients and micronutrients.

### **Effects of Human Activity on the Environment**

Human activities have an effect on the environment. Advances in health and medicine allow for human life spans to increase.

#### **Effects of Human Activity**

Complete the following Thinkwell Biology section:

- ["Human Effect on the Ecosystem"](#)

Be sure to take the quiz after each step in this section to check your understanding.

Read the following in *Biology*:

- [chapter 56 "Conservation Biology and Global Change"](#)

In your notebook, discuss the effects of human activity on land fertility, aquatic viability, and sources of pollution.

Ozone in the stratosphere protects Earth from ultraviolet light. When closer to Earth, however, ozone is considered a form of pollution. In your notebook, describe the location and importance of the ozone layer. Explain the probable cause for the recent depletion of the stratospheric ozone layer.

### **Protecting Our Ecosystems**

Members of an ecosystem each serve a role allowing the ecosystem to thrive. Decomposers break down material supplying nutrients to the soil, thereby allowing plants to survive. Plants, in turn, are a food source for numerous animals. If the balance within an ecosystem is disturbed, the impact can be profound.

#### **Introduced Species**

The movement of human populations around the globe has increased the likelihood of species being introduced into new habitats.

Reflecting on your reading of chapter 56 in *Biology*, discuss the problems related to humans transporting species into a new habitat.

#### **Land Use**



Reflecting on your reading of chapter 56 in *Biology*, identify methods of land use and management in your notebook.

### **Habitats and Humans**

Complete the following lab in the General Biology LabPaq:

- laboratory 14 ("Habitats and Humans")

After completing this lab, send your lab report to the course mentor to receive feedback.

## **Final Steps**

Congratulations on completing the activities in this course of study! This section will guide you through the assessment process.

### **Final Review**

The following activities will help you prepare for and gauge your preparedness for the final assessment.

#### **Final Review Activities Before the Final Assessment**

As a science teacher, you should comprehend how these topics are related to each other and how biology is related to the other branches of science.

Consider the following;

- How is cellular biology important to the understanding of heredity?
- How is heredity important to the diversity of life and to evolution?
- How are the interdependence of life and ecology related?
- How is chemistry important to the study of biology?

Create a concept map that shows how all of these topics are related. Share the connections you made with your students.

Consider the unifying concepts that are demonstrated in biology:

- How are systems, order, and organization important in biology?
- How are evidence, models, and explanation used in the study of biology? How is measurement used to determine constancy and change?
- What is the importance of form and function?

Try coming up with one or two examples for each of these unifying concepts.

During your studies, you performed hands-on labs to apply your new knowledge. What strategies helped you learn the material? Write these down and share them with your students when you are teaching.

### **Assessing Pre-Assessments**



For directions on how to receive access to pre-assessments, see the "[Accessing Pre-Assessments](#)" page.

Once you have confidence with your new knowledge, take the pre-assessment again. Schedule the exam after passing the pre-assessment.

## **Assessment Information**

You now need to demonstrate your competency in biology by passing the objective exam and performance assessment.

### **Accessing Pre-Assessments**

Complete the following pre-assessment:

- PBPC

For directions on how to receive access to pre-assessments, see the "[Accessing Pre-Assessments](#)" page.

### **Accessing Objective Assessment**

Complete the following objective assessment:

- BPC2

For directions on how to receive access to objective assessments, see the "[Accessing Objective and Outside Vendor Assessments](#)" page.

## **Feedback**

WGU values your input! If you have comments, concerns, or suggestions for improvement of this course, please submit your feedback using the following form:

- [Course Feedback](#)

## **ADA Policy**

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- [Policies and Procedures for Students with Disabilities](#)